NOXOLO S.P. DLAMINI

PhD PROGRAMME

TOPIC:

Social Informatics perspective as an integrative Design Method for Information Systems Technology and Business Intelligence and Analytics: A Critical Realist Study

Student Number: 692344

Supervisor: Louise Whittaker

Wits Business School

ABSTRACT

This study contends that Information Systems and Technologies (ISTs) fail to adequately provide for effective delivery of Business Intelligence and Analytics (BIA), which limits the value that organisations can derive from their data assets. In spite of the influence that each has on the other and their widely acknowledged and undisputed relationship and interdependencies, design and development approaches still promote a silo approach to IST and BIA in theory and practice. The evolution of the role of data in the digital economy not only compels academics and practitioners to collaborate on how to enable creation of good quality data at source but intensifies the requirement for an integrated approach to IST and BIA design.

The research problem that the study addresses is that design methods commonly employed in both Information Systems (IS) research studies and practice do not advocate for an integrated approach to design and development of IST and BIA. While IS research accounts for both IST and BIA, IST and BIA design and development studies are approached independently and/or in isolation, with limited integration.

The effectiveness of Social informatics (SI) as an interdisciplinary study of design, uses and consequences of use, puts it above the rest of the commonly applied socio-technical design theories and approaches. SI's strength is in studying designs, uses and consequences of IST use after implementation. However, the theory versus practice inconsistencies presented by the interpretivist paradigm, which is an underpinning philosophy for classical SI, limit its use as a design method. Critical Realism (CR) offers the research study a viable alternative and is crucial in addressing both contextual requirements, while embracing the positivist, deterministic aspects of the study. CR is a pluralist approach based on sound research method principles; hence the study adopted it as both the theoretical paradigm and research method. The research study objective is to reconceptualise the SI perspective as an integrative design method underpinned by CR.

The study adopts CR as its research methodology. CR is a philosophy of science that allows for the pluralistic approach to operationalisation of the research strategy, a catalyst in

addressing the paradigmatic challenges of the research study. The ability to address the qualitative realist requirements of the study while effectively dealing with the positivist characteristics of the research was crucial in ensuring comprehensive results. The insights which could only be effectively gained through a qualitative realist process of enquiry were invaluable in advancing the IST and BIA design knowledge and practice.

CR's strength in focusing the research practice on the complexities of the real world is a critical enabler for an open system discipline such as IS. It ensures that the research is placed within the realist context of time, space and culture.

CR is effective in allowing the researcher to explain the mechanisms that influence the social actor action at different levels of social organisations. It allows for the identification of non-deterministic tendencies in a complex, multidisciplinary and open system such as IS. It not only accounts for the varying social actor requirements at empirical level but reveals possible underlying causes and relationships of the observable or non-observable events and/or activities at play. This approach to analysis of IST and BIA requirements offers a unique ability to frame problems in meaningful and social actor-centred ways, at all levels of social organisation, enabling design and development of IST that are BIA centric. The development of new knowledge advances the field of IS design, a crucial step towards offering practitioners with a practical, structured and integrative design method.

The critical realist approach is the most appropriate theoretical paradigm to adopt to address the theory-practice inconsistency challenges at the heart of the IS field. Its strength as a research methodology offers the researcher a unique ability to interact with data at a level that other research methods do not: that is, to examine the impact of data at the three fundamental levels of research – empirical, actual and real – thereby enhancing the effectiveness of its application in practice. Therefore, reconceptualisation of the SI perspective theoretical paradigm from interpretivism to CR offers greater benefits not only to this research study but to the IS field. This is yet another development in the field which seeks to address the long-standing challenge of IS value contribution that is constantly diminished by ineffective design methods and poor integration of the IST and BIA disciplines, which by design should be leveraging on each other's strengths in a quest to deliver superior results to businesses.

Business requirements analysed as input into the design process using the integrative CR-based design method account for BIA requirements, thus enhancing value derived from both IST and BIA.

DECLARATION

I declare that this thesis, which I hereby submit for the degree, Doctor of Philosophy, Information Systems at Wits Business School, University of the Witwatersrand is my own work and has not previously been submitted by me for any degree or examination in any other university.

DEDICATION

This work is dedicated to my late Mother and Father, Zabanguni Daphne Kubheka and Bongani David Donald Kubheka, for the love that had no measure, teachings that humility determines ones greatness and unwavering belief in my strengths.

ACKNOWLEDGEMENTS

Your eternal star has always guided me even when I doubted and questioned my own inner strength and destiny. You have been my north star and continue to shine the light on the path to my spiritual and intellectual maturity, here's to you late brother Muziwandile Simphiwe Kubheka. Khathide!

My husband Mswati Dlamini; for the late nights, the brainstorming sessions and input as I journeyed in this process of self-discovery and growth. It was all possible and worth it because of your unconditional love, sacrifice and encouragement. You are my life.

My children; Asemahle Zothani, Aphelele Wisani and Amisokuhle Temahlubi for your love and understanding as I missed out on important milestones in your development and growth. I love you more than anything in the world.

Talente and Lindokuhle, to have you by my side and be graced by watching you, spreading your wings to soar high and become the men and pillars that you are has truly been a blessing I did not deserve. Thank you for your bottomless love, sharing in my dream and unquestionable support. I love you back.

My family; Lungile, aunt Nompumelelo, Thandeka and Londiwe, for the unending love, interest in my study and encouragement.

My sincere and deepest thanks goes to my supervisor Louise Whittaker, whom I believe went beyond her call of duty to support me throughout this journey and ensuring that I attain my dream. I could not have been blessed with a better mentor, coach and a supervisor.

My appreciation goes to Transnet Executives for authorising the study, allowing me the space, time and resources and unassuming openness in participating in the research and study. You have demonstrated your commitment to being a learning organisation that embraces and sets the tone for continuous change.

To my colleagues at Transnet and everyone who participated in my study, thank you very much.

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CHAPTER ONE

Introduction

1.1 Background and Research Context

The digital economic era puts data at the heart of the business transformational agenda. Data makes representation and interpretation of virtual and physical capabilities possible, thus intensifying the requirement for an integrated approach to Information Systems and Technology (IST) and Business Intelligence and Analytics (BIA) design. How IST and BIA are designed determines the level at which data from diverse sources can be exploited for the benefit of business. The digital economic era, catalysed by the 'Nexus of Forces', namely Big Data, Cloud Computing, Mobility and Social Media (Gartner, 2013, 2014) and the 'Internet of Things' (Perera, Zaslavsky, Christen, & Georgakopoulos, 2014) are by today's standards the biggest driver of enterprise change, forcing organisations to revisit the role that IST and BIA play in surviving the new and disruptive rules of competition. How organisations respond to these changes determines their performance and competitiveness in the market. According to Gartner's 2014 CIO Survey, 'enterprises are being engulfed in a "digital tsunami" that is rapidly changing the competitive forces within and across industries'. At the heart of this digital disruption are IST and BIA capabilities that are designed to support and enable businesses in this transformation journey (McQuivey, 2013). Of significant concern, hence this research study, is the continued lack of integration of the two sub-disciplines at the heart of this evolution. The silo approach in both scientific research and practice results in the lack of a unified voice on how the IS field addresses the need for the integrated approach to IST and BIA development.

Empirical research reveals that IST are the backbone of BIA function through the provision of technology infrastructure and data assets. Although the relationship is undisputed and interdependencies are widely acknowledged, a literature review revealed that the design and development approach still encourages these silos. Furthermore, assumptions that inform the design and development practices represent this silo mentality among many factors, thus further widening the gap. This is attributed to the fact that since the introduction of BIA in the 1990s, the IS field has lacked a disciplined and integrative design approach to IST and BIA.

1.2 Information Systems and Technologies and Business Intelligence Analytics in Practice

As information and intangible assets such as 'Data' take precedence over tangible physical assets, emphasis should be moving towards ensuring development of IST that better provide for the BIA capability. Gartner, (2016) in support of this notion add that 'significant complementary and synergistic opportunities exist when neither the applications nor the data for integration requirements are stand-alone'. Regardless of how favourable or unfavourable current conditions are to enable the convergence of IST and BIA, organisations cannot afford not to take that first step towards closing this gap. IST and BIA practices and their widely accepted relationship in the IS field are the following:

- IST is the source for data that business intelligence and analytical capabilities are designed to consume in order to deliver business value.
- Business intelligence and analytical capabilities are powered by technology infrastructure and platform, without which BIA capabilities would be non-existent.
- The BIA design discipline is founded upon IS design principles that drive the IST design discipline.

Therefore, aiming to address one discipline in isolation from the other, is counterproductive. The silo efforts aimed at advancing the two disciplines in isolation can be equated to forging ahead without the fundamentals that sustain the efforts and results. It is no surprise that leveraging information for effective and timely decision making continues to be an elusive goal for many organisations. The study is premised on the notions that IST provides a solid foundation for BIA, and that attempting to design BIA without going back to the basics of understanding and aligning to IST, and vice versa, precludes any sensible business action.

In the context of the study:

- IST are any systems and technology applications ranging from information systems, information technology and engineering systems to communications technologies such as GPRS (2G, 3G and now 4G), GPS and Wi-Fi that are designed to facilitate the development of BIA.
- BIA includes all business intelligence and business analytics application systems that support the creation and consumption of business intelligence reporting and analytics.

1.3 Information System Technologies and Business Intelligence and Analytics History

As IST continue to transform the manner in which business is conducted, so does BIA in transforming data and information assets into insight, thereby empowering organisations to make intelligent business decisions. The journey which started in the early 1970s with the introduction of computers in the organisational setting, has changed the IS role to include BIA responsible for the provision of performance management and competitive insights, a force that underlies transformation across industries. However, it is critical to point out the foundational function that IST continues to play in the field in powering BIA. Essentially IST, whether communications, web, systems and/or technology based, are the life-blood for the capabilities and functions founded on IST platforms.

There were various defining milestones in the advancement of the IS field in which IST was always a foundational enabler. The early 1980s as an era during which the introduction of decision support systems (DSS) and Enterprise Information Systems (EIS) transformed both IS research and practice, building a solid ground for decision-making processes. In the late 1990s the introduction of business intelligence (BI) tools and capabilities which were built on DSS and EIS platforms expanded the scope and approach of reporting to include the development of insights to improve business performance. In the mid-2000s the drive towards the process-driven organisation forced yet another round of development and extended the scope of BI capability to include process intelligence. It was at that point that systems and technologies were built to support advanced process requirements to include workflow, event-driven and rule-based processing capabilities in order to adequately address operations business and/or process intelligence. Most recently, early 2010 marked yet another milestone, the biggest in impact and influence coined by industry experts as the era of digitisation, which was characterised by the 'Nexus of Forces', often referred to as 'Four mega IT Trends' and the 'Internet of Things' (IoT).

This era is unique in the sense that all four trends and the IoT are converging and are interconnected and interdependent, thereby redefining how business was conducted, as well as product development processes and service delivery mechanisms. Its impact spans across every industry and conceivable business domain. Moreover, the four mega trends pose a threat to businesses as they cannot afford not to address them or to prioritise one trend at the expense of the others. The swiftness and fluidity of organisations in responding to these trends determines their success and competitiveness in the future (Forrester, 2013).

Noteworthy in all the above highlighted developments in the IS field is that IS and IT remain central in serving as the backbone for BIA. While the IST role in business is undisputed, reliance on BIA to monitor all aspects of business in or near real-time basis in order to make decisions based on relevant, reliable, accurate and timely data about their business, customers and the competition, is now the biggest value generator (LaValle, Lesser, Shockley, Hopkins, & Kruschwitz, 2011). IST have an integral part to play in the process, however, until the puzzle is complete and data is transformed into actionable insights, IS's value will remain elusive. It can therefore be argued that BIA is the piece that completes this IST puzzle and ensures that businesses derive value from IS investments. Therefore, the silo approach to IST and BIA does not compel the vendors to address the requirements for embeddedness and the interdependence of the two disciplines as they design and configure capabilities for consumption. Unless academia and practitioners put pressure and emphasis on this integration, vendors will continue to exploit the gap that exists.

Although the BIA industry, in its response to the requirements for real-time access to multiple sources of information and data integrity issues, continues to introduce advanced tools, dependency on IST as a primary source of information remains unchanged. In fact the more clean, relevant and accurate the data is from source, regardless of the number of sources, the better the results and the more cost efficient BIA solutions become.

1.4 The Relationship between Information Systems and Technologies and Business Intelligence and Analytics

In view of the above it is fitting to conclude that IST are the core of all of the processes involved in the business intelligence applications that deal with gathering, storing, sorting, as well as in analysing data for an organisation. Without sophisticated BIA software and applications, data would remain unseen and untapped, resulting in a loss of opportunity. In the same vein, without IST, BIA software and applications would not have data to work with, and the capability made possible by technology would also be nonexistent or ineffective.

Another way that IST are related to BIA is the way in which data, information and insights are disseminated to social actors for consumption. This is a process which is designed to ensure that all data, information and insight is packaged in an appropriate format, stored in its right place and accessible when social actors and other software applications need to consume it.

Acquiring an appropriate IST is a necessary but not sufficient condition for realising value from investment (Agarwal, 1999). Equally important to appreciate is that implementing advanced BIA tools, platforms and data processing engines, does not guarantee value realisation. Hence the IST and BIA cannot be meaningfully separated from each other. When one considers the reciprocal relationship that these have, it becomes easy to see that the two are intertwined, and how vital each is to the other. Rodrigues (2002, p. 234), defines IST as the enabler of the intricate processes, systems and tools engaged in the development of BIA. Yeoh and Koronios (2010), argue that BIA's primary function is to ensure that the corporate asset – data – is accessible, relevant and usable.

To use an example, communication tools such as Wi-Fi, GPS and GPRS (2G, 3G and now 4G) communications platforms cannot function independently of IST platforms. Equally, data generated through these communication platforms is transmitted via communication channels and technologies into the BIA platforms that generate insight. Following on this example, it can be argued that IST and BIA are the cornerstone of business value generated through various forms of IS. As such they need to be treated as interdependent disciplines rather than the current approach whereby they are largely seen as separate, resulting in silo research and silo design and development methodologies.

The value that BIA can bring if implemented correctly is widely accepted across industries. This is further reflected in the number of CIOs that continue to prioritise BIA in their programme plans, strategic agendas and budgets (Goasduff & Pettey, 2012). Gartner (2013), in support of this view, indicates that BIA consistently ranks as one of the top five search items on their site. However literature reveals that in spite of all the investments made in IST and BIA technologies, benefits still elude businesses (Anandarajan, Anandarajan, & Srinivasan, 2012; Clavier, Lotriet, & Van Loggerenberg, 2012, p. 302; Kohli & Grover, 2008). The business landscape, which is changing at an unprecedented pace, further deepens the concern as these changes are happening at the point where businesses are still battling to maximise the value derived from conventional BIA.

It is therefore imperative for IS researchers and practitioners to work collaboratively in going back to basics and understanding what it is that they need to commit to in order to build a sound and sustainable discipline and to base it on solid principles and governance. In that way, the latest advances inspired from within this continually changing field will not put further strain on the IST and BIA capability and the value that it can provide, thus allowing the two sub-disciplines to move at an acceptable pace in order to respond effectively to the developments that emerge regularly and disrupting the IS field.

1.5 Information Systems and Technology and Business Intelligence in Context

Before any meaningful progress can be achieved, it is paramount to set the context upon which this research study is based.

This study takes a view that IST have a systemic character, and that their configurational nature makes them complex technical objects to understand and manage. The fact that IST are implemented in complex organisational settings and are manned by complex individuals, social actors, further compounds the challenge. Scholars and practitioners have over the years tried to find a solution to this complex phenomenon, making strides but with limited traction as the IS field continues to evolve at a very fast pace, diminishing critical milestones in the process. Of the many milestones achieved, and a key consideration for this study, is conceptualisation of IST as socio-technical systems (Mumford, 1995), and of business users as social actors (Lamb & Kling, 2003). Thus, positioning the research to focus on either the social or technical aspects of computing at the expense of one over the other, would render futile all efforts in this journey.

Transactional and operational systems and technologies are implemented to support and enable the process or business transactions in various capacities, whereby the drivers of process technology enablement are simplification of complex process steps, efficiency improvement, and visibility of execution of process activities or business transactions, to mention but a few. In each of the activity steps, social actors create, change and share data with each other as data flows through the process value chain. It is in this regard that the context of use needs to be incorporated in the design of IST. In this way, the process and the data generated through the process reflects reality and can add value when harnessed through BIA.

At the heart of the BIA concept is a process concerned with collection, integration and storage of data in a manner that allows querying, mining and analytics for the purpose of business analysis and decision making. BIA has as its foundational platform the data warehouse (DW), which in its broader context includes data stores used to support delivery of data in the enablement of BIA. Essentially DW and BIA are intertwined in the sense that no data warehouse can deliver value without a BIA presentation layer and tools. In turn, effectiveness of the BIA is directly dependent upon the provision of relevant, reliable and timely data from transactional and operational systems and technologies.

Both DW and BIA have distinct roles to play which have been well defined in the academic literature. DW technology is an important piece of the technology enablement puzzle, in that it does not sit on the same platform as the transactional and operational systems. It is a separate technology layer on top of operational and transactional systems (Marjanovic, 2007). Among the many reasons for the separation between BIA and IST, was the requirement to provide sufficient guidance to the technical teams who were involved in the design and development of these tools (Sprague Jr, 1980). While this approach was effective in addressing business reporting and analytical requirements, over time the silo design approach created a legacy of platforms that presented constraints when integrated. This situation represents a large proportion of DW structure in many organisations where DW design is a process independent from IST design.

The classical approach to BIA implementation, where DW is a layer on top of operational and transactional systems, is in itself not a problem. The challenge is presented by the silo approach of design methods that are employed to design IST and BIA platforms. The design methods have a limited view as they do not adequately consider requirements beyond their scope of development. The process should ideally start at the source by designing IST that are BIA centric, thereby enabling a unified process between source and BIA function. Essentially, design methods should consider all three elements, IST, DW and BIA, if organisations are to ever realise value from their investments. However, in simplifying the process and the discussion, BIA will refer to both DW and BIA. At this point, it is crucial to examine the extent to which the design methods advocate an integrative design approach in support of the notion that IST cannot add full value outside of BIA, and equally so, BIA value is limited without data generated using IST.

1.6 The Research Problem

The research problem that the study addresses is that design methods commonly employed in both IS research studies and practice do not advocate for an integrated approach to design and development of IST and BIA. While IS research accounts for both IST and BIA, IST and BIA design and development studies are approached independently and/or in isolation, resulting in design methods that do not promote natural convergence of IST and BIA solutions. The IST and BIA integration silo hinders progress as digital businesses are forcing a migration from classical BIA architecture designs to modern BIA architecture environments that allow for a pervasive integration capability. In driving inherent synergies between IST and BIA in order to support the increasing number of business activities and data movements in real time, there is a greater need to rethink how to achieve the synergy required for the IST and BIA disciplines and harmonise their existence Gartner, 2016.

In addressing the research problem, the study examines how SI can be reconceptualised as an integrative IST design method that adequately considers BIA requirements. Classical SI is a multidisciplinary study approach to IST design in a context founded on sound analysis principles, thereby offering a solid basis upon which to analyse requirements for BIA.

The research study problem is limited to requirements for ensuring data quality at source in support of both the traditional and evolving BIA requirement for clean and good quality data. In this study, 'data quality' is defined as data that is relevant, reliable and accurate, delivered timeously for its intended purpose. Gangadharan and Swami (2004) refer to BIA as a specialised discipline designed to facilitate generation of quality information with which to manage business performance and create competitive advantage.

A preliminary review into the SI perspective revealed gaps in the theoretical paradigm underpinning SI. SI is premised on interpretivist theory, which inherently limits its extension as a design method. As a consequence for this study, SI use could not be extended to include the process or function of design, thus limiting its usability to its classical objective, a retrospective study of designs, uses and consequences in context. This discovery was instrumental in influencing the direction and the shape the study took. This was a defining moment for the study in that it compelled the researcher to extend the research beyond the research paradigms that dominate the IS research field, resulting in the consideration of a theoretical paradigm that, although it was not new in the academic field, was relatively new in the IS research field. This paradigm offers a lot of promise and had the potential to address the limitations of the study's theoretical base, SI. Critical Realism (CR) was thus introduced as the research's underlying theoretical paradigm and methodology.

1.6.1 Research Practical Problem

The research was grounded in the practical problem of redefining and reconceptualising SI as a design method that would ensure that BIA requirements were explicitly addressed during the design of IST. The secondary requirement was the need to ensure that the set of socio-technical and SI principles in place currently were not compromised by this philosophical move. The silo approach to IST and BIA design, the current lack of design methods that provide a satisfactory means of including BIA elements, as well as limited practical application of research methodologies with the potential to address the existing paradigm-practice inconsistencies, necessitated an investigation into how CR could be used as the underlying theoretical paradigm for SI. As a consequence, the study reconceptualised SI's ontology and epistemology from its original theoretical underpinning to CR.

The study's view on this seemingly radical approach was that while there were certain elements that distinguished the SI approach from other perspectives, the researcher had to be open to renouncing certain SI ideologies in order for the study to adequately address the research problem and to contribute to the body of knowledge. This risk was mitigated by two principles that SI subscribes to, namely, the methodologically independent and problem-oriented nature of SI, and the fact that SI is not a theory but a perspective or approach to examining and understanding the design, uses and consequences of IST being deployed.

1.6.2 Implication for Addressing the Research Problem

The implication to the study was that the study transitioned from a retrospective multidisciplinary research study to a multidisciplinary study method that combined SI and design research with CR as the theoretical paradigm and research method. This enabled the researcher to capitalise on the strengths of the SI and design to address the research study problem. SI's strength is in its socio-technical underpinnings, its principle foundations, and the process of enquiry which allows it to comprehensively account for the contextual factors (Layder, 1993). What design research brings to the table is the design knowledge that enabled the study to adequately address design principles as well as to capitalise on the design art to effectively transform SI from a retrospective study post implementation to a comprehensive design approach. In this way, IST designed employing SI would not only deliver useful and usable systems and technology but also ensure delivery of BIA-centric IST.

At this point two things became clear: (a) SI as a chosen research perspective offered a viable alternative to other socio-technical design approaches due to its comprehensive analysis and design approach; (b) CR's strength in addressing theory-paradigm inconsistencies that characterise SI and methodological pluralism that enables the research to combine both interpretivism and positivism attributes under a single research case study, increases the study's potential contribution to new knowledge. The interpretivism characteristics pertain to the study's need to answer the 'why', 'how', for 'whom', under 'what' circumstances questions with the objective of providing a good explanation and understanding as to why IST uses are the way they are, as well as understanding of the consequences of such uses in order to improve design of IST and BIA. The positivist characteristics of the study emanate from the requirement to utilise the output from the interpretive qualitative enquiry to inform the enabling of design requirements, thereby addressing the need to use the outcomes of the study to facilitate learning and/or bring closure to the phenomena being studied (M. L. Smith, 2006).

Figure 1 below presents the conceptual framework for the study which details a bold and yet comprehensive approach to the study.

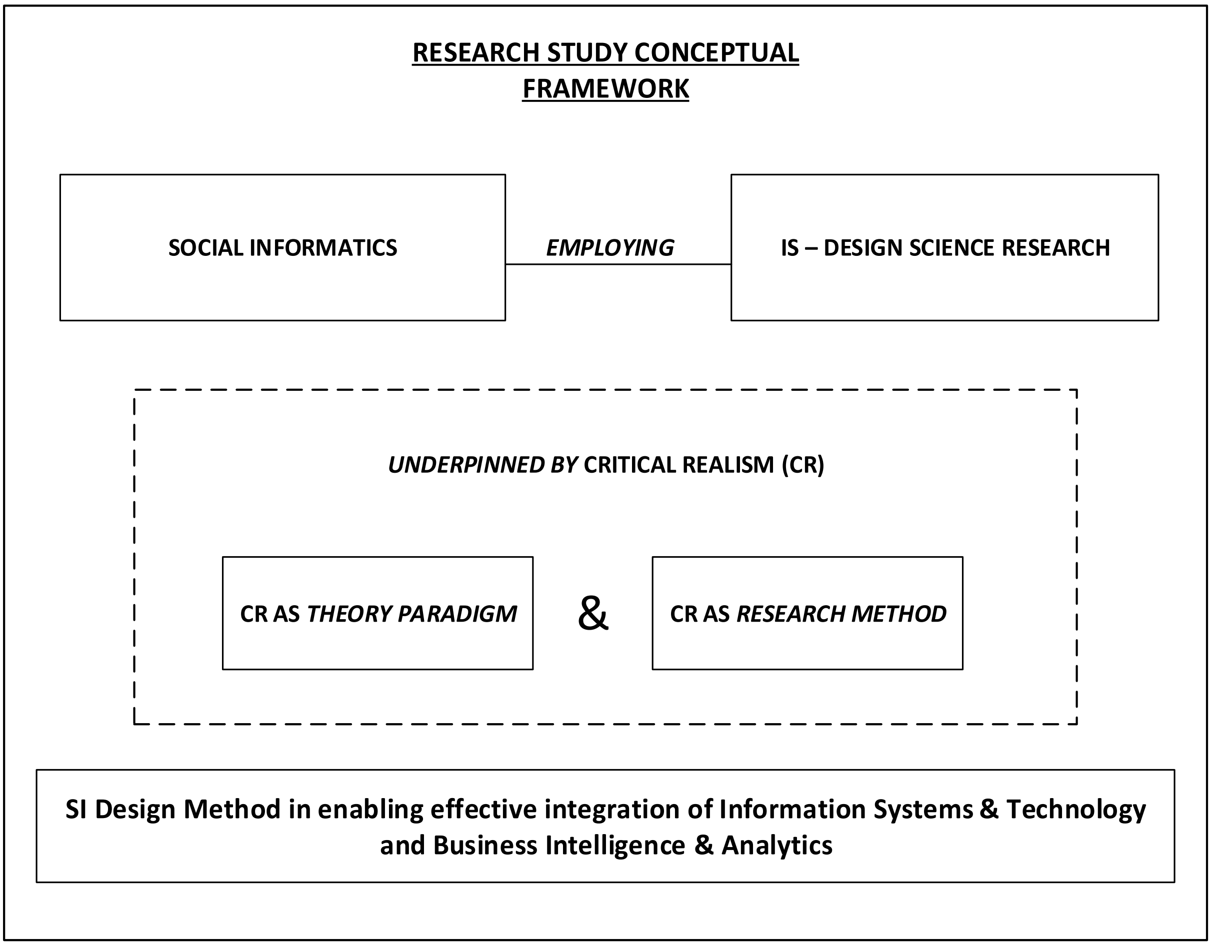

FIGURE 1: CONCEPTUAL FRAMEWORK

1.7 Recognising the Need for a Paradigm Shift

Classical SI offers a more comprehensive and effective approach in gaining insights into its uses and consequences in context. Although SI provides good explanations and understanding of 'why' and 'how' IST and BIA are utilised and consequences of their use, its retrospective, after-the-effect approach to the study of IS limit its effectiveness; hence it is seldom employed in practice. This study therefore takes a view that the study's reconceptualisation of SI's theoretical paradigm from interpretivism to CR philosophy offers a more comprehensive and effective approach in gaining insights into IST uses and consequences in context. Further to this reconceptualisation, Layder's (1993) stratified research framework was adopted to provide structure into the process of enquiry because of its strength in accounting for the different levels of IST and BIA uses. The different level structures are context, setting, situatedness of activity and social actors.

1.7.1 Embracing the Changing Business Landscape

The changing BIA landscape enforced by the four mega trends in the digitised economy calls for a change in how BIA is viewed, approached and enabled. The Forrester Big Data Analytics report (2016), argued that 90% of the data in the world today was created in the past two years. At the Gartner IT-SA conference (2013), it was argued that the emergence of social media put businesses under pressure to access and translate social media data into a competitive edge. In corporate organisations, not all the data or 'noise' in the social media data can be translated into business value. Tools to identify and transform data into information that can be combined easily with structured data from transactional or operational systems to generate competitive insights are essential in facilitating this shift.

The speed with which this process can be achieved is another critical success factor, as data about customer preferences, behaviours and patterns is openly and easily accessible to the competition. The increasing reliance on IST to generate relevant, reliable, accurate data at source is due to the realisation that data in context is increasingly becoming a source for differentiation from the competition. Insight into what information is required to answer business questions and from what perspective, is a critical input into the design of both IST and BIA tools. Conventional ways of designing systems and technologies do not put the organisation at an advantage.

1.8 Information Systems Field and Design Research Gap

This section addresses the design science research gap that has to a large extent failed to take the lead in driving the development of design methods that advances the IS field, hence the IST and BIA integration challenges characterising the field.

A substantial volume of IS academic work has theorised about and empirically examined IST and BIA. However, evident in the empirical literature is the silo approach to the study of IST and BIA. Design science research has to a large failed to promote this integration. New insights and knowledge on how IST can support and enable the development of effective BIA is limited. Currently technology-driven research dominates the industry and often relies on vendors and practitioners in the form of trends and best practice. The concern with a single view is that the practitioner's viewpoint often lacks scientifically and theoretically grounded evidence.

The limited cross-examination and integration of learning of the two specialised disciplines is reflective of the lack of foresight by both academia and practitioners, as such influencing the IST and BIA success (Yeoh & Koronios, 2010). Understanding the relationship and the impact that the two disciplines have on each other can provide leadership and direction as to how the two disciplines can capitalise on their strengths and complement each other in realising the primary goals of each discipline.

As with many discipline areas in IS, BIA has continued to evolve. The scope of BIA to date includes real-time and Big Data analytics. Requirements for real-time data mining, analytics and reporting have largely been addressed by the development of advanced BIA programmes and application tools. Research pertaining to real-time reporting has been driven by the industry with a limited contribution from academia. Besides the fact that real-time data reporting is a relatively new subject within an already new discipline, little has been done to understand what the development means for the field, in particular, in terms of understanding the relationship and influence it has on IST. The challenge is compounded by the fact that conventional BIA is still not fully understood nor fully integrated into the IS studies. Available literature suggests that the reason for this has been inadequate drive both from academia and industry research to fully integrate BIA into IS studies (Wixom et al., 2011), in that these are viewed as independent disciplines requiring a specialised focus when they are in actual fact interdisciplinary and interrelated subject areas in the IS field (Gangadharan & Swami, 2004; Yeoh & Koronios, 2010). To the detriment of the field, this position has resulted in limited benefits accruing to both schools of thoughts.

Furthermore, there is limited insight informing how to best integrate BIA into mainstream IS in order to capitalise on the value chain capabilities. The efforts required to integrate the learning from the interdisciplinary and interrelated disciplinary areas may not be fully understood and appreciated. However, it is becoming more evident that the influence the two disciplines have on each other cannot be ignored, and that there needs to be a way of leveraging off each discipline's strengths and capabilities to the benefit the IS field. Hence, there is a need to refocus and realign the IS design research agenda to the needs of the field.

1.9 Justification of the Study

In the early 1990s, the IST function extended to facilitate the development and delivery of BIA in organisations. However, organisational research studies focusing on IS did not evolve to integrate the BIA function in the study of IST. Golfarelli, Rizzi and Cella (2004), suggest that the mid-1990s saw BIA becoming an object of interest in the academic world, a process which transformed and formalised the earlier techniques into well-founded approaches of sourcing and processing of information. Although the research went a long way to bringing structure and maturity to the discipline, because of its silo approach, the developments were limited to the BIA discipline. This resulted in a lack of scholarly leadership and direction in terms of how the two could proactively augment the seemingly diverse yet complementary functions. Furthermore, when the need for accessing and analysing data from IST arose, forcing the IS field to evolve to include BIA, not much effort was invested into understand what the development meant for theoretical paradigms grounding the field. The theoretical assumptions which existed prior to the introduction of BIA were not once reviewed in light of these developments, resulting in incompatible and inappropriate application of theories. For example, in-spite of the popularity of the technology deterministic theories underpinning design methods such waterfall and systems development life cycle (SDLC); social determinism theories underpinning design methods such as social construction of technology (SCOT) and socio-technical systems theories underpinning design methods such as social actor network design method and social informatics perspective, there is still a gap in literature reviewing how BIA is impacted in this changing business landscape.

This has unfortunately given way for industry researchers to create their own niche within the industry whereby research such as ‘white papers’ are driving the industry culture, trends and practice (Yeoh & Koronios, 2010). The industry researchers concern themselves with designing methodologies that are oriented towards ensuring practical implementation of the vendor products. In practice, vendors who are doing well in the market are considered market leaders, and so the methodologies they promote are used as a benchmark. However, their solutions are not necessarily effective and sustainable in delivering results. This is largely because these methodologies are not grounded in theoretically and scientifically proven concepts. Employing design methods that are based on scientifically approved theories provides a certain level of comfort that the underlying causes of certain responses to IST and BIA solutions can be dealt with effectively. This is particularly true where BIA is concerned, as the process of creating insight and implementation of knowledge-based solutions is largely a cognitive human function. This brings contextual factors and dynamics into the picture, which can effectively be understood through a scientifically supported and enabled process. Indeed tools have a crucial role to play in this, but the true value is achieved through social actor attitudes and behaviours as they assume the varying roles in multiple settings, contexts and places of activity.

BIA is advancing at a fast pace due to the increasing demand for the use of information to make decisions that will see organisations retaining their existing clientele and capturing new markets. It is no longer enough to rely on the conventional BIA tools due to the tools' limitations in handling advanced processing requirements, such as the integration of data sources in real time in order to enable real-time analytics and querying capability, as well as Big Data where applicable. The challenge with the growing demand for real-time analytics is that it places a high dependence on IST to produce high quality data at source, and the need to integrate a variety of sources in real time to enable reporting from multiple perspectives as well as the requirement to disseminate such insights on a real-time basis.

Conventional BIA programmes and tools enable fixing of data quality during the Extract, Load and Transform (ETL) process using advanced BIA tools. The retrospective approach of BIA solutions offers limited benefits and requires significant capital investments to address quality gaps in the data produced in order to make it useful and accessible. Progress and capital savings can be realised when systems are configured to produce quality data and infrastructure that enable appropriate levels of integration for both conventional and real-time BIA as well as Big Data. Golfarelli et al. (2004) highlight the significance of the change in the business landscape, and suggest that the mere rearrangement of the conventional BIA solutions will result in unsustainable results, emphasising that a global rethinking of methodologies, models and techniques is required. Thus scholars need to produce scientifically researched design approaches that extend beyond the design of IST to account for both technical and contextual factors in order to proactively facilitate BIA requirements. The proactive approach requires practitioners and academia to join forces to develop new knowledge that will contribute to the development and effectiveness of the IS field.

1.10 Research Study Contribution

The research study contribution is at theoretical, methodological and practical levels:

In theoretical terms, this research:

a. Adds to the body of knowledge and contributes to the literature of an emerging area of research interest, namely BIA, by generating new insights as to how business intelligence reporting and analytical requirements can best be integrated into the design of IST.

    - This is facilitated by the examination of the relationship between IST and BIA and how the IST elements influence data quality and the outcomes of the BIA process.
    - Understanding of this relationship is extended to examine the impact that the four mega trends have on both IST and BIA.

b. Adds to the development of the BIA-centric IST design model, the CR-SI Design Method.
c. Promotes the refocusing and realigning of IS design research to the development of new knowledge that will enable IST design methods to effectively account for business intelligence reporting and analytics requirements.

In methodological terms, the research:

a. Adopts a CR method, one of the early developments in SI and BIA research studies. The view of the study is that if the contribution is going to make a difference in practice, it has to extend beyond theory and be practically implementable. Hence, the study employs CR methodology principles to gain deeper insights into results from the field research work. This process was indeed effective in arriving at conclusions that the study could not have predicted prior to the analysis, offering the findings an opportunity to recommend an effective and efficient way to address similar challenges.

b. CR theory states that the outcome of the investigation must be used to improve the situation. The study uses the findings to determine recommendations that take the IS field forward, from the perspective of addressing the research study problem than one sets out to address.

In practical terms, the research:

a. Uses a practical case study to assess the feasibility of reconceptualising SI as design method, which was key in arriving at the study conclusions. The findings would not have been as accurate had the SI perspective theoretical standing not been reviewed and tested in a practical case study. The research study questions and interpretation of the results were largely informed by the study position and theoretical paradigm.
b. Furthermore, an opportunity to extend Layders' research framework plays a major role as research results were assessed at various levels of social organisations and social actor actions. Hence it is recommended as an effective tool in gaining insight into organisational character, structure and environment.
c. The research study recommendations provide a framework of empirically based practice approach to analysis and design of the IST and BIA that is vendor neutral, and can be tailored to the nature, size and complexity of the IS project.

1.11 Research Questions

Fundamental to the positioning of the research questions within the body of the knowledge, is the understanding of how the research problem fits within the IS research field and then the isolation of the 'core' subject within the field in relation to the two sub-disciplines being studied. This approach helps create a structure for the examination of the relationships of the interwoven disciplinary areas under enquiry. Central to the research study were the four research questions outlined in the section below.

1.11.1 Main Research Question

How can SI be reconceptualised as an integrative design method that accounts for both IST and BIA by applying a CR theoretical paradigm?

1.11.2 Research Sub-Questions

a. How can SI be extended to consider information reporting and analytical intelligence requirements when designing ISTs that are a good foundation for BIA?
b. In what ways does the CR paradigm address SI theoretical foundational constraints?
c. What are the key design principles and activities that are required to ensure effectiveness of IST and BIA design knowledge through design science research?

1.12 Research Structure

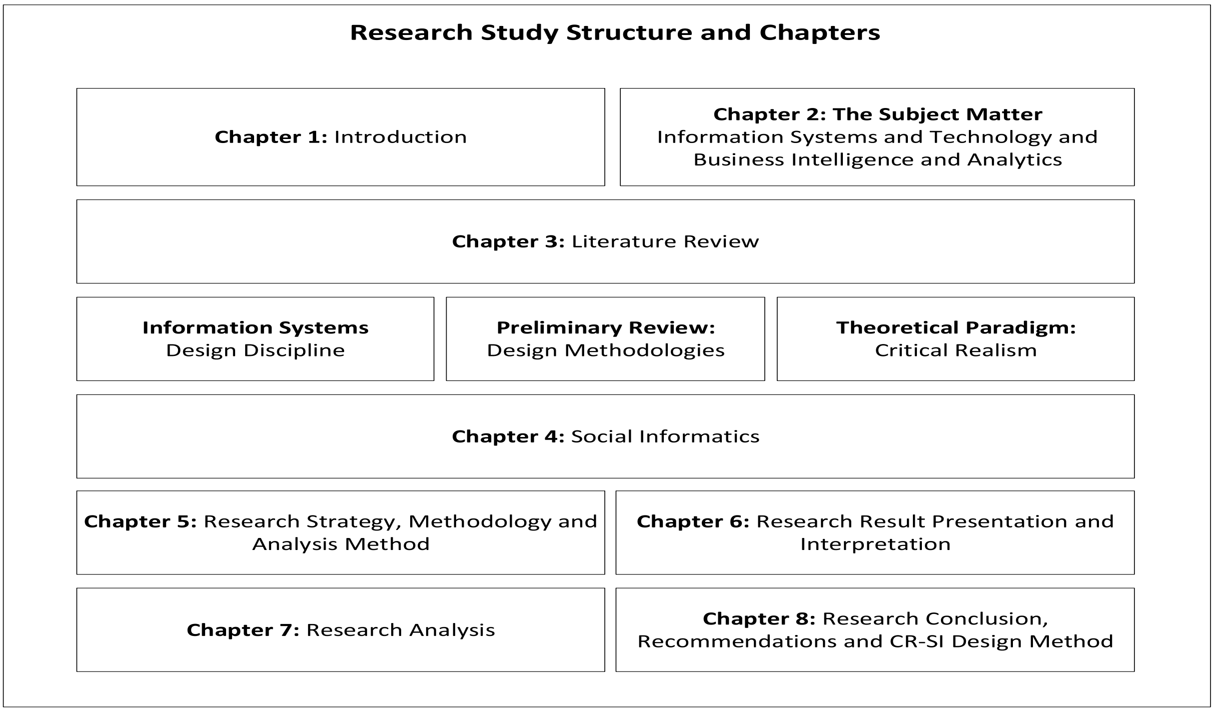

FIGURE 2: RESEARCH STRUCTURE AND CHAPTERS

Error! Reference source not found. outlines the research structure. The section below b riefly describes what each chapter entails in relation to the outcome of the research, starting with Chapter 2, since Chapter 1 has been discussed at length.

Chapter 2

This chapter focuses on the subject matter, which is IST and BIA. The objective is simple, namely to ensure common understanding of the two sub-disciplines, how these fit in within the IS field as well as the assumptions the researcher made in addressing the study research problem.

This chapter further goes on to critically analyse IST and BIA characteristics at length, how their role is changing in a highly competitive business environment as well as understanding the impact of the latest digital development in the field in achieving business value, thus setting the tone for the rest of the study.

Chapter 3

Chapter 3 expands on the IS design research as a means to create a solid base upon which to assess the design methods identified as critical in the IS developmental journey that led to the development of the SI perspective. In this chapter, the researcher's focus is on understanding the theoretical paradigm underpinning each design method, to expand on how each design method interprets the relationship between technical and social as well as the extent to which IST design methods consider BIA requirements during design and conceptualisation of IST solutions.

The last section expands on CR as both the research study paradigm and method. This was a bold move in that the researcher was not only reconceptualising the paradigm upon which SI was founded and proposing new lenses in the role SI can play, but was challenging the widely accepted theoretical assumptions of the IS field. This was due to SI belief systems and theoretical assumptions that are in conflict with the outcome of scientific research process and as such cannot be implemented. This reduces them to a scientific research process, with limited practical impact or value in practice.

CR has been receiving interest in IS research studies but with limited practical studies in the literature to reference. However, it does offer a promise of addressing the limitations of the most popular theoretical paradigms in the IS field. An added advantage is that it is in itself complementary in that it is governed by sound research principles which offer new and unique lenses to analysing data sets. This offers depth, breadth and rigour to the process, thereby taking the IS field forward.

The conclusion reached in this chapter was instrumental in setting the foundation for the research study and simplifying the application of seemingly complex concepts and terminology, making them easy to apply in the research study. This inspired the change in that the practical application of CR encourages understanding of the under-utilised theoretical paradigms.

Chapter 4

This chapter focuses on the theoretical base of the study, SI, for purposes of ensuring enhanced understanding of the discipline and how to better extend its re-conceptualisation from an interpretivist philosophy to that of CR. Critical to point out is the discussion on the social actor concept as one of the critical and unique ways in which SI attempts to address the social aspect of computing. In this chapter, the social actor view is further extended in line with Layder's (1993) stratified framework. This framework considers social organisation and actor action, thereby providing an effective way of approaching SI analysis and design discipline.

As an outcome, this chapter demonstrates two things:

a. SI was chosen for its strengths in its comprehensive, rigorous dynamic as well as its balanced approach to IST and BIA requirements analysis. This rigour and inclusive approach enhances the effectiveness and relevance of systems designed. The study's viewpoint is that analysis is the first step towards achieving success and that analysis is a critical aspect of design thinking. Design art and knowledge has a limited range if it is not powered by an effective analysis philosophy.

b. An alternative to interpretivism exist and SI does not have to change its core principles to be effective. Reconceptualisation of its theoretical foundation was not unfounded. It is an alternative to advancing the SI perspective, thereby making it more effective in practice. After all, science is more effective if it adds value in practice. In essence, the study transformed a rather irrelevant discipline in practice due to its failure in bringing closure after understanding the 'why', 'how', for 'whom' and under 'what' circumstances questions to a more effective discipline. SI, underpinned by CR, takes the process further and uses the analysis outcomes to inform design of IST and BIA that are useful, usable and that enhance human experience and value.

Chapter 5

This chapter unpacks the research strategy as well as detailing the methodology and analysis method adopted by the study. At the heart of this chapter is the research framework which outlines where the single case study of Transnet Freight Rail (TFR) fits in as well as how the theories that are core to the study were applied and tested to ensure learning and contribution to knowledge. The framework was instrumental in driving the efforts and ensuring that the researcher does not divert from the set objective. It provides structure to the approach and guides the process of enquiry as the journey unfolds.

Chapter 6

This chapter focuses on the presentation and interpretation of the research results from the research fieldwork. It is a consolidated view of the results from the various data collection methods and is reflective of the journey of the research study. Presentation of data sets using thematic networks and the interpretation of the story behind the themes in relation to the research study problem was further enhanced by the application of five key CR principles.

Chapter 7

This chapter puts to the test the CR research method principles as results from the research fieldwork are analysed. The researcher contends that the conclusions and the recommendations of the research would not have been possible had CR not been adopted as a research method.

CR principles were a catalyst in aiding the researcher to consider multiple explanations of the phenomenon and applying different lenses to the obvious. This way the researcher was able to arrive at a conclusion with the best explanatory power compared to other available alternatives.

The analysis step provided key learnings, both from the data itself as well as from the effectiveness of the research method in achieving the research study objectives.

Chapter 8

This chapter focuses on the research conclusions and recommendations, as well as the outcome of the research study process, CR-based SI design method. The key theories upon which the study was based are revisited and research study questions are reviewed to assess the effectiveness of the research study process and level of contribution to the body of IS research.

Although the CR-SI design method development was informed by a specific case study, the researcher believes that with a reasonable amount of tailoring, practitioners in similar environments, contexts and social actors' profiles can adopt and adapt it to their circumstance with a high degree of success.

1.13 Out of Scope of this Research Study

Below are aspects which, although playing an important role in the development of effective BIA, and therefore impacting on both the IST design and BIA function, are considered to be out of scope of this research study:

a. The process involved when translating data into insight that enables fact-based and sound decision making: The study briefly touches on the role of BIA in decision making for purposes of creating context.
b. Development of BIA Tools and application systems: This element focuses on the solution development aspects, competencies and the technical process.
c. Implementation of BIA Tools and application systems: These include BIA implementation methodologies and/or critical success factors.
d. BIA platforms and infrastructure: These are presumed to be addressed under technology infrastructure and architecture.
e. Technical requirements focusing on enabling system and technology integration: The study's focus is limited to the enablement of sourcing of data from disparate systems and technologies for the purposes of closing the loop from a data perspective. It determines the ease with which information can be reported from multiple perspectives and at various levels.
f. Infrastructural requirements for enabling Big Data capability: Its focus on rich text data as well as unstructured data introduces new infrastructural and architectural dynamics. Classical DW tools and platforms would require a complete overhaul if they were to adequately enable Big Data. Therefore, the scope is limited to addressing issues relating to data quality and cleanliness (relevance, reliability, accuracy) as critical success factors for superior and effective delivery of BIA.
g. Infrastructure technology required to facilitate BIA: This is not a major concern and the focus is on processes that enable the design of effective BIA.
h. Specialist and/or technical methodologies (such as project management, change management): These are excluded from this research study.
i. Systems Development Lifecycle (SDLC), Waterfall and Agile: These are widely accepted technology and systems development methods in the field. The study accepts that these methods are well documented elsewhere and as such are not the subject of this study.

1.4 Summary

This chapter has laid the foundations for the research thesis. Having introduced the research problem, research objectives and questions, and justified the research, it was necessary to discuss the need for a paradigm shift, given the researcher's proposed paradigm changes and assumptions on which this research was based. The next chapter explores the research problem in terms of the existing literature, and to define the subject matter that form the basis of this research.

CHAPTER TWO

Information Systems Technology and Business Intelligence and Analytics

2.1 Introduction

This chapter presents literature that is relevant and instrumental in positioning the subject matter of the study. The study contends that the effectiveness of the BIA function in delivering reliable, relevant and timely information is directly linked to the design of IST. As IST supports business processes that create and transfer data through a dynamic and continuous set of processes and practices embedded in individuals, as well as in groups and organisational structures (Sharma & Djiaw, 2011), BIA helps creates synergy needed to enhance decision making in order to compete effectively. The synergy across key organisational processes and enabling IST and BIA is crucial in ensuring that decision-making processes are effective and that low latency is achieved. The extent to which management achieves low latency in decision making largely depends on the degree of credibility, integrity, and accuracy of the data produced by IST for BIA to harness (Schneider, 2007). If the BIA function relies on inferior information generated by IST, the effectiveness of BIA will be severely comprised (Li, Peters, Richardson, & Watson, 2012). The scenario becomes more complex with the advent of real-time and Big Data analytics in the changing business landscape, to the extent that the IST discipline has more pressure to ensure that IST solution designers think BIA when designing IST.

To confirm or nullify the study's argument that an integrative design method is paramount to business deriving value from IST and BIA, the relationship between IST design and BIA function is examined with the view of ascertaining the extent to which BIA effectiveness depends on IST effectiveness in production of reliable, relevant and on demand (timely) data for the BIA to exploit. In order to conduct this assessment, the following dimensions were identified as appropriate measures of effectiveness of IST and BIA: (a) How IST addresses social, contextual and environmental factors; (b) How effective IST's usability and usefulness is in performing business functions; and (c) How effective systems and technology design reduces latency between data creation and decision making and improves BIA effectiveness. The study takes a view that if design should fail to adequately address the three dimensions, BIA function will be compromised. The three dimensions are discussed in relation to their contribution to enabling effective BIA.

However, before this chapter can address the literature and expand on the dimensions identified as critical in creating effective BIA it is necessary to position the subject matter in the context of the IS field.

2.1.1 The Subject Matter in Context

The aim of this section is to position the two sub-disciplines which are focal to the research study in the context of the IS field research. In positioning IST and BIA in context, the approach the study takes is to first understand how the two fit into the wider body of organisational research knowledge followed by its parent field, IS research. The next step is to examine the relationship and the influence these may or may not have on each other. The last and equally important step is to ascertain the role of design research as the subject area in which the solution to the research study problem lies. Figure 3 below depicts the relationship of the sub-disciplines, identifying and defining the subject area that is critical in finding a meaningful resolution to the research problem, as well as positioning SI as the chosen design method. In this regard, the IS design research role is fundamental in developing knowledge relevant in advancing the IS field.

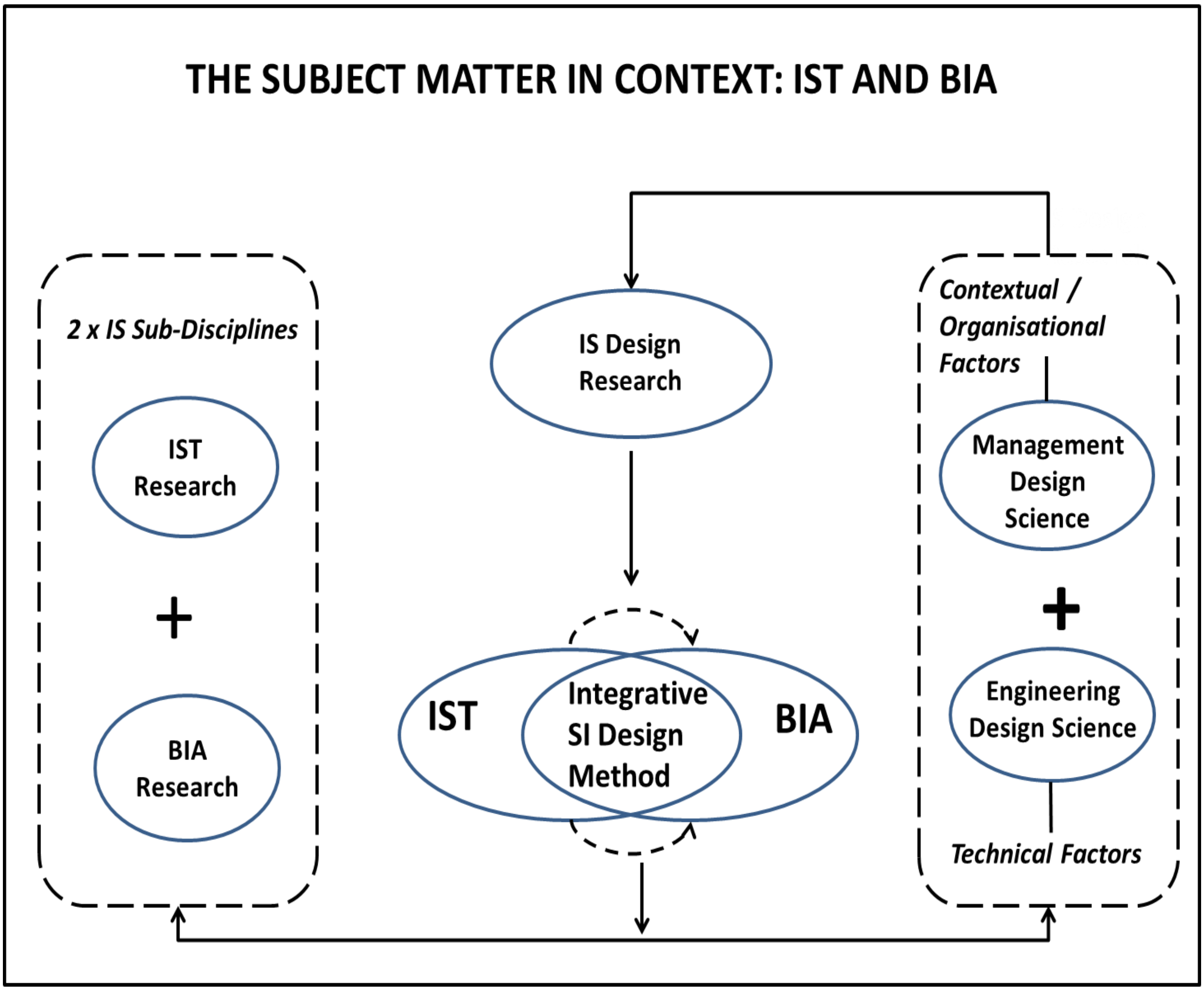

FIGURE 3: THE SUBJECT MATTER IN CONTEXT OF THE IS RESEARCH FIELD

Figure 3 depicts IST and BIA in their current state as independent research efforts when the desired state is a single effort with two uniquely defined attributes. From right to left, the diagram depicts engineering science as the source for design knowledge relating to technological elements and management science playing a vital role in producing knowledge required to adequately account for non-technical elements that the study refers to as social, contextual and/or environmental factors. The diagram positions IS design research not as an independent discipline but rather borrowing learnings from both engineering and organisational design science. This approach fits well with the premise of the study, that IST and BIA are multidisciplinary subject areas requiring multidisciplinary solutions to their problems, in order to advance their cause.

At the heart of the diagram, SI is positioned as an integrative design method of both IST and BIA, enabling organisations to realise full value from their investments. In closing the loop and ensuring that learning is a continuous process, output from the design science is used to inform the research study of both IST and BIA. In this way, academia and practice continue to remain relevant to each other, producing reliable knowledge with which to advance the field.

The section below is dedicated to IST and BIA literature with the objective of ensuring alignment on the common concepts, terminology used and what each discipline entails, thereby enabling examination of the relationship and influence each has on the other.

2.2 Information Systems and Technologies and Business Intelligence Analytics Literature

Although the emergence of the high-impact applications and advanced analytics capabilities have generated a great deal of excitement within both the IST and BIA industries and the research community, what remains a concern is the lack of integration of the two sub-disciplines. Review of the IS literature reveals that while the IST and BIA disciplines may appear to be well researched, a disconnection in the commonly held assumption has been identified. This disconnection exists at two levels, practice and research, as derived from the study's review of literature. At practice level, academia and practitioner focus tends to differ, whereas at research level alignment is noted as outlined below:

Practice focus: The industry focuses on implementation of scalable and integrated systems and technologies, whereas the academic community focuses on advancing the field through the development of new knowledge.

Research focus: In a silo approach to IST and BIA, IST researchers (academia and industry) tend to focus on conducting systems- and technology-related research, whereas BIA researchers (academia and industry) tend to place emphasis on factors that impact on the BIA discipline and industry.

Beyond the classical role of technology as an infrastructure and backbone of BIA, integration of the two disciplines is under-researched, and as such, limited authoritative literature exists on the relationship and influence that the two disciplines have on each other. The modern and emerging role of BIA challenges the role IST plays as a foundational enabler, compelling the industry and research community to invest more time and effort developing new knowledge and practices.

The continued lack of collaboration tends to result in minimum integration, and lost opportunity to transfer learning across the two sub-disciplines. The resulting consequence of this is that the IS field may continue to be characterised by poor performance and failure to deliver meaningful, visible and sustainable results. It is thus critical for both the industry and academia to work together in challenging the current practices that hinder advancement of the field. IS value can only be fully realised if IST and BIA share a common vision and position themselves to capitalise on the strengths of each sub-discipline while supporting the umbrella IS field.

2.2.1 Information Systems and Technologies

As BIA emerges as a critical area of focus for both researchers and practitioners, insight into how to account for the social, contextual and environmental factors given the complex 'systemic character' of systems and technologies, becomes a critical success factor. IST is and will remain one of the vehicles for the production of business data with which to manage business performance and create competitive edge.

According to Hughes (1987) 'systemic character' of systems and technologies refers to more than functionally interdependent elements and components configured together to form a system. In echoing this view, Geels (2004, p. 234) add that 'systems engineers define a system as a set of interrelated components working toward a common objective'. Geels (2004, p. 234) further states that 'systems are made up of components, relationships, and attributes'. This is echoed by Blanchard, Fabrycky, and Fabrycky (1990) when adding that 'the system is more than the sum of its parts'. Components are the operating parts of a system, for example social actors or organisations and/or physical or technological artefacts such as IST and telecommunications lines. They can also be institutions in the form of legislative artefacts such as regulatory laws, and social norms. Relationships are the links between these components. The properties and behaviour of each component influence the properties and behaviour. Attributes are the properties of the components and the relationships between them. Attributes characterise the system. Further to the characteristics of the systems, Sawyer and Rosenbaum (2000) highlight that systems and technology are not an end state; Sawyer and Tyworth (2006) support this view, adding that once systems and technology are implemented and used, they result in new patterns of use, thus forcing them to evolve (Henderson & Kyng, 1991). Hence, technology is considered by Kling (2003) and Sawyer and Rosenbaum (2000) as being a complex socio-technical network.

In this regard, the 'systemic character' of technology is viewed from a perspective that there is more to the technology than hardware: that is hardware, software, information structure, network or even telecommunications devices, and recognising it as a complex socio-technical network where individual components have limited functionality and value. Sawyer and Rosenbaum (2000) add that IST are collections of distinct components, and that only when they are arranged in a way that creates a pattern of functional interdependence (Kallinikos, 2004) and produce results in the form of an output in accordance with predefined process steps, do they add value. The complex, unique configuration concept of system and technology, as Sawyer (2006) succinctly captures it, means that different configurations of the same technology or system may have varied consequences within different organisational settings; accordingly this is an instrumental characteristic for consideration during the design, development and implementation process. Rowlands (2009, p. 54), states that the configurable nature of IST means that they are 'interpretively flexible' (Orlikowski, 1992, p. 405) and 'adaptive in use'.

In light of this, designers of IST have a challenging role to play in balancing complex systems technology functions with intuitive functioning of the IST in context. Their design has to support social actors and perform amidst the challenging organisational context, setting and environment, while empowering the actors to create clean and relevant data with which to manage performance of the business. At the heart of this complex scenario is data that needs to be managed throughout its lifecycle, that is, from generation to consumption as insight.

In light of this, designers of IST have a challenging role to balance complex systems and the configuration of systems needs to address the requirements for databases that collect data from and feed data into modular applications, enabling automatic updates of related data as actors transact. This can only be effectively achieved if requirements are clearly articulated upfront and are supported by a sound design method. However, as evident in the limited research literature that advocates for IST and BIA integration, or study of the relationship and influence each has on the other, this function is often overlooked. The silo approach to IST and BIA function limits value that can be derived from IS investments. Kling, Crawford, Rosenbaum, Sawyer and Weisband (2000), add that this separation is rarely feasible for designing a workable and integrated IS environment.

Although scientific research exists for IST and BIA as independent disciplines, empirical evidence points to the fact that a large portion of BIA research is driven by industry-based research and as such influences practice. The challenge with this situation is that the research produced tends to be oriented towards vendor assumptions on what best practice is (Davenport, 2008), thereby compromising organisations. BIA is the means by which business synergies are realised, processes are integrated and systems and technologies are harmonised in the realisation of the 'single version of truth' of the information. This is highly significant for a progressive field.

2.2.2 The Contextual Factors' Impact on Business Information Analytics

Contextual factors remain relevant in the BIA space; hence designing systems and technologies requires a design method that can adequately consider both technical and contextual requirements impacting on effective BIA. IST, no matter how advanced, can only go so far in producing actionable insight. It is the actors who apply their business knowledge and expertise to the analytics produced by BIA tools to create business value. Therefore, the BIA tools' role is to facilitate action and not to take over human action. It is on this basis that design has to enable both cognitive action and technical capability as social actors perform critical business functions, taking actions required to optimise business performance. Olszak and Ziemba (2007) state that all employees are decision makers at some point as they execute business function. In the process of making these decisions they need access to reliable, relevant and timely information to ensure accurate and appropriate reactions and results.

In this regard, the design of IST needs to be informed by the informational requirements of the organisation, and by how information is shared among the impacted parties and consumption patterns. In addition, understanding of the measures and the metrics that make up standard reporting Key Performance Indicators and reports enable organisations to proactively consider future reporting requirements, and consequently the integration required at a point of design. However, although literature suggests that Enterprise Data Warehouse (EDW), advanced analytical and data mining tools do provide this capability, it is still a reactive process. Literature reveals that this approach is still reactive and does not adequately address the real-time reporting requirements. Further to this constraint, legacy systems present BIA with many challenges and any work solution is not only time consuming, but also delayed and very costly. Where Enterprise Resource Planning (ERP) systems are concerned, challenges experienced are caused by their unique position in the field, that is, best practice. Unfortunately best practice, according to suppliers of the solution, is limited to what the suppliers define as best practice, and is often oriented towards the products the supplier is producing or associated with. The problem with this supplier approach is that suppliers do not have intimate knowledge of the business as such lack in consideration of business context and often does not go to the required level of analysis to understand business requirements in order to design a solution that addresses them adequately.

2.2.3 Usable and Useful Information System Technologies

The usable and useful IST dimension addresses the requirement for usability and usefulness of the IST. It is interlinked with the dimension of contextual factors in that it is highly likely that IST cannot adequately account for social, contextual and environmental factors in its design to deliver on its intended function. IST has to be usable in its context and setting, and it must support the varying dynamics under which social actors have to perform their day-to-day functions. It is with this view that the researcher has identified Layder's (1993) stratified framework of social organisation and human action as the most appropriate framework to extend into an analysis framework. This framework recommends that analysis needs to be conducted at four levels, namely context, setting, situated activity and social actor level, thereby enabling the comprehensive analysis of the requirements serving as an input into the design of IST and BIA in an integrated manner. As a guiding principle, designers should aim to design IST that are integrated into people's daily routine without being an additional burden (Maunder, Marsden, & Tucker, 2006).

The measure of success for the usability and usefulness dimension is the ease with which the social actor can intuitively perform key functions and obtain appropriate data from a multifaceted information setting. The preparedness of the organisation to equip social actors with relevant and good quality information, in or near real time, determines the extent to which social actors are allowed to participate in decision making at their level of operation. Analysis of who should get access to what information, when, how and in what format, is a critical input into how social actors are allowed to participate, placing pressure on how IST are designed as foundational enablers of the BIA function. Often during execution, staff members do not have the luxury of waiting for information to be delivered to them in a format and time required by them, especially when dissemination processes and protocol are too rigid; thus they make decisions independently. In assessment of the health state of the IST and effectiveness of the design methods in integrating the ISTs and BIA function, organisations ought to find answers to the following questions:

a. How reliable is the information that the operational staff are basing their decisions on?
b. How relevant is information produced from BIA?
c. How timely is the information?
d. To what extent do the decisions align to the strategy of the organisation?
e. How and when will the organisation know if a decision that has been made is good or bad for business?
f. What will it take for organisations to equip staff with appropriate information so that decisions made during operation enhance business performance?

2.2.4 Integrative Design Method in Reducing Decision and Action Latency

In fast-paced and interconnected global markets, elapsed time, which Golfarelli et al. (2004) refer to as 'action time', becomes critical to manage or possibly reduce to a reasonable period of time. The ability to reduce latency between activities enables business to react to changes in the business environment appropriately, enhancing the effectiveness of decisions being made. This capability is more relevant now with organisations' reliance on near real-time information to make decisions.

Real-Time Reporting and Analytics in Enhancing Business Value

Real-time BIA enables organisations to have access to real-time data in or near real time, shortening the time it takes to make informed decisions while enhancing the effectiveness of the decision-making process. In echoing this view, Seufert and Schiefer (2005, p. 3) add that 'real time BIA shortens the period of time between the occurrence of a business event that requires an appropriate action by the organisation and the time the action is finally carried out'. Following on this argument, it is therefore logical to conclude that the less the lapsed time between the occurrence of the event and the decision-making process, as well as the time that elapses between the decision that has been taken and the action in response to the actual event, the greater the business value, and vice versa.

Big Data focuses on building the capability to tap into large volumes of rich text data on a real-time basis from social media, customer contact centres and general consumer behaviour-related information. This is often sourced from third parties in an unstructured format for data and text mining, as well as advanced analytical and behavioural intelligence creation. The volumes, variety and velocity of this data place pressure on organisations to ensure that valuable time is not lost trying to clean data from systems when this could have been enforced through systems control at design. This affords organisations the time to integrate structured data from systems with unstructured data from the variety of sources in motion, in near real time, in the production of insights with which they manage business performance or create competitive edge.

To illustrate this point, the study borrows from Hackathorn (2005), to illustrate that the greater the time between decision-making process and action, the greater the loss of the value that would have accrued to business had the decision-making process and action time been close to the occurrence of the event. Four components of action time which are adopted from Hackathorn (2005) are briefly discussed in the section below, namely data, analysis, decision and response latency.

Data latency refers to the time that lapses between the occurrence of the business event until data is stored and ready for analysis. Data refresh cycle time determines how quickly data can be made available for analysis. With more organisations adopting real-time BI and Big Data strategies as sources for competition, the need to reduce the data latency has increased, thus placing pressure on BI delivery.

Analysis Latency refers to the time from when data is available for analysis to the time the information has been analysed and outputs produced for consumption. A variety of tools are available for this process and with the increasing demand for exploration of large amounts of rich text data in order to discover unknown relationships between variables or single data items, BI tools and platforms are advancing to include real-time BI and Big Data analytical capability.

Decision latency refers to the time it takes decision makers to make fact-based decisions from the information or insights delivered. This type of latency is determined by the time required to select appropriate actions for a response to the business environment.

Response latency refers to the time needed to take an action based on the decision made and to monitor its outcome. This includes communicating the decision made as a command or suggestion, or executing a business action in a target system.

Figure 4 depicts latency between the occurrence of the event and the business value of action taken.

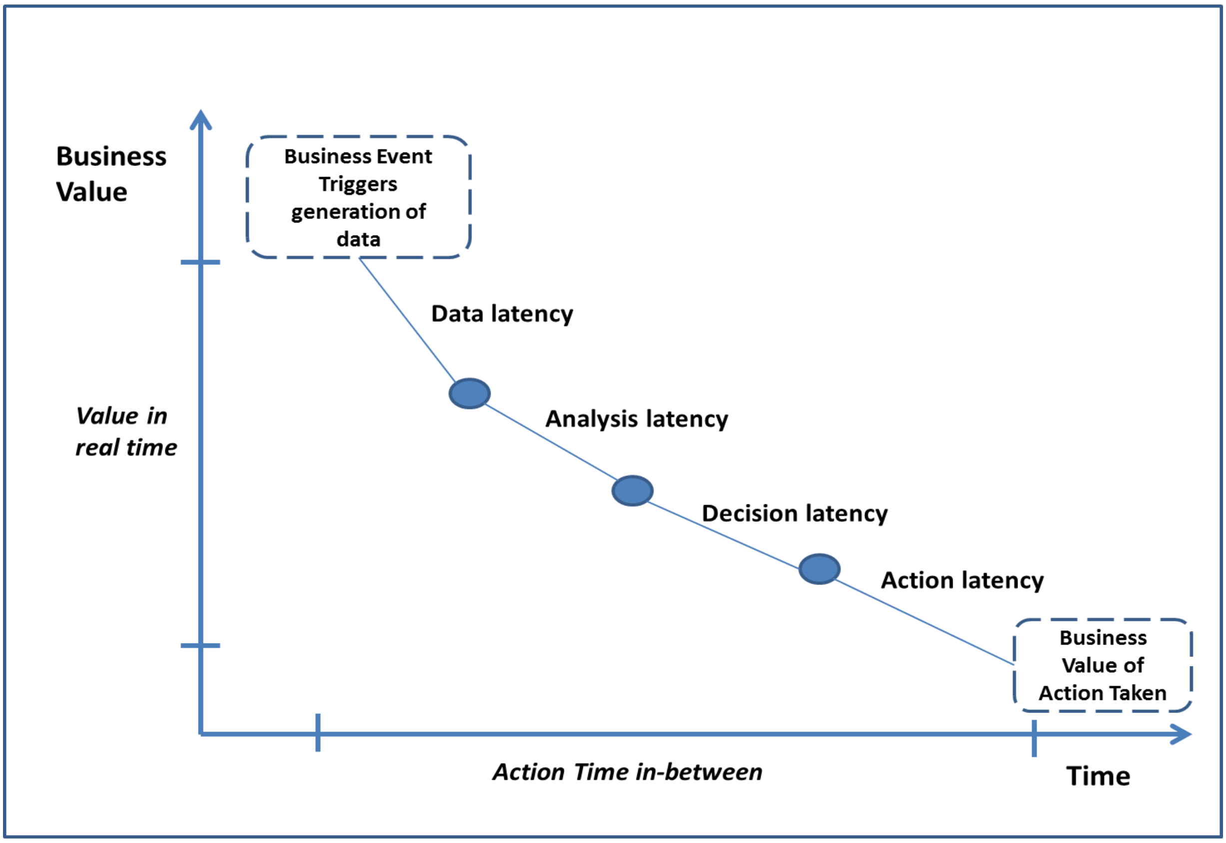

Figure 4: Business Value and Action Time (Hackathorn, 2005)

Schneider (2007) cautions that while the time taken to make a decision may be quick, the time taken to gather relevant and reliable context against which to make the decision may not be as quick, contending that without sufficient context that social actors bring, decisions made may be of limited usefulness.

As an example, transaction-based IST, such as ERP, are now commonplace in every major industry, effectively levelling the playing field across industries. This has changed the source for competitiveness from system-based advantage and leveraging of data, to how data is exploited, with what combination of tools and actors. Actors offer unique value contributions to organisations and as such are central to everything an organisation can achieve.

Organisations that want to remain competitive capitalise on the above reality by investing in tools, methodologies and techniques that will see them reduce the action time between the four key components and increasing the business value. This research illustrates that BIA investments should not be made independent of IST investments, whereby the process starts with understanding how the systems and technologies, methodologies and techniques that support their design and development, align to the desired end state of IST that are a good foundation for BIA. That is, real- or near real-time analytically oriented IST, event reporting, advanced analytical and data mining capabilities, provide organisations with an ability to rediscover and capitalise on the information they already own. Staying abreast of their competition means that an organisation has to have the ability to produce quick responses and results to changing business scenarios.

2.3 Business Intelligence and Analytics Evolution

BIA has come a long way as a function and continues to shape and re-shape the BIA discipline. It is not a complete departure from DSS and EIS, but is instead an evolution from classical forms of information-based decision support systems which were introduced in the 1960s and 1980s respectively. In organisations, reporting needs have evolved with more information becoming available, the demand for data mining and advanced querying and analytical capability, and so the concept of BI as a discipline was coined. BIA is currently the most comprehensive business performance-management capability the industry has experienced, and it continues to evolve with newer and more advanced tools and methods being introduced. The new wave of digital transformation of the industry is yet another way in which the discipline has been compelled to adapt. The new era of Big Data, cloud computing, mobile computing and social collaboration brings with it new dynamics. Unfortunately, this challenging new problem is happening at the time when IST and BIA value is still being questioned.

The evolution therefore does not relieve the field from the basics, particularly because the foundation upon which to build capacity to deal effectively and efficiently with digitisation forces has to be built on sound principles and IS fundamentals. For instance, whether the business model is changing from being based on infrastructure and hardware services to cloud computing service, from traditional methods of delivery to mobility, from focusing on structured sources of data to social collaboration platforms and Big Data, the fundamentals remain unchanged (Seufert & Schiefer, 2005). Hence there is a requirement for researchers and practitioners to work collaboratively in the development of BIA-centric design approaches (Golfarelli et al., 2004).

BIA has been defined by scholars and industry researchers from various perspectives; however, simply put and at the core of all the definitions is an acknowledgement of the key role that BIA plays in transforming raw data into meaningful information and insight with which to manage business performance. Olszak and Ziemba (2007), argue that the primary purpose of BIA is to develop insight and knowledge for optimising future actions and where necessary to align organisational performance appropriately in order to help enterprises realise their strategic objectives more effectively and efficiently. In supporting this view, Ranjan (2009, p. 60), highlights that BI process entails 'sifting through large amounts of data, extracting pertinent information and turning that information into knowledge upon which actions can be taken'. According to Chen, Chiang and Storey (2012), BIA is often referred to 'as the techniques, technologies, systems, practices, methodologies, and applications that analyse critical business data to help an enterprise better understand its business and market and make timely business decisions'. Khan and Quadri (2012), suggest that BIA's objective is to improve the timeliness and quality of information, and enable managers to be able to better understand the position of their firm in comparison to competitors. For this research work, the study borrows its working definition from Golfarelli et al. (2004, p. 1), where they define BIA as 'the process of turning data into information and then into knowledge'. A precondition for successful BIA function is therefore the ability to improve the quality of data while decreasing the time it takes to make it available for consumption (Kallinikos, 2002).

Gaining in importance are techniques, tools and platforms capable of handling advanced reporting and analytical requirements, as well as responsiveness to changing business scenarios such as demand for real-time event reporting and Big Data analytics. According to Golfarelli et al. (2004, p. 5), 'DW is not enough to this end since its technology is neither suitable for the grain nor for the freshness of the collected information, that should quickly flow throughout the different levels of the company'. The classical approach to BIA, which has DW embedded in it, creates limitations in terms of the direction that the discipline should be going, in particular how it is currently positioned within the architecture landscape.

2.3.1 Transition from Classical and IT-Centric Business Intelligence Analytics to Modern Business Intelligence Analytics

Traditionally, for information to be availed for reporting in various forms, information from operational source systems and technologies was transformed via an extract, transform and load (ETL) process, a process designed to ensure that data that is transformed into the EDW does not lose meaning and value and that it balances to its original source. The ETL is often executed at specified timeframes, allowing all systems that share related data to update at a specific time, allowing the processing of data into the warehouse to be executed in batches when there are not many new transactions taking place. This approach is time consuming and often results in delayed decisions, thereby minimising their effectiveness.

In addition, due to the traditional rigid design of DW, integration of different, dispersed and heterogenic data, organisations were challenged as BIA could only deliver within the constraints of the environment, thereby limiting delivery of effective BIA. The challenge was further uncovered when organisations began to pay particular attention to unstructured market data, generated both internally and externally. This meant that organisations had to invest in high-cost tools and expertise to work on the advanced analytical and data mining tools. Investing in advanced capabilities and tools did not help much as they did not address the underlying problems – the ability to seamlessly integrate multiple data sources, clean data in motion and the reality of legacy environments.

For a long time, traditional forms of BIA (like Management Information Systems, Decision Support Systems and Enterprise Information Systems) have been supporting all BIA requirements (C. M. Olszak & E. Ziemba, 2007). Today many fall short in delivering on the organisation's requirements due to the changing BIA landscape: organisations' reliance on BIA to monitor all aspects of their business in or near a real-time basis in order to make decisions based on timely, clean data about their business, customers and the competition.

The speed with which good quality information is made available matters, and this becomes a challenge if the tools that are employed cannot handle integration of different, dispersed and unstructured data. Today, business is run and managed using complex systems and technologies. Data from these data sources has to find its way into BIA platforms, and do so quickly without losing its value. For example, data from the web environment, call centre logs and social media can add considerable business value, and is thus crucial in giving business the leverage it needs over its market and competition. These new sources of data require advanced data mining and statistical analytics tools like text and web mining, social analytics, and geospatial analytics. However, for the value to accrue to organisations, these need to be integrated with traditional business applications.

2.3.2 Integrated Process Systems' Impact on Real-Time reporting

Risk in business is also increased due to the high level of integration of processes across functional areas. Visibility of how one decision impacts on other related business functions is crucial, particularly for time-critical operational processes to allow decision makers to tune their actions accordingly (Golfarelli et al., 2004). In process-driven environments, it is crucial to understand the requirements for delivery of information in order to ensure that data updates are made available at the right time, at the proper decision level in the best form. Failure to align to the business requirements may result in inconsistent feeds that result in creating chaos as opposed to enabling a meaningful supply of timely data for consumption by other related functions. In support of this view, Golfarelli et al. (2004, p. 3) caution that BPM systems, while they are a type of BIA, due to their business focus 'are not supposed to operate in real-time, but rather in right-time, meaning that it is crucial for information to be fresh enough to be useful for decision making'. A concern addressed by near real-time or high performance reporting is that they both seek to take into account the use case of data reporting to ensure meaning and value are not lost in the process of providing real-time capability.

2.3.3 Real Time in Supporting Decision Making

Business's ability to adjust to changing circumstances as expeditiously as possible is a critical success factor (Yeoh & Koronios, 2010). Access to all the information business users need on a real-time basis enables them to learn from and make decisions on the go. Because business users are informed on all relevant business aspects, anytime and anywhere, the decision-making process is enhanced and effective. Furthermore, real-time support equips business users from all levels with the ability to make decisions at the point of operations anywhere as they do not need the information to be delivered after the event to make informed decisions. This is the power of connected and visible business processes enabled by both BI-centric IST and a digitised BI environment.

2.3.4 How the Nexus of Forces and Internet of Things Extend the BIA Evolution

While the focus of the study is on understanding how to design IST that are BIA-centric by going back to basics, since the two are interdependent sub-disciplines of the IS field, it is important to highlight how this journey is potentially made complex by the emergence and the disruptive nature of the nexus of forces and the IoT (Gartner 2013, 2016).

The study takes a view that while these extend the sources of data input beyond the application systems and social actors, designing without the context of these defining events in the field will limit the depth and breadth of the study, resulting in capabilities that do not add value in practice and in the digital economic era. Hence the decision to include in scope the nexus of forces and the IoT as the researcher journeys in the course of the research study.

The four mega technology forces are described briefly in the section that follows.

Figure 5 depicts the individual functions of the four mega trends in the business setting. Further to outlining the functions, the diagram highlights their interdependent, interrelated and interconnected nature, compelling businesses to develop integrated strategies on how to respond to them.

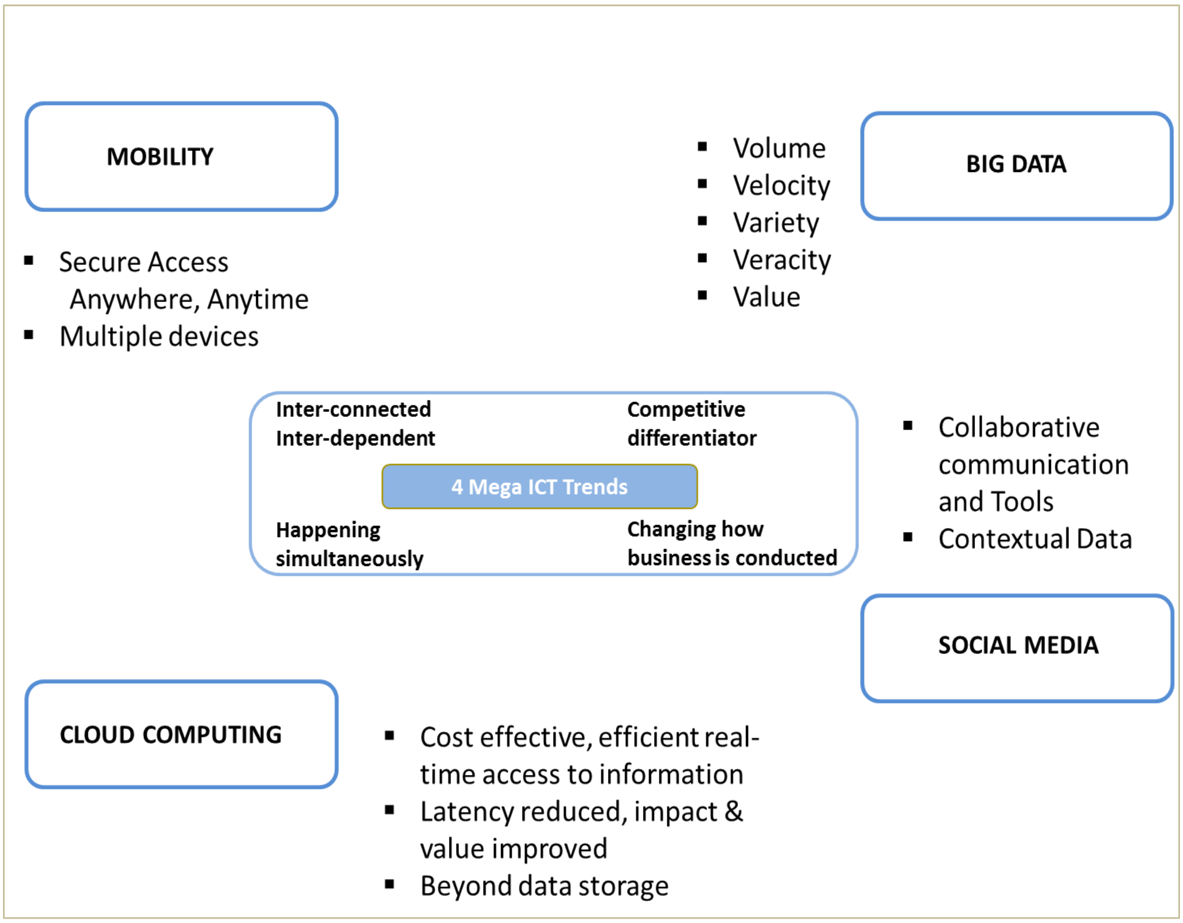

Figure 5: Nexus of Forces (Gartner, 2014)

The section below briefly outlines how each trend challenges the conventional ways of doing business, to leverage IST in more strategic and transformative ways.

Cloud Computing

Cloud computing leads to commoditisation and repackaging of IST capabilities. Due to its impact in reshaping the provision of infrastructure-related service offerings to business users, such as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS), it forces IT organisations to rethink their role in the value chain. The movement to the cloud is inspired by the opportunity to reduce cost and to leverage the elasticity it offers.

SaaS applications are designed for end users, delivered over the web; PaaS is the set of tools and services designed to make coding and deploying those applications quick and efficient, and IaaS is the hardware and software that powers it all – servers, storage, networks and operating systems.

Cloud services provide business with new and cost-effective options to host their technology requirements. Further to the provision of technology hosting and infrastructure, the cloud computing option now extends to BIA in a smart, near real-time basis. This means that organisations only have to concern themselves with the cost of providing the intelligence and analytics results, and not support and maintenance of the technology infrastructure, hardware and platforms that provide them. A significant number of cloud service offerings are based on availability and offer limited support when it comes to performance isolation. Organisations that require this service offering have to be prepared to pay a premium for performance requirements that do not come standard as a package offering.

Because of social media platforms enabled by cloud technology, certain businesses are now scaling down on heavy asset investments such as buildings that serve as a meeting place for consumers and service providers. The focus is now on how to best enrich online, web-based customer experiences and allowing the cloud service providers to take care of the infrastructure and hardware costs.

Social Media

Social Media is mainly driven by user-generated contents from online sources which include but are not limited to forums, online groups, web blogs, social networking sites as well as social multimedia sites (for photos and videos).

In a business context, social media facilitates a much broader and deeper involvement of customers and employees in the manner that automates commercial activities. In support of this view, Zeng, Chen, Lusch and Li (2010, p. 14) add that 'businesses are tapping into social media as both a rich source of information and a business execution platform for product design and innovation, consumer and stakeholder relations management, and marketing'.

The connectedness of both the customer and business world results in changing business models in terms of how business can connect their customers and further enhances customer understanding and appreciation of their needs. This allows businesses to be more responsive and effective in their target market strategies. Other organisations take it a step further and leverage the network of their customers as marketing strategies, offering creative ways of doing business.

Social media has created opportunities for product developers and service providers to have real-time insight into both prospective and existing customers' needs, in a manner that would not have been possible outside of the social media networks. It is arguably the critical part of the information ecosystem (Zeng et al., 2010).

The Internet and mobile technologies are the primary drivers behind the social media uptake in both social and organisational settings. The reduction in cost for Internet access and widespread use of mobile phones adds to the unprecedented reach to customers, providing for a good platform for businesses to ensure their presence in the market. The most common of these platforms and benefiting both customers and business are MySpace and Facebook (social networking), YouTube (social networking and multimedia content sharing), and Twitter (social networking and microblogging), to name a few.

Big Data

Gartner, Inc. defines Big Data as 'high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making and process automation' (Gartner IT Glossary, n.d.).

Definitions of Big Data volumes are relative per industry type and vary by factors, such as time and the type of data, thus making it difficult to define a specific threshold. For example, what may be deemed Big Data today may not meet the threshold in the future because storage capacities will increase, allowing even bigger data sets to be captured and or what may be deemed big in one industry may not meet the threshold of Big Data in another industry. The type of data inform what is meant by ‘big’. The tabular data type requires different data management technologies to the video data type.

As data in multiple formats and from diverse sources, both internal and external to business organisations, becomes possible, it means that more data is now available with which to generate enriched insights as compared to limited data that was available in the past. The volumes, variety, velocity and veracity of data provide opportunities to perform more accurate analytics, supporting better predictions of, or reactions to, events that characterise the business and customer environments. The new data sources are made possible by cloud computing technologies, extended in use by the spread of social media and access being made possible by the mobility of access anywhere, anytime. The challenge with voluminous, heterogeneous and autonomous sources of data is that their distributed and decentralised nature makes it difficult for any organisation to exercise control or tracking of the complex and evolving relationships among data (Wu, Zhu, Wu, & Ding, 2014).

Volume refers to the magnitude of data. One terabyte stores as much data as would fit on 1 500 CDs or 220 DVDs, enough to store around 16 million Facebook photographs (Schroeck, Shockley, Smart, Romero-Morales, & Tufano, 2012). Beaver, Kumar, Li, Sobel, and Vajgel (2010) reported that Facebook processes up to one million photographs per second. One petabyte equals 1 024 terabytes. Earlier estimates suggest that Facebook stored 260 billion photos using storage space of over 20 petabytes.

Variety refers to the structural heterogeneity in a data set. The latest advances in technology extend the scope of data sets that can be utilised for the benefit of the organisations who invest in them. By variety the research refers to structured, semi-structured and unstructured data. According to Cukier (2010) structured data constitutes only 5% of data stored in tabular format found in spreadsheets or relational databases. Text, images, audio and video are examples of unstructured data. Often this type of data lacks the structural organisation required by machines for analysis and requires advanced tools to store and analyse it. Semi-structured data on the other hand is data with the format that does not conform to strict standards of fully structured data and yet its unstructured elements are machine readable and as such supported and manageable by many textual languages for exchanging of data. Extensible Markup Language (XML), a textual language for exchanging data on the web is one such example.

Velocity refers to the rate at which data is generated and the speed at which it should be analysed and acted upon. The explosion of digital devices such as tablets, smartphones and sensors has led to an unprecedented rate of data creation and is driving a growing need for real-time analytics and evidence-based planning. This data provides sound information about customers that can be used to create a competitive advantage for organisations that exploit it to create real customer value. The information includes geospatial location, demographics, spending patterns and behaviour.

Veracity refers to the inherent unreliability in some sources of data. Certain data sources are uncertain in nature and with low predictability yet they contain valuable information, especially when acted upon at the point or time it was captured or sourced. For example, customer sentiments in social media are contextual in nature and reflect human judgement. Yet they contain valuable information. According to Raghupathi and Raghupathi (2014, p. 4) ‘veracity assumes the simultaneous scaling up in granularity and performance of the architectures and platforms, algorithms, methodologies and tools to match the demands of big data’. Thus the need for advanced platforms and tools to deal with imprecise and uncertain data is another facet of Big Data, which is addressed using tools and analytics developed for management and mining of uncertain data.

Value refers to the value derived from analysing Big Data, taking into account all four characteristics of Big Data. Oracle (2013) argues that Big Data is often characterised by relatively ‘low value density’. That is, the data received in the original form usually has a low value relative to its volume.

Mobility

The explosion of devices such as smartphones and tablets that have already surpassed the PC as the primary means for accessing information (Gartner, 2013), has changed the face of computerisation and how information is consumed. Accessibility of downloadable applications and reduction in associated cost for downloads are fast transforming industry and society at large. Businesses that have caught up recognise the fact that limiting access to business and corporate information does not only result in lost opportunities but comes at the cost of efficiencies and productivity as employees can be equipped with the tools to do business anywhere, anytime as long as it is in a safe and secure manner. Furthermore, organisations are opting for Apps that can be utilised in the field to digitise processes that were previously manual in order to minimise human-generated input that is often prone to error.

Internet of Things

Coetzee and Eksteen (2011, p. 1) describe the IoT as 'a vision where objects become part of the Internet: where every object is uniquely identified, and accessible to the network, its position and status known, where services and intelligence are added to this expanded Internet, fusing the digital and physical world, ultimately impacting on our professional, personal and social environments'. Figure 6 below presents an overview of the IoT, its application and potential benefits to the organisation and the economy at large.

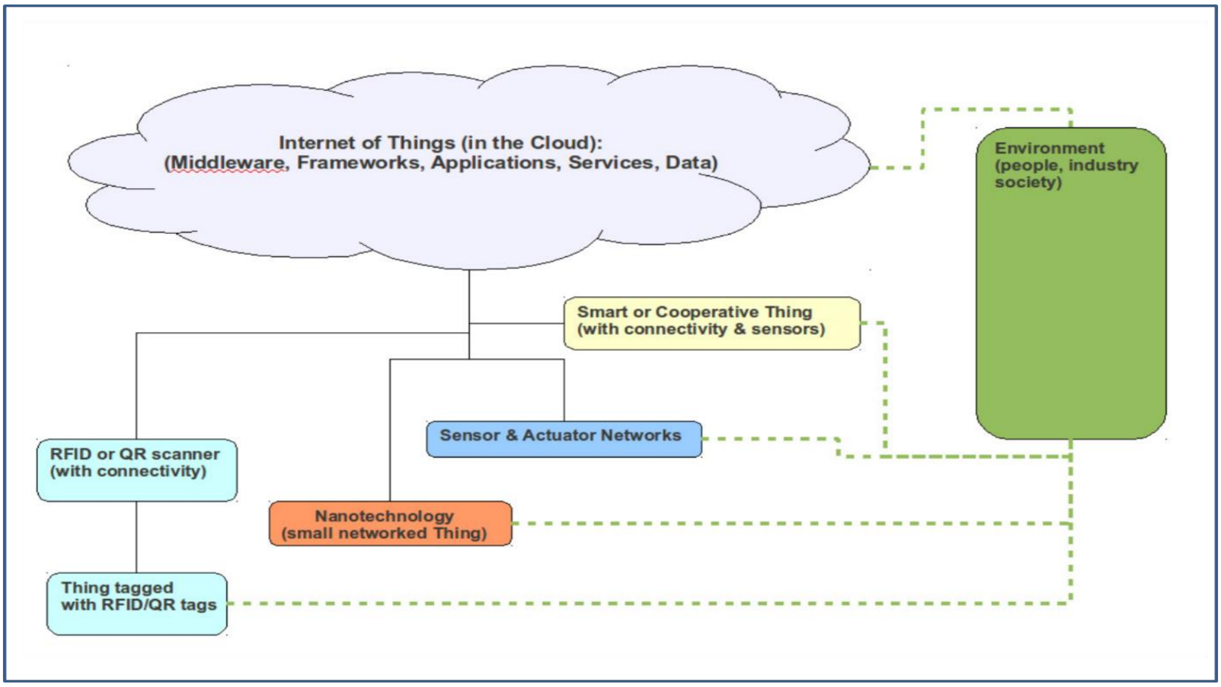

FIGURE 6: INTERNET OF THINGS (COETZEE & EKSTEEN, 2011)

Figure 6 illustrates how the everyday objects equipped with ubiquitous intelligent interconnection are enabled by Internet networking. Gubbi, Buyya, Marusic, and Palaniswami (2013) add that ubiquitous sensing enabled by Wireless Sensor Network technologies cuts across many functional areas and industries. The IoT increases the ubiquity of the Internet by integrating every object for interaction via embedded systems, which leads to a highly distributed network of devices communicating with human beings as well as other devices.

The IoT opens up exciting new streams of innovative applications with machine-generated data that may contain attributes that are not readily discernible as necessary for analysis (for example sensor hardware/firmware, semantic, cloud, data modelling, storing, reasoning, processing and communication technologies). Sensors and actuators blend seamlessly with the environment, enabling sharing of information across platforms and offering the ability to measure, infer and understand environmental indicators. These generate enormous amounts of data which have to be stored, processed and presented in a seamless, efficient and easily interpretable form.

Furthermore, critical in adding value using IoT is understanding of context of raw sensor data, situations or conditions (for example sensors in infrastructure or environmental conditions such as temperature and moisture) of the artefacts for which the data is being collected. Accurate information about the status, location and identity of things allows for smarter decision making and appropriate action taking. Gubbi et al. (2013) posit that for technology to disappear from the consciousness of the user and evolve to smart connectivity and context-aware computation, the IoT has to have at a minimum the following: (a) a shared understanding of the situatedness of use of IS artefacts, machines, appliances, networked objects etc.; (b) software architectures and pervasive communication networks used to process information in context without losing its meaning and value; and (c) the analytics tools in the IoT that aim for autonomous and smart behaviour.

2.3.5 Interdependence, Interconnection, Interrelatedness of the Four Mega IT Trends and Internet of Things

The interdependence and interconnection of the four mega trends and IoT further complicate the IST and BIA debate in that sources of information are not only expanding but are adding more complexity in terms of what data is sourced and what combination of tools can be utilised to source and integrate relevant data with which to provide insights in order to respond effectively to business moments or events.

Social media benefit organisations through interconnectivity and the public platform which makes connecting to market audiences fast and cost effective. The wealth of information that is suddenly available through social media channels for organisations to tap into is astounding. Large volumes of data from a variety of sources which were previously not available are now accessible to businesses to mine as competitive sources of information, now formally known as Big Data. This translates to Big Data in that the information that BIA tools need to transform into insight is not only in huge volumes but it is diverse and from a variety of sources. The speed with which BIA tools are able to isolate the noise in the data and select relevant data without losing its reliability as a differentiating factor and competitive advantage, offers added advantage.

In addition to the mining of data and analytics is the ability to disseminate information and intelligence quickly, making information readily available to decision makers and the knowledge workforce. This dynamic introduces an additional scope of BIA capability, namely tools that extend their delivery platforms to include mobile platforms. In essence BIA development now includes mobility enablement. This challenges the mindset of not only the developers but also the social actors as they now need to understand the risk associated with having organisations' data suddenly available on mobile devices. The risk relates to having limited control over their business data assets.

Linked to the above concern is the risk and the cost associated with storage of the large volumes of data. This makes the business case for cloud computing as an option for storing of the large volumes of data, shifting the risks and costs associated with ensuring that services in the form of information are available on demand for consumption by business. However, this option is not without risk. Organisations' data stored in public or private cloud solutions that are sometimes shared with other clients, poses a risk, hence the need for strict compliance measures.

The interdependence, interconnection and interrelatedness of the four mega IT trends and the IoT present the IS design science discipline with new challenges which necessitate a review of the impact and influence that these challenges may have on an integrative approach to IST and BIA design. Gartner (2014), enterprise architecture hype cycle, reported that disruptive technology-based trends such as IoT, social, mobile, Big Data and cloud computing, have and will continue to have a profound impact on business and IT. Chen et al. (2012, p. 1168) in contextualising the impact of these disruptive trends add that 'the ability of such mobile and Internet-enabled devices to support highly mobile, location-aware, person-centred, and context-relevant operations and transactions will continue to offer unique research challenges and opportunities throughout the 2010s'.

It was therefore prudent for the researcher to assess the design limitations introduced by disruptive technology-based trends in order to ensure that these are understood and effectively addressed as the researchers and practitioners continue to advocate the need for symbiotic approaches to IST and BIA.

2.3.6 Design Considerations in the Digital Economic Era

IST and BIA design challenges extend as new forms of data sources emerge and stream at an unprecedented speed. In responding to the design limitations which constrain an organisation's response to changing configuration and data convergence requirements, this study examined how the evolution of four mega IT trends and the IoT complicates the design function and increases elements for consideration during design. Further to the need to design for this new phenomenon, designing for converging data sources, new skill sets and the way of thinking about design is required more than was the case for the commonly employed design methods, namely Waterfall, Rapid, Spiral and Agile development.

During the IST and BIA design and development life cycle, internal, external, multiple data formats and structures as well as multiple locations, context and situated uses need to be analysed. The analysis phase is thus becoming more crucial as different sources of data, data types and formats present unique challenges that need to be identified with reasonable accuracy in order to better inform design requirements. To illustrate this point the researcher identified a number of elements for consideration from analysing the literature pertaining to data sources that emerged with the digital evolution. They are discussed in the section below:

Social media metadata structures. Social media metadata structures do not conform to traditional metadata standards. Its enriched set of metadata is largely underdeveloped in data and text mining literature and design science. Examples include tags, user-expressed subjective opinions, and both explicit and implicit social networks. Metadata structures for the Internet-based data sources such as social media are a new area of development which requires new skill sets and knowledge on how to effectively address it in order to facilitate its integration with metadata conforming to standard or structured formats and structures.

Integration of context-sensitive text sources with data from business systems. Design function has to look carefully into the integration of context-sensitive text sources with business systems as these often have data structures that require careful and innovative ways of converging data while maintaining its inherent business context.

Lack of common data dictionary in design. Often BIA tools are packaged solutions, even those that are designed and developed in-house, often lack use of common definitions of business data, thus creating challenges further down the chain when data from different IST needs to be sourced to BIA platforms. For example, aligning customer definitions from different systems adds complexity to the mapping of data and increases processing time. By the time insight is generated, business has missed the opportunity to add value or respond to business events efficiently and effectively.

Governance. When traditional IST sources and unstructured data sources that are destined for BIA meet, governance should not be compromised. It is thus crucial for design methods to ensure consistency in the application of governance standards and rules when information reporting requirements are identified and analysed. Failure in achieving this may result in the delivery of analytics that lack in governance, which may have further implications for the business when in use.

Data Quality. As context becomes more important to ensure that insights can be derived from a variety of data sources, quality characteristics are becoming more of a challenge to manage. The contextualising structure of data streaming from all these sources is less determinate, and is irregular, nonrepeating and unpredictable. The emergence of diverse data types, coupled with increasing data volume, raises new data quality concerns such as a decline in data veracity. The challenge with variability of sources such as customer service call details, emails, Twitter streams and Facebook status updates, although proving to be rich sources of business information, is that they are not in formats and structure that easily support analysis. An integrative design allows for IST to be configured in such a way that the relative effort involved in achieving the required data quality standard and optimal contextual understanding is maintained, thus enhancing the analytical valued that can be derived.

Match the speed of business. Digital business increasingly requires organisations to process data in real time, at the relevant time or the specific moment that matches the speed of the business. It becomes a challenge to deliver on this requirement when data required to answer certain business questions and/or respond to critical business moments effectively comes from sources that do not share the same frequencies and patterns of data creation and delivery of data at the right time and in the necessary context. IST and BIA design has to account for this requirement and ensure that the analytical insights produced are of high impact and value.

Learning from BIA not transferred to IST and vice versa. Silo approach to design limits transfer of learning from one sub-discipline to the other in that as organisations are under pressure to modernise the BIA environment, new and advanced tools are introduced. The culture of shared and cross-functional learning needs to be embedded as it is the means through which IST can be positioned to better support the process of integrating business data to other forms of data from a variety of sources for enhanced business benefit.

Serendipitous identification and discovery of useful data. Identification and understanding of the business events and/or moments that are likely to benefit from the process of identifying useful sources and discovery of useful data within the pool of data from various sources need to facilitate convergence of data sources at more critical points, enabling delivery of reliable, timely and relevant data.

2.4 Summary

While the new era of BIA offers great promise in terms of addressing challenges presented by conventional BIA techniques, tools and platforms, there is a limit to what technology can achieve as an enabler of BIA. Technical challenges such as systems and/or technology integration and DW capabilities may be addressed or reduced to a minimum in the bigger scheme of things. However, it is important to appreciate the qualitative aspect of BIA, such as data relevance and reliability, which can be best addressed at source through proactive interventions such as design methods that take a BIA-centric view in designing IST that support business processes from a particular business context.

The literature revealed that there are still a lot of unknowns in an era of digital disruptions that the IS field has to deal with as academia and practice strive to move the field forward and develop new design knowledge and skills. Among the many things that the IS design science discipline has to address is to ensure that the design methods strive to improve effectiveness, efficiency, and innovativeness through: (a) commoditisation of non-core organisational competencies (like outsourcing and out-tasking); (b) improving the collaboration within the organisational functions and ecosystem within which the organisation belongs; (c) prioritising information security for all sources of information and dissemination mediums; and (d) separating production and consumption of a service in order to allow a better mix of IS artefacts that facilitate exploitation of information.

It is further noted that while the lack of integrative approach to design of IST and BIA has always presented challenges for BIA delivery, the digital developments in the IS field escalates costs further due to overlapping effort in data mapping, processing and reconciliation of data context from multiple sources as well as conflicting approaches in fulfilling integration requirements. It is therefore crucial for this study to review IS design science research literature in order to ensure an aligned view of the design methods considered for the research as well as understanding of the research paradigms and traditions underlying their application in practice.

CHAPTER THREE

Literature Review: Design Research and Social Informatics

3.1 Introduction

Chapter 1 laid a foundation for the research study by summarising the problem that underlies the research, indicating its importance within IS research and practice. Chapter 2 presented literature that is relevant and instrumental in positioning the subject matter of the study, IST and BIA. This chapter examines the literature on IST and BIA design function, and is divided into three sections. Section one (3.2) examines the building blocks of IS Design Science Research (DSR), by reviewing the design science literature in order to ensure that the preliminary review of IS design methods is founded on sound design science principles. Section two (3.3) seeks to reflect on design methods commonly employed in IS research and their underlying research paradigms and traditions, exploring the relevance of CR as a research paradigm underpinning SI, the theoretical base for this study. Section three (3.4) goes into more detail in reviewing CR by focusing on its concepts and application in the IS field in order to ensure the reader's understanding of CR as both the research paradigm and method employed in this study. It is intended to present the journey undertaken by the researcher to finally arrive at the design method adopted as the theoretical basis for the research and how the research paradigm enables the cause of the research study.

3.2 IS Design Method Literature Review

In recent years several academic researchers have played an important role in integrating DSR as a major component of IS research (Gregor & Hevner, 2013; Hevner & Chatterjee, 2010c; Niederman & March, 2012; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). However, the researcher contends that while DSR has gained its legitimacy in the IS field as evident in the number of IS design science studies that have been published over the years (Hevner, March, & Park, 2004; Iivari, 2007; March & Smith, 1995; Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011; Wieringa & Moralı, 2012), it has yet to attain its full potential impact in the IS field. Failure in having a striking influence and impact in the IS field is attributed to the lack of understanding and application of the concepts and methods that can reduce the tension between relevance and rigour DSR application (Gregor & Hevner, 2013; Hevner & Chatterjee, 2010c; Wieringa & Moralı, 2012). The researcher asserts that in addressing the requirements for relevance and rigour, the disciplines should begin to pioneer the adoption of an integrative approach to the design of IST and BIA in context (Heeks, 2006; Hevner et al., 2004; Wieringa & Moralı, 2012).

Design is fundamental to the IS discipline (March & Storey, 2008). It is the means by which IS artefacts may increase their effectiveness in resolving business problems and improve performance of business organisations. The very concept that design science is premised on – to solve critical business problems – presents a gap or risk which needs to be managed by having a sub-discipline focus in how the problems are addressed as evident in DSR studies that are aimed at addressing specific use cases (Peffers et al., 2007; Wieringa, 2009). Upon review of IS design science literature, it became apparent that studies focusing on solving IST use cases tend to adopt a systems and/or technology design approach, and where reporting requirements are considered, do not go beyond transactional reporting. On the other hand, BIA design studies are largely oriented towards generation of business insight in support of decision-making processes with limited concern for data sources and quality before it reaches BIA platforms. It was further noted that BIA design studies are few compared to IST design studies.

The misaligned goals of the two disciplines make it difficult to align common methodologies or frameworks for the design function to be effective in practice (Kuechler & Vaishnavi, 2012; Peffers et al., 2007). The misaligned priorities and focus emanate from the fact that while IST and BIA share a common interest in ensuring that business organisations realise value from the IS investments, their unique identity and discipline focus influences how this is achieved (Vaishnavi & Kuechler, 2015). The review of literature has further revealed a weakness in DSR consideration of contextual factors which are central in making a case for an integrative approach for design and development of IST and BIA. Hence there are studies that advocate for DSR methodologies and frameworks that account for context (Wieringa & Moralı, 2012). Gregor and Hevner (2013) write on understanding of how DSR relates to human knowledge and Niederman and March (2012) highlight the importance of linking design and behavioural perspectives. The relevance of IS solutions is directly attributed to the design effectiveness in accounting for the context upon which the deployed artefact needs to thrive (Sein et al., 2011).

Successful application of DSR can be achieved through understanding which of the design concepts and methods can be effectively applied in IS studies and practice. The study takes a view that in examining these concepts and methods the researcher will be able to define the path the study should undertake in order to develop new knowledge that will contribute in the advancement of the IS field. This section has been categorised into three parts. Part one seeks to understand the design science concepts that are commonly applied in IS as these may be useful in informing the concepts for consideration and increase the effectiveness of the research journey. Part two focuses on examining the process of developing new design science knowledge as crucial step in advancing the field. Part three focuses on understanding the role of design methods in ensuring relevance and rigour when DSR outcomes are applied in practice.

3.2.1 Understanding of the Conceptualisation of IS Design in the Broader Literature

McKay, Marshall, and Heath (2010), note that while the design concept is conceptualised differently in non-IS versus IS studies, there are commonalities across the disciplines that are worth noting. This study concentrated its efforts on evaluating the four concepts that are commonly applied in IS research and practice. The four predominant conceptualisations are: design as problem solving, design as product, design as process, and design as planning, modelling and representing. The researcher has observed that although IS DSR scholars put emphasis on different concepts and approach their research studies differently from one another, there is more alignment on which concepts are critical in pioneering DSR as a catalyst in IS design and development of IST and BIA.

All four concepts are supported by the study's IS design science definition, assimilated within the design method attributes through which these concepts are actualised and lastly link to the process of enquiry advocated by study in designing IST that are a foundation for BIA. The study defines IS DSR as 'a process used to translate qualitative and technical requirements specified during analysis into design, enabling configuration and development of the socio-technical systems and technologies that enhances human experience and meaning, while improving BIA capability'.

The researcher does, however, caution that where design is conceptualised as product, it tends to give the power to the designers of IS artefacts if not managed adequately. Where a product view is adopted, the study strongly advocates for a strong systems design thinking philosophy as it ensures that social actors, context and environmental factors receive the same level of priority as the technical requirements. Meinel and Leifer (2010, p. xiv) define design thinking as, 'a human-centric methodology that integrates expertise from design, social science, engineering and business'. It is centred on creating meaningful and human-centred experiences through understanding of behaviours and values when confronting complex problems. Furthermore, design thinking philosophy is founded on sound design principles, preventing the designers from constraining their competency and assumptions. Design thinkers use their ability to be intuitive, to recognise patterns in their environment, and to construct ideas that have emotional meaning as well as functional value. Although design thinking research is outside the scope of this research, the researcher acknowledges the fact that it plays a significant part in the mindset change and competency building of designers, and is thus an important consideration for those advocating a product view.

The section below briefly outlines the four common design concepts identified in the IS design science literature.

Design as Problem Solving

Design has been rationalised as a problem-solving tool by many disciplines (Dorst, 2006; March & Storey, 2008). Kruger and Cross (2006) support this notion, but go further to emphasise the need to gather sufficient information that helps in accurately defining the problem before jumping into the solution-design mode. They place emphasis on design as being the solution to the problem rather than the existence of the problem. According to McKay et al. (2010), research studies that view contextual factors as critical elements for consideration during design, view design as solving field problems where activities involved go beyond designing a solution, but ensuring that the solution will work in the targeted social and organisational context.

Design as Process, Action

Looking at the process involved in designing a particular solution, it cannot be disputed that involved in that creative process is a series of thoughts and activities by which an artefact is created and realised. In supporting this view, Hevner et al. (2004) and March & Smith (1995) add that design science has a process element. The process elements are build and evaluation. Worth noting is that the process design concept is closely linked to the problem-solving concept in that artefacts are built to solve problems and their performance evaluated with respect to the utility provided in solving those problems. Important to note is that what differentiates an effective design process from a poorly delivering one, is how the designers view their role as well as their understanding of the activities involved in delivering the final output. Galle (1999) advocates for the notion that for the design process to be effective, activities involved in designing the solution should be extended to include activities concerned with ensuring that the IST delivers on its intended function and that it is useful and usable in the context for which it was designed. This study argues that examination of mechanisms that underlie these activities helps in the identification of non-deterministic tendencies on which design can be informed.

Design as Planning

Wieringa and Heerkens (2007) argue that design is an activity concerned with conceptualising a solution, followed by laying out a schematic of how the different components of the solution come together to form a solution that will address a particular problem. Galle (1999) takes the concept further to argue that the process of conceptualising the solutions involves a series of planning activities aimed at ensuring that each activity and phase considers how the solution can be embedded in its context of use. This is directly in line with the CR thinking that the activities should be mapped at various levels of the social organisation and human action, otherwise it becomes a challenge to unearth the mechanisms that trigger certain events.

Design as a Product

Hevner et al. (2004) and March and Smith (1995) highlight that there are four products of design science, namely constructs, models, methods and instantiations. The constructs aid in providing a common language in which problems and solutions are defined and communicated to the impacted stakeholders. Models aid in understanding the real world context in order to assist in the exploration of the effects of design decisions and changes. Methods provide a step-by-step guide or framework on how to solve problems. Instantiations are aimed at minimising design failure through testing of feasibility and suitability of the solution before implementing the artefact.

The product view of design puts the designer at the heart of the design process and thus positions design as an outcome of human creativity and industry (McKay et al., 2010). The danger with this view is that activities associated with producing the 'actual' design output, are not independent of the designer. The influence of the designers is problematic and therefore needs to be managed to ensure that the output is not limited to designer's assumptions, experience and skills, but is shaped by the process and is driven by the set of predefined activities and recommended design principles per phase while adequately accounting for contextual factors.

3.2.2 IS Design Research Gap in Advancing Design Knowledge and Understanding

Having considered the role of DSR in IS, this section focuses on the role of the DSR in advancing design knowledge and understanding in the IS field in order to increase its adoption in practice. The role of DSR in advancing the IS research and practice agenda is undisputed; hence it is critical to understand the current state in relation to its desired position in IS research. To achieve this objective the study evaluated DSR literature from the early 2000s to date.

DSR is critical in advancing design knowledge within the broader field (Venable, 2006). However, the past 25 years have seen a decline in the contribution of design research in mainstream IS research. According to Iivari (2007, p. 40) this decline was in part due to 'the hegemony of the North-American business-school-oriented IS researchers over the leading IS publication outlets (such as MIS Quarterly, founded in 1977; ICIS, started in 1980; and Information Systems Research, founded in 1991)'. While the motive was genuinely to try and close the gap between developing research that had little relevance in practice, design research suffered as a consequence. At this point scholarly research philosophy had been to develop theory-based research oriented towards business development and practical knowledge. Unfortunately, this approach understated the design research role in the development of design knowledge and practice which would have enabled mainstream IS research to address the needs of the industry, and at the same time provide scholarly support and leadership.

Iivari (2007) points out that the 'theory-with-practical-implications' research strategy failed to produce results that benefited practice, but instead created a gap in the development of design knowledge required to deliver true business value. As a consequence, IS design knowledge has been largely driven from practice with limited contribution from scientific research. This is evident in fewer research papers focusing on information systems design being published in leading IS journals (Vessey, Ramesh, & Glass, 2002). A pilot analysis conducted on the practical recommendations made in articles in *MIS Quarterly* between 1996 and 2000, revealed that the 'theory-with-practical-implications' research strategy was weak and ineffective as the gap between design and reality continues to widen (Iivari, Hirschheim, & Klein, 2004). This is further supported by an analysis conducted by Indulska and Recker (2010) on DSR paper publications in the three years between 2005 and 2007. It indicates a steady increase of on average 3% in articles published across five major conferences, namely ACIS, AMCIS, ECIS, ICIS and PACIS. This was the situation after a concerted effort to try to revive the discipline by various scholars (Hevner et al., 2004; Peffers et al., 2006). Failure of the IS field to provide scholarly support and to promote this IS design science results in fewer design research undertakings, resulting in a lack of understanding and application in practice. Peffers et al. (2007, p. 1) argue that, 'without a strong component that produces explicitly applicable research solutions, IS research faces the potential of losing influence over research streams for which such applicability is an important value'.

This gap was also identified in an analysis by Goes (2014), which revealed that the total number of IS DSR publications in *MIS Quarterly* in the period between 2006 and 2014, accounts for less than 5% of the total publications in the journal. While progress was noted in terms of academic research papers aimed at advancing the discipline since the late 2000s, it is nonetheless steady in relation to the central role DSR ought to play in championing design of relevant and purposeful IST and BIA. In context of the field that is under pressure to deliver more to support the digital economy, the percentage of research papers published during this period makes the situation look bleak. The researcher contends that more deliberate if not direct effort from both academia and practice is required to correct this situation. The energies of both academic and industry researchers should be directed not only at providing guidance on how to conduct research and employ suggested methodologies and frameworks but also at generating new knowledge that will continue to advance the field amidst the digital disruption.

3.2.3 The Role of Design Science Research in Creating Design Knowledge

Before proceeding to understand what design knowledge is, it is imperative to understand what knowledge is and what we can know. Given that the study's theoretical philosophy is CR, the context of this exercise was therefore CR.

In the context of CR research, what is knowledge?

Although many definitions of knowledge exist, there is common understanding that knowledge is the difference between what is perceived, and grounds for taking effective action, and that it has no end state (Dalkir & Liebowitz, 2011; Lewis, 2016).

Below are some of the definitions of knowledge that in part speak to how Roy Bhaskar defines knowledge:

Drucker (1990, p. 242):

> ***Knowledge*** *is information that changes something or somebody – either by becoming grounds for action, or by making an individual (or institution) capable of different and more effective actions".*

Bunge (1996):

> ***Knowledge*** *arises through the interaction of many forms of learning.*

Kolb (1984):

Knowledge *is a dynamic process of continuous reproduction and regeneration*

Bhaskar (1975) argues that there are two forms of knowledge, transitive and intransitive. They are defined as follows:

Intransitive knowledge refers to the elements of the world that, in our limited capacity, senses and experiences, we are unable to explain or account for.

Transitive knowledge refers to the knowledge generated through research and theory. Artificial objects are fashioned into knowledge by the science of the day.

In keeping with Bhaskar's definition, design knowledge is founded on epistemological assumptions, and is transitive in nature. It refers to the knowledge generated by human beings through research, theories and experiences and is a continuously evolving process. In research, it is a process that advances the body of knowledge of various disciplines and research fields. In practice the process helps practitioners take effective action or make informed decisions.

In the design research context, design knowledge gives a broader understanding of general principles which when applied in context serve as guidelines for the designer. It arises from the theories that allow us to question and learn from the world around us. Friedman (2000, p. 412), in echoing this view, adds that 'a solid foundation of design knowledge anchored in broad research traditions gives each practitioner the access to the cumulative results of many other minds and the overall experience of a far larger field'.

Traditionally IS DSR has been seen as a sub-discipline of engineering design research (Simon, 1996) because of its roots in engineering and other applied sciences (Venable, 2006). This is evident in many design methods that focus on the technology aspect of computerisation. In cases where design methods consider non-technical, qualitative contextual aspects, one often finds that the design assumptions are based on engineering theories and assumptions. This is largely attributable to the lack of appreciation that the engineering discipline is founded on sound engineering theories and principles which may not necessarily work well for a multidisciplinary and open field like IS. From the perspective of acquiring knowledge necessary to combine technical systems knowledge with organisational and people knowledge, this study proposes a complementary approach, enabling learning from all impacted disciplines. In the case of IS research, due to the argument that IST and BIA artefacts cannot be isolated from their context, settings and actors who use them, there is value in applying learnings from engineering, natural and social science design theories and research studies. This approach creates a holistic and comprehensive approach to the design of IST and consequently effective BIA delivery (Nunamaker, Chen, & Purdin, 1990).

Design Method

Having discussed the design science concepts and addressed the role of DSR in creating design knowledge that can help advance the field, we turn next to the question of how a design methods contribute to the application of design science knowledge and bridging the gap between relevance and rigour where IS artefacts are designed and developed.

During the analysis of an apparently under-researched discipline the researcher found gaps in the IS design method both from a design knowledge and design practice point of view. The research study has characterised IS as an applied science premised on the DSR discipline, because IS solutions do not spontaneously emerge, they are a product of the design process, intended to address a particular business need. The explicitly applied character of IS practice presented challenges when the researcher needed to draw lessons from the implicitly applied character of IS research. At this point of the research process, it was imperative to ensure a healthy translation of design research knowledge into practice. Design science practice depends on design method research for the development and improvement of the discipline.

In this study the researcher argues that design methods are a vehicle through which useful and usable systems in the context or setting for which they are intended and situatedness of action by the actors for whom the systems are designed. Hence it was important to examine design methods literature and ground the enquiry of the re-emerging reference discipline (Hevner & Chatterjee, 2010a).

An effective design method emphasises the importance of the analysis function and has robust techniques that enable a comprehensive account of IS and/or technology requirements and the contextual factors that enable or constrain them. Kruger and Cross (2006), in support of this view, add that design involves careful analysis and definition of the problem, but with a greater focus on designing of the solution. Braun, Wortmann, Hafner, and Winter (2005, p. 1296), argue that for the design function to deliver artefacts that are purposeful, four design method attributes ought to be adopted.

Table 1 summarise the different attributes of design method as applicable in IS design, as seen in Table

TABLE 1: DESIGN METHOD ATTRIBUTES (BRAUN ET AL., 2005)

Attributes	Description
Goal orientation	Design methods are goal-oriented, as such are concerned with achieving a defined goal or objective.
Systematic approach	Design methods provide systematic structure with rules on how to act and instructions on how to best address business problems through design and development of appropriate IST and BIA.
Principles	Design methods are largely based on design principles, thus making their approaches grounded on the need to solve a particular business problem.
Repeatability	Design methods are inter-subjectively practicable and thus repeatable.

Having examined the design concepts that are key in positioning DSR within the IS and better equipped to understand the process of developing and leveraging on new DSR knowledge, the next session extends the design method section through preliminary examination of IS design methods.

3.3 Prior Empirical Research of IS Design Methods

This section describes the preliminary analysis that was conducted on the design methods that have been influential in the development and evolution of IS design methods in the field, and as such are widely researched. The objective of this analysis was to understand the journey of IS design methods as well as to establish the extent to which these methods began integrating BIA into the mainstream IS research since its introduction in the 1990s.

There has been much speculation regarding the relationship between IST and BIA. Questions about the influence the two disciplines have on each other have been oversimplified following the assumptions about their relationship, thus justifying a critical enquiry into this phenomenon. Because the study views IST and BIA as socio-technical systems, the scope of the preliminary review was limited to methodologies that seek to balance the social and technical requirements of computing. The objective was to clarify the extent to which these methodologies consider the social, contextual and environmental requirements of both IST and BIA. To achieve the preliminary review objective, the theoretical paradigms underpinning each of the identified methods were examined. The focus was on understanding how each of the underlying philosophies' methods enable or constrain consideration of social, contextual and environmental factors. This exercise was instrumental in identifying the most suitable socio-technical method for addressing the research study problem.

3.3.1 Theorising of the Relationships

Often when IST are designed, designers have a particular view of the relationship between IST and social actors as well as between IST and BIA. The view designers hold is largely informed by prior experience as well as the theoretical assumptions the designers hold regarding these relationships. The assumptions are informed by the theoretical paradigm and the scientific research process which tend to be accepted without questioning its validity and reliability. It goes without saying that these assumptions stimulate certain speculations regarding the impact that IST may have on social actors and BIA, and will be visible in how IST are designed in relation to the influence they have on both society and BIA. In an attempt to clarify the influence that theoretical paradigms have on how the research is conducted, assumptions that designers make, as well as how the design principles are shaped, three paradigms were identified and subsequently examined. They are positivism, interpretivism and CR. Positivism and interpretivism have dominated IS research over a reasonably long period of time and are in opposition to one another (Orlikowski & Baroudi, 1991; Smith, 2006).

'Positivism is premised on the existence of a priori fixed relationships within phenomena which are investigated using structured instrumentation' (Orlikowski & Baroudi, 1991, p. 6). Positivist studies serve primarily to test theory, with an objective of increasing predictive understanding of phenomena and employ quantitative techniques and methods. Interpretivism on the other hand, assumes that 'people create and associate their own subjective and intersubjective meanings as they interact with the world around them' (Orlikowski & Baroudi, 1991, p. 6). Interpretive studies are oriented towards understanding phenomena through accessing the meaning that the social actors assign to them. In its rejection of 'objective' and 'factual' accounts of events and situations it advocates for relativistic, albeit shared, understanding of phenomena under enquiry. The theories are in direct conflict with one another in their theoretical underpinnings, research philosophy and techniques commonly employed, thus making them difficult to reconcile.

This preliminary review is structured into three parts. Firstly, the study examines the role of theoretical paradigms in research in general, and how they apply to this study. Secondly, it examines the design methods in relation to the theoretical paradigms that underpin them, in order to ascertain the extent to which they enable or constrain the design methods in effectively accounting for the social, contextual and environmental factors as IST and BIA are designed. Each of the design methods were identified due to their relevance to the problem the study seeks to address as well as the study's position on IST and social relationship. Finally, a summary of the preliminary findings of this analysis process, are discussed.

3.3.2 The Role of Theoretical Paradigms in Research

Theoretical paradigms or philosophical assumptions about what reality is are crucial in grounding the overall perspective on which the study is designed and carried out. A paradigm is defined as the 'basic belief system or worldview that guides the investigation' (E. G. Guba & Lincoln, 1994c, p. 105), and assumptions are a representation of the worldview and are usually expressed in a researcher's work. Simply put, assumptions are a researcher's theoretical lenses, representing the researcher's position about the subject under enquiry and how the researcher intends to approach the work at hand, which is further expressed in the assumptions the researcher makes. Sale, Lohfeld, and Brazil (2002, p. 45), in supporting the view, argue that, 'the underlying assumptions of the quantitative (positivism) and qualitative (interpretivism) paradigms result in differences which extend beyond philosophical and methodological debates'.

The misalignment between the academic researchers and the practitioners lies in how the academic researchers express their philosophical views through their work. Practitioners base their adoption of the design methods on three things. These are (a) presumed relevance to their need; (b) the ease with which the design method can be implemented; and (c) methodologies recommended by the vendors of the products the organisation has adopted as part of their standard architecture and infrastructure landscape. Furthermore, the issue of IS research relevance in practice has been debated in the IS community in journals like *MIS Quarterly* and *Communications of the Association for Information Systems*. Scholars such as Agarwal and Lucas (2005) and Klein (2003) argue in part that IS research tends to produce results that have limited use in practice.

Critical elements for consideration when selecting IST and BIA solutions in organisations speak to issues of governance, standardisation, economies of scale, as well as in-house skills and competence. While this selection approach is not optimal, it is a common practice in the industry (Peterson, 2004). Empirical analysis reveals that practitioners do not care about underlying theoretical assumptions and how these may constrain or facilitate their course of action. It also does not help if design research does not do much to equip practitioners with relevant knowledge, tools and skills on how to make informed decisions. Teddlie and Tashakkori (2010) argue that the underlying worldview hardly enters the picture when design methodology decisions are taken. Until such time that this gap is addressed, there continues to be misalignment between academia, industry researchers and practitioners.

3.3.3 The Theoretical Paradigms Underlying the Design Approaches under Enquiry

The objective of this enquiry was to examine each of the paradigms in relation to the design methods they underpin by focusing on the following questions: (a) What underlying theoretical paradigms do the design approaches under scientific enquiry have? (b) What design-reality gaps arise due to theory-practice inconsistences? (c) How do each of the design approaches interpret the relationship between IST and society as well as between IST and BIA? (d) How do IST and BIA enable each other to deliver in practice as interdependent disciplines? The objective was to empirically examine the design approaches considered during the study and to demonstrate how SI was identified as a viable approach in order to make a meaningful contribution to IS research and practice. To focus the study, the researcher set the boundary to the socio-technical approaches.

The examination of the relationship between IST and society, and again between IST and BIA, started by reviewing ‘technological determinism’, which according to (Chandler, 1995) is still the most popular and influential theory of the relationship between technology and society. It is followed by examination of the Social Construction of Technology (SCOT), a theory which views technology as a social phenomenon shaped by the society producing it. The last two design methods examined are based on socio-technical theory but differ slightly in their approach to achieving a balance between IST and society. Their analysis is further extended to examine the extent to which their design approach explicitly considers BIA requirements, namely Socio-Technical Systems (STS) Design and SI approaches. Both the STS and SI researchers consider both social and technical aspects as mutually constructive and are against substituting one form of determinism (technical) with another (social) (Horton, Davenport, & Wood-Harper, 2005, p. 9). Lastly, the study briefly introduces the SI perspective that has been chosen as an integrative design method for the IST and BIA.

Two major paradigms in the IS field are positivism and interpretivism; where positivism is largely concerned with the testing, confirmation, predictability as well as generalisability of research results (Orlikowski & Baroudi, 1991). As such it is adopted to address concerns of applicability in other contexts and to ensure that the results can be repeated when applied in a different setting. On the opposite end, interpretivism is largely associated with social and contextual factors which are often best understood through an interpretive qualitative study.

3.3.4 Positivism Paradigm in Deterministic Approaches

Positivism has dominated IS research and practice since the introduction of computers in the early 1940s. Its dominance carried through to the introduction of computers in the organisational setting in the early 1970s. The impact of the positivist assumption in IS research and practice still prevails (Avgerou, 2000). Assumptions and beliefs systems underlying the positivist information systems researchers' philosophy are outlined in terms of Orlikowski and Baroudi's (1991) account in order to lay a foundation for the deterministic approaches in the IS field. Positivist ontology assumes an objective and singular reality, that the social world exists independently of humans, and its nature can be relatively unproblematically apprehended, characterised and measured. The epistemological belief of the positivist perspective is concerned with the empirical testability of theories, which are either 'verified' or 'falsified' through a scientific research process. The positivist believe that scientific enquiry is 'value-free' and that the relationship between theory and practice is purely technical, allowing them to remain detached from the phenomena of interest. Positivist argue that their impartiality enables them to remain objective observers of actions or processes. The positivist belief system implies that people are not active makers of their physical and social reality; hence positivist research methods encourage deterministic explanation of phenomena under examination.

The positivist paradigm's staying power is attributed to research reliance on models of rationality (Heeks, 2002, p. 107).

Models of rationality assume an objective and rational view of knowledge resources with respect to the problems to be solved. In the context of open and complex IS artefacts in an increasingly disrupted digital economy, such assumptions are dangerous and may result in a limited account of contextual factors impacting on IS artefact design and uses.

Quantitative research methodologies that keep reinforcing the use of positivist methods over other paradigms due to the traditional thinking that quantitative methods are superior to qualitative methods (Guba & Lincoln, 1994a). This hinders progress as the theory and research method choices are influenced by the entrenched beliefs in the academic field. Pratt (2008) states that while there is clear evidence that the application of qualitative research methods is increasing, the work of qualitative researchers is subjected to higher levels of scrutiny compared to the work of their quantitative counterparts.

Evident in practice is the absence of a clearly defined evaluation methodology that can be used to quantify the value of STS investments (Peacock & Tanniru, 2005). This is largely because benefits accruing from consideration of social elements are intangible and cannot be quantified using conventional methods.

The positivist reliance on the Humean notion of causality (ability to infer an effect from a cause based on a flat ontology of the Humean theory of causal laws) as a constant conjunction of events (Bhaskar, 1978; Hume, 1967) and universal laws, is inconsistent with the view that social and technical factors have the power to induce certain responses and these cannot be predetermined at the point of designing and IST.

While IS research and practice have made strides in addressing the conventional thinking in the field due to the concerns mentioned above, although not in full scope, in practice design approaches still exist that are founded on deterministic elements. These are founded on positivist assumptions about technology implementation's impact on social actors and its consequences (MacKenzie & Wajcman, 1999). These are in terms of predicting social actor behaviour towards technology, impact and consequences of use. In reality, there are contextual factors which influence the environment in which IST should function. The impact of the limited account of contextual factors which influence the environment in which IS artefacts function is the design of ineffective IST and BIA that fails to produce the insight and knowledge required to achieve superior business performance. The challenge with this situation is that organisations are investing substantial amounts of capital in the implementation of IST and BIA that often do not deliver business benefits (Jenner, 2009).

Technological Determinism

Technological determinism is founded on a positivist theoretical paradigm and argues that technology is the primary motivator of social and cultural change (Cutcliffe & Mitcham, 2001). According to this view technology is construed as an independent factor in social change, something presumed to be 'outside' society (MacKenzie & Wajcman, 1999). Technological determinists insist that technology is the source of transformation of both organisations and society, holding the view that technology is neutral and autonomous, and that it is designed and developed separate from politics, economics, and power (Oostveen, 2007). This view is limited in its consideration of contextual factors inherent to the organisations.

Typically, technology-centred design approaches such as Agile development, Rapid Application Development, Prototyping and Waterfall are based on positivist assumptions that IST shape organisational practices and user actions in a particular manner. These assumptions are largely deterministic and do not consider the affiliations of the users, interaction requirements, organisation identity as well as the environmental characteristics (Lamb & Kling, 2003). Kling (2000a) adds that the deterministic approaches convey certainty about uses, consequences, outcomes and benefits of computerisation, but lack adequate empirical data to support their theoretical underpinnings. Technological determinism is based on the assumption that 'IT has the same meaning for all who use it and that it will have similar consequences for all' (Kling, 2001, p. 1).

Social Determinism

Social Construction of Technology Theory

Social Construction of Technology (SCOT) theory argues that technologies are produced and used in a particular social context, and that the processes of technological change are intrinsically social rather than simply being driven by a technical logic (Castells, 1996). Social constructivists argue that technology does not determine human action, but that human action shapes technology (Oostveen, 2007). This approach advocates that the IST development process is informed by the social circumstances, where social groups negotiate and agree on the design. While this perspective is responding to a requirement to consider social aspects of computing, it is socially oriented and biased towards socially dominant groups. Furthermore, the SCOT approach is socially deterministic in nature, a direct contrast to the technology-deterministic approaches. This determinism is at a cost of ensuring a balance between social and technical requirements necessary in ensuring development of appropriate IST.

In Oostveen (2007), four shortfalls of the SCOT theory are identified:

- It fails to adequately attend to power asymmetry between groups. Russell and Williams (2002) add that not all social groups will have equal access and power to influence the design process.
- It is concerned about the effects of technology during the design process and ignores effects of technology after it has been developed (Pinch & Bijker, 1987).
- It is not normative in its orientation, thus creating a gap in understanding which social groups need to considered when IST are designed and how IST should be constructed (Hamlett, 2003).
- It tends to focus on small-scale systems and not adequately address the characteristics of complex and highly configurable IST (Oostveen, 2007).

3.3.5 The Birth of Socio-technical Approaches

In the late 1960s, IS research studies revealed that there was a gap between professional claims about social aspects of computing and empirical reality (Kling, Crawford, Rosenbaum, Sawyer, & Weisband, 2000). The gap relates to IST that fail to deliver on the need for 'joint optimisation of social and technical requirements' (Mumford, 2006, p. 321). Failure of IST to deliver on this need resulted in widening of 'the gap between design and on the ground reality' (R. Heeks, 2003, p. 1). Since the focus on office systems by STS design in the 1970s, we have seen an evolution in the design approaches aimed at addressing this gap, from various theoretical perspectives such as web of computing in the 1980s, which later evolved into SI in the late 1990s. However, in spite of these advances, design approaches commonly employed are to a large extent failing to deliver on their intended function (Day, 2007). The consequence of this is IST that are not utilised and BIA that is ineffective.

Interpretivism with Socio-technical Systems Approaches

Interpretivism asserts that 'reality, as well as knowledge thereof, are social products and hence incapable of being understood independent of the social actors (including the researchers) that construct and make sense of that reality' (Orlikowski & Baroudi, 1991, p. 14). Furthermore, interpretivists argue that the world is not a fixed constitution of objects, but rather an emergent social process. Hence interpretive research's aim is to understand how social actors engage in social activities and processes, enact their particular realities and endow them with meaning. In understanding this process, interpretivist researchers are able to examine how these meanings, beliefs and intentions shape or influence their behaviour and actions.

Interpretivist studies are characterised by the prioritisation of 'subjective meanings and social-political as well as symbolic action in the process through which humans construct and reconstruct their reality' (Orlikowski & Baroudi, 1991, p. 13). Interpretivism assumes that the social world is not 'given' but rather subject to a process of reconstruction through social actor actions and interactions. This is supported by the interpretive methods of research that adopt the position that our knowledge of reality is socially constructed. It is with this view that social systems and artefacts that are manned by social actors cannot be measured in some objective or universal way. Interpretivist further contend that the meanings given to the social systems and interpretations of reality may shift over time as circumstances, objectives and constituencies evolve. The interpretivist philosophy is premised on the epistemological belief that understanding social process involves getting inside the world of those creating it. This cannot be achieved unless the researcher understands the language and tacit norms shared by social actors in the social system being studied. The interpretive research approach towards the relationship between theory and practice is that the researcher can never assume a value-neutral stance, and is always implicated in the phenomena being studied.

Interpretivism's rejection of the notion of the existence of causal power of the natural and social worlds makes any form of acknowledgement of the cause and effect relationship in an attempt to answer the 'why' question flawed (Smith, 2006). This reduces interpretivism's paradigm relevance and viability only in theory, by suggesting that the interpretation and understanding of the world is constrained in terms of our knowledge of it (Bhaskar, 2008). In a case of research with a theoretical base underpinned by interpretivism, any attempt to use an analysis output of the research process of enquiry where its theoretical paradigm is interpretivism, such as classical SI, such output cannot be used as input into the design process. Gregor and Jones (2007) argue that sound design theory in IS research involves the exhuming of deep prescriptive rules and its explanation for resolving real world problems. Therefore, any approach that neglects the influence of the natural world in its analyses by focusing only on the social aspects of computing will result in design that does not adequately account for the context of IS artefact uses, namely the structural and institutional aspects that influence social behaviour. Interpretivism cannot therefore adequately answer the 'why' question that most IS research and practical studies are striving to have addressed in order to improve utilisation and relevance of the IST they implement. Peffers et al. (2007) argue that while the use of interpretive research paradigms has seen an increase in application in IS studies, the resulting research output is mostly explanatory and thus not often applicable to the solution of problems encountered in research and practice.

In recognising that problems characterising the IS field relate to the design, development, implementation as well as uses that intimately concern people, and cannot be addressed in isolation, the social world presents a better platform to study these phenomena than the purely material world of technology. Hence the drive towards socio-technical design approaches. The two that the preliminary study examined are STS Design and the SI perspective underpinned by the interpretivism paradigm.

Social-Technical Systems Design

STS was born as result of the failure of deterministic approaches to deliver useful and usable IST. STSs are based on the principle of interdependence of social and technological aspects of an organisation (Mumford, 2006). STS researchers contend that both social and technical aspects are mutually constructive; a move that is against substituting one form of determinism with another (Horton et al., 2005). It is founded on the theory that user participation in the IST design process is critical, 'opposing the traditional system design methods that focus attention exclusively to activities of system engineers who design the computational functions and features in isolation of users' (Scacchi, 2004). While the STS design concepts are empirically grounded, examination of the theoretical foundations reveals that its principles are based on positivist assumptions about user participation, creating a gap in terms of their involvement and representation during the design process.

3.3.6 Social Informatics as a Design Approach

The study adopts the SI perspective as the design method because of its strength and flexibility in capturing social, contextual and environmental factors as well as its concern with what happens when ISTs are consumed, and the effects of their consumption. SI is founded upon the same concepts and principles as the SCOT and STS, and is thus not a complete departure from socio-technical research studies. The premise underlying socio-technical theory on which SI is founded, is that neither technology nor social context are isolated, isolatable or unchanging. In support of this view Sawyer and Tyworth (2006) add that social contexts and technological artefacts are perpetually interacting and shaping each other. SI challenges the theoretical assumptions of the early developments in understanding the influence that technology has on the society, both in the society development and organisational perspective. However, for this exercise, the focus is on social impact in an organisational setting. Furthermore, the growing number of networked organisations and application technologies, particularly in large organisations, introduces new challenges to the phenomena. Thus, Kling (2001) argues that in order to understand the uses or consequences of an IST application in a specific setting, organisations first have to understand the unique socio-technical network that the IST need to support and enable.

‘SI is based on the concept that IST is socially shaped’ (Kling, 2000c, p. 219). However, it differs in a number of important aspects from the approaches discussed in the above section. These will be discussed in detail in the SI chapter. Furthermore, SI concerns itself with the understanding of complex relationships that are involved when IST are used in different types of social, cultural, organisational and institutional contexts. According to Oostveen (2007, p. 2), ‘SI neither understates nor overstates the relative autonomy of society and technology from each other’. From this standpoint, SI enables the design of IST from the perspective of people who design, set up, maintain and use them, and the different settings in which they are used. This includes understanding of the network of social actors as they exchange and consume information from various levels of operation and interaction for varying operational and affiliate requirements, which is a function of BIA. This is a capability that none of the previous design methods offer and are ineffective at accomplishing.

3.3.7 SI Limitations

The limitations highlighted in this section pertain to the adoption of SI as a design method that effectively integrates BIA. In light of the fact that classical SI is positioned as a retrospective study founded on the interpretivism paradigm, any attempt to reconceptualise it is likely going to be met with theory-practice inconsistencies. The theory-practice inconsistences for adopting SI as an integrative design method for IST and BIA in its classical form manifest themselves at two levels, namely performative contradictions and simply a mismatch between theory and empirical evidence.

The performative contradictions are due to SI’s limitation in addressing the ‘why’ question which constrains its focus to the social systems impacting the uses of systems. The interpretive ‘why’ question uses a hermeneutically oriented approach which focuses on contextualisation, understanding and meanings oriented towards explaining why people act as they do (Walsham, 2006). The challenge with this theorisation is that it limits the examination of the social world to our knowledge or understanding of the world. In the context of IS that is impacted by both the social and natural or physical world, this perspective is limited. The CR ‘why’ question uses abduction and retroduction logic enabling it to go beyond contextualisation, understanding and meaning to uncover real existing structures and mechanisms that may or may not generate the phenomena under examination (Dobson, Myles, & Jackson, 2007).

The theory-practice inconsistencies manifest when the stated or implicit philosophical assumptions the researchers make are contradicted by the empirical results. The mismatch between theory and empirical evidence is from a perspective that SI rejects the existence of causal explanation. Accordingly, the output from the process of enquiry or examination of design, use and consequences of use post implementation is limited to understanding, as causal explanations are not supported, and therefore cannot be used to inform the design requirements. Effectively, interpretivists' goal to consider both interpretation and understanding of the meanings as significant to causal explanations of social actions leads them to implicitly accept a causality that transcends the empirical conjunction of events. This challenges the interpretivist theoretical position as their rejection of regulation of knowledge afforded by the objective world puts them in a situation where they compromise the practice of science.

Smith (2006) argues that in order to resolve these inconsistences, a researcher needs to revisit the ontological premises that underlie the research in line with the philosophical assumptions that are in conflict with empirical events. This may result in a fundamental shift in the positioning of the theoretical foundation of the subject being researched. It was on these grounds that the researcher had reconceptualised SI's underlying paradigm from interpretivism to CR.

SI's theoretical base of interpretivism constrains the use of insights as proposed in the research study to better inform the design of IST that integrates BIA effectively. The question that the research asks is what happens beyond the goal of knowing if the output of the critical process of enquiry cannot be used to improve the design of IST and seamlessly integrate the BIA function? For the study, this challenges the fundamentals of interpretivism. 'The interpretivist rejection of the causal power of the natural and social worlds belies their inclusion of this world in their research' (Smith, 2006, p. 192), thus rendering efforts to adopt SI as a design method fruitless. If this limitation is not addressed at a theoretical level, SI's strength in adequately accounting for social, contextual and environmental factors during analysis cannot be exploited beyond its retrospective state.

Not wanting to diminish the value that SI brings to the IS field, the research proposes a paradigm shift that will see the SI theoretical basis being reconceptualised into a more fitting, promising and viable theoretical paradigm. The researcher argues for an approach to address the research problem based on the philosophy of science of CR as developed by Roy Bhaskar and expanded in Bhaskar (1975, 1978, 1998a, 2008). The term critical realism has been used in a number of different traditions by scholars with different takes on the critical realism philosophy. In this study the researcher focuses on a version developed from the foundational work of Roy Bhaskar in the philosophy of science, *A Realist Theory of Science* (Bhaskar, 1975) and *The Possibility of Naturalism* (Bhaskar, 1998b). His philosophy recognises the existence of reality independent of human consciousness (Sayer, 2004, p. 12) adding that 'it is impossible to fully apprehend this reality as our knowledge of the world is always mediated by discourses available to us'. The next section addresses CR in much more detail, enabling researcher and the reader to be at same level of understanding CR, its terminology and concepts.

3.4 Critical Realism

This section is designed to expand our understanding of what CR is, and why it is considered a fruitful alternative to the many research paradigms available to address the research study problem. The focus is on ensuring understanding of CR philosophy as well as clarifying the terminology and concepts that are central to CR.

CR is a relatively new philosophical perspective that offers a radical alternative to the established paradigms of positivism and interpretivism (McEvoy & Richards, 2003). It is a philosophy of science that is founded upon positivism and interpretivism principles and continually seeks to uphold the truth about the nature of the world. Being a realist philosophy, CR introduces a more nuanced version of realist ontology which provides a middle ground between empiricism or positivism on the one hand, and anti-naturalism or interpretivism on the other. CR achieves this by maintaining a strong emphasis on ontology which makes a distinction between the transitive and intransitive dimensions of knowledge. Pather and Remenyi (2005, p. 80) in referring to Bhaskar (1975) simplify the dimensions of knowledge by highlighting that 'the objects of science (physical processes or social phenomena) form the intransitive dimension of science; whereas the theories and discourse as media and resources of science are part of the transitive dimension'. The intransitive dimension argues for the idea that there is reality which exists independently of our knowledge or perception of it and the transitive dimension argues that the generation of knowledge is a human activity and depends upon the specific details and processes of its production.

In spite of the strong realist ontology, the analytical distinction of knowledge allows for a degree of epistemological relativism where the process of scientific knowledge is viewed as historically emergent, political and imperfect (Smith, 2006). Acknowledging the inevitability of the fallibility or relativity of our knowledge is useful for IS research, which is a practice-based research domain impacted by both natural science and social sciences (Venkatesh et al., 2013). This is largely experienced in the case of the social world or where intransitive dimensions of the study that rely on social actors data are addressed, thus requiring the researcher to recognise that such data cannot be independent of existing knowledge, and as such cannot be assumed to be unbiased or neutral (Pather & Remenyi, 2005).

Emphasis on understanding assumptions and limitations of the research is of major importance for the best methodological approach to be adopted for the research study. CR does not have a commitment to a single form of research; rather it involves particular attitudes towards its purpose and practice (Mingers, 2004). As Sayer (2004) puts it, while human knowledge of the world is mediated by the discourses available to humans it is accessible through empirical events. Scholars such as Layder (1993), Mingers (2001), Sayer (2000) and Smith (2006) have explained, refined, and extended the concept of CR as founded by Bhaskar (1975, 1978, 1998a), thereby positioning it as an alternative to the positivist and interpretivist paradigms. Contemporary CR provides IS researchers with an opportunity to leverage elements of both paradigms to enhance the effectiveness of the IS based research, and advancement of IST design approaches in a quest to advance the IS discipline.

Another critical element of CR is its stratified ontology: domains of the real, the actual and the empirical. In essence this implies that while reality may exist, it is not immediately accessible to us or that we are able to observe and realise its every aspect. The domain of the real refers to the objects and structures with inherent causal powers and liabilities which result in mechanisms that may not be visible. Real represents the 'whole of the real', that is, mechanisms, events and experiences that generate the phenomena. Carlsson (2007) points out that the generative mechanisms, residing in this domain, exist independently of but are capable of producing patterns of events. In simplifying the concept of mechanism Bhaskar (1998a, p. 38) define it as 'the way of acting of thing' and Volkoff and Strong (2013, p. 821) interpret the meaning of 'acting' as, 'having an effect'. Mechanisms may arise from a structure, or from the relations between structures, or from the relations between structures and actors. The actual, a subset of the real, represent the events generated from both exercised and unexercised mechanisms. An event may occur but not be observed or experienced. Finally, the empirical refers only to the subclass of observable or experienced events. It is characterised by those aspects of reality that can be experienced either directly or indirectly. Therefore, in attempting to answer the long-standing IS research questions, the researcher has to go below the surface of the observable, the level of the real, to identify generative mechanisms that provide us with causal explanations for 'how', 'why', for 'whom' and under 'what' circumstances, things happen.

The mechanisms are called generative mechanisms to reflect the existence of structures that have powers to trigger certain events to occur or through their weaknesses prevent certain events from materialising. The fact that the potential for structures and powers exists whether they are exercised or unexercised (Bhaskar, 1998b) has methodological implications in that in selecting the appropriate research method, the researcher has not only to identify a methodology that will help explain 'what' and 'why' certain events occur but a method or a combination of methods that can effectively identify the mechanisms giving rise to those events and the conditions under which those generative mechanisms are experienced. The CR pluralistic approach and characteristic that does not have a commitment to a single form of research, offers a great relief in that the researcher can go beneath the surface to identify, understand and explain the structures and mechanisms that shape observable events (Pather & Remenyi, 2005).

CR theorisation stems from transcendental realism (Bhaskar, 1986), and is influenced by dialectical Marxism where laws are seen as tendencies that are transfactual in nature (that is, separated from the factual outcomes the tendencies produce). Hence, in Bhaskar (2008), CR argues for a non-deterministic, non-Humean notion of causality. The CR notion of tendencies provides for the scientific explanation that allows for the causal effect of the artefact while stressing the importance of the local context and social diversity. 'To ask for the cause of something is to ask "what makes it happen", what "produces", "generates", "creates" or "determines" it, or, more weakly, what "enables" or "leads to" it' (Sayer, 1992, p. 104.) This addresses a challenge of how CR analyses causation as well as the requirements for ensuring validity and generalisation of research. In CR, context matters; however, not the only determinant of the outcome of the event triggered by the generative mechanisms and structures, context only represents a potential rather than a guarantee that the mechanisms will be activated. Simply put, 'circumstances and conditions in which a technical object or social exist do not guarantee that a particular event will materialise' (Sayer, 2000, p. 136). Volkoff and Strong (2013), in support of this notion, argue that mechanisms are capacities or tendencies, not powers with deterministic effect. This resonates well with the SI perspective in its quest to adequately account for both social and technical elements in context, although falling short of understanding of the underlying mechanisms that induce certain outcomes.

The limitations induced by theoretical fundamentals mean that in its retrospective state, SI cannot concern itself with the identification of the generative mechanism and structures that underlie certain events. This suggests that the causal powers that effect changes where social meets technical are left untapped, limiting our understanding and transferring of learning to other similar contexts, where the same generative mechanisms and structures can be said to be the cause of events experienced or observed.

Because CR embraces both the quantitative and qualitative method of research, interpretivism (in terms of its core interest in contextual understanding and meaning of behaviours from the perspective of the actors), and determinism (that allows for a new type of generalisation that is not subject to the limitations of induction and universal laws), thus reconceptualises Humean causality into non-deterministic causal tendencies that reside at the level of the real and not the empirical. Their use provides for the scientific explanation of causal impact of the artefact while stressing the importance of local context and social diversity. Hence we see that the conception of technological determinism is softened into a less threatening conception of the actualisations of technologically based causal powers.

3.4.1 Theoretical Positioning of the Research Paradigm and Research Methodology

In adopting CR as SI's underlying theoretical paradigm, the study addresses key philosophical concerns emanating from SI's original underpinnings, namely interpretivism, as well as those associated with the use of multiple research methods. CR's pluralist approach enables the researcher to best integrate qualities offered by an interpretive qualitative method with the understated positivist philosophy of general laws and Hume's notion of causality, wherein Hume (1967) argues that causation is the observation of a constant conjunction of (observable) events. A critical realist's view of causation is quite distinct in the sense that it includes both observable and non-observable events. They argue that in order for understanding and learning to take place, researchers should seek to unearth the deeper structures and mechanisms that trigger the event to occur. Zachariadis, Scott, and Barrett (2010), in support of this view, add that objects (physical or social), have certain structures and powers that can behave in a particular way and cause the change to occur. These are not always known or observable at an empirical level, hence the need to examine deeper structures and mechanisms that underlie the events in question. This approach offers greater potential in using the research findings to enhance the role of IST design in the development of BIA for the betterment of the IS field.

In IS research, the need for adopting multiple research methods has long been recognised; however, its implementation is faced with a number of challenges. Jones (2000) points to the challenges that come with integrating approaches that come from incommensurable theoretical positions, highlighting that philosophical issues have practical consequences, whereby data collected has implications in terms of how findings are reported and their proposed uses in the broader knowledge base. In addition to the above-mentioned challenges, a number of barriers have prevented mixed methods' popularity in practice. Mingers (2001) cites a number of examples of barriers that have been noted: cultural, psychological and practical. Cultural barriers exist in the sense that there is a tendency for researchers from a particular environment to belong to a cultural group of scholars that subscribe to a particular paradigm, whereby anything contradictory to their philosophical views is considered outside the norm and therefore not supported. Psychological barriers refer to a situation where researchers tend to prefer methods in which they are well versed, and know that they are going to receive support from their peers and their success is guaranteed. On a practical level, the ease with which a method can be applied and coupled with the fact that it has been tried and tested, become attractive.

Mixed methods are challenging due to the amount of work required and consequently the time invested in ensuring that the combined methods are applied in a cohesive and seamless manner. However, in spite of all the challenges that have been cited, there is value in considering multiple research methods for IS research due to the need to combine natural and social science regimes under a single umbrella. Mingers (2001) further points out that the design and use of multiple research methods, each with their own philosophical nuances and practical challenges, encourage creativity in terms of how the study is carried out, thus offering greater potential for new insights and developments.

In practice, the motivation for adopting a mixed-method approach is often linked with the need to address issues of credibility, validity and reliability of the study. The pressure comes from the fear that certain methods have traditionally been considered superior to others as evident in the types of IS research that receives more airtime in published journals (Mingers, 2003) and as well as the need to demonstrate return on investments which is linked to quantitative studies (Mingers, 2003, 2006a). However, where the mixed-method approach often falls short is in its relatively small regard for the philosophical consequences. CR is to date the most promising method because of its approach in addressing a number of challenges associated with the traditional approach to multiple research methods.

3.4.2 CR Ontology

According to Bhaskar (1975), CR philosophy argues that reality possesses a stratified and differentiated ontology, in three domains, namely the domains of the real, actual and empirical as depicted in Figure 7 below, hence the argument for stratified ontological assumptions. The structures and mechanisms make the ontological assumption that social structures, natural objects and conceptual entities such as language, opinions and goals occur at the real domain level (Fleetwood, 2005). The events occur at the domain of the actual, while the empirical contains the subset of the actual that is observable. Implied in CR ontology is that while we may experience or observe certain events, there are domains of events that are independent of our perceptions of them, and that these events exist whether or not they were observed or there even were observers (Mingers, 2004a, 2006c). Volkoff and Strong (2013, p. 820) contend that 'epistemologically our perception of the real is necessarily fallible as it depends on our interpretation of what we see'.

STRATIFIED ONTOLOGICAL DOMAINS

	REAL	ACTUAL	EMPIRICAL
MECHANISMS (Structures and mechanisms with enduring properties)	X		
EVENTS *(Events that are generated by structures and mechanisms)*	X	X	
EXPERIENCES *(Events that are observed and experienced)*	X	X	X

FIGURE 7: CR STRATIFIED ONTOLOGY

Figure 7 indicates the domains of reality in which mechanisms, events and experiences respectively reside, as well as the domains involved for such a residence to be possible.

Bhaskar (1975, 1989, 1998a) and Sayer (1992) share in the view that ontologically, CR is based on the following basic assumptions: existence of an independent reality; a stratified ontology comprising structures, mechanisms, events and experiences; and emergent powers dependent upon but not reducible to lower-level powers, and an open-systems perspective.

Table 2 below summaries the CR's ontological assumptions in the context of the research study.

TABLE 2: ONTOLOGY ASSUMPTIONS

Key Assumptions	High Level Description of the Assumption
The independent reality	This assumption is at the heart of the CR ontology which advocates that reality exists independent of human knowledge or human ability to perceive it. It further argues that the world is not easily reducible to human perceptions of it, and that human experience is only a portion of it. Hence in CR, a socially constructed view of reality held by a given actor or actors may be incorrect with respect to the intransitive domain of an independent reality.
Stratified Ontology	The key aspect and a unique way in which CR addresses the concept of realism is the stratification of reality into three nested domains (Bhaskar, 1975). The domain of the Real, Actual and Empirical. Stratified ontology comprising structures, mechanisms, events and experiences; each of which is described below:
	Structures Sayer (1992, p. 92) defined structure as the 'set of internally related objects or practices'; for example, a single organisation is an example of a large structure. Structures may also contain a number of component sub-structures. Typically in IS, socio-technical environments consist of several interacting structures (i.e. social structures, physical structure and conceptual structures), each of which has the potential to impact the existing situation to generate the events. According to Danermark, Ekström, Jakobsen, and Karlsson (2002) the ontological value of these structures is that they have characteristics and tendencies that cannot be reduced to those of their component entities.
	Mechanisms Conceptually, mechanisms are 'nothing other than the ways of acting of things' (Bhaskar, 1975, p. 14), conceptualised by scholars such as Mingers (2004a), Sayer (2000) and Smith(2006) as either causal powers or tendencies. They are inherent to physical, social and conceptual structures, enabling or limiting what can happen within a given context. To the extent that in an organisational setting, actors are components of the structure in which a set of events takes place, they must be considered as bearing causal powers (Groff,

	2004), actor's beliefs or reasons that motivate or result in certain or common behaviour among a group of actors correspond to a tendency to act in certain ways (Bhaskar, 1998a).
	Events An event can be defined as a specific happening or action resulting from the enactment of one or more mechanisms. According to Bhaskar (1975) CR philosophy, events are ontologically distinct from the structures and mechanisms that generate them. Gambetta (1998) further points out that although these events may be a result of the enactment of causal powers or tendencies emanating from a structure, mechanisms associated with the structure may counteract the effects of a structure reducing it to none. In the same vein, the outcome of one mechanism may exacerbate the effects of another mechanism, further varying the magnitude or perceptibility of actual events. This is especially true for complex events which are less likely to be observed directly, and when they are observed, often difficult to explain. Business Intelligence although not coined and positioned as such, is another way that organisations can be seen to understand the happenings and connect them back to the actual events. However it all starts with how the systems that produce such data are designed and configured. Design informed by CR-based design methods can assist organisations in not only understanding those requirements upfront but in articulating them in a manner understandable to designers who then configure BIA-centric systems.
	Experiences This assumption refers to those events which we are able to directly observe. However, critical to note is that in an open system what we experience may only be a subset of the actual events generated in a given context (Collier, 1994). The limited instances of events that can be directly perceived may under-specify the entirety of the events actually occurring and the mechanisms generating them.
Emergence	While an entity or an object is made up of components, CR's ontology states that these are independent from, and irreducible to, the components of which they are composed (Archer, 1995). Sayer (1992), adds that the properties, capabilities, and powers that can be ascribed to a given entity or structure depend on not only those aggregated from the components, but also on the synergistic effects resulting from the pattern of their organisation. For example, the systemic character of IST refers to the many components that make up a system (i.e. software, hardware etc.), and that the capability of the system cannot be meaningfully reduced to independent components. As a system it produces functionality

	that would otherwise not have been possible independent of the actors that utilise them. Easton (2010) emphasises that the importance of maintaining clarity of the scope and the level of analysis as mechanisms that are causing certain events to occur may be identified as emerging from structural components at lower levels than the focus of analysis. In this way bringing visibility to the connectedness of elements within and between levels is critical, more so in IST analysis as actors have differing requirements of the same IST at different levels of social organisation (Layder, 1993).
Open System	Bhaskar (1998a) adopts a view of reality as an open system that is outside of human control. He further argues that in an organisational setting made up of social structures with complex social systems, understanding of generative mechanisms cannot adequately be constrained in the real world as can be done with laboratory experiments. Archer (1995) further notes that influence of the causal powers available within a social structure as well as continuously changing contextual conditions, resulting from the socio-technical system examination cannot be considered conclusive. This suggests that the fluidity of the STS makes it dangerous to assume that the mechanisms that were enacted in a given system and environmental context will generate the same events if enacted in the future or different context or setting. In CR, the dynamic and variable reality of open systems shifts the focus onto identifying the tendency of mechanisms to act within a specific contextual environment at a specified time (Sayer, 1992).

3.4.3 CR Epistemology

Epistemological assumptions are concerned with what counts as acceptable truth by specifying the source, characteristics, and assessment of truth claims (Chua, 1986). Epistemological assumptions are useful in determining which data is required, identification of data sources for the data required to develop knowledge claims, and pointing the researcher to how to evaluate the truth or validity of the claims being made as well as how the claims are to be measured against existing knowledge (Wynn Jr & Williams, 2012). A CR-based research study focuses on descriptions of reality based on an analysis of the fieldwork data. The resulting knowledge claims are focused on specifying and describing those elements of reality which must exist in order for the events and experiences under examination to have occurred. The nature and form of these knowledge claims are derived from specific epistemological assumptions linked to the ontological premises of CR. As discussed, CR has a stratified rather than a flat ontology (Bhaskar, 1978). This theoretical perspective of the ontology has major implications for the epistemology based on CR ontological assumptions.

These implications are that the researcher has to be equipped with techniques and skills to go beyond the empirical domain where observations are made and experienced by observers in order to examine if the events that are observed are understood differently by observers or not (Easton, 2010). The ultimate goal of the critical realist researcher is to arrive at a reliable truth through demonstrated understanding of the mechanisms that operate in the real domain, triggering certain events to occur. In the absence of a criterion to judge what the truth is and with the notion that observation is fallible, the researcher has to analyse data collected thoroughly, distinguishing among alternative explanations. This enables the researcher not just to accept the first logical explanation as fact but rather to interrogate data by wearing different theoretical lenses (Woodside, Biemans, Pattinson, & Miller, 2005; Woodside & Wilson, 2003). From a critical realist perspective, the best explanations are those that are identified as having the greatest explanatory power (Smith, 2006), whereby weak explanations may be rejected in favour of alternatives that best explain the phenomena under enquiry (Bunge, 2004). Epistemological assumptions that inform the CR research are discussed in more detail in Table 3 below.

TABLE 3: EPISTEMOLOGY ASSUMPTIONS

Key Assumptions	High Level Description of the Assumption
Mediated Knowledge	CR defines scientific knowledge as having both transitive and intransitive dimensions (Bhaskar, 1975). The intransitive dimension refers to the elements of the world that in our limited capacity, senses and experiences are unable to explain or account for in the varied ways in which they respond. Here the transitive dimension includes researchers' observations, as well as theories about the independent world that have been developed as the result of scientific enquiry (Collier, 1994). CR assumes that our knowledge of the intransitive entities that comprise an independent reality is formed in the transitive dimension, mediated by the social structures to which we belong (i.e. other researchers, disciplinary groups, co-workers, etc.). This knowledge

Key Assumptions	High Level Description of the Assumption
	of underlying structures and mechanisms are formed in conjunction with existing social interactions and beliefs along with our own sensory and conceptual interpretations.
Explanation Rather than Prediction	While the CR study focuses on explaining the mechanisms that generate a certain event, more so than the ability to make predictions about future events or to understand the social/cultural meanings behind the events, CR researchers contend that a certain level of prediction can be achieved for a stable context and setting. In this study, one of the researcher's key positions is that, over time and with careful and comprehensive analysis of the environment (actors, context, setting and situatedness of use), the organisation can get to a point where design of IST is based on less guess work and more informed requirements. The drive to adopt non-deterministic tendencies CR philosophy in IS field studies is informed by acknowledgement that IS operates in an open systems, complex organisational setting and that ability to make precise predictions is limited. Also studying and identifying the causes of a particular phenomenon that has occurred gets us closer to understanding the generative mechanisms and to most accurately anticipate a given outcome. For example, it follows then from this logic that that even though STS context varies from context to context, there is value in trimming the environment down into classes and categories of events, an exercise which can only be optimally achieved when the CR approach is adopted. This provides the capability to isolate the regularly occurring events within a particular context, complex setting and situatedness of use where the events are identical. Although one hundred percent fit cannot be achieved, the approach offers better opportunity and potential to reduce the current dilemma of IST that are not useful and usable and that constrain the development of effective BIA.
Explanations via Mechanisms	The focus of this assumption is to theorise about the existence of mechanisms by examining the empirical data (causal powers or tendencies) surrounding the phenomenon under enquiry (event) in context and/or setting of the event. This assumption helps to arrive at the most appropriate explanation and answers the following question: What must reality be like in order for this event to have occurred? In achieving this outcome, a critical realist approach is holistic and comprehensive in that consideration is given to all variables applicable to the enquiry, that is, physical, social and conceptual structures at various levels of interactions. Identifying enabling and

Key Assumptions	High Level Description of the Assumption
	constraining conditions, triggered or reinforced stimulus for each level of interaction (Hartwig, 2007).
Unobservability of Mechanisms	The unobservability of the mechanisms limits the efforts to study and examine them, requiring a dedicated effort, time and rigorous process of enquiry. Further complicating the equation is that a mechanism's existence cannot be easily measured hence the qualitative aspect of the research is encouraged. The critical realist position on the existence of mechanisms is that reality is independent of our conception of it, and that in a case where the real or actual cannot be observed it does not mean that it is not there or that the observable event is unconnected to it. 'Observability may make us more confident about what we think exists, but existence itself is not dependent on it' (Sayer, 2000, p. 12).
Multiple Possible Explanations	When examining the mechanisms that underlie certain events, it is always important to keep in mind the fact that, almost always, there will be multiple possible sets of mechanisms which may have produced the outcomes being studied in a given research programme. Hence breadth and depth is critical in a critical realist approach. This is particularly relevant for the IS research study, where context, setting and situatedness of use of IST often results in varied outcomes and/or consequences. These may be realised in varying ways in different time periods or as new contextual conditions are encountered. As has been established in earlier sections, the existence of multiple possible explanations to the generative mechanisms which may have triggered or stimulated events being examined, necessitates a means of evaluating and comparing alternative explanations. While CR describes knowledge as transitive and intransitive, in ensuring that the most appropriate explanation of a cause of the event is chosen, the analysis is conducted at a transitive level. This enables the selection of an accurate representation of the real world based on our transitive knowledge of it, a process which critical realists describe as judgemental rationality (Groff, 2004).

3.4.4 CR Methodological Principles

Table 4 below outlines methodological principles applicable to the CR paradigm. It further indicates ontological and epistemological assumptions upon which each principle is based, thereby assisting the researcher in their application. While all CR method principles are critical, the study employed the principle of retroduction, due to its focus on critical examination of the causal mechanisms triggering certain events to occur, and triangulation, which enabled the researcher to validate the effectiveness of the study's primary method of analysis.

TABLE 4: CR METHOD PRINCIPLES

CR Method Principles	Description	Ontological assumptions	Epistemological Assumptions
Explication of events	Explication is a principle that points to the importance of identifying, describing and sequencing aspects of events that constitute the outcome under enquiry in order to determine the scope, level and breadth of the analysis. It is best achieved through analysing experiences linked to the empirically observed event enabling the researcher to describe in detail the mechanisms that were enacted.	Stratified Ontology	Mediated knowledge
Explication of Structure and Context	Once the mechanisms have been identified through an analytical process, tendencies of the identified mechanisms are examined in view of the contextual influences produced in open systems. In an open and complex setting such as IS where the different structures (physical, social, conceptual) exist, it is advisable to decompose structures into their constituent parts such as actors, relationships and rules that govern their actions. The process entails identifying the connections and interdependencies between these parts, linking them to the outcomes of the events. In this way the researcher is best positioned to select an alternative with the great explanatory power to the events under enquiry.	Stratified Ontology Open-systems perspective	Mediated knowledge Unobservability of mechanisms
Retroduction	Retroduction is a complex and non-linear process of enquiry focused on identification of a set of plausible causal mechanisms. The aim is to examine elements of the causal mechanism in relation to the contextual	Emergence	Focus on explanation rather than prediction

CR Method Principles	Description	Ontological assumptions	Epistemological Assumptions
	influences responsible for its activation in a process, a useful instrument in arriving at a reliable truth. In this case the researcher accounts for the varied ways in which mechanisms at different levels interact, producing varied outcomes and experiences at an empirical level (Wynn Jr & Williams, 2012).		Explanation via mechanisms Multiple explanations Unobservability of mechanisms
Empirical Corroboration	This principle's aim is to ensure that the proposed mechanisms were selected on merit and their adequate representation of reality. By proving that they have more depth and explanatory power than alternative explanations. The process entails corroborating proposed mechanisms with empirical evidence on case study data.	Independent reality Stratified ontology	Unobservability of mechanisms Multiple explanations
Triangulation & Multi-methods	This principle encourages researchers to employ multiple approaches when analysing data based on a variety of data types and sources, analytical methods, investigators and theories. It is crucial in controlling various biases in the research process and the results generated by the process. Mingers (2001) cautions researchers on challenges associated with practical implementation of multiple research methods.	Independent reality	Mediated knowledge Unobservability of mechanisms Multiple explanations

3.4.5 Design Methods Comparison Diagram

Figure 8 below summarises the four design methods or approaches analysed in the above section. The technology determinist view holds that technology impacts on society from outside society and is therefore an independent factor of change (MacKenzie & Wajcman, 1999). The diagram accommodates both hard and soft determinism, where the strong view argues that technology is the sole driver of change in society and the weak view acknowledges that society does have a role to play in the process, but with technology being a facilitator of the change in human behaviour.

Another form of determinism that the diagram points to is the SCOT, which states that technology development is the social process and as such it is difficult to isolate the technology from its designer or developer. For example, the values, biases and assumptions of the dominating group of designers are always expressed in the technology. These views are represented in the bottom-right quadrant where there is less emphasis on technology and high social representation.

In the bottom-left quadrant, the diagram positions the STS which concerns itself with striking a balance between technology and social factors. However, due to the theoretical paradigms that underpin it, it is not nearly as effective as it could be. For example, users' construction is still founded on soft positivism assumptions that user needs can easily be represented by a small group of users and designers due to the assumption that their requirements are simple and static.

Lastly the proposed design method, SI, is in the top-right quadrant. SIs are socio-technical and go further to account for context, setting and situatedness of use, viewing users as social actors. While there a few limitations highlighted in its classical form, an alternative conception of SI's theoretical paradigm resolves this disjuncture, whereby a new set of ontological premises is adopted enabling reconceptualisation of SI and its weaknesses being supplemented.

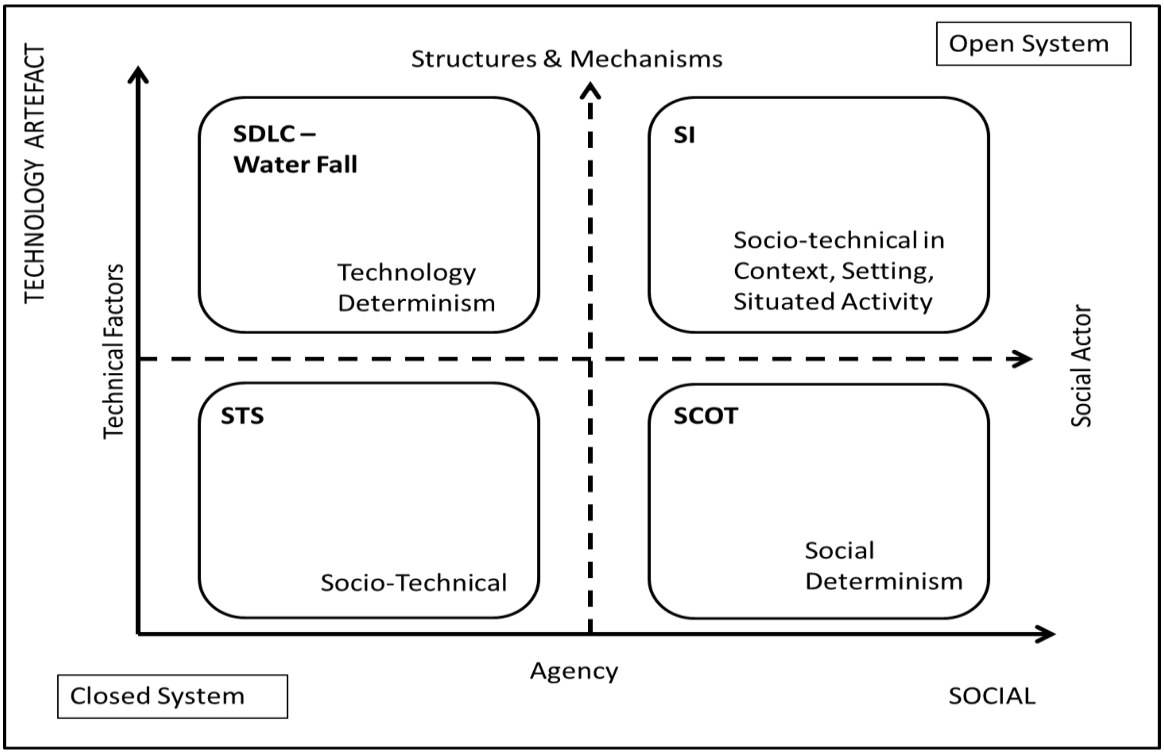

FIGURE 8: THEORIES WITH UNDERLYING PARADIGM COMPARISON

While CR makes a distinction between agency and structure, their interdependencies are acknowledged. Structures are presumed to create the conditions for the actions, and agency refers to things (people, processes) that have the tendency to produce an effect or change. According to Ononiwu and Brown (2013, p. 6) 'the prime power of agency is the capability to reproduce or transform the structures encountered by not only depending on their individual reflexivity or meanings enacted, but by also depending on people's collectiveness sufficient to attain the threshold of political or social visibility for change to erupt'. The separation provides for the ability to examine and understand the different properties and powers that the agency and structure hold. This enhances understanding of their potentialities when they meet and create events that may or may not influence one another's result. Furthermore, for structures that tend to be enduring, explanation of the causal powers for the processes that occur through time is feasible. However, due to their silent power they have the ability to enable or constrain action.

In Figure 8 above, design approaches that account for natural and technical structures are sitting at the top quadrants – SDLC and SI. Because these tend to be more enduring, their structures do not change frequently and their impact usually has a long-lasting effect. The design approaches with assumptions that are social, with people and process influence, are located at the bottom, where the agency has more causal powers and change as social systems change.

The approaches that are oriented towards social requirements and underpinned by the interpretivist paradigm can be found on the X-axis with the degree of influence determined by assumptions that each design approach holds about the level of complexity of the world in which systems exist and ought to thrive. The assumptions that are premised on the notion that systems are open and complex in nature with a high degree of social influence as compared to the technical and natural world such as SCOT can be found on the bottom-right quadrant. Similarly, assumptions that are premised on the notion of the systems that are open and complex, but with both a high degree of influence of the social and natural world, where technical and social balancing is high, such as SI, can be found in the top-right quadrant. The design approaches that are founded on assumptions that systems are closed are placed on the Y-axis. The design approaches that are premised on natural laws, with a high degree of control, and are deterministic in their approach are placed in the top-left quadrant. The design approaches that are underpinned by approaches that IS can effectively be addressed with both social and technical considerations but their assumptions do not adequately account for dynamics of open systems and consequence of IS uses are at the bottom left quadrant. SI has both the agency and structural requirements, a requirement for surviving in open systems; hence it is in the top-right quadrant. Structure in this context is concerned with the natural world order.

3.5 Summary of the Preliminary Analysis of the Design Methods

Preliminary examination indicates that theoretical paradigms that underlie the design methods determine their relevance in practice. The further theoretical assumptions are from practitioner reality the more irrelevant they become and reduce to an academic exercise that has no relevance in practice. This is a serious concern in that the aim of conducting scientific enquiry is to contribute to the improvement of the discipline. IS research is still struggling to move beyond issues of relevance of IST, largely because dominant paradigms of IS research, and consequently the design approaches, still lack a proven recipe on how to effectively answer the ‘how’, ‘why’, for ‘whom’, and under ‘what’ circumstances, IST work. The view the study takes is that if IST are to integrate effectively to BIA, the cost of delivering relevant, reliable and near real-time BIA will diminish, while the value that IS delivers increases, as is currently not the case.

It was also noted that different perspectives and theories define the relationship between IST and BIA differently. The assumptions held about the relationship, as informed by the philosophical paradigm, are usually expressed in the design of IST which further determine the effectiveness of the relationship. Further to understanding of the relationship, empirical examination revealed that there is limited literature available that can be consulted to understand the extent to which BIA elements are considered during IST design. This is further demonstrated by the silo approach to IST and BIA function in both research and practice. In this regard, conclusions reached were limited to the available literature and field analysis.

The analysis further revealed theory-practice inconsistences in various forms and levels of the theoretical paradigms the study examined. All scientific research initiatives, regardless of their philosophical stance, aim to move beyond capturing ‘who’, ‘what’ and ‘how many’, to uncover the ‘why’, ‘for whom’ and ‘under what circumstances’ certain events take place. This is particularly challenging for positivism because of its interdependency with the quantitative research methodology. Quantitative methods do little to generate insight on the empirically observable and non-observable events and the causal processes that bring them about. At the practical level positivists insist on providing meaningful answers, yet they are constrained by their very philosophical position. This is further confirmed by positivist arguments for generalisability of the research results, the challenge being experienced when results are applied in a different context because generalisation requires the assumption of the uniformity of nature which cannot be justified logically.

Interpretivism suffers similar theory-practice inconsistences in that it rejects the positivist goals of generalisation and prediction in favour of contextual understanding and description of events being examined. The implication is that in providing descriptive narratives of why and how, certain events that take place in a particular context are forced to accept the Humean notion of causality, which their underpinnings reject. Interpretivist rejection of the causal power of the natural and social worlds limits its application in the IS field. IS concerns itself with how IST and BIA are experienced as well as how that translates into consequences of use, leading the researcher to understand the underlying mechanism that triggers the events.

In addition to the above-mentioned inconsistency in theory-practice, explanation of the research results in the hope that they can be used to explain events observed within the specific context of the new setting, requires some form of prediction or generalisability, or else the process of enquiry has no value in practice. For interpretivist work, any form of generalisation to population would be construed as being deterministic. In essence, generalisation within a critical realism-based case study research concerns itself with generalisation to validate the explications of causal tendencies and the interplay of mechanisms and context, for purposes of refining theories.

The next chapter reviews social informatics literature in more detail, enabling the reader to gain more insight into what SI is about and ways in which it can play a meaningful role as a design method for IST that are BIA centric. It also goes further to addresses the theoretical impact of reconceptualising SI's paradigm to CR. This philosophical stance for the research is critical to positioning of the study's research paradigm and methodology.

CHAPTER FOUR

Research Theoretical Base of the Study: Social Informatics

4.1 Introduction

Chapter 3 established a gap between research and practice with regard to the development of research that guides the design of BIA-centric IST. The researcher went further to outline paradigm-practice inconsistencies that contribute to this gap. The process put into perspective why design research plays a crucial role in the generation of knowledge required to develop design methods that are informed by both practice and scientifically researched knowledge. This approach was instrumental in informing the preliminary research analysis process that was conducted.

This chapter expands on the SI discussion under the preliminary review section in Chapter 3 in a more detail, thus providing a view as to why SI was adopted as an integrative design method that effectively integrates IST and BIA, while adequately accounting for social, contextual and environmental factors.

4.2 Social Informatics Perspective

Literature review as well as comparative assessment of design methods present compelling evidence that supports the argument that SI is the single most effective approach in dealing with design, uses and consequences in context because of its strength in accounting for socially and organisationally complex and fragmented work settings (Westbrook, Braithwaite, Iedema, & Coiera, 2004). Kling et al. (2000) advocate SI as a method appropriate to IST given the social forces and social practices influencing organisations. According to Kling (2000c, p. 259), 'SI concepts and analyses provide increased understanding of the design, use, configuration and consequences of IST so that they are actually workable for people and can fulfil their intended functions'.

(Kling, 1999, 2007) highlights that SI research has produced some useful ideas and findings that are applicable to many kinds of information technologies. Preliminary analysis of the literature has provided sufficient evidence which supports this view; hence SI has been chosen as the study's theoretical base.

4.2.1 Social Informatics Definition and Practice

Kling (2000c, p. 245), defines SI as 'the interdisciplinary study of the design, uses and consequences of information technologies that takes into account their interaction with institutional and cultural contexts'. This definition emphasises the SI ontological assumption that IST does not exist in social or technological isolation. (Kling et al., 2000, p. 15) highlight that 'the cultural and institutional contexts influence the ways in which they are developed, the kinds of workable configurations that are proposed, how they are implemented and used, and the range of consequences that occur for organizations and other social groupings'.

SI is not a theory but a methodologically independent approach inclusive of normative, analytical or critical methods of enquiry into social and technical elements of IST and how these shape and influence each other within a specific organisational setting (Sawyer & Tyworth, 2006). SI's main strength as a context-specific, situated and problem-oriented approach is that it does not follow a predetermined structure or format. It has an element of ingenuity (Brown & Duguid, 2001), thereby enabling one to use one or a combination of any of the three critical and reflective methods of enquiry, while, according to Robbin, Hara, and Day (2005), appreciating the benefits and limitations that IST provides.

SI in its orientation towards critical scholarship, helps to identify all key stakeholders and a wider range of effects than do other approaches to studying computerisation. Sawyer and Tapia (2007, p. 3), suggest that 'IST is inherently socio-technical, situated and socially shaped'. Elements that make up the SI definition as borrowed from Kling (2000c, p. 245) are briefly discussed in order to contextualise SI as a design and development model.

'Interdisciplinary' Study

IS as a discipline has not invested much effort in the development of its own theories, but instead imports from disciplines such as sociology, organisational and management studies, and science and technology studies (Benbasat & Zmud, 2003; Vessey & Ramesh, 2002). Theory development in each of these disciplines is conceptually rich and matured in its application in enriching IS knowledge of complex social phenomena. The second element is that IST and BIA uses encompass various fields and disciplines, thus expanding the scope of SI application. While diversity may be viewed as a strength in that it offers rich insights, concepts and new approaches on designs, uses and consequences, caution needs to be exercised. The wide scope, lack of structure, fragmentation, as well as the silo approach, present challenges of misaligned discourses making it difficult to develop a set of key attributes and well-defined borders. Each of these disciplines and fields of study are subject to their own contexts and as such present their own unique dynamics.

IST design, Uses in Context and Consequences

SI's critical and problem-oriented analysis of uses and consequences of IST stems from the failure of direct effects models and technology-deterministic approaches to deal with the dynamic and complex situations of IST and BIA uses. Understanding the uses and consequences of IST and BIA application is a complex process which requires one to draw on SI's key principles and common themes as these serve as a relatively stable framework to guide and inform the factors in Table 5 below. This process is instrumental in minimising the imbalances that may occur where positive consequences accrue to other parts of organisations while other parts are negatively impacted by the introduction of IST and BIA. To produce reliable predictions about uses and help deal appropriately with consequences in varying organisational settings, circumstances and practices, the situation depicted in Table 5, although not a complete suite of scenarios, serves as practical guide in the process of critical and reflective enquiry.

TABLE 5: CONSIDERATIONS OF ENQUIRY ADAPTED FROM (KLING ET AL., 2000)

Uses	Consequences
Situation of uses does not remain constant; it changes over time	Time frame considerations will be informed by the requirements
Configurable nature of technology and the varying context will be taken into account in order to address all application scenarios	Analysis sample will be determined by scope and size in order to make reliable predictions about consequences

IST design and configuration will consider and represent the different situations and level of application by different groups of users	Level of analysis will be kept at a reasonable level of analysis such as a social group as opposed to an individual level

Institutional and Cultural Context

In its concern for the context in which IST are used, SI considers the institutional character and structure, as these shape how the social actors engage IST and exchange information throughout the network. According to Lamb and Kling (2003), institutionalisation is a process by which an organisation develops a set of norms and values, rules of engagement and legitimising practices and gives meaning to social behaviour. Scott (2005) believes that institutional theory focuses on how structures within a particular network become established and institutionalised, thereby serving as guidelines for social behaviour for the social actors operating within a network. It thus follows that understanding of the institutional character and structure is instrumental in learning about social practices as these inform how social actors leverage IST and BIA.

4.2.2 Common Themes

This section highlights seven common themes or issues that have been discovered by SI researchers (Kling et al., 2000; Oostveen, 2007; Sawyer & Rosenbaum, 2000) in empirical studies concerned with design, development and uses and their consequences. The study argues that although these do not constitute new insight, it is important to highlight them as they demonstrate the comprehensiveness, robustness and relevance of IS as a practical approach. During the research fieldwork the researcher observed the extent to which these prevailed in various forms and shapes in the TFR case study. Lamb and Sawyer (2005), Sawyer and Crowston (2004) and Wood-Harper and Wood (2005) write at length about how practitioners would intentionally and unintentionally suppress or magnify these by making certain decisions, taking particular actions and managing certain arrangements just to get around the common themes as outlined in Table 6.

These SI scholars have identified a number of common themes that help practitioners to have a structured approach to examining the design, uses and consequences in context, thus different from the deterministic approaches and conventional socio-technical approaches discussed in the literature analysis in Chapter 3 section 3.3. The summary of the common themes adopted from Sawyer and Rosenbaum (2000) is briefly discussed in Table 6.

TABLE 6: SI COMMON THEMES ADAPTED FROM (STEVE SAWYER & ROSENBAUM, 2000)

The context of IST use directly affects their meanings and roles.
In SI, context matters (Kling et al., 2000), and IST are designed to support the social and organisational dynamics. This means that an IST is always linked to its environment of use. It thus follows that IST cannot be considered independently from the situation in which they will be used.
IST are not value neutral: their use creates winners and losers.
IST are often designed to support social and organisational structures. Given the contextual nature of IST, the process may directly or indirectly re-enforce or strengthen the existing structures and in a process that creates winners and losers.
IST use leads to multiple, and often paradoxical, effects.
The contextually dependent nature of IST suggests that similar IST can have different outcomes in different situations. According to S. Sawyer (2006), another element for consideration during design is that implementation of IST tends to have multiple effects. These may be contradictory, unexpected and/or planned.
The design and implementation of IST have moral and ethical consequences.
The critical approach of SI facilitates and surfaces the moral and ethical consequences of IST uses.
IST are configurable and their effects will vary by the level of analysis.
IST are designed for the specific organisational context and as such configured to deliver on the specific organisational dynamics; these dynamics are contextual (Steve Sawyer & Rosenbaum, 2000).
IST follow trajectories and these trajectories favour the status quo.
The configurable nature of IST means that the key components tend to have a series of versions. That is, the initial design and the versions representing the enhancements thereof. However, the enhancement and later version are often designed to maintain and strengthen pre-existing relationships of power and social status.
IST co-evolve during design/development/use (before and after implementation)
The process of design, development and use does not end when the system is implemented. It unfolds over time in a form of mutual adaptation between the IST and the social system into which it has been placed (Clausen & Koch, 1999). The requirements for use evolve and are different in every stage of IST life.

4.2.3 Social Informatics Principles Grounded in STS Theory and its Principles

In ensuring that the study was based on sound principles, the analysis of the SI principles was grounded in socio-technical theory and its principles. In fact, the study goes further to argue that SI is not a total departure from socio-technical theory but has evolved due to the need to focus on IST that are BIA centric. These are IST that are designed to enable business to perform certain business functions optimally, geared towards execution of complex business processes and the creation of operational efficiencies. All of this produces data, a key business asset without which business intelligence and the analytics function would not exist. In support of this view, Sawyer and Tyworth (2006, p. 50), argue that 'social informatics is grounded in the principles that guide socio-technical theory'.

As socio-technical research has evolved, scholars have continued to adapt and re-shape the principles to reflect new insight and discovery in socio-technical studies. In order to reflect on the principles that ground socio-technical theories, analysis of SI takes into consideration the manner in which SI principles support and/or are based on the socio-technical principles designed by Bijker (1995): (a) the seamless web principle; (b) the principle of change and continuity; (c) the symmetry principle; and (d) the principle of action and structure. These are elaborated on in the section below.

SI principles are the vehicles through which SI seeks to ensure design and development of appropriate IST. For this study these are extended to consider integration into BIA through adoption of CR as an underlying philosophy. According to Horton et al. (2005), analysis conducted using SI principles yields better understanding of both IST and BIA requirements and results in the design of IST that are workable and fulfil their intended functions. The section below discusses SI principles in detail.

ISTs Are Viewed as Socio-technical Systems

STS's primary goal is to promote the development of socially sensitive, ethical, and humane methods for technology design (Lamb, Sawyer, and Kling, 2000). Simply put, STS's viewpoint is that IST cannot work on their own, but through the involvement of people, which means that any form of determinism, either technical or social, will result in IST that are not useful and usable. STS theory thus advocates that social and the technical should, whenever possible, be given equal weight (Mumford, 2006). SI is built in part on STS concepts, in particular the *seamless web principle* which states that neither technological nor social views should be privileged over the other (Sawyer & Tyworth, 2006), by going further to account for social consequences of the design, implementation and use of IST over a wide range of social and organisational practices.

SI is Context Specific

Of critical importance and consideration from conception to design and development are contextual elements that may influence the data output as social actors engage IST and BIA. Sawyer (2005) argues that context and use are intertwined, thus having a direct influence on one another and as a result the output. The social context nature of IST and BIA brings about complexity in the design process in that designers do not only need to concern themselves with balancing technical functionality with social factors, but also with understanding how the prevailing social dynamics facilitate or constrain the production of high quality information required to enable the BIA function to deliver business value. In line with the STS *principle of change and continuity*, designers should also concern themselves with design of scalable IST and growing BIA needs. These are systems and technologies that while retaining their inherent structure, are able to adapt over time as needs continuously evolve (Sawyer & Tyworth, 2006). In addressing context of use, design IST that integrate BIA, embracing the STS *principle of symmetry* which states that the successful working of technology must be viewed as a process rather than an end state. These would be adaptable to actors' needs as the situatedness of use changes and networks evolve (Sawyer & Tyworth, 2006).

SI Is Problem Oriented

SI is a problem-driven research domain that begins with the assumption that IST and the social and organisational setting in which they are embedded, are a relationship of mutual shaping (Bijker, 1993; Kling, 1996; Orlikowski & Baroudi, 1991). IST are developed to address a business need: improvement of work processes or practices, performance of complex business function or compliance, execution of processes and efficiency improvements. However, regardless of the business need, for IST to be considered successful, they have to deliver results, that is, value through the delivery of effective BIA. In this context, SI's advocated approach has to be applied in a manner that best enables an IST solution to address the specific business needs and beyond, to enabling monitoring, measurement and management of business performance, a function of BIA.

The ultimate objective of this principle is to assist organisations and institutions to make better use of IST and thereby derive real value from their IST investments. IST value can only be truly and fully realised if BIA delivers optimal value, and vice versa.

SI is Critical in Nature

SI is critical in its approach to the design and development of IST in that it challenges the taken-for-granted assumptions about the material value of an IST by its explicit focus on investigating the embedded assumptions, exposing them in order to address them effectively. In its conventional approach, SI prioritised an empirical view, which is limited to observable consequences. Adopting a CR approach enhances this principle in that the focus is at the level of the real, encouraging an understanding of both objects (social and technical), and mechanical structures that trigger certain events to occur, regardless of whether they are observed or not. In this case, SI can now generate insights into both observable and non-observable consequences of use. These can be utilised to inform future design of IST and to integrate effectively it into BIA.

People Are Social Actors

In order to develop an understanding of IST and BIA uses and observable and non-observable consequences in context, the study adopted the social actor concept which considers IST and BIA users as more than individual actors. According to Lamb and Kling (2003), social actors are socially complex individuals who are engaging in IST uses and consume information in ways that are not only characterised by their environment but are informed, enabled and constrained by the institutional character, structures and social practices and preferences of the network within which they operate. This further accentuates the STS *principle of action and structure* (Sawyer & Tyworth, 2006). The social actor concept is an effective and realistic view of how IST are used as it does not only consider the complex and multiple roles that individual actors fulfil while 'adopting, adapting, and using information systems' (Lamb & Kling, 2003, p. 197) but it recognises that business activities they perform compel them to act in 'socially legitimate ways, juggling conflicting and ambiguous requirements' (Lamb & Kling, 2003, p. 218).

The CR approach is appropriate in that it acknowledges the role of subjective knowledge of social actors, and that in each situation there are independent structures and mechanisms that constrain and enable their actions. Hence the view is that in designing IST and BIA that meet the requirements for the network within multiple social contexts, requirements have to be analysed at a social group level. This ensures the representation of the practices, preferences and tendencies of a collection of actors and the roles they are expected to fulfil as informed by the varying levels of interaction, affiliations, environments and identities. Lamb and Kling (2003, p. 218) further state that 'social actors are not only primary users of IST', arguing that social actor theory accounts for all types of users. This includes but is not limited to anyone who interacts with IST in a social setting. In support of this argument, Meyer (2006) adds that the social actor concept 'allows for analysis of less computer-intensive professionals who are nevertheless routine users of IST'.

The study further argues that in order to get the most out of the IST implemented, social actors, as people directly engaging with the IST and whose engagement determines the quality of the data output, need to be viewed as critical players and their behaviours and patterns of uses thoroughly examined. This should be further contrasted with how certain objects (social and technical) tend to behave when certain functions are performed or IST utilised and under what conditions and circumstances these tendencies materialise and what their consequences are, observable or not. This level of analysis will better position future design, and ultimately improvement of BIA function.

SI is Methodologically Independent

SI is not a theory but a perspective, characterised by problems being examined. Furthermore, SI research is not limited to a particular research methodology. This is the strength of SI as the research method is informed by the problem being studied. For example, this study adopted CR as both the research paradigm and methodology. In addressing the research study challenges pertaining to theory-practice inconsistences, conceptualisation of the use as well as transferring of learning by using knowledge gained through the research, CR was adopted. Because of the flexibility offered by SI, this approach simplifies the process of obtaining answers, as each case study is unique. However, this study does caution against putting more emphasis on qualitative and non-technical requirements at the expense of sound technical capability and downplaying the socio-technical principle.

4.3 Social Informatics' Contribution to the Study

In line with the above principles, this research study seeks to make a contribution at two levels of SI orientation, that is, the normative and critical levels, and it cautions against the analytical level. At a normative level, using CR as the study's underlying philosophy identifies the set of non-deterministic tendencies for consideration when designing IST that integrate effectively to BIA. This assists in accounting for varied outcomes that may occur as actors work with IST and BIA in a wide range of organisational and social contexts.

At the critical level, the study subscribes to CR principles, in that it encourages researchers to critically examine assumptions made by the designers and developers with a view to ensuring that IST developed serve as a good foundation for the BIA function. To analyse the design of socially complex IST critically and comprehensively, the study extended the SI to include social actor activities in terms of the network within which they operate. This enhances understanding of behavioural tendencies as social actors exchange information across the network.

In view of the fact that where social and technical meet there are multiple realities, regardless of whether the context of engagement is the same or not, the researcher cautions that using the study findings to inform design of IST in other institutional and cultural contexts needs to be done with considerable care about existing social, context and environmental factors. This is largely due to the view that although non-deterministic tendencies can be identified with a softened generalisation in similar contexts considerable care is required as causal mechanisms from one situation or context may differ and thus manifest themselves differently in other contexts. For example, since this was a single case study, the conclusions could be met with certain cultural and contextual limitations; therefore caution was needed in the analytical applicability of the study findings in the design of other IST and BIA in other contexts.

The next section paves a way for section 4.5 which is aimed at demonstrating how CR addresses design gaps in SI and contextual gaps in design as well as to contextualise the paradigm shift as well as the methodological implications of the chosen approach.

4.4 The Paradigm Shift in SI's Theoretical Framework

As the study's proposed design philosophy, SI offers promise in addressing the research study problem, in that its interest goes beyond the implementation of IST to examine how it is utilised and its consequences. It is therefore fitting that the SI design method will concern itself with how data produced using IST is advanced into insight through the BIA function. In this study, the consequences the study is concerned about are at an empirical level, in terms of facilitating an understanding of the context in which observable patterns of events occur (Mingers, 2001, 2004a, 2004b), as well as understanding how these events may enable and/or constrain BIA development.

At a conception level, SI's underlying paradigm is interpretivism; one could argue that this makes sense at a number of levels. Firstly, interpretive studies are valued for their ability to address qualitative, non-technical and context-sensitive research. Secondly, the scholars that espouse and continue to promote SI work advocate for the socio-technical philosophy which by default is non-deterministic and therefore not positivist in nature. While this seems stereotypical, the environment and the culture play a big role in influencing the adoption of certain paradigms. Thirdly, while Sawyer and Tyworth (2006) argue that SI is methodologically independent, and that any research method can be employed, it is largely associated with qualitative methodology because of its concern for context, given the view that technical and social are not meaningfully separable.

Adoption of CR was critical in this study for developing and supporting in-depth causal explanations for the outcomes of IST, taking into account the breadth of social, contextual and environmental factors which may have caused their occurrence. The practicality of resolving the research problem therefore lies in redefining the theoretical paradigm underpinning SI as a selected design method, thus enabling the process of reconceptualising it as a proactive analytical study of IST design, uses and consequences in context. The need to reconceptualise the theoretical paradigm that underlies SI emanates from the point that conventional SI is a retrospective study, founded on the interpretivist paradigm and ontological assumptions that are contradictory to the study's objective. As a consequence, applying SI in its classical form will result in theory-practice inconsistences.

Although SI is a promising multidisciplinary approach to the study of IST, the theory-practice inconsistences render it an unsuitable option for the study under enquiry. As Walsham (1995) puts it, the interpretivist ontological position is internally focused with intersubjective construction. This is in contradiction to the CR ontology which asserts the existence of reality independent of our conception of it. As Bhaskar (1975) puts it, this form of realism is in contrast to 'external' realism. Bhaskar's (1998a, p. 16) view of ontology is that, 'for science to happen there must be a reality independent of our knowledge of it'.

In employing Bhaskar's ideology, the researcher argues further that where IST and SI meet, there are always multiple realities. This is demonstrated in SI's concern for context and acknowledgement of the variable outcomes. Contextual dynamics therefore account for different observable events. With this explanation it follows that no design can anticipate all realities, thus making it difficult to make provision for all realities when developing IST. However re-constructing SI's ontological assumptions in line with CR's ontology offers an opportunity to minimise the gap in a specific context by employing a non-deterministic tendency principle when studying a particular phenomenon.

In its conventional state, SI has made significant contributions to the advancement of the IS field of study research. This study draws from these inputs; in fact the study argues that SI has an invaluable role to play in the understanding of the processes that give rise to the patterns that might be observable in a particular context. The insight generated through this process provides understanding as to for whom and in what circumstances these patterns become established. Carlsson (2006) adds that IS design research's main goal is to establish why and how IST work through understanding the context action mechanisms: that is an understanding of how the introduction or use of IST into pre-existing contexts can generate particular outcomes. The capability to generate these outcomes is referred to as generative mechanisms (Bhaskar, 2008). Simply put, generative mechanisms are 'nothing other than the way of acting of a thing' (Bhaskar, 1998a, p. 38). According to Smith (2006, p. 203) 'this way of acting always happens in an open, highly stratified context of mechanisms whose presence (or absence) co-determine what happens'. This said, it can therefore be argued that not all events that occur in the actual at a given time can predetermine the outcome (Mingers, 2004a, 2004b, 2009), and equally, the observable events are not always traceable back to the events that produced them.

Examining the technical artefacts and the social structures enables us to have deeper understanding of the underlying triggers in context (Sayer, 2000), which are better thought of as tendencies. Equally important is acknowledgement that at the level of the 'real', separately the social and technical artefacts have the power and the capacity to induce particular responses as actors engage with them. Central to this ontology are non-deterministic causal tendencies that help us to effectively account for certain reactions when social meets the technical at the level of the real and not the empirical.

4.4.1 Why is Critical Realism a Better Option than Positivist and Interpretivist Approaches?

Despite its prevalent position among the rest of the paradigms, positivism has been criticised for 'naïve realism' in which reality is apprehendable and knowledge can easily be captured and generalised in a context-free form (Guba & Lincoln, 1994a).

CR is premised on the view that science is not just about recording constant conjunctions of observable events, as the Humean view of causation embedded in positivism suggests, but is about mechanisms that exist and generate the events that may or may not be observed. The point that mechanisms (objects, entities and structures) that underlie the events are not observable, does not mean that the event did not have a cause. Therefore both events and the mechanism cannot be apprehended directly, as they are not open to observation, but they can be inferred through a combination of empirical investigation and theory construction (McEvoy & Richards, 2006). Conceptually, mechanisms are ‘nothing other than the ways of acting of things’ (Bhaskar, 1975, p. 14). They are inherent to the physical (technology and systems), to social structures (organisations, social, environment) and to the conceptual (ideas or categories). The mechanisms have the power or the tendency to enable or limit what can happen within a given context (Sawyer, 2006; Sayer, 2000).

Powers referred to here designate possibilities which may or may not be enacted in a given context to generate the events that manifest as empirical experiences (Wynn & Williams, 2012). Fleetwood (2005, p. 46) defines powers as the ‘dispositions, capacities, and potentials to do certain things, but not others’. These powers arise from the essential nature of the entities that possess them.

The concept of tendencies is used to describe those actions which are characteristic or typical of a given class. Following the suggestion of McEvoy and Richards (2006) and Smith (2006), to recognise mechanisms as tendencies, the researcher contends that this concept is even more appropriate for the study as it offers an opportunity to clarify which classes of IST tend to have desired or undesired consequences and in what context and for whom. And this can be further examined in relation to how those IST enable or limit the development of effective BIA solutions. In the critical realist’s view, the real world operates as a multi-dimensional open system, a view that is more fitting in the IS context. In organisational settings nothing adheres to a set order; instead effects arise due to the interaction between social structures, mechanisms and actors. Causal mechanisms have the potential to make an impact; however, the variable conditions in which the mechanisms operate determines the nature and severity of the impact (Lawson, 1997). In making an impact in an IS study where actor interaction is at stratified levels of social organisation (Layder, 1993), approaching the world in terms of tendencies that are produced by underlying causal mechanisms is more appropriate than empirical generalisations (Lawson, 2003).

The second argument is that IS research conducted using one of the dominant paradigms of positivism and interpretivism suffers from persistent theory-practice inconsistencies. These inconsistencies are located between researcher’s stated or implicit ontological assumptions and research practice and results. By design, IST cannot be isolated from the context of their implementation. The failure of the positivist paradigm and associated research methods to address contextual factors renders them irrelevant in practice and unattractive to the researchers who have the goal of understanding the uses and consequences of IST. On the other hand, the interpretivist rejection of the causal power of the natural and social worlds results in theory inconsistency when knowledge gained from their research is shared with a view of advancing the design of IST. This rejection disqualifies any attempts to use the findings in a manner that suggests determinism of any kind, resulting in the question of why to conduct the research study if the findings are not going to be useful in advancing the cause for which the study was conducted.

While critical realists acknowledge the value of interpretivist methodologies that focus upon discourse, human perception and motivation as human reasons can serve as causal explanations (Bhaskar, 1989). They are critical of interpretivists who fail to get to the root cause in order to understand the mechanisms that underlie the social structures as these may enable or constrain the actions of individuals or the social networks in which social actors are embedded (Williams, 2003). Further, critical realists understand that while actor experiences and perceptions matter, they are limited in their account of generative mechanisms that cause certain events to occur. It is the duty of the critical realist researcher to unearth these by examining the evidence provided by the participants (Potter & Lopez, 2001).

The third argument is that the notion of the transitive and intransitive domains of knowledge is an additional benefit for the researcher in that it enables the researcher to effectively manage the systemic character of IST. The researcher who is aware of the interactions of the various components of the system (hardware, software, data and actors), is best positioned to manage the relationship and the theories that apply in the study of these. Sayer (2000) points out that in taking a critical realist view, the researcher is mindful that the intransitive dimensions of their study, especially where evidence is collected from social actors, are not independent of existing knowledge and thus cannot be assumed to be unbiased or neutral (Easton, 2010). In this way, CR recognises the inevitable fallibility of observation where the researcher has to be conscious of how the study’s assumptions enable or constrain the research study.

A fourth argument, as Mingers (2004a) points out, is that CR does not have a commitment to a single methodology, hence its pluralist approach. The IS researchers have an opportunity to choose a methodology based on merit as opposed to being constrained to a particular form of research.

The critical realist balances purpose and practice and strives to get to the root cause by unearthing the generative mechanisms underlying the observed or experienced or perceived events, thereby providing explanations as to why the objects of the study are as they are. 'To ask for the cause of something is to ask "what makes it happen", what "produces", "generates", "creates" or "determines" it, or, more weakly, what "enables" or "leads to" it' (Sayer, 1992, p. 104.). This is followed by under 'what' circumstances or in 'what' context; the 'how' and 'why' questions. In essence the critical realist is never content just with description, whether it is qualitative or quantitative hence its strength in answering the 'how', 'why', for 'whom' and under 'what' circumstances, questions that positivism and interpretivism are not capable of adequately addressing.

Lastly, and also at the heart of CR is acknowledgement of the fact that in today's world of inter-connectedness the success of scientific research lies in embracing the trans-disciplinary nature of the world of science and practice. This embraces the socio-technical dimensions of IS and of this study as well, thereby making CR an even more useful consideration. The variety of objects or components of IST can be effectively accounted for, enablers embraced, constraints better understood and instead of focusing on elimination strategies, capitalising on turning constraints into positive outcomes.

It is with this background and bold assertion of the existence of an objective natural and social world, as well as ontological assumptions, that the researcher considered CR an appropriate research paradigm and methodology for this study. Interpreting the research study problem in light of the ontology central to CR, adoption of a non-deterministic causal tendencies approach is essential for resolving current theory-practice inconsistencies in IS research.

This allows for the translation of the knowledge gained in the study into useful design knowledge for fellow IS researchers, practitioners and designers interested in betterment of their skills and design knowledge. Pather and Remenyi (2005) argue that the CR approach transcends the limitations of both positivism and interpretivism, and thus it is a viable alternative to IS researchers. It is now well established that IS is informed on both a theory level and a practice level by a wide variety of disciplines, hence its trans-disciplinary nature. This points to the great efforts which IS researchers have to invest in understanding the choices and the implications of the options available to them when conducting research. This will prevent a mismatch at a philosophical level between the paradigm and methodology in the research problem under study.

4.5 Benefits of Employing a Critical Realism Approach

This section addresses benefits of adopting CR both as research paradigm and methodology, highlighting its strengths, and explaining why the researcher adopted it as a vehicle to address the research study problem. The researcher reviews the benefits from Mingers, Mutch, and Willcocks (2013) more from an IS field perspective given the long-standing theoretical foundation challenges characterising the field, hence the theory-practice gap.

Benefit 1: Realist Ontology

CR defends the realist ontology that a world independent of our knowledge of it exists. Opening up to the possibility that a world beyond our comprehension or perception exists moves us forward and closer to addressing the issues characterising complex and social organisations that IST and BIA seek to support and enable.

CR defends a strongly realist ontology that there is an existing, causally efficacious world independent of our knowledge. It defends this against both classical positivism that would reduce the world to that which can be empirically observed and measured, and the various forms of constructivism that would reduce the world to our human knowledge of it. Hence it is realist.

Benefit 2: Assumptions about Understanding and Knowledge of the World

This benefit speaks to the viewpoint that our perceptions and theoretical lenses into the world around us inform our assumptions about the world, in turn constraining our understanding and appreciation of what may really be happening. Mingers et al. (2013) add that this view helps in accepting that knowledge is always local and historical and all viewpoints must be equally acceptable. In the context of IS design, CR creates a platform for researchers and/or practitioners to seek to understand beyond their own perceptions of organisational context, setting and situated activity and actors for whom systems are designed.

Benefit 3: Different Types of Knowledge

'CR accepts the existence of different types of objects of knowledge—physical, social, and conceptual—which have different ontological and epistemological characteristics' (Mingers et al., 2013, p. 795). In accessing these, a range of different research methodologies are required. Hence it was fitting for the study to adopt SI, as it is methodology independent, prioritising critical and context-specific problem-solving approaches. SI principles are enhanced by CR's pluralist approach in embracing the use of both positivist and interpretivist philosophical thinking. However, the view of Smith (2006) must be borne in mind: he cautions against theory-practice inconsistences that come about when their philosophical stance is not softened to a less threatening degree.

4.6 Summary

This chapter has demonstrated that with the right level of engagement and reconceptualisation of SI's paradigm, the researcher will not only address the theory-practice relevance gaps but will be in a position to effectively address the research study problem. CR's pluralistic and pragmatic approach was a catalyst in addressing theory-practice inconsistencies which were identified as a limitation for adopting SI as an integrative design method.

CR focuses on the substantive and not trivial uniqueness of events, taking a view that in some sense every event in the world is unique and impossible to explain in all its detail. Thus it is able to identify causal tendencies that can be utilised to transfer learning from one context to the other without underplaying the context-specific nuances. Furthermore, its pluralistic approach gives a solid ontological grounding for interpretivist research, reaffirming the importance of a focus on meanings, interpretation and context as causal influences without unnecessarily denying their existence.

Understanding of theoretical literature that drives the research study was crucial as it enabled the researcher to develop an effective research strategy supported by an appropriate research methodology with which to carry out this study and address the research study problem. The research strategy, design and methodology are discussed in detail in the next chapter.

CHAPTER FIVE

Research Design, Methodology and Analysis Method

5.1 Introduction

In a scientific research study, the effectiveness of the strategy for executing the research is determined by the appropriateness and strength of the research method (Edmondson & McManus, 2007). In this chapter the researcher outlines the strategy employed in ensuring that the research design, methodology and analysis method of an under-researched theoretical paradigm were effective in addressing the research study problem as defined in the theoretical framing section. CR as a philosophy of science that allows for the pluralist method, was a catalyst in operationalising the research strategy, given the paradigmatic challenges the study faced. The ability to address the qualitative realist requirements of the study, while at the same time effectively dealing with the positivist characteristics of the research, was empowering. Key to the positivist characteristics of the research was the ability to adopt non-deterministic tendencies and ‘softened’ causal powers approach (see Chapter 3 section 3.4) when analysing the findings which later informed the development of an integrative design method which would have otherwise not been possible had the SI perspective been adopted in its traditional form. The insights that were invaluable in advancing the IST design knowledge could only be effectively gained through a combined use of positivist and interpretive realist process of enquiry.

CR’s strength in focusing the research practice to the complexities of the real world is a critical enabler for an open system discipline such as IS, accordingly ensuring that the research is placed within the realist context of time, space and culture (Syed, Mingers, & Murray, 2009).

The challenges experienced by the researcher when examining the design and development of IST and BIA were the multidisciplinary and cross-functional nature of the elements impacted, requiring a comprehensive method of research. Applying methodological principles consistent with the CR paradigm in the study improved the quality of the research field output, as detailed causal explanations of the phenomena under enquiry from actors' perspectives account for the structures and mechanisms that interact to produce those outcomes (Wynn & Williams, 2012).

5.2 Research Journey

Figure 9 below outlines the researcher's journey leading to the adoption of CR as the research study method and summarises the resulting fieldwork process and the development of the design model.

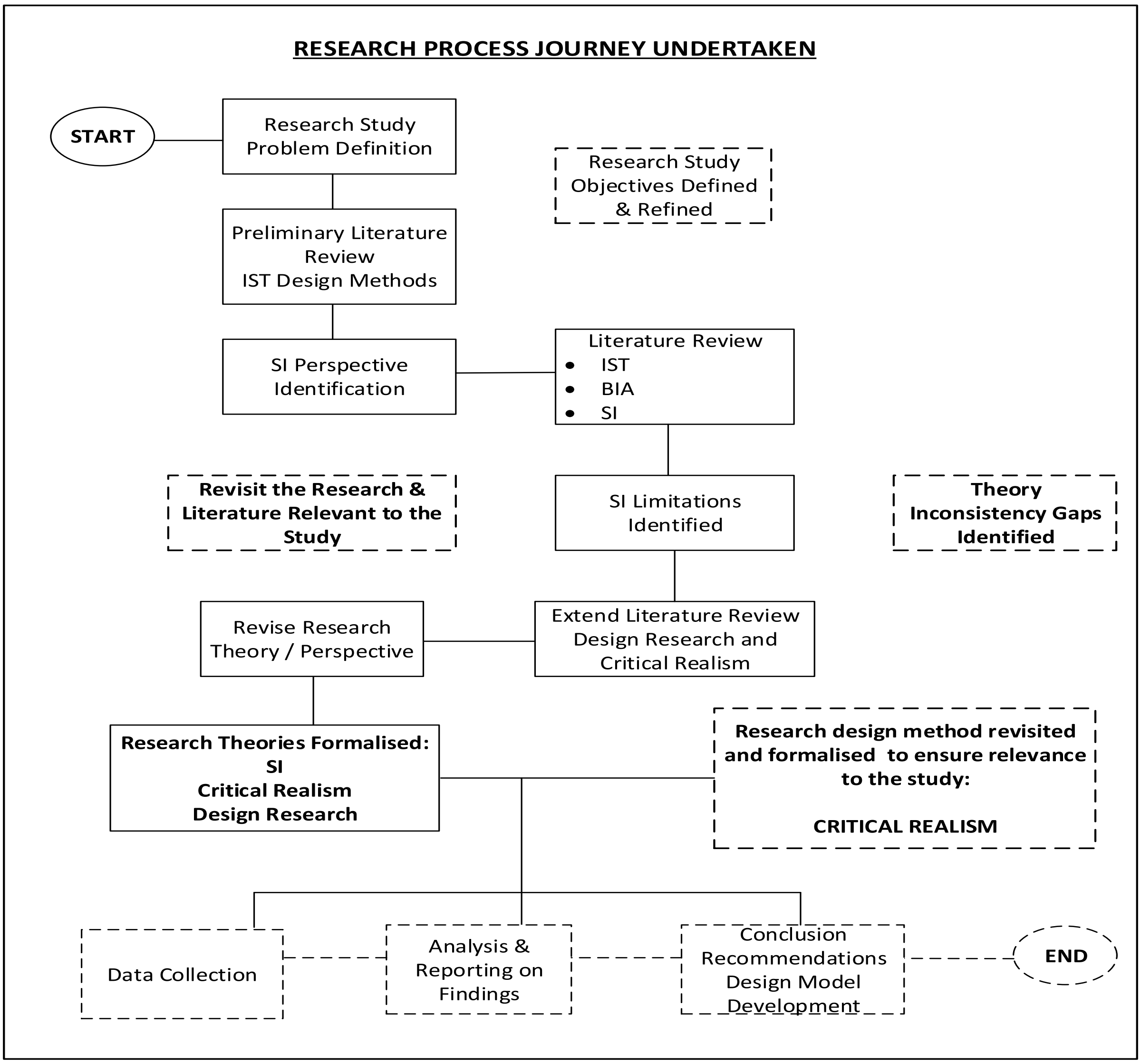

FIGURE 9: RESEARCH PROCESS JOURNEY

5.3 The Researcher's Study Reality

As Wikgren (2005, p. 11) states, 'research is always a question of making choices'. One of the many choices a researcher makes during the life of a study, is deciding on the part of reality the research wants to focus on. This reality informs the researcher's assumptions of what the reality is like, which in turn carries implications for the way knowledge is conceived, regulating the study approach and focus. For this study, it was important to move beyond describing the events that manifest in the IST uses and their consequences at an empirical level, but to unearth the possible underlying causes and relations. Further to making a choice about what reality to focus on, the researcher needed to clarify the epistemological and ontological requirements that were necessary for conducting the research study successfully.

For CR, 'the link between the assumptions about the existence of the world and society (ontology), the idea of how knowledge is possible and of what (epistemology), and the choice of methodological approach is of major importance' (Zachariadis, Scott, & Barrett, 2013, p. 2). Consequently, the ontological and epistemological requirements of the research study necessitated the adoption of the CR paradigm as a philosophical approach. According to Bhattacherjee (2012), research ontology is concerned with the assumed reality of the research, which represents the researcher's study position. The study ontology is based on the assumption that IST are socially shaped (Kling, 2000c, p. 219), and that mutual shaping of technology and society is a continuous process (Kling, 1996; Rosenbaum, 2004), inseparable from the environment in which IST and BIA should function (Ciborra, 2000). These assumptions are premised on the CR view that events that manifest at the empirical level are a result of the operation of mechanisms that are the tendency of the real structures. It further acknowledges that the structures and mechanisms that underlie the events influence the use and consequences of IST and BIA at an empirical level. These actual events are socially shaped and cannot be isolated from the structures and mechanisms that trigger them to occur.

Research epistemology is concerned with the way in which reality is represented by theory as adopted by the researcher to address the research problem (Bhattacherjee, 2012). An epistemological assumption of this research study is that IST design requirements can be addressed adequately if SI is adopted as a design method enabling effective accounting of social and technical aspects of IST and BIA. This can be achieved through examination of the structures and mechanisms that trigger the events that manifest empirically when social and technical meet.

To address the role of design in the development of IST that are a good foundation for BIA, as well as to attend to the rigour required throughout the qualitative enquiry, the research was conducted in a single environment of a South African Railway Freight Company (TFR). In order to address the research problem, the study focused on IST and BIA implementation over a period of five years from 2009 to 2013. The research exercise assessed the effectiveness of the design approach and process adopted in the development of IST. The objective of employing this approach was to assess the effectiveness of the design method in its consideration for the information reporting requirements during analysis and design of the IST. In ensuring structure in the process of enquiry, five dimensions were identified. These were informed by a literature review of the categories of IST implementation (Delone & McLean, 2003; Richard Heeks, 2002) and criteria used to categorise and prioritise IT projects in TFR, namely organisational, operationalisation, employee, design as well as the technical dimension.

While neither SI nor CR recommend a specific research methodology, the case study method has proven to have been effective in several SI and CR research assignments and is therefore popular for delivering results. In support of this view, Ackroyd (2010) adds that the case study method has been cited by many CR researchers as the best approach to exploring the interaction of events and actions with causal mechanisms in a specific context. Furthermore, TFR's operating model and footprint call for consideration of situatedness of action as the different execution areas tend to be characterised by contradictory dynamics and processes tailored to suit the differing conditions of work. In echoing this sentiment, Yin (2003) highlights that the case study enquiry process copes well with technically distinctive situations and many variables of interest and data points.

(Yin, 2003, p. 6) further adds that case study's strength is in dealing with operational links which need to be traced over time in order to answer the how and why questions, rather than mere frequency or incidence. This is particularly relevant for the study of IST and BIA in the TFR context as this will help the researcher to gain deeper insights into how the design practice has been over the year, its effectiveness in attaining the design objectives, as well as to examine how the IS artefacts have delivered on their intended functionality and business value. This method enables the researcher to understand the complex real-life activities in which multiple sources of evidence were used.

According to Yin (2002, p. 186), ‘a case study is an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident’. According to Yin (2003) a case study design should be considered when case research has the following characteristics: (a) the focus of the study is to answer ‘how’ and ‘why’ questions; (b) the behaviour of the social actors involved in the study under enquiry cannot be easily manipulated; (c) when contextual factors and/or environmental conditions are critical in understanding the phenomenon being studied; or (d) the boundaries between the phenomenon and context are not clear. CR as a coherent, rigorous and novel philosophical position that not only substantiates case research as a research method but also provides helpful implications for both theoretical development and research process extends the questions of ‘how’ and ‘why’ to understanding for ‘whom’ and the under ‘what’ circumstances do certain events occur.

In ensuring that the research analysis was comprehensive in addressing the qualitative aspect of the research study problem, given the extent to which CR goes in answering the research questions, the researcher employed a retroductive process as outlined by Zachariadis et al. (2013). They argue that the retroductive methodology focuses on ‘research and intervention not as a discrete event but as a creative process with different phases that involve different types of activities’ (Zachariadis et al., 2013, p. 12). The four-step processes are:

a. The description or appreciation of the research situation which focuses on the identification of the composite events or phenomena under study. The researcher has to carefully identify components of focus as it is not feasible for any study to examine all distinctive constituents of the phenomena under study. Situatedness of action is one such means of focusing the study.
b. Retroductive analysis of the data. This entails hypothesising about the possible mechanisms or structures capable of generating the phenomena that have been observed or experienced. It involves abstracting objects in terms of their constitutive parts in order to identify conditions and properties under which the events under study may occur. This may result in scope or research boundaries being revised.

c. Critical assessment and elimination of the alternative explanations that have been produced. This involves use of complementary theoretical interpretations to explain how different mechanisms interact under certain conditions and contribute to concretising the social event under enquiry. This entails an iterative process of comparing between the findings or inferences produced by the combination of methods.
d. Action required in order to implement the research findings. It is the only way that the causal explanations can be put to the test to see if they do or do not provide satisfactory explanations upon which change can be effected.

5.4 Case Study Design and Unit of Analysis

Research design links the data to be collected and conclusions to be drawn to the initial questions of the study – it provides a conceptual framework and an action plan for getting from questions to a set of conclusions. It is suitable for studying complex social phenomena, for example, where procedural characteristics in the situation may include but are limited to many variables of interest, multiple sources of evidence and theoretical propositions to guide the collection and analysis of data. Yin (2013) posits that there are three types of case research study from which the researcher can choose: exploratory, descriptive and experimental. However, deciding on the type of case research study cannot be done in isolation. There needs to be thorough understanding of the study's aim and theoretical propositions that informs understanding of what is being studied. The different types of case research study are briefly described below.

Exploratory case study is applicable when (a) there are few theories or a deficient body of knowledge; (b) the purpose of the study is to better understand an emerging phenomenon and/or to propose new theoretical insights to generate new ideas and hypotheses; (c) the interest is particularly strong when existing theories are incomplete or unable to provide a satisfactory representation of the studied phenomenon; or (d) it is used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes.

Descriptive case study can be effective where the case research study seeks to describe the current practice, namely an intervention or phenomenon and the real-life context in which it occurred or when the generality of the phenomenon is of secondary importance.

Explanatory case study is most appropriate when the existing theory is used to understand and explain what is happening; the goal is to explain a situation, mostly in the form of a causal relationship (too complex for the survey or experimental strategies; or the isolation of factors may be a problem.

In explaining what a case is, Yin (2013) suggests that the term represents the topic of the study empirically (for example the effectiveness of the TFR design approach in designing BIA-centric IST). As (Noor, 2008, p. 1602) puts it, 'case study is not intended as a study of the entire organisation. Rather is intended to focus on a particular issue, feature or unit of analysis'. It is important to select the case and unit of analysis properly. The case research study approach may take a form of a single case or multiple cases. The unit of analysis may be holistic or embedded in approach. The interdependent nature of case and unit of analysis calls for careful consideration of the theorisation of the study at the preliminary stage to ensure that the researcher selects the case research design that is most appropriate for the phenomenon under enquiry.

According to Yin (2014), a single case is recommend in the following scenarios: (a) if case research study seems to represent a critical test to existing theory; (b) if it represents rare or unique events; (c) if it is representative of or reveals a particular situation/activity; or (d) it is longitudinal. Multiple cases are particularly relevant in the following scenarios: (a) when replication logic is supposed to reveal support for theoretically propositions for the study; (b) when they provide a larger picture of a complex phenomenon; (c) when there are contrasting results for predictable reasons; (d) when there are comparable study results from different organisations, countries; or (e) they avoid extraneous variations. The number of case replications depends upon the degree certainty desired and richness of the underlying theoretical propositions.

5.4.1 Unit of Analysis

The unit of analysis is the actual source of information for the research, for example a corporate entity, department, individual or possibly an artefact or activity. It offers the researcher a focal point for his or her research. Yin 2014 posits that there are two case study typologies: holistic and embedded unit of analysis.

Holistic case study includes a single unit of analysis and is relevant when a systemic approach to the phenomenon is required. It is most effective when the aim is to study the global nature of the phenomenon, when no logical sub-units can be identified. Embedded case study includes multiple units of analysis and is applicable when the study focuses on different sub-units of a specific phenomenon or entity. It may include main and smaller units on different levels. It is largely effective when the study aim is to identify consistent patterns of evidence across units within a case type.

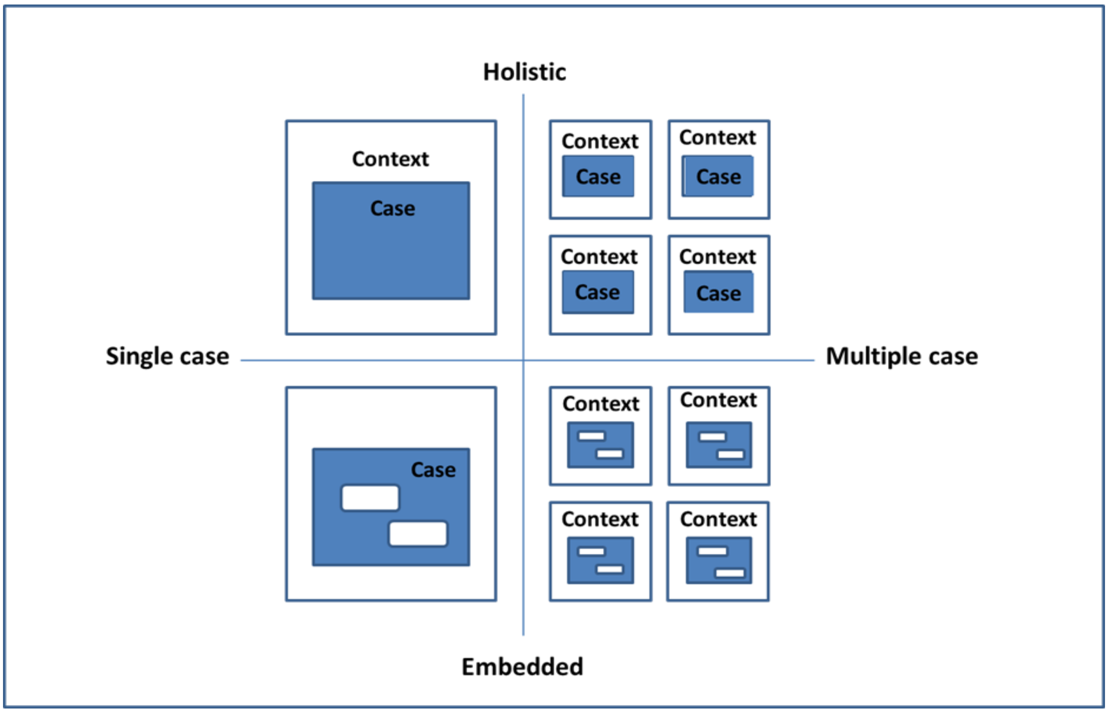

FIGURE 10: CASE STUDY DESIGN DESCRIBED BY (YIN, 2014)

This case study is a single case research study adopting a holistic design approach to the study of IST and BIA design, and IS artefacts in TFR. Identifying a single case, in a specific setting, is a viable means through which the researcher could effectively provide concrete explanatory details regarding a set of events that match the empirical facts of the case study and that could be used to develop new insights regarding the study of IS artefacts. According to Wynn and Williams (2012), intensive study of a particular setting often results in an in-depth and contextually relevant analysis of a complex organisational process.

Its design is depicted in the top left of Figure 10. It is exploratory in that it uses the TFR case context to answer the research study problem of how SI can be reconceptualised as an integrative design method that accounts for both IST and BIA through applying a CR theoretical paradigm. It achieves this by examining the design approach employed when designing IST and BIA with an objective of contextually understanding and examining the causal relationships between design and use in context. The study's adoption of CR as its research method extends the study analysis of the findings to the contextualised explanatory method (Welch, Piekkari, Plakoyiannaki, & Paavilainen-Mäntymäki, 2011), thus enabling the researcher to arrive at the most appropriate explanatory answer to the questions of how, why, for whom and under what circumstances IST and BIA deliver on their intended functions, adding business value. The researcher achieves this through analysing case study data and building an explanation about the case in order to identify a set of causal links.

5.4.2 Case Context Study – Transnet Freight Rail

Easton (2010, p. 119) states that a single case study must be able to stand on its own. The key opportunity it has to offer is to understand a phenomenon in depth and comprehensively.

TFR is one of the five divisions of Transnet, a state owned company (SOC) with the mandate to reduce the cost of doing business in South, and to capture markets in neighbouring countries and Africa as whole. As a rail leg of the value chain, TFR has for a long time been contributing more than 60% of Transnet's revenue. In trying to address some of the challenges that relate to infrastructure, adopting a road to rail strategy to move rail-friendly cargo back to rail and reduce the of cost of transportation, Transnet has set aside a capital budget of over R8 billion over a period of seven years to be invested in both Engineering Technology Solutions and Information Systems Solutions

(IST and BIA) in TFR. These were targeted at transforming key operations functions to become digital in order to contribute to Transnet's vision of delivering freight reliably.

TFR is an operationally intensive business with high levels of dependency on technology infrastructure, like signalling systems, railway networks, real-time train monitoring and train execution technologies and systems, and can thus be classified as a highly technical environment. Its complex organisational character and structure made it an excellent case study for this research as the scope of enquiry process enabled the researcher to examine the effectiveness of the design approaches employed over a five-year period in addressing the operational dynamics that enable or constrain IST and BIA uses.

Furthermore, TFR's Market Demand Strategy (MDS) for increased tonnages, improved operational efficiencies and safe execution, has increased the business reliance on IST and BIA. During this period TFR had a portfolio of projects in execution stage that were aimed at harnessing technology and intelligence for improved business performance and achievement of MDS strategic priorities. To support the business initiative for the IT-enabled operations, the IT department was on a drive to replace legacy systems and technology infrastructure that was outdated and as such limited the scope of IST and BIA improvements. The scope of activity and development around IT in the organisation offered the research project a rich environment both qualitatively and technically to engage with and address the research problem.

While other IST and BIA projects were implemented between 2010 and 2014 as a strategic initiative aimed at creating an environment that can enable and support the TFR digital transformation strategy, the Integrated Asset Tracking System (IATS) Programme was referenced by more participants during the field research work than any other project or programme implemented during the period targeted by the study. It is in this regard that the researcher is highlighting the IATS as part of the case context of the study. The IATS programme comprised the following technologies implemented as individual projects: Locomotive and Wagon Tagging, Hand Held Devices (Radio Frequency Identification Devices – RFID), Wayside Readers, On-Board Computing (OBC), Triton Communication and Graphical View and Train Definition Unit (TDU). These are further outlined in the section below.

The tags store the information related to the specific asset which are read by the wayside as assets move past them, on main lines, at the entrances and exits of yards, major sidings, major traction and wagon maintenance depots, wash bays and border posts

Locomotive Tracking and Communications (Triton) and TDU installation of GPS and communication units to locomotives enable time- and distance-based viewing of loco and train position on the Graphical Viewer.

OBC for diesel locomotives technology provides driver assistance by means of a visual display of line geometric profiles (topography, gradients and curves), speed profiles on the train type, load and profile of the track and early warning systems that enable drivers to facilitate safer handling of trains.

Hand-held scanning devices for yards are used by the yard officials, who point the device at the RFID tags on the wagons and locomotive, scan wagon numbers accurately, and train consist will be immediately available in the system, prior to departure. ('Train consist' is a term for a combination of a set of locomotives coupled with empty or loaded wagons that make up the train.)

IATS Geographical Viewer is a BI medium through which tracking and tracing and accurate real-time management information become visible to stakeholders. This system assist in answering the question: Where is my train, locomotive, wagon or consignment? This improves service and reliability of assets and gives timeous and accurate customer feedback for consignments.

Figure 11 below is a picture of the IATS programme depicting all the projects in an integrated fashion to illustrate how the systems and technologies deployed under the programme deliver on the programme objectives and enable the TFR digital transformation mandate.

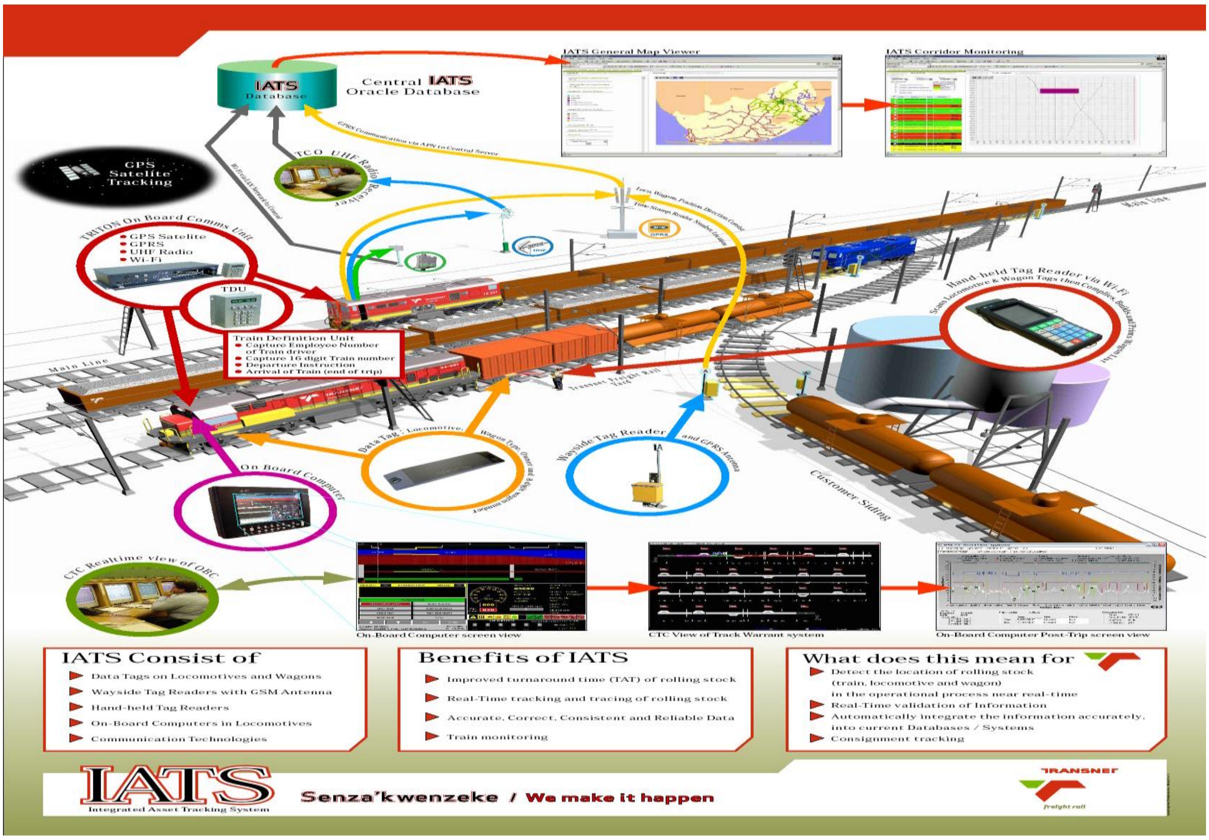

FIGURE 11: IATS PROGRAMME PHOTO COLLAGE, (TRANSNET FREIGHT RAIL, 2011)

5.5 Case Study Protocol

According to Runeson and Höst (2009) the case study protocol is a case research blueprint containing all the design decisions as well as field procedures for the case study. In support of this view, Yin (2013) adds that it is essential for each case research study to have a study protocol to guide the case field execution. It is the means by which the researcher can ensure that the study is carried out in a manner that is satisfactory and in line with the predefined research instrument and plans. The instrument outlines the procedures and general rules that should be followed during the field execution in order to ensure rigour in the research. It is through the case protocol that the researcher can plan the execution of the study and check to ensure that all data identified as critical for the study is collected and managed, such as deciding what methods to use for data collection, what departments of an organisation to visit, what documents to source, which persons to interview and timelines for the study execution.

The study protocol is not a static document. It evolves with the study to continuously reflect the changing plans for the case study. The researcher used it as a log of all information that was identified as important when the case study was reported later. This lowered the risk of missing important sources of information, relevant data sources and key developments in data collection as well as the analysis process. For this research the case study protocol was designed in accordance with the data collection method in order to ensure that specific requirements were attended to adequately. It is outlined in Tables 7–11.

TABLE 7: CASE RESEARCH PROTOCOL DESCRIPTION FOR THE SEMI-STRUCTURED INTERVIEWS

#	Description
1.	Participants to be representatives of both business user community and IT experts (technical resources) that have either been involved in the implementation of IT artefacts or users of deployed IST and BIA.
2.	To identify a minimum of three participants from each level from both business and IT, i.e. junior, supervisory, senior and executive leadership level
3.	Interview protocol to be developed and used to ensure structure and consistency of interview questions.
4.	Memo notes to be taken as part of supplementing verbal descriptors with non-verbal gestures.

TABLE 8: CASE RESEARCH PROTOCOL DESCRIPTION FOR THE FOCUS GROUP DISCUSSIONS

#	Description
1.	Each focus group to be representative of all functional areas for all levels of reporting in the organisation. For example, the focus group for IT technical teams at all levels, need to represent all five functional areas in the IT division. These are: Portfolio Management (Business Analysis), Architecture (Business/process, Technology, Information and Solution design), Systems Applications Development, BIA Development as well as Project Portfolio Management.

	Focus group for business users, is going to be somewhat different in that while the aim is to ensure representation from all department and business units, participants will be identified based on their prior involvement and engagement with IT, either through a project participation or extensive use of IST and or BIA. However, the aim is to ensure representation from all levels.
2.	For the focus group discussion to be considered a fair representation and to continue, a minimum of five functional areas needed to have been represented per session.

Table 9: Case Research Protocol Description for the Observations

#	Description
1.	Observations will be targeted for all six business units.
2.	The observation will focus on the use of IST and BIA that were designed, developed or deployed during a period of 2010 to 2014.
3.	Observations to take place in the natural setting as business users are executing their normal day-to-day duties.
4.	Where an opportunity to ask questions during the execution of certain activities is not available, notes will be taken and discussed with the participants during the debrief session where clarity is required.

Table 10: Case Research Protocol Description for the Documentary Reviews

#	Description
1.	Type of documents to be reviewed will be identified upfront and these will be standard documents identified as key artefacts of the SDLC methodology currently in use.
2.	The documents will only pertain to the IST and BIA projects executed during the period of 2010 to 2014.
3.	The focus of the review will be informed by the first and second round of analysis of the data from the three data collection methods.

TABLE 11: GENERIC – CASE RESEARCH STUDY PROTOCOL

#	Protocol Description
1.	Obtain written consent to use Transnet as a case study for the research study from leadership of Transnet.
2.	Notify the heads of departments and business units of the researcher's intent to conduct semi-interview, focus group, observation and documentation and what their employees could expect from the process.
3.	Send written calendar request to all participants identified for the semi-structured interviews and focus groups. Participants were given an option to choose a meeting place that suited their needs. The researcher went out to meet all the participants.
4.	Send written schedule for the observations informing the Area Production and Yard Managers of the researcher's plan to visit the yards and or depots. This included a detailed explanation of what they could expect from the observations process.
5.	Take as many notes possible during the semi-structured interviews and focus groups.
6.	Use of digital recorder for semi-structured interviews and focus groups.
7.	Produce field notes for observations.
8.	Design a spreadsheet database to store all data collected for each of the data collection methods.
9.	Update the case protocol and the database as the field research work and analysis phase progresses with up-to-date and current developments of the study.

The data collection process that was followed is outlined in Figure 12 below. The case study was based on data collected from semi-structured interviews, focus groups, observations and documentary reviews. Data collected from the multiple data collection points was cleaned up and stored to facilitate the easy of retrieval for data analysis stage.

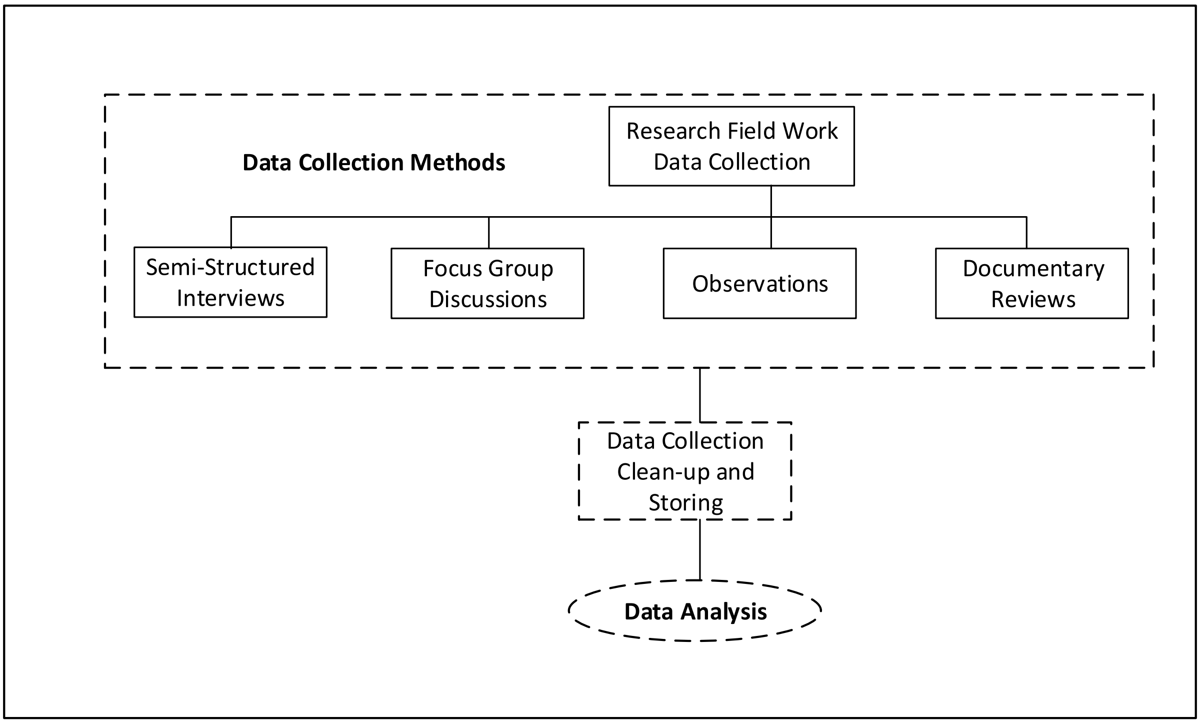

FIGURE 12: DATA COLLECTION METHODS

5.6 Sampling

While the goal of sampling in quantitative research is to obtain large, representative samples and to generalise findings to populations, qualitative research does not attach the same level of importance to sample size (Onwuegbuzie & Leech, 2007). The study entailed qualitative realist research with an objective of obtaining insights into the design process in a TFR organisational setting; therefore purposive sampling was considered most appropriate. Below are the reasons why purposive sampling was adopted as the sampling strategy:

- The aim was to gain insight from all stakeholders impacted and knowledgeable in the subject of enquiry. TFR as a national organisation has employees who are geographically dispersed in offices, yards, operations, the Central Train Control Office, and on-the-ground personnel, ranging from lower levels to the executive management of the organisation.
- IST's systems under enquiry were utilised at various levels within the organisation with a combination of social actors engaging with the IST for multiple functions from multiple perspectives interacting with multiple stakeholders. The research

included those that utilise IST and BIA routinely, but not as intensely as those whose daily functions depend on them.

5.6.1 Unit Sampling

Table 12 for semi-structured interviews, Table 13 for the focus group discussions and Table 14 for the observations below indicate the stakeholder groups within various functional areas in TFR that were identified as crucial participants and thus participated in this study. In order to ensure appropriate levels of representation, stakeholders selected to participate in the study were employees that were directly impacted by IST and BIA introduced between 2010 and 2014 To ensure fair representation, the participants were spread across all the identified groups. This sampling strategy ensured efficient and effective saturation of research themes and accounted for all aspects instrumental in addressing the research study problem.

TABLE 12: SEMI-STRUCTURED INTERVIEW – UNIT SAMPLE OF THE RESEARCH STUDY

# of Participants per Level Category	Information and Communications Department Participants		# of Participants per Level Category	Business User Community Participants
2	Executive Managers		1	Executive Sponsor
5	Senior Manager		2	Executive Managers
1	MIS Middle Manager		4	Senior Managers
2	Middle Managers		3	MIS/BI Middle Managers
2	Junior Manager		1	Middle Manager
1	MIS/BI Analyst (Junior Level)		1	Junior Manager
1	Business Analyst (Junior Level)			
14	Total		12	Total

TABLE 13: FOCUS GROUP DISCUSSION – UNIT SAMPLE OF THE RESEARCH STUDY

# of Participants per Level Category	Information and Communications Department Participants		# of Participants per Level Category	Business User Community Participants
1	Senior Manager		5	Senior Managers
7	Middle Managers		2	MIS/BI Middle Managers
4	Junior Manager		3	Middle Manager
2	Systems Developers (Senior Specialist Level)		4	Junior Manager
1	MIS/BI Developer (Junior Specialist Level)			
1	MIS/BI Analyst (Junior Level)			
3	Business Analyst (Junior Level)			
19	Total		14	Total

TABLE 14: OBSERVATIONS RESEARCH STUDY – UNIT SAMPLE OF THE RESEARCH STUDY

Observations	Job Title	Level Category
Head Office	Duty Managers	Senior Management
	Corridor Managers	Middle Management
	Train Planners	Junior Management
Operations	Area Production Managers	Senior Management
	Operations Managers	Middle Management
	Train Control Officers	Junior Management
	Yard Personnel	Junior Level Employees
	Train Crew	Junior Level Employees

5.7 The Research Study Framework

As reflected in the conceptual model of the study, the preliminary literature analysis indicated three kinds of theorising that could help to close the research and practice gap of IST and BIA. It highlighted SI as the most viable perspective to design BI-centric and context-sensitive IST. This indicated that the theory-practice inconsistences identified as the significant challenge could be addressed through reconceptualisation of the theoretical paradigm underpinning the SI perspective.

CR theory was identified as the most appropriate theoretical paradigm to adopt to address the theory-practice inconsistences challenge at the heart of the SI perspective's strength as a design methodology. After this, design thinking principles and practices could be adopted for the actual practice of design.

SI, CR and design science have therefore been identified as the three theories and/or perspectives that have potential to address the practice reality gaps. The three theories challenge the common design methodologies by focusing on the theoretical paradigms' foundations as these are fundamental in informing the assumptions that designers make when designing IST and BIA. These further inform consideration for BIA requirements as well as the process of enquiry in accounting for the qualitative requirements.

These theories are further united by their concern for the social actor, the environment in which IST and BIA need to function, as well as in-depth understanding of the consequences of use post implementation. In taking the debate that was initiated by SI beyond the understanding of consequences of use, CR places emphasis on thorough examination of the structures and mechanisms that triggered results in observable and non-observable events at an empirical level. This enables better understanding of qualitative aspects of computing, providing insight into how to minimise the unintended consequences and maximise the uses.

The research study framework is depicted in Figure 13 below.

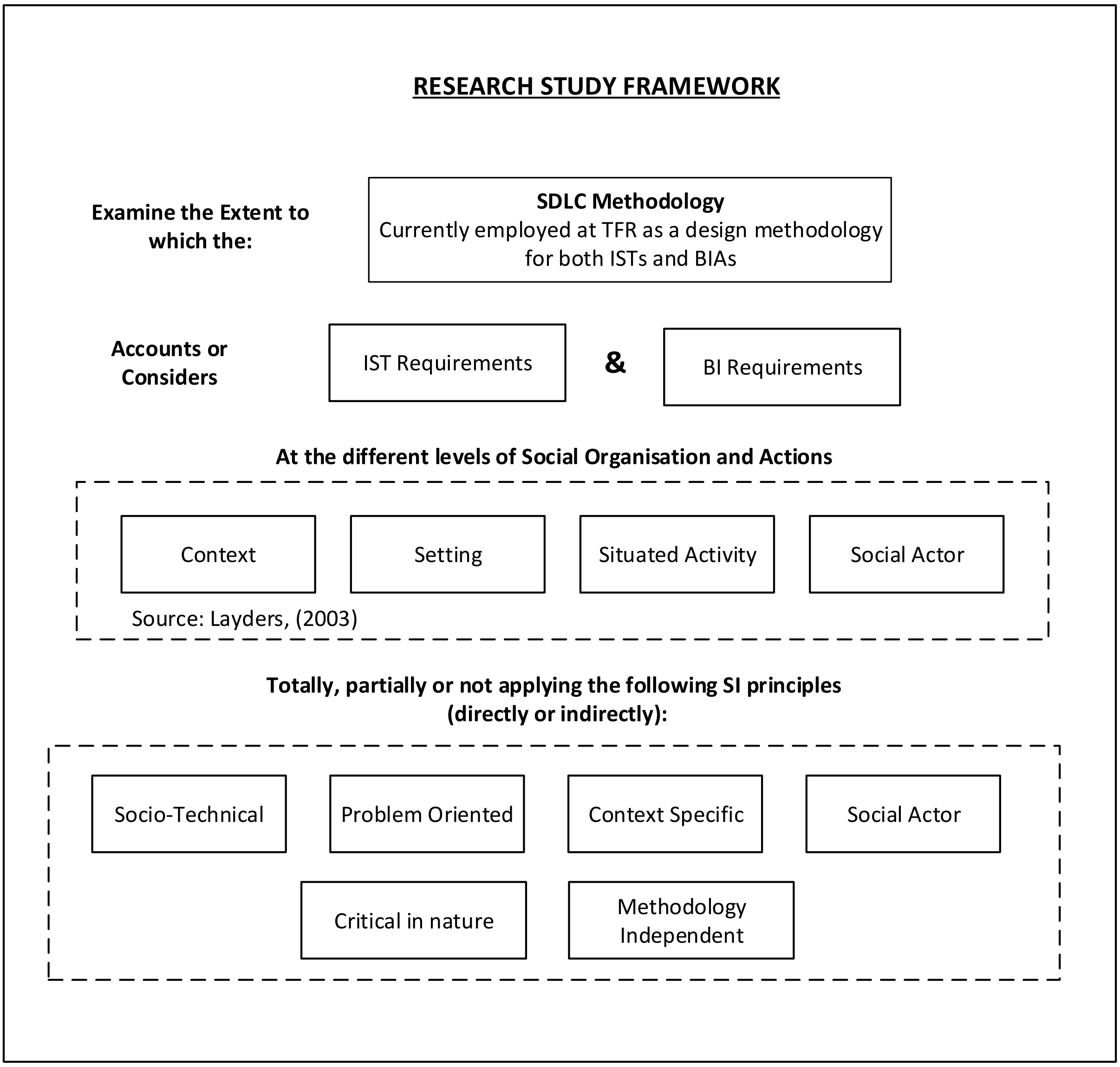

FIGURE 13: RESEARCH FRAMEWORK

Figure 13 illustrates the research process that was followed in the research fieldwork. There were two parts to the process. First, the study focused on examining the extent to which the design methods adopted in the development of IST considered BI requirements. This enabled the researcher to ascertain the extent to which the design methods were effective in accounting for information reporting requirements.

Similarly, part 2 of the exercise was used to ascertain the extent to which the design methods aligned to SI principles, either directly or indirectly. The researcher took care to ensure that terminology used was not a limiting factor by recognising the same concepts that were expressed using different words in practice and translating them into the concepts used in the study.

In addition to the SI principle, it was of importance to assess consideration of contextual factors, implicitly or explicitly. Again the purpose of the exercise was to assess the effectiveness of the methods used in addressing this requirement.

Semi-Structured Interview and Focus Group Protocol

The interview protocol used to guide and focus the discussions during the semi-structured interviews and focus group discussions focused on examining the extent to which design methodology in use at TFR accounted for the areas outlined below:

- Work and social practices associated with the use of IST and BIA;
- How IST impacted on the employee work-life balance;
- Understanding of their level of involvement throughout the life cycle of the IST and BIA design, configuration and development; and
- How IST accounted for the environmental conditions and dynamics as well as the relevance of the technical functions and the ease of use post implementation.

The above areas of focus for the study were shaped by the literature review in line with the research study problem. They further informed the five dimensions detailed in Appendix A of the semi-structured interviews and focus group discussion protocol.

5.8 Research Data Collection Methods

The primary means of addressing the research problem was through examination of the SDLC methodology that was adopted as the primary development process at TFR. Data was collected using focus groups, semi-structured interviews, observations and document reviews. This strategy allowed the researcher the opportunity to employ different methods of data collection at various levels and from multiple stakeholders. The application of CR research principles during the process of gathering data allowed an opportunity to contrast and compare the findings, thus increasing the validity and credibility of the research results.

Data and insights gathered were used to direct, re-plan and re-strategise on the way forward. In addition, the mechanisms employed enabled the researcher 'to systematically and incrementally contribute to reliability and validity and, thus, the rigour of the study' (Morse, Barrett, Mayan, Olson, & Spiers, 2008, p. 17).

5.8.1 Focus Groups

Focus groups in critical realist research proved to have been a relevant method in gathering data related to the social and contextual aspects which are the primary focus of the research study. A total of six focus groups, three from IT and three from business, with a minimum of four and maximum of six members were conducted. Table 15 below indicates the number of focus groups discussion as well as the how the groups were constituted:

TABLE 15: FOCUS GROUP DISCUSSION - PARTICIPANTS SUMMARY

# of Participants	Job Title	Anonymised Unique Identifiers	Participant Level Category	Focus Group
Information and Communications Department – Focus Group Discussion Participants				
1.	Programme Manager	IT_SP001	Senior Manager	ICT - Focus Group 4
2.	Business Analyst	IT_SP002	Middle Managers	ICT - Focus Group 1
3.	Systems Developer	IT_SP004	Middle Managers	ICT - Focus Group 1
4.	Systems Developer	IT_SP003	Middle Managers	ICT - Focus Group 1
5.	Data Architect	IT_SP005	Middle Managers	ICT - Focus Group 1
6.	MIS/BI Analyst	IT_SP006	Middle Manager	ICT – Focus Group 4
7.	MIS/BI Developer	IT_SP007	Middle Manager	ICT – Focus Group 4

# of Participants	Job Title	Anonymised Unique Identifiers	Participant Level Category	Focus Group
8.	Security Architect	IT_SP008	Middle Manager	ICT - Focus Group 1
9.	Systems Developer	IT_SP009	Junior Manager	ICT - Focus Group 4
10.	Systems Developer	IT_SP010	Junior Manager	ICT - Focus Group 2
11.	Business Analyst	IT_SP011	Junior Manager	ICT - Focus Group 2
12.	Systems Developer	IT_SP012	Junior Manager	ICT - Focus Group 3
13.	Systems Developer	IT_SP013	Junior Level	ICT - Focus Group 3
14.	MIS/BI Developer	IT_SP014	Junior Level	ICT - Focus Group 2
15.	MIS/BI Developer	IT_SP015	Junior Level	ICT - Focus Group 2
16.	Business Analyst	IT_SP016	Junior Level	ICT - Focus Group 3
17.	Business Analyst	IT_SP017	Junior Level	ICT - Focus Group 3
18.	Business Analyst	IT_SP018	Junior Level	ICT - Focus Group 2
19.	MIS/BI Analyst	IT_SP019	Junior Level	ICT - Focus Group 3
Business User Community – Focus Group Discussion Participants				
20.	Duty Management	BU_SM001	Senior Manager	Business – Focus Group 4
21.	Logistic Integrator	BU_SM002	Senior Manager	Business – Focus Group 4
22.	Resource Manager	BU_SM003	Senior Manager	Business – Focus Group 4
23.	Operations and Development Manager	BU_SM004	Senior Manager	Business – Focus Group 4

# of Participants	Job Title	Anonymised Unique Identifiers	Participant Level Category	Focus Group
24.	MIS/BI Manager	BU_SM005	Senior Manager	Business – Focus Group 4
25.	Resource Manager	BU_SM006	Senior Manager	Group 4 – Focus Group
26.	MIS/BI Manager	BU_JM007	Junior Manager	Business – Focus Group 5
27.	MIS/BI Manager	BU_JM007	Junior Manager	Business – Focus Group 5
28.	Resource Manager	BU_MM008	Middle Manager	Business – Focus Group 6
29.	Train Planner (National Command Centre)	BU_JM009	Junior Managers	Business – Focus Group 6
30.	MIS/BI Analyst	BU_JM0010	Junior Level	Business – Focus Group 6
21.	Resource Manager	BU_MM011	Middle Manager	Business – Focus Group 5
32.	Corridor Manager	BU_MM012	Middle Manager	Business – Focus Group 6
33.	Train Control Manager	BU_JM013	Junior Manager	Business – Focus Group 5

The focus groups lived up to expectations in terms of the benefits that were anticipated at the planning phase of the study. Firstly, relevant and rich data was collected fast from various participants in an economical manner. Secondly, the discussions proved to have been a very effective method of collecting data. They allowed for robust discussions which enabled the researcher to collect data from multiple perspectives at the same time. Often the participants in the group had different views and understandings of the question being discussed which allowed them to listen to other people's views and created an environment for understanding and alignment of certain aspects of the discussion. Finally, the discussions and the atmosphere created during the process enabled the researcher to gain insight into the organisational practices. The group experiences and perceptions of certain social and behaviours influencing IST uses enhanced my understanding of the environment. This would have been possible had other methods been adopted.

Compared to the semi-structured interviews, focus groups discussions provided more in-depth understanding of the concepts discussed, and the level of engagement among the participants from across the functions provided a wealth of insights to all who participated. The discussions moved beyond the study in terms of offering the participants an opportunity to learn from each other's perspectives of what was perceived to be reality.

5.8.2 Semi-Structured Interviews

Due to the rich data collected from the six focus group discussions where junior employees, middle management and senior leadership from both business and IT participated, only 26 of the initially intended 30 semi-structured interviews were conducted. The interview participants represented IT experts for both IST and BIA to ensure full representation. Equally the business user community participation ensured that insights gained represented the experience and perspective of users across all business levels through their engagement with IST and BI solutions.

The Table 16 below details the number of interviews conducted between ICT and Business. The table shows the participant level category, their job title and duration of the recorded interview.

TABLE 16: SEMI-STRUCTURE INTERVIEW PARTICIPANTS SUMMARY

# of Participants	Job Title	Participant Level Category	Anonymised Unique Identifier	Interview Duration (Minutes)
Information and Communications Department – Semi-Structured Interview Participants				
1.	Applications and Project Executive	Executive Manager	IT_EX001	65
2.	Chief Architect	Executive Manager	IT_EX002	72
3.	Portfolio Manager	Senior Manager	IT_SM001	72
4.	Portfolio Managers	Senior Manager	IT_SM002	59
5.	Programme Manager	Senior Manager	IT_SP020	120
6.	Programme Manager	Senior Manager	IT_SP021	69
7.	MIS Analyst	Middle Manager	IT_SP022	115
8.	Business Analyst	Middle Manager	IT_SP023	60
9.	Developer	Middle Manager	IT_SP024	51
10.	Developer	Junior Manager	IT_SP025	68
11.	MIS/BI Analyst	Junior Manager	IT_SP026	75
12.	MIS/BI Analyst	Junior Level	IT_SP027	58
13.	Business Analyst	Junior Level	IT_SP028	65
Business User Community – Semi-Structured Interview Participants				
14.	Operations and Development Management (Executive Sponsor – IT Project)	Executive Manager	BU-M001	58

# of Participants	Job Title	Participant Level Category	Anonymised Unique Identifier	Interview Duration (Minutes)
15.	National Command Centre General Manager (Duty Management)	General Manager	BU_EM002	120
16.	Strategy and Business Integration Executive Manager	Executive Manager	BU_EM003	105
17.	Duty Management	Senior Manager	BU_SM007	62
18.	Change Manager	Senior Manager	BU_SM008	53
19.	Resource Manager	Senior Manager	BU_SM009	71
20	Operations and Development Manager	Senior Manager	BU_SM010	68
21.	MIS/BI Manager	Senior Manager	BU_SM011	66
22.	MIS/BI Manager		BU_SM012	60
23.	MIS/BI Manager	Middle Managers	BU_MM014	115
24.	MIS/BI Manager	Middle Managers	BU_MM015	102
25.	Operations Manager	Middle Managers	BU_MM016	57
26.	Planner (National Command Centre)	Junior Managers	BU_JM017	66

The interview duration averaged an hour and 10 minutes, allowing time for the researcher to gather sufficient data from the participants. To effectively capture both verbal and non-verbal communication data, audio recordings and complementary memo notes were utilised. Audio recordings were used primarily for the collection of oral data, offering the researcher an opportunity to identify critical information which may have been missed during the course of the interview process. In addition, the memo technique was used to describe non-verbal communication which may be in a form of gestures, movements, voice pitch, and so on. According to Onwuegbuzie, Leech, and Collins (2010), non-verbal communication is critical in creating shared understanding and deeper meaning of the voice in context.

The reasons for conducting semi-structured interview were as follows:

- To offer an opportunity to engage openly as the process encourages the participants to speak freely on the subject of their interest;
- To offer guidance and direct the process in order to solicit information crucial to understanding the subject from the perspective of the participants; and
- To complement the interview protocol, as it is a good tool to obtain detailed in-depth evidence, recording both verbal and non-verbal communication data from the participants.

5.8.3 Observations

Observations were conducted on a continuous basis for the duration of the fieldwork which was 10 months. Observations ran in parallel to the interview process and analysis of research documentation. The 10-month duration of observations was necessary to ensure that the researcher reached a wide audience of business actors impacted by the development, deployment and/or use of IST and BIA. Further to the observations that the researcher conducted, and also critical to the process, was the opportunity to examine the underlying phenomena, events, and/or cases (Onwuegbuzie et al., 2010) from various settings and contexts.

These are (a) IST use in line with the processes documented as standard business functions in order to ascertain the effectiveness of the IST in enabling those processes; (b) the consistency of IST use across all functional areas examined; (c) BIA reports in place to report on the same key performance areas in order to ascertain the extent to which these have been aligned or standardised across; and (d) The area-specific initiatives implemented as the work around to certain gaps identified.

To provide structure and guide the observation process for assessing the ease with which the social actors can intuitively perform their duties and obtain appropriate data for decision making using IST and BIA provided, the researcher used the questions recommended in the literature and discussed in section 2.2.3 under Usable and Useful ISTs and BIAs. These proved to have been useful as a means to interpret the participant actions as they performed their duties. For the official audit process where participants were asked to provide certain evidence to support their actions and processes it was evident that processes, ISTs designed enable BIA capability were not effective. Often participants had developed their own manual process to close the gaps.

During the observation process, the researcher used the data collected from the interview and focus group process to focus her observation efforts, which were later compared with the results of the document review process. Furthermore, field notes and pictures of the technologies that were being observed in action, were taken. The researcher avoided taking pictures of the people as they felt uncomfortable being associated with the findings of the study. They viewed the observation process as an opportunity to air their frustrations with technologies that from their point of view were a waste of investment and effort. Field notes were utilised to capture observations in the field, and local dynamics presented by the geographical landscape as a means to capture and reflect on the spatial and geographical context of data gathered.

Further to the observations that were scheduled, the researcher was fortunate to have been afforded an opportunity to participate in the organisation's official process audits. The invitation extended the scope of the observations and presented an opportunity to capture practical experiences from an official audit. The researcher's participation in these process audits extended her footprint and reach in that it was a global process in which all TFR business units and support functions participated.

This opportunity was invaluable in the sense that the researcher gained access and insight into processes that she would otherwise not have been privy to. In addition to this access, the researcher gained a better understanding of what the business processes are meant to achieve as business outcomes and how IST and BIA are meant to support and enable them.

The official process audits were conducted over a period of six weeks whereby all six business units and three business support functions participated. The audit process was aimed at assessing the extent to which the business units and support functions adhered to the standard processes, procedures and guidelines. Among the many processes and activities that were being assessed was an IST and a BIA Module. This module was designed to assess the following aspects:

IST Utilisation

- The output as an outcome of a predefined process or activity within a set process was assessed to ascertain if business users utilised the IT tools that were at their disposal.
- Where they were said to be utilising them, the quality of the output produced using the systems and/or technology was evaluated.
- Where they were not utilising them as dictated to them by the process and an official business tool, the assessors engaged the business actors to understand the limitations of the systems both from a functionality point of view as well as qualitative factors that may have contributed to them not optimally utilising the official system or technology.
- This exercise was repeated for each output articulated in the assessment pack per business unit or function.

BIA or MIS Utilisation

- A similar process was followed for the BI and MIS assessments where the BI tools and reports were articulated per output and linked to the desired outcomes.
- The process indicated how each of the predefined reports should be used in the decision-making process, pointing to how each report enables measurement of other process activity performance.
- Analytics literacy was assessed to examine the extent to which the business users used the information produced by their MIS functions to make informed decisions or to connect to performance in other areas.

The process audits were educational in the sense that each output had its intent clearly articulated in the assessment pack, and quality requirements were also addressed in their order of importance, indicating the tools prescribed to the business community. Furthermore for each output, those responsible, accountable, communicated and informed (RACI) were outlined thus leaving less to individuals' interpretation. The assessment packs were circulated to the business community a month in advance, thereby enabling them to engage where they had questions or concerns. This process is conducted twice a year and is a continuous exercise intended to assist the organisation with its process improvement initiatives. A sample of a consolidated output of the observations process can be found in Appendix B for a more detailed view and appreciation of the level of detail that went into this process.

5.8.4 Documentary Materials Reviews

Two types of documents were collected and reviewed as part of the data collection: firstly, the literature pertaining to the research problem and the research study questions, and secondly, TFR-specific project documentation was collected and analysed over the period of the research study, namely SDLC, business cases, functional specifications, technical specifications, and MIS/BI technical specification (see Table 17 for a brief description of each of these documents). The information gathered from these documents was used to assess the extent to which the contextual factors, BIA elements and design principles were addressed.

To focus the analysis, data from semi-structured interviews and focus groups was used during the documentary review. The SDLC methodology was developed internally and signed off as an official design and development method. Documents that were identified and reviewed made reference to methodology and the teams tried to stick to the process insofar as RACI was concerned. Follow-up discussions were scheduled with the authors of the documents that were reviewed. These are detailed in Table 17 below. The objective was to understand the process followed in completing the document.

Table 17: Document Review

#	Document Name / Type	Document Description	Document Purpose	Job Title
1.	SDLC Document	A document used to outline the Systems Development Life Cycle methodology that all ICT development projects should adhere to. It outlined the person(s) responsible, accountable, consulted and informed (RACI) for each of the phases and document artefacts to be produced by each of the functional areas responsible per phase.	The purpose is to ensure alignment, standardisation and seamless execution of all ICT projects. It is used to orientate business on what they should expect at each phase of the project and the timelines associated with delivering on each phase of the project with ICT. It further serves as a common language and expectations management document.	1 x Business Relationship Manager
2.	Business Case	A document used to detail the business case for investing capital on the development of a new ICT & or enhancement to an existing ICT.	The purpose is to guide the business decision to invest, evaluate the business benefits, manage and monitor value derived from capital invested.	1 x Senior Business Analyst
3.				1 x Business Architect
4.	Business Functional Specification	A document used to detail the business requirements of a new or enhancement of the existing ICT. It details what must be developed in terms of the business rules, business process and scope of work required.	The purpose is to specify the requirements for development purposes. It serves as an input into the technical specification documents.	1 x Senior Business Analyst
5.				1 x Junior Business Analyst
6.	MIS/BI Specification	A document used to detail the reporting requirements. This includes, reporting theme, business rules, logic (calculations) and report	The purpose is to serve as a guide to the Data Architects that develop the MIS/BI technical specification as well as the MIS/BI	1 x MIS Analyst (Middle Manager)

#	Document Name / Type	Document Description	Document Purpose	Job Title
		dimension requirements. It serves as an input to the report development.	development team in order to ensure that the report delivers on the business reporting requirements.	
7.	Technical Specification	A document used to detail the technical requirements based on the business requirements. This includes, Solution Design, architecture standards, platform and operational maintenance requirements. It serves as an input to the development of the solution	The purpose is to serve as a development guide to the development team in order to ensure that the solution designed can be developed according to specification, architecture standards and platform requirements.	1 x Solution Architect

5.9 Data Analysis Method

Data analysis is the most difficult and crucial aspect of the qualitative research process because events that occur during the implementation of IS artefacts are rarely experienced directly or recorded in a manner that is close to the event (Basit, 2003). 'It is a dynamic, intuitive and creative process of inductive reasoning, thinking and theorizing' (Basit, 2003, p. 143). In order to ensure reducing the time lapse between data collection and analysis and to increase the time reliability and credibility, a concurrent approach to data collection and analysis was adopted. The iterative process allowed modifications, adaptation or changes to the approach, aligning to the developments as the research unfolded. Furthermore, recruitment of participants was an ongoing exercise and the research approach was flexible enough to accommodate the evolving research study requirements. According to Morse et al. (2008), the greatest skill that a researcher needs is responsiveness. In other words, the researcher needed to be open to relinquishing any ideas that first appeared to have had potential, regardless of the effort and time invested in pursuing them, when they eventually proved not to be appropriate or supported by the data as the journey unfolded. This was one of the crucial points of learning for the researcher. This principle helped in improving the quality, reliability and credibility of the research.

The analysis methods or techniques adopted by the research study are discussed in the next section. They are thematic analysis and thematic network approach complemented by Layder's stratified framework.

Thematic analysis and the thematic network approach was identified as the most viable alternative to an automated process offered by Atlas Ti Software. It allowed the researcher to be close to and in control of the data, which enhanced reporting and analysis of the findings. This was a critical consideration for the researcher as the limited literature available on IS practical research studies conducted using CR, presented the following risks:

- There is a threat to the need to remain in touch with the data as the researcher reported and analysed the research results.
- The software's potential to lock the researcher into the themes generated by the software as the only possible or legitimate way of looking at the data, making changing or even exploring different links or explanations of the data impossible.

Furthermore, the direct involvement of the researcher did not only ensure increased understanding of the data but appreciation of the context in which comments from the participants were being made. Better understanding and openness of the researcher in line with the assisted the researcher in managing their own biases and ensure a balanced view when reporting the findings.

The second requirement was ownership and comfort in the process as the researcher began translating of context, meaning, nuances as well as expressions coded in memos as results were reported. The risk associated with loss of meaning or misinterpretation of data becomes greater in the critical realist approach than in research conducted using the two major paradigms in IS field research, positivism and interpretivism. The underlying tones, sequence of events and/or combination of certain events can mean different things and can result in different outcomes.

The third requirement was the ability to link data to prove the research study theory. This requirement could only be achieved by being close to and at the centre of the research process and research study method (Basit, 2003), which was particularly important because the study was challenging widely accepted assumptions and theoretical underpinnings of the theory adopted in the study.

Fourth, the need for thought in concluding the research themes remained the responsibility of the researcher as the product of her research work. The thought process was reflected throughout the research study journey. With this view in mind, it is fair to conclude that the researcher's thought process is the difference and value add of the researcher in any research study undertaking.

Lastly, the use of software does not eliminate the need to deliberate as the researcher generates codes. The process is such that as new codes are generated and accepted, others are rejected and/or replaced with others that are more illuminating and give better explanation to the phenomenon under enquiry.

Thematic Analysis and Thematic Network

The researcher adopted thematic analysis aided by and presented as a thematic network of web-like illustrations of the themes summarised from the data collected using the various data collection methods of the study. Smith and Firth (2011, p. 3) define thematic analysis as 'an interpretive process, whereby data is systematically searched to identify patterns within the data in order to provide an illuminating description of the phenomenon'. Thematic network approach is an analytical technique used to 'define and elaborate the typical, formal elements of arguments as a means of exploring the connections between the explicit statements and the implicit meanings in people's discourse' (Attride-Stirling, 2001, p. 386). The researcher used the thematic analysis approach to analyse the qualitative data that came out of the various data collection methods from a critical realist standpoint and used the thematic network to summarise and represent the main themes identified out of the data sets. Thematic analyses seek to unearth the themes salient in a text at different levels, and thematic networks aim to facilitate the structuring and depiction of these themes. Thematic networks' aim is to explore the understanding of the phenomena under enquiry, rather than to reconcile conflicting definitions of a problem. It is effective in presentation and visualisation of data sets from the analysis. The two techniques enabled a systematic classification process of coding and identification of themes, both elements crucial in management of the qualitative text data. These techniques were not limited to analysing textual data but were used to analyse data collected using non-verbal gestures in order to ensure focus, not only on what was communicated but on how it was communicated.

Complementing the thematic analysis method for the areas that it has been criticised for results in difficulties when judging the rigour of the findings, that is the lack of depth, fragmenting of the phenomena being studied and subjectivity, as well as limited transparency in relation to the how themes are developed (Attride-Stirling, 2001). The researcher adopted the process of retroduction as the study's core methodological principle. The retroduction principle is arguably the most effective in linking the structures and causal powers of the objects under study to the events being examined (Wynn & Williams, 2012). It is derived from the ontological assumption of emergence and epistemological focus on explanation. Beyond using the causal mechanisms as the basis for this explanation its recognition of the potential for multiple potential explanations, and the knowledge that these causal mechanisms may or may not be observable empirically renders it more effective in studying highly complex phenomena such as IS artefacts.

In this study retroduction was used as a form of inference to meet the research study's objective of explaining by identifying and verifying the existence of a set of mechanisms which were theorised to have resulted in the current state of IST and BIA in Transnet Freight Rail. This approach to analysis ensured that the requirement for depth and breadth in the research study were addressed adequately. Although the retroduction method of analysis was effective, thematic approach to analysis was instrumental in the synthesising of data sets, thus remaining a key analysis instrument as supported by (Guest, MacQueen, & Namey, 2011, p. 11) when arguing that, 'thematic analysis is still the most useful in capturing the complexities of meaning within a textual data set'.

Furthermore, and in line with the CR standpoint of reality as an open system that is beyond our ability to control directly (Wynn & Williams, 2012), the researcher applies an open system philosophy to the data analysis process and in so doing allows the dynamic and variable themes to emerge during the course of an enquiry that could not have been anticipated in advance. Qualitative methods can help to illuminate complex concepts and relationships that are unlikely to be captured by predetermined response categories or standardised quantitative measures (Curry, Nembhard, & Bradley, 2009).

Because of the limited number of IS research studies using CR as their underlying philosophy, the researcher was challenged to find tangible recommendations in the literature on how to conduct this type of research, and this further challenged the analysis of data sets. As a result of this the researcher found it necessary to integrate a large body of abstract philosophical literature in order to produce research that would be consistent with its ontological and epistemological assumptions.

While the study relied on the process of retroduction to ensure depth, breadth and credibility was achieved for this dynamic and complex research study, the CR principles, namely explication of events, explication of structure and context, empirical corroboration as well as triangulation and multi-methods continued to serve as the reference.

Layder's Framework as an Analysis method

The researcher adopted a triangulation approach where thematic network results were triangulated against Layder's stratified framework. (Layder, 1993) argues that realist projects concern themselves with causality and the identification of causal mechanisms in social phenomena in a manner different to positivist projects search for causal generalizations. Layder suggests a stratified framework of social organization and social action. The framework focuses on macro phenomena like structural and institutional; and on micro phenomena, such as behaviour and interaction respectively. His framework is best suited for theory development and elaboration and less relevant for theory testing, which is why it is a relevant tool for consideration in the development of an integrative design method based on critical realism-based social informatics method.

Figure 14 below depicts Layder's framework, briefly describing the different levels of social organisation and social action as potential areas interest for the research study.

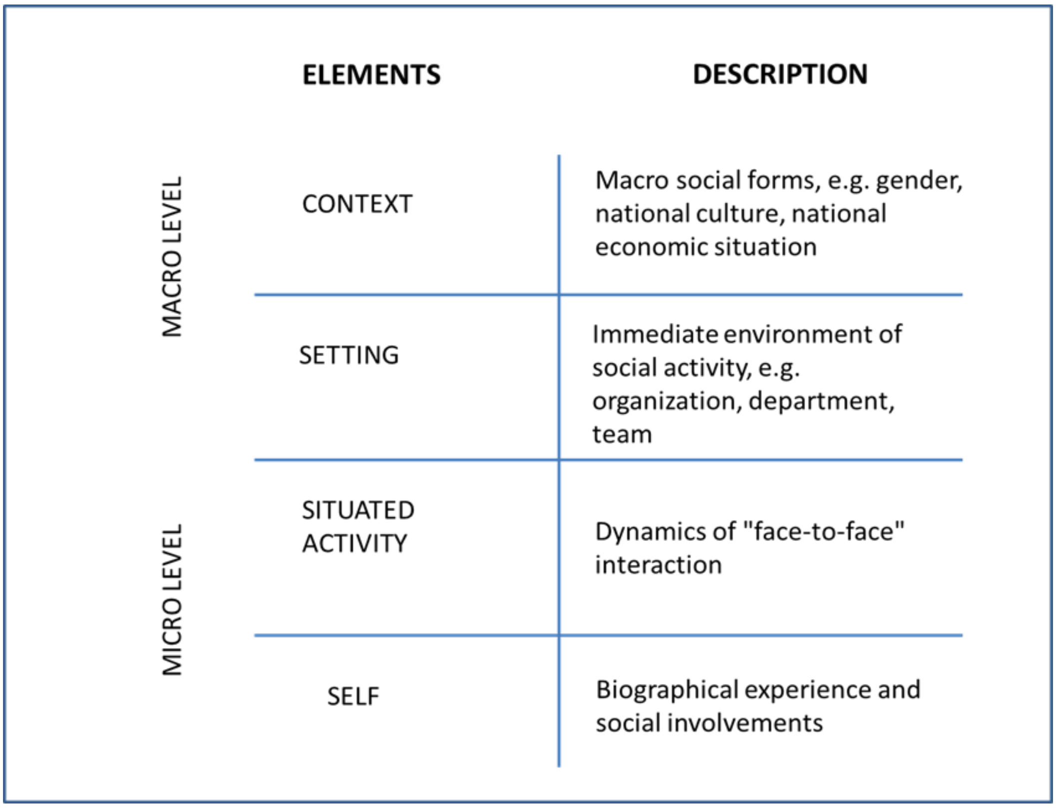

FIGURE 14: SOCIAL ORGANISATION AND HUMAN ACTION FRAMEWORK - ADAPTED FROM LAYDER, (1993)

The different elements are briefly discussed in order to provide better understanding and context for their relevance and application in this study. At macro level, Layder identified context and setting elements of consideration. Context focuses on the wider macro social forms that provide the more remote environment of social activity. Hence, large-scale and society-wide features are identified as critical areas of focus in order to arrive at better understanding of social organisation impact and how these influence (legitimises or limit) social action. The focus in setting is on the intermediate forms of social organisation, for example, an organisation specific setting which provides the immediate arena for social activities. Hence, organisational culture is often identified as playing a big part in social actors' attitude towards IST and BIA and as a consequence their uses.

At micro level, Layder identified situated activity and self as elements of consideration. In situated activity the focus is on the understanding the dynamics of social interaction, more from the perspective of the nature of the social involvement and interactions as social actors perform their day to day organisational functions. According to (Layder, 1993) self refers '... primarily to the individual's relation to her or his social environment and is characterized by the intersection of biographical experience and social involvements'. Therefore, self focuses on how an individual is affected by and in turn responds to social situations.

The researcher argues that Layder's framework is effective in enabling the both the researchers and practitioners in viewing the analysis, design, development, implementation, as well as IST and BIA uses as layers of social activity in a social organisation. This approach will enable both researchers and practitioners to be sensitive to the different elements with their distinctive features and time scales. Both factors are critical in identification of causal mechanisms required to better understand uses in context and inform non-deterministic tendencies for evaluation when the same are considered in different settings or contexts.

5.10 Analysis Process

The interview and focus group recordings were partially transcribed, and a thematic analysis (Braun & Clarke, 2006) was adopted to identify and organise data from the research fieldwork into codes and themes. Data from observation and documentary reviews was later analysed and organised into codes following a similar approach to that of interviews and focus groups. These were later consolidated and triangulated to the interviews and focus group data. However, it is important to note that both data from observations and documentary reviews provided practical examples to the reported data.

Figure 15 below outlines the analysis process followed in analysing data collected from the field research using all four data collection methods. Note the activities highlighted in the box with dotted lines.

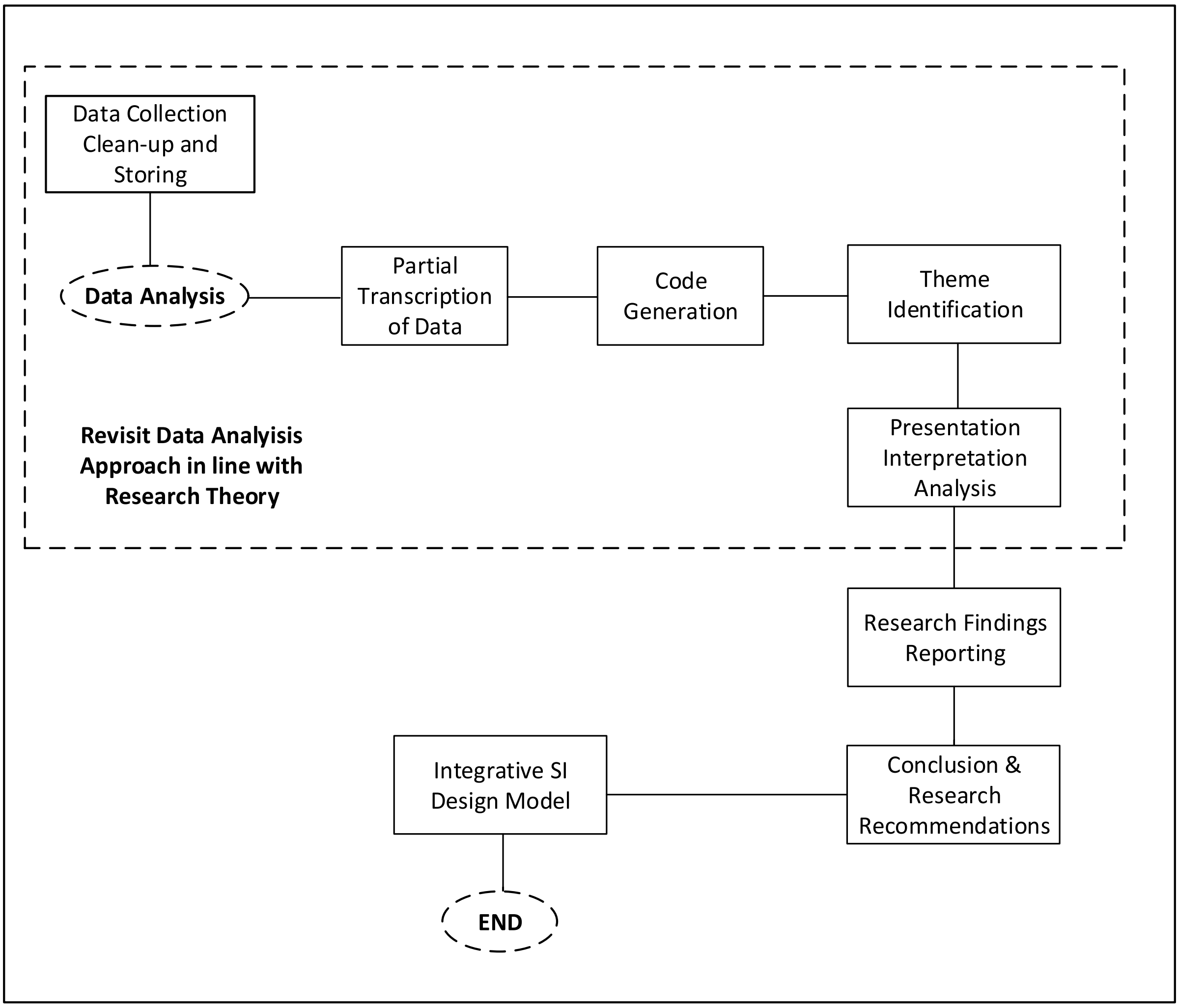

FIGURE 15: DATA ANALYSIS PROCESS

5.10.1 Partial Transcription

Following the critical realist method research, CR methodology principles were used to inform the depth and breadth of the transcription of both the interviews and focus group data. Since there is no one set of prescribed guidelines for transcribing critical realist study data, the researcher opted for partial transcription of data to the level that was practically suited to the purpose of the analysis. However, in ensuring rigour and relevance are adhered to, Braun and Clarke (2006) advise that transcripts should retain the information the researcher needs in a way which is true to its original nature. The research ensured that 'verbatim' account of all verbal (and sometimes nonverbal) utterances as per the field notes were transcribed.

The partial transcription of data entailed listening to all the semi-structured interviews and focus group discussion digital voice recordings and transcribing data into an Excel database that was predesigned in line with the semi-structured interview and focus group discussion protocol. Each interview participant response and follow-up response to the questions posed was recorded with each participant given a unique identifier. In case of focus groups, all responses to the question posed to the group were captured with each participant given a unique identifier. The researcher ensured that a minimum of two sittings for each of the recorded interviews were done at different date and transcribed notes revisited each time the recording was played. The transcribed recordings were assessed against the notes taken during the session for completeness. Partial transcription made the process of managing data from the field study less complex and cumbersome. Because the approach was iterative, concerns of validity of the data were addressed and in the process the researcher familiarised herself with the data as she repeatedly listened to the recorded interviews and focus groups.

5.10.2 Coding of Data

Coding is one of the significant steps in the analysis of data collected from the field. It helps the researcher to organise and structure textual data in a manner that makes sense. An essential step in the development of a useful framework for analysis is to determine the applicability of the code to the raw information (Boyatzis, 1998). The codes served as a data management tool, whereby text data was managed and organised into similar and/or related data, simplifying the data interpretation process (Crabtree, 1999).

Listening to the recorded audios repeatedly proved to be very effective in becoming familiar with the data and it assisted with the process of coding the data. The researcher was able to capture the mood, feelings and context of some of the discussions, as audio recordings took the researcher back to the interview and focus group setting and day. These were further reviewed against the notes that were taken during the process, enabling the researcher to compare and contrast while coding the fieldwork data. As was expected during the first stages of data categorisation, the process was slow and the researcher often needed to pause so as to review and reflect. However as the researcher proceeded to the later stages of coding of data, she began progressing with confidence. As (Dey, 1993) points out, at this point of the data interpretation and presentation, categories are clarified, ambiguities resolved and fewer surprises and anomalies are encountered in the data. The speed and efficiency of the process improves considerably.

5.10.3 Thematic Analysis and Thematic Network

The section below briefly describes the thematic approach which was central to the research results presentation, interpretation and analysis.

Thematic Analysis Process

Thematic analysis is a method for identifying, analysing and reporting, allowing for the organisation and description of collated data in rich detail (Braun & Clark, 2006, p. 79). After coding of data, data sets from the interviews, focus groups, observations and documentary reviews were organised into key and logical themes, representing patterned responses or meaning within the data set. The thematic analysis exercise was a critical step towards causal analysis as it is not tied to a particular philosophical or theoretical paradigm (Braun & Clark, 2006). It is in this regard that the researcher chose to conduct her own analysis from transcription of data to coding and identification of key and logical themes. A parallel process was run, whereby theory-based themes from literature and CR theory were identified and organised for the study. This was so that unconstrained themes from the fieldwork could later be reviewed and contrasted against the theory-based themes, to ascertain the extent to which they aligned or misaligned. Also further analysis could be conducted to understand the rationale behind alignment or misalignment, if any.

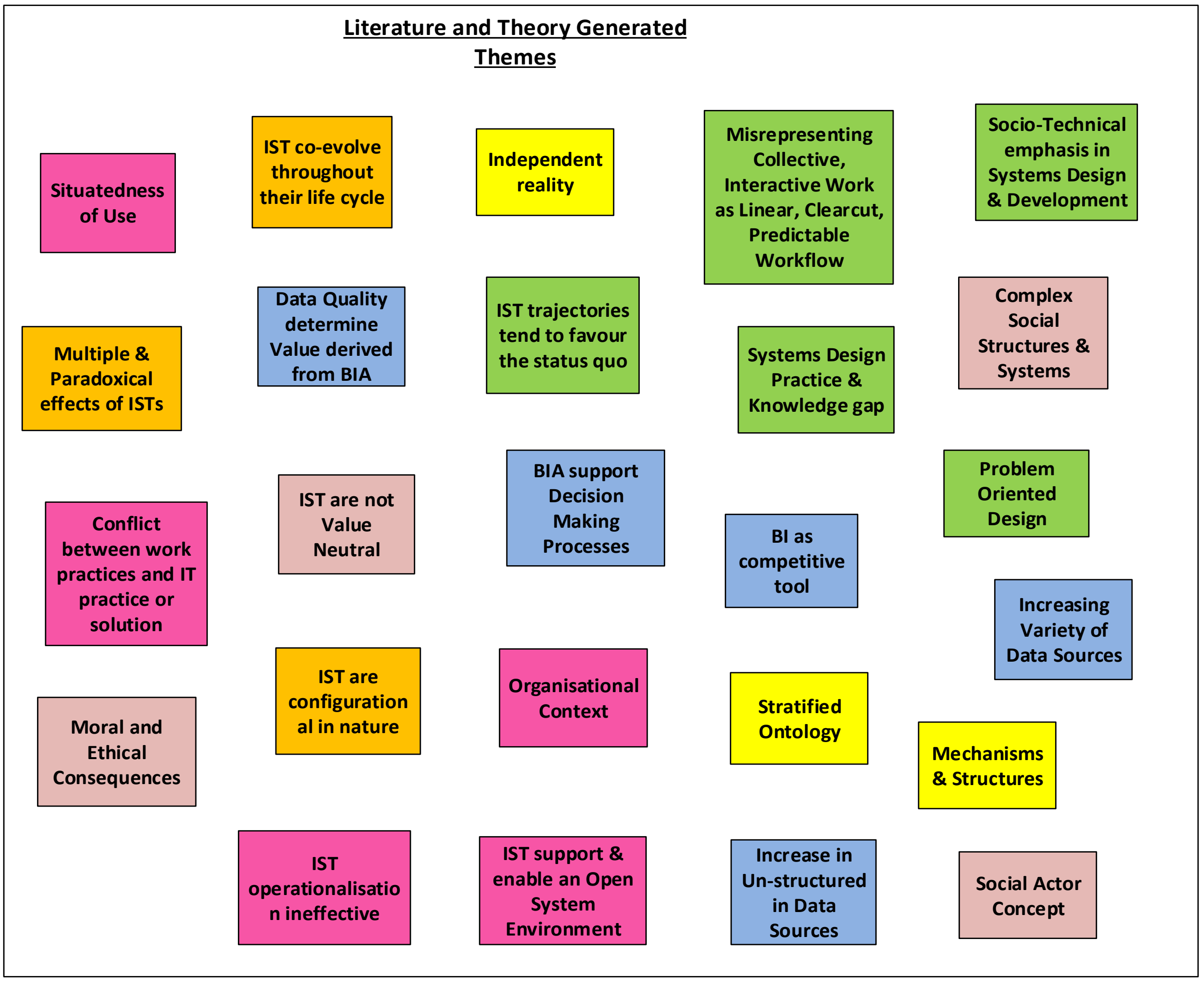

FIGURE 16: LITERATURE AND THEORY GENERATED THEMES

Thematic Network

Global themes are the core part of a thematic network and represent the main ideas and metaphors in the data as a whole. Organising themes are middle-order themes that organise basic themes into clusters of similar issues. Organising themes represent the main components of the superordinate theme from the text as a whole. A group of organising themes forms a global theme. They need to be read in the context of other basic themes which when taken together represent an organising theme. Basic themes are the lowest-order themes derived from textual data. Taken in isolation, a basic theme will tell the reader very little. Figure 17 below is an illustration of the thematic network model that the study adopted.

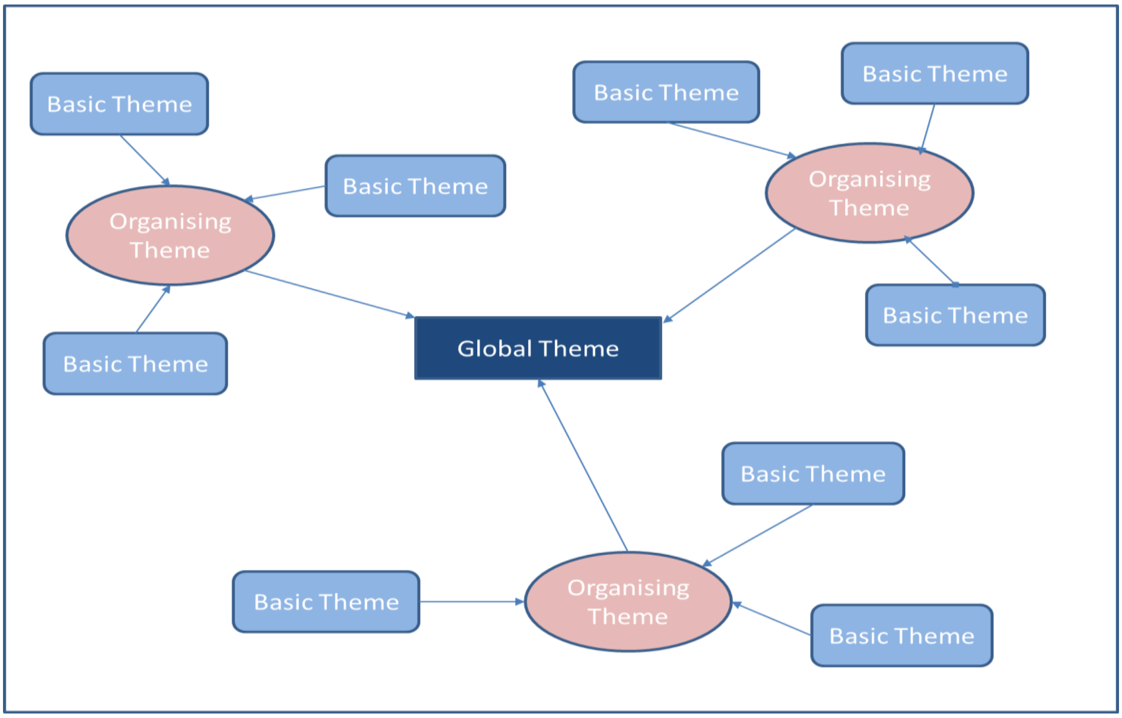

FIGURE 17: THEMATIC NETWORK MODEL

A thematic network was developed starting from the basic themes and building them up to derive the organising themes according to the underlying story they told and then work towards the development of a global theme. The global themes were brought together to illustrate a single conclusion or superordinate all-encompassing themes in line with the story they each told. Key to thematic networks developments was the fluidity and the interconnectivity throughout the web-like network.

The section below outlines how the adoption of the thematic network approach benefited the study at both the theoretical and practical levels.

Theoretical Level

At a theoretical level, a thematic networks approach was adopted based on the strength and effectiveness in the representation of the analysis, with a view to enhancing the reader's understanding. The web of interlinked cross-functional themes at various levels of analysis, depicts the relationships between the data presented, and assists the reader in understanding the flow and meaning of data being represented in the study. The three levels of network employed are: (a) global themes – superordinate themes encapsulating the principal metaphors in the text as a whole; (b) organising themes – categories of basic themes grouped together to summarise more abstract principles; and (c) basic themes – the lowest-order premises evident in the text.

Practical Level

At a practical level, the thematic network method of visualising data sets in global, organising and basic codes turned out to be the effective analysis approach and tool as data could be visualised in a single view and instance. The researcher was able to view data from different perspectives without needing to switch pages. This approach enabled the researcher to highlight data with similar meaning or having the potential of contributing to the same outcome or perception.

Thematic Analysis Process

The process used to analyse the field data is outlined in the section below and follows the guidelines provided by Braun and Clark (2006). Figure 17 further illustrates the process the researcher followed.

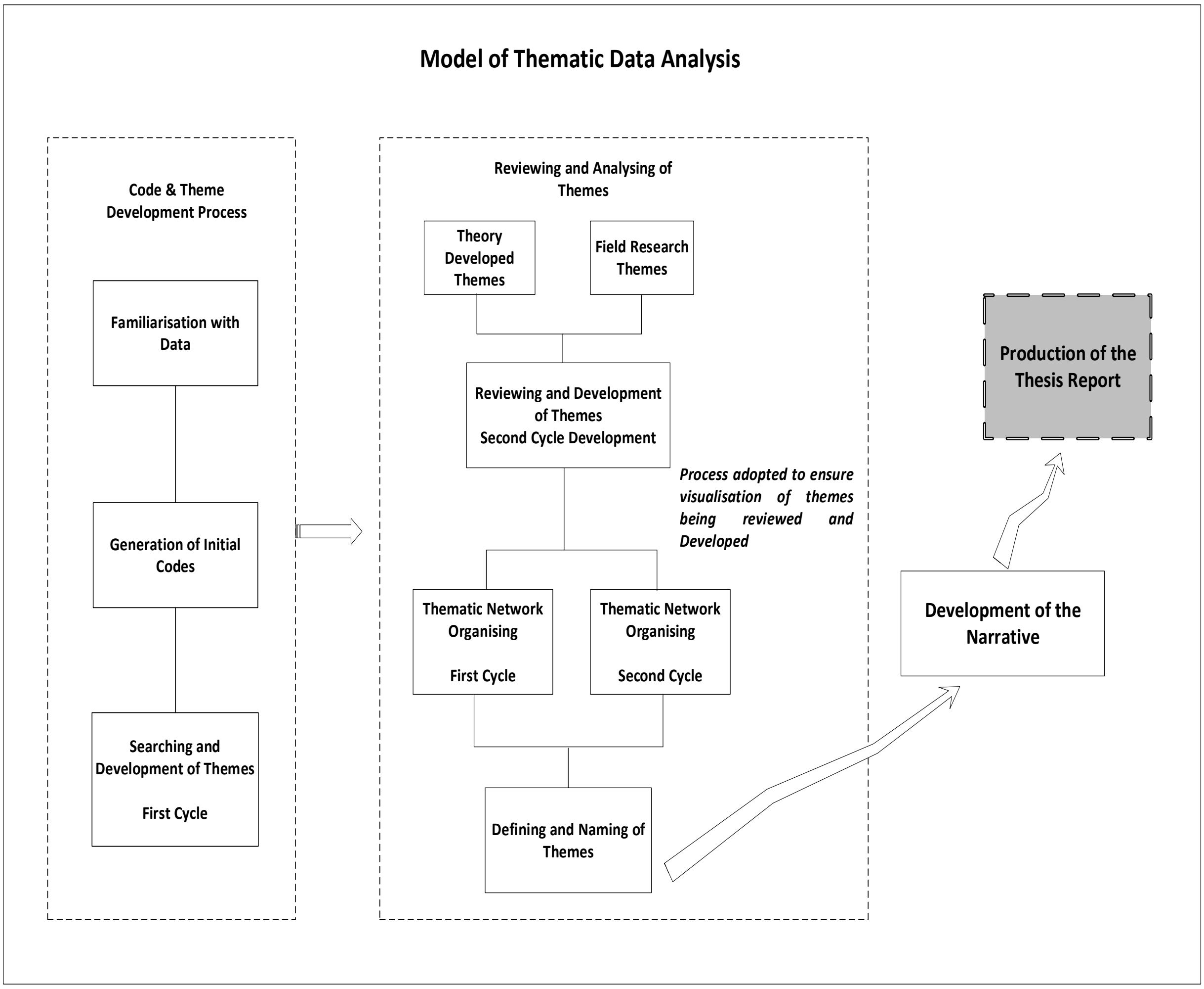

FIGURE 18: MODEL OF THEMATIC DATA ANALYSIS

1. Familiarisation with the Data through Partial Transcription

Despite prior knowledge of the data through having been involved in the data collection process the researcher was required to go through the data sets in detail to a degree that ensured depth and breadth of the content. In searching for meaning and patterns from the data, no aspects of the data set were ignored or put aside for late review. The systemic approach that the researcher followed is outlined below:

- Repeatedly listening to audio recordings and transcribing of the semi-structured interviews and focus groups;
- Reviewing and comparing of interviews and focus group discussion notes with audio recordings;

- Partial transcription of observations which was a continuous formal and informal process; and
- Documentary reviews which were done at the initial and last stages of the fieldwork.

Throughout this phase, the researcher was taking notes or marking ideas for coding using the database for fieldwork. This was a useful exercise in that the researcher was able to go back to these notes and some proved to be more useful in subsequent phases.

2. Generation of Initial Codes

The list of initial ideas and notes of what was interesting in the data at that stage from phase one was used as an input into this process. With both the theoretical themes and questions in mind, the researcher systematically worked through the entire data set to code data as close to participants' anecdotal responses to the questions as possible to ensure that data meaning and context was not lost.

- At this point, the researcher began organising answers to questions per interview and focus group discussion.
- The next step was to examine each question to highlight words that gave a particular meaning to the responses that were given. Again the same approach was followed per interview and focus group discussion.
- Following the two levels of organising of data, the researcher began highlighting data with the same meaning and/or use the words or expressions with the same meaning in context to the study and questions.
- These were further reviewed against the manual notes taken during both interview and focus group discussions.
- Using a spreadsheet, the researcher systematically worked through the entire data set, using a colour coding system to highlight related data, patterns and initial themes. These formed the list of initial codes shown in Figure 19 below.
- This approach focused on reducing the data set into manageable and yet meaningful field data, enabling analysis of findings.
- For a sample of the Excel-based process, see Appendix C. This process was used to inform the themes depicted in figure 19 below.

FIGURE 19: INITIAL GENERATION OF CODES FROM FIELD DATA

Crucial in this phase was working systematically through the entire data set, giving full and equal attention to each data item, and not making any assumptions about what the data may mean or trying to link data sets at this point. Allowing each data item to stand on its own was key as it enabled the researcher to identify interesting aspects in the data items that might form the basis of repeated patterns across the data set. The scope of coding was open as the researcher coded as many potential themes or patterns and coded individual extracts of data in as many different themes and as many times as relevant to the those themes.

3. Searching for a Theme

- Once the entire data set was coded, the researcher began sorting the codes into logical themes. At this point colour coding systems reduced the complex process of working through large volumes of organised codes to a manageable task, especially since the entire exercise was done manually.
- Using a matrix structure, codes were grouped by considering how different codes may be combined together within one (or more) overarching themes.
- Data extracts were then organised under potential themes and descriptions of data narrated to ensure that meaning and context was not lost in translation of data into themes.
- Visual representations and colour coding of data extracts was useful and the first step in sorting the different codes into themes. These were them represented using the thematic network structure.
- At this point, the relationship between codes, between themes, and between different levels of themes began to emerge while others needed the researcher to assess their potential to influence or impact on one another.
- A miscellaneous theme was used to house the codes that did not seem to fit into the main themes. Often the researcher would go back to check as new meanings and relationships began to develop and those would then be integrated back into the main themes.

Figure 20- below is an example of the first cycle of initial codes represented using the thematic network approach in order to assist with the review of initially coded themes. This example depicts a qualitative global theme with of the three organising themes (contextual, social theme, and skills and competency themes) each with themes linked to it. A detailed output of this process can be found in Appendix D.

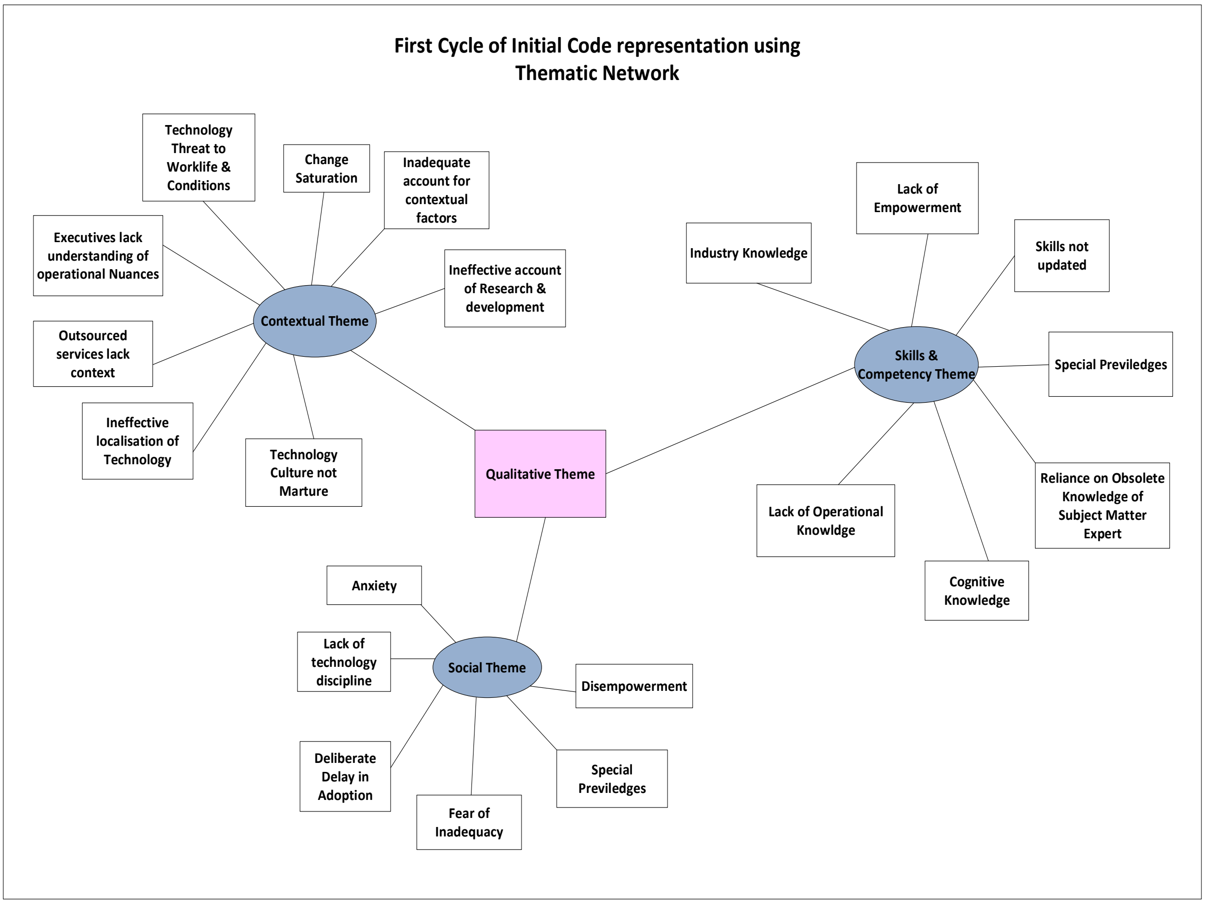

FIGURE 20: INITIAL CODES REPRESENTED USING THEMATIC NETWORK APPROACH

Figure 21 below is an example of the second cycle of initial codes where a colour coding system is used to enhance the analysis of the themes in order to ensure optimum grouping of themes. The colour coding system helped reduce the complexity of working through a number of initially coded themes. A detailed output of this process can be found in Appendix E.

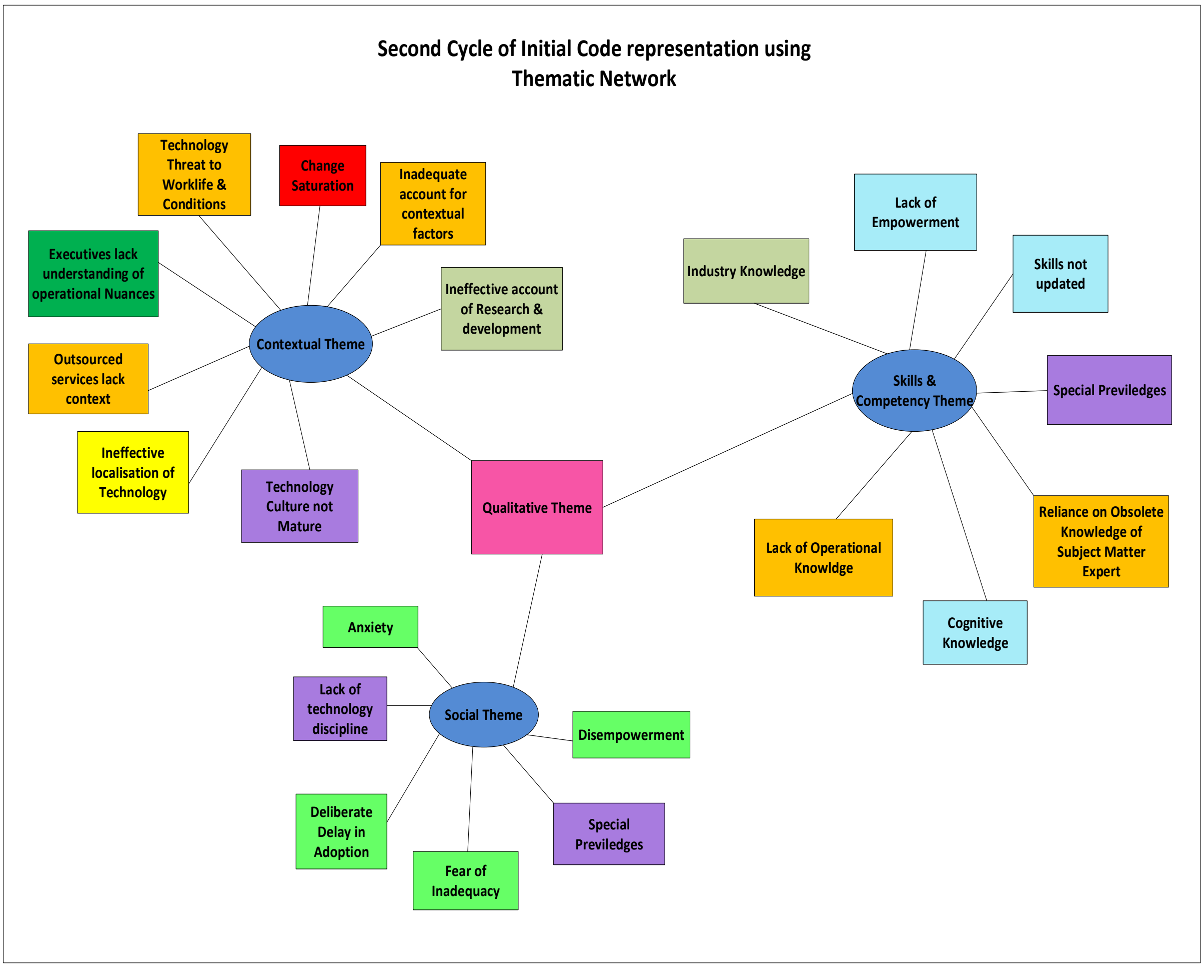

FIGURE 21: INITIAL CODES REPRESENTED USING THEMATIC NETWORK APPROACH - COLOUR CODED

Further to the management of themes, the colour coding of themes revealed the level of interrelatedness and interdependence of themes across the organising themes. At this point it became clear to the researcher that in-depth analysis of the relationships was required. These were identified across the data sets. The output of this phase was used as an input into the review process which included the literature and theory-based themes.

4. Reviewing Themes

The objective of this phase was to ensure that data within themes cohered meaningfully, while clear and identifiable distinctions between them were maintained. This step involved revisiting the entire data set to ensure that:

- Literature and theory-based codes as well as the field research data sets from phase three – searching for themes – served as an input into this review process.

- The field research data sets were tested against the literature and theory-based codes, and the researcher identified overlaps between the two data sets necessitating a next level of review to ensure that the new themes that emerged were grouped meaningfully together.
- The new themes accurately reflected the meanings evident in the data set as a whole.
- No data that could be incorporated had been missed.
- Identified themes were further refined to ensure each was specific enough to be discrete from the other themes, but broad enough to capture all the codes contained within it.
- The outcome of this refinement process can be seen in the thematic map presented in Appendix F for qualitative global themes and Appendix G for technical capability development global themes.

At this stage cross-functional relationships began to emerge, pointing the researcher to a new narrative. This revealed that each of the themes had a potential to have multiple relationships with other themes through their relationship with the organising themes which they might not be a property of. For example, a basic theme might be a property of an organising theme, while at the same time associated with and/or identified to be a part of another organising theme. This is demonstrated in Appendices F and G, illustrating the third cycle of theme development. The third cycle focuses on organising of the themes into a meaningful narrative that begins to tell a story about the data and its context. This process was key in analysing the relationships of themes that were emerging at the basic, organising and global level. At the end of this phase the researcher had a fairly good idea of what the different themes were, how they fit together, and the overall story they told about the data.

5. Defining and Naming Themes

In ensuring that the themes that had been identified captured the overall essence of each theme and that the organisation of themes into appropriate levels enabled representation of themes in a manner that enabled a narrative in relation to the research study objective.

- This was an iterative process of ongoing analysis to refine the meaning and context of each theme. Emphasis was placed on ensuring that individual themes fitted within the overall narrative reflected throughout the research study.
- Final names were given to the themes. These had to be concise, 'punchy' and needed to immediately give the reader a sense of what the overall theme was about.
- The outcome of this phase can be seen in the thematic map presented in (Figure 24 – Qualitative Global Theme, and Figure 32 – Technical Global Theme).

6. Production of the Thesis Report

Production of the report offered an opportunity for analysing the findings in relation to the literature as well as the theory underpinning the research study.

- This ensured a logical connection to the study and flow in the representation of findings and analysis of data.
- Contribution to knowledge, advancing both IST and BIA sub-disciplines of the IS field.

At end of this iterative six-step process, the researcher began illustrating the story that the data and the analytical narrative revealed in relation to the research study problem and the questions.

5.11 Research Process and Strategy Strength

In this section the researcher revisits the research journey, only this time the focus is on measuring the reliability and validity, ethical considerations, limitations, risks associated with the study and observations on process as a conclusion to this long, yet exciting journey of both self-discovery and empowerment.

5.11.1 Reliability and Validity

According to Easton (2010, p. 124) 'critical realists accept that there are differences between the empirical, the actual and the real, and that data are collected from people as well as from, and about, material things'. Therefore, the study adopted critical realist principles of testing reliability and validity of the data. Central for a qualitative realist study is the ability to test for reliability and validity of the data; hence the researcher employed critical realist principles of testing reliability, the triangulation principle and validity, which uses construct, internal and external techniques to test for validity of data.

Triangulation was used to analyse the themes generated from theory and the field study which were analysed using Layder's adapted analysis tool in order to ensure reliability and validity of the data used to generate the themes. Furthermore, in ensuring validity from a critical realist perspective, construct, internal and external techniques were assessed throughout the analysis journey. The overall objective of assessing these three forms of validity was to establish the extent to which the generative mechanism can be said to cause the actual events in the problem domain, with each form of validity operating in a different space within the three domains of the real.

Construct validity was used to assess the extent to which the data collected in the case study provided reliable insight on whether what the participants perceived or experienced to have been happening, in the form of empirical traces, was what had actually happened. Internal validity focused on establishing if there was a valid connection between certain events and the themes that were thought to be causing them to happen. These created reliable insights on which structures and mechanisms have a tendency to cause certain events to happen, regardless of whether or not those events are empirically observed. Finally, external validity was used to assess whether or not the actual events in the broader research boundary could be accurately predicted from the themes that were identified. It further assessed the likelihood that the structures or mechanisms in a form of activities identified in the field data and caused certain actual events to occur could be reliably connected to the events that are expressed widely within the problem domain, but under a different context or research boundary. This addressed the issue of how deterministic tendencies come about and can be used to reliably predict behaviour of certain events in a context separate to the study.

Figure 22 below is an expression of how the study assessed the validity requirements.

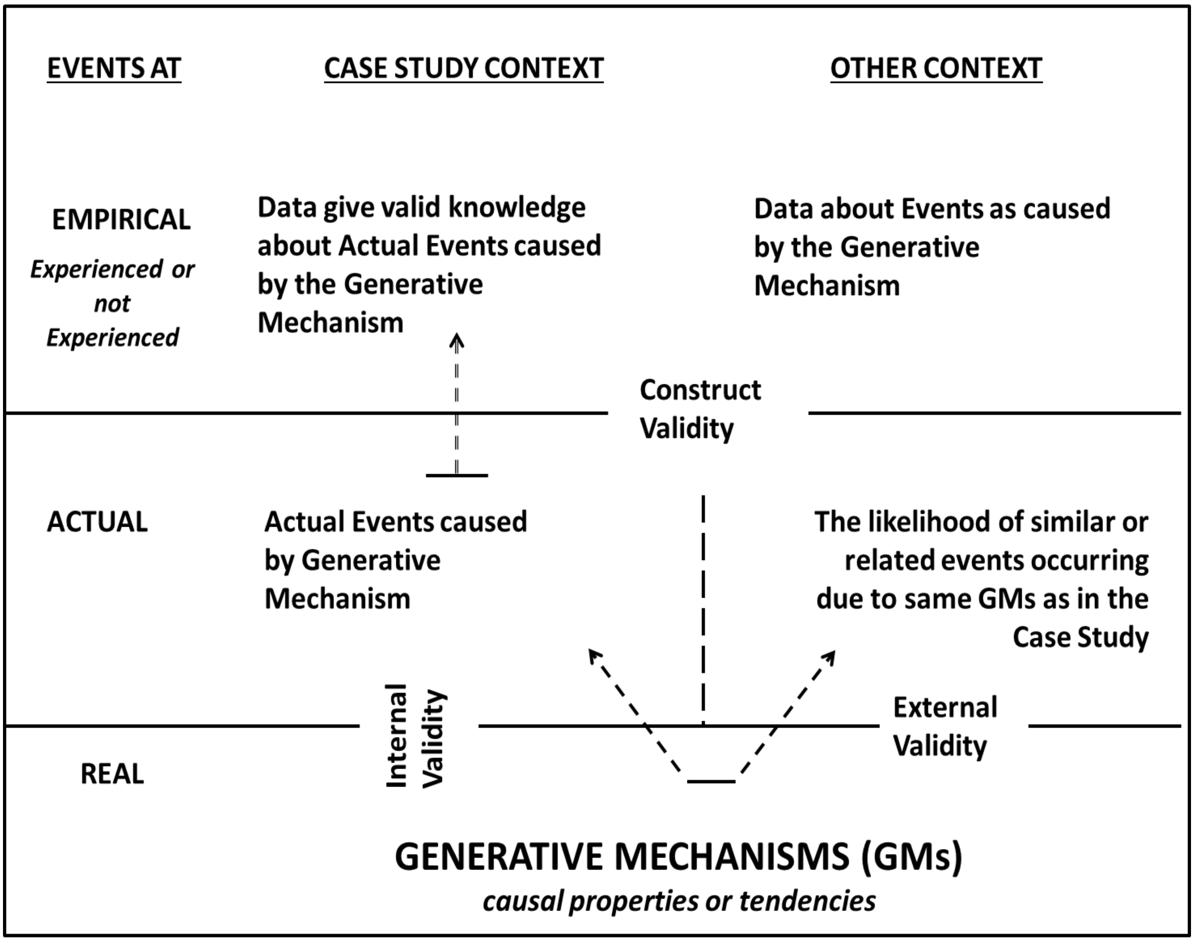

FIGURE 22: CRITICAL VALIDITY FRAMEWORK ADAPTED FROM BHASKAR)1975)

Triangulation

The researcher adopted a triangulation approach where thematic network results were triangulated against Layder's stratified framework. Triangulation was key to support causal analysis of research results, enabling the researcher to identify the structures and mechanisms with the tendency to influence certain outcomes when ISTs and BIA are used. In accordance with the epistemological principles of mediated knowledge, unobservability, and the possibility of multiple mechanisms, the researcher was conscious of identifying the underlying reality from multiple viewpoints in order to overcome the perceptual limitations inherent in research studies.

5.12 Ethical Considerations

In the context of the research, according to Saunders, Lewis, and Thornhill (2009), ethics refers to the appropriateness of the researcher's behaviour as a researcher in relation to the rights of those who become the subject of this research work or are affected by it. For the researcher, this applied to both the individual participants and the organisation in which the case study was conducted.

The researcher abided by Mouton's (2001) moral covenants, namely integrity, objectivity, the maintenance of ethical relationships with the participants, ensuring all data are authentic, accurate and transparently handled and follow ethical publishing practices.

In complementing the above ethical behaviours, the researcher further complied with the following categories of ethical values, namely protection from harm, informed consent, right to privacy, and honesty (Leedy & Ormrod, 2001).

- At the beginning of each semi-structured interview, focus group discussions as well as the interviews that were later scheduled with the authors of documents identified for documentary reviews, participants' consent was sought, their rights shared with them and they were afforded the opportunity to withdraw from participating in the study once the process started.
- During interpretation and analysis of the results, participants' identities were protected as only anonymised unique identifiers were used and their roles not disclosed for the fear that since the organisation was known, internal staff members could easily deduce who may have made what comments.
- Participants' comments and views were reported and interpreted in context and as informed by the mood and setting during data collection.
- Participants were further afforded an opportunity to raise any questions they might have had on the process and the research study objectives.

Furthermore, in ensuring that the organisation under study was protected from any indirect or direct harm, particularly regarding confidential documents that were analysed, permission was sought and approval of documentation obtained. Secondly, no physical documents were shared as part of reporting, and only descriptions of the documents that were reviewed during analysis are provided. This was a critical requirement to adhere to, especially because TFR is an SOCS and it subscribes to data classification laws as set out for all SOCs. Lastly, the researcher ensured that she adhered to any confidentiality clauses and agreements contained therein.

Lastly, the researcher subscribed to the code of ethics from the University of the Witwatersrand, which requires all informants to sign the Informed Consent Document (see Appendix H for participant documentation). Research consent forms and information leaflets were provided in advance as an attachment to the participation invitation (using Microsoft Outlook) to all the targeted participants individually and again on the day of the interview.

5.13 Limitations

Below are the three limitations identified for the research study:

- Data from an application system that is used by TFR IT to manage and monitor progress of IT projects may not be represented in the study due to its quantitative nature. The concern therefore is that an opportunity to assess the value and effectiveness of the approach from this perspective may have been missed.
- Due to the fast evolving IS field and the risk of losing relevance, the researcher was under pressure to conclude the research within a reasonable time. In managing this risk, the researcher did not extend the study to the testing of the CR-SI design method. The researcher did, however, recommend testing of the method for further research. There were funding limitations, meaning that certain resources could not be tapped into. For example, full transcription of semi-structured interviews averaging an hour and 15 minutes and focus group discussions of up to two hours proved to be costly and due to limited funding was not an option. Full transcription would have extended the time of the research.

5.14 Risks

The following risks to the research study were identified:

- There are limited practical studies and supporting literature on the theories adopted by the research study, although the choice of theories was what made the study unique and provided an opportunity to advance the field.

- IS is a fast evolving field. New developments while the study was underway, threaten the scope of the study, and literature which the study needs to consult grows at an equal pace. Digitisation of the IS industry in terms of the services provided, products produced as well as the medium for marketing the services and products, are examples of this.
- Application of CR in IS still remains a challenge due the limited number of studies published.
- CR philosophy is complex in that it tries to deal with contextualisation and causal claims, both difficult elements to deal with individually in an open and complex system such as IS.

5.15 Summary

Throughout the research study, the researcher noted that no data set is without contradiction, tensions and inconsistencies; thus it was important to ensure that the thematic map conceptualised for the study was based on data patterns and relationships between themes as identified in the research data set. It is important to retain accounts which depart from the dominant story in the analysis, and not ignore these while coding.

The outcome of this chapter is a clear, concise and structured approach to conducting the study and facilitation of the data collection process. Clarity at this point minimises the need to go back and forth trying to identify the optimum research and presentation method. The presentation of results enhanced the analysis process.

CHAPTER SIX

Presentation and Interpretation of Research Results

6.1 Introduction

Chapter 5 described the research design, methodology and analysis method employed in the research study. This chapter focuses on presentation and interpretation of the results from the field work. Data from multiple data collection methods is reviewed, and the process by which the results were interpreted to enhance understanding of the data collected during the fieldwork is outlined.

Research result presentation is the first step towards ensuring successful research analysis. In a critical realist study, data presentation is a strategic consideration as CR's analysis goal is the explanatory power achieved through the method's strength in ensuring depth and breadth. This justifies the time and effort invested in the presentation of research study data sets.

6.2 Presentation and Interpretation of the Results

The process of presenting and interpreting the results evolved through three distinct phases. This process was done in line with the research study theories and principles that governed the study. Phases one and two focused on the presentation of themes using the default thematic network approach whereby application of CR principles enabled the research to highlight data with similar meaning or having the potential of contributing to the same outcomes resulting in the final evolution of the process.

The second most important point to be noted is the strength of the CR approach in supporting the interpretation and analysis of data sets. The iterative process of analysis and application of the CR principle of retroduction resulted in the migration from a default approach of analysing and organising data based on interrelatedness of data from a logical and/or functional perspective, to an approach concerned with understanding the connection of data from various levels and perspectives of IST and BIA impact in an organisation. Indeed the CR approach delivered on its promise of providing better explanations and meaning of basic theme relationships, influence and association than alternative research methods that are limited in the analysis of causal relationship and identification of mechanisms and structures that trigger certain events to occur.

Phase three and the final phase was the web of interlinked network of themes. Table 18 below depicts how the default thinking and presentation of global and organising themes migrated to the web of interlinked cross-functional themes. Table 18 further highlights the effectiveness of the presentation and interpretation method adopted in that, while the organisation and presentation of the themes through a thematic network process evolved during the interpretation and analysis process, the content remained unchanged. This is a comforting picture in that data and meaning from the initial process were not lost, and that at best, they were enhanced through rigour and vigour. In fact the process assisted in getting to the most appropriate approach of analysing the findings, further enhancing the depth and breadth of the analysis.

TABLE 18: DEFAULT THEMES TO WEB OF INTERLINKED NETWORK OF THEMES

#	Global Themes	Organising Themes	#	Global Themes	Organising Themes
Initial Global and Organising Themes			The final Global and Organising Themes		
1.	Qualitative	Social Theme	1.	Qualitative	Social
		Contextual			Poor IT brand
		Skills and Competency			IT Planning and Strategy Development
2.	IT Brand	Perception of IT			Contextual Factors
		IT Planning and Capacity Development			Business Participation and Involvement Limited
3.	Strategy and Planning	Strategy			Design
		Return on Investment			
4.	Technical	Design	2.	Technical Capability Development and Enablement	Technical Systems
		Functional			BI and Analytics Tools
		Technical			Systems Integration
		Compliance, Governance Risk and Security			Process Engineering & Intelligence Capability
5.	Reporting and MIS	Business Intelligence & Analytics			Compliance, Governance, Risk & Security

6.2.1 Critical Realism's Web of Interlinked Cross-Functional Theme Presentation of the Results

This section presents the study results in a web of interlinked cross-functional themes. Further to the presentation, the results are interpreted to understand the world of TFR from the perspective of the users, triangulated with observations and documentary review outcomes. The themes identified and presented as final themes are the output of a rigorous and iterative analysis process outlined in the previous section. At the heart of the analysis was the need to identify patterns on causal powers and mechanisms that underlie events that are empirically observed or perceived by business users. This was necessary to investigate in depth which of the causal powers and mechanisms trigger what response and behaviours on the part of the business users. Hence the analysis went beyond interpretation of the results to answering the 'why' question and understanding the circumstances under which certain responses and behaviours undermine the use and exploitation of IST and BIA.

6.2.1 Themes Names and Family Colours

Table 19 below describes both qualitative and technical capability development in their family colours for ease of reference by the reader. Qualitative Global Theme is an umbrella name the researcher used to organise themes that were qualitative, non-technical and intangible in in nature, and as such cannot be measured in absolute terms. Technical Capability and Development Global Theme is a term used to organise themes that were technical and tangible in nature and with measurable performance.

TABLE 19: FAMILY COLOUR FOR GLOBAL THEMES

QUALITATIVE THEMES		TECHNICAL CAPABILITY DEVELOPMENT THEMES	
	Social Theme		Technical Theme
	IT Brand Theme		System Integration Theme
	IT Planning and Strategy Development Theme		Process Theme
	Business Participation and Involvement Theme		Business Intelligence & Analytics Theme
	Art of Design Theme		Security Theme
	Contextual Theme		

6.2.3 Understanding and Reading of Themes

The family strands are described using the threads as described below. The legends proposed in the second phase of analysing the themes were further refined to enhance the analysis exercise. The family strands were formalised as follows:

- ‘is a property of’
- ‘is associated with’
- ‘is a part of’.

Each organising theme has its own colour to uniquely identify its family colour. The family colour indicates that it *‘is a property of’*. This will be indicated by a solid line to the organising theme.

For basic themes with a solid line in a foreign organising theme, the relationship *‘is associated with’*. This indicates that the basic theme influences or impacts on how the organising theme behaves in context. Hence it will be depicted in a foreign colour to reflect its home theme.

Basic themes with a dotted line to a foreign theme indicate that they are *‘a part of’* the organising theme. This indicates that the basic themes may be ‘a property of’ another theme but their behaviour is influenced or impacted by other organising themes to which they are connected by a dotted line.

6.3 Global Themes Relationship Mapping

The global themes qualitative and technical capability development themes relationship has been mapped against each other in order to ensure understanding of the global themes interrelationship, interconnection and interdependencies. The analysis was further extended to unpack how the organising themes relate to one another using the criteria defined above. The family themes that are a property of a global theme are depicted by organising theme colour and relationship indicated using a solid line of ‘is a property of’ The relationship of the organising themes that impact or influence the on the other organising themes is depicted using an ‘is associated with’ strand using a solid line and the behaviour of the organising themes that is influenced by another theme is depicted using ‘is a part’ of strand of relationship, reflected using a dotted line. The web of interlinked cross-functional relationship at a global theme level is depicted in figure 23 below.

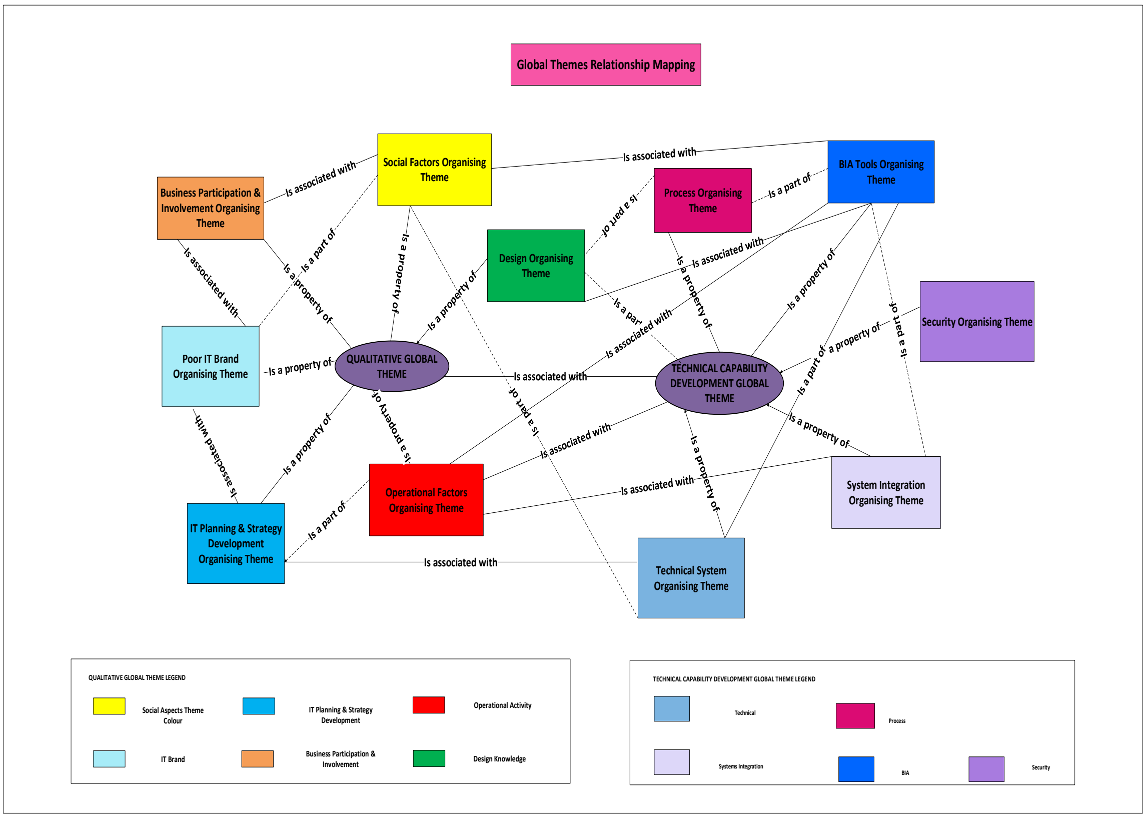

FIGURE 23: GLOBAL THEMES RELATIONSHIP MAPPING

The next section presents the global themes, qualitative and technical capability development global theme individually. The discussion is extended to ensure description in context of each of the organising themes presented under each global theme.

6.4 Qualitative Global Theme

The section below focuses on the interpretation of the results of the qualitative global theme.

Figure 24 below depicts the qualitative themes at a global level as identified in the interpretation and analysis of the results from the fieldwork. It highlights the web of interlinked cross-functional relationships the themes have with one another at various levels. Each strand is designed to reflect the relationship as described in the section above.

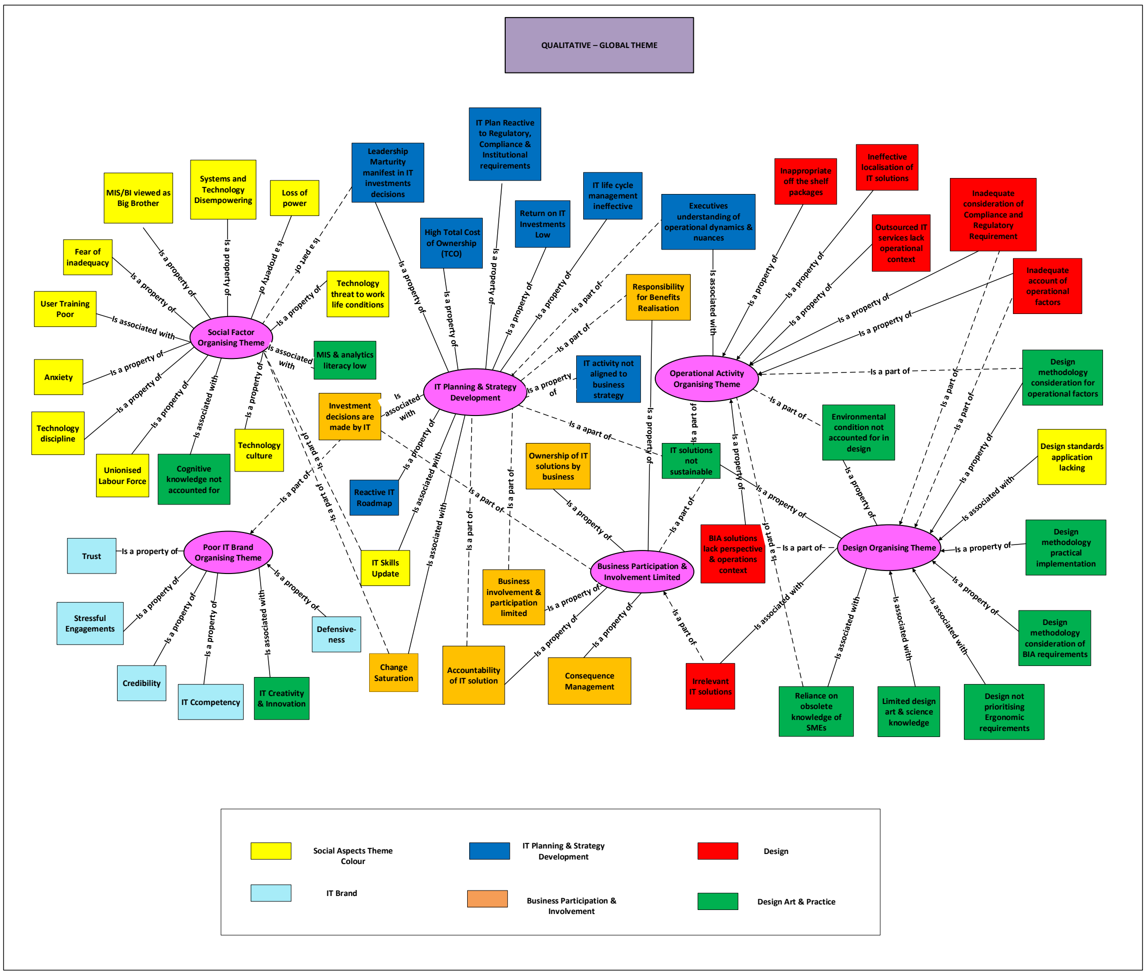

FIGURE 24: QUALITATIVE GLOBAL THEME

Worth noting is the web of interlinked cross-functional networks expressed in the structure the themes have taken on during the presentation and analysis of the results. There is no definitive way in which the order of functions and activities can be determined. In fact it is imperative to consider them as a network of connected functions and activities and instead to invest effort and time in understanding how the relationships influence the behaviour of other functions or activities and vice versa.

Figure 24 below is a graphical presentation of qualitative themes. It summarises the web of interlinked cross-functional relationships the qualitative themes have with one another at organisation theme level. The first strand described as **a property of** highlights the family themes that are a property of organising theme as depicted by the organising theme colour. The second strand described as reflecting the association of a basic theme with the foreign theme as **associated with** addresses the basic themes that are associated with foreign organising themes. This relationship addresses the impact and/or influence the basic themes have on the behaviour of the foreign organising theme. The last strand reflects **a part of**, highlighting the basic themes that are a part of other organising themes. At this level, the behaviour of the basic themes is influenced by the organising themes to which they are linked. For ease of reference, the first series is added to indicate the family colour.

FIGURE 25: GRAPHICAL PRESENTATION - WEB OF INTERLINKED QUALITATIVE THEMES

The qualitative diagram depicts the web of interlinked cross-functional relationships that each organising theme has with the other themes. With the exception of business participation and involvement theme which does not have basic themes that are **associated with** other organising themes, the rest have associations at various levels and points.

Important for later reference is that the sub-basic themes skills development and design knowledge do not have a family organising theme but have a solid **association with** social, IT planning and strategy as well as design art and practice themes. Under the skills development theme, the skills update theme is influenced by the social organising theme while in the same vein influencing the IT planning and strategy organising theme. The training theme influences the behaviour of the social organising theme. This is more from the perspective that poor training of business users renders them unfit to use the systems and technologies that IT deploys.

Design knowledge has a unique type of relationship compared to the rest of the basic themes. It impacts on both social and design art and practice theme behaviour and is not influenced or impacted by any other theme.

Noteworthy from this diagram is that there is no organising theme that can exist in isolation. The basic themes that are **a property of** other organising themes have a web of interlinked cross-functional relationships. There is no formula for boxing these themes into their home themes. They all influence and/or are influenced by other themes at various levels of interdependent relationships. Therefore, the default thinking that basic themes can only belong to a particular organising theme with no relationship to other themes and vice versa is not realistic and is very limiting. In fact, on the basis of this analysis, the functional logical explanation and/or organising of themes defies the open system logic of IS in an organisational setting.

It therefore becomes important to reflect this reality when designing systems and technologies. In fact the process should not start with the practitioners at implementation of the design approaches but should start at the conceptualisation of design methodologies and approaches. The theoretical underpinnings and assumptions made during the conceptualisation of the design methodologies determines implementation standards and consequently their effectiveness in practice.

In this regard, CR proposes a non-deterministic approach which states that although IS reality is that of an open system where the themes follow a web of interlinked cross-functional network structure, it is possible to examine and understand the tendencies and patterns in behaviours and arrive at less confusing non-deterministic conclusions upon which to base design requirements. This approach is likely to be effective in environments with similar contexts, settings, situated activity and profile of actors as in Layder's layered framework. In order to enhance the insight generated thus far, more in-depth analysis using Layder's extended analysis framework was conducted.

The following section focuses on the interpretations of the qualitative themes at both an organising and basic theme level.

6.4.1 Social Factors Organising Theme

The social theme focuses on the human aspect of computerisation as these influence and are influenced by other organising themes. The elements addressed under this theme are at the heart of social factors resulting in intended and unintended consequences of use. Because of their diversity they are difficult to pin down into a specific causal power and mechanism. The order in which social events happen, as well as their synergistic effects when they meet, define the outcome. The varying pattern of their social organisation, coupled with the configurational nature of IST and BIA capability, adds to the complexity of the phenomenon.

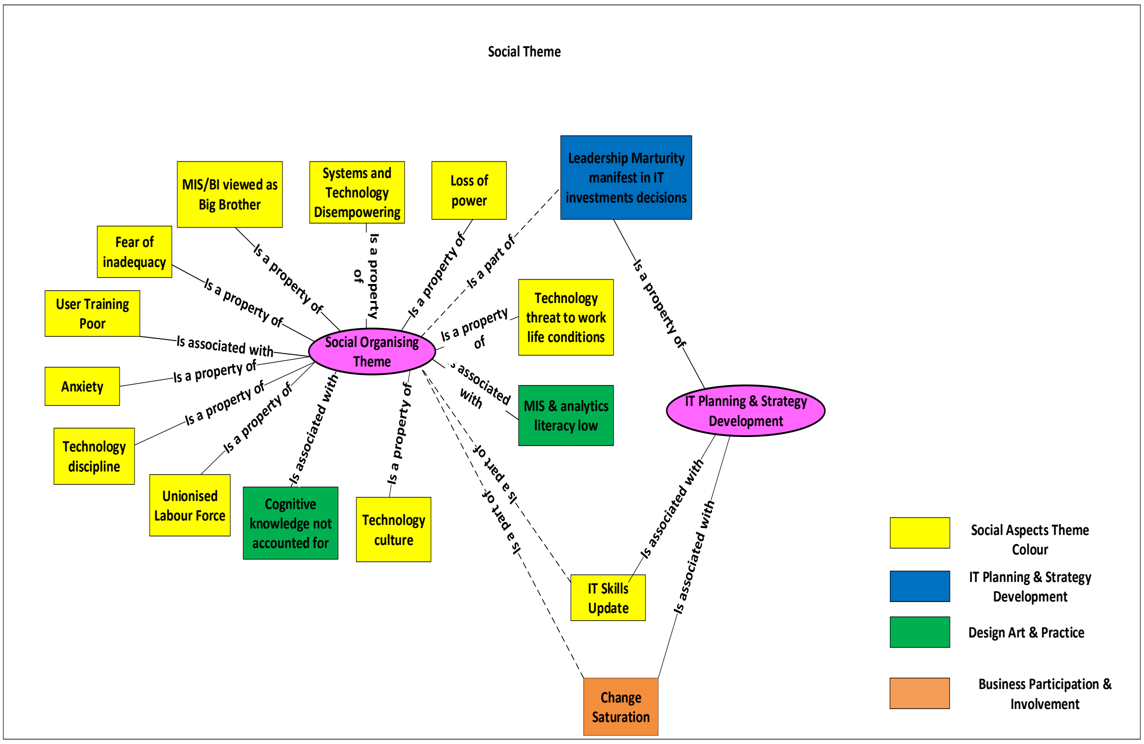

FIGURE 26: SOCIAL ORGANISING THEME

Elements of the social theme outlined in Figure 26 are discussed below.

Anxiety

This theme speaks to the business users feeling anxious about the impact the introduction of IST and BIA in the organisation or functional areas is going to have on them. The feeling of anxiety is largely associated with past experience of what happened when systems and technologies were introduced. They had either been directly impacted or knew of colleagues who had been impacted. The impact varied from job profile changes to process and procedure changes in execution of job functions, to the extreme where some of their colleagues had either been moved completely to another job function or jobs were lost due to systems rendering those job functions redundant.

Job security is at the heart of this theme. There is a fear of the unknown, as some alluded to the fact that they cannot trust the leadership's intentions. Leaders communicate one thing while intending something else. Their experience taught them that with many systems or technology introductions, job changes or losses were imminent. This is demonstrated by the following comments from participants:

- Everybody knows that with new systems come job losses and can understand when employees are coming up with strategies to disrupt implementation of technology (BU_SM001).
- Our employees have learned over the years that what management communicate is not always what it seems (BU_SM006).
- The biggest resistance of OBC [On-board Computer System] was a rumour that information the OBC produced could be used to fire train drivers who were over speeding (IT_SP020).
- People do not trust the implementation of the system, they worry about what they are not being told about, the real intent of implementing the system. Incentive behind introducing the systems needs to be properly thought off and communicated effectively (IT_SP004).
- Depends on the type of user. In IT you may be encouraged. But as a user you may not want to explore due to fear that the more reliance you put on the systems proving systems capability, may end up making your role redundant. Fear of job loss. Background counts. Hence most users use the bare minimum in order to remain relevant. If I have a perception about the system I will not exploit it. No matter how attractive (IT_SP003).

Fear of Inadequacy

The growing complexity of the technology landscape and the inter-connectedness of the solutions that business users have to work with, results in growing concerns of user competencies in manning the IST and BIA. This is contrary to the popular perception that as computer literacy grows, so does the level of competency in utilising systems and operating technologies.

The level of fear of inadequacy varies in particular between the old and young generation. For the older generation, having generally lower literacy levels, the fear of inadequacy is more apparent compared to the young who generally have higher levels of literacy. The old and aging work force do not think it is necessary to be learning new capabilities, whereas others feel that they may not get to the level of competency required to operate these new and complex systems and technologies. This is demonstrated by the following comment from a participant:

- A lot of the work force is close to retirement and feel that the systems being deployed are a waste of time. They have no incentive for learning new systems since they are left with a few years when the systems that are being introduced are complex and are going to take the same amount of time to learn (IT_SP011).

On the other hand, the young, who generally look forward to the introduction of technology, are challenged by poor training and lack of exposure to the full capability of technology, resulting in the fear that they do not know enough compared to their peers or how to perform the functions required of them.

- Some people are not computer literate, some technologies are complex. They can accept the benefits. But have fear of whether or not they will be able to grasp and be competent in using the systems (IT_SP016).

Systems and Technology Disempowering

In line with the expectation that systems and technologies are designed to enhance work functions or to advance the processes, the expectation of systems or technological capabilities grows. The business users expect the systems and technologies to have the capability to deal with complex and varying work dynamics and process variances. Business users expect systems and technologies to anticipate and seamlessly deliver on the varying business requirements. Failure to deliver on these expectations is disempowering for users as they expect systems and technologies that account for the varying user roles at different levels of the social organisation and performance. The gap is attributable to the constrained and deterministic view of the social actor actions and the inflexibility of design to account for the dynamic requirements.

The following are some of the comments from participants regarding view that business users tend to feel disempowered by technology introduced:

- The new systems and technologies fail to improve work functions or create efficiencies in business processes (BU_SM003).
- We cannot work the new systems or technologies, due to poor training by IT (BU_JM013).
- New systems fail to produce meaningful information with which to better manage business (BU_MM015).
- IT discrimination in provision of tools and technology equipment is disempowering and hinders achievement of business goals (BU_SM007).

Loss of Power

The business users that have mastered their environment and positioned themselves as experts, the go-to person(s) in their area of speciality, tend to feel that the introduction of new systems and technology takes power away from them. IT failure to recognise the individual experts and engage them during analysis and design extends the problem as they feel that their input and role is suddenly not important. This gives birth to a number of assumptions and perceptions, when a simple intervention and beneficial to the process would have been to consult them to draw critical insight on work practices, local dynamics and nuances in the business process.

- Feeling of loss of power and influence specialist work now done by technology (BU_SM002).
- Dashboard that were introduced made some people’s work and roles relatively obsolete and others who had the power in the information no longer had that power as information was now available and accessible (BU_EM003).

The business user who views the process as a threat will not only withhold critical information but will also resist the new tool and find reasons to default to the old system. This is demonstrated in the participants' statements below:

- Adopt a wait and see attitude in hope that the delay in adoption of the new technology will result in a number of system gaps surfacing and the initial adopters losing trust in the promised system and default to the traditional way of working (BU_EM003).
- Current culture is to use only if you have to, else wait to see if goes away (IT_SP021).

The actors' view is that the solution does not have to be 'fancy'; as long as it works, it suffices.

Technology Threat to Work-Life Conditions

This theme addresses a view that at times systems and technology implemented introduce health challenges that were otherwise not present prior to the implementation of the new solution. This view was supported by evidence identified during the observation process. Hand-held devices that had been introduced to automate the process of building the train-consist in order to improve the turnaround and enhance data integrity was one such system. The technology that was chosen was assessed based on functional capability and little consideration was given to ergonomics relating to health, risk and safety requirements.

Below is an example shared by a participant during a semi-structured interview on the issue of lack of ergonomic consideration:

- The device was too big and heavy to carry around and for the length of the train. The train size varies from 40 wagons for the general freight train, to 200 wagon train in the coal line, and an exception of a 342 wagon train in the ore line (IT_SP023).
- When the solution to the problem was designed and tested in order to address the challenge of carrying around a heavy device, the solution of 'straps' to help carry the device was not suited for female employees in the yard (IT_SP023).

The above are examples of how solutions that are designed without first understanding the social actors involved and ergonomic requirements result in health, risk and safety concerns.

MIS as Big Brother

In response to the low adoption of IST and BIA designed to improve operational business performance, TFR resorted to MIS as a monitoring tool. IT was tasked to produce utilisation statistics and publish them for review in strategic forums. Instead of encouraging the utilisation of systems and technologies, the decision had a negative consequence on business. MIS was viewed as 'Big Brother'.

Big Brother Watching: Organisations Using Tech to Check over People (BU_SM005)

Instead of encouraging optimal utilisation, business users devised strategies and tactics to manage the outcome of the MIS statistics on utilisation of IST. As a result the MIS statistics produced do not reflect reality. Processes were carried out manually and outside of the IST designed to provide automation and MIS systems are updated retrospectively to enable reporting. In instances where data could be manipulated to reflect the expected reality they were manipulated to improve the MIS stats.

An example – On-time performance of train monitoring:

- The practice was that instead of recording accurate train departure time on the system as the train departs in order to reflect the actual train departure time, the system was updated once at the end of the shift with planned departure time, reflecting that all trains for that particular yard departed on time. However, when analysis was conducted as to why more than 80% of trains that departed on time were arriving late, it was discovered that the time of updating the system did not match the train departure time, with deviations of more than 15 minutes … Upon further enquiry, it was discovered that this was the practice to ensure that the MIS stats reflected on time departure to get out of trouble when in reality more than 80% of trains were departing late (Process Audit Observation, Researcher).

This example demonstrates that MIS reporting was performed to comply. Operations had identified a loophole in the system and manipulated it to stay out of trouble. The net result of this process was that not only were the benefits never realised, but business user understanding and appreciation as to why MIS was a vehicle through which business performance could be managed, was missed. The business user perception regarding the MIS is that it is used as a stick to enforce system and technology utilisation when IT is failing to deliver solutions that work and address operational requirements.

Technology Culture

The culture of an organisation is undoubtedly central in determining its readiness to undertake any IS initiative. Technology further speaks to the attitude towards use and perceived value of systems and technology. Hofstede and Hofstede (2005) define culture as the collective programming of the mind which distinguishes the members of one group or category of people from another. They add that culture will not just shape an individual's patterns of thinking, feeling and potential action but will also influence behaviour and rules of engagement when enacting systems and technology in the organisation. TFR technology culture is not at the level of maturity required for the types of systems and technology investments that TFR is making. This misalignment is costly in that the organisation is investing in systems and technologies to drive efficiencies and performance when the employees on whom the investment depends lack understanding and appreciation as to why this is necessary. This is demonstrated by the following comments from the participants:

- The culture to use IST and BIA only when business users have to, or utilisation that is directly linked to performance incentives, is entrenched in the TFR system (IT_SP021).
- Any culture shift attempts are perceived as threats and business users are quick in formulating their own strategies rallying behind their networks to silently resist the change (IT_SM001).
- Company not technology oriented, people lack competency (BU_SM003`).

Resistance to a new initiative can be explained by noting its inconsistency with the values and assumptions of a strong organisational culture. Peng and Nunes (2010) add that the nature of the culture determines its importance in both individual use and organisational exploitation of IS in general. Organisational theory suggests that the degree to which a firm's culture is integrated and aligned with its strategic objectives, goals and expected outcomes (Mackenzie, 1986), positively affects the overall organisational performance.

Workforce Discipline

There is a general lack of discipline across TFR in respect of the utilisation of systems and technologies at the disposal of business users to help simplify complex business processes. This extends to the management team that does not have the necessary influence over the systemic discipline challenges facing the organisation. Traditional change management efforts have proven not to be effective, particularly when dealing with operational business users. The systemic challenges go back in history and are largely informed by the organisation's character and structure at both executive and junior (lower) levels within the organisation. This is demonstrated by the following comment from a participant:

- The response you get is informed by how they are affected by the technology you are introducing. If they know that technology is going to leave them jobless, then they will not support it regardless of the level within the organisation. In essence it is not technology that is a threat but it is the reality that is a threat (IT_SP020).

MIS and Analytics Literacy Low

Literacy levels for MIS and analytics were considerably lower compared to the business operations requirements for reporting. The underdevelopment of the discipline in TFR meant that demand for BIA is not matched by the right skills and competencies across business. During the observations, MIS analysts and managers were business users who were taken from other disciplines and functions to fulfil this function. This is directly linked to the low level of maturity and understanding as to why MIS is important and to what kind of skills and competencies are required to drive the development of the function.

The skill and competency gaps related more to the analytics and the process of creating insights. Neither IT nor business demonstrated the required maturity level in employing BIA as a performance-management tool. In cases where MIS was available, the assessment revealed that interpretation and level of analysis required to create insight was limited by experience and literacy levels. Instead of producing MIS that integrated business processes and provided visibility of operations across interlinked business functions, MIS remained largely fragmented and functionally silo driven. As a consequence, decisions are made in isolation, with limited understanding of their impact on the rest of business functions. As a result, the current reality is that the quality and impact of decisions made is somewhat ineffective.

User IT Training Not Effective

There is currently no centre of excellence for IT training. Business analysts are currently fulfilling the function. This approach compromises the quality and effectiveness of training, leaving business users feeling that they have not been adequately trained and equipped to utilise the IST and BIA optimally.

The other common training model is the 'train the trainer' approach, justified on the basis of capacity constraints from IT business analysts to provide training given the number of business users in operations that require training. This model is not effective as the trainers that are nominated to provide training often come in at the end of the project and do not have sufficient background to justify them providing training to other users. Since these trainers are not qualified training is based on their limited understanding and experience of the systems. The impact of this is that the trainees are presented with half the picture and the consequence is solutions being underutilised.

- Currently, IT does not invest in systems training. There is limited training for systems and inadequate training material, people are trained by their predecessors who also do not refer to any formal training material. So train users on what they know (IT_SP025).
- IT are not trained trainers therefore training is compromised and understanding of full capability of the training (IT_SP028).
- Lack of training on systems is a reflection of that we do not train people on the process which are a primary driver and the process is open, leaving training approach open to the areas to choose (IT_SP010).

Unionised Labour Force

Systems that influence the unionised labour force are the most challenging to introduce into the system. There is an unwritten rule that before IT can embark on any project, labour union buy-in has to be sought and transparency on the project progress maintained through all the project phases. Unions should first be convinced that their constituents will not be disadvantaged in any way by the introduction of a new system before the project will be endorsed. During the implementation they become part of the team that does the change management to ensure that their constituents' concerns are addressed to their satisfaction.

Management has developed a strategy to ensure that the benefits of the system and technologies being introduced appeal to the union reps and that they use them to lobby for social actor buy-in. However, they do mention that it is a complex relationship to manage. They argue that the unions have the power to stop or derail project timelines if they are unhappy, and when that happens management has no choice but to go back to the drawing board and comply with their demands. Obviously they have developed strategies on managing such cases but these are not without challenges.

6.4.2 IT Brand Organising Theme

This organising theme concerns itself with business perception of IT. However, it is important to point out that the general perception of low credibility is due to IT's poor performance that was shared by staff members internal to IT. It is a reflection of the health state of the relationship IT has with business.

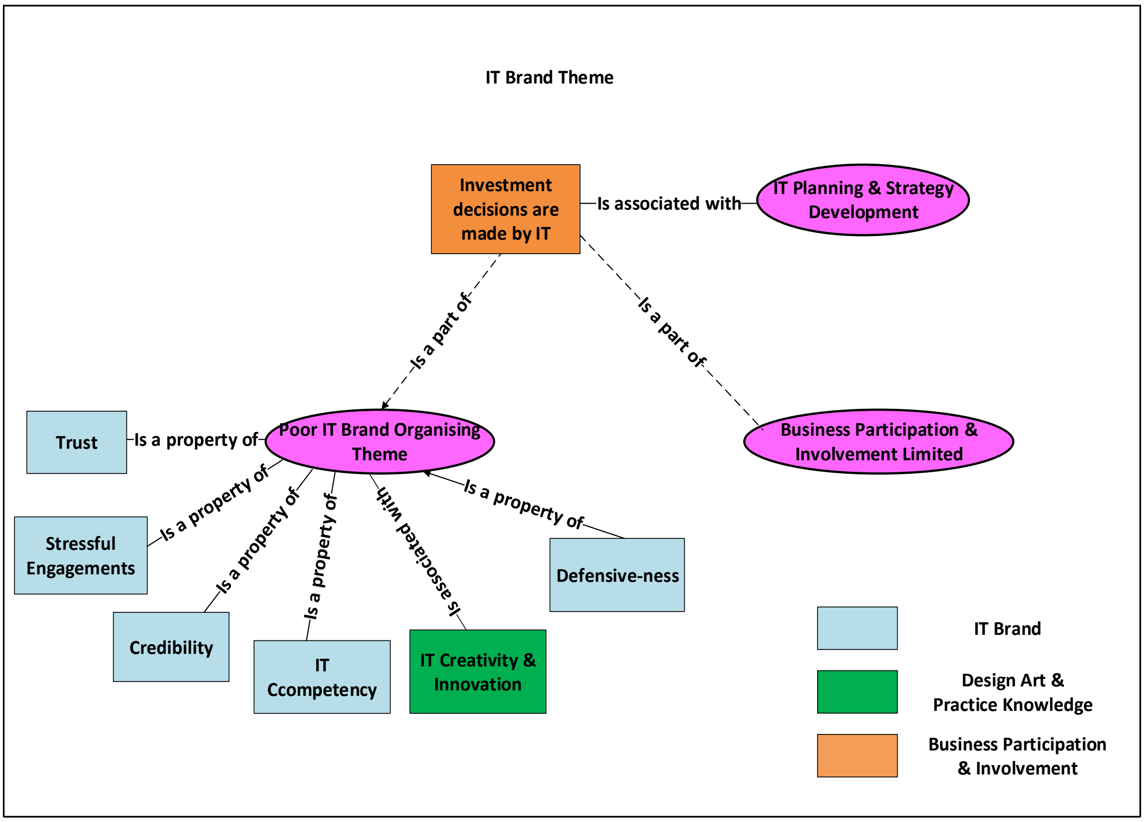

FIGURE 27: IT BRAND ORGANISING THEME

The IT brand theme touches on very sensitive issues, largely reflecting a broken relationship between IT and business. It was important to highlight the view business has of IT, in particular because of IT's strategy and vision to become the strategic partners of business. The following themes were identified: trust, credibility, competency, innovation and creativity as well as stressful engagements.

The comments below are from empirical data pointing to the levels of discomfort and frustration of business users with IT as well as a loss of credibility over the period. These are quoted verbatim and are self-explanatory and as such do not need interpretation. These themes are a reflection of how bad the IT brand is over failure to meet business expectation at various levels of support and enablement.

- We do not trust IT (BU_MM016).
- IT is not competent (BU_SM004).
- IT lacks creativity and innovation (BU_SM003).
- IT is defensive (BU_SM006).
- Stressful working with IT (BU_MM012).
- IT is not credible (BU_SM004).

6.4.3 IT Planning and Strategy Development Organising Theme

This theme is strategic to IT's position in business. It highlights the points for consideration when working towards a vision and strategy to become a strategic partner to business.

Themes relating to planning and strategy development are addressed in this theme. IT executives set the direction for the entire organisation in terms of what systems and technologies to invest in, in support of organisational strategy and planning. Through this theme IT builds its own capability (technical and social), processes and methodologies in order to deliver sustainable capabilities in support of strategic, tactical and operations requirements.

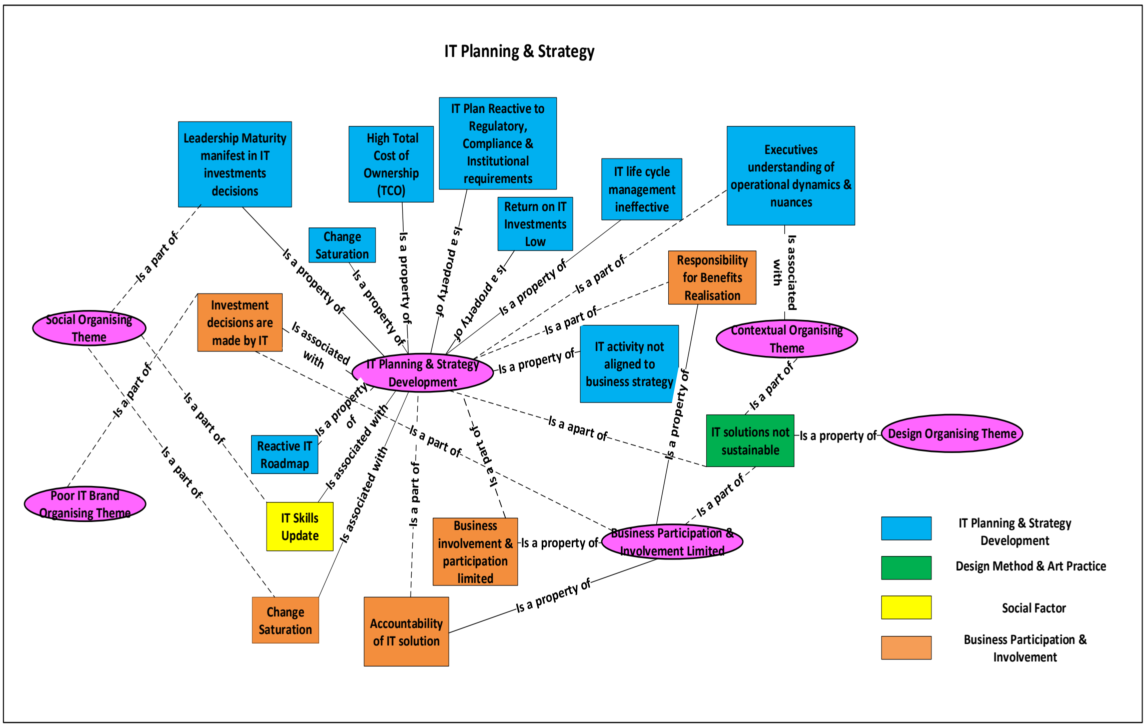

FIGURE 28: IT PLANNING & STRATEGY ORGANISING THEME

The above web of interlinked cross-functional network of basic themes was identified and categorised under IT planning and strategy development theme. These were themes that related to either planning or strategic activities. The comments below reflect on the health state of this global theme. They provide a good sense of how the activities associated with this theme are generally performing in TFR.

- IT road map is reactive (BU_EM001).
- IT activities not align to strategy (BU_EM003).
- Leadership maturity manifesting itself in poor IT investments decision (BU_EM002).
- Business influence in decision making and solution development life cycle limited resulting in development of inappropriate systems, technologies and business intelligence and analytics solutions (BU_EM002).
- IST life cycle management ineffective (BU_JM007).
- IT lack big picture thinking resulting in poor and ineffective long-term planning (BU_MM008).
- IT creates its own chaos and constraints and thereafter use those as an excuse for poor performance and delivery (BU_SM005)

The above comments point to the business concerns of the state of IT planning that is seemingly done in isolation from business requirements and as a consequence resulting in IT plans that are ineffective and solutions that do not deliver on the required functionality. There is a perception that IT is not able to anticipate business requirements and as such is reactive. This is a concern in a fast-paced and changing environment because by the time IT delivers a solution the business requirements have either changed or evolved.

The following results are an interpretation of the comments received during data collection on aspects relating to this theme.

- IT failure in translating plans into executable and manageable deliverables to business resulting in failure to deliver meaningful and impactful results (BU_EM001).

IT implementation plans are not informed by enterprise-wide change and as a result compete with other changes for time and business participation. When there is too much change in the organisation at the same time, implementation and operationalisation of IT solutions suffers. IT needs to align with business and identify opportunities for synergies in implementing when implementing change.

- Saturation of change in the environment – poor planning and lack of visibility of initiatives underway, lack of synergies in planning of projects and execution thereof (BU_SM008).

Triton Communications Module fitment on board the locomotive was one such example shared by participant IT_SP020.

- IT had put together a plan to implement Triton Communications Module on board locomotives to enable wireless communication and transmission of data about the train position and health status while the train was in transit. However due to lack of engagement with areas that were impacted by this plan, after half of locomotives that were fitted with the Triton Solution in the Iron Ore Corridor, IT learned that there was another business project mandated by Rail Regulatory that was took priority over IT implementation. The business project interfered with the actual solution design which meant that all the Tritons that were fitted had to be removed and solution redesigned to fit within the new business solution and retrofitted. This was a huge impact on budget, effort and time lost to the project.

Furthermore there is a view that IT roadmaps and plans are piecemeal and do not follow an enterprise approach. This is supported by comments on a chaotic IT environment.

- Lack of an enterprise approach to investment decisions and working, results in high total cost of ownership, and low return on investment (BU_EM002).

Business lacks confidence in the vision that IT has of enabling and supporting business strategy. There is a sense that it may not even exist, and if exist lacks clarity in how IT aims to support business in achieving its strategy. This is demonstrated the following participant comment:

- ICTM [Information Communication and Technology Management] has no vision of where they want to take the organisation. Vision informs the direction and type of systems and MIS the organisation invest in and prioritise (BU_SM002).

6.4.4 Business Participation and Involvement Limited

This theme is concerned with reviewing the effectiveness of the engagement, consultation and involvement of business throughout the implementation of the SDLC methodology. Business user participation and involvement, especially in analysis and design, which are areas that are a sore point for the research study, can be reviewed through the eyes of this theme. As with the rest of the themes, it is influencing and impacted on by other organising themes.

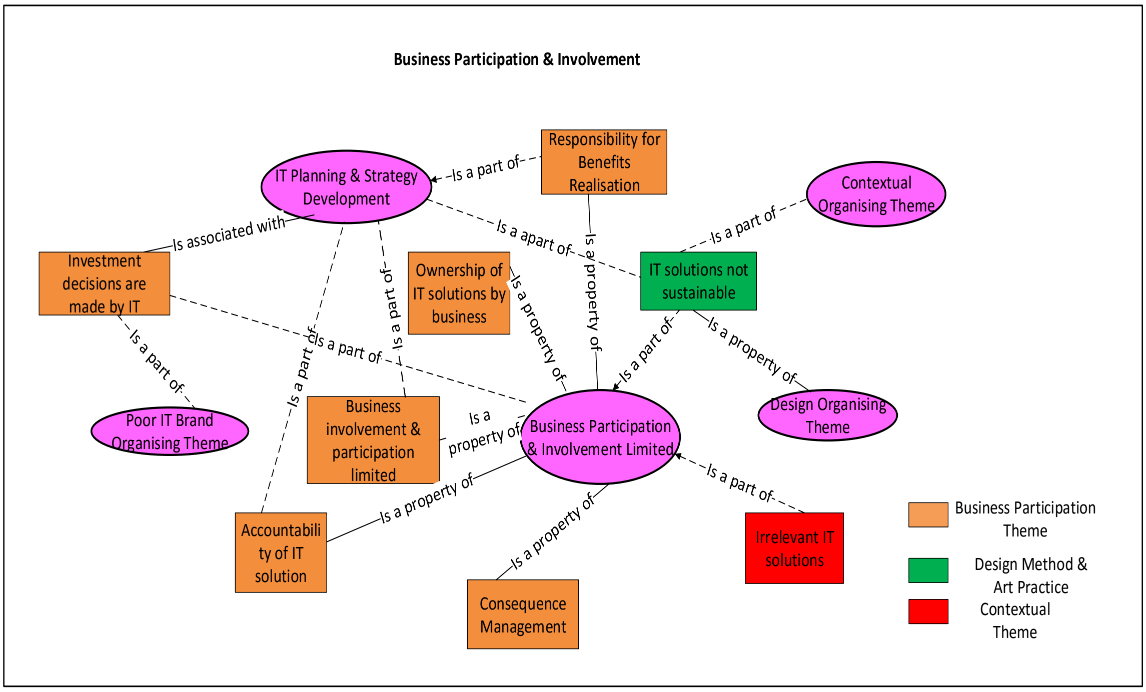

FIGURE 29: BUSINESS PARTICIPATION AND INVOLVEMENT ORGANISING THEME

IT does not seem to create enough opportunity for business to participate in the development of IST and BIA. Where business is involved, participation is limited, and is driven by IT requirements for business sign off to pass the gates as set out in the SDLC methodology. For example, the analysis revealed that users are largely consulted during user acceptance testing as the SDLC methodology dictates that systems and technologies cannot progress to implementation without user sign off.

This effectively means that business involvement has less to do with soliciting user input and ensuring meaningful contribution and more to do with compliance on the IT side. Hence IT continues to design systems that are limited regarding the qualitative aspects during design, such as ergonomics requirements, cognitive knowledge, work-life balance, social elements, environmental conditions and local dynamics and work practices.

This is a comment from an IT participant which seemed to contradict the business view of the events:

- Users are included in the process, but availability is always an issue. At times business do not always know what they want. Users do not say everything. During testing users begin to have a view of what could happen and begin to think of the gaps (IT_SP016).

Further to the above assessment, and highlighted consistently during the semi-structured interviews and focus group discussion, was user involvement during training and change management.

User Training. Business users' involvement in the provision of training takes the form of a 'train the trainer' approach, adopted where a select number of users are identified as super-users to provide training on behalf of IT. Reasons highlighted were as follows:

Four participants (IT_SP027, IT_SP028, and IT_SP016; IT_SP017) raised the concern the IT capacity has constraints and that due to the School of Rail's primary focus on providing operational training, their training model did not provide for IT training. Hence the responsibility now falls in the hands of the business analyst.

Change Management. Business user involvement during change management is considered an afterthought, in that when change initiatives are designed, users are not consulted. Development of the change strategy, plan and content is done in isolation. Users only get involved when the change programme is presented to them, in which case it is too late for users' input. It is therefore viewed by many users as a means to try to obtain buy-in and encourage utilisation after the event. This is demonstrated by the following comments from the participants:

- The process is largely ineffective and done to comply and abdicate the responsibility (BU_SM010).
- It is largely a tick box exercise to blame business users that everything has been done including change management yet business doesn't want to utilise systems developed for them (BU_JM017).

Consequences of Limited User Participation and Involvement

The benefits realisation process is ineffective. Both business and IT recognise its importance, but it is not effective due to a lack of clarity of RACI in terms of who is responsible, accountable, and who should be consulted and/or informed between business and IT. As a result, there is no officially known process and/or framework to facilitate the benefits realisation from IT investments.

- IT solutions are deployed to support business and their requirements yet IT is left to quantify the value that these solution provide to business. This is an unfair practice since IT has delivered on its part and business has to ensure utilisation by its users. That is why accountability of business will continue to be a problem and IT will continue to be blamed for poor value that IT delivers (IT_SP021).
- Everybody knows that benefits realisation is a business responsibility, as to why things are different at Transnet no body know. This has to change (IT_SM001).

Lack of ownership of IT solutions. There is misalignment between business and IT on who should take ownership of IT solutions. Business feels that since IT makes investment decisions on their behalf and that business user involvement is limited, IT should then take ownership of IST and BIA after implementation. IT on the other hand, have a view that IST and BIA are developed to support business requirements, and that business should therefore take ownership and ensure utilisation and benefits realisation.

- Until business takes ownership of IT systems designed to improve their operations and hold their employees accountable for not using systems provided to them nothing will change in TFR (IT_SM001).

No accountability by both business and IT. IT's view and position is that business, in particular business executives, should be accountable for the utilisation after deployment. Yet business's position is that IT's role does not end with deployment of IST and BIA, it is a continuous process. Again business is linking accountability and return on investment to IT as drivers of decisions to invest in IT capabilities.

- This starts from the top, where management does not feel personally responsible and accountable for the IT investment. Viewing it as separate issue from their own business. This is further translated to the end users who know they will not be held accountable for failing to act or perform (IT_SP025).

Poor consequence management. This is yet another contentious issue between business and IT in that business argue that it is unfair to manage business users on poor utilisation when IST and BIA capabilities are not useful and/or usable. Before business can be penalised, IT should be held accountable to deliver capabilities that work and add value to business. IT should start by recognising business and involve them during the design and development of systems and technologies that deliver on their intended functions.

- Users allowed to say no, and hiding behind that they have not been trained sufficiently enough. Meanwhile it is the culture thing. They know they can get away with it and there will be no consequences for non-performance. Business users have a tendency to hide behind that they inherited some of the projects. Due to sponsor or user changes in project and loss of value from benefits that are not being realised (IT_SP010).
- If there is nothing that forces users to use the systems and there are no consequences if they do not use the system. What would motivate them to use new system and change from what they are used to doing (IT_SP003)?

6.4.5 Operational Factors Organising Theme

The operational factors theme's focus is on understanding how operational elements, as identified in the literature review as one of the biggest concerns and gaps, impact on design and development of useful and usable systems. In the context of the study, operational elements are any factors that are contextual in nature either from a social, environmental and/or context perspective that play themselves out at various levels of IST and BIA design, development and uses.

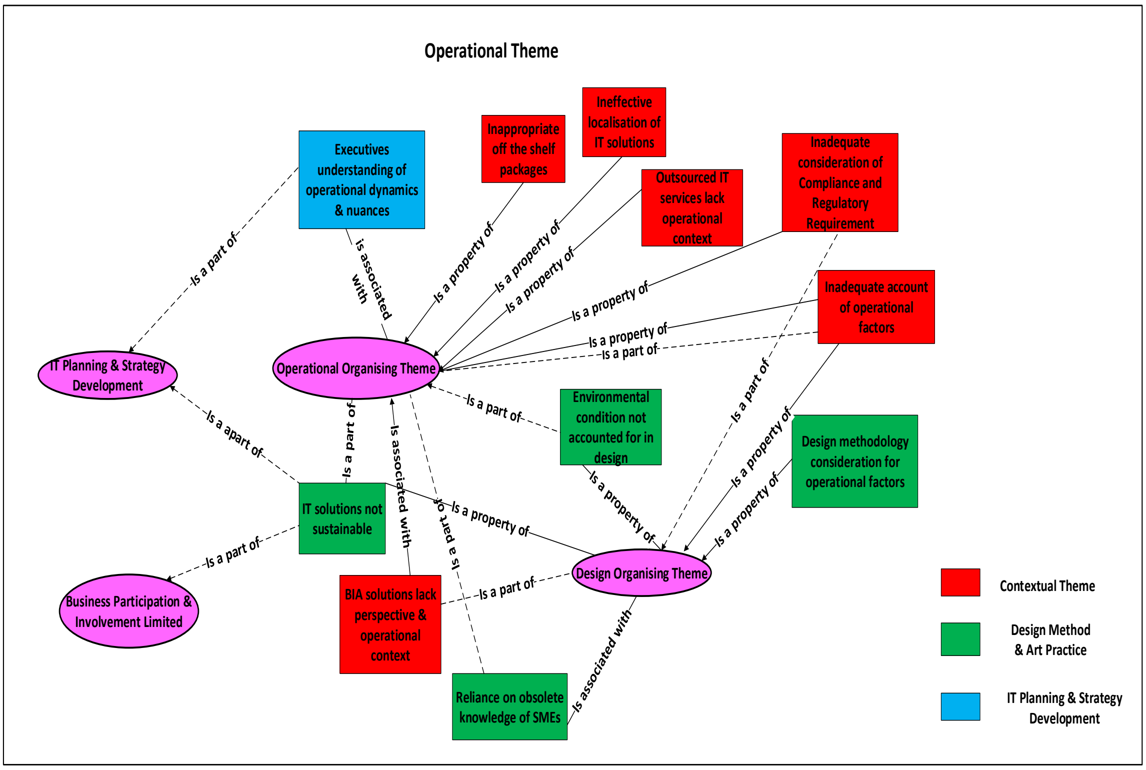

FIGURE 30: OPERATIONAL ORGANISING THEME

The elements that are a part of the operational theme, either from a primary perspective ('a property of') or foreign perspective ('associated with or a part of') are discussed below.

Cognitive Knowledge

Due to the limited involvement, consultations and actual observations on the current work practices and how work procedures are carried out by business users for whom the technology is designed, cognitive insight is not captured. Cognitive knowledge is qualitative, and often designers have limited know-how on how to solicit qualitative requirements. Once solicited, they do not always have the skill to translate them into technical design requirements that can be addressed during system or technology configuration.

Below is an example that a participant shared about OBC Technology – train handling by train crew:

- Due to the geographical landscape in South Africa and the rail track network, there are steep inclined and low gradient train routes. During analysis and design these conditions were not considered and as such the OBC software did not have the in-built intelligence and algorithms to handle them. For example, train consist of a 200 wagon train of coal is handled differently from a train consist of a 60 wagon train of general freight when it comes to steep inclines and low gradients. This is to manage or release the pressure from the load depending on the route characteristics (IT_SP018).
- As train crew started applying their route knowledge and techniques in line with the size and length of the train adapting the speed accordingly, the OBC system prevented such actions, bringing the train to a complete stop. This presented safety risk as the train would be automatically stopped by a system with no consideration of where in the rail track the train was. Where train crew ignored the alarm signals in line with configured range, were penalised for non-compliance. Since none-compliance especially in a case of an accident was a dismissible offence, it resulted in silent resistance from train crew (IT_SP018).

The re-work impacted on the operational environment and other projects, costing the project more than the initial budgeted investment in the solutions.

The biggest challenge in not engaging at appropriate operational levels, but instead focusing on eliciting requirements from business executives, is that they have limited operational knowledge and are usually concerned with the impact on IT investments. The executive's lack of understanding of operational dynamics is a reflection of how removed the executives are from reality.

Executive operational process understanding. One of the biggest concerns during the fieldwork and highlighted consistently at various data collection points was the executive lack of understanding of the operational environment and its nuances. This unfortunately impacts on IT investment decisions and long-term planning. The SDLC methodology approved by IT executives is reflective of the fact that IT leadership does not have an appreciation of the complex environment playing itself out in contextual factors, environment and dynamics. Hence the methodology is not explicit in its accounting for these factors.

Outsourced services lack context. Services and solutions designed and developed by external service providers often lack context and consideration of local dynamics, work practices and understanding of social dynamics. Their timelines are often rushed and instead of spending time observing business users in action, they rely on workshops and interviews. These are not sufficient as input into design, so IST that are based on leading practice are not adopted or optimally utilised.

- The practice of buying systems that are not customised is not working for TFR. TFR is a complex business and new systems that are not build for TFR specifically often adds to the current workload as opposed to making the work easy, lighter or manageable. We view them as an unnecessary add-on rather than improvement (BU_SM004).

Ineffective localisation of technology solutions. IT has a tendency to assume that adoption of systems that have been proven to work in other organisations will work in TFR. These assumptions are often the source for adoption and deployment of inappropriate solutions or lack investment of time and effort required to localise the solution in order to ensure relevance and fitness for purpose in context, setting, situated activity and the social actors for whom these systems and technologies are designed. For example, one of the technologies that was observed due to poor adoption after change management efforts, training and adaptation of technology failed; discipline in the workforce and social factors emerged as the man reasons for poor adoption.

- Local instructions that's issued, how these link to the general instructions, procedures and guidelines that are issues. Especially in operational environment, e.g. maximum allowable train length in other areas different to national view. How do you then cater for such local dynamics as the process and procedure is different due to the physical layout of the yard (IT_SP002).

BIA lack in perspective and context. In addition to the concern that analytics as a function in both IT and business is underdeveloped and characterised by limited skills and competency, reports developed lacked perspective and context. While the analysis points to processes that exist to drive development and manage system impact, there is no explicit focus in ensuring that MIS reflected perspective and context. Attempts to do so failed due to poor support and executive buy-in to drive the efforts.

- IT frustrated that business use Access Database which is not an official tool. But business feel that it is more effective than what IT provide them as tools for MIS – Business Objects (BU_MM014).

- More time spent creating data rather than creating insight (BU_MM015).

Environmental conditions not accounted for during design of IST and BIA. Three technologies deployed under one of the strategic programmes were impacted by the environmental conditions. Upon further investigation, it was clear that the feasibility study did not consider nor anticipate the impact these conditions would have on the successful implementation of the project.

- Some of the challenges related to telecommunication network and physical conditions in the areas where these technologies needed to function. The process of fixing these was derailed by the fact that none of these were dependent on internal processes but external service providers and geographical landscape in South Africa (IT_SM002).

Furthermore, concerns were noted that no matter how hard IT try to anticipate and identify every single requirement in the detail that is required to ensure that solution design addresses those requirements, it is very difficult for any system to account for each and every possible requirement and nuances in the process. Other things do not seem to be a threat until something triggers them and only then can an issue be identified that needs to be addressed. This is well captured by the following comments from participants:

- We always have to consider environmental factors that may impact on the technology. How will the environment impact on the technologies? However, there are still those factors that will always be unknown until they manifest themselves (IT_SP020).
- There is a limit to what you can do in terms of considering all social, environment aspects etc. that may impact on the effectiveness of any system. It also depends on the business area you are developing the system for example, finance is by nature rigid and operations complex and scope for things to consider always big (IT_SP002).
- Lack of the big picture understanding of processes by business yet expect IT to know and understand everything that business does. Business users do not know what processes are impacted by which processes and how thus making it difficult for IT to design a complete system. E.g. Users understand own processes and do not know the impact their actions have on the next lag of the process or big picture (IT_SP001).

Off-the-shelf IST and BIA packages tend to present problems relating to business processes fit for purpose. They dictate process and perspective of reporting. Often, the predefined processes render the tools inappropriate and require effort in localisation. The responsibility to address the localisation and customisation falls into the designers' hands to address. The challenge with pressure on designers is that they themselves are constrained by limited knowledge and skills to address the requirements. Off-the-shelf packages are designed to address global and generalised requirements, but they lack consideration of local dynamics, work practices and nuances that provide relevant and actionable context. This is demonstrated by the following comments from the participants:

- Solution assessment for fitness is based on head office requirements neglecting the local requirements. For example, structures within the two National Command Centre (NCC) vs Satellite Command Centre (SCC) play a pivotal role, large contingent of people at NCC to maintain the segregation of tasks when at SCC one person completing two or three roles merged into one role compared to NCC, resulting in a conflict when systems are rolled out to local sites (IT_SP011).
- MIS reporting in the areas is detailed and done daily yet reports developed by IT are for monthly reporting of managers. That is why we have our own manual systems and do not use MIS reporting that IT produces (BU_SM011).
- MIS report from IT are for head office only and IT never engages us on our requirements, yet we are always questioned on the numbers we produced using manual systems (BU_SM012).

6.4.6 Design Organising Theme

The design theme assesses data, collected from a design point of view, of methodology, skill, knowledge and practice. Design being the subject matter for the study, it is crucial to examine how this capability can be improved upon from both a practice and a science point of view. Hence the focus on reviewing and understanding design gaps from the perspective of the designers themselves and/or those impacted by designed systems.

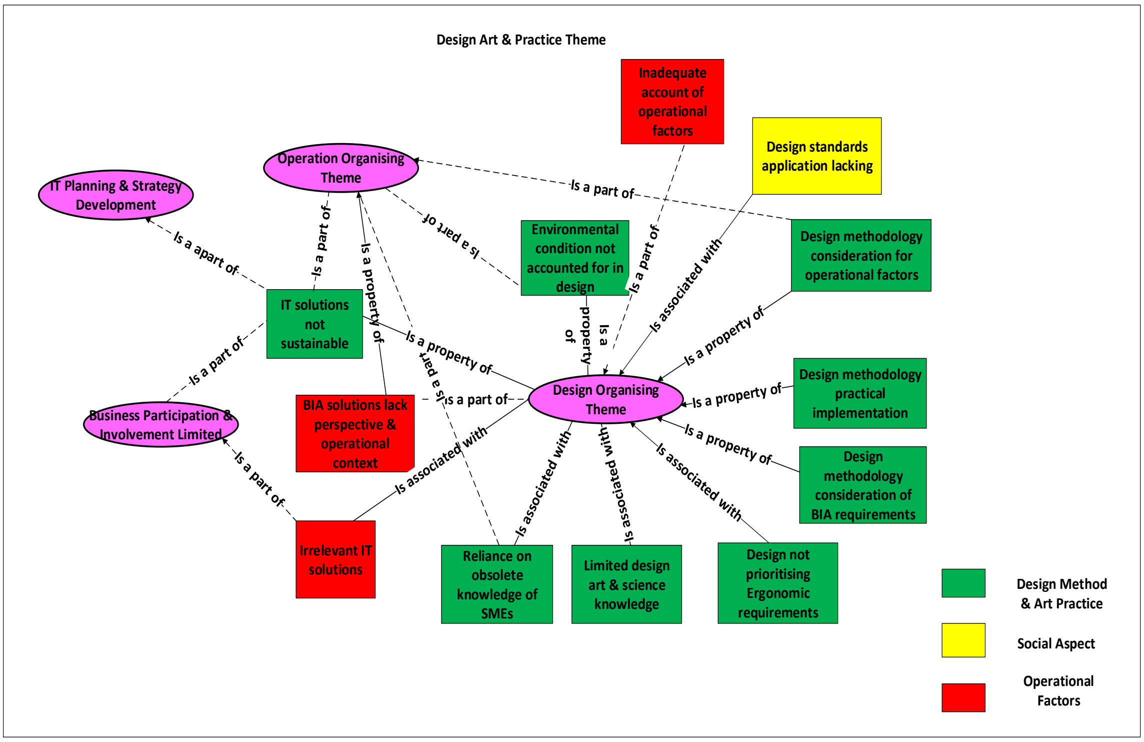

FIGURE 31: DESIGN ORGANISING THEME

This theme focuses on the aspect of IST and BIA that limits the effort and effectiveness of the design function. The participants' responses were specific and need little interpretation to understand the participants' perspective. The questions were based on the current SDLC analysis, design and development methodology employed in the TFR IT department. In essence, the findings from this theme were that the SDLC design methodology is ineffective in accounting for contextual factors, resulting in design of IST that lack in context, and BIA that lacks in perspective. Below are anecdotal comments from the participants:

- We have the methodology but we do not have the accountability. Roles and responsibilities not clear from the onset. No consequences for not taking responsibility and ownership (IT_SP025).
- Design methodology exists but not applied consistently across (IT_SP018).

It was further noted that the SDLC does not emphasis the need to elicit requirement that address social requirements, social systems, social norms or even work practices that are often reflective of social structures and behaviour when business users are fulfilling their job functions. This is demonstrated by the following comment from a participant:

- Question never even arises in the SDLC consideration of social aspects and work practices. Not considered (IT_SP004).

The SDLC methodology that was developed to guide design and implementation of IST is applied to design and development of BIA solutions. This is demonstrated by the following comment from a participant:

- Design method exists but lacks practical implementation when it comes to MIS, we have been requesting for a methodology that addresses unique needs of MIS environment (IT_SP006).

There also seems to be misalignment in terms of whether or not the design standards exist and how effective are they in aiding in the design and development of effective IST and BIA. The misalignment is amplified by the following comments from the participants:

- If design standard exist, then there is definitely lack of discipline in application of those standards (IT_SP008).
- IT has no strict design standards or codes, we design systems based on specifications received and experience, we try and make it work (IT_SP005).
- In some instances we do consider standards and in other instances we do not. The methodology does not enforce the standard to ensure that irrespective of who is doing the analysis or designing a solution they are going to enforce and adhere the standard (IT_SP017).

The SDLC methodology does put an explicit emphasis on the need to consider ergonomic requirements. Upon reviewing the SDLC methodology document and guidelines, there was no mention of the need to assess the ergonomic requirements in order to ensure that the solution design addresses them. In fact some participants did not even have an understanding as to when these should be considered during design. This is highlighted in the comments and questions by participants:

- Design of ergonomically sound systems and technologies is lacking resulting in uncomfortable working conditions (IT_SP001).
- Business has had to reject some IT solutions because they were causing harm to our employees (BU_MM016).
- IT design solutions that are not sustainable for business (BU_SM007).

Instead of taking the time to assess and analyse the environment in which IST should exist and engage target business users, IT tends to rely on desktop assessment, meetings and workshops and often the people who are impacted directly by these solutions are not represented. This can be demonstrated by the following participants' comments:

- We have a tendency of relying on obsolete knowledge of subject matter experts when designing systems (IT_SP023).
- IT design solutions for decision makers and not employees on the ground who can tell them the real challenges of their environments (BU_SM010).

Lastly, there are a few practical use cases shared with the researcher during the data collection that illustrate how much the SDLC methodology's ineffectiveness and inefficiencies are resulting in limited value being realised from IT investments.

The SDLC design methodology exist but is difficult to implement in practice due to its unrealistic approach and incomplete view of what a design method should entail. There also seems to be lack of understanding and interpretation of the method within IT which is a concern as they are the ones supposed to be applying it in their day-to day-duties as they strive towards delivering to business solutions that work.

Implementation of an OBC System in Locomotives

The OBC system was adopted from a railway organisation in North America with the view of localising it to the South African context and environment. The proof of concept (POC) was initiated and the different components were designed, developed and tested in the laboratory setting, and field implementation then commenced. Later in the POC, a number of technical and qualitative challenges emerged which could not be avoided as they threatened the success of the POC.

It is an example of analysis which did not include social, contextual and environment factors.

Social consideration. Although the POC was run from a specific area, because the impacted stakeholders were train crew, they had a network of relationships across the organisation with whom they shared values, belief systems and attitudes. In the way that the POC communicated the intentions, benefits and impact of the project on the train crew created resistance that three years into the project was still being managed. Train crew from other areas started resisting the project before it was launched officially in their areas, citing issues that had been shared by their counterparts during the time of the POC. While the issues that were cited were true and were being worked on by IT, the real issue was that the OBC system meant visibility of train handling, speed and fuel consumption.

Contextual consideration. When the software was configured, the impact of existing processes, master data and systems supporting the environment was not examined, yet the OBC was designed with the assumption that it was going to plug into the existing landscape and feed into the existing processes and interface to the existing systems.

OBC software was configured with a new definition of station codes to the existing station codes that feed into all the operations systems and processes that need them. Although the purpose and use case was different, it nevertheless created challenges in that efforts to align the two were eventually abandoned because they were not reconcilable. The old station codes were used to define the train and inform the train number used to manage train slots allocation, resource the train and to track and trace the train *en route* as per the service design, while the OBC codes were used by software to identify the train route and direction in order to refer to the correct route knowledge map for train handling and performance of the OBC. The difficulty was that in both instances the codes were part of the train number logic, but for the reason that the two train numbers were configured differently for different purposes they could not be reconciled. The resulting consequence for the train crew was that they were expected to use both numbers as they were both required for different reasons. This resulted in resistance and not even change management efforts could assist with the challenge. The solution is being reviewed with the new generation of OBC and replacement of legacy systems. However this is a seven-year journey and in the meantime the organisation has to live with the unintended consequences that could have been minimised had the right level of analysis and engagement been done. This is in spite of the time, effort and cost to try and fix the constraints only to arrive at a conclusion that it cannot be reversed with the current capability.

Environmental consideration. The conditions under which the trains run in South Africa are different to North America where the technology had been designed. As such the specification of one of the components needed to be changed. This was not obvious until technology started failing. Upon completing the root cause analysis, it became clear that the units were failing because they could not withstand the pressure from the geographical landscape where trains were running, and lost connectivity. All units that had been installed had to be retrofitted after new specifications for the peripherals had been redesigned. This was obviously at a cost and delay to the project timelines.

6.5 Technical Capability Development and Enablement Global Theme

The section below focuses on the interpretation of the results of the technical capability development theme.

Figure 32 below depicts the technical capability development themes at a global level as identified in the interpretation and analysis of the results from the fieldwork. It highlights the web of interlinked cross-functional relationships the themes have with one another at various levels. Each connector is designed to reflect the relationship as described in the section above.

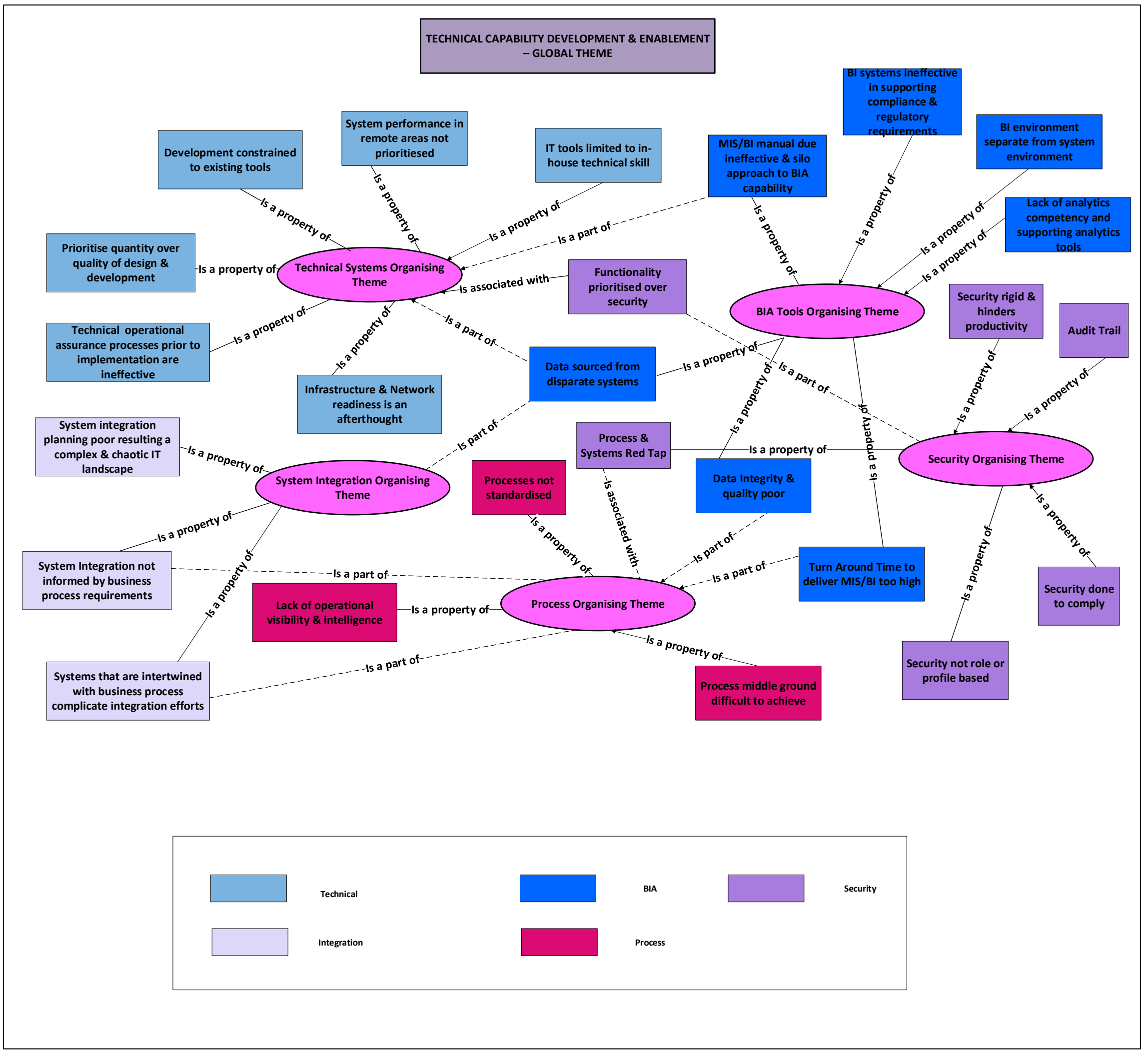

Figure 32: Technical Capability Development Global Theme

Figure 33 below is a graphical presentation of technical capability development themes. It summarises the web of interlinked cross-functional relationships the themes have with one another at an organisation theme level. The first strand is described as **'a property of'**, and it highlights the family themes that are a property of the organising theme as depicted by the organising theme colour. The second strand is described as reflecting the association of basic theme with the foreign theme as **'associated with'**, addresses the basic themes that are associated with foreign organising themes; this relationship addresses the impact and/or influence the basic themes have on the behaviour of the foreign organising theme. The last strand reflects **'a part of'**, highlighting the basic themes that are a part of other organising themes. At this level, the behaviour of the basic themes is influenced by the organising themes to which they are linked.

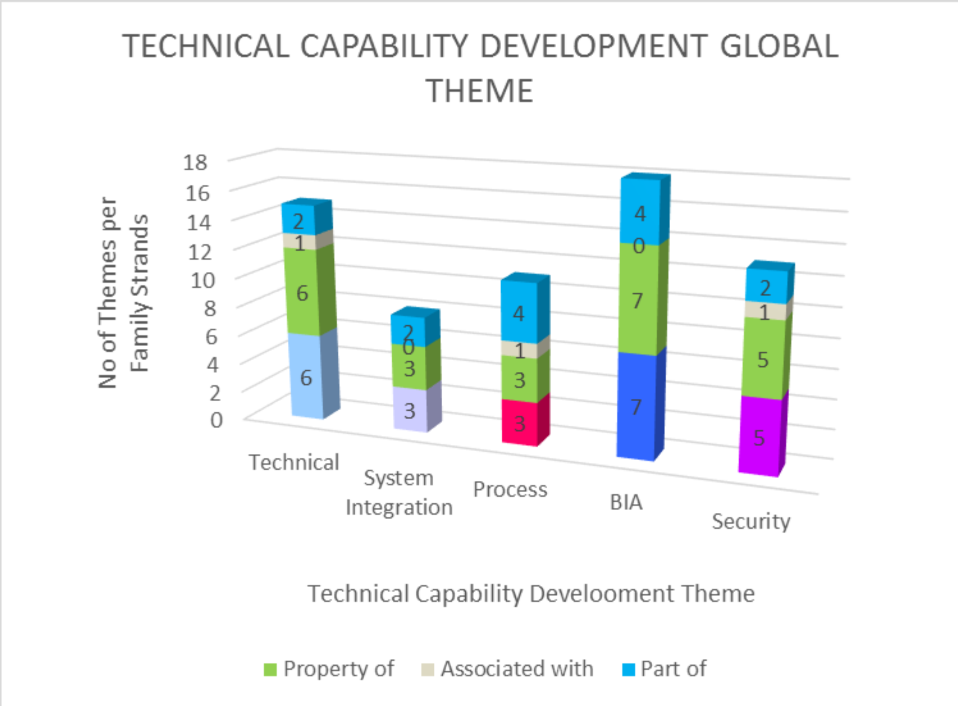

FIGURE 33: GRAPHICAL PRESENTATION - WEB OF INTERLINKED TECHNICAL CAPABILITY DEVELOPMENT THEMES

For ease of reference, the first series is added to indicate the family colour.

The technical capability development theme has a limited number of basic themes that ***'are associated with'*** other organising themes as indicated by an across the board level one influence or impact on other organising themes. Themes that are **'a part of'** other themes are reflected as having a solid relationship with other organising themes. This means that the solid relationship from a technical capability development is that of organising themes influenced and/or impacted by other organising themes. However, noteworthy in this analysis and of interest to the study is that from a technical capability development perspective, the BIA and system integration organising theme have no basic theme **'associated with'** other organising themes. They only have basic themes that are **'a part of'** other organising themes within the technical capability development global theme. The last point to be noted is the process organising theme. It has more basic themes from foreign themes that are **'a part of'** process than its own family themes. This effectively means that process is influenced or impacted by more foreign themes. It is not surprising, given that business processes are the foundation for business activities, that the behaviour of basic themes which are **'a property of'** another themes are influenced or impacted by the process theme.

The diagram highlights that the emphasis which TFR IT is placing on technical capability development at the expense of the qualitative factors, comes at a cost, in that there are limited and at times no basic themes **'associated with'** other organisational themes and less basic themes identified to be **'a part of'** other organising themes compared to the qualitative global theme. Where emphasis is really required is in the qualitative global theme as it is currently underdeveloped. Its cross-functional nature and web of interlinked cross-functional themes reflect the interdependencies across the themes.

The web of interlinked cross-functional network of themes, presents challenges that come with understanding the depth and breadth of the influence these have on one another. Norman (1993) points to the fact that techno-centric approaches to systems and technology design do not properly consider the complex relationships between the organisation, the people enacting business processes and the system that supports these processes.

6.5.1 Technical Organising Theme

This theme was limited to the technical aspect of IST from a design, development and operationalisation point of view, although the qualitative elements are critical in the design and development of useful and usable IST and BIA. Technical elements are essential in ensuring that the solution works and delivers on its intended function when operationalised. Empirical evidence supports this view, hence the emphasis on capability development, supporting infrastructure and operational readiness.

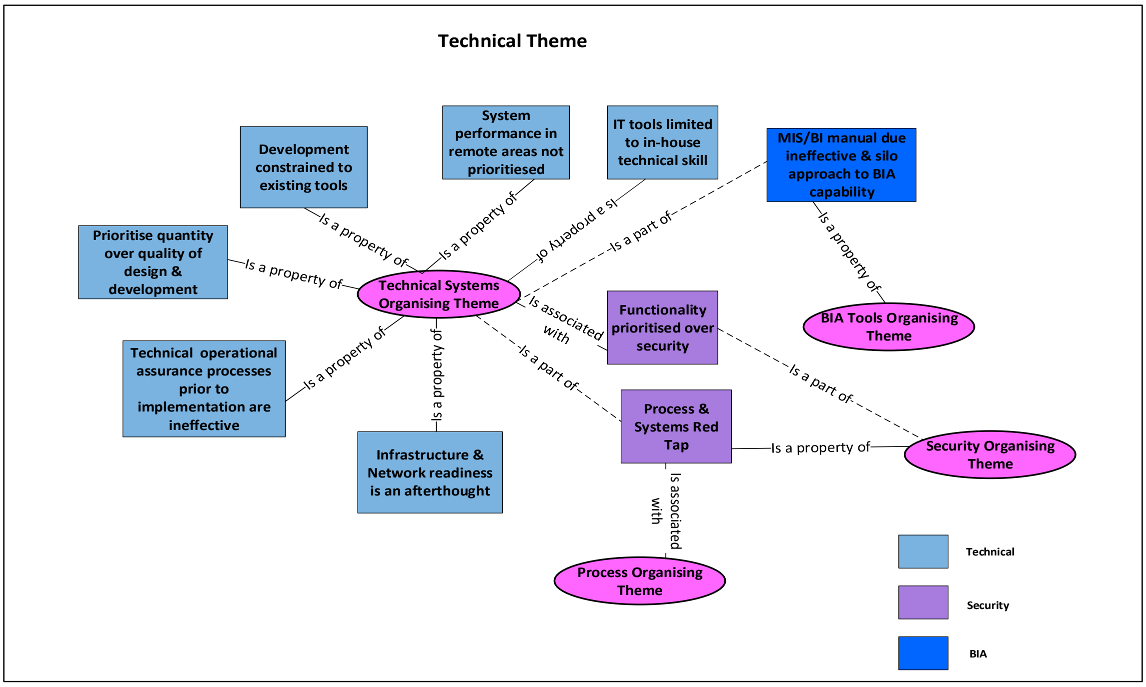

FIGURE 34: TECHNICAL ORGANISING THEME

System development constrained to existing skills and tools. This is an interesting finding in that both business and IT share the same concern that IT constrains its capability to what their skill base can handle. IT resources raised concerns that their skill is not developed and/or refreshed in line with the growing field, and as such default system capability to their skills. Others pointed to the fact that at times business asks IT for capabilities that IT did not know existed. This is a serious concern as IT is perceived not to be taking the lead in their own space.

Prioritise quantity over quality of design and development. In responding to business pressure largely due to poor planning and IT's reactive approach, IT prioritises delivery over quality of the solutions developed or deployed. Business users argue that if IT would take the time to understand their requirements and spend time in their environment it would be better positioned to inform long-term IT planning, invest in value-adding capabilities, and ensure that design function accounts for contextual factors. In this way IT would not have IT projects competing for scarce skills, budget and time.

System performance. Bandwidth and network requirements are noted as standard considerations but are not being actioned as per the analysis or recommendations during analysis and design. These are a source for poor system performance. When IT tries to address the performance issues in retrospect, it is confronted with systemic delays since this is an outsourced service and delivery takes a long time, by which time business users have abandoned the solution.

- Systems in head office work like a charm, but as soon as you get to the areas find that it does work. Network a problem (BU_SM005).

Infrastructure readiness. This was identified as an area of weakness in IT processes. Infrastructure forecasting, planning and IT investment decisions are not aligned to growth in business requirements, and is thus highly reactive during IT project implementation. Although the impact is felt under the technical theme, the concern can best be addressed in line with IT planning and strategy theme.

- Nowhere in the project life cycle do we consider how the new project is going to impact on the existing infrastructure. We implement solutions hoping it will work, only when there are issues reported post the implementation do we investigate. Even then we register another project which will take months, by the time the infrastructure issues are sorted the business users have abandoned the systems making it difficult to revive. IT always falls into the same trap not sure why we do not fix this gap (IT_SP022).

IST and BIA Silos. A silo approach to IST development results in poor BIA, at both a transactional reporting capability and a BIA level. This points to the silos at IST and BIA sub-discipline level as well as maturity in practice approach.

- Reporting requirements are limited to transaction reports that come standard with the system developed in-house or off the shelf. There is no link to the MIS environment. The MIS is a separate function altogether with its own team (IT_SP026).
- Our processes do not consider intelligence or analytics, it is a business function. It makes an assumption that data is in the data warehouse already and MIS developers must develop reports. Other business users do not even come to IT for MIS report, it is largely manual. They come to IT requesting raw data with which create their own reports (IT_SP027).
- We have our own MIS team that is responsible for MIS development and report, IT supplies data from systems. Where reports are from IT, our team still has to add logic or certain information to make it complete (BU_SM012).

During the observations, BIA literacy levels and skills were noted as one of the reasons why the BIA function is not delivering the promised results. Some of the MIS Managers did not seem to appreciate the value and impact of what they were responsible for. Most of them were put there because they had been with the organisation for some time and had capacity to work in the MIS department. The level of MIS generated was also noted as more focused on data gathering and reporting and not creating insights.

Functionality prioritised over security during technical design. Security is paramount in any organisation. As an SOC, TFR is subject to regulatory requirements, and so the issue moves from being just a security issue to being a non-compliance issue. Yet IT is perceived, internally to IT and by business, as behaving as though security is an option. The findings point to the fact that IT prioritises system functionality over security requirements during system design and development. When the security gaps are identified during testing or post implementation, the gaps are addressed at a cost and/or business users find themselves having to do more in order to comply. At this point an opportunity to design with security requirements in mind is lost.

- Developers tend to focus on functionality as opposed to balancing functionality with security requirements as it tends to delay their development. They are chasing after deadlines and culture of enforcing security not entrenched and included in the analysis and design requirements (IT_SP008).
- Control and governance should be designed such that people are prevented from doing stupid mistakes rather than present them with an error message. It is counter-productive. Then people will not be bothered by governance (IT_SP005).
- Because IT is always under pressure with limited capacity to deliver, we tend to develop bare minimum, only cover security requirements that can easily be picked up by the audit. Basically, we pushing the quantity rather than quality (IT_SP011).

6.5.2 System Integration Organising Theme

This theme focuses on Integration of IST in support of operational processes and reporting requirements. It points to gaps in analysis and design, from the perspective of understanding process interfaces that the design needs to enable. Where integration is achieved, but with little thought and consideration, it results in a complex landscape making it difficult to deliver business value.

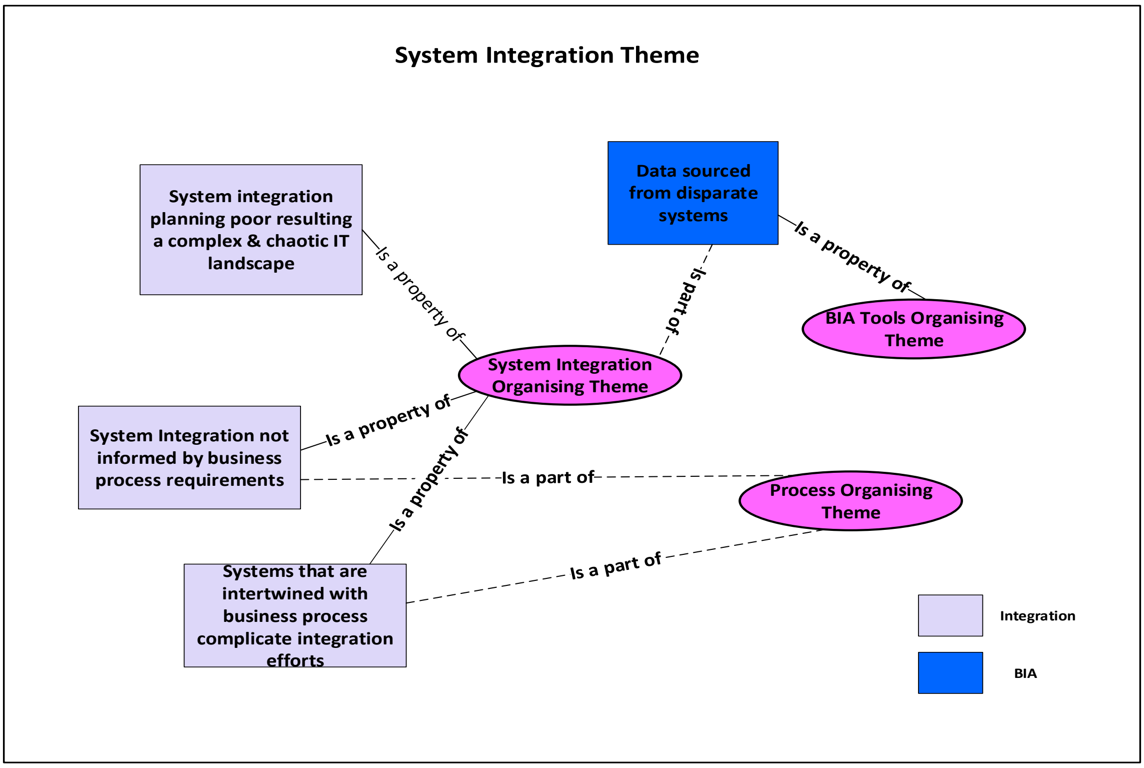

FIGURE 35: SYSTEM INTEGRATION ORGANISING THEME

At the time of conducting the research, the IT landscape was viewed by participants as being 'chaotic'. IT in their defence argued that the current landscape is reflective of the legacy of the business environment and systems that hinder progress and attainment of business goals.

The current business processes that are intertwined with IST are difficult to separate, thereby compounding the integration challenges. This complex IT landscape makes it difficult to support and enable the flow of information from one system to the next, resulting in poor BI and analytics capability. For example, TFR train station master data is encoded into descriptive train station codes. The train plan and its supporting process such as booking of train slots and allocation of train numbers have been designed around this master data. The train movement process is enforced through a train movement and monitoring system. This has introduced its own constraints in that any changes to the process have a direct impact not only on the master data and system but to systems and processes that use this master data as source, and/or integration into these systems and processes.

System integration issues means that for every new BI and analytics requirement, data has to be sourced from disparate sources of information, stored in the warehouse and a model designed to enable delivery of a report or dashboard. Below are some of the comments that were made by research participants:

- System integration planning poor, resulting in a complex and chaotic IT landscape (BU_SM009).
- Complex IT landscape due to isolated and silo approach to architecture landscape and design. Failure in rationalisation efforts due to poor planning (IT_SP007).
- System integration not informed by business processes (IT_SP017).

6.5.3 Business Intelligence and Analytics Organising Theme

The BIA theme is broad in that it touches on a number of aspects within the BIA space. It also happens to be one of the subject-matter themes. The BIA aspects ranged from data during process execution to integration constraints and all the way to how IT enables the demand for BIA at both technical capability and business value-add level.

As pointed out in the literature review, the BIA discipline issues such as the silo approach to BIA and competency, needs practitioners, product vendors and academia to come together to address them. As highlighted early in the study and supported by the empirical data, BIA value is limited without IST, and vice versa. Continuing on this tangent to deliver solutions in isolation is not taking the IS field nor the industry anywhere. The advancement in the IS field calls for radical action supported by pragmatic approaches in challenging widely accepted assumptions about the IST and BIA relationship.

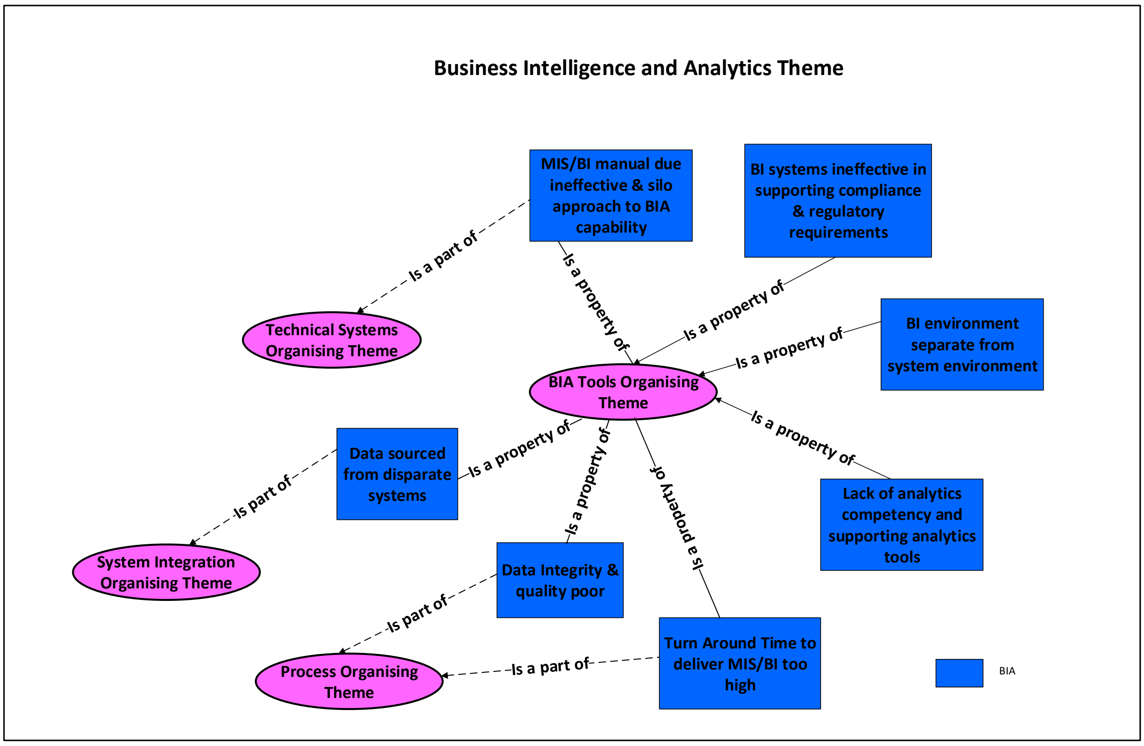

FIGURE 36: BUSINESS INTELLIGENCE AND ANALYTICS THEME

This theme speaks to the problem the study is seeking to address. Empirical evidence pointing to this problem was identified at various points of data collection. As with other themes, the BIA theme is impacted or influenced by themes in both the qualitative and technical global theme. However, for ease of presentation of data sets as well as the view that BIA capability is mostly impacted on by technical aspects of computerisation, the researcher categorised it under the technical capability development global theme. A few elements that influence or impact on the BIA theme are outlined below.

From a technical capability development global theme perspective, the following organising themes impact BIA delivery:

- Process organising theme – The impact that the analysis noted is from a perspective that processes are the means through which data is generated, as such as a source for driving data quality and integrity.
- System integration organising theme – While there is nothing wrong in sourcing of data from disparate systems, it does become a challenge when there are

integration challenges as critical systems cannot be accessed to provide data critical to ensure comprehensive and effective reporting.

- Technical organising theme – Ineffective and silo approach to MIS/BIA results in business users developing their own systems or defaulting to manual solutions that help in providing MIS/BIA that business needs to drive performance.

From a qualitative global theme perspective, the following organising themes influence the BIA output:

- Social organising theme – The level of maturity and MIS Literacy determines effectiveness of the MIS/BIA the organisations produced and the value derived from MIS/BIA investments.
- Operational organising theme – Business understanding and operational context is critical to ensure that delivery of MIS/BIA lacks perspective and contexts.
- Design organising theme – The design methodology is a method that guides how the design process ought to deliver BIA reporting requirement. The effectiveness of the design method determines the quality of the BIA output.

Analytics skills and competency, as well as the supporting analytical tools and processes, came at the top of the areas requiring focus and development. IT is investing in analytics tools that not even IT resources can use, which is creating a challenge when these tools are extended to business to utilise as IT cannot support them. Further to the support issue, IT is supposed to be at the forefront and not lagging behind business on the development of analytics capability. This is particularly important because the operating model that IT subscribes to prevents business from developing its own capability, investing in any IT capability and engaging with service providers directly without IT's involvement.

While IT has one broad landscape and BIA is supported from the IT department, the reality is that the systems and technology environment is separate from the BIA environment. This silo approach is more visible when IST are developed, as little consideration is given to reporting requirements that the system and technology need to enable. The reporting requirements are left to the data or information architecture and BI team to address. In addressing limitations caused by poor system integration, this introduces more complexity into the process. The more complex the BIA landscape becomes, it further limits opportunity for self-service by business as it requires understanding of this complex environment.

- Organisation has a lot good information but not in one system. Users end up using spreadsheet to combine information from multiple systems to make sense for a particular purpose (BU_SM012).

The strategy to introduce new capabilities has not worked and these have become white elephants and are being underutilised. The new tools assume that the IT landscape is simple and that anyone including business users can use it, only to fail because of a complex and inflexible environment. This is demonstrated by the following comment from one of the participants:

- Business Object Tool (BoBJ) [Management Information Systems (MIS) Tool] can be overwhelming. What we need to understand or try and do is what is actually the information that we need to manage our business as opposed to pointing everyone to BoBJ, a system with all the information but not structured in a meaningful, usable and useful manner (BU_SM005).

Turnaround time to deliver BIA is too long due to ineffective processes that support delivery of MIS. Currently there is still a large focus on IST development and less on BIA. The view is that business analytics is the responsibility of the business and not IT. As a result supporting solutions from process to BI tools reflects a lack of understanding of the role of IT in the provision of timely and accurate MIS. Because of the time it takes to deliver MIS, time to action between identification and sourcing of data from various systems to decision making and action is too long. This creates inefficiencies in business processes and capabilities as business cannot rely on MIS to address business issues timeously.

The increased focus on BI as a performance-management tool has meant that reliability of BIA is increasingly becoming a challenge for TFR. In response to the pressure business users are receiving from poor utilisation of IST as reporting in MIS stats or generally poor business performance, they have learned to manipulate the report outcomes. This points to gaps in the system and unintegrated processes and systems that support them.

- Business users are defaulting to manual reporting due to BIA that does not add value and tools that are not intuitive (BU_MM013)
- Data integrity continues to be a challenge and starts with lack of understanding of the value of ensuring clean data capture and reliable process that support the culture of performance based reporting (IT_SP022).

6.5.4 Process Organising Theme

Process remains at the heart of all IST and BIA endeavours. This theme is premised on the view that IST are designed and developed to support and enable business processes and that BIA is the vehicle through which performance can be enhanced.

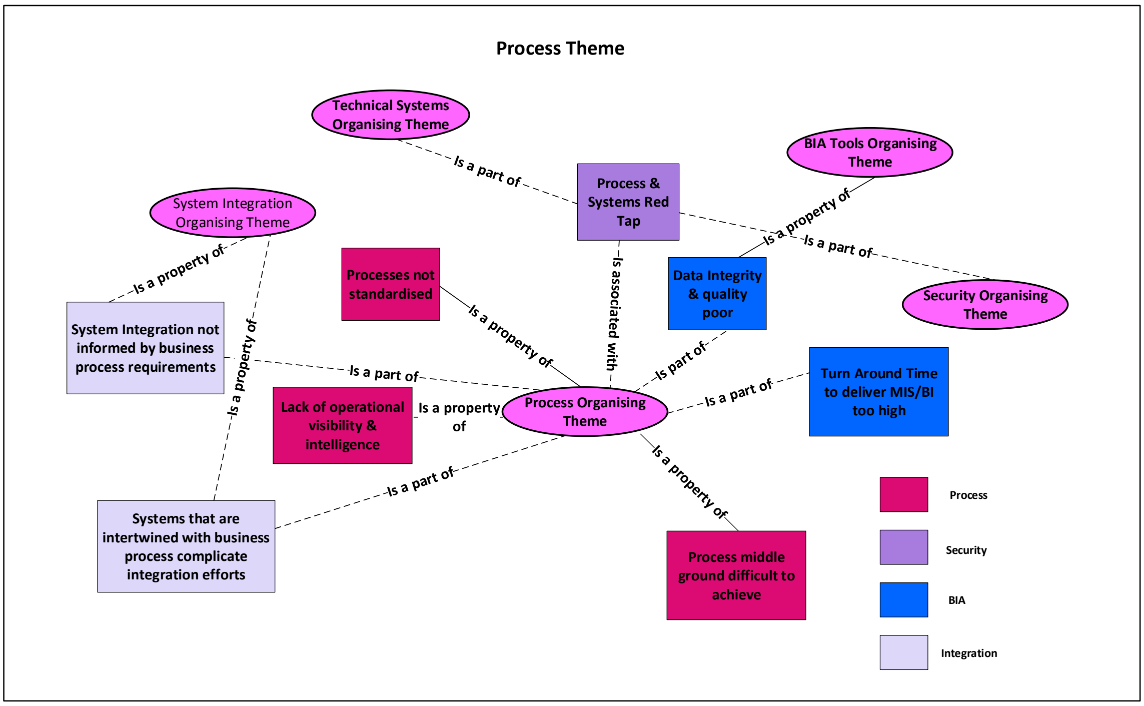

FIGURE 37: PROCESS ORGANISING THEME

The process organisation is a contentious one in that it is a source of many challenges prevailing in other themes, at both global and organising theme level. In an ideal world, it all begins with a process. IST by design are meant to support, simplify and/or optimise business processes. In the same vein, while BIA technical sources are IST in reality, the source for information is process. Data is created as part of execution or process.

Therefore, data issues can best be resolved at a process level, in that any attempts to correct or clean data outside of the process are reactive as well as costly.

The challenge that is facing TFR at a process level is the complex and dynamic environment that is difficult to pin down into a specific process or set of principles that address all variations in the operations environment. The end result is that it becomes difficult to find the middle ground when developing a system or technology. In trying to address variation in the process IST either becomes too complex or unusable, or if simplified, it does not adequately address business needs.

Over the years, systems and technology solutions have been developed to support the complex business processes. The more the system becomes entrenched, the more difficult it is to improve, as any improvement impacts directly on the processes that the system supports.

Lack of operational visibility and intelligence. Lack of standardisation and integration of business processes makes process automation difficult, and an inability to automate results in poor management and measurement of execution activities against process. This further limits the provision of intelligence on how well business processes are adhered to as well as operational performance against desired process outcomes. One of the participant's comments that reflects the challenge that finds expression under this theme is:

- Lack of standardisation and too much variation of operational processes result in requirements that are difficult to support technically (IT_SP021).

6.5 Security Organising Theme

This theme focuses on understanding the extent to which endeavours to address the business security needs support and/or hinders progress and performance.

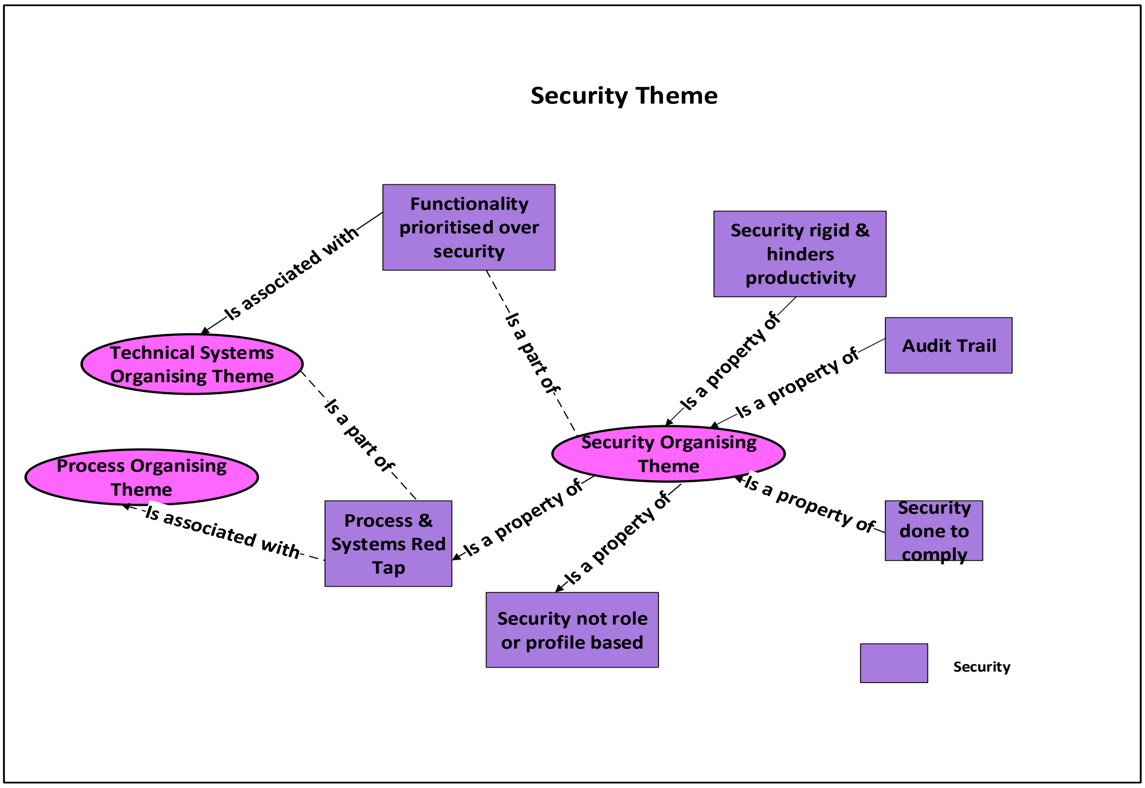

FIGURE 38: SECURITY ORGANISING THEME

The security organising theme focus was on understanding how security is viewed in TFR, considering that it is a key requirement in any organisation and is viewed even more seriously in an SOC. The general feeling was that security is critical to protect the organisation from unauthorised access as well as from poor behaviour from both internal and external forces. The comments presented below are anecdotal views of the security function in TFR and they do not need any interpretation.

- Security needs to be robust and withstand any threats, it should safeguard the information. (IT_SP008).
- Security is done to comply (IT_SP008).
- Security viewed by business users as rigid (IT_SP016).
- There is too much red tape in the system and process (BU_SM007).
- Security implementation not role or profile based, hence it is seen more as a hindrance to people performing critical business functions (IT_SP021).
- Security approach lacks in accounting for the changing roles of business users as they perform different functions at different levels of the process (IT_SP008).
- Security at IST and BIA is often an afterthought (IT_SP009).

- Efforts of re-designing the system to cater for security is more compared to what it would have taken in terms of time and cost to proactively address all security requirements (IT_SP008).

While there is appreciation and why security is important, there is also a sense of frustration both from IT an business that the function is not receiving the right level of attention that will help inform processes and standards to ensure that effective implementation, and not create a bottleneck to business users performing business functions.

6.6 Observations from the Data Collection Process

Participants in both semi-structured interviews and focus group discussions do not think of their environment or operating culture as researchers do. Concepts that others may deem common knowledge were not so commonly understood by the participants and this was across the levels and user groups (technical and business). For example, questions around work and social practices, context of IST use, impact of environmental conditions on the successful implementation of IST, organisational dynamics triggered or conflict generated by the introduction of IST all had to be elaborated upon in the context of the study.

This presented a challenge in that their responses were largely from the perspective of the novice and did not provide the depth and insight into their operational environment. Without a robust analysis methodology such as CR and context from the interview and focus groups, much context to the answers would have been lost in translation and analysis.

The sampling of the users was largely based on the participants' involvement in the implementation of IST and BIA projects for the selected period of the study, so during the introduction participants were asked to draw on their experiences of having been involved in those implementations, either as technical team or business users. Participants' prior involvement in many other implementations from a technical or user perspective, influenced their responses and the researcher needed to control and limit the discussion to the time period provided.

Other participants saw the interview and focus group discussions as an opportunity to vent and express their experience and at times dissatisfaction with IT as a department and the systems and technologies the department provides. The participants based their responses on their general experience of IT engagement, IT systems and technologies and so they spoke from the heart. In the end the researcher used a set of standard questions and used the implementation of specific projects as examples.

During the interviews and focus group discussions, participants consistently mentioned that the IST lacked in context and understanding of the different roles the users needed to perform at various levels as they performed their job functions and that security functions were constraining usability of IST. Furthermore, the participants viewed IST and BIA as being the primary capabilities of the IT department and they did not distinguish between the processes that design and govern IST development from those that govern the users. Their expectation was that the IT department should address both requirements in equal degrees and that IST should make delivery of BIA seamless.

During the observations, the researcher noted that there was misalignment between business requirements for IT support and IT prioritised activities and projects. The more observations were made, the more the researcher became sensitised to the interview and focus group discussions where business felt that IT systems and technologies lacked context as well as the fact that IT distanced itself from business once solutions were delivered. There was a strong perception that IT disappeared after implementation and the next time business would see IT was when they were back to implement yet another IT project. Participants further highlighted that instead of enhancing their functions, the technologies that were deployed created more bottlenecks and limited their creativity in coming up with workarounds on the operational challenges they were faced with.

6.7 Summary

The analysis of the results supported the inter-relationship and interdependence of themes as the themes in Layder’s framework were plotted across the levels. The themes could not be limited to a particular element or level as the basic themes belonging to same family have presence across the elements. However, in addition to the thematic network account, Layder provides new insight insofar as the degree of presence at various levels is concerned, whereby basic themes present varied from element to element. This is reflective of the type of events that impact on the social actors and activities prevalent at each level.

The retroductive logic allowed the researcher to go beyond the conventional synthesising of the results and question the assumptions and conditions under which they were produced in order to uncover the generative mechanisms

CHAPTER SEVEN

Analysis and Discussion of the Research Field Results

7.1 Introduction

This chapter focuses on the analysis and discussion of the results of the study with the aim of providing insights that contribute to the body of knowledge. CR principles played a significant part in providing unique and yet rich insight as output of the analysis process.

The section below analyses and discusses the research results against the research field framework. To ensure consistency as well as compliance to the CR principles of triangulation and multi-methods, the same data set used for the thematic analysis process was used to test for reliability and credibility of the research field framework. Additionally, the consistent use of the data sets became key in validating the results presented and the conclusions are based on sound analysis. Each of the key research framework components were analysed, namely, TFR's SDLC methodology; Layder's stratified framework with four elements (context, setting, situated and social actor); and SI design method principles (socio-technical, problem oriented, context specific, social actor, critical in nature and methodology independent) (see research field framework in Figure 13).

7.2 SDLC Methodology

The SDLC methodology employed in the case study goes to great lengths in detailing what should happen at each phase of the systems and/or technology development life cycle. Furthermore, the methodology does a good job in specifying the RACI and outlining the artefacts for each process or methodology step. However, in examining the methodology the following was noted as issues of concern:

- While the methodology was comprehensive it was not always practical to implement and lacked context.
- The timeframes within which the methodology could be applied in practice were constrained by the project timelines.

- It was a blanket approach and was not always relevant or practical.

The same methodology is used to govern the development of reports and dashboard, when the nature of BIA requirements is unique and requires a quick turnaround time and that the artefacts produced are different from the ones produced as the output of a system and technology.

Further to this discovery was that literacy levels in both IT and business analytics were concerning as they were lower than expected. IT left it to business to conduct analytics when the analytical tools and training were not provided. IT raised concerns that they were not sufficiently trained to coach business users and/or to provide support. Business analytical tools were subject to endless debate with IT executives not wanting to make a decision and invest in the tools and skills required to provide the support.

While the RACI is clear, there are no clear guidelines or step-by-step approach on how to conduct analysis and account for contextual factors. In fact, the methodology assumes that these are given as no explicit mention nor techniques are provided on how to effectively elicit or translate contextual requirements into design output. The challenge with the implied rule or discipline is that understanding is lacking of what should happen, at what stage of the process, and how varied from participant to participant. Although the more experienced and seasoned participants demonstrated understanding of the importance of accounting for contextual factors during design, they could not provide clear guidelines on how this requirement is met. The gap in the application of their knowledge can be attributed to a lack of clarity and enforcement of the methodology.

There is no specific mention of the information, business intelligence or analytics requirements in the methodology. As a result the team that drives implementation of BIA, relies on templates that are not necessarily governed by the methodology. The lack of formalisation of the BIA discipline, when the demand for reporting and dashboard is high, results in a delivery of service that is difficult to govern and improve.

Besides a lack of consideration of contextual factors and BIA requirements, the application of the methodology proved to be a challenge. It is very cumbersome and rigid, making practical implementation difficult. Lack of clear and concise process meant that in responding to timeline pressures the practitioners took shortcuts. While the shortcuts were in themselves not a challenge, the inconsistency in terms of where to take shortcuts across the practitioners meant that the implications were not understood and output varied to the extent that the practitioners themselves did not have a standard against which to measure quality.

The linear process was highlighted as a challenge as it did not allow for iterations once the design was fixed. Furthermore, the linear approach meant that the solution could only be implemented once the final IT artefact development was complete. This presented a number of challenges: (a) testing can only completed once all parts of the artefact being developed are completed, thus making it difficult to close design or development gaps until the final solution is ready for testing; (b) the evolution of the solution being developed is limited to the requirements specified and signed off as being in scope; (c) the speed of delivery is slow; and (d) access to the parts being completed successfully is also limited. This is in contrast to the current developments in the field where organisations are actively seeking to deliver on requirements quickly and do not miss opportunities available to add business value. The agile development requirements to meet the right speed of IT seem to be totally missed.

This was a source of frustration for the business users as they were not always able to highlight all their requirements in advance. This meant that a solution had to be implemented as signed off in a rigid process and methodology, and only after implementation, could changes and enhancements be introduced. While this provided structure and ensured that the scope was not changed, which would jeopardise completing development, it came at a quality cost of solutions being delivered by IT.

The SDLC methodology adopts the traditional user concept and as such was a source for many user-related gaps in the analysis process and design assumptions. As a result of the conventional view, the systems and technologies developed failed in many ways to address the multiple and varying requirements that users had as they assumed different roles or performed different functions. This challenge was compounded by the rigid approach to development and supply of reports and dashboards. The limiting view of social actors inhibited the understanding of information requirements across the network, at different levels of social organisation and varying activities users perform. This reflected on the effectiveness of the SDLC methodology as well as the level of maturity of the IT leadership, as they are supposed to drive the development of a culture of leveraging information to manage and improve business performance. A surprising observation, however, was that business users demonstrated a level of understanding and appreciation of both IST and BIA requirements better than IT did. In fact, even if IT did not adopt the concept of social actor, they could have at least been working towards aligning IT activities and methodologies to the multiple and varying requirements of the complex network that utilises IST and consumes information. Instead, they are far from it; hence the gap between IT and business will continue to widen.

7.3 Layder's Stratified Framework as a CR-based SI Analysis Method

This section illustrates as per the field research framework how Layder's (1993) stratified framework addresses the requirements for a comprehensive and in-depth analysis into any organisational environment.

Layder's framework on how to conduct research from a critical realist perspective is extended as an analysis method in practice. Its adoption into an analysis technique helps provide meaning and structure into the analysis process. The different levels of the social organisation represent how the organisation is structured and provides insight into social actor activity at different levels of operation. Their actions can therefore be better understood in relation to how the different levels legitimise or constrain social actor actions. This is a critical input into the design process of any system or technology. The researcher goes as far as arguing that Layder's stratified framework provides the first level of comfort in determining how social actors tend to act as they seek to perform their duties at different levels. His framework offers an opportunity to focus analysis at all levels of social organisation and addresses the issue cited in (Baldwin & Rice, 1997; Lamb & Kling, 2003) that user study findings do not scale up to the organisational or industry level.

7.3.1 Social Organisation and Social Actor Analysis

The research aim was to develop reliable insights into IST and how these influence the reliability and effectiveness of BIA with a view to proposing a design method that integrates them seamlessly. In analysing social actor dimensions borrowed from Lamb and Kling (2003), the researcher identified a useful link to Layder's stratified framework of social organisation and human action (Layder, 1993), which the study adopted in order to provide structure for the analysis framework. These were contrasted against each other, enabling the researcher to systematically analyse the relationship of IST and BIA. In trying to examine the characteristics for different domains in understanding the different levels of human actions, the study noted that social actor dimensions enhance understanding of social action at different levels in the social organisation element. This enabled further analysis of the BIA requirements against each social organisation element for different actor dimensions. Table 20 is a brief summary of the analysis of IST and BIA focus areas from a social actor action point of view.

TABLE 20: SOCIAL ORGANISATION, SOCIAL ACTOR ALIGNED TO IST AND BIA

Elements	Distinctive Characteristics or Features		Dimensions	Distinctive Characteristics or Features
Social Organisation	IST Perspective	BIA Perspective	Social Actor	Social Actor Perspective
Context	Context within which the social organisation exists and operates or functions, For example Developing economy context, macro social forum, economic situation, Institutions	What information is required to understand the environment or world in which the organisation operates or function? Information about external pressures that has influence over the organisation. Structured and unstructured information capabilities as	Environments	Environments exert technical and institutional pressure over organisations and its members For example, how information is generated is informed by the external requirements

		information is not generated internally. For example, regulatory or compliance information requirement.		
Setting	Immediate environment of social activity. For example, organisation, department team, including those the organisation is affiliated to, etc.	Understand the multi-level, multi-networks that need to exchange or share information Networks of relationships are shaped by the activities and actions that are performed by organisation members and evolve as the networks of relationships changes	Interactions	Informs how actors engage and interact with affiliated members. For example, rules of engagement legitimising ways of engaging or interacting and even sharing information. Between individuals in groups, among groups within an organisation, among groups and individuals performing roles in cross organisations
Situated Activity	Dynamics of engaging or interacting with others in the social organisation.	Dynamics of networks that need to exchange or share information when performing certain activities or actions. Understand the media of exchanging information in order to perform specified activities or actions on behalf of the organisation.	Affiliations	Dynamics as actors engage and interact with those whom they are affiliated with Relationships are shaped by networks of organisational affiliations These may be professional relationships that connect an organisation member to industry, national and international
Self (Social Actor)	Individual or collective entities understanding or experience of social organisation relations	Individuals or collective entities requirements for consuming information transcend roles.	Identities	How do I identify with the network in which I belong Individuals or collective entities, networks are

		Information presentation requirements aligned accordingly.		enabled and enhanced through IST and BIA.

7.3.2 Research Findings Presented Using Layder's framework as an Analysis Tool

This section presents the research results from the TFR case study, whereby the study themes are interpreted in relation to Layder's extended framework. The framework was first applied during the research fieldwork, where the data collection process was informed in part by his philosophy of thinking. This section does not only present an opportunity to test the effectiveness of the framework as a research tool but to analyse the data from the field and examine the extent to which these provide new insights and/or a different perspective to what the researcher may know already.

Figure 39 below is a matrix reflecting the different perspective to the interlinked cross-functional themes that are prevalent at various levels of the framework. The analysis exercise was approached at the basic theme level per organising theme category, hence the consistent application and use of colour per global (qualitative and technical capability development) theme. The objective was to not lose sight of the insights gained from thematic network presentation of data but to obtain a different perspective and complement the results from the thematic analysis approach. This was necessary because from a literature point of view, Layder's framework offered a promising technique in ensuring that the analysis was comprehensive having breadth and depth thereby allowing for contribution to the body of knowledge.

The colour and size of the circles represent the number of themes under each organising theme as (a) events that occur at each of the levels of social organisation elements and influence how the themes behave; (b) activities that are legitimised and/or constrained by the elements, thereby influencing their outcome; or (c) events and/or activities that relate to the element influencing each other's behaviour and/or performance.

The exercise was constrained to basic themes that are ***a property of*** and/or ***associated with*** as these ensured a clear delineation of themes per organising themes. All basic themes were accounted for using the two types of relationships with the organising themes. Figure 39 depict themes as plotted into Layder's stratified framework using the definitions articulated in Table 21.

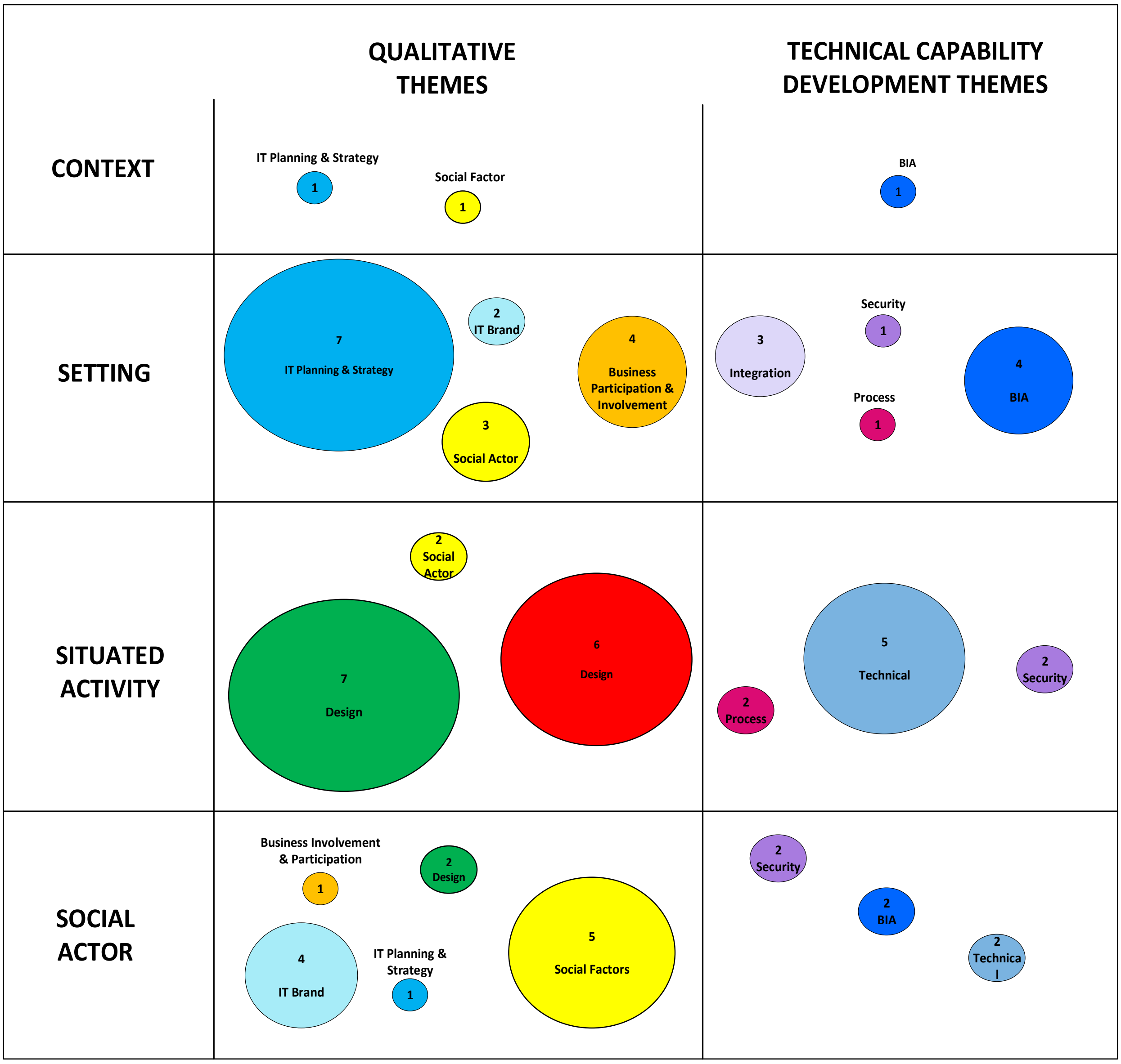

FIGURE 39: ANALYSIS RESULTS LAYERED ON LAYDER'S EXTENDED FRAMEWORK

The analysis process entailed reviewing both qualitative and technical capability development themes, where a matrix table was designed using Layder's four elements: namely; context, setting, situated activity and social actor and final themes. The analysis was conducted using basic themes as a factor of analysis. The analysis identified basic themes that are 'a property of' an organising theme indicated using a solid strand in both Figure 24 and Figure 32 as well the basic themes that influence or impact on the organising theme and identified 'as associated with' indicated using a solid strand in both Figure 24 and Figure 32. The number of basic themes occurring at each of the elements per organising theme were layered on the matrix table. The numbers were used to inform the number of times each of the activities or events prevailed at each level or for each of the four elements and these determined the size of the circles as depicted in Figure 39 above.

The matrix table summarising the number of basic themes and used to plot in Figure 39 above is presented in Table 21 below.

TABLE 21: BASIC THEMES VS LAYDER'S ELEMENTS ANALYSIS

Qualitative Themes						Technical Capability Development Themes				
	Context	Setting	Situated Acticity	Social Actor			Context	Setting	Situated Acticity	Social Actor
Social Factors	1	3	2	5		Technical Systems	–	–	5	2
IT Brand	–	2	–	4		IST and BIA	1	4	–	2
IT Planning and Strategy	1	7	–	2		Integration	–	3	–	–
Business Participation and Involvement	–	4	–	1		Process	–	1	2	–
Operational Factors	–	–	7	–		Security	–	1	2	2
Design Factors	–	–	7	2						

Figure 39 provides a different perspective to the web of interlinked cross-functional themes which depict the inter-relationship and interdependence of themes. While the stratified view of themes is based on macro and micro elements of social organisation, it supports the initial finding that no theme can exist in isolation from the other themes.

At a single glance, the researcher is able to visualise the themes that are prevalent at the different levels of social organisation as well as their varying importance as they occur.

Taking a critical realist view into the results enables the researcher and an analyst practitioner to identify the mechanisms that underlie the activities and events experienced. The varying degree of theme occurrences indicates their varying importance and influence within and in relation to the other elements at different levels of social organisation.

Furthermore, Figure 39 highlights key activities and/or events that manifest at different levels of social organisation. Understanding which of the activities prevail and the degree of their occurrence, led the researcher to identify activities and/or events that tend to prevail for each of the elements or levels of social organisation. The analysis of the results in relation to the literature points the researcher to the non-deterministic tendency finding whereby certain social activities and/or events have a tendency to occur or not to occur, and that when they do occur the degree of occurrence varies significantly. This is in line with the earlier discussion that social actors' actions and behaviour is to a large extent driven by the dimension applicable to each of the social organisation elements.

The section below goes into more details in analysing the results presented using the framework.

Context Level

At a ***qualitative context level,*** two themes were identified, namely IT planning and strategy development, and social actor.

At this level, IT planning and strategy factors are an expression of the macro level tone set by the context of the organisation which prescribes the organisational character and structure and legitimises business strategy and plans. By design IT strategy is derived from the business strategy with the view of aligning IT plans and activities to better support and enable strategic priorities. It therefore becomes crucial for any IT organisation to understand the context of operation, or else, as is the case in TFR, IT project selection and prioritisation is informed by strategy. However, IT value and impact are not felt by business. The conflicting opinions on the effectiveness of IT in enabling business strategy is a reflection of an ineffective approach in the translation of IT strategy into operational plans and activities.

The institutional bodies that govern and regulate the operational activities, define the constraints within which organisations operate. In ensuring the appropriate level of planning, control and governance, the institutions of power inform reporting requirements, format and frequency. In turn, these influence operational processes, rules of engagement and organisational structure to support business activities.

The manifestation of social factors at this level of social organisation is a reflection of the role and involvement of social actors across all levels of the organisation. This is a critical insight to understand as it has an impact on how IT enabled business organisational change is managed and implemented, and leads to failure in managing and accounting for social factors brought about by macro dynamics manifesting when IT plans are operationalised, at which point the opportunity to effectively address them and minimise their impact is lost.

Because IST and BIA are designed to support organisations through the enablement of operational processes, it is incumbent upon IT to ensure in-depth understanding of organisational context in relation to macro forces to which it is subjected. Hence it is crucial to examine the relationship and influence context factors have on IT planning and strategy development.

Unintended Consequences

The results suggest that in the pursuit of high-tier IT function, IT strategy and business plans developed overlooked the requirement to address pre-conditions inherent to an organisation's existence. IT organisation was not only out of step with the macro context that influences organisations' operational activities, but it also leads to irrelevant, inappropriate and ineffective IST and BIA solutions. Any interventions to recover and redeem credibility and realignment to pre-existing contextual predispositions often result in actor frustrations and duplication of effort and resources.

At a ***technical capability development context level***, the BIA theme is prevalent.

Because the technical capability development theme is in its very nature an enablement global theme, the occurrence of themes is an expression of the capability and development requirement. Given the activities of a context element, BIA is a key driver at this level. It is the vehicle through which transparency and visibility of how well the organisation plans and delivers on strategic priorities as well as on its obligations from a regulatory and compliance perspective.

Unintended Consequences

Despite obvious sentiment of no malicious intent, as a reflection of the misaligned IST to contextual predispositions, BIA are ineffective.

Setting

The setting element is at the heart of the macro level activities, in that it puts into perspective the context of operation for the organisation. Macro level defines the constraints within which organisational activities can be achieved at various levels of social organisation. Without a clear and thorough understanding of context, organisational alignment on why the organisation exists, clearly defined strategic goals, and how it plans to achieve these, the organisation's drive is weakened. The weakness in the organisation's systems and engines translate into misdirected efforts, energies, lack of directed leadership and ultimately the results reflect 'reality'.

The setting elements set the contextual, social and environmental context that IT needs to be responsive to when designing BIA-centric IST. Hence it is a glue between macro and micro elements (situated activity and actor actions).

As depicted in Figure 39 above, for both qualitative and technical capability development global themes, the setting elements have the most representation of organising themes than any other element. This clearly points to the need for in-depth analysis of how an organisation's specific setting influences the operational environment.

Qualitative themes – The dominance of the IT planning and strategy theme, followed by an equal degree of business participation and involvement in IT activities, social factors and IT brand prevalence, points to the strategic nature of this element in facilitating macro and micro activities alignment. The influence that these have on each other is an issue that IT has to understand if it is to be effective in providing enabling systems and technologies.

At the setting level, alignment of IT and business roadmaps is crucial, with planning being a big part of it. Furthermore, IT cannot develop effective plans in isolation from business partners. Business participation and engagement encourages collaboration and buy-in. The plans, methodologies and implementation strategies that IT adopts determine the degree of success achieved, in that, if these are not appropriately aligned to business requirements, social actors express their dissatisfaction through limited use of IST and BIA, lack of ownership, accountability and consequence management. Where these are experienced, return of IT investments is low and benefits are not realised. This does not serve well for the IT brand and initiatives aimed at reducing total cost of ownership as these are driven from healthy engagement with business and buy-in.

Unintended Consequences

The two limiting factors towards the single vision IT organisational integration are that IT innovative developments do not always match business goals and there is no strategic engagement/alignment and ownership of IST from business resulting in IT planning that does not permeate through and reflect business requirements. The unintended consequence is the entrenchment of a culture that does not embrace IT and further translates into poor IT branding and discipline towards use of IST.

Equally observable in the ***technical capability development theme*** is the high prevalence of themes compared to the other elements. The BIA themes have a primary degree of importance, while the integration and security themes share a secondary level. In keeping with the role of the setting element in translating strategic objectives into operational plans, transparency of activities and visibility of performance becomes a key enabler of the element.

In translating the operational plans and ensuring effective implementation, IT landscape, IT product life cycle and methodologies have to be formalised at this level, otherwise their effectiveness and sustainability at an operational level are compromised. This informs the context diagram for the flow of information across different functions and the integration requirements in facilitating secure and role profile-based delivery of relevant, reliable and timely intelligence and insight enabling business to act on decisions taken.

Unintended Consequences

Without proper engagement prior to investment in IST, the solutions provided by IT lack the competence, flexibility and desired impact by business and where adopted, business adopts an attitude that is limited to compliance, and so the opportunity to transform both IT and the business landscape is lost as the two operate from different paradigms.

Situated Activity Level

Due to its operational nature, situated activity is a micro element. Its focus is on understanding the dynamics and nuances as business activities are carried out in its areas of operation. It recognises the need to zoom in and focus on the context of operation. While business processes are defined at a setting level, the actual execution of processes and/or activities are carried out in operational business areas with varying dynamics and conditions, calling for an understanding of how these differ from the standards set out at an organisational setting level. The openness and realistic approach in running business is crucial if consequences of use are to be managed effectively. Depending on the area of activity, systems and technologies may have varying effects and as a consequence result in varying results. Hence a critical realist approach is effective in understanding the impact of the structure and order of activities in producing different results when they meet. Where the mechanisms and structures exist but are not enacted, critical realist are able to account for the inactive causal powers resulting in the lack of activity and events. For both the qualitative and technical capability development themes, the degree of themes prevalence is higher than anywhere in the framework. This reflects that although strategies, plans and methodologies are defined and designed at a setting level as informed by context, their implementation and effectiveness can only be realised where business activity takes place.

From a ***qualitative themes*** perspective, operations and design are the dominant themes. The dominance of the two themes is a reflection of the fact that IST design methodology effectiveness in enhancing understanding and consideration of operational factors when systems and technologies are designed, determines the relevance of IST in delivering on their intended functions. In keeping with this argument, it is reasonable to conclude that when IST are not effective, BIA solutions will produce limited value. BIA effectiveness in delivering results depends on the effectiveness of IST to support business and production of relevant, reliable data, and reducing decision-action latency.

Unintended consequences

The implementation and enhancements of IST do not take into account the local requirements, dynamics, nuances and pre-existing environmental conditions that may impact on their seamless implementation and long-term sustainability.

The ***technical capability development themes*** support the qualitative view in that the focus is on ensuring readiness in all impacted operational areas. It highlights that infrastructure and network availability and performance should be the same regardless of operational area, placing emphasis on assessment of the accessibility and reliability of systems and technology performance in remote areas. This objective can only be achieved if the element of situated activity is adequately addressed and actions are put in place to deliver the same experience regardless of where in the area of operation is the social actor.

Unintended Consequences

Design undermines other elements that expose IST to circumstances that render them ineffective, vulnerable and out of context, which suggests poor planning and acknowledgement of each environmental landscape variation.

Social Actor Level

The social actor level presents unique dynamics in that social actor action spans all elements of social organisation with varying degrees of importance due to the differing requirements that social actors have at multiple levels of operation as they carry out different functions. This is illustrated in the size of the circles that reflect the level of influence social factors have and the complexity of the social systems and structures that trigger the varying events and activities at each level of social organisation.

The degree of importance for social factors and IT brand prevalence is higher for the ***qualitative global theme*** than anywhere else in the method. This is largely due to the qualitative, non-technical and interrelatedness nature of the social actor element. IT brand is a social commodity, and as a result it is not surprising that actors' perception and attitude towards IT translates into how they behave towards IST and BIA. How actors experience systems and technologies influences how they perceive the function responsible for designing and developing them. It then follows that where IST and BIA are experienced positively and are perceived to be adding value in social actors' work life, the IT brand will be healthy and where they are not the opposite will be true.

Unintended Consequences

A top-down approach in the implementation of IST undermines the actor level of knowledge base, preparedness, openness and capabilities rendering them unsustainable and ineffective. In turn, this fuels apathy and resistance to IT and management innovations and cements prejudiced sentiments regarding IT brand.

In the ***technical capability development theme***, as systems and technologies influence the quality and effectiveness of BIA function, actors are concerning themselves with how security enables or hinders their performance. The challenge that the IT department faces is balancing and aligning security requirements with the varying, multi-layered actor requirements as they assume different roles during operation. Although actors appreciate the requirements for securing access to organisation's systems and information, the requirement to be productive at all times presents IT with pressure to identify innovative ways of designing systems and technologies that are reflective of actors' day-to-day reality and expectations without compromising security. It therefore becomes critical for IT to invest time and effort upfront in understanding these complex and competing requirements.

Unintended Consequences

IT tools are seen as rigid and the lack of focus on training and development minimises proper exploitation of the best of breed capabilities and is threatening to actors' jobs.

7.3.3 Global Theme Analysis against Layder's Stratified Elements

This section presents the analysis of the two global themes, qualitative and technical capability development themes, that has been conducted against Layder's stratified elements with the view of assessing the elements for consideration for each of the proposed design themes. The analysis is categorised into two global themes, with the former having six and the latter having five basic themes. These analysis outcome is discussed Table 22 and Table 23 below.

Qualitative Themes

The global qualitative theme is a grouping of themes that are qualitative, non-technical and intangible in nature. Although these are logically organised, the web of interlinked cross-functional themes is amplified by the thread that links them across different levels of social organisation. Table 22 provides a brief description of six qualitative organising themes.

TABLE 22: QUALITATIVE THEMES LINKED TO SOCIAL ORGANISATION ELEMENTS

Theme	Description	Social Organisation Level Application
Social	This theme addresses the social aspects of computerisation. Because social activity spans across all levels of the social organisation, social dynamics manifest at all levels with varying degree of importance and perspectives. Understanding how the different dynamics manifest becomes crucial when analysing requirements for both IST and BIA. The analysis	Context Setting Activity Actor

Theme	Description	Social Organisation Level Application
	outcome better informs design and enhances relevance, effectiveness and applicability, thus reducing the undesired and unintended consequences of use.	
IT Brand	This theme mirrors how social actors perceive IT department as well as how the systems and technology artefacts delivered by IT make them feel. The artefacts that IT produces and the experience these create for the social actors inform how they feel towards IT department, their attitude towards IST and BIA and ultimately how they behave in response to both IT department and systems and technology artefacts.	Setting Actor
IT Planning and Strategy	The health state of any organisation can be measured from the performance of this theme. This theme captures the effectiveness of the organisation in addressing the context in which it exists and how that translates into the organisation's structure, strategic objectives and enablement thereof. An organisation that fails to articulate this and / or put pressure on the supporting functions such as IT shall suffer in consequence. This macro perspective of the organisation sets the tone for the rest of the IT activities and consequently how these are implemented. How IT plans its activities determines delivery strategies, product and service quality.	Context Setting Actor
Business Participation and Involvement	This theme puts emphasis on the social actor participation and involvement in the design and development of appropriate, useful and usable systems. Business involvement encourages ownership and accountability. When such is present, consequence management is effective as business sees benefits realisation as their responsibility.	Setting Actor
Operational Factors	An organisation's existence is intertwined with its context and as such operational factors inherent to it need to be addressed in one form or the other.	Activity

Theme	Description	Social Organisation Level Application
	This theme describes how IT design and development processes assesses and consider operational factors which have a potential impact or influence on IST and BIA performance and effectiveness.	
Design	This theme addresses the practice and art of designing IST and BIA as enabled by the design methodology that the organisation subscribe to. The focus is on design principles and process that designers abide by as they design IST and BIA. It is against these principles and process that performance and effectiveness of the designs can be measured.	Setting Activity

Technical Capability Development Theme

This is an organisation of themes that are not only technical in nature but are interrelated and interdependent in function and behaviour. They influence each other at a level deeper than their relationship to the qualitative themes. Furthermore, their application and prevalence at the different levels of social organisation is largely from an enablement of technical capability from a social organisation than social action, hence its technical, quantitative and tangible nature. Table 23 provides a brief description of five technical capability and development organising themes.

TABLE 23: TECHNICAL CAPABILITY DEVELOPMENT THEMES LINKED TO SOCIAL ORGANISATION ELEMENTS

Theme	Description	Social Organisation Level Application
Technical	This theme is fundamental to all themes addressed as it is the foundation for IST and BIA solutions. It is complemented by the tools and capabilities required to translate the designed capability to business enabling systems and / or technology artefacts.	Activity Actor

Theme	Description	Social Organisation Level Application
	Furthermore, technical requirements are matched to the needs of the organisation, where scalability & reliability of the architecture, infrastructure and network delivery are crucial.	
Integration	This theme addresses system and technology integration requirements with a view of enhancing process interface and cross-functional performance reporting requirements. It is more applicable to the setting level as integration need to be achieved at an organisational level if it is to be effective in supporting the operational activities from multiple perspectives.	Setting
Process	This theme focuses on how organisational processes and structure are enabled and supported by technology. Process variations and nuances as per operational activity area are addressed in view of the overall organisational setting process requirements. This theme is premised on the notion that while areas of operations present unique dynamics, there is an acceptable degree of standardisation that is necessary and achievable. This ensures that sound governance and adherence to key and standard business principles is achieved.	Setting Activity
Business Intelligence & Analytics	This theme addresses the technical, technology and process aspect of BIA, without which BIA delivery will be limited. These are generally determined at organisational context level and executed at micro level; hence the context element is identified as its driver.	Context Setting Social
Security	This theme describes the IT security requirements that IT design methodology needs to account for and/or be sensitised to. It provides a perspective from which security enables or constrains operational activities and provides guidance as to how to effectively address IT security requirements when designing and developing IST and BIA solutions.	Setting Activity Actor

7.4 SI Principles

The following matrix was used to examine the extent to which the SDLC applied the SI principles, either directly or indirectly. The researcher was mindful of the possibility that terminology in use may have been different to that used by SI. What was critical was understanding the principles in use and trying to match them to the standard SI principles.

TABLE 24: SOCIAL INFORMATICS PRINCIPLES

SOCIAL INFORMATICS PRINCIPLES APPLICATION BY THE SDLC METHODOLOGY				
#	**Social Informatics Principles**	**Full Application**	**Partial Application**	**Limited Application**
1.	Socio - Technical		√	
2.	Problem Orientated	√		
3.	Context Sensitive		√	
4.	Critical in nature		√	
5.	Social Actor			√
6.	Methodological Independent			√

The above matrix points to the gaps in the SDLC, either explicit or implicit, direct or indirect, accounting for SI principles when developing IST and BIA at TFR. During the assessment of the SDLC methodology through interview discussions and documentary reviews, it was evident that there was a significant focus on solving business problems using systems and technology solutions, hence the 'full application principle' under the 'problem oriented' category.

Socio-technical, context-sensitive and critical orientation principles were partially addressed. Depending on who the researcher interviewed or who the author of the document reviewed was, different levels of focus and attention to detail were identified. There was implied understanding of the principles, but practical or physical evidence was found lacking. It did not help that as detailed as the SDLC methodology was, there was no explicit mention of this requirement which meant that there were no control mechanisms in place to assist with the assessment of the quality of the artefacts produced. This is further confirmed by the operational factors organising theme and design organising theme that have a number of basic themes pointing to their gap in consideration for context and environmental factors.

Social actor and methodology-independent principles were limited in the sense that they were less than partially addressed or discussed. While the issue of multiple roles which the employees assumed at different times came up, it was from a security point view. The requirement was to ensure that security was role or profile based to enable optimal utilisation of the systems. It was not from the perspective of ensuring in-depth understanding of the functions to facilitate design of systems and technologies that improved work functions and/or facilitated the exchange of information to various actors in the network they interact and/or are affiliated with.

The state of the BIA function was concerning for an organisation with such obvious demand for analytical intelligence capabilities. This goes beyond the issue of not having a methodology that adequately addresses BIA requirements. It is matter of principle and understanding of BIA discipline by IT leadership. Thus no effort was ever made to formalise it beyond the data warehousing function. The discussion that was said to be taking place around the function improvement was driven largely from business and not because IT strategy and vision was intended to match the demand. In fact comments were made regarding IT hindering progress by controlling access to the business data via the data warehousing function, yet nothing was forthcoming in terms of enabling intelligence and analytical capability development. What the IT executives were missing is that until such time as BIA is treated as an official discipline that is interdependent with IST, the value of IT investments will continue to be elusive at TFR.

7.5 The Configurational Nature of Information Systems and Technologies and BI Resulting in Different Outcomes

In the IS field, system and technologies are the artefact of a combination of components that are highly configurable in nature. Literature was validated by empirical research results in the following manner:

Example 1: Same system and context with different configuration

The same system and technology components, but with different configurations, resulted in a solution that had different impacts on the same actors and/or environment.

To support the heavy hand-held devices that the IT had implemented as a solution to improve the quality of employee work life in the yard environment, the solution that was deployed had different impact on females than on their male counterparts.

Generative mechanisms underlying this event

There was poor analysis and consideration of the needs of the actors for whom the solution was designed.

The solution was rushed into design without ensuring social actor participation in the solution being proposed and obtaining feedback before firming up the design and going to production.

Example 2: Same system and configuration in different context

The same system and technology components configured in the same way but in a different context, setting and situation of use may trigger different responses or the net effect may be different, where the same outcome may be experienced differently and/or perceived differently by different actors.

A hand-held device was designed to automate the process of building the train. The same technology with the same configuration which had worked elsewhere, failed to deliver results when implemented in TFR. Technology failure was attributed to the poor analysis of the environment under which technology needed to function, data coverage upon which the technology depended to function was never tested. It was assumed that because the signal strength for data in urban areas was good, it would perform in the same manner in remote areas. When the technology failed to perform, the initial assumption was that business users were resisting the change. When change management efforts failed to deliver results, only then was management prepared to investigate further. The issue was poor coverage and ergonomics of the technology solution. Solutions to the issue fell outside the scope of the project, presenting the project team with challenges. The service provider on whom the solution fell, did not have the justification to invest in remote areas only for TFR. When agreement was eventually reached, the service provider had other priorities and so it took longer for the problem to be resolved.

Generative mechanisms and structures underlying the failed IT event:

Due to poor consultation and limited site visits and live system testing during the POC, the IT project team made an assumption about the signal strength in rural/remote areas. Further assumptions made were that the service provider was at their disposal should they experience challenges with the solution. Service level agreements (SLAs) did not address issues of technology success being dependent on the functioning of the telecommunications solution.

For a project implementation that spans geographical boundaries, live and scenario testing is not only crucial but mandatory. It saves organisations from making huge technical assumptions and affords them an opportunity to use the test results to negotiate better SLAs from service providers.

Example 3: Same System, Configuration and Context

The same components configured in the same manner for the same context, setting and situation of use but different actors may trigger different responses or the net effect may be different due to perception and experiences of the actors impacted by the technology. In such a case, analysis and in-depth understanding of the actors' attitudes, values and norms, and group power may go a long way in influencing the perceived value or non-value of an IST or BI, and consequently the response to it.

A TDU solution was designed to create a link between the locomotive and the train, uniquely defining the train for tracing and tracking purposes. The function of the solution depended on the train crew capturing the train number on the TDU in locomotives. This level of dependency put train crew at the heart of the solution, so that effectiveness and value realisation was directly linked to train crew behaviour.

In designing a solution that has this level of dependency on the social actor, organisations need to consider profile, culture and discipline and use these to ensure that the social actor had limited leeway or power to make or break the solution. Where such cannot be achieved, it is important to align and understand what the social actors stand to lose and to what lengths they would go to protect what they stood to lose. For example, in case of the TDU solution, social actors stood to lose overtime pay as the systems enabled the organisation to plan their roster efficiently and minimise hours accumulated outside of the scheduled train transit time. In a situation like this it is important to negotiate in advance this level of understanding and agree on what the organisation is willing to give up in order to gain. In this case what is the cost to the organisation if the solution is not implemented, or is implemented but fails?

Generative mechanisms and structures underpinning the resistance of the solution:

The technology tracked the speed the drivers were doing per kilometre and estimated time of arrival of train. Because this information could stand up in court when an accident occurred and train crew could be found guilty of speeding, it was resisted.

Secondly, the ability to record actual productive time and automated time of departure and arrival of trains, challenged train crew claims to overtime. Train crew had been accustomed to overtime and their lifestyle revolved around it. They rallied together and silently resisted the technology.

Failing to reduce the dependency on train crew, the next best option was to design the solution around their profile. Neither was done, resulting in a stalemate because the train crew resisted the technology and management had no alternative since the technology was designed around the train crew.

7.6 Summary

The adoption of CR principles proved to be invaluable in ensuring depth and breadth in the analysis of research study results. Practitioners adopting the method are encouraged to extend the process of enquiry to examine how the context within which the organisation exists and its operational activities influences the degree of occurrence of these themes. This will indicate the level of importance and influence each activity and/or event has within and in relation to the rest of the activities across the method. The web of interlinked activities needs to be embraced as these inform the measures that can be put in place to minimise unintended consequences and to capitalise on the enabling capabilities. As the organisation matures and understands the environment more intimately, the level of planning, governance and control will improve.

CHAPTER EIGHT

Research Conclusions

8.1 Introduction

This chapter draws a number of conclusions and proposes recommendations based on the empirical results.

The chapter begins with an overview of the study objectives followed by discussion, after which the conclusions relating to the research objectives are presented. These are followed by the recommendations and introduction to the CR-SI Integrative Design Method, a method that the research proposes to address the current gaps in the information systems field and help advance development of knowledge in the digital era characterised by rapid and disruptive trends, leaving not much time for the scholars and practitioners to advance the field of IS design science.

The aim of the study was to examine the extent to which an SI perspective can be reconceptualised as a multidisciplinary study of IST and BIA design underpinned by a CR theoretical paradigm.

The sub-objectives of this study were:

a. To extend the SI perspective to consider information BIA requirements when designing ISTs that are BI centric.
b. To examine the ways in which a CR paradigm addresses SI theoretical foundational constraints.
c. To identify key design principles and activities that are required to ensure sustainability of IST and BI design knowledge through design research.

Critical realism is rapidly emerging as a viable paradigmatic alternative for conducting information systems research that is well suited for developing causal explanations of complex phenomena. Although CR is not method specific, this study focused on case study research as it is particularly well suited for CR-based efforts to develop explicit causal explanations of the complex social and open systems organisational and interorganisational phenomena encompassing the IS field (Wynn & Williams, 2012). This study has synthesised the very deep, complex, diverse, and in certain ways underdeveloped literature in order to enhance understanding of the theories involved to effectively address the research problem. The process entailed examining the profile of complex social actors and open-system organisational environment of the case study as these introduce many structural entities and contextual factors that influence the events of study. Some of the events identified were directly observable and others not. Critical realism method principles were a catalyst in theorising about the causes behind the series of events that were identified. By employing thematic analysis and a network process, the researcher was able to decompose the relevant structures into their constituent parts, enabling examination of the relationships between themes.

Analysis of the relationship between themes was a complex process since the themes were reflective of the events and experiences that are intertwined and not easy to dissect. What was evident during the interpretation and analysis of the research results was that events could not be easily identified and isolated. The event frames included a specific project, an information system artefact, a decision point or a meeting. When on the other hand, experiences were difficult to point to a specific event, time or place or even a project and they often overlapped between similar events and or different types of events. To enhance the process of enquiry, the researcher adapted questions from Sayer (1992) which proved to have been useful in analysing the events and their associated experiences: (a) What does the existence of this event mean in this context for the research question or overall study? (b) Can it exist on its own? (c) If not, what else must be present to give effect to it or for it to be experienced in the manner that it did? (d) Can the researcher identify the structures or mechanism and underlie such events? (e) What is it about the structures or mechanisms that give effect to it, for it to manifest in the way it did?

Another key discovery was that the perceived relationship between events and experiences can change over time as related events unfold and are explored. This process is highly iterative in nature in that as the researcher theorised that a certain event must have occurred and looked for supporting evidence to explain the claim that was possible, additional events that needed further explanation were identified. To manage the process, it became necessary to understand the significance of the additional events to inform a decision to analyse or not, else the process was going to be unending iteration of events and sub-events. Hence the decision was to keep the assessment at a global theme level using the organising themes and at organising theme level using basic themes. The potential causal linkages between the structure and events could be derived, informing the relationship-based outcome of the themes.

The outcome of the themes informed the development of a CR-SI based integrative design method. To deliver on the requirements for operationalisation of the CR-SI design method, the researcher developed a set of methodological principles to guide the implementation and enhance practice relevance and benefit. The principles capture the essence of what is needed to ensure that the CR-SI design method is effective in ensuring the right level of implementation and that the environment in which they are adopted is enabling. This does not outline specific procedural requirements to be followed. The specific approach should vary based on the circumstances of each project and the objectives of the understanding.

8.2 Conclusion on the Theoretical Elements Addressing the Study Objectives

This section summarises how the research study delivered on this study objective and sub-objectives outlined above. Over and above the interpretation and analysis of the research results and findings discussed in Chapters 6 and 7, empirical data proved the relevance and appropriateness of the theories (SI underpinned by CR and design thinking philosophy) that were adopted by the research study. It suffices then to argue that key elements identified through analysis of the field data to drive the adoption of the CR-SI integrative design method, will facilitate the evolution of classical SI perspective to an integrative approach relevant and appropriate for the digital era of the information systems field. The following are key elements that need to be addressed for the CR-SI integrative design method to be effective.

8.2.1 Independent Approach to the Development of IST and BIA capability

The qualitative and technical capability development global themes point to the fact that the independent approach to the development of IST and BIA capability is not working and is not beneficial to the organisation. As with other themes, the conventional approaches to BIA fail to address the full potential of IST. At a technical level, BIA is largely impacted by integration of systems and processes, which is a function of architecture planning and design, a key activity of the setting. At a qualitative analysis level, the quality of BIA design is influenced by operational business participation and involvement and social aspects of computerisation. It therefore follows that BIA cannot be effectively addressed as an isolated IS design challenge but as part of the IST design. ISTs can only truly deliver value when they enable delivery of relevant, good quality and timely data with which to drive the BIA, a function of creating and delivering analytics and business insight to business. It is therefore imperative to ensure that IST design methodology effectively accounts for aspects of the design that deliver on BIA requirements.

8.2.2 IST and BIA Methodology and Literacy Concerns

Over and above the obvious silo approach to IST and BIA development, the researcher did not anticipate the low levels of literacy on BIA function discovered during data collection. The overwhelming empirical evidence in that regard points to the fact that the low literacy levels and a lack of appreciation of value of the BIA role in business were not only prevalent at operational level but across all levels.

The increasing demand for BIA function is not matched by both IT and business plans for capacity creation and competency development. Until BIA is viewed as a critical enabler of business and measures are put in place to ensure that both capability and capacity are built to deliver the function effectively, not only is the literacy level going to be disappointing but IST value is not going to be fully realised. This is an organisational challenge in that, as much as IT needs to take the lead in delivering solutions that are appropriate, business has a responsibility to ensure that social actors whose role it is to create impactful insights are adequately trained and that social actors that consume such insight have the capability to do so effectively, otherwise the organisation is not going to win the decision-action latency battle.

Social actor application of cognitive knowledge coupled with understanding of business process interfaces to anticipate the impact of one function to the other as well as the appreciation of how business outcomes in one function determine the overall performance of the BIA function. Failure to connect the critical dots as the social actor used MIS/BIA reports came out repeatedly during the observations and was not isolated to a specific area of business or function.

8.2.3 Varying Perceptions of IST and BIA role

The perceptions of IST and BIA roles emerged repeatedly during the data collection process. Operational staff have a different perception to management, often referred to as ‘head office people’ during the discussions. To operational staff, IT staff and management are the same and they share the same vision, yet they do not understand operations enough to give them authority to make decisions that impact on the operational environment. While there may have been an understanding among the leadership of the perceptions that exist in the organisation, appreciation of what the perceptions really involve and understanding of the perceptions’ foundation meant that little was being done to manage or minimise the social impact that the perception had on the organisation’s plans and strategies.

Head office staff world view

- IST is about transparency, visibility and management of the operations execution environment.
- Technologies are deployed to create operational efficiencies.
- Management want standards and bring control.

Operations staff world view

Operations staff generally view technology as an unnecessary expense designed to micro-manage them when they are those doing the real job.

To the operations staff, the technologies are not adding any value but create bureaucracy for management to interfere with processes and dynamics which they do not understand. Operations staff want flexibility to respond to the situated activity.

Operations technologies do not give meaning or enhance work duties nor work life. They are about automation of processes of collecting information so that head office staff can have information with which to manage operations.

Operations staff view IST and MIS as a selfish act by management, introduced at the expense of improvement of work-life balance and ergonomics.

Focus in design is more about what managers want out of technology, visibility, transparency and data, when what users want is true job enhancements.

Some of the comments from the research fieldwork include:

- What is the real value add of these technologies, we are moving volumes, trying to meet operational target and will do whatever it takes to do so (BU_MM012).
- We can see through these things, none of these technologies are designed for us but for managers to micro manage operations while sitting in big and fancy offices in head office (BU_JM017).

8.2.4 Other Remarks

IT goes beyond technical capability and functionality of the systems. IT is about people in context, setting and actual work to be performed at a particular time. Lamb and Kling (2003, p. 198) concur that 'social actors are the active agent in information system use'.

IST design has more to do with the people for whom the solution is designed, than the competence of the designer in capturing the context, setting and work to be performed, translating it into a configurational object/artefact.

In analysing IT impact, effectiveness, consequences of use and reactions to IST deployed, there is no single account that is applicable to multiple technologies or the same technologies in different contexts, settings and uses. However, analysis conducted using CR-SI method creates deeper understanding of the operational activities and the structures and mechanisms underpin them, thus facilitating identification of non-deterministic tendencies required to inform the design process. The explanatory power of the philosophy of thinking offered by CR-based methodology results in some degree of generalisability into similar contexts and/or environments for social actors that share the same profile.

It seeks not for a blanket approach but for an analysis approach that will assist in understanding of the environment, context, setting and actual work function to be performed and users the solutions are targeted for. In that way they get closer to designing solutions that actually work for the people that they are intended for.

True value of IT will be realised once the IT discipline conquers social aspects of computing. Until then IT value will continue to escape the IS community. There is a need to integrate social science-related skills (such as sociology, psychology, cultural anthropology, social communications and the analysis of networks of people, not machines) with technical skills, engineering, development and computer science.

In an era where organisational change is driven largely from IT enablement, IT is moving out of the back office and into the front office, and aligning business and IT strategies is becoming a critical enterprise success factor.

Lamb and Kling (2003) highlight that IS field studies frequently show that projections made in laboratory contexts do not accurately predict IS use in practice. In support of this view, Agarwal (1999) argues that technical capability is a necessary but not sufficient condition for their effective use. Analysis of factors that influence IS implementation (Vithanage & Wijayanayake, 2007) help the organisations to design IST and BIA that are fit for purpose, preventing organisational effort and investment being wasted unexpectedly.

8.3 Conclusion on the Reconceptualisation of the Theoretical Paradigm

The study's theoretical paradigm was reconceptualised from interpretivism to CR in order to enhance the effectiveness of the SI perspective in addressing the research study problem. The researcher contends that this move was necessary if the study was to be able to address the implementation gaps that came about because of SI's theoretical underpinning, namely interpretivism.

That SI is underpinned by the interpretivist paradigm is in itself not a problem. What introduces the challenge is that the study extends SI beyond its traditional focus of studying IST design, uses and consequences in context to inform the design of IST and BIA. While the objective was to utilise the knowledge gained from the research study to improve practice relevance, the theoretical underpinnings of SI introduced a number of inconsistencies. These ranged from the gap between theory and practice, to the gap between research method and application of principles. Effectively, ignoring this emergent finding of the research would have equated to giving up the practice of science.

Reconceptualisation of the SI paradigm promotes the goal of using research results and prior learning to extend our understanding of the world. The study has argued extensively against the Humean notion of causality. Therefore the researcher contends that in a complex, multidisciplinary and open system such as IS, arguing for constant deterministic conjunction of events may cripple the discipline. On the other hand, the interpretivist denial of the existence of causal powers prevents the generalisation of findings from scientific enquiry, thus limiting the use of the research results. CR offers a healthy balance: It is able to distinguish between contingent and necessary causal factors, thus making it effective in addressing theory-practice inconsistencies. The study demonstrated how this is achieved by adopting the notion of non-deterministic tendencies and softened account of causal powers in contexts that are relevant. This is further achieved through consideration of alternative explanations by assessing the event from multiple perspectives; assessing how it is that when the event is observable it is experienced the way that it is, and/or when not observable, why this is the case when the event indeed did occur. This is the strength of the CR paradigm and these explanations would not have been possible had the alternative paradigm of interpretivism been employed. CR assisted the researcher in arriving at the alternatives with the most plausible explanation after the pattern in which the event occurred, the order in which the event manifested and the effects it had were considered.

8.3.1 Social Informatics and Critical Realism Principles

CR challenges the assumptions upon which SI principles are based. The change in the ontological premise compelled the researcher to revisit the application of each of the SI principles during the course of the study. This process ensured that the research study questions were carefully constructed, and assessment of the documents was informed by well-balanced assumptions which also informed how the observations were conducted. This was a significant step forward in the process of enquiry as CR principles were employed on solid research findings.

CR principles were fundamental in guiding the application of CR as a research method, thereby offering the study the opportunity to embrace both interpretivist and positivist characteristics of the research. The CR principles extended relevant elements of SI and discarded those that constrained its extension as an integrative design method for IST and BIA. This offered the researcher new lenses from which to interpret the findings and draw the conclusions from the results. For example, identification of the web of an interlinked network of themes deepened the analysis and affirmed the effectiveness of CR principles in unearthing relationships and linkages that would otherwise not have been feasible had the researcher employed a purely interpretivist enquiry, and the development of the integrative SI-CR-based design method would not have been possible. Interpretivist enquiry would have been concerned with the understanding of 'what' is the event and consequences of the event in context and 'how' the events or consequence occurred. CR on the other hand went beyond the understanding of 'what' is to examine 'how' it is that the event is taking place and for 'whom' and under 'what' circumstances, thus better understanding the mechanisms that trigger the event to happen. Understanding of the consequences after such a process is deeply enhanced and adds meaning to the study under enquiry.

This account of process demonstrates that all the steps in this research journey were interconnected, in that the output of one process determined the relevance and the effectiveness of the next step or activity in the research journey. For example, reconceptualisation of the SI theoretical philosophy resulted in the adoption of CR as both the research paradigm and research method. This further challenged the use of SI principles and common themes, which in turn informed how the research was conducted. The richness of the findings from the study meant that the application of CR principles could only enhance the interpretation and analysis of the results. Therefore the study recommendations are founded on solid, comprehensive and robust processes of enquiry and are well placed to contribute meaningfully to the discipline, fostering yet another shift and a significant step forward for the field of study.

8.4 Conclusion on the Relevance of the Research Questions

The research questions are revisited in light of the research results, interpretation and analysis of the findings.

8.4.1 Research Study Main Question

How can SI be reconceptualised as an integrative study of IST and BIA design underpinned by critical realism theoretical paradigm?

Context to the research question is important.

The literature review and SI theoretical philosophy review revealed that there were theory-practice inconsistences presented by the interpretivist paradigm as an underpinning philosophy for SI. This discovery meant that SI could not be adopted as a design perspective or approach. This resulted in the reconceptualisation of the SI theoretical paradigm to CR and challenged entrenched assumptions and offered new lenses and means of viewing the research problem. In addition, for SI to remain relevant as a design method, the aspect associated with interpretivism had to be reviewed and adapted accordingly to CR.

Furthermore, the CR research method was adopted. The method's breadth and depth offered the research the rigour, relevance and reliability that it needed to arrive at meaningful conclusions and contribute to the body of knowledge.

In summary, SI can to be adopted as an integrative design method for IST and BIA, provided SI theoretical paradigm is reconceptualised into CR in order to address the performative contradictions as well as the mismatch between theory and empirical evidence as these limit its application in practice. One of the ways in which this can be achieved is by employing the method proposed in Figure 40 of the recommendations.

8.4.2 Research Sub-Questions

The research sub-questions are addressed at various stages of the research in line with the research study question. This section summarises the conclusions.

a. How can SI be extended to consider information reporting and analytical intelligence requirements when designing ISTs that are a good foundation for BIA??

The proposed method adapted from Layder (2003) addresses this question adequately.

Business requirements analysed as input into the design process using the SI perspective and social actor dimensions at all levels of social organisation account for business intelligence or reporting requirements. This method ensures that IST requirements are not assessed in isolation but are integrated into outputs for consideration by the design team. Employing design thinking philosophy helps translate these into technical and configurable requirements.

This approach ensures that the BIA tools can deliver the required information at the frequencies and intervals required, and packaged appropriately for the target audience and use at various points and levels of interaction.

In this way, IST is developed with the end in mind, enabling a culture of development of BIA-centric IST. Inherent to this culture is the delivery of relevant and accurate information in support of business requirements for exchanging information for purposes of executing or monitoring the performance of business functions.

b. In what ways does the CR paradigm address SI theoretical foundational constraints?

CR uses its pluralistic ontology to challenge widely accepted and entrenched assumptions about SI theoretical foundations. It provides an alternative or middle ground to either the positivist or interpretivist paradigm in a manner that no other paradigms do, including mixed-method approaches.

It offers an effective solution to the dynamics of the complex and open system fields such as IS, non-deterministic tendencies through thorough examination of empirically observed or perceived events, and uses data to link these to causal powers or mechanisms that underlie those events. Patterns are examined and the tendency of mechanisms or social actors to behave in a particular fashion in similar contexts, settings and situated activities when performing certain functions are identified and examined further for consistency. Having answers to the 'why' question and understanding of the circumstances under which certain events happen and/or actors behave in a particular manner helps identify non-deterministic tendencies which can be used to enhance the design function and improve effectiveness of IST and BIA.

Because of an open system and the complex nature of social actors, CR reduces the gap between reality and practice better than most paradigms can.

c. What are the key design principles and activities that are required to ensure effectiveness of the IST and BIA design knowledge through design research?

Design thinking enabled by SI-based analysis ensures that there is rigour and that comprehensive analysis is conducted at appropriate yet practical levels of social organisation, the outputs of which serve as an input to the design process. The socially conscious, context and environmentally sensitive art of designing systems minimises the design-reality gap characterising many IST implementations to date, thereby enhancing the value that both IST and BIA disciplines can offer in this ever-changing field.

8.5 Conclusion on the Research Study Contribution

8.5.1 Practical Level Contribution

At a practical level, the researcher tested the practicality of adopting SI as an integrative design method for IST and BIA through a practical case study. In addition, the use of Layder's social organisation and social activity framework in analysing the data sets, demonstrated the framework's usefulness as a tool in practice. The activities and/or events were broken down into meaningful yet manageable levels of social actor interactions and elements.

As it became clear through the study results that the problem was not so much with technical functional requirements but had a lot to do with qualitative intangible aspects of computing, it was critical to assess the extent to which TFR design processes subscribed to the design thinking philosophy and standards. The design thinking philosophy in its concern for design of systems that enhance meaning and experiences for social actors, among other critical elements, considers behaviour, values as well as investment in time in understanding of patterns and environments in which IST and BI thrive.

The case context has been instrumental in crystallising and synthesising the application of the CR method principle of retroduction in a real case study. The results of this have been used to develop an integrative design method outlined in Figure 40 of the recommendations and supported by a descriptive framework detailing CR-SI Design Method principles as well as a qualitative and technical capability development analysis framework, outlined in Table 23 and Table 24 respectively.

In addressing the long-standing perception that STS approaches were not easy to implement in practice, the study extended the scope to include recommendations on where to focus the implementation efforts. Often useful design methods fail not because they are ineffective, but because they fail to articulate the design principles that design knowledge workers and practitioners can subscribe to. There therefore needs to be an easy-to-use, step-by-step principles guide. To address this requirement, the recommendations section articulates the design thinking strategies that will help ensure operationalisation of the CR-SI Design Method. The view taken was that the design art knowledge and principles are key in ensuring that these are embedded as the discipline strives to extend the scope to include information reporting and analytical requirements in order to enable effective BIA.

8.5.2 Theoretical Contribution

The research study is pushing the boundary and challenging both social informatics scholars and practitioners to use different lenses to review the relevance and effectiveness of social informatics in addressing the challenges currently characterising the information systems field. In this way, the study exposes the limitation of the theoretical paradigm underpinning classical SI in relation to the theory-practice inconsistences. It achieves this by highlighting the theoretical assumptions and belief systems of interpretivism that limit SI effectiveness and application in practice. Critical realism’s ontological and epistemological assumptions, its pluralist approach and method principles’ strength in addressing requirements of complex and open systems such as information systems enhance the practice relevance of IS artefacts designed using design methods underpinned by the critical realism paradigm.

The digital era and the changing rules of the competition are compelling information systems researchers and practitioners to challenge the norm and revisit the theory-practice gaps that if left unchallenged have a potential to impact on the effectiveness of the field in dealing with the changing business landscape. Critical realism offers greater promise than the interpretivist paradigm in addressing the complexity of designing solutions that can effectively account for the social, context and environmental factors characterising the information systems field whilst addressing the requirements for an integrative approach to delivery of information systems and technology and business intelligence and analytics. Over and above challenging widely accepted assumptions about IST and BIA design and theory-practice inconsistences introduced by the SI default theoretical paradigm, the study contributes to the body of knowledge by expanding the IS research domain to introduce new themes and perspectives that would otherwise not be possible due to the mainstream focus on North American and European contexts.

For example, in understanding context at a micro level, new themes were introduced relating to the culture and discipline challenges introduced by the institutional character and structure of SOCs such as TFR.

The geographical landscape and conditions were yet another value add, in that performance of otherwise successful concepts and solutions was limited. Although literature highlights localisation of solutions as a critical success factor, limited practical examples exist to contextualise the impact such dynamics might present, and the TFR case study enabled the research to bring the point across effectively.

8.5.3 Methodological Level

The contribution at this level was more from the perspective of employing CR as a research study method. The study complied with the rules advocated by CR and employed the CR principles successfully during the analysis of the data.

The depth and breadth of the study helped to move away from logical and functional organisation of themes to categorising data sets and themes from the perspective of the social actors who participated in the study. This approach resulted in a web of interlinked cross-functional themes, a perspective which the researcher could not have anticipated when the study commenced with the interpretation and analysis of the results. The manner in which themes linked to each other reflects on how the themes influenced and/or were influencing each other at various levels or interfaces.

8.6 Recommendations of the Research Study

This section presents the recommendations as well the outcomes of the research study process, namely a CR-based SI Design Method and is divided into two sections. Part one details the recommendations flowing from the research study and part two focuses on the presentation of the CR-based SI Design Method.

The recommendations point the reader to new insights on how to address some of the recurring challenges that could not be addressed using traditional analysis and design approaches. The principles-based recommendations provide a framework of empirically based practice, enabling practitioners involved in the analysis and design of ISTs and BIAs to have a systematic approach to design of IS solutions. The principles are not prescriptive in nature but are intended to:

- Provide a set of minimum guidelines ensuring appropriate use of the method;
- Ensure consistency in the application of the design thinking guidelines;
- Tailor and adapt the method in context; and
- Provide an appropriate level of planning, control and governance.

The nine CR-SI Design Method principles are briefly discussed in the section below.

8.6.1 CR-SI Integrative Design Method Principles

The CR-SI integrative design method principles recommendation addresses sub-objective number three of the research, which is to identify key design principles and activities that are required to ensure sustainability of the IST and BIA design knowledge through design research. They are discussed in detail below.

Integrated Approach to Development of IST and BIA

Identify digital and business moments to which your organisation must respond, and create the necessary data and application integration capabilities to respond to those moments.

IST and BIA are interdependent functions and as such neither can deliver value in isolation or independently of the other. To ensure that IST does not deliver systems that lack in BIA fundamentals and building blocks for BIA, a paradigm shift is required.

At Theoretical Level

Academia, through research, conferences and ad-hoc engagements, needs to address the requirement for an integrated approach between IST and BIA. This starts by revisiting the theoretical foundations of both sub-disciplines as well as assumptions that have been developed and now govern both academia and practice approaches.

There needs to be collaborative effort from academia and practice to address the practical implications of this approach. It is more than necessary to move in this direction. Advanced and effective ways of implementing such an approach in practice would need to be researched. Resistance that may arise from vendors that have a niche and are benefiting from this silo approach would also need to be carefully examined and buy-in into this process obtained in order to ensure alignment and support of the new vision and approach.

At a Practical Level

At a practical level, analysis, design and development methodology can be revised to embrace the philosophy of the interconnected and interdependent nature of IST and BIA. In the same way that artefacts are managed and monitored through gate reviews and sign offs of IST development. These gate reviews need to be revisited to ensure that they include assessment of BIA requirements.

Secondly, skills and competency development need to be prioritised, otherwise the effort may yield no results if the social actors who need to deliver on it are not adequately trained and socialised into appreciating the value of BIA.

8.6.2 Social Actor

The design method views business users as social actors. Social actor philosophical thinking about the user has proven to be the most appropriate conceptualisation of the system and technology users in a complex and dynamic environment. An analysis approach informed by social actor principles delivers better results compared to the default concept of a business user. Furthermore, assumptions the designers make as they begin designing the system and technology capability, are largely informed by how the users are conceptualised.

Consistency in conceptualisation of the users and application of the proposed techniques between the analyst and the designers of the systems and technologies are a prerequisite to any successful design. It therefore becomes important for the two resources to be aligned in their thinking and approach.

This principle takes a 360-degree view of the social actor, encouraging practitioners to consider the following characteristics:

- Varying requirements as actors assume different roles;
- Different levels of operating presenting different dynamics and expectations;
- Multi-networks that legitimise and constrain their actions; and
- Social actors' perceptions of themselves in the workplace in relation to IS.

8.6.3 Hybrid Design Model Supported by a Strong Design Philosophy

Adoption of the CR-SI Design Method was supported by design thinking philosophy and strategies in order to address hybrid requirements.

- In addressing requirements with aggressive turnaround time and quality, practitioners need to employ design thinking strategies that are effective and exploratory in nature to support revolutionary business opportunities.
- To support traditional business requirements that grow and evolve under more stable and evolutionary directions, practitioners need to employ stable design thinking principles.

The reality is that not all business requirements can be addressed by an agile and pragmatic design method. From this standpoint, it makes logical sense to adopt a hybrid design model that integrates the two and leverages their possible synergies.

8.6.4 Development of Core Teams to Support the Hybrid Model

In addressing and bridging the gap between IST-specific solutions which tend to be long term as compared to the BIA deliverables which are in their very nature short term, requiring near real-time responses to real and dynamic business scenarios, the study recommends a hybrid approach to staffing of core teams. This will further ensure that the proposed design method is cost effective and delivers business results, enabling the department to keep a minimum core team to address day-to-day IT enablement requirements with a view to scaling resources up and down based on the IT department's strategic plan and roadmap.

This approach ensures that sufficient resources are available to deliver efficient and prompt service to business with limited opportunity for the staff to be unproductive. To ensure sustainability of the hybrid model, sharing or reusing resources across the two methods should be avoided. If resources must move across, governance on circumstances under which the migration between the two method needs to be articulated clearly and unambiguously in advance. Implementation of this method requires strict management and discipline, otherwise the chances of it failing, resulting in unsustainable business benefits, become high.

8.6.5 Modern IT Team Profile

The level of complexity and dynamism presented by the interlinked, multidisciplinary and cross-functional nature of the themes identified in the study as impacting on the IST and BIA requires a modern IT team profile that will be able to view and challenge dominant assumptions in the IS space in order to move the discipline forward.

A multidisciplinary team of marketers, ethnographers, psychologists, industrial designers, anthropologists and engineers might be recruited to work alongside one another to support the integrative SI design methodology. This means that the profile and skills of the IT personnel have to be reviewed in line with the desired outputs at each phase of the system development life cycle.

8.6.6 Partner Networks

The ability of internal IT departments to partner with external IT partners or information vendors to provide the information which cannot be developed or produced internally within the required timeframe and justified cost is fast becoming a reality and is crucial to the survival of businesses. IT departments are fast going to be measured by the speed with which they deliver the required data or by the ability to integrate structure and unstructured data from external sources that have such data readily available for consumption. This approach will go a long way in reducing data and decision-impact latency.

8.6.7 Service Provider Networks

The ability to negotiate SLAs on the basis and merit of the project and/or business requirement has become crucial. Standard SLAs no longer serve the organisation in this fast-paced and demanding environment. Contractual agreements need to be relevant and specific. Generic contract agreements are constraining. They limit business velocity and responsiveness to changing business requirements. The sooner organisations start engaging their service providers on the realities of their operations and putting pressure on them to be agile, the better.

8.6.8 Governance

The new and creative ways of doing business and leveraging of data assets puts pressure on governance. The newly designed IST and BIA need to be integrated into, and coordinated with, the core organisational systems, ensuring that the same level of efficiency and security requirements are met. Carefully crafted governance needs to be in place to make that possible.

8.6.9 Design Thinking Approach

Designers need be trained to apply a healthy mix of analytical and design thinking strategies when designing IST and BIA solutions. That would assist in improving user experience of technology and minimise the influence of the qualitative social and environmental factors that trigger certain events resulting in undesired outcomes.

Traditionally, designers focused their attention on improving the aesthetics and functionality of products. In the IT space, application designers traditionally focused on building systems that reflected the wants and needs of end users. Designers are trained to visualise abstract experiences, recognise patterns of behaviour, integrate information from multiple sources and work collaboratively in the field with a variety of communities. Design competencies, such as the ability to frame problems in meaningful, human-centred ways and to integrate components into better outcomes, are now being applied to complex issues and global challenges.

Design thinking – due to its concern for human experience, the social actor – is more than an appropriate way of conceptualising business users. Furthermore, designers are encouraged to consider the commonly applied and effective design principles in the IS field, where design is conceptualised as follows: design as problem solving, design as planning and/or design as process or action.

8.6.10 Other Recommendations

The environment and the conditions under which the technology needs to survive must be understood, and a solution designed that can withstand all the conditions and the environment.

Simulation of the environment in the lab is not enough. Testing on site is a requirement. Selection of testing sites has not only to simulate but be representative of all conditions and geographical landscapes under which the technology needs to survive before commissioning and implementation. Recovering from a failed implementation is harder compared to soliciting buy-in the first time around, while change management efforts are less challenging.

Change management must be aligned to the deployment of a working and thoroughly tested technology. Consideration and alignment of time to market is crucial. Going to market too quickly is dangerous, as perception and experience created by the first experience of the technology are difficult to challenge and change. Empirical evidence points to the fact that these often become the biggest source of failure.

Practitioners need to move beyond stakeholder analysis to stakeholder profiling and simulation of the social actor real-life environment, conditions and practices, if adequate solutions are to be designed.

Time and effort must be invested in understanding what it is that the social actors value the most and what it is that the technology is threatening to take away or diminish. A win-win strategy must be formulated, and something given back in exchange for that which the organisation deems to be more important. Work practices and culture are one thing, but loss of a group of people that are united is another. It needs to be viewed differently and seriously. The social actors need to feel that they are gaining something in the space of what they are losing with the introduction of new systems and technology.

8.7 Critical Realism-Based Social Informatics Design Method

The CR-SI Design Method is an integrative design method that addresses requirements for IST and BIA that enhances business value. It describes aspects of the analysis and design that must be addressed if BIA-centric IST is to be developed. It is based on the premise that IST value is directly linked to the quality the BIA function delivers to business. Neither can deliver and/or enhance business value in isolation.

The level at which the method is designed is such that practitioners that apply the method thoroughly will address the design-reality gaps empirically observed and the current characterising practices. Its strength lies in the way in which the integrated web of interlinked cross-functional themes are carefully mapped into social organisational elements at different levels of the organisation. These further enhance the understanding of social activity and action at various levels of the social structures.

8.7.1 Application of the Critical Realism-Based Social Informatics Design Method in Practice

In a complex, open and multidisciplinary field such as IS, application of the method should be tailored according to context, inherent organisational domains (cultural, economic, political, social, ethical and environmental) as well as the institutional character and structure. Tailoring helps with appropriate application of the method as well as providing practitioners with the structure, ability and confidence to facilitate analysis and design of IST and BIA regardless of nature, size and complexity. It enables an appropriate level of control as the design method is adapted to the varied requirements and contexts of IS projects.

The strength of this stratified analysis and design method is the way in which the four levels help to provide structure at both macro and micro levels, empowering practitioners with the understanding of which themes are likely to prevail at which level without underplaying their integrative and cross-functional nature. The method's treatment of each theme as a unique theme, enables effective engaging and exploitation in the context of the level at which they are appearing, thereby facilitating deeper meaning and understanding of their varying importance as they occur at various levels.

The logical thread that runs through each theme is highlighted, enabling guidance on the treatment of the themes as they prevail at different levels of social organisation.

This approach enhances understanding of the underlying structures and mechanisms that influence the outcomes as social actors perform their functions, a critical step towards understanding systems and technology interaction, capability and performance requirements.

Figure 40 below is a CR-based SI design method. Over and above the high level description of each element and dimension, it further details key aspects for consideration at each level of social organisation when conducting an analysis with a view to enhancing the design function. The integrative approach to both IST and BIA design is instrumental in the alignment of both functional and reporting requirements.

CR-SI DESIGN METHOD

Level	Social Organisation Elements	Social Actor Dimensions	Qualitative	Technical
MACRO LEVEL	**Context** Context within which the social Organisation exists and operates or functions. E.g. Developing Economy Context, Macro Social Forum, economic situation, Institutions	**Environments** Environments exert technical and institutional pressure over organisations and its members. E.g. How information is generated is informed by the external requirements	IST analysis & design consideration for: • Contextual • Institutional • Regulatory & Compliance IT Planning & Strategy Development	IST & BIA effectiveness in supporting & enabling • Organisational • Institutional • Regulatory & Compliance reporting requirements
MACRO LEVEL	**Setting** Immediate environment of social activity. E.g. Organisation, Department team, including those the organisation is affiliated to, etc.	**Interactions** Informs how actors engage and interact with affiliated members. E.g. Rules of engagement legitimising ways of engaging or interacting and even sharing information.	• Technology Culture & Discipline • Trust & Credibility • Return on IT Investment • Ownership, Accountability, Responsibility, Consequence	• IT landscape planning • Process standardisation • Design methodology & standards • Operational assurance & Readiness
MICRO LEVEL	**Situated Activity** Dynamics of engaging or interacting with others in the social organisation.	**Affiliations** Dynamics as actors engage and interact with those whom they are affiliated with. Relationships are shaped by networks of organizational affiliations.	• Operational dynamics, nuances & environment • Ergonomics & work-life impact of technology • Design art and knowledge • Actor knowledge	• Infrastructure, technology & systems readiness & performance standardised for all operational areas • Functionality & Security
MICRO LEVEL	**Social Actor** Individual or collective entities understanding or experience of social organisation relations	**Identities** Individuals or collective entities, networks are enabled and enhanced through ICTs and BI. How do I identify with the network in which I belong	Actor Conflict: • Inadequacy, loss of power, anxiety, disempowerment IT brand: • Competency, innovation & creativity, customer attitude	• IT Tools • Skills & capability • Security role profiles • IT & BIA literacy

FIGURE 40: CR - SI DESIGN METHOD

Figure 41 below illustrates how the integrative method facilitates deep insights into the BIA requirements and enables the design of ISTs that are BIA centric. The method's strength is in the structured and systemic analysis approach, the output of which informs design.

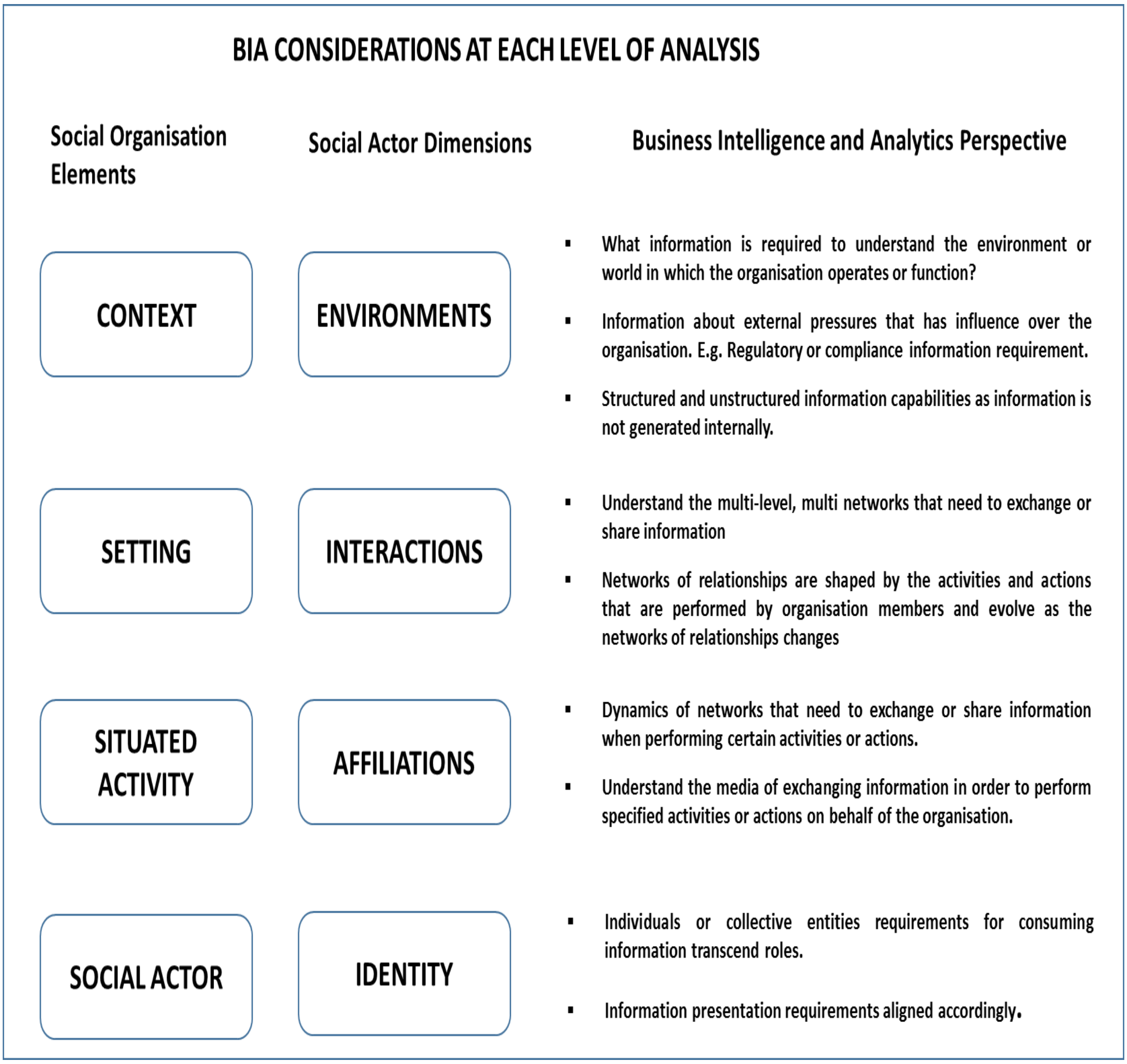

FIGURE 41: BIA ORIENTED VIEW OF THE CR-SI DESIGN METHOD

Delivery of useful and usable ISTs and BIAs is not an end state that organisations should be striving towards, nor can it be achieved in isolation through a structured initiative or project. It is a continuum trajectory of improvement with integrated processes and initiatives that are targeted at various levels of the social organisation to achieve certain business outcomes. Hence the CR-SI method has structured the key IT implementation outcomes into technical and qualitative themes. Qualitative, non-technical and intangible elements cannot be measured in absolute terms, for example, social, contextual and environmental aspects of computing. Technical Capability and Development Global Theme is a term used to organise themes that were technical and tangible in nature and with measurable performance, for example, capability aspects of ISTs and BIAs such as infrastructure, architecture, configurability and functionality.

The stratified framework has context, setting, situated activity and social actor levels whereby context focuses on the environmental factors; setting is concerned with interactions; situated activities address requirements informed by affiliates; and lastly social actor focuses on how social actor identities influence how social actors behave. The researcher has found this approach useful in that not only does the stratified framework provide structure to the application of CR principles when analysing the events at the different levels of social organisation but it also enables a clear account of causal powers and mechanisms that trigger certain events to occur. Deeper understanding of the business and non-deterministic tendencies as social actors use ISTs and BIAs to enhance effectiveness of the analysis approach and create better opportunities for integrative IST and BIA design processes.

While the method does not claim to fully account for the powers and liabilities derived from the various structures in different organisational settings, given the complex and varied organisational context, social systems and environment, it offers a solid base from which the CR-SI method can be based. The proposed implementation strategy is to maintain focus by focusing on those parts which are most relevant for the intervention. For example, the purpose and context of the information systems intervention, time horizon (days, week, months, years) and appropriate boundaries (this department, this firm, this system), provide specific characteristics to focus the intervention.

8.8 Future Research

Due to the limited application of critical realism in the design science research and information systems research fields, several opportunities for further research have emerged from this research.

First, there is the need for additional research into the role of design science in the digital economic era, taking into account the multi-disciplinary and complex nature of the IS field. This research can extend to how the traditional roles in IS are challenged to evolve in order to effectively deliver on the new thinking and development in the field.

Second, the application of the CR method principles is not yet well represented in the IS literature. Research studies that focus on the application of these principles will help provide practical references for application in practice. The IS field is complex and nuanced and as such requires research from different perspectives and contexts to be conducted in order to continue advancing the field.

Third, there is an opportunity to test the proposed integrative CR-SI design method with an objective of examining the method's effectiveness in determining the non-deterministic tendencies as well as how these can be used to inform integrative design requirements of ISTs and BIA in different settings and contexts, with minimal adjustments or enhancements. Method testing is recommended as a future research study in order to ensure comprehensive testing in a different contexts and provide an opportunity to compare and contrast the results of the two studies. This will contribute to the development of new knowledge, given that CR adoption in the IS research field remains under-developed.

8.9 Conclusion

The need for a highly integrated multidisciplinary approach to the study of information systems has been reiterated in a number of IS researcher studies, but the level of integration in the existing research tends to be low. The research findings have further confirmed this and it is becoming a concern in this growing field due to the digital era that is revolutionising the field. Few research undertakings adopt an integrated research approach to the study of information systems and technology and business intelligence and analytics. It is only when both academia and practitioners collaborate that the information systems field can begin to enhance our understanding and explanations of information systems phenomena in organizations.

The critical realist approach is the most appropriate theoretical paradigm to adopt to address the theory-practice inconsistency challenges at the heart of the IS field. Its strength as a research methodology offers the researcher a unique ability to interact with data at a level that other research methods do not: that is, to examine the impact of data at the three fundamental levels of research – empirical, actual and real – thereby enhancing the effectiveness of its application in practice. Therefore, reconceptualisation of the SI perspective theoretical paradigm from interpretivism to CR offers greater benefits not only to this research study but to the IS field. This is yet another development in the field which seeks to address the long-standing challenge of IS value contribution that is constantly diminished by ineffective design methods and poor integration of the IST and BIA disciplines, which by design should be leveraging on each other's strengths in a quest to deliver superior results to businesses.

Business requirements analysed as input into the design process using the integrative CR-based design method account for BIA requirements, thus enhancing value derived from both IST and BIA.

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APPENDIX SECTION

The tables below present the samples of partially transcribed interviews, focus groups, observation notes as well as phase one and two figures of coding of themes.

Appendix A: Semi-Structure Interview and Focus Group Discussion Protocol

TABLE 25: SEMI-STRUCTURED INTERVIEW AND FOCUS GROUP DISCUSSION PROTOCOL

1	Organisational Dimension
1.1	What are the drivers of decisions to invest in new technology in your organisation? Who has the most influence and why?
1.2	What organisational dynamics might the introduction of the new technology trigger and what type of conflicts might it generate?
1.3	What impact do environmental conditions have on the successful implementation of technology solutions? How does this relate to your organisation?
1.4	Are strategic and tactical goals supported by development of appropriate systems and MIS/BI
1.5	Are systems and MIS/BI accessible and usable at all appropriate levels of the organisation?
2	Operationalisation Dimension
2.1	What support and/or resources are required for the successful implementation of technology solutions? How does this relate to your organisation?

2.2	What are the incentive and reward structures associated with the introduction of new technologies within your organisation? Do they translate into high adoption and utilisation levels?
3	Employee Dimension
3.1	Are user requirements adequately considered during analysis and Is the process inclusive and transparent?
3.2	Under what circumstances do employees feel empowered or disempowered by systems or MIS/BI introduced?
3.3	In what instances do technology improve or degrade the quality of employee work life?
3.4	Is MIS/BI designed in manner that empowers users to take action and exploit the information?
4	Design Dimension
4.1	Are IST designed in manner that is supportive of the development, effective use and delivery of MIS/BI?
4.2	In what ways do the IST development approach embrace work practices related to the use of MIS?
4.3	In what ways do the IST development approach critically examine application of information at various levels of reporting from multiple perspectives?
4.4	To what extent do IST development approaches enable design and configuration of intuitive, easy-to-use MIS/BI systems?
4.5	Is the application of MIS/BI regularly reviewed and monitored to ensure appropriate use and application of insight?

5.	Technical Dimension
5.1	Does the organisation use a consistent and standardised approach or a structured methodology for developing Systems and MIS/BI?
5.2	Is this methodology effective in accounting for multiple social and business context in which systems and MIS/BI are used? (Situatedness of use)
5.3	Is this methodology effective in examining the networks of relationships that call for the exchange of information and use of Systems?
5.4	How do technologies deliver on the requirement for system controls, data governance and management of risks? How does this relate to the work output you have to produce?

Appendix B: Observation Notes

System / Application and or Technology	System Observation Notes	Summary of Results used to Inform Preliminary Data Codes
Integrated Asset Training System (IATS) Hand Held Devices (HHD) Technology	HHD System working, however **optimum performance of the system limited by GPRS capability** (Communications Medium). G**eographical area analysis and Data Coverage strength analysis conducted post deployment due to inadequate coverage or network.** This point to poor analysis and understanding of **local dynamics as well as service provider readiness to provide the required service.** Assessment of **technology capability focused on technical criteria and not contextual requirements**. Assessment revealed that **technology was not ergonomically viable** for employees, majors to circumvent the challenges were not adequate. Further analysis revealed that due to introduction of technology certain p**rocess nuances were not considered** resulting in loss of benefits that emanated from local variations of process. All these were not considered in design to establish the extent to which unintended consequences could be minimised or technology enhanced to address those requirements. **Processes which could be integrated manually could no longer be integrated due to inflexibility of the system.** Solution design and technology sourcing of the process of building of the train and generation of the vehicle list was done in isolation of the end to end Yard process activities and as such analysis and design was not comprehensive. Whilst the solution was enforced, promised benefits such as Data Integrity and total automation of the process of building of the train and generation of the vehicle list were not realised in full due to fact that the solution could only be fully implemented in certain geographical areas. **Due to the solution limitations, the solution could not be extended to certain operational process areas** (Yard) and activities to benefit fully from the solution.. I.e. En-route functions remain untapped and certain yard area remain excluded from the solution. Assessment and understanding of the requirements	***GPRS limiting optimum performance of system / capability*** ***Feasibility study not conducted to assess viability of the proposed data coverage strength in the Geographical areas to inform negotiations with the supplier prior to implementation & optimise the solution*** ***Local dynamics*** ***Service provider readiness in providing the required level of service*** ***Technology assessment focused on technical criteria and not environment*** ***Technology not ergonomically viable*** ***Process nuances and practices not adequately considered*** ***System not flexible to support integration requirements of certain manual processes*** ***Due to solution limitations systems could not be extended as plan to support other processes*** ***Assessment of system dependencies or processes integral to the successful execution or utilisation of the process not conducted*** ***Solution viewed as creating new inefficiencies in the***

	or dependencies of the HHD to function were not conducted such as support and maintenance of Tags that the HHD needed to read for the process to work, resulting in dependencies that over time were not easy to manage and processes that were not sustainable in the long term. Business users not trusting the capability of the HHD solution and view solution as waste of company resources as it creates more problems and inefficiencies than the manual and integrated process.	***process than the original / manual process***
Integrated Asset Training System (IATS) Train Definition Unit (TDU)	6 years into implementation, capability still not fully implemented and as such capability partially utilised. Implementation Approach challenges was to roll out technology when proof of concept (POC) scope was only limited to Laboratory environment. Deploy technology before change management. Business users were exposed to technology before technology was functional, perceptions around what the technology was deployed created and not adequately managed due to poor change management. A**ssessment of the environment in which the solution needed to exist was not properly conducted, resulting in technology specification and peripherals needing to be revised to address geographical and environmental conditions under which technology needed to survive.** Assessment of processes that were impacted by or that the new process impacted on were not understood and requirements for engineering such processes not adequately addressed. Dependencies of other functions or processes were not identified or adequately managed resulting in a solution that had poor support and maintenance. **Project roll out plans not coordinated properly as the solution was deployed on Critical business assets - Locomotives which could not be removed from service, furthermore alignment to other projects was not done, resulting in conflicting designs as other projects impacted on the design and fitment strategy and plan which needed to revised and interfaced to other critical projects and delivery a seamless solution.** **Assessment of work practices of drivers that could be threatened by the introduction of solution was not done**, resulting in a solution viewed as a threat to how drivers were driving e.g. visibility of speed and Estimated time of Arrival Impact on the other **contextual and social factors**	***Environmental conditions for technology viability not considered*** ***Consideration of social factors*** ***User profile and impact of unions*** ***Capability designed around human beings for success creating dependency*** ***Assessment and alignment of plans of projects running concurrently and impacting on the same assets.*** ***Solution design did not consider other project designs and solutions that impacted on the same asset. Poor alignment of projects*** ***Assessment of how work practices could be Negatively impacted by introduction of the system not done resulting in misconceptions.***

	not anticipated e.g. Overtime that the drives had become accustomed to. impact on operations design, e.g. station codes and area names **Designing a system that relied on user for success when the motive was to improve quality and minimise human dependence.** Poor assessment or consideration of target use profile, social dynamics of the group and labour unions. Further, failing to address those upfront to minimise their impact.	
Management Information Systems (MIS) and Business Intelligence (BI)		
MIS / BI and Analytics	Due to a number of process, system functionality gaps and or utilisation thereof, **MIS was used as a tracking, monitoring and or enforcement tool where either process or system could not deliver intended output or outcomes.** **Often information from various and yet related systems did not tell a story due to processes that are not integrated as well as isolation of system design**. Often when a detailed analysis is conducted, the scope of the analysis is often limited to the boundary of the project. Hence one often finds that context, social and local dynamics and dependences are overlooked during design, picked up as issues later in the process making it difficult to understand and address.	***MIS used as an enforcement tool. However often not as effective.*** ***Information thread missing due to lack of understanding of process touch points*** ***Context of reporting lacking***
Business Object Application (BOBJ)	**The observations revealed that while the approach to central MIS environment made sense, the solution did not match all the business requirements for MIS reporting, dashboard and analytics.** It had the following constraints: It was not scalable to respond to the changing MIS reporting requirements Dashboard requirements had to be complemented by another solution which was also falling short in delivering on the full scope of the requirements and representation of the dashboard Analytics requirements were not addressed, with **IT abdicating the responsibility to business when the self-service environment was not ready nor supported.** The legacy BI and Data Warehouse environment was also not conducive for the evolving business requirements for reporting. **Limited benchmarking and training of staf**f was done to keep up with the changing business and BI landscape, resulting in IT confirming BI capability to the in-house skills and competence which was an unfair thing to do to business.	***MIS system not scalable to address changing reporting and business requirements*** ***Analytical capability lacking*** ***IT hiding being self service capability instead of providing optimum solutions*** ***Legacy BI and Data warehouse environment*** ***Limited training and benchmark enabling staff development*** ***Business users knew more than IT*** ***IT environment, architecture, platforms and culture limiting creativity of IT personnel in providing superior solutions***

	Business Users were beginning to introduce their own BI Tools and Capabilities justifying the decision by saying they are accountable for performance of their respective departmental functions and areas. Sighting that they do not have the luxury to wait for IT to wake up and begin investing in appropriate and relevant tools. Business Users seemed to know more about the latest trends and BI capabilities and how these could assist improve decision making processes and performance management. There was a **sense of frustration from IT resources in that, some understood that the solutions that IT was offering to business did not represent a full system capability, their creativity and imagination was constrained to in-house capabilities, landscape, architecture.** Reality that data required for reporting on process and business performance from different perspectives does not always come from automated application systems pushed the requirement for a BI tools that can easily and seamlessly integrate data from automated and manual systems and technologies.	
Dashboard Reporting	**Whilst there was a fair level of integration across business critical, operational and or transactional system, the level of integration that was achieved was limited to what could be achieved using the legacy platforms, systems and their underlying processes.** The dashboard uses are such that data from multiple systems, levels of reporting and perspectives is considered, thus extending the dashboard challenge to beyond technology or platform capability but that of challenges presented from the need to consolidate data from different systems and may not be fit for purpose. Escalation of budget cost and scope as data need to first be cleansed and made to be fit for purpose which is not always done successfully. **Dashboards functionality, look and feel was also limited and reflected the level of skill and competence** in house. The team often had to rely on the consultants who also had limited background and context resulting in poor solutions being developed. **Data quality** from the point the following view point: Access to relevant and accurate data Manual sources inconsistent business processes, presenting challenges where data from multiple sources and or	***Legacy platforms and systems limited level of integration*** ***Functionality limited to in house skill*** ***Data quality & integrity issues*** ***Master data legacy challenges***

	captured from multiple points and by multi users resulted in inconsistent data from which to generate deliver reliable data outputs. Master data sources designed with a particular view and purpose in mind, identified for uses in different context posing challenges of data integrity. Use of data that is relevant but not fit for purpose.	
Operational Scorecard Reporting	Dashboard utilisation poor, compared due to: **Data integrity issues such as incomplete data, inaccurate data and multiple sources of the same data** Culture of using system based dashboard, business users trusting manual data captured in spreadsheet **Business users questioning data sources, reporting logic and business rules applied in information reporting on dashboard** **Maturity of reporting whereby users are used to reporting of performance in isolation** and not creating the link between what each report of information is saying and what the total picture means.	***Data integrity, incomplete data sets, inaccurate and multiple sources of the same information, manual sources*** ***Culture of using system sources and based dashboards*** ***Business rules and logic applied to processes and information*** ***BI and MIS maturity, information reported in isolation***

Appendix C: Sample of Generation of Theme

Field Data Set Semi-Structured Interviews & Focus Groups Discussion (post transcription)	**Identified Codes**	**Grouping of related data sets into codes**
	Strategy and vision	Strategies not communicated clearly and how its can translate to action and what action contribute to MDS. We do not always know what the IT is working towards and how to get there.
Irritated users, demakar systems, IT do not listen, IT hide behind, users do not trust IT, lack of confidence, users do not care what IT says as they know it is not going to materialise, it's a nightmare dealing with IT. Do not bother requesting, bus perceive IT as rubbish and incompetent		
IT lacks creativity		
Systems are so demakar, so many request that go thru IT, different priorities and requirement, confuse systems resulting in complex system design	Trust	Irritated users, demakar systems, IT do not listen, IT hide behind, users do not trust IT, lack of confidence, users do not care what IT says as they know it is not going to materialise, it's a nightmare dealing with IT. Do not bother requesting, bus perceive IT as rubbish and incompetent
Resistance		Systems are so demakar, so many request that go thru IT, different priorities and requirement, confuse systems resulting in complex system design
Feeling of loss of power and influence specialist work now done by technology		
Company not matured in the use technology oriented, People Lack competency.	Poor Communicatio n	resistance
Processes loosely defined, lack of standardisation, structures and capacity e.g. NCC vs SCCs. Resisting changes		Lack discipline for use of technology
Big Brother Watching, Org. using tech to check over people		
Off the shelf packages enforce standards, IT and business do not adequately prepare for what software brings with it.	Process	Processes loosely defined, lack of standardisation, structures and capacity e.g. NCC vs SCCs. Resisting changes

No consequences for not utilising technologies and application systems provided.		
Users avoid accountability of not utilising technology or application systems through collective bargaining (throwing a weight behind each other in silently fighting the cause)	SDLC Methodology	SDLC implementation is not monitored and measured in terms of how effectively has it been implemented, adhered to in relation to the benefits realised and compared projects that realise benefits to those that don't and ascertain the extent to which they adhered to the SDLC or not and identify the common gaps, areas of concern and put in preventative measures to ensure that future projects do not miss the steps that has a potential of impacting on the quality and result in Poor ROI.
Engagement prior introduction of technology not done effectively. Approach not effective, often done once tech is deployed when perceptions are created already		
Approach incorrect, executives involved and not the users on the ground, as users of the system on a day to day who understand the situated and context of use		
IT do not get or understand business requirements. E.g.		
Disjoint between what business needs and tech. that org. is investing on.		
IT not close enough to business		
Engaging with user is important to understand what the need is. Not adequate, requirements gathered or dictated to IT by senior users who have less knowledge of the actual uses and context. Have an idea of how things should be and users on the ground tell BA that its not going to work in the org, setting	No consequences for no action	No consequences for not utilising technologies and application systems provided.
Organisation has a lot of good information but not in one system. Users end up using spreadsheet to combine information from multiple systems to make sense for a particular purpose.		
There is a need to consolidate reporting measures, agree on the measures that are important and relevant to all, simplify. Currently over 3000 KPIs and about 300 at group.		

Current MIS system, deemed to be the standard has all information business need to manage business but not structured in a meaningful, usable and useful manner.	Integration	Integration requirements are not considered with new systems developed enabling real time reporting and portal single sign on. However there is still a long way to go in designing reporting application that provide meaningful and value adding reports.
MIS systems have all information but not informed by an understanding of what Information Business actually need to manage its business.		
MIS application not monitored to ensure provision of relevant reporting and enhancement of decision making.	MIS	organisation has a lot of good information but not in one system. Users end up using spreadsheet to combine information from multiple systems to make sense for a particular purpose.
Current systems and MIS applications and tools do not support strategic goals, reports and dashboard design does not seem to enable report on how the organisation is performing against its strategic goals.		There is a need to consolidate reporting measures, agree on the measures that are important and relevant to all, simplify. Currently over 3000 KPIs and about 300 at group.
Lack of clear Vision for IT resulting in poor investments decision, priorities and choice of Tools.		Current MIS system, deemed to be the standard has all information business need to manage business but not structured in a meaningful, usable and useful manner.
Due to poor planning, IT develop system on outdated platform, change them before users get use to them.		MIS systems have all information but not informed by an understanding of what Information Business actually need to manage its business.
IT taking longer to respond to the changing business requirements - Agility		MIS application not monitored to ensure provision of relevant reporting and enhancement of decision making.
IT systems are not flexible and scalable to address changing business needs. New requirements are addressed by introduction of new and not scalable systems.		Current systems and MIS applications and tools do not support strategic goals, reports and dashboard design does not seem to enable report on how the organisation is performing against its strategic goals.
IT deploy systems that are not usable, hiding behind poor utilisation.		Business to not have access to information they need to manage business hence they default to spreadsheet and create their own reporting.

IT has a tendency to think that implementation of systems means delivery. Do not take care to ensure that systems are addressing business requirements or not.		IT failure to replace legacy systems which are difficult to integrate result in a poor reporting capabilities. Business complimenting current reports with manual data.
OBC, software do not have the intelligence to know and control the speed when going down the gradient and yet the drivers through their experience and route knowledge have the intelligence to balance managing the speed at which the train goes down the gradient with the load pushing and heavy without losing the momentum it will need when having to go up the steep hill given the size of the load of the train.		
Parallel to that, is management of the fuel consumption as the train drivers man the trains.	Cognitive or human	OBC, software do not have the intelligence to know and control the speed when going down the gradient and yet the drivers through their experience and route knowledge have the intelligence to balance managing the speed at which the train goes down the gradient with the load pushing and heavy without losing the momentum it will need when having to go up the steep hill given the size of the load of the train.
Often this is the detail that the analyst will not know and can only be provided by the drivers on the ground through their route knowledge and experience and practices. However often they are not included in the JAD session. Engineers and IT work with business managers and do not engage at appropriate operational level. Business users will not volunteer right level of details as they do not always deem it critical to inform design an appropriate capability.		Parallel to that, is management of the fuel consumption as the drivers man the trains.
There is a tendency to rely on meetings, workshops and engaging one another and think that is sufficient as opposed to physically going out there to see in all reality (situated-ness of use) how things are happening and why certain things are the way they are and consider them during design.		Often this is the detail that the analyst will not know and can only be provided by the drivers on the ground through their route knowledge and experience and practices. However often they are not included in the JAD session. Engineers and IT work with business managers and do not engage at appropriate operational level. Business users will not volunteer right level of details as they do not always

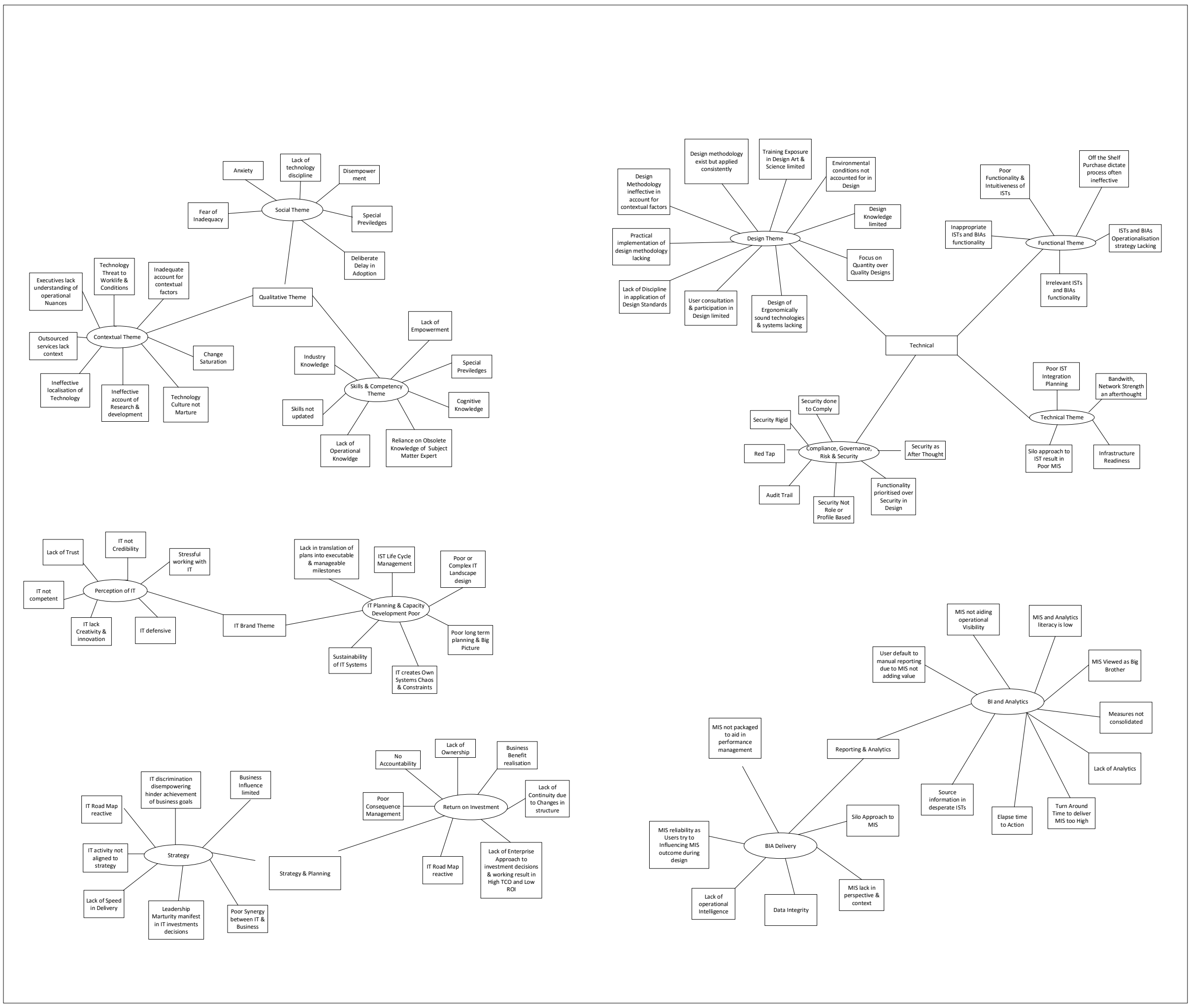
		deem it critical to inform design an appropriate capability.
There is tendency by IT people that have been in an organisation for a long period of time or been in operations earlier in their careers to make assumptions based on what they used to know meanwhile business processes have changed and environment has evolved.		
SDLC implementation is not monitored and measured in terms of how effectively has it been implemented, adhered to in relation to the benefits realised and compared projects that realise benefits to those that don't and ascertain the extent to which they adhered to the SDLC or not and identify the common gaps, areas of concern and put in preventative measures to ensure that future projects do not miss the steps that has a potential of impacting on the quality and result in Poor ROI.	Poor planning	Due to poor planning, IT develop system on outdated platform, change them before users get use to them.
Lck of understanding of situated-ness of use, local practices and work-round impact on efficiencies created. E.g. HHD writing of vehicle list of 2 trains & walk train length once, Heavy and strings on women breast uncomfortable.		IT systems are not flexible and scalable to address changing business needs. New requirements are addressed by introduction of new and not scalable systems.
Employees feel empowered when using systems that are easy to use whilst enabling them to perform their duties optimally.		
Right questions not asked to ensure understanding of situated-ness of use. And efficiencies created as a results	Appropriateness (usability and usable)	IT deploy systems that are not usable, hiding behind poor utilisation.
No consultation done to understand local situations, lack of understanding of consideration of what to combine technology with to make it work.		IT has a tendency to think that implementation of systems means delivery. Do not take care to ensure that systems are addressing business requirements or not.
systems in Head office work like a charm, but as soon as you get to the areas find that it does work. Network a problem		

SDLC does not cater for operationalisation requirements resulting in deployment of systems with poor network and insufficient bandwidth. No analysis done to stress test the system against the network strength in the areas and the number of users and transactions to be performed on systems.	Poor analysis (gaps)	There is a tendency to rely on meetings, workshops and engaging one another and think that is sufficient as opposed to physically going out there to see in all reality (situated-ness of use) how things are happening and why certain things are the way they are and consider them during design.
Operationalisation roles and responsibilities are agreed upon up front but issue when it comes to realisation. As such BA have to provide support. This impact on the attention and quality they give to the other projects. More so with off the shelf packages. No operationalisation team. it is currently a huge problem and a gap.		There is tendency by IT people that have been in an organisation for a long period of time or been in operations earlier in their careers to make assumptions based on what they used to know meanwhile business processes have changed and environment has evolved.
in his experience not aware of concerted efforts to try and balance the varying context and situated-ness of use. At the same time arguing that it would be difficult to involve everyone, there needs to be an effective process of identifying key players that will represent uses in differing context, settings and situated-ness of use		
Need to use a JAD session of representation from across the country and not just locally. Structures within the 2 SCC vs NCC play a Pivotal role, large contingent of people at NCC to maintain the segregation of tasks when at SCC one person completing 2 or 3 roles merged into 1 role compared to NCC.	Context	Right questions not asked to ensure understanding of situated-ness of use. And efficiencies created as a results
No business process can cater for all variances, need to std.		No consultation done to understand local situations, lack of understanding of consideration of what to combine technology with to make it work.
System used to automate some of the data capturing and optimise the process e.g. container terminal		Systems in Head office work like a charm, but as soon as you get to the areas find that it does work. Network a problem
Local instructions that's issued, how these link to the general instructions procedures and guidelines that are issues. Especially in operational environment. E.g. Maximum allowable train length in other areas different to national view. How do you then cater for such local dynamics as the process and procedure is different due to		Lack of understanding of situated-ness of use, local practices and work-round impact on efficiencies created. E.g. HHD writing of vehicle list of 2 trains & walk train length once, Heavy and strings on women breast uncomfortable.

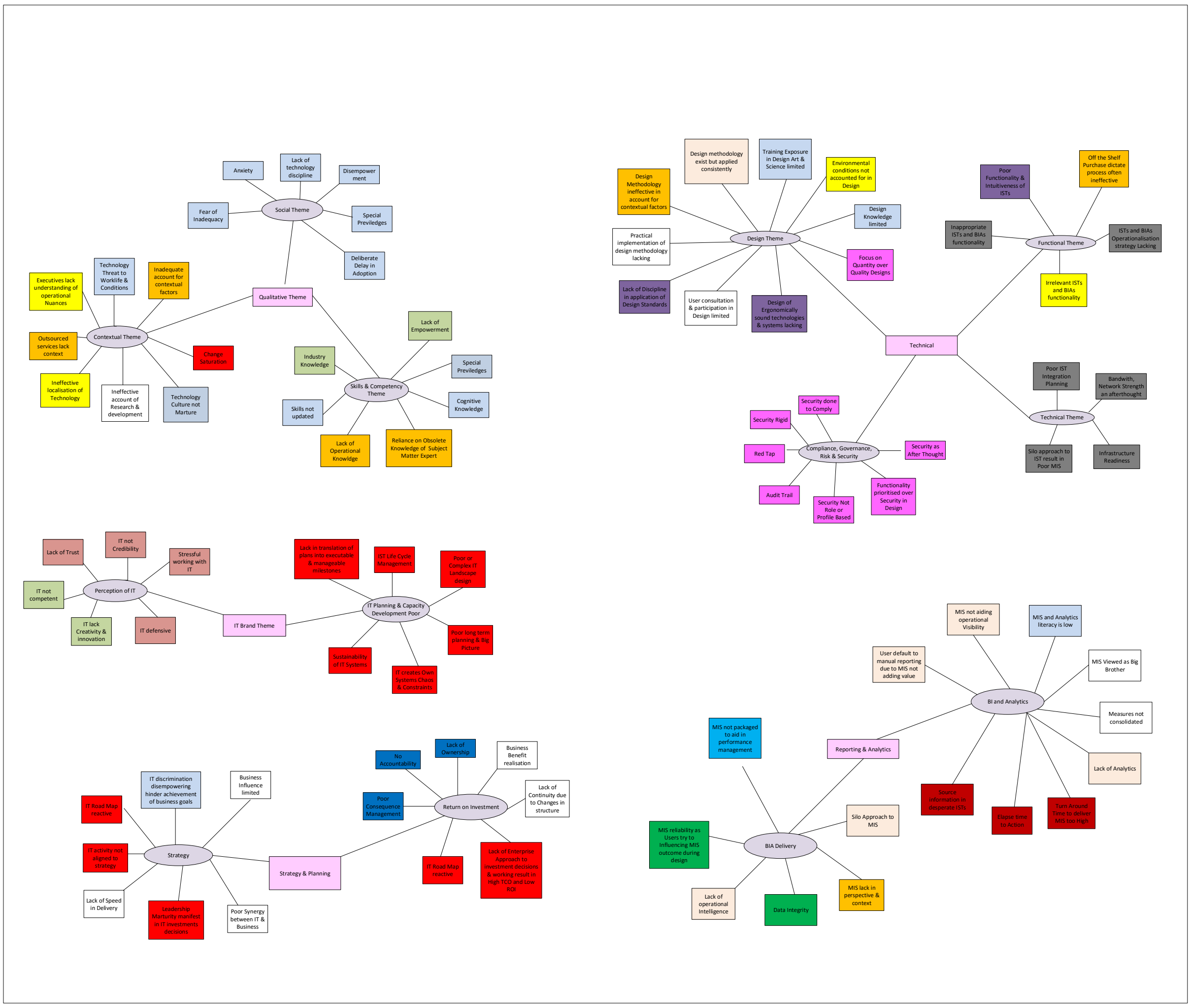
the physical layout of the Yard. Typography		
Not all developers have the same knowledge across the same spectrum of system. Competency is an issue. Result in org not having strong team, too much dependency on certain individuals.		In his experience not aware of concerted efforts to try and balance the varying context and situated-ness of use. At the same time arguing that it would be difficult to involve everyone, there needs to be an effective process of identifying key players that will represent uses in differing context, settings and situated-ness of use
Technology gets updated yet developers skills are not kept up to date in terms of training. They still develop using old techniques which impacts on the usability of the reports.		The question of consideration of social factors never even arises in the SDLC methodology.
Develop bear minimum to get by, only cover things that can be easily picked up by the audit. Pushing the quantity rather than quality. The process will complicate everything especially because we are always under pressure.		Technology gets updated yet developer's skills are not kept up to date in terms of training. They still develop using old techniques which impacts on the usability of the reports.
Security within org. is rigid. It is role based as a result restricting as not all employees perform the same roles. Security needs to be robust and withstand any threats, it should safe guard the information.		
Security try to balance functionality at what cost. Users push functionality but at what cost. Try to block users from doing things they not supposed to be doing. Compromising the organisation. Need to balance it	Security	Develop bear minimum to get by, only cover things that can be easily picked up by the audit. Pushing the quantity rather than quality. The process will complicate everything especially because we are always under pressure.
Security requirements and enforcement not considered during analysis as such do not make it to design as a requirement. Hence development do not consider. Knowledge on how and culture not there. Not linked as that.		Security within org. is rigid. It is role based as a result restricting as not all employees perform the same roles. Security needs to be robust and withstand any threats, it should safe guard the information.
Security often an after-thought. It is costly to address it reactively. Efforts of re-designing the system to cater for security is more compared to what it would have taken in terms of time and cost to		Security try to balance functionality at what cost. Users push functionality but at what cost. Try to block users from doing things they not supposed

proactively address all security requirements. Audit finding. Impact is huge.		to be doing. Compromising the organisation. Need to balance it
Security profile do not take into account the changing user roles and responsibilities and enabling to move from one profile to the other.		Security requirements and enforcement not considered during analysis as such do not make it to design as a requirement. Hence development do not consider. Knowledge on how and culture not there. Not linked as that.
Especially when consultants are involved. Make assumptions about the environment, what people mean when they say certain things. Background knowledge critical		Security often an after-thought. It is costly to address it reactively. Efforts of re-designing the system to cater for security is more compared to what it would have taken in terms of time and cost to proactively address all security requirements. Audit finding. Impact is huge.
The question of consideration of social factors never even arises in the SDLC methodology.		IT are not trained trainers therefore training is compromised and understanding of full capability of the training
Work practices are often overlooked due to the lack of emphasises, measurement on how effectively the systems accommodate work practices in their design. Pressure of timelines to deliver the final analysis specification is also limiting factor.		

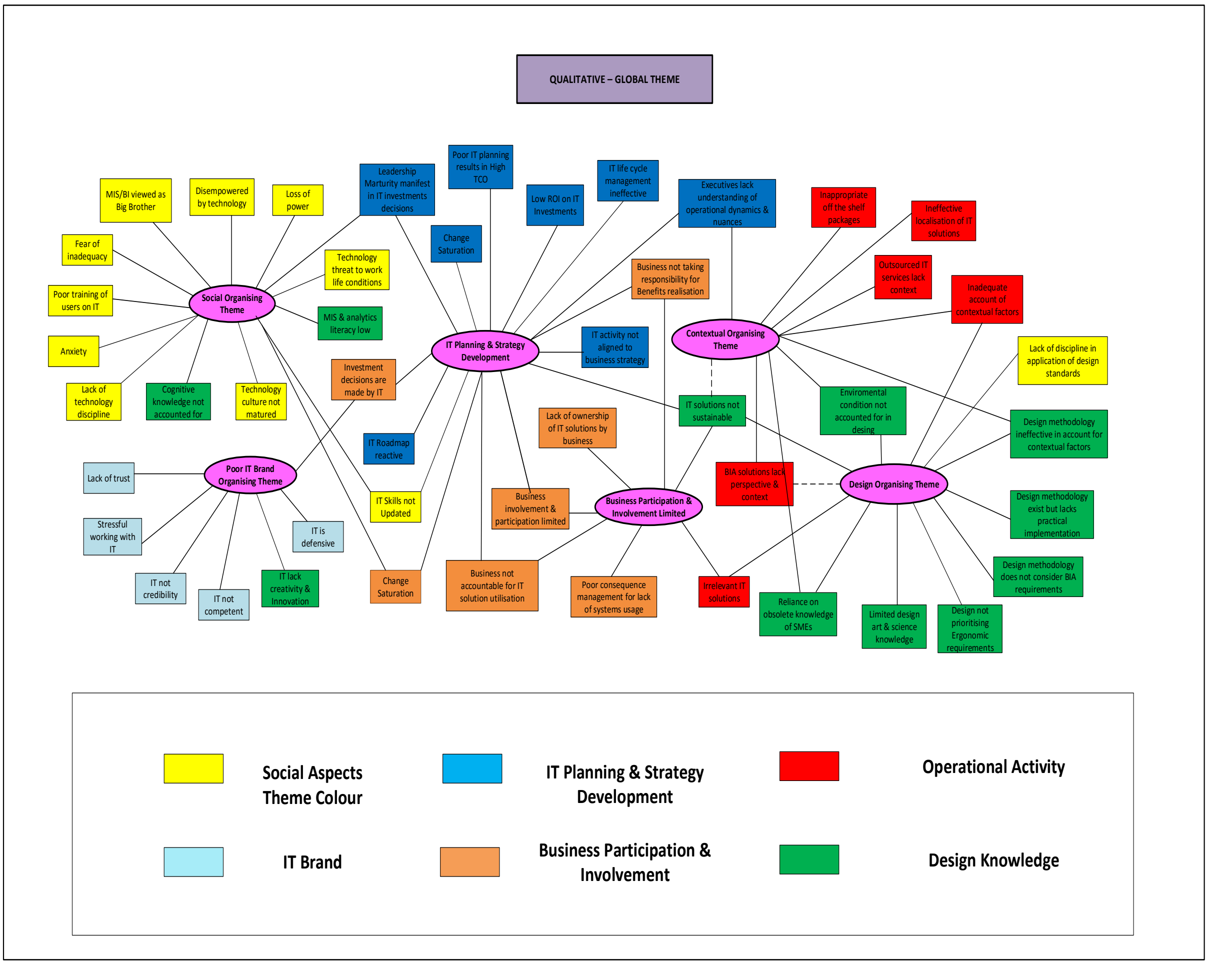
Appendix D: First Cycle Code Generation



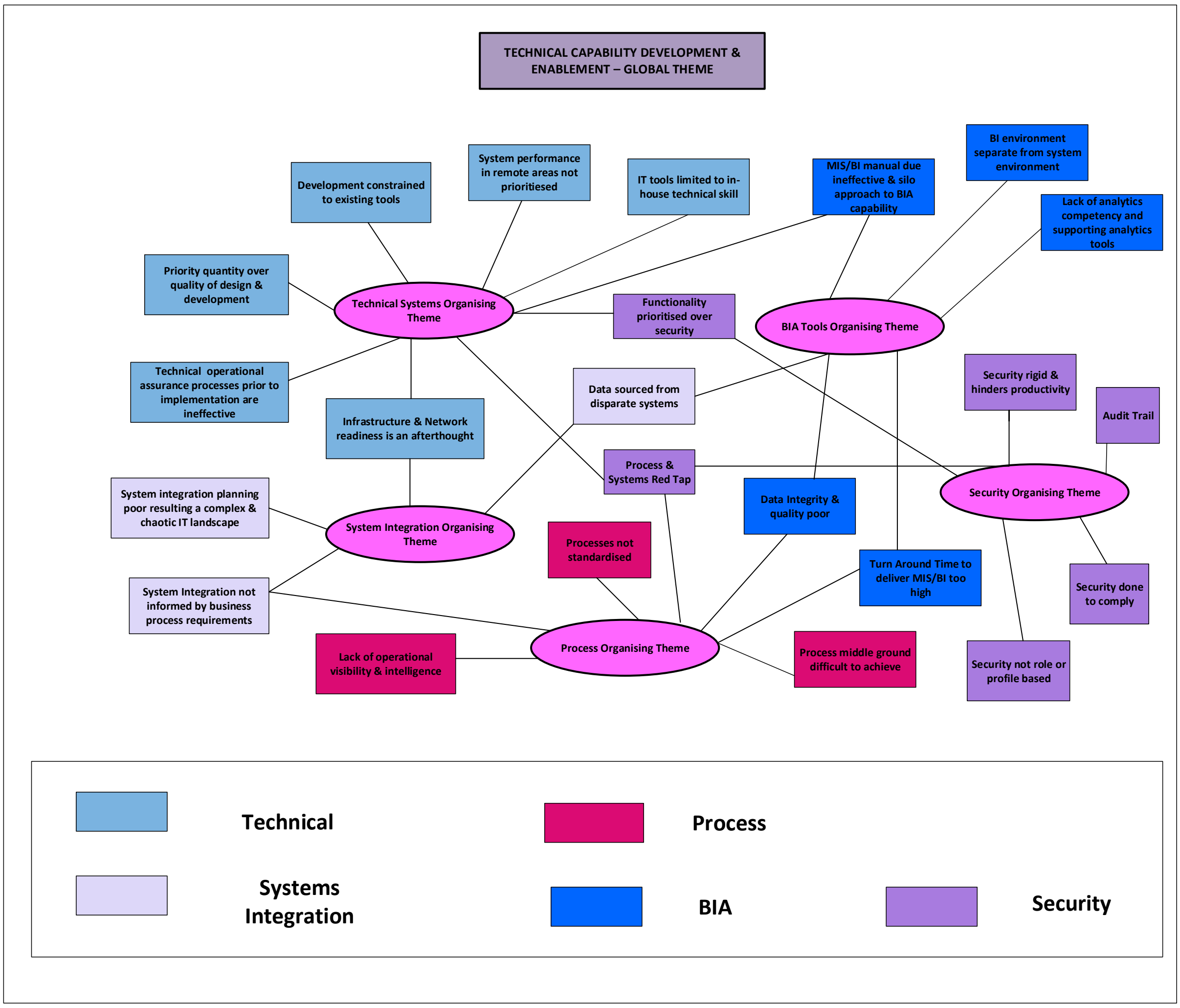
Appendix E: Second Cycle Code Generation



Appendix F: Qualitative Network Themes – Prior determining Themes relationship



Appendix G: Technical Capability Development Network Themes – Prior determining Themes relationship



Appendix H: Focus Group Discussion and Semi-Structured Interviews Consent Forms – Sample

The research topic change was approved by the Wit Study Committee.

University of the Witwatersrand, Johannesburg

Focus Group Consent Form

Researcher Name	Noxolo S. P Dlamini
Student number:	692344
WBS:	PhD Programme
Contact Details:	083 270 0209
	Nuh.kubheka@gmail.com

Background

I am currently employed by Transnet Freight Rail (TFR) as a Business Relationship Manager in the Information and Communications Technology department (ICT). I am studying towards a PhD in Social Informatics through the Wits Business School. My research project is based on TFR case study, a South African Freight Railway Organisation. To successful complete the research study and to address the research study problem, two Implementation Programmes that are currently underway at TFR have been identified. Namely; Integrated Asset Tracking System Programme (IATS) and Train Execution Management System (TEMS).

The Research Topic is "A Social Informatics Perspective on the Design and Reality Gap in Information and Communications Technology Development".

Objective of the Study

There is a growing concern that huge amounts of capital continue to be invested in the development of ICT development methodologies that minimise the design-reality gap, however these have yet to translate into organisational benefits. Empirical research has revealed that this is largely due to the tendency of the development approaches to focus on the technical aspect of systems and technology in-spite of the wide acceptance that non-technical (social and context) factors are a major factor in successful development and use of ICT.

This study will be used as a vehicle to generate insight into the complex relationship between technological artefacts and social aspects in which they are situated and as well as to examine the factors that prevent the shift from technically oriented development methods to methodologies that focus on "joint optimisation of social and technical requirements" (Mumford, 2006, p. 321).

Research Approach and Methods

To address the research study problem, and to attend to the rigour required throughout the qualitative enquiry, focus group method has been identified as one of the 4 data collection methods that will be employed in the study. The other 3 research methods will be semi-structured interviews, observations and documentation reviews.

Participation:

Participation in the study is voluntary. You may leave the study at any time. If you decide to stop participating in the study, your decision will not affect your future relationship with the researcher, and there will be no penalty.

Feel free to ask questions before making your decision whether or not to participate. If you decide to participate, you will be asked to sign this form and will receive a copy of the form.

Procedures:
Participants will be given a set of pre-defined questions to discuss and answer as a group. The researcher will facilitate the process in order to guide and direct the process. Both the researcher and the assistant will remain impartial throughout the process.

The participants are encouraged to answer questions freely and to the best of their knowledge and understanding.

Duration:
The duration of the focus group discussion is estimated to take approximately 1 hour to 1 hour 30 minutes.

Confidentiality:
Information provided and/or shared with the researcher shall remain confidential.

Anonymity:
The researcher will report findings to reflect a group perspective rather than specific individual perceptions and experiences. Where necessary to provide verbatim, a systematic naming conversion shall be employed. However, it should be noted that since the focus groups are group discussions involving other participants, confidentiality cannot be guaranteed, but will be requested and encouraged from each individual participating in a group discussion.

Refreshments:
Participants will be provided with refreshments.

Signing the Consent Form:

The Participant:

I have read (or someone has read to me) this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.

I agree to the focus group being audio recorded. ☑

<u>Important Note:</u> **Audio and / or Video recorder will not be utilised where at least one of the participants has indicated that they would not like the interview to be recorded.**

Signed at Parktown On this day 9

Signature: ______________ Date: October 2013

Researcher:

I have explained the research to the participant before requesting the signature(s) above. A copy of this form has been given to the participant.

Signed at PARKTOWN On this day 9/10/13

Signature: ______________ Date: 9 October 2013

University of the Witwatersrand, Johannesburg

Interview Consent Form

Researcher Name:	**Noxolo S. P Dlamini**
Student number:	**692344**
WBS:	**PhD Programme**
Contact Details:	**083 270 0209**
	Nuh.kubheka@gmail.com

I am currently employed by Transnet Freight Rail (TFR) as a Business Relationship Manager in the Information and Communications Technology department (ICT). I am studying towards a PhD in Social Informatics through the Wits Business School. My research project is based on TFR case study, a South African Freight Railway Organisation.

The Research Topic is "A Social Informatics Perspective on the Design and Reality Gap in Information and Communications Technology Development".

Objective of the Study

There is a growing concern that huge amounts of capital continue to be invested in the development of ICT development methodologies that minimise the design-reality gap, however these have yet to translate into organisational benefits. Empirical research has revealed that this is largely due to the tendency of the development approaches to focus on the technical aspect of systems and technology in-spite of the wide acceptance that non-technical (social and context) factors are a major factor in successful development and use of ICT.

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To address the research study problem, and to attend to the rigour required throughout the qualitative enquiry, semi-structured interviews method has been identified as one of the 4 data collection methods that will be employed in the study. The other 3 research methods will be focus groups, observations and documentation reviews.

Participation:

Signing the Consent Form:

The Participant:

I have read (or someone has read to me) this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.

I agree to the interview being audio recorded. ☑

<u>Important Note</u>: Audio recorder will not be utilised where the participants has indicated that they would not like the interview to be recorded.

Signed at Parktown On this day 15/07/13

Signature: ________________ Date: 15/07/13

Researcher:

I have explained the research to the participant before requesting the signature(s) above. A copy of this form has been given to the participant.

Signed at Parktown On this day ________________

Signature: ________________ Date: 15/07/2013