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Declaration / Verklaring: I declare that this assignment, submitted by me, is my own work and that I have referenced all the sources that I have used. */ Ek verklaar dat hierdie opdrag wat deur my ingehandig word, my eie werk is en dat ek na al die bronne wat ek gebruik het, verwys het.*

Signature of Student / *Handtekening van student*	Themba Sindane
MARK / *PUNT*	

ABSTRACT

The aim of this study is to develop a framework to understand the challenges and benefits of cloud-based Enterprise Resource Planning (ERP) Systems in the mining industry in South Africa. Large corporates and organisations invest a lot of money and resources in the implementation of ERP systems. Much of this goes towards the high licencing and maintenance costs of these systems. Although the CIOs of many of these companies are reluctant to adopt the latest trends in Information Technology (IT) infrastructure when it comes to ERP implementation, one premise is that ERPs are becoming more complex to manage as there is often a shortage of in-house ERP system skills, which impacts on the maintenance of such systems. This has led many mining companies to turn to ERP service providers for their maintenance needs.

This study has four objectives. Firstly, to understand the current state of adoption of cloud-based ERP systems in the mining industry in South Africa; secondly, to define the aspects that influence the move to cloud-based ERP systems in general; thirdly, to understand the type of IT infrastructure and resources needed by South African mining companies to enable them to adopt cloud-based ERP systems; and fourthly, to develop a framework to understand the factors that influence the migration to cloud-based ERP systems in these mining companies.

A thorough literature review was done on ERP systems, cloud computing, cloud-based ERP systems and TOE framework, followed by qualitative research done in the form of interviews. Experts in the field of ERP implementation, as well as some of the core service providers of ERP systems in the South African mining industry, were interviewed to tap their knowledge on the use of cloud-based ERP systems. A total of ten semi-structured interviews were conducted, after which the data were transcribed and analysed using Atlasti.7.0. The topics which emerged from this analysis were used in conjunction with the Technology-Organization-Environment (TOE) framework of DePietro, Wiarda and Fleischer (1990) to construct a framework of the benefits and challenges that affect the implementation of, or the migration to, cloud-based ERP systems. The framework is aimed at assisting the management of South African mining companies to understand the benefits and challenges of cloud-based ERP systems. It is further intended to be used as a readiness framework to determine an organisation's readiness to move to a cloud-based ERP system.

The results of the study revealed that there was a low level of migration to cloud-based ERP systems in the South African mining industry with some experts projecting that it could take up to 10 years for these companies to adopt the cloud deployment model. These experts, however, propagated the migration to cloud-based ERP systems as they believed it would assist these companies with reducing their ERP operational costs; it would allow for more flexible ERP systems, and it would provide for data storage at a lower cost. Despite these advantages, the hindrances for cloud-based ERP system migration include poor bandwidth offered at a high cost; unfavourable maintenance contracts; concerns around data security, electricity and theft; and issues around the mindsets of management, resulting in insufficient change management and a lack of priority in ERP investment. To overcome some of these hindrances, the experts firstly recommend that mining companies adopt a hybrid strategy when migrating to cloud-based ERP systems. This implies that the production ERP system is hosted on premise while only the non-production ERP system is migrated to a cloud computing environment. A further recommendation to mining companies includes a proposal to increase the investment made towards a cloud computing environment to reap future benefits of cloud-based ERPs. Secondly, service providers are recommended to create value propositions for the migration to a cloud computing environment, which should incorporate an extension of cloud computing skills; to revise unfavourable support contracts which could lead to vendor lock-in; and to work on ensuring uncompromised data security. Finally, policy makers are advised to build in regulations to improve the availability and accessibility of broadband to enable the move to cloud-based ERP systems.

Keywords: Enterprise Resource Planning (ERP) system, cloud computing, mining company, readiness framework, migration, challenges, benefits, Technology-Organisation-Environment (TOE) Framework

Declaration

I declare that this study is my own, unaided effort. It is submitted in the execution of the requirements for the degree of Masters of Commerce in Informatics at the University of Pretoria. It has not been presented before for any degree or examination in any other University, and that all the sources I have used or quoted have been specified and recognised by way of comprehensive references. I further assert that I have attained permission and consent to conduct this study.

Name: Themba Sindane

Signature: _____

Date: _____

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Developing a Framework to Understand the Challenges and Benefits of Cloud-Based ERP Systems in the South African Mining Industry

By

Themba Sindane (13367634)

Submitted in fulfilment of the requirement for the degree

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In the Faculty of Economic and Management Sciences

University of Pretoria

Supervisor: **Dr. Lizette Weilbach**

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Abbreviations

- BYOD – Bring YourOwn Device
- CIO - Chief Information Officer
- CM - Change Management
- CRM -Client Relationship Management
- CaaS - Communication as a Service
- DaaS - Database as a Service
- ERP – Enterprise Resource Planning
- EaaS – ERP as a Service
- IS – Information System
- IT – Information Technology
- IaaS - Infrastructure as a service
- MaaS - Monitoring as a Service
- PaaS - Platform as a service
- SCM - Supply Chain Management
- SaaS - Software as a Service
- SARS – South African Revenue of Service
- TA - Thermatic Analysis
- XaaS - Anything as a Service

CHAPTER 1: INTRODUCTION & PROBLEM STATEMENT

1.1 Background to the Research Problem

Since the 2008 economic crisis, mining companies have been looking to downscale their IT spend and consolidate their IT resources and services and realise value or benefits from their IT investments (Gartner, 2013). The Enterprise Resource Planning (ERP) market space is becoming unattractive for IT Investment due to the high maintenance costs, inflexibility and intricacy of such systems (Suriah, 2015). One of the present ubiquitous occurrences, which seem to provide a solution to these hindrances and break down the barriers of business applications, is cloud-based ERP systems.

An ERP system is a computing solution that coordinates complex business requirements and goals by competently making use of IT infrastructure, and simplifying the business processes, data distribution within the company as well as interaction with external parties, for instance, clients and suppliers, in an integrated and cohesive flow in the whole organisation. ERP systems assist organisations to execute their core functions such as managing their expenses, managing their procurement process, managing their material replenishment process, managing their employment engagement process and managing their sales and distribution process which are firmly connected in order to achieve business objectives (Murray, 2001). An ERP system permits all its applications to share a single database and business reporting tools such as Business Intelligence to operate business processes end to end, and to report in real time (Murray, 2001).

ERP systems can be categorised in terms of three features – firstly, they are **informational systems** in terms of providing real-time data for business reporting and simulation of data replication; secondly, they are **organisational systems** in terms of their comprehensiveness, and they are able to offer support to the whole organisation's process with its several ranks of supervision. ERPs enable seamless connection and integration among different divisions or departments of an organisation. Finally, ERPs are **technical systems** regarding their flexibility to support different technologies in the IT environment and their ability to interface and communicate with third party systems or business partners (Schubert & Adisa, 2011).

The main challenges faced by businesses today are the increased competition they experience, as well as an increment in IT costs. How do organisations maximise their ERP

investment without increasing costs, while also supporting their business strategic requirements or initiatives? According to Suriah (2015), ERP systems will need to evolve to solve these operational requirements by following current trends which could have a huge impact on ERP software. These trends include, but are not limited to: cloud computing, mobile computing, social media and data mining or information management (Suriah, 2015). These trends could lead ERP technology to move away from the traditional on-premise ERP deployment architectures to a cloud-based ERP system and mobile ERP system (Schubert & Adisa, 2011). Although this technology is still developing and it might be risky and challenging to adopt, businesses might immediately increase their value if deployed with urgency. Of the entire trend mentioned above, this research focuses on cloud-based ERP systems (Berntsen & Herman, 2004).

The arrival of cloud computing is at the forefront of change in businesses around the world. According to Gross (2012), businesses are seemingly set to adopt cloud computing in current and future ERP systems. An ERP system deployed on the cloud computing environment is an ERP application that is hosted in a data centre and accessed over the Internet. In Information Technology (IT) terms, cloud computing means the inclusion of different sets of software (ERP) or applications (SaaS) and a different set of deployment models where data are stored and computing takes place. Although cloud computing is a platform hosted off premise and accessed over the Internet, the look and feel of the application remain the same as with the regular desktop application (Amar, Vasileios, & Achilles, 2013).

Initially, ERP on the cloud was meant for small and medium size companies to save costs; ease of use; utilise minimum IT infrastructure and cut down on deployment time. ERP on the cloud has now opened the market for businesses across the universe to be more efficient in reacting to the rapidly changing business environment of the present. This could be done by moving their ERP system from a non-premise ERP system to a cloud-based ERP system (Castellina, 2013). Lately, a large number of companies are looking at migrating their ERP systems to the cloud computing environment, and there has been a notable increase in the number of deployments of ERP systems on the cloud in South Africa (SAP, 2013).

Research conducted by ITweb (2014) in South Africa shows that - currently, 18 of the 20 largest corporations are using ERP systems as their business system and three of South Africa's biggest banks are using SAP ERP systems. Additionally, respondents to the research have reported that upgrading their current ERP platforms is their most expensive undertaking with regard to the implementation of their ERP systems. For corporations, the move to cloud-

based ERP system could lead to lower support costs and less challenging platforms to be managed.

Mining businesses everywhere in the world are confronted with many challenges, such as, handling or supervising distinctive operational complications while remaining cost-effective in this economic crisis. Cloud computing has long been publicised as one of the Internet's biggest achievements for transforming numerous industries by refining business operations, proficiencies and precision regarding providing reliable data for business decision-making (Chin-Sheng, Wen-Yau, & Hui-Yu, 2014).

In the next section, the problem statement is presented, followed by the research questions posed to investigate the problem.

1.2 Problem Statement

At the beginning of the 2000s, ERP systems became one of the most extensively used computing application services (Gartner, 2013). ERPs software providers also have recently built up scalable and flexible software solutions that can be customised to meet the specific requirements of individual businesses, while also establishing industry best practices. ERP systems are categorically complex systems which can be influential in performing business processes and as such, they encompass many features for business operations to use. Businesses are unable to leverage the significant business benefits that come with investing in a traditional ERP system such as low cost and data integration (Fengze & Max Erik, 2014).

Large corporates and organisations invest a lot of money and resources in the implementation of ERP systems. A lot of this goes into the high licencing and maintenance costs of such systems and these costs are the most widespread concerns when it comes to ERP system deployment. The deployment costs of software vendors such as SAP and Oracle are accompanied by operational costs and other unknown or hidden costs which comprise 30% to 70% of the total licence costs (Gartner, 2013).

The South African economy has been weakening since 2008 and businesses have not been doing well (Steenkamp, 2014). If one looks at the struggling mining companies in the country, the decline of the economy might be the reason why CIOs are reluctant to procure the latest IT infrastructure when it comes to ERP implementation. On the other hand, ERP systems on-

premise are becoming more complex to manage because very often, there is a shortage of in-house ERP system skills and this normally impacts on the maintenance of such systems. This is why mining companies have been looking to ERP service providers to respond to this challenge of ERP system maintenance.

South African mining companies are seeking to reduce the hardware and maintenance costs of their operational ERP systems. Firstly, to free up their cash flow, mining companies are looking for IT service providers that are willing to be responsible to all of their ERP system maintenance at a lower cost – including hardware, servers, software and business application support (Epicor, 2015). Secondly, as on-premise ERP systems constantly require more processing speed, more data storage and more memory; and all of these come at a high cost, cheaper alternatives would look very attractive. Lastly, mining companies are looking for an IT landscape that will be able to embrace the mobile technology, so that they will be able to access business data directly from their tablets and smart phones (Schofield, 2015).

In the current economic crisis, a comprehensive re-evaluation of ERP system investments seems necessary, which means that there is a need for the IT departments of such businesses to reinvent themselves through the possibilities and advantages offered by IT-driven strategies such as cloud-based ERP systems (Suriah, 2015). Cloud computing is a computing model used by companies that are financially struggling who want to move away from investing heavily in limited computing resources that are internally maintained, to a “pay as you go” model where a company can buy or rent services that are supervised and controlled by cloud service providers (Xi, 2014).

Currently, large corporations have seen the evolution into cloud computing and have displayed a keen interest in joining the cloud phenomenon (Castellina, 2013). However, embracing cloud computing means companies need to rethink their whole ERP system landscape and maintenance process. Cloud computing promises cost reduction on the IT resources, adaptability, infinite elasticity and the innovation that comes with disruption (Armbrust, et al., 2010). How will a CIO make a mining company migrate to a cloud-based ERP system? According to Atul, Amarendra Kumar, and Swapna (2013), cloud computing has been a disruptive innovation in the IT space since the dawn of the Internet, because it affords service providers the flexibility to service their clients anytime and anywhere. According to Bálint, Gyula, and András (2013), mining companies are faced with the cloud computing phenomenon as a trend and CIOs are cautious about their decision whether to join the cloud

computing trend or not because of the risks and challenges that are associated with such a move.

According to Grubisic (2013), companies in Europe who have deployed cloud-based ERP systems have saved up to 25% on their licence and maintenance costs (Grubisic, 2013).The main driving forces behind the migration to cloud-based ERP systems are maintenance costs; productivity; and gaining competitive advantage (Steenkamp, 2014). According to Suriah (2015), the cost efficiency and agility that comes with a cloud-based ERP system has led to some large companies migrating their ERP systems to the cloud computing environment.

The cost cutting exercises that these mining companies are engaged in presently, gave momentum to the movement of ERP systems onto the cloud computing environment as an alternative to the expensive ERP systems hosted on-premise. Cloud-based ERP system adoption in South Africa has been lagging behind, but that is about to change as more and more mining companies gain interest on cloud-based ERP systems by investing resources towards understanding how cloud computing will benefit them and how it will impact on their operational costs (Fengze & Max Erik, 2014). Many mining companies still have concerns around data security and government regulatory requirements which are not evident in South Africa.

A cloud-based ERP system provides a business with the elasticity of IT infrastructure delivered by cloud computing architecture, without buying large IT servers required for running their ERP system. This model is exceptional, considering the IT history of having a data centre, and huge IT bills for employment of personnel in IT departments (Amar, Vasileios, & Achilles, 2013). The mining environment is a very competitive and sensitive industry; therefore, whoever has access to the best resources and most accurate data, can make key business decisions and deliver more value to the business (Grubisic, 2013). The problem for mining companies is their ability to evaluate the feasibility and the risks of migrating their cloud-based ERP system and making a decision around whether it is worth taking the risk or not. South African companies have concerns around data security and data loss, and according to Bassett (2015), there is a perception that they might lose control over their data.

According to Gartner (2013), a legacy system is any system that is not adequately flexible to meet changing business requirements. Most of the ERP systems in the mining industry were bought before cloud computing became an alternative solution, and the ERP market is changing at a fast pace as a result of technology innovations manifesting around the world

(Gartner, 2013). Consequently, mining companies are battling to keep up with the speed of the digital era, and they find that they experience more frequent downtime of their ERP systems due to a rigid and inflexible ERP system landscape.

Furthermore, an ERP system that does not meet the current business needs because it is not agile might lead to a situation where it cannot interpret the primary data in the system to support efficient decision-making of the company (Suriah, 2015). An ERP system that is not able to adjust to meet the changing business environment is an obstacle that strains the company, and its progress is held back by out-dated systems and processes (Amar, Vasileios, & Achilles, 2013)

According to Trope (2014), when looking at migrating to a cloud-based ERP system, it is important to understand the motivating factors and influences for migrating an ERP system to the cloud computing environment, especially in South Africa. In the western countries, the decision to migrate to a cloud-based ERP system is attributable to the value a cloud-based ERP system offers the company. In contrast to this, such a migration decision in South Africa is becoming more complex for CIOs because it needs to be made within the framework of an ever-evolving technological space, changing business requirements and the different business environment from western countries (Salim, 2013). Add to this the slow migration rate of cloud-based ERP systems within South African companies and it becomes increasingly clear that well-documented factors that influence the cloud-based ERP system adoption decision will provide valuable knowledge, especially to CIOs to assist them with their decision to move to the cloud or not (Trope, 2014).

DePietro, Wiarda and Fleischer (1990) have conducted a theory of literature on the TOE framework to evaluate factors which might influence the migration to cloud-based ERP system. Thus, there is a need to carry out a cloud-based ERP system literature review in the South African context because Bálint, Gyula, and András (2013) pointed to some success factors and barriers which might apply to South African companies.

According to the above information, this dissertation aims at developing such a framework to understand factors that influence the migration of cloud-based ERP systems in the mining companies in South Africa. As the move of ERP systems to the cloud computing environment promises to be a significant milestone for the IT industry in South Africa, the contribution that this research makes to the topic needs to be documented properly.

1.3 Purpose and objectives of the research

The purpose of this research is to develop a framework to understand the factors that influence the migration to cloud-based ERP systems in mining companies in South Africa. Based on this purpose, the following objectives of the study were formulated:

- What is the current state of migration to cloud-based ERP systems in mining companies in South Africa?
- What are the factors that influence the move to cloud-based ERP systems in mining companies in South Africa?
    - What are the benefits of having a cloud-based ERP system?
    - What are the limitations and challenges that come with a cloud-based ERP system?
- What types of IT infrastructure and resources do mining companies need in South Africa to migrate to cloud-based ERP systems?
- What would a framework look like which could be used by the management of mining companies to determine and understand the factors that influence the migration of cloud-based ERP systems

This paper, therefore, contribute to the on-going deliberation around cloud computing; ERP systems and cloud-based ERP systems.

1.4 Delineation and Potential Limitations

This study is restricted in the following way:

- This research does not, in detail, deal with the costs of moving an ERP system from on premise to the cloud computing environment.
- This research does not deal, in detail, with the timeline and stages of deploying a cloud-based ERP system.
- This research does not report on ERP systems implemented using a cloud computing environment.
- This research reports on ERP systems at a general level and did not examine the distinction between the different ERP software providers.

- This study does not report on the post-implementation and maintenance of cloud-based ERP systems.

These restrictions mentioned above are not considered as factors that would compromise the integrity and the outcome of this research.

1.5 Underlying Assumptions

- A cloud-based ERP system is a system which provides good value to mining companies in the mining industry.
- A cloud-based ERP system is still a developing platform in the IT market, and many companies are migrating their ERP systems to the cloud computing environment, due to the benefits that come with this phenomenon.

1.6 Significance of the study

This study contributes to the general discipline of the IS field of study, particularly to the research field of ERP system maintenance and deployment. Firstly, the inspiration for this dissertation is the freshness and unknown nature of the cloud-based ERP subject among mining companies in South Africa. It is devoted to mining companies in South Africa who needs to understand the factors that should be taken into consideration when migrating to a cloud-based ERP system (Moyo, 2016).

Secondly, mining organisations have invested millions of Rand in ERP systems; and there is a slow climbing in the number of organisations migrating to cloud-based ERP Systems in South Africa in general, and around the African continent. It is apparent that organisations are finding it difficult to see the business benefit of cloud-based ERP systems and are struggling with their decision to migrate their ERP systems to the cloud computing platform - mainly due to high operational costs (Lechesa, Seymour, & Schuler, 2012).

Thirdly, the challenges, limitations and benefits experienced by companies who have deployed cloud-based ERP systems in developed nations, such as the USA and the UK, have been well documented (Amar, Vasileios, & Achilles, 2013). South African companies could most probably also reap the benefits offered by cloud-based ERP systems to reduce costs

and share in the benefits that will make them more competitive. This could consequently result in economic growth which could be to the country's advantage. Therefore, it is significant for this study to understand the factors impacting cloud-based ERP system migration as an alternative to on-premise ERPs to enable cost efficiency and productivity within the South African mining industry (Maluleka & Ruxwana, 2013).

Fourthly, some research has been done on cloud computing in South Africa, which includes that of Bassett (2015) who did a study to explore the feasibility, benefits, barriers and risks associated with cloud computing for records management; that of Van der Merwe (2013) who particularly studied the benefits/success factors and obstacles of cloud computing in South African banks; that of Maluleka and Ruxwana (2013) who explored how the South African government could adopt cloud computing as a model to enable cost reduction, effectiveness and productivity; as well as that of Trope (2014) who did a study which aimed to develop and subsequently test a model of the institutional pressures and IS innovation appearances that influence company adoption of cloud computing. However, no literature reports on cloud-based ERP system migration factors, such as potential benefits and challenges in the South African context, particularly for mining companies.

This study developed a framework to assist South African mining companies wanting to move from on-premise ERP systems to cloud-based ERP systems. Although much research has been done on cloud-based ERP system adoption in the USA and Europe, no significant research has been done on cloud-based ERP system adoption in South Africa. This aim of this research is twofold: on the one hand it is aimed to be useful to the management of South African mining companies who have to understand and evaluate the factors playing a role when making a decision to migrate to a cloud-based ERP system or not; on the other hand, it is aimed at providing cloud service providers with an understanding of the factors that their consumers consider when they make the migration decision.

1.7 Research Chapter Overview

This dissertation comprises five chapters, with the flow of the chapters provided in Figure 1 below.

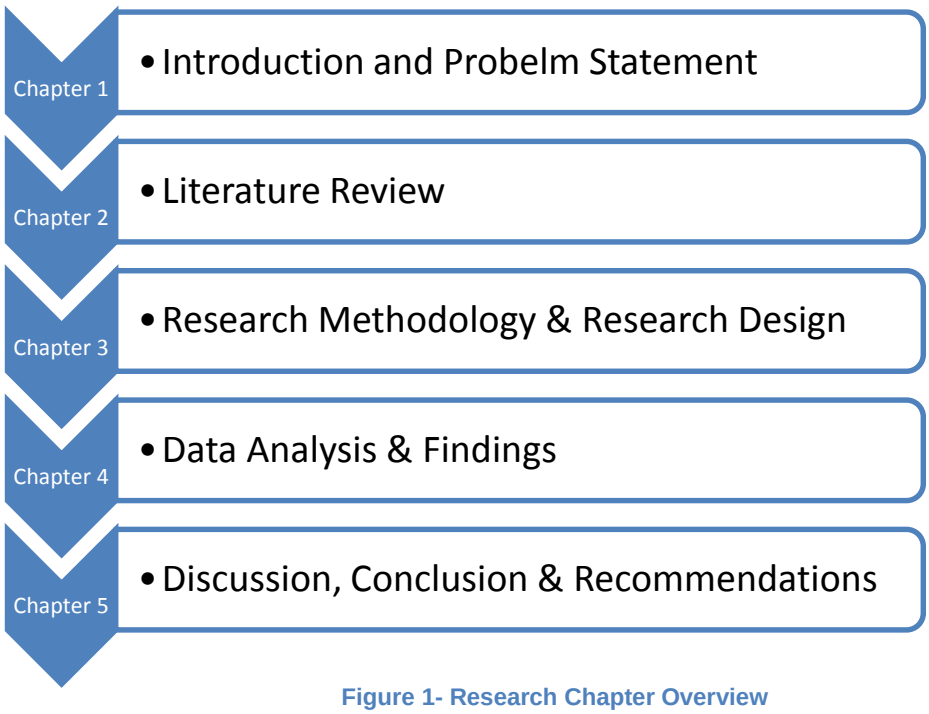

Figure 1- Research Chapter Overview

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reports on the literature that exists on ERP systems, the cloud computing environment and the TOE framework which applies to this research. A general understanding of ERP systems and the cloud computing environment is required. ERP systems reform the method with which companies execute their business processes and offer maintenance and support to various traits of business reporting necessities. To assist South African mining companies with understanding the factors that will influence their decision to migrate such systems to the cloud, it is imperative also to have a proper understanding of cloud computing.The better we understand the barriers and limitations of the software and technology, the greater are the chances of successfully deploying the software (Beedle, 2001).

The first section of this chapter reports on the ERP systems literature with regard to its impact on organisational processes and the nature of ERP deployment models in companies. It defines ERPs in broad terms and then goes into more detail on ERP best practices. It also reports on how the implementation of ERP systems can be restructured and reconfigured and what the effect of it could be on businesses.

The second section of the chapter reports on cloud computing concepts and models, providing detail about best practices and the different cloud-based ERP deployment strategies. The third section discusses cloud-based ERP systems, while the final section of this chapter describes the theoretical TOE framework used in the study and provides a final glimpse of the future of ERP systems.

2.2 ERP Systems

2.2.1 Defining Enterprise Resource Planning (ERP) systems

There is no fundamentally accepted definition of Enterprise Resource Planning (ERP) systems. However, Rosemann (1999) defines Enterprise Resource Planning (ERP) systems as a bundled (but customisable) business software application, which stores information from various departmental tasks and/or procedures and supplies a fully cohesive solution to the company and enables access to the data in real time for business reporting (Rosemann, 1999). ERP systems permit for both the major organisational procedures, such as supply chain

management, financial accounting, and human resource management, as well as integrated software modules which can be adapted to provide support to the main business processes; such as logistics management; engineering maintenance and sales management across the whole company. ERP business application software allows companies to achieve an integrated flow of information between various departments (Duranti, 2014).

Initially, Enterprise Resource Planning systems were designed to supervise the material replenishment process in the industrial sector. In recent times, ERP acts as a bundled software solution with a significant contribution to the needs and plans of a company (Esteves & Pastor, 1999). An ERP system is designed around the functioning view and the intentions or the strategy of the enterprise, while concurrently and securely connecting all business functions of the company in one database platform. This definition puts integration of business processes by ERP systems at the core of its functions, between various departmental/division networks, and more precisely, operational departments within an organisation. These include financial accounting, sales management, supply chain management, human capital and payroll management - which are all business processes embedded in an ERP system on a single database platform (Hotăran & Horga, 2011). Most scholars and academics of Enterprise Resource Planning define ERP systems by putting importance on its capability to integrate all functioning departments in an organisation (Murray, 2008).

An Enterprise Resource Planning system is a wide-ranging system of handling and supervising all company infrastructure and data flows. Moreover, such ERP systems can be extended and be integrated into areas of e-commerce with business partners such as SCM (Supply Chain Management), B2B (Business-to-Business) and CRM (Customer Relationship Management) (Duranti, 2014). This type of innovation and development places the Enterprise Resource Planning system in the e-commerce space, while also making it an extensive management system for business functions and relationship or association management between various participants, be it business partners, vendors and/or our clients (Hotăran & Horga, 2011).

An ERP system is best defined as the customisable software application suite that incorporates information-based processes and data throughout functional departments in a company with the ERP system Best Practice procedures (Vandaie, 2008). Best Practice methods regarding ERP systems are described as third-party evaluations of best practice procedures carried out by various organisations' processes. ERP systems present best procedures which are academically acknowledged procedures of managing business

processes or functions at that particular time, and represent the ultimate customs and principles embedded in the functioning of the ERP software modules by the software suppliers (Sachs, Laurindo, & Tomi, 2004).

Gartner (2013) indicates that the best procedures embedded in the ERP system emanate with comprehensive documentation for beginner ERP system users, directing them about what procedure activities or which steps to take, when and by what method. It is consequently merely rational to contend that an ERP system is not business software consisting of modules or applications; but also a business outline that influences the way individuals work by giving its own characteristics which makes provision for business strategy to flourish within a company. Principally, ERP systems deliver process directives for the place of work (Gartner, 2013).

Consequently, a company that implements an ERP system must, for the most part, deploy the third-party anticipations about the business and transform the existing methods and processes to adapt to best practice. These best practice procedures that emanate with ERP systems do not pay sufficient attention to how the South African corporate environment is affected by the course of implementing an ERP system, furthermore, the actual operating and utilisation of the ERP system, and whether or not the ERP system is compatible with the South African corporate environment; and its values (Gros, 2011).

The leading software vendors or providers of Enterprise Resource Planning (ERP) systems are Microsoft, Baan, JD Edwards, ORACLE, SAP and PeopleSoft. SAP AG, which was started in Germany, in 1972, is the ultimate prevalent ERP system in the South African business environment and one of the biggest ERP systems at the pole position across the whole world with a reasonable segment of 12% in the ERP sector (Gartner, 2013).

2.2.2 Traditional ERP systems

Different IS scholars or researchers refer to an on-premise ERP system as the traditional ERP system. For companies, this meant that when a business bought an ERP system, it was installed on the customers' business servers or computers (Elbardan & Ali, 2007). A traditional ERP system allowed companies to conduct and execute all the maintenance related to that ERP system itself on their premises. This maintenance included providing the IT infrastructure for the ERP software; customising and the deployment of the ERP system. Nevertheless, with

such a model, the business will have more control regarding managing and gaining access to their data (Machal, 2013).

An ERP system enables the seamless flow of information in a company because it comes fully integrated with business applications in almost every aspect of the business. These business applications can be found in any organisation's computers connected to the server that enables employees from different departments to communicate in real-time (Berntsen & Herman, 2004). By analysing Figure 2, we can see that all business departments are integrated into the ERP system which means data can flow effortlessly throughout the business. In other words, the entire company has access to the same data in real-time (Esteves & Pastor, 1999). Even so, Gartner (2013) holds that ERP systems will need to be constantly upgraded to the latest version. Ultimately, then, an ERP system is a life-time investment and a software with a sustainable life-span. Figure 2 shows a graphical design of an ERP system with the related applications.

Figure 2 - Typical ERP Business Applications (Esteves & Pastor, 1999)

2.2.3 Life Span of a Traditional ERP System

The life span or life cycle of an ERP system is a key aspect in consideration of an ERP investment. Figure 3 shows the life cycle of an ERP system.

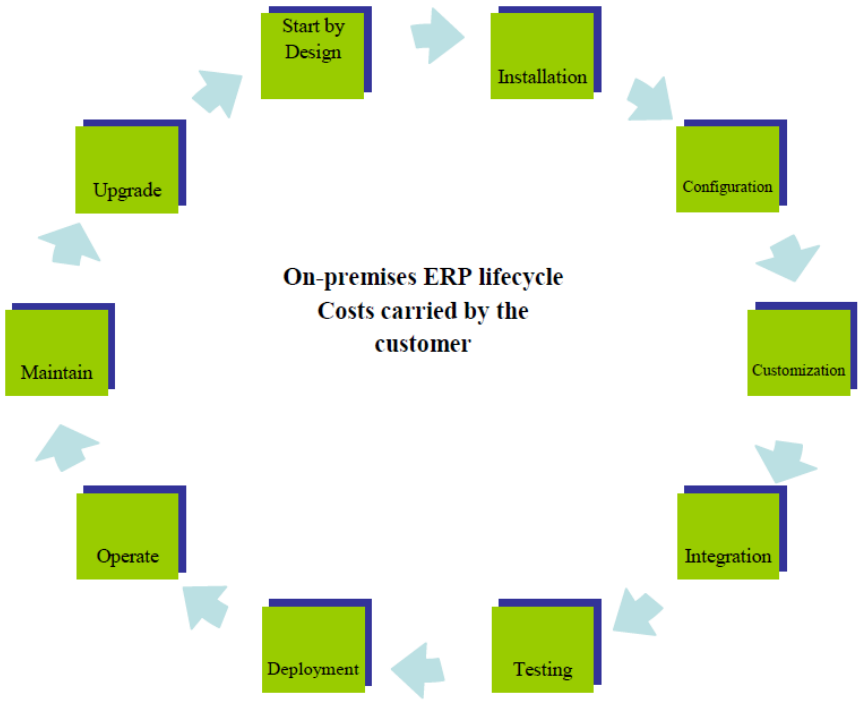

Figure 3 - Traditional ERP Life Span (Machal, 2013)

The companies that have implemented the traditional ERP system model have to sustain and service their ERP system until the conclusion of the life interval. In other words, for a company to realise the anticipated benefits from an ERP system with a complex maintenance life cycle, with the potential catastrophe if not mintained, it will need proper ERP system maintenance which comes at an additional cost (Gros, 2011).

Nevertheless, it is suitable to have a maintenance plan for the system to avoid an ERP system disaster; there are further challenges that could result from the misalignment between the business and ERP system over a period of time. ERP vendors consistently release new versions of their ERP software package which may not necessarily be in line with the business requirements at the time as Figure 4 shows.

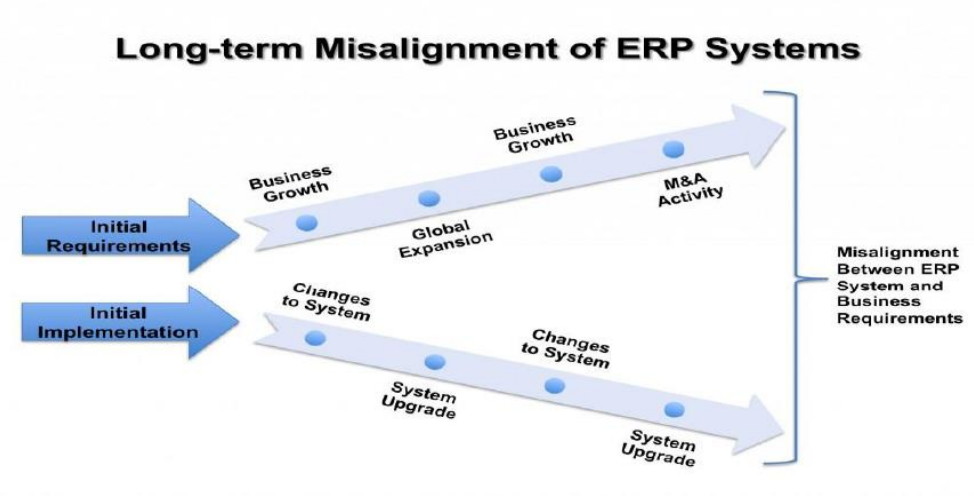

Figure 4 - Long-Term Misalignment of ERP System (Machal, 2013)

Figure 4 illustrates that the upgrades performed by companies over a period of time might create a misalignment between the initial business needs and deployment of the ERP system, which is both time consuming and costly. Hong and Kim (2010), in their case study, have identified critical success factors for ERP deployment, such as adopting an appropriate ERP life plan at an early stage (Hong & Kim, 2010). They insisted on proper planning and management of the ERP system, and adequately trained users to use their different ERP modules. In South Africa, the most shared issue among mining companies related to ERP system deployment is overspending of the budget allocated to the ERP system deployment.

Essentially, these traditional ERP system problems and complaints from different companies have required ERP software vendors to think about different and efficient ways to minimise the costs and support matters of an on-premise based ERP system. The advancement of the Internet and the growth of online services have pushed ERP providers to offer services such as cloud-based ERP systems (Fengze & Max Erik, 2014).

2.2.4 ERP Deployment Models

The emergence of cloud computing gives ERP customers a series of deployment models to choose from, such as hosted ERP system; on-premise ERP system and hybrid-ERP system deployment. In this literature, we review the various ERP deployment models that are currently available in the IS field of study. In the cloud computing section as well as in the cloud-based ERP system section of the literature review, the different parts of cloud computing delivery models and cloud-based ERP delivery models are presented which will assist in unpacking this sub-topic.

- **On-premise ERP** – this is a solution where ERP software providers are selling to companies via a licence model. The ERP software is installed on the business client servers and computers. The company has control of the IT infrastructure, and it handles and absorbs the cost of maintaining the ERP system (Fredriksson & Ostling, 2012).
- **Hosted ERP** – this is a solution where a client rents out the hardware from the ERP supplier and also leases the licence. The ERP system is delivered via a private cloud (Duranti, 2014).
- **Hybrid ERP** – this is a solution for companies where some portions of the ERP system landscape are hosted in the cloud computing environment, and some are hosted on-premise. The hybrid approach could be used where sensitive business data is hosted on a private and secluded cloud computing environment and not so critical data can be housed in an open public cloud (Amar, Vasileios, & Achilles, 2013).

2.2.5 Motives for and Benefits of ERP systems

ERP Deployment is still the foremost concern for businesses in South Africa because ERP implementation needs an enormous monetary and workforce investment. It is vital to conduct a study on South African organisations' ability to deploy and support their own ERP systems to minimise the likely demoralising effects of poor ERP system deployment (Aslam, 2010). The upsetting effects may comprise unintended fiscal expenditures (over budget); the incapability to perform core business processes in the ERP system; and consequent threats to regular business functions. Moreover, the outcome of failed ERP deployment may result in the loss of corporate integrity in the industry; low employee self-confidence and low production and thus, a loss of business income (Hong & Kim, 2010).

Elbardan and Ali (2007) contend that software service providers were behind most Enterprise Resource Planning system deployments with a drive of business process re-engineering (BPR) which is a primary function of Enterprise Resource Planning system (ERP) implementation in any organisation. These software service providers were presenting ERP systems from various software suppliers as a solution and answer to their operational business problems and they could offer an integrated ERP system on a single database platform.

According to a report by Epicor (2015), corporates in South Africa are still spending enormously in ERP system on maintenance even though this is expensive due to the

compulsory licence fees that emanate with the ERP business software (Epicor, 2015). There are other expenses in between which include professional fees; hardware costs and personnel training cost. This research identifies other overheads at the operational level of businesses through change management process and business process re-engineering (Elbardan & Ali, 2007).

For years now, among other main benefits for employing ERP systems in their businesses, top management were looking to replace old existing business systems that included attaining competitive advantage over their peers in the market while improving the performance of the company; unified data for decision making in real time and the lowering of workforce costs (Epicor, 2015). Other barriers for ERP system deployment included process standardisation and adjustment across various countries and different locations; the integration of various functional areas; and improved authorisation and security control in the system (Esteves & Pastor, 1999).

Nevertheless, when organisations embark on an ERP system deployment model, they have different motives and intentions; both inner and peripheral in nature (Hawking, Stein, & Foster, 2004). Otieno (2010) categorised three drivers/reasons for deploying traditional ERP systems. These are: Strategic, Operational and Technical (see Table 1):

Strategic	Operational	Technical
1. Normalisation of business procedures across the business	1. Business Process Re-modelling	1. Single and centralised database warehouse
2. Improve customer familiarity and endowment	2. Increase supervision and control for management	2. Business support system replacement
3. Integration of business processes	3. Financial cost reduction and better production process	3. Governance and Risk Model
4. Augment decision-making procedure	4. Data Integrity and visibility	4. Real-time data
5. Cohesiveness and Inclusiveness of information	5. Industry Best Processes	5. Flexibility

Table 1 - Drivers and Reasons for Implementing ERP systems (Otieno, 2010)

According to a study conducted by Epicor (2015), there has been an increase in ERP systems implementation in South Africa among various companies and organisations, particularly in mining companies and such ERP systems have since matured (Epicor, 2015). It has thus become vital to research new trends, such as cloud computing in ERP markets, where growth can be attributed or expected now and in the near future, and to document these findings adequately.

ERP system deployment could affect critical business processes and adjustments which will potentially necessitate a change in management practices that will ensure comprehensive supervision (Rabaai, 2009). The ERP software packaging is not the same for an in-house designed business support system because an organisation will be required to adjust its methods of doing business to act in line with the entrenched ERP standard processes of the system (Aslam, 2010).

Epicor (2015) has pragmatically exposed that a change in the management of procedures is the most important aspect influencing the achievement or botching of a traditional ERP system deployment, and any deviation will cause ERP performance issues within the company. ERP software vendors normally undertake that the ERP system epitomises the most important best business practices in the industry; and additionally, that most business will adapt ERP system to their unique operational models (Hong & Kim, 2010).

ERP experts or internal business specialists cautiously study the current business procedures and models to endorse IT system solutions that are planned to carry out far-reaching changes to the company procedures. The main task in ERP system implementations is the recognition of gaps between the ERP system's normal processes and functionality; and the overall operational needs of the organisation. An acceptable solution should then be determined to alleviate those identified gaps (Elbardan & Ali, 2007). Occasionally, the gaps arise from the conflicting business needs of a company process owner or country-specific legislation and needs, and/or the requirements that ERP software suppliers have not yet catered for in their current design (Hotăran & Horga, 2011).

A successful deployment of ERP systems is connected to the magnitude to which the ERP software supplier accommodates the business process owner in the quest of meeting the operational requirements (Baxter G. , 2010). To fill the gaps between what the ERP business solution can offer and what the business needs, the process owner may design a customised add-on to the ERP package to effectively provide for such operational requirements (Hotăran & Horga, 2011).

In the business process re-engineering framework that comes with normal ERP system, the main objective is to re-model existing business processes in accordance with ERP best business practices which are more suitable for the organisation and their customers. Thus, business process re-engineering can be understood as a framework for improving business processes to realise organic growth in the company and this case is driven by IT strategy (Otieno, 2010). It is consequently imperative for businesses that embark on an ERP system deployment project for business process re-engineering to take on an ERP system to be used as an enabler of processes and a practical tool to accomplish corporate strategic goals and objectives. ERP systems necessitate an alignment and ratification between the business strategy and the IT strategy (Otieno, 2010)

2.3 Cloud Computing

The drive behind the concept of cloud-based ERP systems stems from the cloud computing phenomenon. Essentially, for a reader to understand cloud-based ERP systems, it is necessary to lay out cloud computing in detail first.

Cloud computing can be described as a service which allows present, appropriate and on request web access, linked or connected to a collective pool of computer infrastructures, such as computer servers, data security and storage and business software applications in a data centre. These services can be readily made available to a business with less cost and minimised effort (Avinash & Mangesh, 2014).

Cloud computing is fundamentally a data centre which consists of business hardware and software elements with network services and business applications that are placed on the cloud environment and accessed via the broadband network (Bassett, 2015). Cloud computing is a comparatively new concept in computing, which is why there is no standard definition for it yet. However, it has become a paramount computing environment to get cloud computing as the service (after electricity, telephone, and water) to meet the daily operation of a business (Raj Kumar & Dr. Reena, 2013).

In an attempt by Balint, Gyula and Andras (2013) to define cloud computing, it is described as a model or framework that provides a steadily available, and flexible deployable service that can be configured to customer requirements, and delivered over the Internet at any given time and from any place with minimal operating effort or support from the supplier. In broad terms, however, it can be described as a move away from a company owning technology resources to a company sharing technology infrastructure in which customer operators receive data utilities, on-demand request from a supplier accessed via the Internet which, in this case, is the cloud.

2.3.1 Important Features of Cloud Computing

Duranti (2014) describes five important features clients must embrace when looking at cloud computing solution (Duranti, 2014). There features include:

- **Expansive Network Access** – The network provided by the service provider is capable of handling various platforms, such as mobile and normal computer access via the cloud computing environment.
- **On-demand Self-Service** – A client needs to have the capability to unilaterally make provision for computing needs, such as network storage automatically without requiring human intervention from the cloud service provider.
- **Resource Sharing** – The suppliers' computing resources (e.g. processing, memory and network bandwidth) are pooled to serve various clients irrespective of the country or time and can be flexibly allocated or redistributed according to customers demand.

- **Rapid Elasticity** – The cloud service provider can ensure provision and scale rapidly, both outward and inward, and in proportion to the clients' demand and as such, should be unlimited and readily available for usage at any given time.
- **Measured Utility** –The customer and the supplier must be able to monitor, control, report and provide visibility of the resource usage. The provided cloud systems should automatically monitor and enhance resource use.

2.3.2 Models of Cloud Computing Delivery

Cloud computing presently offers different forms of services to clients. Figure 5 shows the delivery models that have been used and recognised widely in the IS field (Bálint, Gyula, & András, 2013). Other models are still under development or being researched as cloud computing advances. These models largely differ with regard to the level of control provided to the client. In this literature, we review the various cloud computing deployment models that are currently available in the IS field of study.

In the ERP system section of the literature review, the different parts of ERP deployment models were presented which assist in unpacking this sub-topic. Figure 5 shows the level of control for each application layer associated with the specific delivery model.

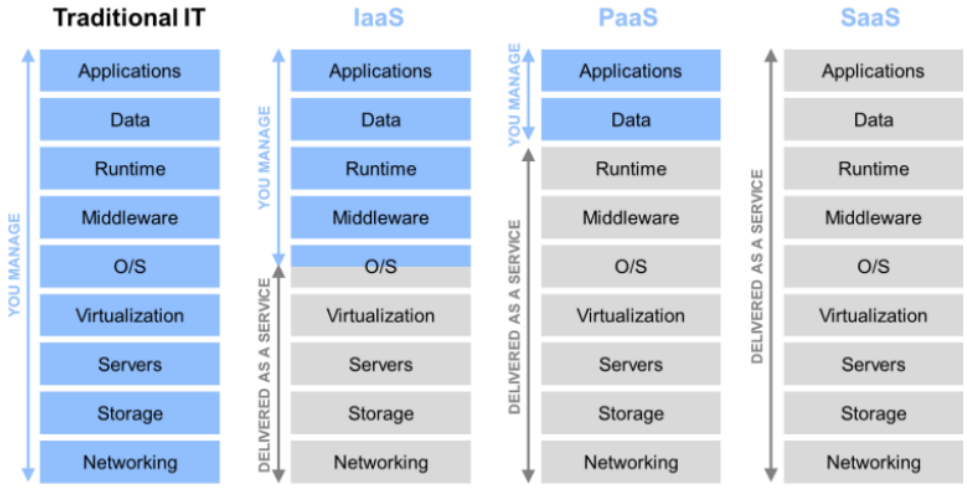

Figure 5- Cloud Computing Delivery Models (Duranti, 2014)

- **SaaS (Software as a Service)** – This is specifically developed and delivered for end-users and can be an operational application system that is hosted in the cloud computing environment. An example of the most competent SaaS solution on cloud infrastructure is web-based e-mail which can be accessed from different devices over the Internet. In this model, the cloud service provider offers the cloud computing infrastructure, and the

customer does not control or manage the backbone of the infrastructure (Avinash & Mangesh, 2014). The cloud service provider offers the application system or the software with the possibly limited configuration settings.

According to Bálint, Gyula, and András (2013), SaaS is the most popular delivery model used for ERP systems. The client has full control of the data, and the system can be accessed in a scalable way. In this model, the cloud service provider is accountable for the operation and the maintenance of the business application software (Bálint, Gyula, & András, 2013).

- **PaaS (Platform as a Service)** – This model or method provides clients - mainly developers - with the competency to design and implement customised applications onto the cloud environment; using a set of software and development tools supported by the service provider. Developers create applications by exploiting the core cloud infrastructure, such as servers, network, storage, or operating systems over the Internet (Castellina, 2013). According to Kumar and Reena (2013), this model is not applicable for cloud-based ERP system because it does not give customers control of the application and the data residing within the infrastructure, and developers mostly use it for web-applications (Raj Kumar & Dr. Reena, 2013).

- **IaaS (Infrastructure as a service)** – This model provides clients with a virtual platform as a cloud infrastructure which has processing, storage, networks and data centre space. In this case, cloud computing introduces a ‘pay as you go’ concept which will allow a company to pay for the resources it has consumed, and to acquire more online resources as soon as it is required (Fakeeh, 2014). The ‘pay as you go’ concept resembles that of the ‘pay as you go’ for electricity and water procedures, as applied by municipalities. In the IS field of study, this concept is sometimes referred to as utility computing.

This model applies to a cloud-based ERP system as the backbone of the cloud infrastructure where an ERP system can be migrated to a cloud computing environment and will offer mining companies huge opportunities regarding managing an ERP system. The client does not supervise or have control over the cloud computing infrastructure. However, the customer has control over all the deployed business software applications and the data residing within it (Avinash & Mangesh, 2014).

In addition to the standardised three cloud delivery model types explained above, the following delivery models are also presented (Duranti, 2014):

- API as a service (APIaaS) - is a cloud delivery model that enables the hosting of application programming interfaces (APIs) and the creation of multi-entry points for API calls such as TC/IP and XML web interfaces.
- Database as a Service (DBaaS) – is a cloud-based database for storing and the management of relational and structured database and it operates the database similar to Oracle and SQL.
- Monitoring as a Service (MaaS) – is a cloud delivery model which facilitates the monitoring of deployed applications, servers, system and other functionalities on the cloud environment.
- Data Security as a service (SECaaS)–is a cloud delivery model which facilitates security management over the cloud environment, such as anti-virus software and user provisioning.
- Data/information as a service (DaaS) – is a cloud delivery model where information and data is stored in the cloud computing environment and is accessible by different applications and devices which are an efficient way of processing and distributing data. This model can also facilitate the analysis of information and the usage of this information.
- Test resource as a service (TaaS) – is a cloud delivery model in which testing activities such as regression testing, testing of ERP system, security testing is performed by a cloud service provider on the business applications that are in the cloud computing environment.

2.3.3 Types of Cloud Computing Environments

According to Atul, Amarendra, and Swapna (2013), there are four different types of cloud computing environments. These types differ with regard to where the cloud computing infrastructure is located and the service part which is shared between the users.

- **Private Cloud Computing** – established exclusively for a single organisation and all its data and processes are handled on a one-on-one basis. The organisation or the cloud service provider can manage and control the cloud infrastructure. This type can be used for migrating ERP systems from a non-premise system to a cloud-based system.
- **Public Cloud Computing** – established purely for public use with all its services available over the Internet. The supplier owns and manages the cloud infrastructure.

- **Community Cloud Computing**– a cloud infrastructure that is shared among various organisations and supports a specific project for the community or companies like SMEs that have similar cloud computing requirements.
- **Hybrid Cloud Computing** – a cloud computing infrastructure that has a mixture of public cloud computing, private cloud computing and community cloud computing which can be developed for a specific purpose, such as data sharing and application portability.

From a user point of view, the software is accessed via the Internet from a server that stores it. See Figure 6:

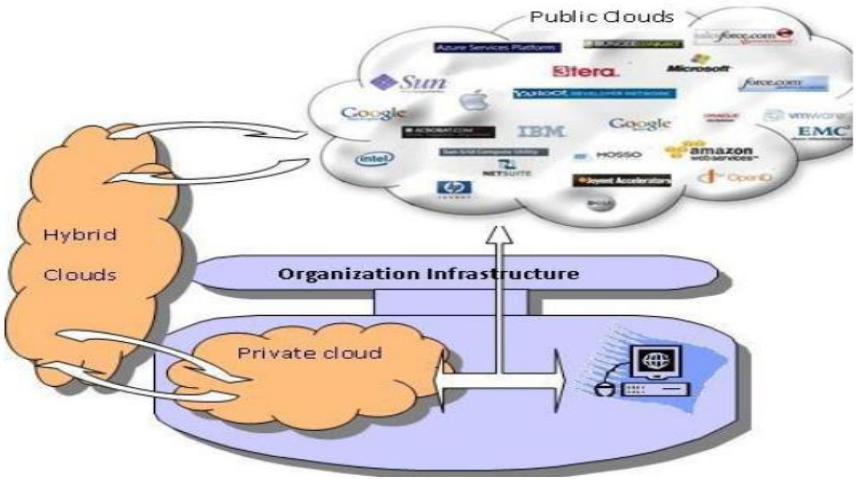

Figure 6 - Cloud Computing Environment (Atul B, Amarendra Kumar, & Swapna S, 2013)

Equally, in the case of deploying an ERP system, it is a system that is hosted on a specific server in the cloud computing environment, and users have a permit to access the ERP system through the network with organised prior exceptional authorisation granted for use "anytime, anywhere" with the company. This cloud computing environment allows one to share information and collaborate with other departments in real-time while making sure their data is stored securely in the cloud computing infrastructure (Chin-Sheng, Wen-Yau, & Hui-Yu, 2014). Accordingly, mining companies which have to decide on migrating or deploying cloud-based ERP systems will have to choose between these kinds of cloud computing environments. Organisations for which data security is essential will rather opt for a private cloud computing option (Avinash & Mangesh, 2014).

2.4 Cloud-based ERP Systems

2.4.1 Defining Cloud-based ERP systems

The adoption of a cloud computing environment has grown at a rapid rate in the last few years. In the mining industry of South Africa, large companies that use ERP systems have however, been reluctant to migrate their business applications to the cloud computing environment (Ford, 2015). More recently, such companies have shown interest in this idea of having cloud-based ERP systems, and it is now regarded as an option which can lead to many cost benefits for this industry (Gillwald, 2015).

For decades, ERP systems have been deployed as standard software that meets the requirements of the business. With the emergence of cloud infrastructure, ERP software suppliers are investing heavily in cloud-based ERP systems and this deployment option is receiving more and more focus as a possible way of delivering ERP software (Epicor, 2015). Cloud-based ERP systems offer companies the possibility of renting their entire ERP system landscape from multiple service providers, including software service providers and infrastructure service providers. Cloud-based ERP systems enable communication between the ERP supplier and the customer to provide an XML format web service that allows the execution of ERP functionalities (Chin-Sheng, Wen-Yau, & Hui-Yu, 2014).

A cloud-based ERP system can be conveyed as a low-cost vehicle for companies to achieve the same value provided by a standard business software package which is commercially available off the shelf. A cloud-based ERP system is different in that it has a low initial investment cost, no servers to procure, and the necessity to only train a limited number of IT personnel. A cloud-based ERP system is an outsourced IT service. This is accomplished by hiring a third-party service provider to perform some or all of the IT support functions for the company. This model changes the focus of the IT staff from concentrating on maintaining the ERP system, to supervising the processes and services that come with the ERP system (Machal, 2013). Figure 7 shows a representation of a cloud-based ERP system.

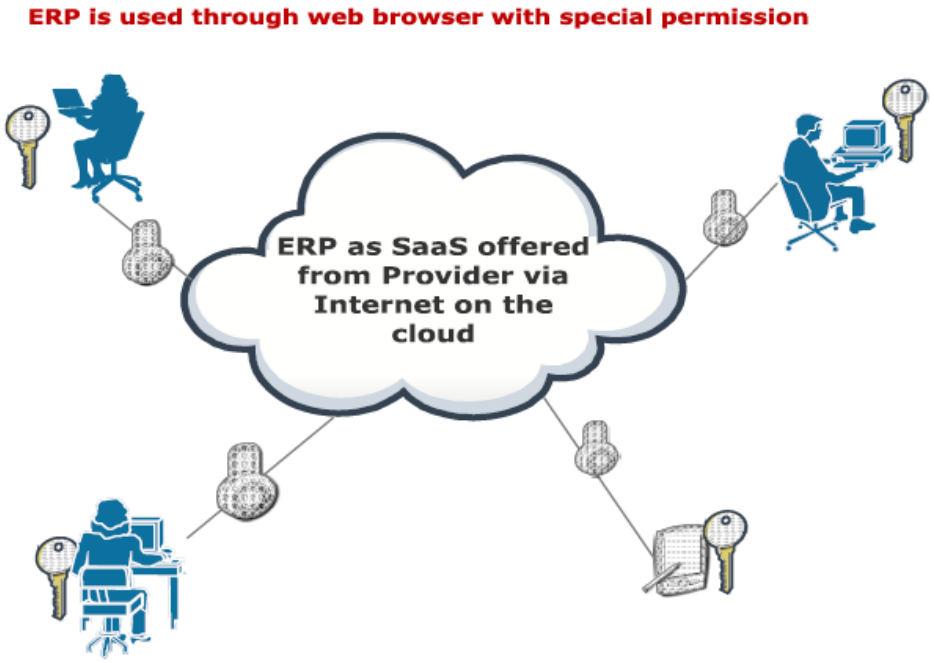

Figure 7 - ERP on the Cloud (Machal, 2013)

As can be seen from Figure 7, cloud-based ERP systems are not installed on the enterprise's servers but are rather installed on the cloud service provider's servers at the data centre. Access to these servers is gained through the Internet. The enterprise's ERP users will only require a user-ID and keyword to gain access to the system. For the user, the access seems to be no different than when accessing a traditional ERP system which is hosted on the organisation's premises (Avinash & Mangesh, 2014).

2.4.2 The current state of cloud-based ERP systems adoption in South Africa

In South Africa, the migration to cloud-based ERP systems is still in its development stage even though our discussion dominates cloud computing. ERP systems have been deployed as standard software that meets the requirements of the business, and now with the emergence of cloud infrastructure, ERP software suppliers are investing heavily in cloud-based ERP systems and cloud computing is receiving more focus as a new way of delivering ERP software (Epicor, 2015). Although these are the trends, there is limited data on the state of migration from traditional ERP systems to cloud-based ERP systems within the South African mining environment.

One of the key drivers of cloud-based ERP systems is the mushrooming of data centres of different service providers such as MTN, Internet Solutions and Vodacom (Moyo, 2016). The

state of adoption of cloud-based ERP systems also depends on the segment of the ERP market investigated. For companies in South Africa, a cloud-based ERP system offers companies an excellent opportunity to transform their processes towards a data-driven approach and cost efficiencies around maintaining the ERP system landscape. The fact of the matter is that most South African companies are not ready to adopt or trust a cloud-based ERP system as it forms the core of their business and failure could be critical - hence the slow adoption rate (Lechesa, Seymour, & Schuler, 2012).

Reports of software vendors such as Acumatica and One-channel indicate that there is rising demand for cloud-based ERP systems and that companies procuring cloud-based ERP system have exceeded those who still have traditional ERP systems (the future Legacy ERP systems) and that the investment will double in the coming years. It is expected that the investment in the traditional ERP market will decline by more than 30% (Ford, 2015). According to Ford (2015), research has pointed to a growth of 85% in the adoption of multi-site and multi-geographical cloud ERPs in South Africa within the last 15 months. For these companies, so-called “true cloud ERPs” or fully-fledged cloud-based ERP systems could provide them with the ability to totally renovate their organisations to offer a data-driven approach instead of only a volume-driven cost effective approach. This new approach could be a lot more rewarding for their customers (Ford, 2015).

2.4.3 Cloud-Based ERP System Deployment Models

Numerous ERP business solutions are promoted and advertised as cloud-based ERP systems while they are in reality hosted ERP systems. Hence, in this literature review, we report on the various cloud-based ERP systems deployment models that are currently available. In the cloud computing section of the literature review, the four different parts of cloud computing delivery models are presented, which assist with unpacking this sub-topic.

According to Fumei and Ming-Chien (2014), the different cloud-based ERP deployment models are:

- **ERP as a Service** (the “accurate” cloud-based ERP system) - this service is offered by a SaaS deployment model through which cloud-based ERP systems are supplied to customers. These SaaS ERP systems are sometimes denoted as ERP-as-a-Service (EaaS) and are reflected to be the actual cloud-based ERP systems because they

combine the vital features of SaaS. In EaaS, the ERP system is plugged into the public cloud by the cloud service provider and the customer can open it via the Internet.

- **Hosted ERP system** – this service is offered through the IaaS deployment model to large enterprises that require their ERP solution to be on a secluded/private cloud. In most cases, it also requires customisation specifically for that enterprise. The IT resources, including servers and networks, are also to be provided by the service provider and dedicated to a specific cloud customer.

- **Hybrid ERP system** – this is a mixed service deployment model offered to cloud customers by the cloud service providers where some parts of the ERP system are hosted on a private cloud and some on the company's premises.

Figure 8 shows the various types of cloud-based ERP deployment models.

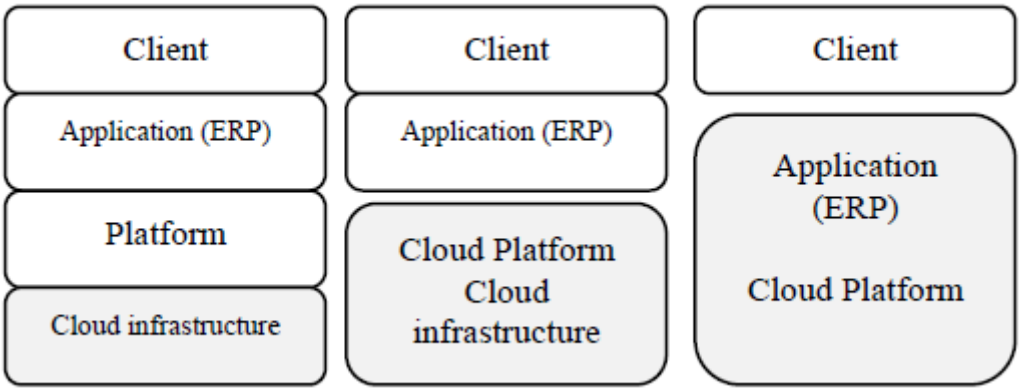

Figure 8- art of Cloud-based ERP System (Fumei & Ming-Chien, 2014)

2.4.4 The Benefits of Cloud-based ERP Systems

One of the research questions posed in section 1.3 of this dissertation aims at understanding the benefits offered by cloud-based ERPs. Thorough literature reviews of the benefits offered by cloud-based ERP systems are presented. These benefits have been analysed and integrated to provide a more detailed view.

2.4.5 Cost Saving

Cost reduction is one of the main benefits of cloud-based ERP systems. Companies are continuously looking for ways to cut down expenditure – especially given the current strenuous

economic climate, while also reaping the benefits of their investments (Chin-Sheng, Wen-Yau, & Hui-Yu, 2014). If a company decides to adopt a cloud-based ERP system, the service provider, and the mining company would have a “pay as you go” model in place which is commonly known as usage pricing model which helps in the initial investment of cloud computing infrastructure and improves its ability to upscale as the demand for services scale up, which will require the signing of a fixed cost maintenance contract with a monthly expenditure.

The initial costs that a company has to incur to deploy a cloud-based ERP system will be drastically reduced by removing the costs of own IT infrastructure such as servers, UPSs and cooling facilities (Bassett, 2015). The support costs, licence fees and upgrading costs of ERP systems and the hardware costs which are related to a cloud-based ERP system are all carried by the cloud service provider at the data centre.

One of the benefits of a cloud-based ERP system is that the organisation can utilise the ERP system at a low cost by paying a monthly rental fee or usage fee to the cloud service provider (Machal, 2013). Companies only need to worry about the devices and computers used to access a cloud-based ERP system through a secure network connection. A cloud-based ERP system will also lower the operating costs related to energy consumption and IT personnel. According to Basset (2015), it might be cost efficient to procure a cloud-based ERP system and utilise it, however, there are other factors which might come into play in the long run and which could push up the costing, such as the number of software licences a company needs.

2.4.6 Availability and ease of access

According to Gartner (2013), a cloud-based ERP system is accessible 24/7 and businesses will not be subjected to any shut down of their ERP services. The cloud computing environment set-up has a resource pooling feature which gives cloud service providers the prospect of efficiently pooling the servers they make available to their clients. This feature allows cloud service providers to afford their customers all valuable measures, such as broadband redundancy; disaster recovery processes; and backup routines whenever required. This feature improves system accessibility and availability and the cloud service provider makes sure that their clients have a backup plan when disaster strikes, hence they can offer 99.99% availability on their service level agreement (Amar, Vasileios, & Achilles, 2013).

Additionally, the information of the client could be stored in different physical locations as to prevent data loss and server outage. Cloud-based ERP systems are ubiquitous, which means the system is always available and can be used independently of the time, device and location. Companies can carry out their business applications at any location and time suitable to them, using any device (Fengze & Max Erik, 2014).

2.4.7 Scalability and Flexibility

Cloud-based ERP systems dynamically respond to the status of the economy timeously as things change in the company. A business that is using a cloud-based ERP system can add or remove users as necessary which allows for fluctuation in usage demand. This, in turn, changes the ERP system needs which is why scalability as a feature is of high significance for prospective cloud adoption (Bassett, 2015). The flexibility feature enables companies to measure their ERP system solution and meet upturns or downturns in transaction volumes, storage needs, computing servers, or broadband network, hence appearing to be unlimited in the eyes of the clients (Chin-Sheng, Wen-Yau, & Hui-Yu, 2014).

The cloud-based ERP system is also flexible regarding the payment models that cloud service providers offer to enterprises.These models include rental fees, pay per service fee; or a mixed payment model which allows companies to select a payment model that is more suitable for their financial situation (Amar, Vasileios, & Achilles, 2013).

According to Suriah (2015), there is high demand in analysing data, notifications and request approvals from any mobile device or mobile application. The speed at which these mobile devices deliver or communicate feedback is the new way of doing business. In addition to this, mobile devices are spontaneous, fast and integrated.

2.4.8 Rapid deployment possibilities

Cloud service providers emphasise faster deployment as an additional value for the cloud-based ERP system to curb costs and to also save time and resources earmarked for troubleshooting issues in such systems. Rapid deployment refers to a cloud service provider's ability to deploy a pre-tested and customised cloud-based ERP system, ready for use (Fakeeh, 2014). The improved and faster deployment is enabled by the abandonment of hardware and software in place and by the ability to deploy the system in numerous places at the same time. Cloud-based ERP systems come in standardised forms, being developed

in line with market specific and country best practices which enable stress-free and faster deployment (Raj Kumar & Dr. Reena, 2013).

According to Duranti (2014), the superiority of cloud-based ERP systems has already been demonstrated on different sites. The implementation of a cloud-based ERP system would take approximately six months compared to twelve months for a non-premise ERP system and for that to happen, all the features of the deployment must be streamlined meaningfully for user training, reporting, and customisation (Duranti, 2014). Figure 9 shows the duration of all the tasks impacted when deploying a cloud-based ERP system.

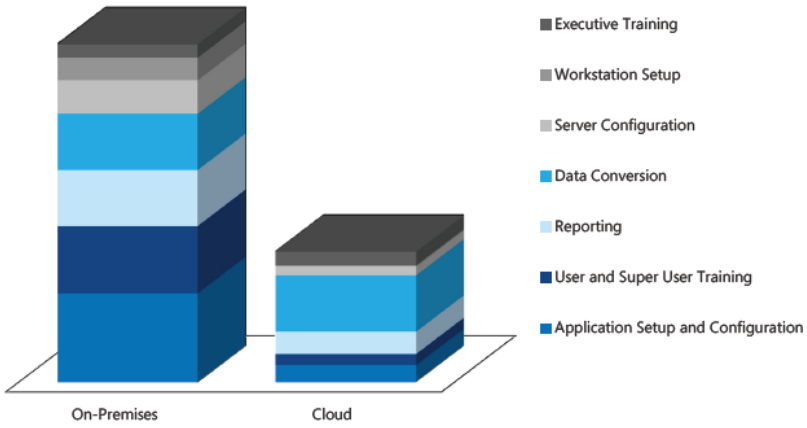

Figure 9 - Cloud-Based ERP Deployment (Duranti, 2014)

From figure 9, it is evident that the amount of time required and the numbers of resources employed during data conversions, as well as the training needed for users, will be reduced dramatically in the case of a cloud-based ERP system.

2.4.9 Unlimited data storage

For a cloud-based ERP system user, data storage will not be of any concern as the cloud service provider ensures reliable and unlimited data storage on the cloud computing environment. Data storage processes within the cloud infrastructure solve both the horizontal and vertical parts of scalability (Pareek, 2014).

A cloud-based ERP system offers online back-up services which might be needed regarding disaster recovery; such facilities can copy, compress and encrypt data files, this is executed

via a secure Internet connection and stored safely in a secure data centre (Avinash & Mangesh, 2014).

Additionally, regarding storage capacity, a cloud-based ERP system offers one of the most cost-effective archiving solutions in the market currently. The archiving solution is required for audit and SARS (South African Revenue Service) compliance, and discovery and intellectual property management because, regarding regulations, a company is required to keep a record of every transaction being conducted every day in an ERP system (Bassett, 2015).

2.4.10 The challenges of Cloud-based ERP systems

In this section of the literature review, we elaborate on the challenges/obstructions that South African mining companies might face or which could hinder their decision to migrate their current ERP systems to the cloud environment.

2.4.11 Data Security

Security is a huge concern for large businesses which aim to move their ERP systems to a cloud computing environment. It poses a significant challenge to cloud computing as companies have sensitive data (Avinash & Mangesh, 2014). According to Basset (2015), when a company adopts a cloud-based ERP system, they transfer the responsibility of their data security to the cloud service provider. Consequently, one of the reasons why companies are not migrating their ERP systems freely to a cloud computing environment is that they are concerned with losing control over their data and/or that their data might be exposed to their competitors, as in essence, anyone with a username and password can access it (even from another company). Another threat is the possibility of hackers penetrating the security parameters of the cloud service provider and consequently, gaining access to their data (Castellina, 2013).

According to Fengze and Max Erik (2014), if a company loses their data control it can affect their ability to report or comply with regulatory bodies and even statutory procedures. A cloud-based ERP system delivery model requires distinct stages of security applications because of the different features that come with models such as public cloud, private cloud, and hybrid cloud for the purpose of improving data integrity and availability (Jia, 2009). Nonetheless, many cloud service providers have been investing in substantial resources to enhance the

security of their data centres and recently, they are likely to deploy better security processes, such as firewalls, anti-virus software, and patch management (Machal, 2013).

Another issue which makes data security a major challenge for companies is the absence of data protection and security regulation. In South Africa, there is currently no clarity on the regulations to be followed because the Electronic Communications and Transactions Act (2002) has inadequate confidentiality security features for data collected by electronic means. However, this Act is presently being revised (Gillwald, 2015).

The Protection of Public Information Bill has been legislated to bring South Africa's information security structures in line with global standards but it is not yet operational, and it does not cater for business transactions conducted over the cloud computing environment or a data centre, not within the borders of the country. Once this Act comes into operation, it will affect the way companies, especially with an international footprint collect, process, and transmit data (Gillwald, 2015). The Act will also include restrictions on collecting, storing and processing data outside the borders of South Africa, creating legal implications for companies who are likely to move data outside of the country due to stricter laws.

So if an international company (IT service provider) offers better economies of scale of a cloud-based ERP system in comparison with a local company (IT service provider), companies will be reluctant to do business with that company because the company might potentially be liable for the breach of the South African law (Schofield, 2015).

2.4.12 Customisation challenges

Cloud-based ERP systems are always a challenge to customise in an attempt to meet specific business challenges, as they come in a standardised form (one size fits all) (Avinash & Mangesh, 2014). Companies with different business processes will find it difficult to adjust to a cloud-based ERP system because it might not be compatible with their requirements. Therefore, a cloud-based ERP system may not be appropriate for companies with very specific needs which are different to those that is considered to be standard requirements (Amar, Vasileios, & Achilles, 2013).

2.4.13 Vendor lock-in

As a cloud-based ERP system client, a company may find an appropriate cloud service provider, but there is always the risk associated with vendor lock-in. This challenge is caused by complex interoperability among cloud service providers and a lack of shared industry platforms for cloud-based ERP systems. The vendor lock-in risk can be considered to be the main reason why there is little or no rapid growth in cloud-based ERP system adoption (Atul B, Amarendra Kumar, & Swapna S, 2013).

One of the thorny issues with vendor lock-in is that a company that wants to move their ERP solution to a different cloud service provider may not be adequately catered for by the current service provider when needs such as cost, consistency and security arise (Amar, Vasileios, & Achilles, 2013).The cloud service provider selection process is, therefore, a tremendously vital step which clients have to take into account before relocating their ERP solution to the cloud computing environment. The cloud service provider has to be selected based on a mutual benefit model and must have the capability to offer a long lifecycle for the cloud computing infrastructure (Machal, 2013).

2.4.14 Performance (response time)

The idea of cloud-based ERP systems is to ensure access to the system anywhere and anytime over the Internet using the same application used for an on-premise system. The strength and consistency of the Internet access is crucial for the performance of the cloud-based ERP system because enterprise users will access their entire work application services over the Internet (Trope, 2014). A cloud-based ERP system will need fast broadband access to ensure that the response time of the cloud-based ERP system is better or at least the same compared to an on-premise ERP system. It is a known fact that data transmission over the Internet can cause slow response times, which could ultimately make cloud-based ERP systems too slow (Chen & Pang-Lo Liu, 2007).

In South Africa, there is a bandwidth cable that is landing on our shores for broadband, but the “the last mile connectivity” is limited because of the missing infrastructural backbone in the country, resulting in the hampering of customer services (van der Merwe, 2013). In a research report conducted by Ookla, an international broadband testing company, broadband in South Africa is mildly satisfactory and ranks 55th out of 64 countries tested. The Ookla finding shows that mobile broadband service performs faster than fixed broadband connection (Gillwald,

2015). According to a survey conducted by the South African Institute of Race Relations; the average monthly price of broadband access in South Africa is 10+ times higher than in the United Kingdom (UK). The average monthly cost for a broadband access for a South African broadband user is about R337 monthly whereas the UK monthly cost is about R36 a month (Lebone, 2015).

Akamai publishes a quarterly report which analyses the state of broadband adoption as well as internet speed and internet usage. According to the published report, South Africa has a mere 47% internet penetration considered in conjunction with its population and in other regions, internet penetration is extremely high – almost 95%. The global average internet connection speed is 5Mbps while South Africa has an average internet connection speed of 3,5Mbps which gives the country a ranking of only the 90th fastest average internet connection speed in the world, out of the global ranking of 112 countries (Lings, 2015). In another comparison, the report found that a UK internet user enjoys a broadband speed that is five times higher than that of their South African counterpart (Lebone, 2015).

As large volumes of data are transmitted between the user and the cloud-based server, a robust Internet speed and sufficient network capacity is of the utmost importance when making a cloud migration decision (Amar, Vasileios, & Achilles, 2013). Uninterrupted service of cloud-based ERP systems will be entirely dependent on the cloud service providers' reliability. The likelihood that a cloud service provider may not deliver according to the anticipated service level agreement regarding the cloud-based ERP accessibility and Internet connection may cause operational inefficiencies in the company and possibly destroy the character of the business to clients (Machal, 2013).

Another issue that might affect the performance of a cloud-based ERP system is electricity. Since 2008, South Africa has been affected by load-shedding, which regularly happens when it becomes a necessary to interrupt the power supply because of high electricity demand and/or usage. Electric supply caused major inconveniences in the mining sector when there is load-shedding. Data centres which would be significant in a cloud computing environment and for the adoption of cloud-based ERP system, need sufficient power supply for them to function optimally (Xi, 2014).

In South Africa, theft and vandalism of electricity cables and optical fibre cuts have been prevalent around mining towns which result in loss of connectivity and essential services, and eventually, a company will have a corrupted connectivity issue. The regularity of the

occurrences and severity of cable theft and fibre optic cuts is shocking; it hampers satisfying customer experience, and this poses a barrier to a cloud-based ERP system. The severity and impact of this is profound (Gillwald, 2015).

2.4.15 Control

According to Avinash and Mangesh (2014), when the business decides to move the ERP system to a cloud computing infrastructure, there has to be clear policies and guidelines regarding the control and the use of data. The challenge here is that any lost data or data that leaks to other parties could be used for espionage or to the advantage of direct competitors (Bálint, Gyula, & András, 2013). One of the primary concerns of a CIO is taking care of the business data. Therefore, the CIO must tread carefully when selecting a cloud service provider. The cloud service provider will have an indirect responsibility as the owner of the cloud infrastructure (Amar, Vasileios, & Achilles, 2013). Another concern for CIOs is the reaction time to urgent business requirements as the company will be heavily reliant on the cloud service provider's support and maintenance (Castellina, 2013).

2.5 Cloud-based ERP systems versus On-Premise ERP systems

In this section of the literature review, the essential differences between cloud-based ERP systems and traditional ERP systems are unpacked. Traditional ERP systems are locally installed on business hardware or servers and are supervised by IT employees, whereas cloud-based ERP systems are offered as a service that is maintained by a service provider (Fengze & Max Erik, 2014). According to Fakeeh (2014), there are key characteristics that a business might look at when considering a cloud-based ERP system. This include:

2.5.1 Ownership Expenses

- **On-Premise ERP** systems will need an enormous and on-going investment to procure and maintain the software and the hardware. Additionally, IT staff will require training on the new software and this is both costly and requires extra effort from the staff.
- **Cloud-based ERP** systems will come at a fraction of the cost of a traditional ERP system because the business procures the ERP services that they require as the company, and they may immediately start using the ERP system. The cloud service provider hosts and maintains the whole cloud infrastructure and makes sure that the system is always operational and secure. Ultimately, this will free up the organisation's IT resources and staff to become more innovative and efficiently serve the business.

2.5.2 System Upgrade and Development

- **On-Premise ERP** software can be customised to a business's specification but those modifications might not be executable after doing an ERP software upgrade, and the IT staff will need to re-customise the system.
- **Cloud-based ERP** software is continuously upgraded/enhanced by the cloud service provider so the business can be consistently operating on the most up-to-date version of ERP software without transgressing the company's' earlier customisations.

2.5.3 Deployment

- **On-Premise** software will be deployed to different users with different workstations, and this will require careful pre-planning. It might take up to 12 months on average to deploy a traditional ERP system.
- **Cloud-based ERP** software can be effortlessly deployed to different users in different regions, departments and other subsidiary companies while avoiding the expenditures associated with those rollouts in a traditional ERP. A Cloud-based ERP system will on average - only require about 3 to 6 months to deploy in a company.

2.5.4 Performance

- **On-Premise** ERP systems performance is usually dependant on the type of resources and IT infrastructure that is available to a company in comparison to a cloud-based ERP system. Initially, on-premise ERP systems are generally slow, and they gradually improve performance as time goes by.
- **Cloud-based ERP** systems generally result in higher performance in comparison to traditional ERP systems; high performance is intended from the start, and this enhances the use of the software. Cloud-based ERP performance can be optimised to fulfil business requirements at any time (Fakeeh, 2014; Fakeeh, 2014; Fakeeh, 2014; Fakeeh, 2014).

The following Framework by Pareek (2014) summarises the characteristics of cloud-based ERP systems versus on premise ERP systems:

Characteristics	On premise ERP System	Cloud-based ERP System
Implementation	Local computer server	Cloud environment server
Server cost	Low expenditures	Expensive
Defining Business Process	Designed by ERP software Vendor and business process owner.	Defined by together with, ERP software and business process owner.
Implementation expense	High	Low
Support costs	High	Low
Management over ERP system	Easily management	Not easily supervised
Integration	Reliant on the ERP service provider	Can be maintained centrally
Licensing fees	High	Low
ERP system application update	Expensive	Low cost
Internet Requirement	No	Yes
ERP Software Upgrade	Challenging	Easy

Table 2 - Cloud-Based ERP vs. On-Premise ERP (Pareek, 2014)

2.6 Level of Mitigation for the South African Context

2.6.1 Bandwidth and Broadband Policy

In South Africa, since there is no clarity on the broadband framework, the private sector has been investing heavily in a reliable bandwidth and broadband connection to drive the growth of cloud-based ERP system adoption, and this will go a long way towards the affordability of services (van der Merwe, 2013). To deal with the issue of broadband constraints, the communication regulator will need to adopt a regulatory model that will foster competition among operators and promote market penetration.

The telecommunication market in South Africa is mostly developed and has continued to grow, notwithstanding the policy and regulatory issues in the country. The mobile sector has seen exponential growth to the extent that mobile broadband can compete with fixed broadband which is mostly provided by Telkom and Neotel because they have the spectrum for fixed broadband (Gillwald, 2015).

The mobile phone penetration has experienced substantial growth in South Africa; it has now become the leading method of accessing broadband, and mobile broadband prices are now relatively lower than fixed broadband prices. In South Africa, we have seen an increase in the number of international submarine cables which has resulted in a noteworthy availability in bandwidth regarding capacity (Gillwald, 2015) (see Figure 10).

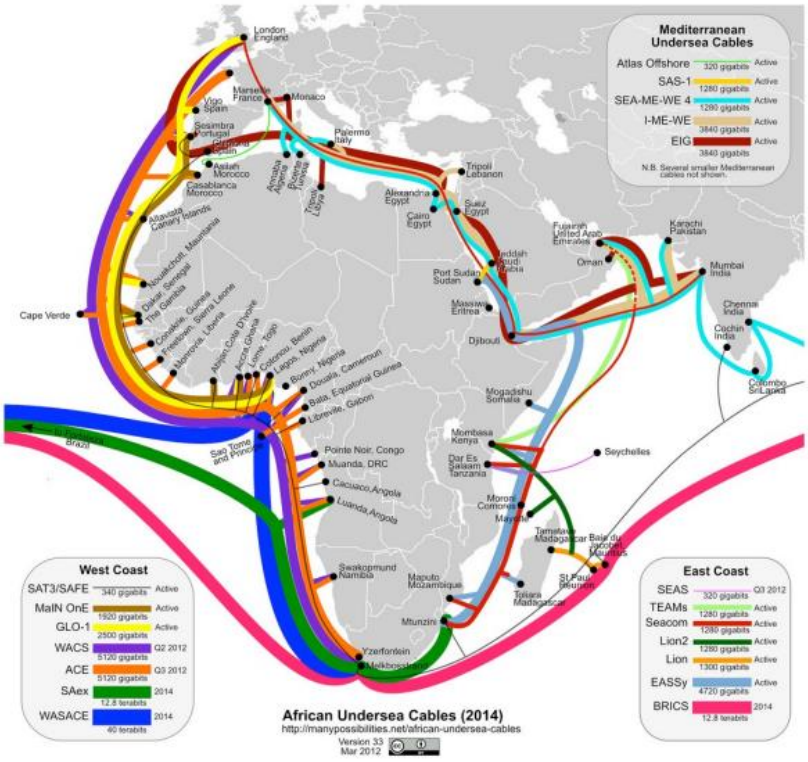

Figure 10 - African Undersea Cables (Gillwald, 2015)

Even though South Africa saw a drop in bandwidth pricing and an increase in bandwidth capacity, prices have remained stubbornly high when evaluated in conjunction with other mature markets. The reason for this is the broadband regulatory body which is reluctant to issue the spectrum to the telecommunication sector so they can increase their broadband capacity (Calandro & Moyo, 2012).

The regulator will also need to introduce a mechanism that will neutralise licencing rules, and ensure effective regulation of the limited spectrum and the efficient management of access to dominant providers' networks that can yield an atmosphere beneficial to boosting private sector investment in infrastructure networks (Calandro & Moyo, 2012).

To deal with the astounding optic fibre cuts and cable theft, the South African government has passed legislation that declares cable theft an economic crime, with huge penalties to the perpetrators (Gillwald, 2015). It is, therefore, paramount for the South African legislature to

fast-track the finalisation of a broadband policy (currently under review) which will recognise the need for less expensive and more reliable access to the Internet, with a spectrum that is properly managed by the regulator to add value to the open market.

2.6.2 Skill and resource diversity

When a mining company decides to adopt a cloud-based ERP system, they must devise an HR strategy that will deal with the training and development of employees who are not familiar with cloud-based services. They consequently also have to deal with change management issues that might come with the changes, given that a cloud-based ERP system is not a centrally managed system and that the ICT skills and resources necessary to effectively manage and control such a system might not exist within the company.

Research has shown that a company that has its own intellectual property or knowledge/expertise has a higher success rate of adopting the ICT innovation (Trope, 2014). South Africa will need to invest in building a pool of local ICT expertise to design, manage and deploy advanced cloud-based ERP systems, specifically, in the area of data centre design, security, advanced decentralised networking, and in the building of virtual servers.

2.6.3 Hybrid Approach

The hybrid approach is one of the deployment models a mining company could employ if they want to adopt a cloud-based ERP system because it gives them the benefit of both a private and public cloud and the confidence it enjoys in the market at the moment (Ford, 2015). The hybrid approach will give mining companies the flexibility to have their production ERP system on premise which will allow for security and data management to be more hands-on to exploit the investment made on the legacy ERP system fully, while their development ERP system and quality/testing system is managed in the cloud computing environment to fully exploit the cost and scalable storage of the public cloud (Schofield, 2015). Other companies could opt for a hybrid solution because it allows the use of on-premise as a normal server and cloud as a backup for data protection. This will also offer the company an opportunity to first evaluate the reliability of a cloud-based ERP system (Bassett, 2015).

2.6.4 Data centre

There is an essential and reflective change happening in the way IT support and maintenance will be delivered to mining companies in the near future. The unique value lies in the mushrooming of different data centres in South Africa which will help the adoption of cloud-based ERP systems to grow in the country - not only in the mining sector but across different sectors (Mokenela, 2014). A data centre allows service providers to offer an integrated solution to mining companies which is a different and more efficient way of managing IT and business applications.

A data centre includes the management of the business processes, software, platforms and IT infrastructure - all as a service (Gillwald, 2015). This will enable mining companies to adopt client specific cloud road maps that meet their immediate requirements and which may consist of custom developed private or hybrid cloud solutions. The importance of a data centre innovation could be seen in its creation of business value which is informed by the growing need of mobile applications and complex information (so-called big data) (Ford, 2015).

A data centre will also reveal the value that comes with an on-demand pricing model and will allow IT in the mining businesses to move from being the enabler of essential business strategies and business processes to become an enabler of infrastructure and virtual workplaces (van der Merwe, 2013). When a mining company decides to move its ERP system to the cloud computing environment, they will get the latest ERP technology which comes with the added value of business agility that users require to save them the time and money of having to continually enter into a lengthy procurement process to add enhancements to their ERP systems.

2.6.5 ERP System Virtualisation

ERP System virtualisation is software which splits physical servers to create different dedicated resources and in turn, powers a cloud-based ERP system as a backbone of the technology (Avinash & Mangesh, 2014). A virtual server will allow mining businesses to reap the benefits of having the capacity and performance of a top ERP server without the need to buy or maintain the physical server. A virtualised ERP system frequently and speedily scales up in the operational environment, thus giving the business the server capacity and power it requires, when it requires it, and for as long as it requires it. In the mining sector in South Africa, companies have chosen to implement a combination of an on-premise and virtualised data centre, allowing them to retain their core ERP system on-site and move non-critical offerings off-site (James, 2012).

Virtualisation is at the centre of cloud-based ERP systems because of the ease of cost avoidance; easy mobile application deployment; and the fact that a virtual server with a high-performance capacity can be built at a fraction of the cost and can be used as a building block to move to a private cloud. Other mining companies have outsourced the management of on-site servers which allows them to save on maintenance costs. It has been found that virtualisation is gaining popularity in the mining sector (Calandro & Moyo, 2012). Virtualisation also brings with it a new level of software denoted as a hypervisor. The function of this hypervisor is to supervise access to the backbone of the physical infrastructure, which will allow for the servers to be shared amongst multiple applications. The hypervisor then offers virtual interfaces to each of the applications, thereby creating a virtual machine (Trope, 2014). The concept of virtualisation is demonstrated in Figure 11:

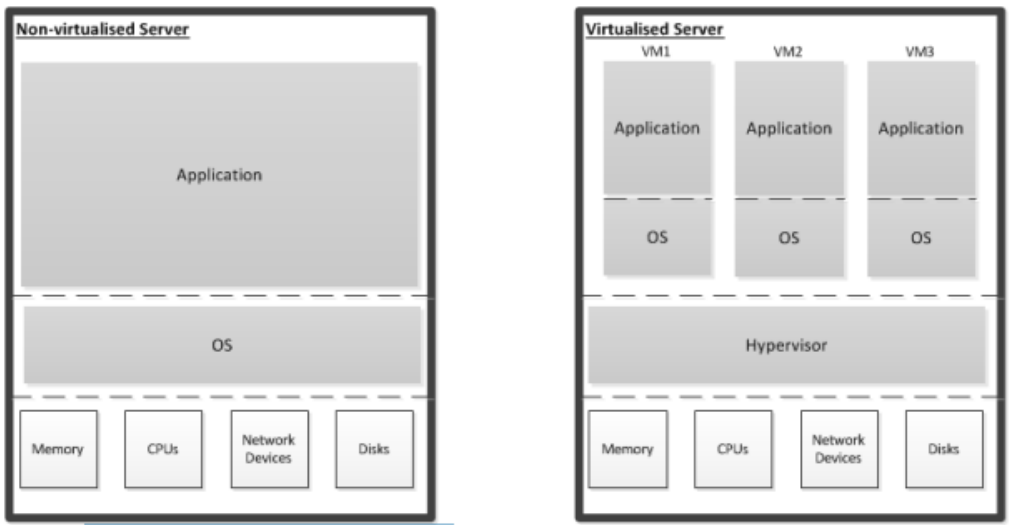

Figure 11 - Conceptual Model of Server Virtualisation (Trope, 2014)

2.7 The Technology, Organisation and Environment (TOE) Framework

This portion of the literature review reports on the framework which was used to assist in categorising the factors, challenges and benefits which influence the migration to cloud-based ERP systems in the South African mining industry.

The framework was found to be useful to study the factors that may affect the adoption of technological innovations in general and it has become an established theory used to examine IT adoption at the organisational level (Shahawai, Hashim, & Idrus, 2014). The extensive use

of this framework has been found in several studies focusing on the adoption of IT by organisations (Chau & Tam, 1997; Zhu, Kraemer, Xu, and Dedrick, 2004; Chong & Ooi, 2008; Pan and Jang, 2008; Srivastava & Thompson, 2010; Oliveira and Martins, 2010).

According to the TOE framework by DePietro, Wiarda and Fleischer (1990), the adoption decision of an ICT innovation is influenced by three different elements of a firm's context – technological context, organisational context and environmental context (see Figure 12).

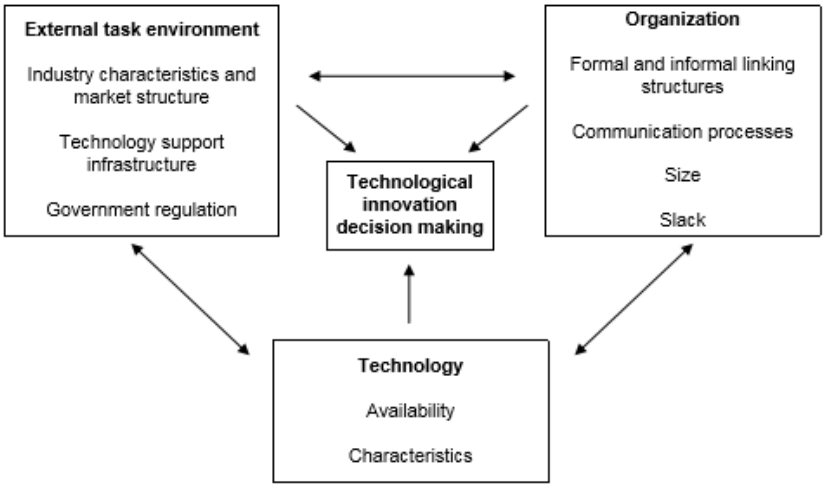

Figure 12 - Technology, Organisation, and Environment framework (Depietro, Wiarda, & Fleischer, 1990)

This framework emphasises distinctive features and both the internal and external features of the organisation as a motivation for the adoption of innovation. These are represented by the technology and organisation contexts of the TOE framework, but the TOE framework also includes a critical component, namely the environmental context. The environmental context represents both the limitations and the good projections for technological innovation (Pan & Jang, 2008). According to Zhu, Li, Wang, and Chen (2010), the fact that the TOE framework embraces the environmental context, makes it easier to validate the adoption of the innovation; and this model is therefore considered to be more comprehensive to illustrate and understand IT adoption (Zhu, Li, Wang, & Chen, 2010). The three related components of the TOE framework by DePietro, Wiarda and Fleischer (1990) are accordingly discussed below.

2.7.1 The Organisational Context

This component of the TOE framework focuses on how organisational factors and resources impact on the decision-making process regarding the introduction and implementation of an IT innovation. Features of the ***organisational context*** normally include the company's size,

centralism and ratification; management structure; the value of human capital; change management; decision-making; and internal communication. These features have a strong influence on the likelihood of the adoption of an IT innovation.

Top management can instigate major structural changes in an organisation by: (1) communicating and sending a strong message of the company's strategy and the role of technology innovation in driving this strategy; (2) showing the value of the IT innovation inside and outside of the company; and (3) creating a change management team responsible for managing the innovation within the company (Angeles, 2014).

2.7.2 The Technological Context

Features of the ***technological context*** are classified in terms of all internal and external technologies relevant to the company. The technological context of the TOE framework is considered separately from the other two components of the framework to place emphasis on the impact and influence of technology on the introduction and deployment process of the IT innovation. These features normally include expert knowledge of the new innovation; comprehension of the technology evolution and the issues related to it; the usage level of the innovation; and technological transformation within a company.

Awa and Ukoha (2012) stated that the successful adoption of an IT innovation depends on the significance of internal technology resources such as infrastructure; technical and functional skills; programmers; and user involvement. Companies with higher levels of technology capability show more ability to adopt the new innovation. Existing internal technology resources are imperative in the adoption process because they set a wide-ranging boundary on the scope and speed of the adoption of the technological innovation which a company could undertake (Baker, 2011). According to Baker (op. cit.), three types of innovations exist outside the company which include incremental; synthetic; or discontinuous changes.

- **Incremental change**

Incremental changes are innovations which introduce new features or new versions of existing technology and pose minimal risk and change for the adopting organisation. An example includes: an upgrade from one version of ERP system to the latest version of the same ERP system.

- **Synthetic change**

Synthetic changes are innovations which represent a moderate change in a system, where existing technologies are merged in an innovative manner. An example is Universities' method of delivering course content via the Internet. No new technologies are utilised, neither is there necessarily an innovation in the course content. Thus, existing techniques are merged in a novel manner to innovate.

- **Discontinuous change**

Discontinuous changes are innovations which introduce a radical change in an organisation, and they represent substantial variations from current processes or systems. An example of this is the move to cloud computing that began in the early 2000s (Baker, 2011).

Companies that have taken up incremental or synthetic change regarding IT innovations allow a calculated pace of IT adoption. However, companies that have taken up the discontinuous change approach regarding IT innovation are required to make decisive adoption decisions to keep the competitive advantage. Corporates must reflect on the type of structural changes that will be the result of adopting an IT innovation. Some IT innovations will have an extraordinary effect on the company and the market in which the company competes, while others will have a moderately small impact (Armbrust, et al., 2010).

2.7.3 Environmental Context

Features of the ***environmental context*** signify the space in which a company operates and manages its business, such as the market sector, mining competitors, and government policy and regulations. They can impact on how a company understands the requirement for the ICT innovation; its capability to invest in resources to adopt the ICT innovation; and its ability to implement the adopted innovation (Angeles, 2014). These stakeholders could either encourage or obstruct the ICT innovation.

Competitive advantage and changing market conditions influence companies to explore ICT innovations. Government policy could also be an additional instrument used to constrain business operations, rising costs of doing business, and initiating an exploration of different technologies that must meet some specific criteria (Awa & Ukoha, 2012).

According to literature, the TOE framework has been used to examine the adoption of a broad range of IT innovations, such as RFID, knowledge management systems and ERP systems (Lee, Wang, Lim, & Peng, 2009; Pan & Jang, 2008). It was also found to be useful in the cloud computing environment and ERP system adoption field (Baker, 2011; Pan & Jang, 2008). A theoretical model for cloud-based ERP system diffusion requires deliberation on the disadvantages in the introduction and diffusion technological innovations, which are initiated by the specific technological, organisational, and environmental aspects of the company. Poba-Nzaou and Raymond (2011) applied the TOE framework empirically to assess the factors that affect the adoption of ERP systems and discovered it to be an appropriate framework that can be employed in the study of ERP system adoptions in a company. However; the challenge lies in making a decision as to whether a cloud-based ERP system would be suitable for businesses with already existing and functional technology (Poba-Nzaou & Raymond, 2011).

Oliveira and Martins (2011) argued that the TOE framework is reliable as it also has a solid theoretical foundation; a consistent pragmatic support, and the application to IT adoption. The successful usage of the TOE framework in past research justify the usefulness and practicality of the framework in this study.

2.8 The Future of ERP Systems

ERP solutions perform a vital role in the proper functioning of many companies. Currently, ERP systems are utilised to track data for business reporting and supervise corporate performance. The future of ERP system developments promises to be streamlined with the system being effortlessly accessible and easy to use (Krigsman, 2014).

According to Krigsman (2014), ERP systems need to be simplified regarding deployment and business practice; and thus should be more useful to the users. ERP implementations that are marginally structured will play a major role as the ERP market is becoming intolerant to expensive deployments. It is expected that user's knowledge of ERP systems will improve in future due to ERP suppliers that are looking at systems which are more stress-free for end-users, for example, embedding functionalities such as voice recognition applications into the ERP solutions. Graphical human interfaces will become more accurate for the user roles/functions and are expected to be modified significantly to improve the users' interaction with the ERP system. They could incorporate the utilisation of sensor devices across the business to gather and process data (Krigsman, 2014).

A study has revealed that businesses are looking at ERP systems which could be effortlessly installed, are inexpensive, and could be utilised by a corporation promptly (Gross, 2013). According to Epicor (2015), ERP systems that are in a cloud computing environment are projected to grow in the immediate future in the South African market and will improve ultimately to become unified with other cloud applications and on-premise ERP systems (Epicor, 2015). Academics expect traditional ERP licence sales to decline in the not too distant future. Big corporates are likely to utilise ERP systems through a cloud computing environment on a requirement basis because they need to implement individual applications of ERP systems without being involved in a large-scale ERP project (Schubert & Adisa, 2011).

In the near future, businesses will be considering green ERP systems or green ERP equipment, to employ ERP systems to track information and supervise certain environmental expenses incured, including water and energy. They can use a virtualisation model which is similar to a cloud computing environment to make the ERP solution a greener IT resource to implement. An ERP module has been designed to track and measure a business's overall environmental outline. This module can realise similar functions, such as gathering energy usage data and energy efficiency in all company plants and all kinds of resources. Through

the virtualisation model, a company can amalgamate all its ERP systems to much fewer computer servers, turning it into a Green ERP Landscape (Castellina, 2013).

According to Epicor (2015), 70% of South African workers have access to a smart phone or a tablet. South African companies are slow to embrace this phenomenon and have yet to benefit from this while ERP vendors have noted the continuing excitement around 'bring your own device' (BYOD) strategy, and they have plans to collaborate with ERP systems. ERP suppliers have now exploited this initiative which comes from a requirement to reduce costs and the requirement to have access to instant ERP systems which could be accessible via a mobile phone. For businesses which have multiple geo-locations, having instant access to an ERP system via a mobile phone will improve productivity and visibility and will enable management to have instant access to data, allowing them to make a decision quickly and react to production issues without delay (Epicor, 2015).

Finally, all these developing trends around ERP systems are aimed towards one objective – improving business procedures by cutting down on the expense of IT and the cost of doing business; enhancing the client understanding of ERP systems; constructing ERP data intuitively to use strategically, and lastly, to increase the turnaround time when it comes to decision-making. For these exact reasons, ERP systems will continue to play a vital part in the South African market and a more meaningful role in the mining businesses.

2.9 Conclusion of Literature Review

The first section of this chapter gave a general overview of traditional ERP systems, as well as the different ERP system deployment models, followed by a section detailing the benefits of ERP systems.

The second section discussed the theory of cloud computing including the vital features thereof as identified by Duranti (2014). The chapter subsequently elaborated on the available models of cloud computing delivery and the types of cloud computing environments.

The third section of the chapter discussed the literature available on cloud-based ERP systems, the different deployment models, as well as the challenges and benefits of cloud-based ERP systems.

In the fourth section, a comparison was made between cloud-based ERP systems and traditional ERP systems based on the following aspects by Fakeeh, (2014):

- Ownership Expenses
- System Upgrade and Development
- Deployment
- Performance

The fifth section of the chapter reported on the level of mitigation which could be undertaken by different stakeholders in South Africa to ease up the adoption of cloud-based ERP, while the last section introduced and elaborated on the TOE framework by DePietro, Wiarda and Fleischer (1990) and its usefulness as a framework to understand the challenges and benefits which organisations in the mining sector of South Africa face when it comes to the migration to cloud-based ERP systems.

This framework is applied in the last chapter of this dissertation, where the researcher develops a complete framework to understand the benefits and challenges offer by cloud-based ERP systems to South African mining companies. The framework is also intended to be used as a tool to assist management in making a decision on their readiness to migrate their current ERPs to the cloud computing environment.

Additionally, the future of ERP systems was finally discussed to shed some light on the trends that could be expected from the ERP market.

CHAPTER 3: RESEARCH METHODOLOGY AND RESEARCH DESIGN

3.1 Introduction

This chapter elaborates on the research methodology pursued in this dissertation. It describes the philosophical position of the research, how the study was conducted and offers insight into the population and sampling procedures that were used. The research instrument for gathering and evaluating the data is discussed, and the chapter concludes with a discussion on the credibility, trustworthiness and ethical consideration of the research.

3.2 Philosophical position

This section encompasses the philosophical position associated with the study. Each of the probable adoptions at this point necessitates prudent consideration as they provide structure, guidance and possible restrictions to the decisions and ultimately, impact on the way the researcher assembles and evaluates data to construct valid findings for the study.

There are three philosophical positions commonly agreed to be used under an ontological philosophy worldwide, and those positions are also dominant in Information system (IS) research. These are objectivism, constructivism and pragmatism research ((Saunders, Thornhill, & Lewis, 2009); (Klein & Heinz, 1989)).

For this study, constructivism, which is also referred to as interpretivism, was more suitable as it is characterised by a need to understand the world as it is, not as a fixed set of objects, but rather as a process that socially develops, being a subjective experience. Interpretive studies assume that humans create, recreate and associate their own subjective and inter-subjective meanings in their interaction with the world surrounding them. The social world is therefore not seen as fixed, but it is constructed and strengthened by people through their actions and exchanges. Interpretive researchers will, therefore, try to understand certain phenomena by accessing the meanings that the people are participating and allocating to them, and will discard the so-called objective or factual explanations of events and situations. They will, as an alternative, pursue a relativistic or shared understanding of the phenomena (Orlikowski & Baroudi, 1991).

Baxter and Jack (2008) referred to findings by Crabtree and Miller (1999) that constructivism affords participants the liberty to tell their own story within a structure that is characterised by a close cooperation between the researcher and the participant. On this basis, it may be inferred that meanings or 'truths' were uncovered by the researcher through interacting with the participants via interviews. The researcher holds a firm belief that the decision to look at cloud-based ERP systems is affected by social and contextual influences, and cannot be researched in an impartial manner (Baxter & Jack, 2008).

3.3 Research Design

Serfontein, Basson and Burden (2009) cited the assertion by Mouton and Marias (1988) that there are three aspects of a research design: the research approach, research strategy, and research methodology (Serfontein, Basson, & Burden, 2009).

3.3.1 Research approach

The research approach is necessary to describe the link between the theory and the research that is being conducted. The two most commonly used methods in social science research are: the deductive method; and the inductive method (Gray, 2009). A deductive research method is a research approach where an existing theory or concept gets evaluated for their feasibility in the research (Kovács & Spens, 2005). Deductive research means that the researcher commences with an assertion or a problem to be investigated, and the study sets out to answer the problem. The researcher then rejects or improves the existing theory based on the study (Bryman & Bell, 2011). An inductive research method is a research approach where a research concept is generated from normal practice (Kovács & Spens, 2005). Inductive research method means that a researcher is practically researching to create a theory or a new concept. This way, the study goes from the research question to observation and explanation, and then to the evaluation phase and finally theorising stage (Bryman & Bell, 2011).

This study adopted a deductive approach to assist in meeting the objective of the study, which is about developing a framework for South African mining companies to use when evaluating to adopt a cloud-based ERP system. The existing theory was based on the TOE framework which was developed by Depietro, Wiarda, and Fleischer (1990). The relevant literature, including theories, was collected and reviewed, as deliberated in Chapter 2.

A deductive research method is a research approach where an existing theory or concept gets evaluated for its feasibility in the research (Kovács & Spens, 2005). Deductive research method means that the researcher commences with an assertion or a problem to be investigated, and the study sets out to answer the problem. The researcher then rejects or improves the existing theory, based on the study (Bryman & Bell, 2011).

3.3.2 Research strategy

The research strategy is outlined by Saunders (2016) as the overall process followed to answer the research questions. According to Denzin and Lincoln (2011), there is a practical link between the philosophy and subsequent choice of strategy which a researcher uses to collect and analyse data (Denzin & Lincoln, 2011). The research strategy bestows an inclusive direction to the study, comprising the method by which the study is conducted (Bryman & Bell, 2011). Action research, experiment, survey, case study, grounded theory, and ethnography are illustrations of such research strategies in a study (Creswell, 2013). In this study, a survey was adopted as a research strategy as it fits the purpose of the study.

Kelley, Clark, Brown, and Sitzia (2003) argue that survey research is suitable to investigate aspects of circumstances or to obtain explanations, in addition to descriptive studies and providing data for hypothesis testing. Denscombe (1998) explains that a survey is a research strategy rather than a research methodology. This was later confirmed by Saunders et al. (2009) in the research onion ring (see Figure 13). A survey strategy is often linked with a deductive research approach. It affords the researcher an efficient way of assembling data to discover the relative incidence, distribution, and interrelations of sociological and psychological variables (Saunders, Thornhill, & Lewis, 2009). This research strategy can generate both prolific and statistical data.

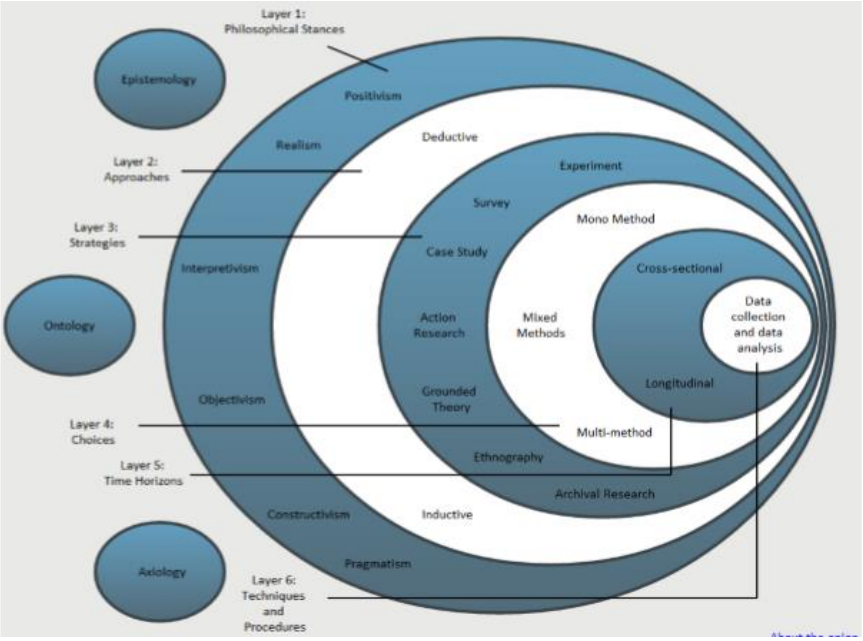

Figure 13 – Research Onion Diagram (Saunders, 2009)

According to Oates (2006), a survey can be used to elicit information from a limited number of participants who are experts or have the knowledge that is being sought, who are able and willing to share, and who are (nearly always) intended to be representatives of a larger sector. In this research, a survey strategy was used to find out participant's opinions, desires, and attitudes towards adopting cloud-based ERP systems. The data collection methods to use with a survey can range from a highly semi-structured interview or questionnaires to in-depth unstructured interviews. After all, if a researcher wants to know, they should ask. This method makes a survey a powerful research strategy when expert information is required, for example, when performing market research or trying to find the opinions of industry experts (Bhattacherjee, 2012). To help the researcher to elicit factual information from the participants, an in-depth questionnaire for interviews was constructed.

3.3.3 Research Methodology

Research methods can be categorised in different ways. There are three common research methods. These are quantitative, qualitative or mixed methods (Saunders, Thornhill, & Lewis, 2009). The application of the quantitative research methods is appropriate when the scholar tries to gather quantitative data to verify knowledge of understanding where information is statistical and can repeatedly be measured. Experiments and correlations are the usual quantitative data collection methods because they recognise the dimension of the research and use principles of legitimacy and consistency. However, the quantitative research method

is lacking in that it fails to adequately define the relations of events and processes, specifically when researching technology and it also uses impartial methodologies (Sousa, Definition and Analysis of Critical Success Factors for ERP Implementation Projects, 2006).

The application of qualitative research methods is appropriate when the scholar tries to deepen his/her understanding or significance of the topic being researched where there is a lack of concept and previous study. It involves prejudiced perceptions of the existing notions and its realistic approach to the topic and it gives precedence to what the information contributes to the significance of the research questions (Sousa, Definition and Analysis of Critical Success Factors for ERP Implementation Projects, 2006). Qualitative data collection methods include reflection and fieldwork, interviews and opinion polls (Otieno, 2010).

The expert sampling technique was used as the participants for this study were purposefully selected as experts who could best assist the researcher with answering the research questions (Creswell, 2013). It was further justified to use expert sampling due to the weak empirical evidence in the cloud-based ERP system phenomenon in respect of some of the sensitivities associated with it, coupled with the view of the time constraints to conclude the study, this method increased the chances of success.

In general, the sample size for qualitative research ought not to be so enormous that it is problematic to mine prolific data, nor too small that it is challenging to attain data saturation (Leech & Onwuegbuzie, 2007). In a semi-structured interview in association with surveys, the recommended sample size is 5 -25 (Saunders, Thornhill, & Lewis, 2009). Guest, Bunce, and Johnson (2006) advise that saturation regularly occurs around 12 participants in homogeneous groups.

A total of 10 interviews were conducted with both the mining companies and the service providers of ERP systems. There were seven from the companies and three from the service providers' side, and their level of expertise is presented in Table 3 :

Participant (ITP)	Role	'Experience in IT (Quotation)	Side of the equation
ITP 1	SAP Integration Manager	"I started my IT career in '98, and I have done various thing, I was a software developer for a number of years, a business analyst, project management, line management, a combination of things also a little bit of experience in enterprise architecture. The main industries that I've worked in are engineering, banking, and mining."	Mining company
ITP 2	SAP Consultant	"SAP Consultant for 15Years in the Basis field and I have done a couple of SAP deployment. My primary role is to manage the Technical side of the SAP System."	Supplier
ITP 3	SAP Basis Consultant	"I started the IT business 16 years ago, working on the AS 400 mainframe system that was the old payroll system before SAP came into the picture. From there I moved to the technician, desktop support. From there programming, I did Delphi and Java and a few other for Lonmin then I moved to the server team where I am now responsible for all the virtual infrastructure and basically all hardware infrastructure."	Supplier
ITP 4	Integration Manager	"I design & implement solutions for new business prospects based on World Best Practices & iSource Methodology. I also do programme management for big Outsource opportunities and Resource Management within the department. I do the reviews of all the proposals."	Supplier
ITP 5	Technical manager SAP 2014	"I did my diploma and B Tech in information systems; I completed at wits tech in 2004, I started with a graduate program for SAP trainees at Deloitte in 2005.then two years later I moved to Accenture as a consultant doing SAP work, then I moved to SARS in 2008, they came to work for the mining company."	Mining company
ITP 6	SAP Technical manager	"I started working in the IT industry in 1998 – first as an auditor and systems analyst, then a Business analyst, then project management and general management. I also have some experience in Enterprise Architecture and auditing. I have worked in three Business sectors, namely business services, Banking and Mining."	Mining company
ITP 7	IT Manager	"I have a development background I been writing code for a large number of blue tech companies from banks to breweries to Vodacom. I have had various leadership roles as well delivering large projects like Internet-based projects; Vodacom's ERP platform, both financial and HR interestingly do not use the same ERP system. They use Oracle for financial and SAP for HR; I was the IT manager responsible for making all that happen. Then five years at Nedbank. So technically if I have to look at my career it's multi-segments, so retail, banking, AR, manufacturing and now mining.I think the view there is that the skills are	Mining company

Participant (ITP)	Role	'Experience in IT (Quotation)	Side of the equation
		transferable. Also up through the ranks from the developer, business analyst, project leader, project manager and also IT manager. So it is a career of about 23 years now."	
ITP 8	Infrastructure and operations Manager	"I'm an IT professional that's been working in the IT industry for 26 years, I started off studying electrical engineering, and then I landed in an environment where I started doing programming, but back in the day was Cobol and from there I went to UNIX scripting and Sybase databases, graphical user interfaces but I did everything from file service to mainframe computers"	Mining company
ITP 9	SAP System Analyst	"I currently hold a BSc IT Hons degree and have been working in the field of IT for over ten years."	Mining company
ITP 10	SAP Business Analyst	"I have 12 years as a SAP consultant; I have studied Honours Business Information Systems and currently doing my MBA at Henley Business School."	Mining company

Table 3- The profiles of the Interview Participants

All these experts met the inclusion criteria of more than five years of experience in IT. The roles of the interviewees included consultants, technical staff, project managers and line managers. The core areas of focus were on ERP systems, and these experts' expertise ranged from software development and business analysis to enterprise architecture.

The experts were on both sides of the equation (customer – mining company and service providers). The interviewees comprised 33% (N= 3) service providers and 67% (N=7) customers. The interviewees were from the three largest mining companies in South Africa, while the service providers' side was represented by two of the biggest suppliers of ERP systems in South Africa. These companies were selected based on the fact that they are big mining companies in South Africa that have been running ERP systems for more than five years. Service providers have been chosen because they are an ERP partner in some of these mining companies as an ERP service provider and have been involved in many ERP system implementations in South African mining companies. Based on their experience in this space, they shared their experience on cloud-based ERP systems and the factors that make mining companies reluctant to adopt such systems in South Africa.

The interviewees who presented the service providers provided an insight gained from the various mining companies in South Africa with whom they had been working. The cloud service providers, therefore, were useful in providing a more spherical observation of the

subject and were able to provide helpful ideas around the implementation of cloud-based ERP systems in the mining industry in South Africa.

Additionally, all the interview sessions were conducted on a face-to-face basis. This process was used because it enabled the researcher to interact amicably with the participants in the interview session. At the start of each interview session, the participants were informed about the purpose of this research, and as aforementioned, the consent to record the interview sessions were requested.

3.3.4 Time horizon

The research time horizon for this study was cross-sectional study. According to Saunders (2009), the cross-sectional study is the study of a specific phenomenon (or phenomena) at a certain time. Leedy and Ormrod (2010) state that in a cross-sectional study, people from numerous and diverse age groups are sampled and assessed. Cross-sectional was used since it is easier to conduct than a longitudinal study because it allows the researcher to assemble all the required data at once. Furthermore, this was driven by the lack of resources as the research was self-funding and had a time allocated in which to be completed.

3.4 Data Collection and Instrument

To achieve the main objectives of this study, it is vital to look at the data collection method for practical and useful analysis. Data collection is at the centre of this research, and it is, therefore, important to carefully look at an applicable data collection method for its subject matter (Yin, 2003). Due to the complex nature of the research or study, which requires high knowledge of the object which is around cloud-based ERP system deployment, the qualitative interviews were conducted to help in accumulating the empirical data. As with any traditional qualitative research, there were numerous influencing factors and many perceptions, which required evaluation and interpretation for the data to make sense to the researcher (Oates, 2006). In this research, there were two approaches for data collection, the literature and interview approach.

3.4.1 Literature Review Approach

Existing knowledge of concepts and notions around ERP systems and cloud computing was not sufficient for providing a comprehensive theoretical background. Challenges of traditional ERP systems and opportunities that came with cloud computing should make up for the limitations that came with a normal ERP system and advocated for a cloud-based ERP system. Different types of cloud computing and their services were researched to fulfil the research purpose. This approach taken in the literature review in section 2.1 above was a method designed to identify, evaluate and examine available principal studies on the subject matter, for the researcher to be able to explore and address research specific questions (Jia, 2009).

The approach was focused on collecting and identifying high-quality exploratory evidence appropriate to meet the objectives of this study. The initial step of the theoretical foundation of the study was to answer research questions, and the next step was to define the research strategy and the search scope, where search strategies and search terms were defined. Terms such as “ERP”, “cloud computing”, “cloud-based ERP”, “TOE framework”, “cloud computing in South Africa” SaaS, IaaS, “cloud service”, “EaaS”, “PaaS”,” CaaS”, “DaaS” were searched from past publications and pooled with Boolean operators. Google Scholar and ACM Digital Library were the primary data sources. Since the subject matter has inadequate resources, the search strategy was defined to include market reports from South African IT journals, South African web journals, suppliers’ white papers and ERP news from professional media houses like ITweb. Data sources before 2001 were used selectively because the IT industry develops at a rapid space (Chin-Sheng, Wen-Yau, & Hui-Yu, 2014).

The disadvantages around the literature review approach were: the information in past publications may not be relevant, and the knowledge might not have translated into an in-depth understanding of practice. Consequently, practical information is required to supplement the study from the point of actual and real-world practices, and also to identify the data that applies to the current environment. As such, in this research, the interviews were used to conquer the disadvantages of the literature review approach (Oates, 2006).

3.4.2 Qualitative Interview Approach

Qualitative interviews are proficient dialogues that are organised with a specific purpose, where two consenting parties converse about the subject matter of interest (Oates, 2006). Creswell (2013) argues that the use of open-ended questions allows a researcher to gain

richer insight into the phenomena, which in this study was the adoption of cloud-based ERP systems in the mining companies. It was through such communication between the scholar and the participant that relevant information was produced. The qualitative interview approach made analysis and evaluation of the assembled data more manageable.

The literature review conducted in Chapter 2.1 has assisted in giving ways of using the data gathering techniques and has also helped to ease the risk of collecting excessive data for the research. Semi-structured interviews were conducted and were one of the main data collection processes because they afforded the researcher meaningful insights based on realities, sentiments and participants' perceptions (Berntsen & Herman, 2004). The semi-structured interviews were constructed based on the understanding obtained from the literature and as such, semi-structured interviews present an occasion to ask a set of predefined questions regarding each topic on the framework to which a participant could give open-ended responses. The interview guide is provided in Appendix I. The interview comprised two sections, with a total of ten open-ended questions. There are three questions, which investigate the knowledge and experience of the participants of IT and cloud-based computing.

The second section consists of five question linked to the research objectives and one final question which allowed the participant to add any other aspect that was relevant to the study. This approach was necessary to ensure that the interview session was concluded by asking the participants if they omitted something or if there was something they needed to mention for further clarification on the subject matter. The abovementioned, the interview structure, served as a guide to complement and facilitated the interview session with the participants with no stringent requirements for it to be followed. At the beginning of each interview, the researcher introduced himself and provided the background of the research and its problem statement. After which, the objectives of the research were defined and the formation of the questionnaires. Ethical considerations were clarified to the participants, as described in the methodology which encompassed the key participant's voluntary involvement in the study, the right to retreat from the study at any time and their right to privacy and confidentiality. The interview sessions were conducted at the premises indicated by the participants. During the interview process, the researcher tried to understand the context of the response from the participants, to establish a rapport with the participants and build trust in line with the proposed framework of Qu and Dumay (2011). Semi-structured in-depth interviews with identified experts on a face-to-face basis were conducted during the investigation of the study. The interviews were administered using open-ended questions.

During the semi-structured interviews, one crucial task was the recording of the interviews (Bhattacherjee, 2012). After receiving a participants' permission, interviews were recorded using an audio recorder so that attention was concentrated on the actual interview and making sure that the interview kept flowing rather than on writing notes. The total duration of the interviews was 400 minutes, with the average times being 40 minutes. The shortest interview was 30 minutes, and the longest interview was 1 hour 47 minutes (see Table 4).

Description	Quantity
Number of interviews	10
Total duration of the interview	400 minutes
Average duration	40 minutes
Shortest duration	30 minutes
Longest duration	1 hour, 47minutes

Table 4 -Details of the transcripts

This approach resulted in a better understanding of cloud-based ERP systems and its issues. The more knowledge acquired about the cloud-based ERP systems and its challenges, the easier it will be to change the tactic of data collection and to get in-depth research from the selected participants. This was possible because the approach employed in this study was flexible, meaning the interview guidelines were not followed strictly, and this also permitted the modification of the order of the questions. Additionally, this approach allowed for follow up questions on a participant's responses to probe for further clarification through additional questions. This method gave the researcher a better understanding of the atmosphere and framework where ERP systems have been implemented and how the framework would impact cloud-based ERP systems deployment (Amar, Vasileios, & Achilles, 2013). The outcome of the interviews was used to deepen knowledge around cloud-based ERP systems.

3.5 Data analysis

Thermatic Analysis (TA) was used for the data analysis. TA is an analytical technique for recognising and evaluating similar precedents or patterns in qualitative data (Clarke & Braun, 2013). These authors view thermatic analysis (TA) as academically adaptable because the quest for, and valuation of patterning throughout languages does not entail adherence to any specific concept of language, or any descriptive denoting construct for human beings, knowledge or practices. Thermatic Analysis (TA) can be pragmatic within a variety of academic structures, from essentialist to constructionist (Taylor & Ussher, 2001). This

academic autonomy means TA can be studied without some of the possibly complex (for new students) theoretical understanding crucial to many other qualitative methods. The six stages of thematic analysis by Braun and Clarke (2013) were employed. These stages include familiarising with the data, producing initial codes, investigating for themes, evaluating themes, describing and identifying themes, and generating the report.

In stage one; the recorded interview data was into transcribed in Microsoft Word to conduct a thematic analysis. During this process, a more thorough understanding of the data was developed.

In stage two, are code of ideas and concepts about the content of the data and the significance of these was generated. This stage then comprised the generation of initial codes from the data. The codes categorised an attribute of the data (semantic substance or latent) that appeared to be aligned to the TOE framework and those dominant in the interviews. This refers to “the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon” (Boyatzis, 1998, p.88). The coding was done with ATLAS.ti as it has been rightly recognised as a critical tool that simplified researchers’ capability to assume well-ordered, efficient, operative and systematic data analysis in many studies (Rambaree, 2013). The researcher had two options to conduct the coding based on whether the themes were more data focused or theory focused (Clarke & Braun, 2013).

Before the coding was done, the keywords of the transcripts were conducted using a word cruncher option of Atlasti. The words which were mentioned in the interviews for 50 times and more are presented in Figure 14. There were a total of 12 words, with the three most mentioned words being cloud, ERP and business. Cloud was mentioned 404 times, which was 26% of the total consolidated keywords (1546 words). This is followed by ERP and system(s), with 12%.

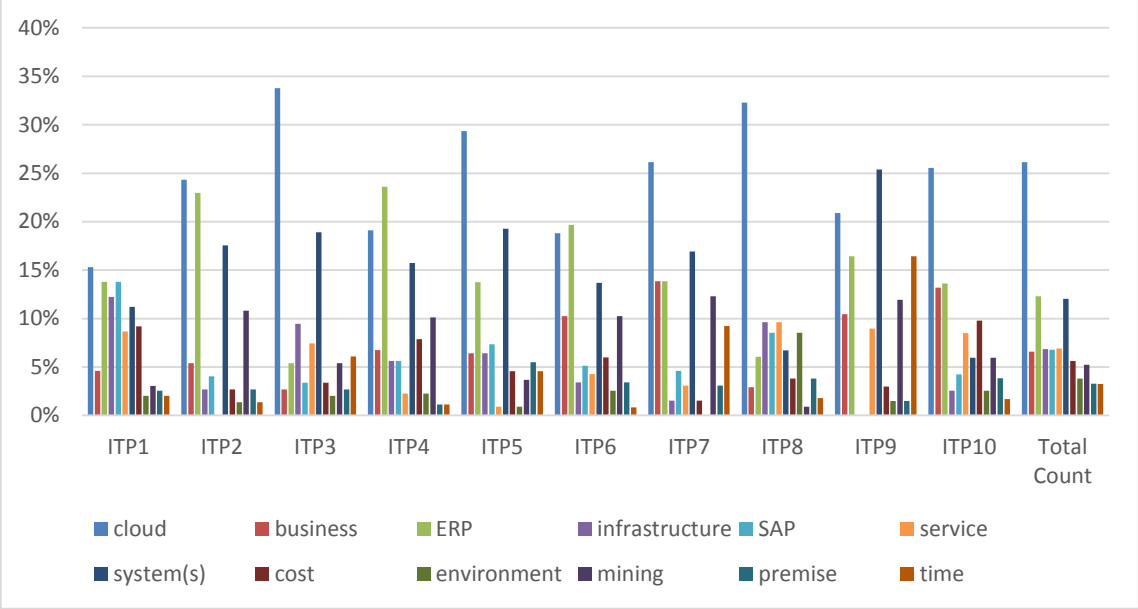

Figure 14 - Keywords of the transcripts

In the data focused coding, the themes hinge on the data, but in theory focused coding the approach is driven by well-defined questions to code around. The mixture of theory-driven based on the TOE framework and data-driven coding was utilised. Furthermore, the coding was done on the content of the entire data set rather than a possibly limited data set features.

Stage three began after the initial coding and collating which resulting in 34 codes. The thematic map, known as a "network of codes", was then developed using relationships between the codes that were categorised across the data set. In this stage, the focus was on themes instead of codes. Some initial codes may go on to structure main themes, whereas others may create sub-themes (Clarke & Braun, 2013).

Stage four included the developing of the set of similar themes and the alteration of these themes. During this stage, all the initial themes are retained. The end-result was an objectively noble idea of the various themes and how they measured up together, telling the story which emerged from the data.

In stage five, the concluding thematic map was developed and finally, stage six involved using the set of fully worked-out themes to compile the findings of the data and the write-up of the report. Chapter 4 contains the themes which emerged from the data. These were discussed in conjunction with the responses received from the interviewees.

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3.6 Credibility and Trustworthiness

Creswell (2013) proposed that conformability, credibility, transferability and dependability be the elements that assure trustworthiness of research results. The credibility and trustworthiness of the study was achieved as follows in this study:

3.6.1 Conformability and objectivity

Conformability and objectivity – findings presented were supported by the data collected which included sufficient interviews, which were expected to reach saturation. As already mentioned, the sample of about 12 is maximum sample size for this type of study (Guest, Bunce, & Johnson, 2006). Firstly, in this study the first four interviews yielded the 34 unique codes, while in the interviews five to eight further five codes were found, which were an investment, economies of scale, diversifying skills, Non-disruptive testing and cable theft (see Figure 15).

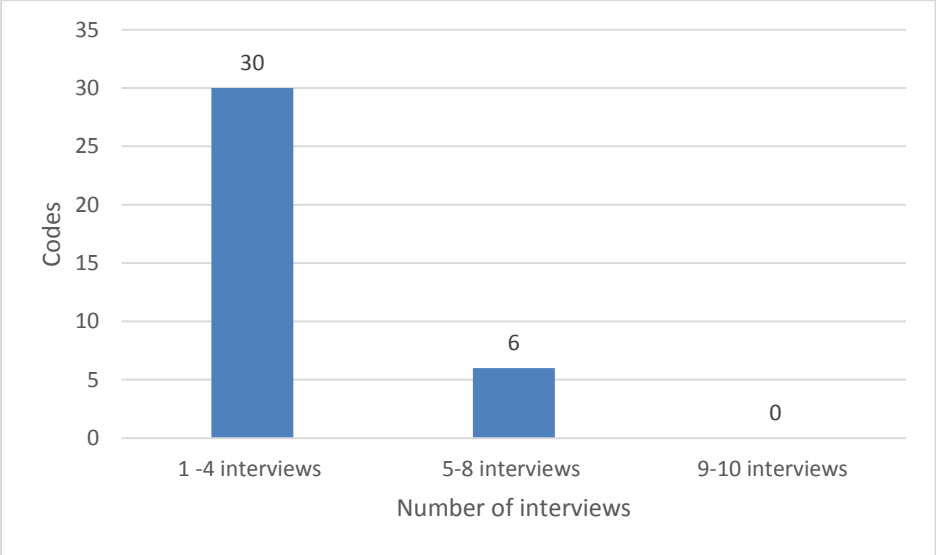

Figure 15 - Saturation graph of the codes

Secondly, after eight interviews, there were no new emerging themes. Based on the guidelines of saturations by Martin (2008) it was concluded that the study had reached saturation, with no new data in the last two interviews. This scope of saturation resulted in the final interviews being ten. Onwuegbuzie and Leech (2007) state that a researcher ought to conduct an analysis with due respect given to sampling.

3.6.2 Credibility and internal validity

The findings of the research indicated participants' views without alteration to ensure that the findings reflect the true views of all those involved without any adjustment to the original data. Initially, the designed interview questions were pre-tested from the three experts for ease of understanding and completeness in testing the objectives of the study. After the interview, the results interpretation reflected the participant's perspective. In addition, data triangulation (Collis & Hussey, 2003) was used to ensure the validity of the results. This was possible as the participants were on both sides of the equation, which were the service providers and the customers (mining companies). This sample size was sufficient for this study as it is a survey study (Guest, Bunce, & Johnson, 2006). Creswell (2013) indicated that a sample size of 5 to 25 was appropriate, while Morse (1994) argued that at least six interviews are required for survey study. Additionally, the fact the both the mining companies and service providers were interviewed, allowed for comparing the results. This approach ensured that there was a validity of the results. In addition, three interviews were sent back to the interviewees for validation of the content.

3.6.3 Transferability and external validity

Transferability and external validity – An effort was made to ensure that the interviews were generalisable, by interviewing multiple mining companies, with a minimum of two to three participants per company. In addition, both the mining companies and service providers were interviewed. However, it was still expected that generalisability would not be achieved fully, and this was one of the limitations of the research.

3.6.4 Dependability, consistency, and reliability

Dependability, consistency, and reliability– the intent of the study was to understand the factors that influence the adoption of cloud-based ERP system. There was an alignment of related themes to the TOE framework, and network analysis of associations and contradictions were done. This approach ensured that dependability, consistency, and reliability was not compromised, while the conflicting views were also reported. Observer error was eliminated by conducting the interviews subjected to a protocol or interview guide. These factors ensured that the researcher did not ask the same questions in different ways.

This study looked at experts in the field of IT with more emphasis on ERP system and cloud computing. The ten purposively selected experts that were interviewed were highly experienced with some as long at 26 years within IT as presented in Table 3. None of the interviewees had less than five years' experience in IT, in line with the set inclusion criteria of the study discussed in the design and methodology. The depth of knowledge of the interviewed experts ranges from software developer, business analyst, enterprise architecture, project management, and line management.

> *"I started my IT career in '98, and I have done various things, I was a software developer for a number of years, a business analyst, business intelligence, project management, line management, a combination of things also a little bit of experience in enterprise architecture."* *ITP1*

> *"I have been a SAP Consultant for 15Years in the Basis field, and I have done a couple of SAP deployment. My primary role is to manage the Technical side of the SAP System."* *ITP2*

> *"I design & implement solutions for new business prospects based on World Best Practices & iSource Methodology. I also do programme management for significant Outsource opportunities and Resource Management."* *ITP4*

It is clear that the interviewed participants possessed the traits and experience that were aligned with the objectives of the study which was to determine the factors that influence the adoption of the cloud-based ERP system in mining companies in South Africa. In summary, the research study sought to ensure that the findings were valid and reliable. The validity and reliability of the study was achieved by eliminating possible bias.

3.7 Ethical considerations

Normally, ethics is defined as the moral difference between good and bad. However, according to the Oxford Dictionary, ethics is described as an adaptation of the principles and values of the conduct of a given career or organisation. Such values are mostly defined and imposed by university commissions at a disciplinary level when a professional code of conduct has been breached or violated. Study morals and values are essential because researchers should not influence their data gathering procedures, analysis method, and interpretation model in a way that will breach their professional code of conduct or violate their ethics for advancing an individual purpose. These ethics differ from one field of study to another (Bhattacherjee, 2012).

In this research, the semi-structured interview was used as a tool to acquire relevant data for our empirical study, and that involves human interaction as a factor. Therefore, it is recommended to consider incorporating ethical or moral standards in this study (Oates, 2006). Ethical Standards for an IS research are relevant because they touch key factors of the study and should be taken into account throughout the entire research journey.

In this study, the researcher followed an ethics standard and professional code of conduct as outlined in the research committee of the University of Pretoria. The ethical standards were at the centre of this study, and other complementary ethics were a requisite to pose this study. A form was signed by both the scholar and contributors or participants to agree to follow the following ethical standards.

3.7.1 Ethical Standards in IS Research

- **Informed Consent** – Each participant's informed consent was requested and acquired before commencing with the interview. The consent form clearly defines their right to participate or withdraw from the research before its publication. All research participants were informed of the identity of the researcher and the objective of the study. The participants were also notified of the approximate duration of the interview. It is important for the researcher to divulge the objective of the study; who is performing the research; the expected results from the research; and the benefits of doing the research before commencing data collection. Informed consent is done so that the participants can decide on their own if they would like to participate. Finally, the participants were informed that their names and their company's name would not form part of this research paper, and the permission to record the interview session with the participant was requested from each participant (Yin, 2003).

- **Privacy and Confidentiality** – Partakers in the research have the right to stay anonymous to protect their identity and readers of the study cannot tie a given response to a specific participant. Responses provided by the respondent will be handled with guaranteed confidentiality, and the researcher promised not to disclose the respondent's identity in any research. The participants were informed that their names and their companies' names would not form part of this research paper as mentioned above, which means they are anonymous. However, three of the participants requested that their names and identities not be part of the study**.** Their

interview sessions were transcribed and recorded and will only be used in this research only, and no other studies.

- **Integrity and Reliability** –The researcher needs to be above reproach and be a researcher of integrity and truthfulness in their professional conduct. As far as integrity and reliability are concerned in this research, these aspects were approached attentively because they are crucial for IS research and also for the improvement of the quality of the study, which in turn, will yield an augmented level of confidence from people who will be reading this research.

- **Reportage and Interpretation** – It is vital for the research to present the procedure of the data reportage and interpretation to the respondents. Unpredicted and pessimistic outcomes should be completely divulged even if the readers of the research question the integrity and reliability of the research. In this research, the data interpretation process starts by going through the raw data to identify themes or similar viewpoints that recur from the collected data and tags them; then classifies the tagged viewpoints according to the recurring themes and then analysed them adequately and finally, tries and conceptualises information gathered to find similar patterns (Yin, 2003).

- **Conflict of Interest** – The researcher has declared upfront that there is no conflict of interest while conducting this research regarding financial benefit or any unfair advantage that might come from conducting this research. In this research, the participants were also made aware that they will not get any financial benefits by participating in this study.

3.8 Conclusion

Research models are at the forefront of every academic research being conducted. The knowledge and implementation of these in a study determine the validity; credibility and trustworthiness of the study. Also, the research model can be used to quantify the concept of the study in IS (Yin, 2003). This chapter has looked at the research design and research paradigm that was applied in this study, which was the interpretivist study based on a qualitative approach. The survey research was selected as a study technique for data collection in conjunction with the research context in section 1.2 of chapter 1, and the research questions as per section 1.3 of chapter 1. This chapter also went into detail on the data

collection and analysis methods used in this study to help answer the research questions. Finally, this chapter looked at the ethical standards adhered to when conducting an IS research at the University of Pretoria.

CHAPTER 4: DATA ANALYSIS AND FINDINGS

4.1 Introduction

In this chapter, the findings of this dissertation are elaborated on, using the six themes which emerged from the data analysis, as the guide for findings alignment. The six themes being cloud-based ERP systems; the state of cloud-based ERP adoption; the motivation for adoption; the hybrid strategy; the business impact; and risk management.

Structured in-depth interviews were conducted with identified experts using open-ended questions to collect the data for this dissertation. It was explained in Chapter 3 that the interviewees were purposefully selected as they had sufficient knowledge and expertise in cloud-based ERP systems and the implementation thereof.

4.2 Finding of the study

The six-phase approach of Braun and Clark (2006) was used for the analysis of the data. A total of 70 codes were extracted. Through the constant comparison of the codes and merging of the similar codes as well as the rejection of some codes which were deemed to be irrelevant to the purpose of the study, a total of 34 codes were selected (see Table 5).

1	Adds on game changer	18	Increased storage
2	Bandwidth catch up in process	19	Lack investment priority
3	Bandwidth considerations	20	Manager not critical
4	Business impact	21	Migration of ERP platform
5	Cloud computing	22	Mindset issues
6	Cloud ERP System	23	Motivation for adoption
7	Concerns about uncertainty	24	Non-disruptive testing
8	Cost reduction	25	On-premise and Cloud ERP
9	Data security	26	Quick resolution of problems
10	Diversifying skills	27	Reliable system
11	Economies of scale	28	Required experience (Cloud computing)
12	Electricity uncertainty	29	Risk management
13	ERP System	30	Theft issue
14	Flexibility	31	Time to adoption
15	Hybrid ERP system	32	Track record of supplier
16	Improved space in cloud computing	33	Unfavorable Contracts
17	Increase Innovation	34	Virtualisation

Table 5 - Table of Codes

At this step, the drive was to create a network of codes which emerged solely from the empirical or interview data. These codes were interconnected logically with others. This process was done with codes that were at the base of their possible relationship during the open coding phase. A network of codes was created using relationships between the codes that were identified in the dataset with the 34 nodes and the relevant connections between them as boundaries or restrictions. This process resulted in the formation of a coding network graph (see Figure 16). Then the focus was on themes instead of codes.

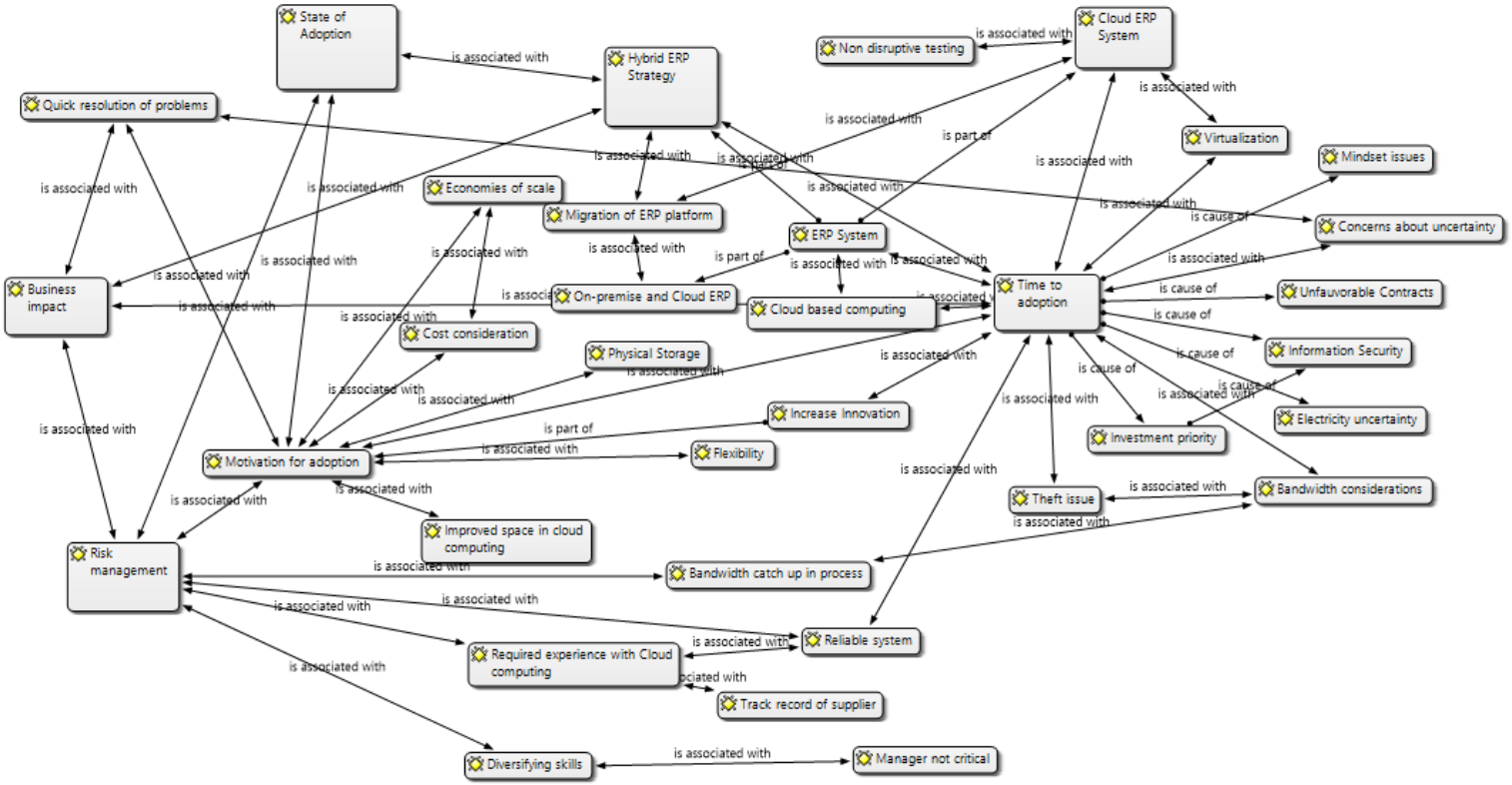

Figure 16 - Network of codes

From this initial network of codes, a total of six themes emerged. The six themes extracted from the data were cloud-based ERP systems; the state of cloud-based ERP adoption; the motivation for adoption; the hybrid strategy; the business impact; and risk management. Using these themes, a final thematic map was developed which is presented in Figure 17.

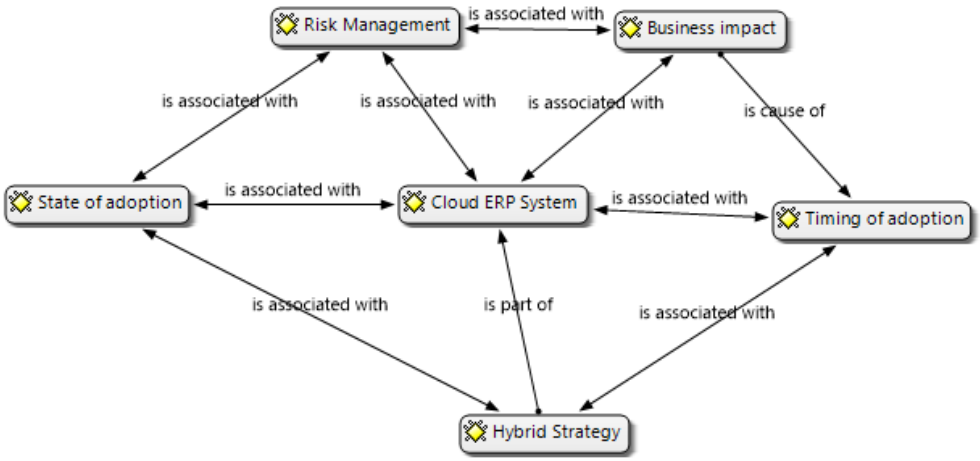

Figure 17 - Final thematic map

Each of these themes is consequently discussed in the section to follow.

4.2.1 Cloud-based ERP systems

The interviewees explained that an ERP system was a business management system that was used by the company to ensure the smooth and efficient running of its processes. Some of the explanations that were given included the following:

> "Enterprise resource planning (ERP) is a business process management software that allows you to use a system of integrated applications to manage the business functions related to technology, services, and human resources – (SAP, Oracle, JD Edwards)" ITP4

> "In layman's term, I would say it is a system to manage all your business processes and how you do business, so it would be your primary focus regarding what processes I run and how they integrate with bigger areas in the business." ITP5

These interviewees explained cloud computing to be:

> "A network of remote servers hosted with large capacity in a farm not belonging to the Client and accessed via the Internet to store, manage, and process data, rather than a local server or a personal computer" ITP4

> "It is computing but without your hardware on site, well technically you do not have the responsibility of managing a server room or even needing database administrators to manage all that." ITP5

With the Cloud-based ERP system being:

> "It is basically one of the cloud technologies if I can call it that way. So what it means is that you will still have a physical server somewhere but the tendency before virtualisation was to have each application you have yourown separate little server and then that started to change where we had like those discs where you had the actual server, motherboard, CPU, etc." ITP4

They deem this system as being the future, and essentially the only thing that will change is its platform of use and development.

> "I think ERP is "here to stay" but in the future, there will be a greater migration and integration to things like cloud, mobility, big data, Internet of Things (major forces that are shaping technology)." ITP6

4.2.2 The State of cloud-based ERP system adoption

There was a general agreement that there was a lack of fully fledged adoption of cloud-based ERP system in the South African mining industry, with only a few pockets which include elements like virtualisation.

> "[Virtualisation] it is basically one of the cloud technologies if I can call it that way. So what it means is that you will still have a physical server somewhere but the tendency before virtualisation was to have each application you have yourown separate little server and then that started to change where we had like those discs where you had the actual server, motherboard, CPU, etc." ITP1

> "[Virtualisation] it is part of the infrastructure package, so instead of using the traditional storage space we have a storage space that we allocate that we say, let's say you are going to get 500 megabytes we can give you. we bought space, but the infrastructure team manages it, so we get allocated space by them that we can use because we want to scrap the maintenance of the physical disc" ITP5

These interviewees provided different time frames as to when the mining companies will adopt the cloud-based ERP system with some indicating a time period of up to 10 years.

> "My gut feel would be eight years before I can see that this is really going to become mainstream but that is just me, there might be other people who tell you that it is going to happen much quicker" ITP1

> "I would estimate that it will take another 8 to 10 years before cloud-based ERP is the norm in SA" ITP6

One of the participants raised a very interesting aspect, about the timing of adoption, alluding that it was baffling that cloud-based ERP system adoption was not happening sooner than anticipated considering the state of the mining companies which were explained to have poor profitability and a high drive for cost reduction - with cloud computing having a potential to assist with both.

> "At the moment, you expect a potentially high rate of adoption due to lack of profitability and cost issues in mining companies. Also expect that uptake will increase as infrastructure contracts are now renegotiated in mining companies." ITP10

Among these experts, there was one in particular who was more optimistic and indicated that they expect the migration to cloud within the next 12 to 24 months.

> "I would say we would be in the cloud or some components of it within the next 12 to 24 months" ITP8

The interviewees also indicated that there was a development within the ERP system space with regard to add-ons, which they regarded as a game changer as it will differentiate SAP from its competitors in the ERP space.

> "S/4 HANA will be a game changer and will vastly differentiate SAP from its competitors in the ERP space" ITP6
> "There will also be additional "add-on" modules e.g. EHS already there; Integration with other products like ARIBA, greater focus on in-memory technology" ITP6

Despite all of this, these specialists saw cloud computing and cloud-based ERP system as the future.

"because if you look just generally we are always seeking to improve particularly in the space. We do not want physical I mean we got rid of paper. So we will get there but we just need to have stronger networks and also the support hubs in terms of, if we are talking about bandwidth it doesn't help if we have to connect to one central place in Africa somewhere that will be the primary supplier if I may call it that, for the whole African continent. The minute we have those hubs, it is going to be easier." ITP5

4.2.3 Timing of adoption

A total of eleven factors were brought forth by the interviewees as the reasons which were influencing the rate of adoption of cloud-based ERP systems. Within these reasons, there were four which were motivating for cloud-based ERP system adoption, while seven were barriers to cloud-based ERP system adoption. The timing of adoption implied that there were twice as many reasons for not adopting cloud-based ERP systems, which could explain the poor state of cloud-based ERP system adoption in the mining industry (see Figure 18).

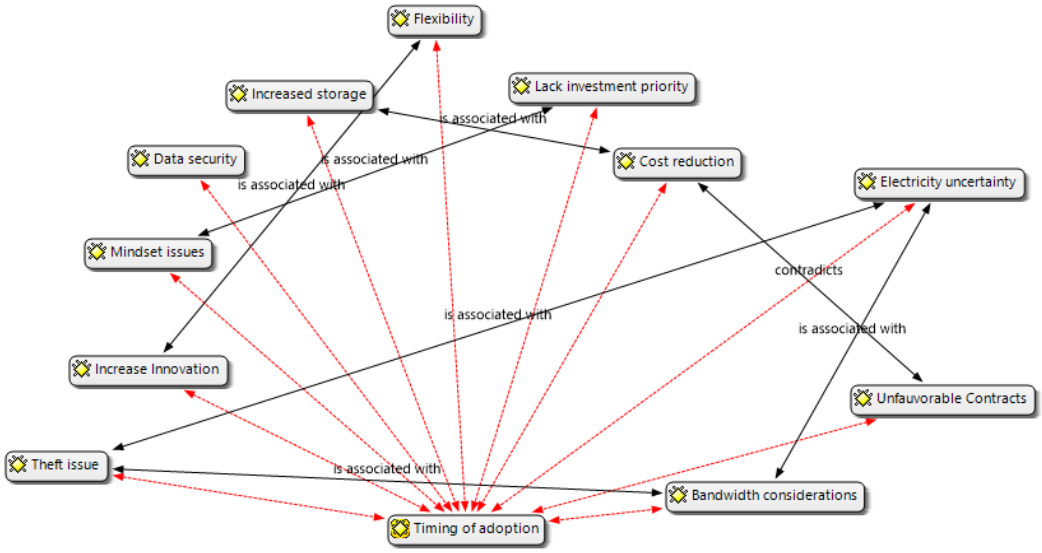

Figure 18 - Timing of Adoption

The four main factors that were motivating for the adoption of cloud-based ERP systems include improved innovation; cost reduction; flexibility; and increased storage capacity.

- **Increased innovation**

> "Cloud should also be able to provide increased speed of innovation as one could use it as a "playpen" or test area without disrupting your current on premise environment" ITP 6

- **Cost reduction**

> "More cost effective and can reduce Infrastructure and Software Costs for Companies. This allows you to make use of the cloud offering with minimal cost exposure and a possible reduction in license cost for an ERP Solution" ITP4

> "it is cheaper because you have a lot more space for less than if you were to have it on premise" ITP5

"Theoretically, companies who provide cloud infrastructure and services should be able to provide this at a reduced cost, owing to "economies of scale". ITP 6

- **Flexibility**

"flexibility -theoretically it should be easy to suspend services and costs if there are cash flow constraints and then reinstate them at a later stage and ease of innovation" ITP6

"A cloud service comes with a lot of flexibility" ITP9

- **Increased storage**

There was also a view that cloud service providers would allow mining companies to have bigger storage capacity if they move their ERP systems to a cloud environment, compared to on-premise ERP systems which usually have smaller storage spaces and were becoming more expensive with each and every storage increase.

"The intelligence sets will be in this, it is talking to storage sets, and this storage is a clear set that we have got, but now we have storage and for storage and SAP. The other thing that is an advantage for cloud storage is that no longer do I need to worry about space outside because each and every cloud provider is selling you that they have the resources Outside their different cloud centres" ITP8

The factors that were hindering the adoption of cloud-based ERP systems were multifaceted and multidimensional. Among these factors, there were some that are internal and some that are external contributing factors.

- **Bandwidth issues**

Bandwidth issues were one of those multifaceted factors, as it comprised lack of reliability, high loss of connectivity, speed and the cost of broadband being high.

"I think in South Africa the biggest challenge we have is, of course, bandwidth; you need a lot of bandwidth, and as you know, the infrastructure is not as good as the other countries." ITP3

"The main consideration is bandwidth (performance of accessing the applications and data at a remote site" ITP6

"That can have an impact on networks etc... and lastly Networks – Bandwidth or broadband in SA is very expensive." ITP2

"the biggest problem that we have here is around our network, because whenever we have problems with the network we looking at we are nowhere near enough, so it is not easy for us to connect from here to anywhere else over the network" ITP5

"In South Africa, there's limited internet coverage which could negatively impact the deployment due to the remoteness of the shafts in mining and the state of connectivity in South Africa" ITP7

- **Unfavorable contracts**

"being locked into contracts with current providers with penalty clauses, the fact that big companies like SAP, have not revisited their licensing models appropriately for things like SAAS to make Business sense. They still want to "milk" their customers" ITP6

"there are a number of dependencies' before we get to that point, and I'm sure you are aware of what those dependencies' are, certainly access to connectivity and so much it's a very real barrier as well as the cost of moving into that world both from a licensing and an infrastructure perspective, it's going to be extremely high" ITP8

"It is a massive problem; I think the principle of pay per use is right but the transition from pay for what you own to pay for what you consume. So, SAP will charge us for a professional license, but you can be very sure that when you move to a cloud, you'd still be using SAP, and they are not going to want to lose out." ITP10

- **Data security**

Data security was listed by the majority of the experts as the reason for the delay in the adoption of cloud-based ERP systems by mining companies. Data security was a major concern considering the source of competitive advantage held by these companies. Some of the comments on this included:

"Companies need to adjust their mindset about cloud-based environments; the biggest issue is security" ITP6

"Data security is one of the factors that makes companies reluctant to adopt cloud-based ERP" ITP2

"Obviously it will be the cost of the storage also, how much are we going to be spending in the cloud? Alternatively, what difference is it going to make financially viable versus if we were on premise." ITP5

Despite this view, there was a contradictory opinion from one of the respondents who argued that there was real security built into the cloud which was well maintained in the cloud computing environment.

> "I am saying a data centre, say a Google data centre or a Microsoft data centre has so many layers of protection far more than my own they have invested far more insecurity and physical access control than I ever could and so for me, cloud is far more secure than on-site information storage" ITP7

- **Poor electricity grid**

> "The only hurdles are the following if you cloud partner is not a global player and Electricity crisis – Current situation in SA is not really conducive as the power grid is very unstable" ITP2
>
> "South Africa we have a problem with our electricity] that's also something to consider" ITP3

- **Mind-set issues**

> "The mindsets of not having your data on-site, as some executives do not feel comfortable to have their data off-site" ITP 2

- **Lack of Investment priority**

> "because mining is not primarily IT focused it's still a bit of a challenge because there isn't that much investment that goes towards our it resources to a certain extent it still appears to be a cost factor, liability but there are different systems running in mining even not considering SAP only that I think if we were to focus on them and invest" ITP5

> "Other factors affecting the spending habits of mines on things like new technologies around South Africa includes the higher wage demands from labour. These demands tend to have a significant impact on the bottom line/profits of these organisations thus also resulting in a cutback of the capital expenditure" ITP9

- **Theft issues**

> "So everywhere you go they are actually busy doing this. So because you know the normal telephone lines are just not reliable. They get stolen, and the speed is limited so with fibre optics you can go high-speed internet" ITP3

The flexibility is associated with increased innovation, and at the same time, the migration to cloud-based ERP system will result in the availability of increased data storage. The increased data storage is also associated with cost reduction; this cost can sometimes be hindered by

the existence of unfavourable contracts which the companies cannot get out of and realise the cost reduction upon migration from traditional ERP system to cloud-based ERP system.

4.2.4 Risk management

There were concerns from the experts on the risk management, as they believed that although the adoption of a cloud-based ERP system has some benefits, such as innovation and large data storage spaces, it was also posing a risk to the business operations. This risk was due to inadequate data security, unreliable connectivity, and insufficient knowledge from the suppliers on cloud-based ERP systems, which could result in unreliability posing huge risks to the company.

Some of the experts acknowledged that mining companies were catching up, especially with regard to connectivity, which was reducing the risk of migrating to cloud-based ERP system.

> "We are catching up if I give you an example Lonmin is in the process of getting a fibre leaf from Johannesburg to this side which will obviously help us get the bandwidth that we need, but in the past that wasn't possible" ITP3

4.2.5 Business Impact

These specialists were more concerned about the business impact of cloud-based ERP system. Production was seen to be the core business of mining companies, and the least of their concerns were the politics of who is performing what function on the ERP system. They were more concerned with the overall functioning of the system, assisting them to reach the targets they have set out to accomplish.

> "They just want a system that is reliable with an acceptable performance and quick turn-around times to resolve issues – regardless of where it is housed or who manages it." ITP6

The business impact factor underpins the importance of proper migration, if needs be, that is seamless without negatively impacting on the business processes.

4.2.6 Hybrid Strategy

There was a consensus from both the side of the mining companies and the cloud service providers that a hybrid strategy for ERP systems, which comprises both on-premise ERP systems and cloud-based ERP systems, is the way to go at this stage. The reason for this was set forward as mainly to minimise the risk.

> "I think a hybrid solution to minimise the risk and trust that is involved coming with cloud computing. The Mine can still deploy the production environment within their own space and the Development, and QA environment can be Cloud to reduce cost and risk" ITP4

> "Short term for comfort I would say hybrid and then we evaluate and see if we have issues connecting to the cloud." ITP5

> "There is also a "hybrid" approach, where certain functions are housed on premise which then integrates with others that are managed in the cloud. I think a hybrid approach would be the best route to follow – gradually see where it makes business sense to run certain functions in the cloud. In this way, you do not put all your eggs in one basket, and you can mitigate risks to an extent. Your will also gain experience in dealing with cloud service providers –what works well and what doesn't" ITP6

4.3 Summary and conclusion

From the ten expert interviews, six themes were extracted and elaborated on in this chapter. These included cloud-based ERP systems; the state of cloud-based ERP adoption; the timing of adoption; risk management; business impact; and the hybrid strategy.

In the next chapter, the researcher discusses these findings and draws some conclusions and recommendations.

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the researcher discusses the findings as stipulated in chapter 4 of this dissertation. The research questions posed in chapter 1 is answered after which the conclusions to the findings follow. The limitations of the study are subsequently discussed, and some recommendations for future studies are made.

5.2 Answering the Research Questions

In this study, four research questions were developed to answer the objectives of the study.

- What is the current state of migration to cloud-based ERP systems in mining companies in South Africa?
- What are the factors that influence the move to cloud-based ERP systems in mining companies in South Africa?
    - What are the benefits of having a cloud-based ERP system?
    - What are the limitations and challenges that come with a cloud-based ERP system?
- What types of IT infrastructure and resources do mining companies in South Africa need to migrate to cloud-based ERP systems?
- What would a framework look like which could be used by the management of mining companies to determine and understand the factors that influence the migration of cloud-based ERP systems?

Each of these questions is consequently answered with reference to the literature study done in chapter 2 and the research findings discussed in chapter 4.

5.2.1 The State of adoption of cloud-based ERP system

Question #1: What is the current state of migration to cloud-based ERP systems in mining companies in South Africa?

The findings of this study have revealed that there is a lack of fully fledged adoption of cloud-based ERP systems in mining companies in South Africa with only a few currently having adopted a hybrid strategy which includes elements such as virtualisation (see section 2.6.5 of Chapter 2). Feedback from interview respondents explained that the poor state of cloud-based ERP system migration in the South African mining companies could be due to the fact there is no clear and defined approach on the effort required to adopt cloud-based ERP systems. A lack of knowledge on what the best solution for mining companies, given their current situation, would be, is also prevalent. This state is expected to remain as such for as long as the next eight to ten years.

These results are not in line with the trends as mentioned in our literature review in section 2.4.2 of chapter 2 that are being observed in the international cloud computing space. Despite the poor migration rate, it was already mentioned in this study; that mining companies have initiated the process of adopting a hybrid strategy or virtualisation, see section 4.2.2 and 4.2.6 of chapter 4. The process of moving applications to cloud computing in mining companies has started using other forms of cloud computing such as virtualisation where they can have an application such as Microsoft exchange and web hosting, which are developed to some extent; commoditised; and are non-critical applications, see section 4.2.2 and 4.2.6 of chapter 4.

The adoption of virtualisation has shown though, that some groundwork has already been done for further migration of the ERP application to a cloud computing environment (see section 2.6 of chapter 2 and 4.2.6 of chapter 4). The issue here is that an ERP system as an application differs from most other applications in that any interruption to it could mean a significant loss of revenue. System interruption and a lack of or need for data privacy/security was identified as some of the reasons for the slow adoption of cloud-based ERP systems in the mining industry. The opportunity to have an on-premise ERP system which uses a virtualised data centre allows mining companies not to move their core services to a cloud computing environment and consequently only move the non-critical application to a cloud computing environment.

5.2.2 Factors that influence the adoption of cloud-based ERP system

Question #2: What are the factors that influence the move to cloud-based ERP systems in mining companies in South Africa?

It is common cause that factors that influence anything tend to be positive and negative. In this regard when evaluating factors that affect the move to cloud-based ERP systems, the positives (classified as benefits), and the negatives (classified as challenges) were assessed. Hence this research question was broken down into two dimensions, namely benefits and challenges. These are discussed in the sections to follow.

5.2.2.1 Benefits and business value of cloud-based ERP system

Question #2.1: What are the benefits of having a cloud-based ERP system?

The main benefits of cloud-based ERP system as per the finding of this study were: innovation; cost reduction; flexibility; and storage capacity. Each of these is consequently discussed below.

- **Innovation**

The findings of this study have revealed that when a mining company adopts a cloud-based ERP system, this system brings a lot of innovation with it. A cloud-based ERP system modernises the way a mining company operates in that it will revolutionise the business process which, in turn, influences revenue. The company would soon realise the benefits of having an integrated ERP system. In the literature review, section 2.4.7, this study reported that there is high demand for analysing data and the speed at which these applications deliver feedback to the users. Furthermore, management will need devices which are spontaneous, fast and integrated. So by adopting an innovative approach, mining companies will be able to drive productivity because executives will be able to check up on operations through their mobile devices from anywhere in the world: a cost and time efficient solution. This is confirmed by one of the respondents of the interviews (as discussed in chapter 4, section 4.2.3) who argued that moving their ERP system to the cloud could increase the speed of their operations, making them more efficient.

In a traditional ERP system, mobility is experienced in scanning which is used when doing material handling, service tracking or tracing products, logistics and warehousing. A true cloud-based ERP system takes advantage of new technology such as HTML5 which allows users to access business applications through any web browser and from any mobile device. Mining companies should view cloud-based ERP systems as an innovation that adds value to their business, making their processes more flexible and easily accessible, especially in remote areas.

- **Cost reduction**

The findings of this study have revealed that when a mining company adopts a cloud-based ERP system, they would be able to reduce their costs. A cloud-based ERP system will be cost-effective as mining companies will neither have to pay for the maintenance of the IT infrastructure and on-going license fees nor need they have to worry about the data storage space of their legacy ERP system. This view is supported by the literature review done in section 2.4.5 where, according to Basset (2015), a company that migrates their ERP system to a computing environment would drastically reduce their ERP maintenance costs and be able to utilise the ERP system at a low cost. Additionally, this view is supported by the findings reported in section 4.2.3 where one of the respondents said that migrating an ERP system to the cloud would be cost efficient and can reduce infrastructure and software costs for mining companies. Another respondent also confirmed that a cloud-based ERP system would be much cheaper because one has a lot more space for less than when having the ERP system on premise.

For mining companies, a move to cloud-based ERPs would be a complex project to execute. Senior finance managers will have to decide on an appropriate model for the business; one which represents the total lowest expenditure over the life of the ERP system and for which the budget forecast is ideal to meet the requirements of the business.

- **Flexibility**

Cloud-based ERP systems are reported to intensify flexibility due to on-demand services across ERP applications and their compact solution for deployment. This was addressed in chapter 2, section 2.4.7. According to Chin-Sheng, Wen-Yau, and Hui-Yu (2014), the flexibility feature that comes with cloud-based ERP systems enables companies to measure their ERP system solution and meet upturns or downturns in transaction volumes, storage needs, computing servers, or broadband networks, hence appearing to be unlimited in the eyes of its

clients. This view is also confirmed by the findings reported in section 4.2.3, where one of the respondents said that with a cloud-based ERP system, it should be easy to suspend services and costs if there are cash flow constraints. These could then again be reinstated at a later stage.

When a mining company has adopted a cloud-based ERP system, it allows for more flexibility with regard to the use of cloud computing infrastructure. Should a company, for instance, have an urgent need to add an additional server to their ERP system landscape,, this server could rapidly be deployed in the cloud computing environment without them having to procure it.

- **Storage capacity**

Cloud-based ERP systems offer one of the simplest applications regarding storage capacity. This sort of storage not only benefits the company regarding not having to buy additional physical storage every time they need more storage space, but it is also useful because the users can access all company data files globally from anywhere. In the literature review in section 2.4.9, it was reported that for a cloud-based ERP system, data storage would not be of any concern as the cloud service provider ensures reliable and unlimited data storage in the cloud computing environment. This view was also confirmed by the findings reported in section 4.2.3, as one of the respondents argued that a move to the cloud would sort out storage issues because cloud service providers should be able to provide unlimited data storage. Cloud-based ERP systems will thus allow mining companies to manage their storage capacity with minimal human intervention.

5.2.2.2 Limitation and challenges of a cloud-based ERP system

Question #2.2: What are the limitations and challenges that come with a cloud-based ERP system?

The main challenges of cloud-based ERP systems as per the findings of this study are: poor and expensive bandwidth; data security; a poor electricity grid; theft issue; unfavourable support contracts; a lack of investment priority and poor change management. Each of these is discussed in the section to follow:

- **Bandwidth – Expensive and poor (high loss of connectivity)**

One of the bottlenecks of cloud-based ERP systems found in this study is the insufficiency of a terrestrial fixed broadband backbone which continues to be dominated by a state-owned operator. In South Africa, the broadband and bandwidth issue has been characterised by licence restrictions imposed by the communications regulator, which has stifled competition among the operators and market entry into the broadband market. The licence issue resulted in a state-owned operator having a monopoly on the fixed broadband with excellent control over essential network infrastructure (backbone network) and a saturated market.

In the mining sector, quality of services has become significantly paramount for IT services offered. Poor connection as a result of poor infrastructure is another barrier presented by participants in the country. For progress in cloud-based ERP system migration in South Africa, the need for a stable and reliable broadband connection will have to be met. In the literature review in section 2.4.14, it was noted that the strength and consistency of Internet access is crucial for the performance of the cloud-based ERP system because enterprise users will access their work application services over the Internet. A cloud-based ERP system will need fast broadband access to ensure that the response time of such a system is better than, or at least the same, compared to an on-premise ERP system. In the findings of this study in section 4.2.3, one of the respondents noted that the biggest challenge they have in South Africa is the limited bandwidth while another one noted the main consideration to be bandwidth and performance of data and application access at a remote site. For mining companies, this limited availability of broadband access or connectivity in mining towns acts as a barrier to cloud-based ERP system migration, because most of their operations are in the remote areas of the country.

In addition to connectivity issues, this study also reports on the problem of expensive costs related to a broadband connection (last-mile access) which is one of the limitations to cloud-based ERP adoption. Last-mile access refers to “the physical network infrastructure and tools that connect end users” (Calandro & Moyo, 2012). This research further revealed the high costs of bandwidth as reported in the literature review in section 2.4.14. The average monthly price of broadband access in South Africa was reported to be 10+ times higher than that of the United Kingdom (UK). The average monthly cost for broadband access in South Africa is about R337 monthly whereas the UK’s monthly cost is about R36 a month. In the finding chapter of this study in section 4.2.3, one of the respondents stated that bandwidth or broadband in SA was very expensive.

- **Information / Data security**

The concern around data security is one of the main barriers to the adoption of the cloud-based ERP systems in South Africa. In the literature review in section 2.4.5.1, it was noted that data security is a significant concern when migrating ERP systems to the cloud as it contains companies' sensitive data and causes the loss of control over data. In the findings of this study as reported in section 4.2.3, one of the respondents noted the biggest issue for mining companies to be data security, and another stated data security to be one of the factors that make mining companies reluctant to adopt cloud-based ERP systems.

- **Poor electricity grid**

The supply of electricity in South Africa is also one of the biggest barriers to the adoption of cloud-based ERP systems, due to the inadequate support and maintenance of the electric infrastructure in the country. In the literature review in section 2.4.14, it was noted that South Africa has an electricity crisis and has been affected by load-shedding several times in the past. It was also pointed out that theft and vandalism of electric cables and optic fibre cuts have been prevalent around mining towns which have resulted in the loss of power and connectivity, and eventually, a company will have an electricity crisis. In the findings of this study as reported in section 4.2.3, one of the respondents noted that the current situation in South Africa is not really conducive to a cloud-based ERP system as the power grid is very unstable.

In a sector such as the mining sector, businesses cannot afford to have ERP system downtime because these systems are their core systems. In South Africa, mining companies are forced to have an alternative electric supply from independent power producers because of limited electricity availability in the country which will considerably increase the operational costs of a cloud-based ERP system. Mining companies also make use of generators, solar panels and power batteries which is why it is now common for large companies in South Africa to have three levels of electricity supply just to manage the sub-optimal electricity supply.

- **Unfavourable support contracts**

Unfavourable contracts with IT service providers which involve the risk of vendor lock-in and the expenses involved when moving from one cloud service provider to another provides a challenge. Vendor lock-in is one of the impediments to cloud-based ERP system adoption because there are no formalised standards across the different cloud service providers which lead to portability issues of data and other data related complexities. In the literature review, it was reported that a company might find an appropriate cloud service provider but that there is always a risk associated with vendor lock-in. This challenge is caused by complex interoperability among cloud service providers and a lack of shared industry platforms for cloud-based ERP systems. In the finding of this study in section 4.2.3, it was reported that one of the respondents noted that mining companies are locked into contracts with current service providers which contain penalty clauses. For this to disappear, large enterprises such as SAP and Oracle, have to revisit their licencing models appropriately to make it more attractive for their clients.

Mining companies are worried that if they do get into unfavourable contracts with a single cloud service provider that it could limit the flexibility of the organisation's business in future. Mining companies should first conduct a thorough check on the cloud service provider before selecting one, and before signing a contract. They should carefully evaluate the data protection and redundancy policies, as well as the service level agreements (SLA) of cloud service provider, before making a decision to migrate their ERP system to a cloud computing environment.

- **Theft Issue**

The issue of cable theft and fibre optic cuts in South Africa is also one of the biggest barriers to the adoption of cloud-based ERP systems. In the literature review in section 2.4.14, it was noted that South Africa has a theft crisis and companies have been affected by cable theft and vandalism several times in the past. It has also been noted that theft and vandalism of electricity and optic fibre cuts have been prevalent around mining towns which have resulted in the loss of connectivity and essential services, and eventually, a company will have a connectivity issue. In the findings of this study as reported in section 4.2.3, one of the respondents noted that the current situation in South Africa is not really conducive to a cloud-

based ERP system as the normal telephone lines are just not reliable and they get stolen which would affect connectivity.

- **Lack of investment priority**

The migration to cloud-based ERP systems seems not to have gained momentum within the mining industry due to their substantial investment in current ERP infrastructure. The cost of moving an ERP system to a cloud computing environment acts as a barrier, particularly when the business has made significant investments in their legacy ERP system and network infrastructure.

The investment factor is a great concern for mining companies who are risk averse and are of the opinion that there will be a loss of data management and ownership of data should they move to the cloud. This view is supported by the literature review in section 2.4.15 where it is reported that there are no clear policies and guidelines regarding the control and the use of data. The challenge here is that any lost data or data that leaks to other parties could be used for espionage or to the advantage of direct competitors. In the findings reported in this study, in section 4.2.3, one of the respondents noted that mining companies are not primarily IT focused and there is not too much investment in IT resources to a certain extent. ERP systems are still being considered as a cost factor and a liability.

- **Mind-set issues – poor change management**

A cloud-based ERP system does not provide a one-size-fits-all solution. One of the restrictions that is commonly overlooked when moving an ERP system to the cloud is the issue of change management. Mining companies seldom ask themselves how the IT innovation will impact the business and rarely follow up with an intensive assessment to determine how ready the business is for this innovation. A mindset change is needed to assist with the acceptance of a cloud-based ERP system. In the literature review in section 2.7.1, one of the features reported on, under the organisational context of the TOE framework, which is considered as an important influence on the adoption of a new innovation, is the need for proper change management and support from top management. In the findings reported in section 4.2.3, one of the respondents noted that mining companies have change management issues where they are not used to the idea of having their data off-site or where they are still captured with the mindset of not having their data on-site.

The support of top management cannot be over-emphasised. It is crucial that top management shows their support for the ICT innovation in which the company engages. In a case where senior management is actively involved in the adoption of a cloud-based ERP system, it shows their determination for the innovation to be successful. It also indicates that they are willing to facilitate and overcome the inhibiting issues that come with such an innovation. If there is uncertainty at top management level, the adoption is less likely to occur (or to be successful) in a mining company. The lack of their support will be reflected as a failure to champion innovation within the business.

5.2.3 IT infrastructures and resources are needed in South Africa

Question #3: What types of IT infrastructure and resources do mining companies in South Africa need to migrate to cloud-based ERP systems?

- **Bandwidth and Broadband infrastructure**

Broadband infrastructure is an enabler of cloud-based ERP systems migration. In South Africa, policy and regulatory challenges inhibit investments in the extension of networks to rural areas where mining companies are operating. Companies, who have invested heavily in broadband infrastructure, are mainly based in the cities. In the literature review in section 2.6.1, it was reported that there is an initiation to persuade the communications regulator to adopt a regulatory model that will foster competition among operators and promote broadband penetration; and a need for the South African legislature to fast-track the finalisation of a broadband policy (currently under review) which will recognise the need for less expensive and reliable access to the Internet. In the findings of this study in section 4.2.3, one of the respondents reported that a big problem mining companies have, is a proper broadband network – they do not have sufficient network resources to allow them to migrate to a cloud-based ERP system.

In mining towns or rural areas, there is low or non-existent levels of broadband and these areas continue to face resource challenges regarding ICT. A cloud-based ERP system adoption in South African is still in development in large firms, especially mining houses. There is a requirement to resolve regulatory and compliance issues that are currently there, and to resolve bandwidth constraints in rural areas around mining companies to represent a full understanding of what makes a cloud-based ERP system different from a traditional on-premise ERP system.

- **Skilled Resources**

Another key feature needed to allow for migration to a cloud-based ERP system is the acquisition of needed knowledge and skills among internal employees. When a company has internal skills on what it takes to move to a cloud-based ERP system, it will be easier to realise the envisioned improvements and to implement the new system. It will assist internal employees to assimilate the new ERP system and to roll it out across the company. In the literature review of this study in section 2.6.1, it was reported that when a mining company decides to adopt a cloud-based ERP system, they must devise an HR strategy that will deal with the training and development of employees who are not familiar with cloud-based services. South Africa will need to invest in building a pool of local ICT expertise to design, manage and deploy advanced cloud-based ERP systems, specifically in the area of data centre design, security, advanced decentralised networking and building virtual servers. In the findings reported in section 4.2.5, one of the respondents stated that cloud service providers could have inadequate knowledge of cloud-based ERP systems, which could result in unreliability, posing huge risks to the company.

There is a need to have a pool of specialised skills which should be accessible to mining companies should they decide to adopt cloud-based ERP systems, and this needs to come at a low cost. Additionally, there will be a counterbalancing process where resources can be moved to a low-cost base as a result of shared infrastructure or resources.

5.2.4 Putting it all together: A framework to understand the challenges and benefits

Question #4: What would a framework look like which could be used by the management of mining companies to determine and understand the factors that influence the migration of cloud-based ERP systems?

This study showed that mining companies in South Africa are reluctant to move their ERP systems to the cloud. As already discussed, this low adoption rate is due to many challenges and factors that influence the migration of such systems to the cloud. Migrating to the cloud could assist such companies to cut costs and to reap the benefits associated with it. What

seems to be missing is a proper framework which could assist management to understand the benefits and challenges offered by a move to the cloud computing environment and to help them to determine what needs to be in place for them to be considered ready to move.

To stimulate migration to a reasonably new technological phenomenon, all the factors that will play a role have to be examined to determine the organisation's readiness for the migration. These factors have been combined into a framework as illustrated in Figure 19. This framework is proposed for usage by management and cloud service providers to assist with the migration to cloud-based ERP systems in South African mining companies and is based on the TOE Framework by DePietro, Wiarda and Fleischer (1990). The TOE framework and its application to cloud-based ERP systems was discussed in chapter 2, section 2.7 of this study. The framework has three elements which need to be considered when adopting a new innovation on an organisational level: the organisational context (top management support and investment, company size, and technology and personnel readiness); the technological context (qualified advantage, intricacy of the innovation, observability, trialability and compatibility with other applications) under which the system is intended to operate; and the environmental context (competitive advantage and policy regulation pressures) (Oliveira & Martins, 2011).

The framework of this study was developed using an approach taken by Depietro, Wiarda, & Fleischer (1990), where they developed the TOE (Technology, Organisational, and Environment) framework. This approach was appropriate as the influencers of adoption in this study were found to be associated with the three dimensions of the TOE framework by Depietro, Wiarda, and Fleischer (1990). These dimensions were the external environmental, organisational and technological factors, and included in the theoretical framework for cloud-based ERP system are some of the questions CIOs of mining companies might answer to determine their state of readiness to migrate to cloud-based ERP system. The three dimensions of this study are provided in Figure 19.

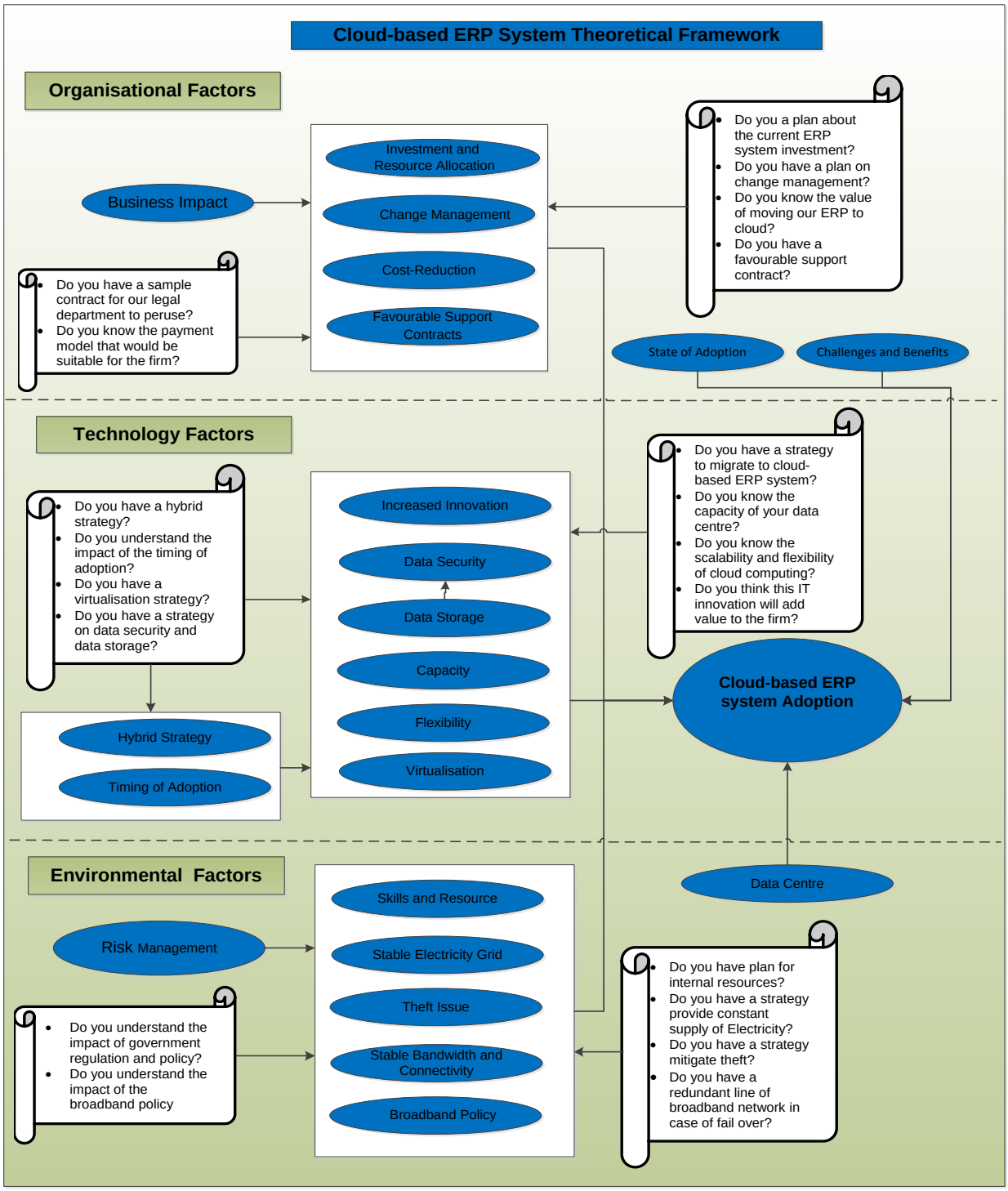

Figure 19 - A Framework to understand the factors affecting the migration to cloud-based ERP systems

The model developed in this study is now explained:

Firstly, organisational factors such as cost efficiency or cost reduction are regarded as one of the factors that will increase the adoption rate of cloud-based ERP systems as that is where direct cost savings will be experienced. Another factor is investment and resource allocation

as mining businesses must be willing to invest and allocate resources into innovation technology to improve the adoption rate of cloud-based ERP systems. Change management is another factor that is important for organisations to manage very well. Mining companies must develop a clear strategy to control and supervise change that is brought by technology innovation. Additionally, mining CIOs must engage in negotiations for favourable ERP support contracts with cloud service providers because this is one of the factors constraining cloud-based ERP system adoption. All the organisational factors depicted on the framework would have a business impact which can be a motivation or a hindrance to migrate to a cloud-based ERP system for a mining company.

Secondly, with regard to technology factors, data security is one of the main barriers to cloud-based ERP system adoption in South Africa. Cloud service providers will need to do more to give certainty to mining companies about how their data security will be ensured, and make sure there is proper data protection to improve the adoption rate of cloud-based ERP systems. Another factor for cloud-based ERP system adoption is data storage and capacity in the data centre. Cloud service providers will need to make sure that they provide sufficient data storage to businesses and attract more customers to improve the adoption rate of cloud-based ERP systems.

Another factor that is related to technology is the innovation factor, which is important because mining companies will revolutionise the business process which in turn, influences revenue. The company will soon realise the benefits of having a cloud-based ERP system, and this factor is also related to flexibility in the sense that a cloud-based ERP system will need to meet the current business requirements at any given point in time. Additionally, the virtualisation factor will help mining companies develop a hybrid cloud computing strategy around it as it allows mining businesses to have the capacity and the performance of a top ERP server without the need to buy or maintain any physical server. A virtualised ERP system frequently scales up in operational environments, giving the business the server capacity and power it requires, when it is necessary, for as long as it is needed. In future, this factor will positively contribute to adoption rates of cloud-based ERP systems.

Finally, in terms of environmental factors, the influencers were skills and resource diversity, and these were deemed critical to ensure support of cloud computing in the case of a fully-fledged cloud-based ERP system migration. In addition, a stable bandwidth and connectivity were found to be an integral aspect of the migration, as the cloud computing operation relies completely on the availability and stability of the bandwidth, and reliable connectivity with the

stability of the power grid and low cable theft and vandalism are related and necessary for the effectiveness of bandwidth. Furthermore, the data centres were found to be one of the contributing factors that can improve the uncertainty and guarantee end-to-end service on cloud-based ERP systems, and meet criteria such as reliability and availability.

In summary, an ideal framework for migration of cloud-based ERP system should be based on the three overarching factors which are the environment, organisation, and technology. It is important that the developed framework be validated using quantitative statistical methods where the validity of the constructs can be drawn up with factor analysis and the reliability considered using Cronbach alpha coefficient. To validate the overall study, a structural equation modelling would be appropriate for a relationship analysis and the variable goodness of fit into the framework.

5.3 Contribution of this Study

This study is designed to develop a framework to understand the challenges and benefits of cloud-based ERP systems in the South African mining industry. This study contributes to the body of knowledge by firstly extending the current understanding of the state of cloud-based ERP systems adoption within the South African mining context; whereas earlier studies that examined cloud-based ERP system adoption focused their attention on small-medium companies. Secondly, the study presents new benefits and challenges of cloud-based ERP migration as factors that influence the decision-making process in the South African mining industry. Benefits and challenges as stated in the literature review in section 2.4 of Chapter 2 are considered as the most important considerations to make in the ERP market for cloud-based ERP system migration. It is important, however, to look at other benefits and challenges mentioned by participants that are possibly not cited in the literature review.

Table 6 shows the comparison of the challenges and benefits as reported on in literature versus the situation for South African mining companies. Participants mentioned challenges and benefits that South African mining companies should be aware of regarding the factors for consideration in the cloud-based ERP system.

Challenges from literature	Challenges for SA Mining Companies	Benefits from literature	Benefits for SA Mining
Security	Information / Data security	Cost saving	Cost-Reduction
Customisation	Unfavourable support contracts	Availability and ease of use	Innovation
Vendor lock-in	Bandwidth – Expensive and poor (high loss of connectivity); Poor electricity grid; Theft issue	Scalability and flexibility	Flexibility
Performance	Lack of investment priority	Deployment	Storage capacity
Control	Mind-set issues – poor change management	Storage	

Table 6 - A comparison of the challenges and benefits as reported on in literature versus the situation for South African Mining Companies

Table 6 represents a comparison of the challenges and benefits as reported in literature versus the situation for South African mining companies above, indicates the challenges that mining companies might come across, and the expected benefits thereof are not the same. The fact that the study findings identify more challenges than benefits, does not mean the challenges outweigh the benefits for cloud-based ERP system migration. Thirdly, this study indicates what types of IT infrastructure and resources are needed in South Africa for mining companies to successfully migrate to cloud-based ERP systems. This study presents several key levels of mitigation features to address these. These key levels of mitigation are as follows:

- **Bandwidth and Broadband Policy** - to deal with the issue of broadband constraints, the communication regulator will need to adopt a regulatory model that will foster competition among operators and promote market penetration. It is, therefore, paramount for the South African legislature to fast-track the finalisation of a broadband legislation (currently under review) which will recognise the need for less expensive and reliable access to the Internet, with a spectrum that is properly managed by the regulator to add value in the open market.

- **Skill and resource diversity** - when a mining company decides to adopt a cloud-based ERP system, they must devise an HR strategy that will deal with the training and development of employees who are not familiar with cloud-based services and to deal with change management issues that might come with the changes.

- **Hybrid Approach** – the hybrid approach will give the mining companies the flexibility to have their production ERP system on-premise which will allow for security and data management to be more hands-on, to exploit the investment made on the legacy ERP

system fully; and to simultaneously have the development of their ERP system and quality/testing system managed in the cloud computing environment, to fully exploit the low costs and scalable storage of a cloud computing environment.

- **Data centre**- a data centre allows service providers to offer an integrated solution to mining companies which is a different and efficient manner of managing IT and business applications.

- **Virtualisation** - a virtual server allows mining businesses to have the capacity and performance of a top ERP server without the need to buy or maintain any physical servers. A virtualised ERP system frequently and speedily scales up in the operational environment, giving the business the server capacity and power it requires, when it requires it, for as long as it requires it.

Empirically, this research contributes by providing critical directives to mining CIOs on what to look at when making decision around migrating their ERP system to the cloud computing environment, based on the TOE theoretical framework.

5.4 Conclusion

In this study, the phenomenon of the migration of the cloud-based ERP systems was investigated in detail within its real-life context in the mining companies in South Africa. The study has revealed that there is currently a poor state of migration to the cloud-based ERP systems in South African mining companies, with the existing information predicting that it will still take some time. Some experts suggest that it will take up to eight years before fully-fledged cloud-based ERP systems are adopted in the South Africa mining companies.

Among the factors listed as the barriers to the migration were poor and expensive connectivity; concerns relating to data security, theft, poor electricity grid, unfavourable support contracts; a lack of investment priority and management support of a cloud-based ERP system uncertainty and lack of change management. Additionally, the study revealed that some of the challenges were being mitigated, which would soon encourage the adoption of cloud-based ERP system. Amongst those, are the catch-up with the bandwidth reliability and the development of the necessary skills.

Despite these challenges and barriers to cloud-based ERP system adoption, the study found that there were also some factors in favour of cloud adoption which include the innovation, reduced cost of operation (within healthy economies of scale), flexibility opportunities and improved storage capacity. Taking all of these into consideration, both customers and service providers believe that a hybrid strategy with cloud-based ERP in support services system and an on-premise ERP system will be the most efficient production system at this stage in the South African mining industry.

Grounded on the TOE theoretical framework by DePietro, Wiarda and Fleischer (1990), this research has developed and extended a research framework within the ERP system migration for South African mining companies. This framework has managed to evaluate the challenges and benefits of possible migration. As a result, utilising this framework can afford better comprehension of the factors that influence cloud-based ERP migration in the South African mining companies.

In general, this research is imperative as it can assist mining companies to attain competitive advantages through the migration of ERP systems to the cloud computing environment. In the midst of the current economic situation around the mining sector, being adept to systematically manage and supervise business operations is critical in maintaining a competitive advantage.

5.5 Limitations of the study

This study was not without limitations, and the following were the limitations that should be considered when the findings of the study are being examined:

- The study was conducted only within three mining companies due to the lack of time and lack of resources, given that the researcher self-funded this study.
- The study used purposive sampling which is a non-probability sampling procedure that is associated with poor generalisability. Although this was the case, the extensiveness and relevance of the sample was met as discussed in the report, which ensured that there was credibility within the selected population.
- Although the interview was conducted with the experts that satisfy the inclusion criteria, it is noted that it was still a perception interview as these experts were providing their opinions. It needs to be noted that exogenous factors might have influenced these experts during the interviews.

5.6 Recommendations of the study

This study was found to be practical as the findings can be used as recommendations to the management of the mining companies, the service providers of the ERP systems, and policy makers in South Africa.

5.6.1 To mining companies

The following recommendations are made to the mining companies:

- **Adoption of a hybrid strategy**

The adoption of a hybrid strategy for a cloud-based ERP system in the mining company will enable an immediate decrease in expenditure while simultaneously gaining flexibility and efficiency at the same time. An ERP system is a three-tier system; mining companies could take both their ERP development system and their quality/testing system and move them to a cloud computing environment because utilisation is generally very low in those systems. With such a strategy or move, mining companies can achieve significant returns on investment because they will be reducing the on-premise physical server size, storage levels, LAN traffic and energy bill. This strategy affords mining companies the opportunity to study the current environment and prepare the company for when they are ready to move all their ERP applications to a cloud computing environment.

Lastly, as the levels of maturity improve in other countries, that will enable mining companies to take advantage of the lessons learnt from those early adaptors and profound improvements would have been revealed in a cloud-based ERP system.

- **Improve the investment in cloud computing**

Mine operations, mine process reengineering and efficiency are the main concerns that miners have, and these create an opportunity for the CIOs to help and support the business strategy. Mining companies must face the difficulties that are associated with cutting costs in IT; this will mean that to achieve process improvement in a mine, mining companies will need to invest in new technology, such as cloud computing, over time. If the mining companies improve their investment in cloud computing, they will be set to take competitive advantage through an efficient operation in the future.

A cloud-based ERP system will be an important part of process re-engineering, innovation, and automation that will improve in the following 24 months. Mining companies who would have improved their investment in cloud-based ERP systems will be in a better and stronger position to take advantage of the next commodity price boom.

- **Promote multi-skills for IT specialists for job sustainability.**

Cloud-based ERP systems are bringing new perspectives and fresh ways of managing IT departments which transform the current skills and practices. This phenomenon calls for a proper look at how our current IT personnel are skilled and how we can make sure that after the company has embarked on this new model, they are employable and are multi-skilled. Mining companies will still need internal IT experts who understand the complexities that come with cloud-based IT infrastructure. New training models are required to make sure internal IT experts are multi-skilled and can grasp issues that go with a cloud-based ERP system.

Companies will be well advised to find a training model that will empower internal personnel to seek solutions for functional and governance matters arising in this new cloud-based ERP system. It is, therefore, important for mining companies to have an HR strategy to address skill redundancy that comes with outsourcing and appropriating skills for cloud-based ERP systems.

5.6.2 To service providers of ERP systems

The following recommendations are made to the service providers of ERP systems:

- **Create value proposition for migration to a cloud-based ERP system**

Mining companies are generally slacking when it comes to new technology adoption and ICT spending, so cloud service providers must create incentives for mining companies to migrate their ERP system to a cloud environment like demonstrating quick wins in investing in new technology. Cloud service providers could create value for the mining sector through showing them a better usage of their existing technology when they migrate to the cloud computing environment. Cloud service providers could deliver value through rapid process improvements in operational processes such as process automation, infrastructure optimisation, control optimisation and lastly, have process transparency across the mining operations.

The use of technology innovation is a distinguishing factor when it comes to cost reduction for mining companies and achieving equipment performance. It is important for cloud service providers to start demonstrating value in technology investment in a short period of time and make sure the mining company sees the benefits of the deployment undertaken. This will require software providers or cloud service providers to have a rapid deployment model for rapid improvement needs in the mining sector.

- **Quality data centres establishment**

To be able to reduce the costs of broadband and also improve the speed of connectivity to the cloud-based applications in South Africa, it is highly advisable that telecommunication companies such as Telkom, Vodacom, MTN and cloud service providers such as Gijima, Internet Solutions and SAP combine and redouble their efforts at establishing data centres in South Africa.This will dramatically reduce the cost of doing business in the country and will see better service levels. A quality data centre for mining companies will need to be business oriented, flexible, be automated and sufficiently secured. A data centre will require the following characteristics (Slaheddine, 2012):

- Adequate and Safe Electric Supply
- Adequate Cooling System for the IT Servers and equipment
- Adequate IT Application Servers
- Proper Network to serve mining companies
- Guarantee Levels of Availability at 99.99% a tier
- Easy to deploy and integrate
- Be able to monitor service remotely

- **Improved contract conditions to motivate adoption**

It is important for cloud service providers in South Africa to improve the low levels of cloud-based ERP system; they must be willing to offer mining companies better contracts which will compel them to move to a cloud-based computing environment. Mining companies are not prepared to migrate to a cloud-based ERP system because they will still bear the cost issues such as software and user licence costs.

Cloud Service providers will need to furnish mining companies with clear conditions of contract termination if they want to terminate. Software vendors and cloud service providers need to standardise outsourcing contracts in South Africa that can also improve the levels of cloud

computing rate. An equally beneficial SLA is also important to ensure mining companies take up cloud computing complete with guarantees. Thus, it is important that service level agreement issues be addressed early in the contract negotiation process.

- **Ensure uncompromised data security**

A Cloud-based ERP system phenomenon comes with other issues such as customer's loss of control of data because it will be entrusted with a cloud service provider or a third-party. So cloud service providers will need to afford mining companies the best possible data and information protection and system availability. The following factors will need to be delivered by the cloud service provider for protection (Slaheddine, 2012):

- Provide for Disaster Recovery and Fallback Strategy
- Data Storage and Back Up
- Data Encryption
- Network Security
- Furnish information for the validation of people accesses to company's data
- Be able to trace people and data operation at any time
- Furnish mining companies with security procedures
- Cloudservice provider must be certified

Hence it is important that data protection issues be resolved appropriately, and should make sure cloud-based ERP systems are protected at all times and are not a hindrance to cloud computing adoption.

5.6.3 To Policy makers in South Africa

Regulations to improve availability and accessibility of broadband. Gillwald, (2015) explained that even though South Africa has seen a dropping bandwidth pricing and an increase in bandwidth capacity, prices in South Africa have remained stubbornly high when evaluated in conjunction with another mature market. The reason here was the broadband regulatory body which is reluctant to issue the spectrum to the telecommunication sector so they can increase their broadband capacity. This is a classic case where policy and regulatory challenges inhibit investments in the extension of networks to rural areas where mining companies are operating. Against this backdrop, where the bandwidth remains an inhibitor of adoption, it is recommended that the government as policymakers pass regulations that will

promote the accessibility and availability of bandwidth so as to improve the country's innovativeness and stimulate the economy.

5.7 Recommendations for future studies

This study has added some impetus to the body of knowledge within the cloud-based ERP adoption research. Be that as it may, it is recommended that the following areas be considered for future studies.

- The study conducted was a qualitative study, which focused on the identification and in-depth analysis of the factors. Within this study, there were six enlisted limitations and challenges, which were bandwidth, data security, unfavourable contracts, theft, mindset, poor electricity grid and lack of investment. It is recommended that a study be conducted that will be able to rate these hindering factors by their level of importance and their subsequent impact on the adoption of cloud-based computing. This is critical as these factors cannot be eliminated all at the same time. In this regard, the 80:20 rule is recommended, where two or three of these factors will result in the higher possibility of adoption of cloud computing. The relationship impact can be analysed using quantitative analysis using either structural equation modelling (SEM) or Pearson Correlation (r) with regression model (r^2).

- Despite the general agreement on cost reduction from the on-premise to a cloud-based ERP system, from the experts, there was a resounding statement that there was no empirical evidence or data that supported this view fully. It is recommended that a study to quantify this cost saving aspect of cloud-based ERP system compared to an on-site alternative is conducted. This possibly might be the catalyst the mining companies need to convince them to migrate toward cloud-based ERP systems sooner that the majority of the experts anticipate, which is in 10 years. This will be possible, especially if a business case can be built with magnificent returns on investment. In the near future, South African cloud service providers will see a peak in business growth with new business models around the cloud computing market. There will be a requirement from IS researchers to do a great many studies in the cloud field.

- Another interesting study that can add value to the body of knowledge in the Information system (IS) sphere is the study on the state of cloud computing adoption in South Africa.

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Appendix I: Interview guide

1. Can you briefly give a short description of your background relating to IT and implementation of IT solutions?

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2. Tell about you experience in cloud system platform?

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3. What is your understanding and experience of the integration of cloud computing and ERP system?

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4. What are the factors that influence the use of cloud computing in the mining companies in South Africa?

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5. What is the state of adoption of ERP cloud computing system in the mining companies in South Africa?

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6. To understand the benefits or business value of having a cloud-based ERP system for a business.

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7. What are the limitations and challenges that comes with a cloud-based ERP system?

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8. How can you appraise the difference between on premise ERP systems and on the cloud-based ERP systems?

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9. Do you have something you would like to add or something you would like to elaborate on, regarding the subject matter?

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10. What types of IT infrastructures and resources are needed in South Africa for mining companies to adopt cloud-based ERP systems?

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