Sustaining and supporting SMME use of Big Data in South Africa

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ABSTRACT

SMEs play a significant role in the South African economy because of their contribution towards employment which makes this a very important sector. Big Data plays a significant role in propelling the digital economy and organisations that are dominant across various industries are those that have effectively adopted and assimilated BDA technologies in their business strategies.

The purpose of the study was to investigate the influence of Big Data Analytics BDA) technologies on sustaining growth strategies of Small and Medium-sized Enterprises in South Africa.

The study was carried out using a non-experimental quantitative research method that draws from a post-positivist worldview. Data collection was done using an online survey in a form of a self-administered questionnaire. The research survey was distributed through email to a random sample of participants sourced from online business directories and IT professionals who work for SME entities and are actively involved in big data initiatives.

The key findings of the study reveal that BDA technologies do positively influence SME's competitive advantage, and resource constraints do have a negative impact on SME growth strategies, but the relationship between adoption and assimilation of BDA technologies and SME growth was found to be very weak and insignificant.

Leveraging and delivering value through BDA, SMEs can develop and sustain a robust SME sector and make a considerable contribution towards employment and improve socio-economic conditions for the South African public.

KEY WORDS

Big Data Analytics, Digital Strategy, Big Data, Small and Medium-Sized Enterprises

DECLARATION

I, Siviwe Xegwana, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Digital Business at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Siviwe Xegwana Signature:

Signed at ……Bryanston……

On the …….28…….. day of ……February…… 2022…..

DEDICATION

I would like to dedicate this research project to my family, for giving me support, motivation and having patience with me when I was not available at times.

To my superb supervisor, Dr J. Msimango-Galawe, for being patient, demanding and accepting nothing less than quality and commitment from me.

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LIST OF ACRONYMS

Acronym	Meaning
BI	Business Intelligence
DBMS	Database Management System
ICT	Information Communication Technology
IT	Information Technology
IoT	Internet of Things
RDBMS	Relational Database Management System
MEs	Medium-sized Enterprises
BDaaS	Big Data as a Service

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

This research is a quantitative study that investigates the influence of Big Data Analytics technologies on sustaining growth strategies of Small and Medium-sized Enterprises (SMEs) in South Africa.

1.2 Background of the study

Small and Medium-sized Enterprises make an important contribution towards the South African economy, according to SME survey (SME SA, 2018). SMEs account for 20% share of the economy with respect to GPD contribution; even though this is small compared to larger corporates and government State Owned Entities, this sector is the largest employer as it accounts for 66% of overall employment (SME SA, 2018). Having this significant contribution towards employment and given South Africa's socio-economic issues such as huge gaps in income inequality and high levels of unemployment, it becomes imperative for this SME sector to be developed and sustained, both through strategic interventions and collaboration between the state and private sector.

With the advent of the 4th Industrial revolution that is being propelled by advances in technology disciplines such as IoT, Cloud Computing, Big Data and Analytics, this evolution has forced organisations to adapt their business models and take advantage of these advances to gain differential competitive advantage, especial in the manufacturing sector which is one of the key industries where SMEs play a significant role, as Sahal argues (Sahal et al., 2020). This technology race has also widened the digital inequality gap that has been shown with recent successful case studies from this digital economy creating a winner takes all environment where digital monopolies have been created, with the likes of Google with their search engine and Facebook dominating the market of social media (Epstein, 2018). This digital disruption has also swallowed entities that have been complacent and maintained a position amongst laggards in the digital

economy, and this inertia also perpetuates that environment of winner-takes-all which in turn, often distorts competition and markets by favouring a few players, according to Epstein (2018). Big Data is touted as a game changer and antecedent to competitive differentiation and promises to give start-ups and smaller entities an edge over their competitors, provided they employ a Big Data strategy effectively (Bartosik-Purgat et al., 2018).

SMEs, due to their inherently smaller size, are better positioned to be more agile and more responsive to market changes, both exogenous and endogenous, despite issues of finite resources and less capital as compared to bigger organisations; they can adapt more easily to lean organisational structures that seamlessly improve on operational effectiveness and efficiencies with agility.

1.3 Research problem

When big data analytics (BDA) is organised effectively as a key resource, it can enable an organisation to gain differential competitive advantage and grow its market share, and that is according to Barney's (2011) resource-based view of strategy, but SMEs lack the necessary resources required to take advantage of these technology advancements. Big Data technologies are built on open-source frameworks and platforms which makes them more cost effective compared to traditional database management systems, including data warehouses and business intelligence platforms, but one of the main issues SMEs grapple with, is that new technology assimilation and adoption happens at a slow pace and the skillsets needed for these Big Data technologies are rare, which makes that pool of resources very expensive and limited (Rajabion, 2018).

Developing countries, such as South Africa, have a unique opportunity to take part in a global digital economy that is currently dominated by multi-national organisations, despite the challenges unique to developing countries such as infrastructure, policy and human capital (Bukht & Heeks, 2018), if the majority of SMEs could embrace and expedite the adoption and assimilation of BDA technologies, effectively embedding them in their digital strategies. Should SMEs fail to adapt their business models and adopt these advancements in BDA, the

following is likely to happen: SME growth prospects will be impeded, they will be less competitive in the digital economy, they will most likely lose market share and become less profitable and consequently, not be in a position to contribute to the macro economy and will remain in the periphery of digital economy, including other digital economy disadvantages examined by Bukht and Heeks (2018).

1.4 Research questions

This study considers the following research questions:

- To what extent does Big Data Analytics technology influence SME differential competitive advantage?
- What type of relationship exists between the adoption rates of Big Data Analytics technology and SME's growth?
- What is the impact of resource constraints on the success of an SME's growth strategy?

1.5 Significance of the study

SMEs play an important role in the South African economy because of their significant contribution towards employment which makes them a very important sector. Big Data also plays a significant role in propelling the digital economy and organisations that are dominating across various industries are those who quickly adapted and accommodated BDA in their business strategy.

There is not enough empirical evidence to show that applied Big Data does support digital strategies of SMEs, even though there have been success stories on smaller digital natives and progressive organisations that have pivoted towards data-driven business models, empirical evidence and use case reports are based on studies done on larger organisations and not traditional smaller entities in the category of SMEs (Oracle, 2019).

There is not enough literature that explores the impact of these Big Data Analytics technologies on traditional SMEs and how these smaller entities could refactor their digital strategies and business models and pivot toward data-driven digital strategies, most studies are focused on large corporate financial institutions with emphasis on benefits and challenges in a South African context, such as that by Matsimbi (2020). Maharaj's (2018) research suggests a positive influence of big data on brand activation strategies related to marketing, while Radebe (2021) measures the effectives of BDA capabilities that can sustain and support efficiencies and operational costs associated with FCMG's logistics and findings suggest improved efficiencies, enhanced decision making and costs reductions. There is however, not enough empirical evidence to show the positive influence of data-driven and digital strategies against overall business value and sustainability of SMEs in the context of developing markets, such as the South African economy.

This study contributes to the body of knowledge with regard to digital strategy options that are available for SMEs to leverage and to influence modern business practices with pragmatic solutions for smaller entities with limited access to human and capital resources. This will benefit SMEs who have not considered Big Data as a key strategy asset that can assist with their growth strategies. This also contributes towards further research studies aimed at exploring BDA capability as a catalyst to digital strategies and how BDA technologies not only can propel growth within the SME sector but that also provide viable options for stagnant SME entities that wish to pivot towards data-driven business models.

1.6 Delimitations of the study

The focus of this research study excludes big corporate organisations, and generally large enterprises, that includes organisations that have a turnover above R220 million and is limited to entities that fall inside the category of SMEs or SMMEs as defined by the Department of Small Business Development of South Africa. This study also excludes small and micro enterprises.

This study also excludes technical application aspects of BDA technologies and the focus is more on BDA and SME business strategy alignment.

1.7 Definition of terms

Term	Definition
Big Data Analytics (BDA)	Big Data Analytics primarily involves technologies and services that transform data into valuable and actionable insights and assist organisations in decision making, and consumers also benefit from personalised services and products that are enabled and supported by data-driven applications and platforms (Bhatt & Srinivasan, 2019).
Big Data	Data can be classified as Big Data when it satisfies several characteristics that are referred to as big 3Vs, that means when data has a huge volume, consider social media, web-clicks and telemetry data streaming every millisecond; data has a variety of data formats, data types vary from audio, video, emails, point-of-sale transactional data; and data is processed at high velocity, such as processing of telemetry data near real-time (Coronel & Morris, 2016).
Business Intelligence (BI)	Set of applications and technologies for gathering, providing access to, and analysing data for the purpose of helping enterprise users make better business decisions (Ranjan, 2009).
Digital Transformation	Is fundamental organisational change that seeks to transform all three key elements of business including people, processes, and technology (Westerman et al., 2014).
Hadoop Framework	Hadoop framework seeks to address some of these management and processing challenges presented by the demand of Big Data, and they introduce various components that make up the Hadoop technology ecosystem and highlight some of the key components including the following: - HDFS and Map-Reduce backend components. - Hadoop extensions that handle various functionalities such as streaming, querying, fault tolerance, synchronisation, RDBMS interfacing and configuration management. Various applications are built on top of Hadoop to manage the various tasks mentioned previously and these include applications such as

	Apache Hive, Zookeeper, Flume, PIG, Sqoop, etc. - NoSQL database systems. (Sing & Singla, 2015)
Small and Medium Enterprises (SMEs)	Small, micro and medium-sized enterprises as defined by the Department of Small Business Development are organisations that employ between 1-500 employees and produce turnover between R5 million and R220 million, depending on size of the entity. This research study uses these two terms, SME and SMME interchangeable (Department of Small Business Development of South Africa).
Internet Of Things (IoT)	Refers to an ecosystem of interconnected devices, sensors, network infrastructure and related cloud services that facilitate data communications, storage and processing of data flowing through this ecosystem (Li et al., 2015).

1.8 Assumptions

Some of the assumptions contained in the study are that SMEs are nimble and well positioned to be agile due to having fewer hierarchical organisational structures; SMEs have finite resources and SMEs have limited access to human and financial capital. SMEs usually prioritise business-as-usual or core capabilities and are often reluctant to invest in unproven or untested innovations as they find it difficult to build strong business cases for those “horizons 3” or “Blue Ocean” strategies. Medium-sized enterprises are formal entities with maturing business operating models and have been a going concern for at least five years and are either experimenting or considering Big Data strategic initiatives.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

SMEs contribute enormously towards macro-economic growth in most developing countries, in terms of GPD and labour market, according to the WTO 2016 report. In South African however, the SME contribution is far less when compared to corporate entities but is still significant with a 47% contribution towards employment, therefore it is important that growth, development and sustainability of this SME sector is prioritised (WTO, 2016).

SMEs do not operate in a vacuum and are susceptible to digital disruption that has displaced and disintermediated bigger corporate entities. This disruption has been largely attributed to lack of digital strategy within SMEs, which is largely driven by an inadequate organisation of critical resources and poor adoption and assimilation of key digital technology enablers such as Big Data Analytics. This lack of coherent digital strategy which factors in data as a strategic asset impedes the growth and differential strategies of SMEs.

2.2 Background discussion

Digital disruptions come from a combination of exogenous and endogenous factors that have a considerable negative impact on an organisation's business model, and that can lead to a complete business disruption or disintermediation, so it is imperative for organisations to develop digital strategies that evolve and counter the constantly changing business environment and dynamic consumer behaviour but most importantly, deliver business value. Digitalisation involves the transformation of processes, services and products from traditional analogous and physical forms into digital forms and is propelled by digital technology advances and convergence (Lederer et al., 2017), and this paradigm shift is what Digital Transformation is anchored on and it is influenced by a set of drivers that are discussed in the next section.

Key drivers towards effective digital transformation are articulated by Hrustek (Hrustek et al.,2019) in a paper that explores customer-driven, technology-driven, and organisational development-driven factors that influence the creation of transformative business models that seek to innovate services and products, augment customer experience and improve the way the organisation works. Drivers of digital transformation are dependent on the absorption capacity of an organisation, meaning the speed at which an organisation can adopt technology and adapt its business processes in order to accommodate digital technology, so that they can be more competitive over their peers (Kane et al., 2019), and this adaption gap can be achieved much faster by smaller entities that resemble SMEs.

Ulas (2019) explores the Industry 4.0 ecosystem and key technologies that are enabling and supporting digital transformation initiatives within organisations; from a technological perspective, these are considered key digital technologies that are driving innovation and are very important for SMEs to keep up with those developments and leverage against benefits associated with them, and these technologies include the following: robotics, IoT, artificial intelligence, big data, augmented and virtual reality, 3D printing, cybersecurity, blockchain, nanotechnology, cloud computing, etc. Ulas (2019) reiterates the importance of digital technologies as being catalysts and enablers for growth and innovation for SME business models that operate within the manufacturing value chains.

In the following sections, the study explores BDA technologies and examine challenges facing SMEs with regard to the adoption and assimilation of such digital technologies, and the study also explores approaches that SMEs can adopt in order to achieve strategic alignment between Big Data and SME business models, all of which seek to improve growth and competitiveness of SMEs.

2.3 Theoretical foundation

The theoretical framework that underpins this study is based on the Technology Adoption Model (Davis et al., 1989). The TAM framework has been proven

reliable and consistent in its application and the exercise of discovering empirical evidence based on studies that concern technology adoption. Due to some of the gaps in TAM, regarding consideration of cost implication with regard to technology adoption, which is crucial factor in the context of this study (Nysveen et al., 2005), this research report makes use of the extended version of TAM, namely Unified theory of Acceptance of Use of Technology (UTAUT) (Venkatesh et al., 2003). UTAUT is more pragmatic in the context of this study for two main reasons; it factors in performance expectancy which directly relates to the SME's growth and performance dependent variable; and also takes into account the facilitating conditions which are relevant in the study when one considers auxiliary resources that are needed to support a successful BDA initiative, such as capital resources, scare skillsets and other peripheral resources supporting technological components such as networking, cybersecurity, cloud computing and data governance (Venkatesh et al., 2003). The UTAUT model is comprehensive by taking into account other key elements that influence the effectiveness of digital technologies, such as security, risk and trust factors that are key determinants of senior stakeholders who have responsibility for on-boarding these innovative digital platforms, these factors directly influence behavioural intention of adoption as Khalilzadeh (2017) argues in his extension of UTAUAT TAM model.

2.4 SME growth and performance

Between 2013 and 2019, SME contribution towards the macro-economy of South Africa grew from 17% to 34% while big business saw their contribution fall from 75% to 68% when measuring turnover of businesses across various industries against overall GPD (Stats SA AFS, 2019). The Covid-19 pandemic impact on the labour force from key industries where SMEs operate, such as services, trade and hospitality, has had a devastating impact that has led to closure of businesses, and given the limited bargaining power of SMEs with suppliers and business partners (Moola, 2020), this problem has forced a few entities to close and others to reduce their workforce and halt services. The high rate of failure of SMEs in South Africa is a serious concern and based on literature and market-based research done through consultancy entities, the following factors are

considered drivers behind these SME failures; access to funding, access to markets; support from state and private sectors by integrating SMEs into industry value chains and high levels of competition within the sector (Leboea, 2017).

SMEs contribution towards employment and job creation is based on research by IOA and SME South Africa. SMEs contribute far less to employment, contrary to previous reports with only 47% of SMEs having between 2-5 employees and according to the SBI base line study, SMEs only contribute 28% towards the job market, according to the Small Business Institute survey of 2018 (The Small Business Institute, 2018) and this is low performance compared to other developing nations, according to the WTO survey (World Trade Organisation, 2016). South Africa has a high level of unemployment compared to other developing nations; according to the latest quarterly labour survey from Stats SA for 2021, unemployment rate is at 34.9% and a concerning fact that for youth, between 12-24 years of age, the rate is 66.5% which is problematic because the African populace is dominated by youth (Stats SA, 2021).

This study examines the challenges to the sustainability of SMEs through the measurement of the growth of SMEs. According to IOA research, SME maturity ranges between 3-5 years on average and 59% of SMEs are less than three years old; the study takes a closer look at some of the contributing factors to this slow development. The highly competitive nature of SMEs in South Africa (SA) due to high levels of unemployment is another contributing factor. Market access and participation in big industry supply chains is vital for SMEs and needs to be encouraged through private and state intervention programmes.

South Africa’s economic recovery, after the Covid-19 pandemic, will be determined by the amount of support and the sustainability prospects of the SME sector because of its vital role in contributing towards the country’s economy growth, employment and job creation and socio-economical aspects. To mitigate this onslaught of Covid-19, one of the key recommendations from the McKinsey study is for SMEs to leverage technology and improve on cost efficiencies and competitiveness in services and products and scale (McKinsey & Company, 2020). Given the correlation between organisational growth and employment, it is vital that SMEs get the necessary support with regards to capital resources.

2.4.1 BDA capability is key enabler of growth

Big Data Analytics is considered one of the pillars of the 4th Industrial revolution, commonly referred to as Industry 4.0; in the manufacturing and production systems context, it has been regarded as one of the key enablers propelling automated business models (Erboz, 2018). One of the key objectives of Industry 4.0 is developing smart industries by leveraging innovative practices and technologies focused at integrating production and manufacturing processes, this is practically achieved through advances in IoT and Cloud technologies and anchored on a need for real-time data pipelines and distributed systems. BDA technologies can facilitate large volumes and support the high velocity of this streaming data, including various formats of data generated through smart systems far better than traditional database systems, and this makes BDA technologies crucial downstream with regards to capturing, streaming, and drawing of insights and decision-making, through descriptive diagnostics and predictive analytics (Menezes et al., 2019).

A considerable number of SMEs are concentrated in the manufacturing sector according to the SME SA landscape survey; therefore, it is imperative that their growth strategies consider Industry 4.0 key elements with respect to strategic and propelling enablers that could allow them to pivot their business models and gain an edge over competitors. The leading key enablers in relation to manufacturing industries, according to literature, include IoT, cloud and Big Data technologies (Stentoft et al., 2019). There are several business cases from consultant firms relevant to the local context that prove the success of industrial projects from automotive to manufacturing companies. The BCG report makes suggestions on how African companies can compete effectively against multi-national companies by leveraging the power of data and technology advances in their execution and strategy combination (BCG, 2019).

Earlier studies that explored the state of readiness and orientation of South African companies towards Industry 4.0 (Dewa et al., 2018) suggest that SA organisations were previously just below leaner and intermediate levels of readiness. There is not enough literature that explores Industry 4.0 strategies of SMEs with regards to industry value chains with respect to the South African

context but given cost-effective technology platforms, local SMEs could assimilate some of the collaborative strategies from their developed country counterparts and consider other business model innovation strategy options targeting value creation, value capturing and value proposition, such as Germany (Müller et al., 2018).

2.5 Differential competitive advantage and growth strategies for SMEs

SMEs contribute positively towards regional economic growth through an industrial value creation mechanism that is noticeable across several industrial value chains such as manufacturing, automotive, retail and services sectors in South Africa. This study examines the extent to which an SME's growth and performance is influenced by BDA technologies. Based on recent literature from academics and consulting agencies, BDA technologies have a potential to drive growth when strategic interventions are employed effectively, such as the deployment of affordable open-source technology stacks; accessible and cost-efficient cloud-based infrastructure and more importantly, strategic alignment (Obuokiri et al., 2015) which requires careful orchestration and configuration of resources and the consideration of contextual factors that influence performance gains (Mikalef et al., 2019).

Benefits afforded by the application of BDA in organisations across industries include enhancements on quality of services and products, new customer-centric value propositions, optimisation of internal processes, and the study explores these benefits further in the following sections.

2.5.1 BDA enabling competitive advantage in SMEs

According to a market survey of top BDA use-cases done by Oracle, BDA application is evident across all industries from health to finance sectors, and organisations that can harness BDA technologies whether to optimise production and manufacturing processes or to draw valuable insights from client behaviours

are well positioned to deliver new and improved value propositions and become market leaders (Oracle, 2019).

In order to achieve competitive advantage, traditional organisations adopt a resource-based view strategy that focuses on cost and differentiation techniques (Barney, 2011) and some organisations adopt a position-based and dynamic capabilities view with regard to business strategy, and BDA applications are more aligned to these resource-based views due to the emphasis on the importance of technical and human resources that have high impact on the successful delivery of these BDA initiatives. Recent market reports on successful case studies point to the fact that successes in BDA application have given leading organisations far more differential competitive advantage and skewed certain markets and led to winner-takes-all scenarios, such as Google's dominance in the search-engine market and Facebook's monopoly in the social-media sector (Epstein, 2018).

Proliferation of the so called "digital natives" start-up businesses that have data-driven business models, such as Uber and Airbnb, is a testament to the power of leveraging BDA technologies and being able to identify industry and technology convergence, where the transport sector interacts with logistics in case of Uber and where hospitality intersects with a sharing economy in the case of Airbnb, that digital movement leads to the development of new markets (Armstrong & Lee, 2019).

Competitive advantage can be derived through the effective application of BDA and in turn, this allows for the following benefits to be realised and these include the support of organisation's decision-making processes, decrease in costs and enable agility in responding to opportunity by analysing and processing data in real-time and customer benefits also involve personalised services based on individual consumer behaviour profiles, time savings gained through relevant and targeted marketing (Bartosik-Purgat et al., 2018). Individual and organisational benefits culminate into more sales, cost-savings and innovative services and products that translate into both intangible benefits, such as brand and market exposure, and tangible benefits, such as profits and quality products and services (Radebe, 2021; Maharaj, 2018). Advantages from BDA are not only reserved for large corporate entities, state and public institutions can also benefit through the

collection and collation of public data that can lead to optimised and responsive public services such as responsive emergency and security services; power and resource management optimised through smart grids that enable smart cities, and SMEs that have an active role in supplying such services within this value chain must invest time and capital towards the industrial application of BDA (Bhatt, 2020).

2.6 Big Data Analytics Technologies

Big Data Analytics primarily involves technologies and services that transform data into valuable and actionable insights and assist organisations in decision making, and consumers also benefit from personalised services and products that are enabled and supported by data-driven applications and platforms.

Bhatt and Srinivasan (2020) explore application use cases and benefits of Big Data Analytics against the domains where BDA plays a significant role and sectors that are leading with regards to BDA initiatives; those sectors include healthcare, banking, manufacturing, industrial internet of things, media entertainment, retail and e-commerce. This paper makes a compelling case on why organisations should invest in BDA platforms, given the value proposition detailed on various use-cases shown in Table 1. These use-cases should be convincing for SMEs with operating models that are targeting business value chains found on those domains mentioned above; the challenge for smaller entities is to align each business case to dynamics capabilities needed to deliver such Return On Investment (ROI), and SMEs are also required to be cognisant of and address organisational counter-productive forces that prohibit the development of such dynamic capabilities as Mikalef argues (Mikalef et al., 2020).

Table 1: Big Data Analytics Domains and Use Cases

HEALTHCARE	Develop more effective treatments and personalised medications.
BANKING	Fraud detection, risk assessment, customer retention, etc.
MANUFACTURING	Process optimisation, supply chain efficiencies and product customisation.
INTERNET OF THINGS (IOT)	Industrial machine predictive maintenance, support and enable smart grid networks
MEDIA ENTERTAINMENT	Personalised experience, content monetisation, context-centric content delivery
RETAIL & E-COMMERCE	Personalised recommendations and offers, omni-channel enablement

Big Data Analytics technologies have advanced over recent years and Gökalp et al.'s (2019) literature review of leading Big Data open-source tools explores the development of reference architectures that can support and enable organisational efforts towards establishing Big Data Analytics capabilities that can support decision-making and process optimisation functions. The Big Data reference architecture proposed by Gökalp et al. (2019) is comprehensive and takes into account key elements that are required and makes good recommendations for tool stacks that are applicable on each component but lacks the detail on technology compatibility and integration concerns, which are key

factors to consider if organisations are trying to string together combinations of various technology stacks, and another risk is around specialised support and maintenance of heterogenous tool stacks and capital resource challenges that come with that, but addressing technical, domain-specific and firm-specific challenges is key when considering the custom nature of SME that often have niche and specific operating models.

Aljehane (2020) explores challenges and opportunities in adopting Big Data Analytics within organisations and the study puts emphasis on human capital and operational inadequacy as hindering effective implementation of BDA and highlights data management shortcomings that lead to gaps and makes practical recommendations on how to resolve such challenges, such as strengthen resource capacity with specialised analytics and management competencies, but the paper fails to cover other critical aspects, such as strategy alignment and practical BDA value proposition, aspects that are needed to successfully execute BDA initiatives.

2.6.1 Hypothesis 1: Big Data and Analytics technologies has a positive influence on SME differential competitive advantage

Big Data Analytics technologies can have apositive impact on SMEs' digital strategies and afford them a competitive advantage over their peers, when these resources are organised and streamlined against SMEs' operational context and clear strategic intention.

2.7 Adoption and assimilation of BDA in SMEs

Data is predominantly becoming a strategic asset for many organisations, state and private institutions, data privacy and security concerns are considered one of the key challenges facing organisations and society at large, and that issue has led to the development of regulations such as the Protection of Personal Information Act (POPIA) in South African and the European Union's General Data Protection Regulation Act (GDPR), to guard against risks associated with the collection, processing, and storage of personal data. Implementing policies and

control processes to support these new regulations requires investments and specialists who are well versed both in data management and security aspects and are usually acquired through consultancy and advisory services that are not easily accessible to SME organisations.

Advances in digital technologies that are driving the advent of the digital economy is characterised by interconnected and platform-based systems that are cloud-based and distributed. Given the recent reports on cyber-attacks and data breaches across industries due to a constantly evolving threat landscape in cyberspace, cybersecurity has become paramount in protecting and preserving the integrity of these critical systems, and costs associated with putting policies and procedures in place requires additional costs that have an impact on the implementation of Big Data Analytics initiatives, as Willetts et al. (2020) suggest.

Open-source Big Data Analytics platforms are relatively new compared to traditional Database Management Systems (DBMS) and are constantly enhanced by a network of distributed software development communities of highly skilled resources. BDA resources from data engineers, analyst to machine language programmers are specialist resources that are scarce and often require constant upskilling and that creates a constrained and highly competitive labour market. SMEs have limited human resource budgets and often struggle to compete with large organisations that have large capital resources. This challenge does limit SMEs' access to the limited resource pool of specialised skills required and it negatively impacts the development of their Big Data Analytic capabilities.

SMEs with traditional business models do not consider data as a strategic asset that can be tied to their core business models, and other SMEs are less inclined on including data on their strategic objectives. This lack of Big Data strategy alignment to the overall business strategy often leads to management and strategic inertia of investing capital towards Big Data strategic initiatives. Managerial awareness and competency are important requirements that can support BDA implementation within organisations and according to Burtosik-Purgat et al. (2018), this function leads to a better strategy alignment.

Recent business reports and academia have highlighted the issue of organisations not understanding how to create and capture value from their data, and most importantly, some organisations do not understand how to build data-centred business cases and to articulate data-driven innovations with new and improved value propositions (Muller et al., 2018). SMEs' awareness of BDA and their inability to formulate business cases with improved ROI is also a challenge for smaller entities whose focus is often specialised and focused on day-to-day operations. as Iqpal et al. (2018) suggest.

SMEs have limited access to funding institutions and generally have limited financial resources, therefore most of these small entities are reluctant to invest their capital on capabilities that are not core to their business models, such as BDA technologies, although a few SMEs do acknowledge BDA opportunities as horizon ventures rather than short and medium-term growth strategies.

Shah et al.'s (2017) paper explores the adoption challenges facing SMEs and groups these challenges into three categories of technical, managerial and of an economic nature. The above study highlights an important issue where organisations tend to focus more on technology instead business opportunity. Big Data is a change tool for growth and performance and it is a continuous learning process, and given the vast amount of data generated by SMEs in the manufacturing sector, the adoption of BDA technology and a positive attitude towards the agency of continuous learning and knowledge gathering, SMEs can achieve higher performance levels, improve efficiency, discover new markets, grow revenue and reduce costs of production and this approach is transformative and can contribute towards overall SMEs digital strategy (Shah et al., 2017).

2.7.1 Hypothesis 2: Poor adoption and assimilation of Big Data technologies has a negative impact on SMEs growth

Poor adoption of Big Data Analytics technologies within SMEs has a negative influence on digital strategies of these small entities, and the lack of assimilation poses a risk of having SMEs operating on the edges of the digital economy.

2.8 Resource constraints of SMEs

Investing in BDA technologies alone will not translate into business value; organisations need to organise their structures and resources into efficient BDA capabilities in order to realise and capture value (Gupta & Gourge, 2016). Mikalef et al. (2019) support this argument with an emphases on resource and contextual significance in realising BDA strategies, and the consideration of interdependent dimensions, coupled with varying degrees of importance around tangible and intangible resource combinations.

Human and capital resource constraints appears to be a recurring theme through academic literature, business reports and industry surveys, Willetts et al. (2020) explore BDA adoption barriers with a literature systematic review and they performed a thematic analysis of barriers toward Big Data Analytics adoption, and two out of six themes alluded to the issues of resource constraints, namely, knowledge and skills; and (capital) resources where SMEs lack of access to funds being some of the major challenges.

2.8.1 Big data strategies for SMEs

The top-down approach towards strategy can be limiting, a more pragmatic way is to connect analytics to strategy as a continuous process and be cognisant of the fact that different organisations will require different strategies, based on their operational context (Mikalef et al., 2019).

There is not enough literature and empirical evidence that can guide organisations of what are the conducive conditions needed for SMEs to invest capital that can lead to performance gains and competitive differential advantage, but there have been several theoretical and digital frameworks that enable assessment, benchmarking, and digital maturity measurement of digital strategies (Armstrong & Lee, 2021; Mikalef et al., 2019).

Big Data Analytics technologies are a set of tools that can potentially improve performance prospects of an organisation, but they require sufficient consideration towards organisational operating models and capabilities for

successful implementation (Mikalef et al., 2016). SME business operating models are often specialised with a targeted focus but expand as the entity grows. This is evident from the SME survey that suggests a strong positive correlation between an organisation's resource growth and turnover growth over time, according to the SME SA survey (IOA, 2018).

The shorter lifespan of organisations in the digital era is a reality, digital disruption is forcing organisation to adapt, or risk being disintermediated or displaced, hence the recent literature emphasis on the importance of learning organisations that can develop dynamic capabilities with the aim of sustaining market positions and a competitive edge over competitors and help avoid digital disruption (Castleman, 2018). SMEs' capacity to learn quickly and respond is paramount, and given the nimbleness and less hierarchical organisational structures of SMEs, they are well positioned to learn, assimilate and adapt far more quickly than larger organisations which makes their strategies simpler.

The advent of the data-driven decision making paradigm is gaining traction across industries, whereby organisations are moving away from guessing or making business decisions based on experience and gut feel, and are leveraging facts and insights drawn from data, this strategic capability requires an organisation-wide culture shift and change management effort, and can be facilitated through BDA initiatives that are developed around key organisational strategic key performance indicators and scorecards.

2.8.2 Hypothesis 3: Resource constraints have a negative impact on SMEs' ability to adopt and pursue Big Data strategies

Big Data technologies are relatively new and analytical methods and techniques, even though they are developed from matured statistics domain; technical platforms that leverage those methods are complex and require considerable investments in terms of human and technological resources. Peripheral technologies that support BDA technology platform such as networks, cybersecurity, cloud computing also add an overhead on the capital requirements and in turn, that complicates the business case for BDA initiatives.

2.9 Conceptual Framework

A conceptual framework is a graphical or narrative form showing the key variables or constructs to be studied and the presumed relationship between them (Miles & Huberman, 1994). It is a statement of the researcher's understanding of how the research problem is best explored, the specific direction the work will take, and the relationships between the different variables in the study. It is a system of concepts, assumptions and beliefs that support and guide the research plan, which lays out the key factors, constructs or variables and presumes relationships among them, a structure for moving forward with the study (Grant & Osanloo, 2014). It sets the stage for the specific research questions (Bordage et al., 2001). The conceptual framework is informed by the critical theoretical framework(s) above that are relevant to the topic. It is a subset of those and contains the specific aspects, constructs, and variables that you plan to apply in your research. It provides an integrated way of looking at the problem under study. If possible, this is represented diagrammatically as well as by narrative.

The conceptual framework for this research report is reflected in Figure 1 below. It examines three key constructs related to Big Data Analytics technology, negative low adoption and assimilation, and resource constraints, and how these three concepts have an impact on SMEs' differential competitive advantage and growth and Big Data strategy.

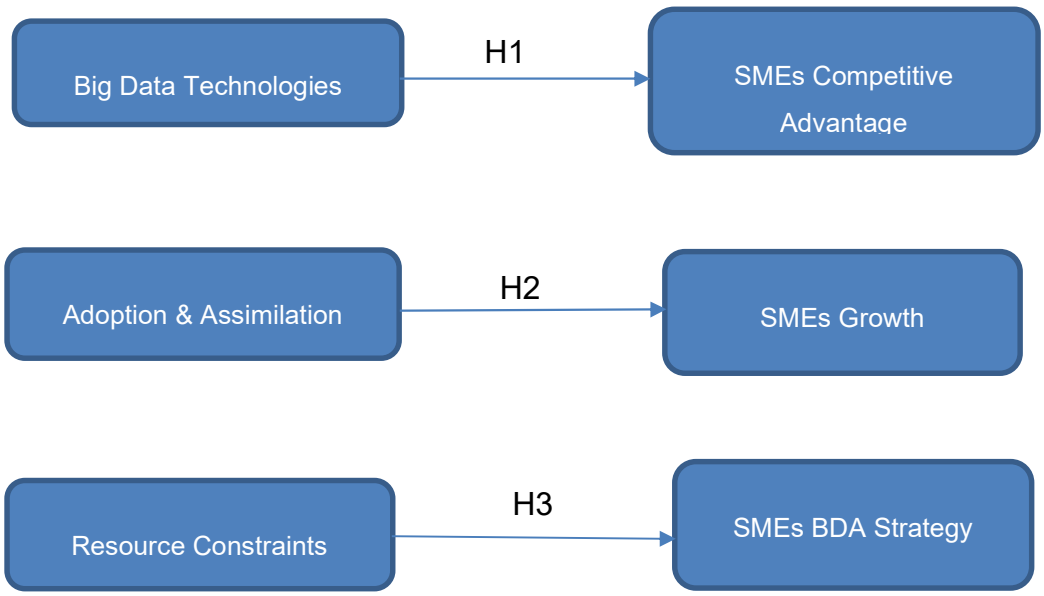

Figure 1: Conceptual Framework

2.10 Conclusion of Literature Review

It is evident from both academic literature and reputable business reports, including consultancy surveys, that the contribution of SMEs towards the greater economy is crucial and even from a South African context where the turnover proportion and employment absorption are relative lower compared to other developing countries on both measures, the SME sector is a critical player in mitigating risks associated with income inequality gaps and high levels of unemployment and is a key ingredient in solving local socio-economic dynamics.

The literature review from the study reflects common themes of the challenges that seek to explain low levels of adoption of BDA within SMEs and some key challenges are related to resource constraints, strategy alignment and organisational configuration, and those patterns are reiterate from grounded theories on strategic assembly of key resources and that supports Barney's (2011) argument on RBV. The literature used on the study also highlights key

opportunities and application strategies with regards to assimilating effective BDA technologies that can effectively and efficiently enable SMEs to achieve competitive differential advantage over their competitors.

This study's literature review aligns the conceptual framework that draws from two key propositions, namely BDA enabling competitive advantage and supporting growth, and addressing the challenge of low adoption rate among SMEs, and this leads to the third proposition of SME's strategic alignment.

Table 2: Consistency table: research questions and propositions

RQ #	State Research Question	hyp #	Hypothesis
1	To what extent can Big Data Technologies influence SME differential competitive advantage and growth?	1	Big Data Analytics technology has a positive influence on SMEs differential competitive advantage.
2	What type of relationship exists between adoption rates of big data technologies and success of SME Digital Transformation initiatives?	2	Poor adoption and assimilation of Big Data Analytics technology has a negative impact on the success SMEs growth.
3	What is the impact of resource constraints on success of SME Big Data strategies?	3	Resource constraints have a negative impact on the success of SMEs Big Data Strategy

CHAPTER 3. RESEARCH METHODOLOGY

This chapter outlines the research methodology and techniques followed in addressing the research hypotheses as described in the previous chapter namely:

- BDA has a positive influence on SMEs' differential competitive advantage.
- Poor adoption and assimilation of BDA has a negative impact on the growth of SMEs.
- Resource constraints have a negative impact on the success of an SME's BDA strategy.

In this chapter, the study describes the research design that underpins the research methodology; explores methods used for data sampling; includes a discussion on data collection and analysis methods used; this chapter also describes the research instrument used which includes a discussion on the research's validity and reliability measures; and the study also defines measures and controls put in place to address ethical considerations relating to the research strategy adopted.

3.1 Research approach

The research paradigm adopted in this study draws from the post-positivist worldview that ascribes to methods that verify theories drawn from literature review and methods that identify and relate variables back to the hypotheses which the study attempts to validate (Creswell, 2014).

Consequently, this quantitative research study was carried using a non-experimental survey research with an intention of exploring the relationship, through statistical correlation, between variables and measuring the magnitude of that relationship.

- Independent variables:
    - Implementation of BDA
    - Adoption

    - Resources
- Dependent variable:
    - Growth
    - Competitive advantage
    - BDA Strategy

3.2 Research design

Research design approach followed in this study was a cross-sectional study that was conducted using an online survey that solicited and consolidated primary data at a point in time with an objective of generalising research hypotheses from the sample to the target population (Creswell, 2014). Cross-sectional study was deemed appropriate for this research study because of its ability to study multiple variables and being less expensive as data is only collected once, compared to a longitudinal study that spans several years and only factors in a single variable and requires the researcher to revisit study participants. One of the disadvantages of a cross-sectional study is that it cannot establish a cause-and-effect relationship among dependent and independent variables. Because of the time constraints and scarce availability of participants and several independent variables adopted in this research study, cross-sectional methods seemed appropriate for this research study.

3.3 Population and sample

The research study was focused on a population of medium-sized entities within the SME sector and with a sample of 162 survey respondents made up of senior IT management-level resources that are involved in decision making structures.

3.3.1 Population

This study was based on a population of medium-sized entities, which is a subset of SMEs, excluding small and micro-organisations, as described by the Department of Small Business Development of South Africa; small organisations that make a turnover of less than R210 million and employ a total number of

employees between 50 and 500. This study focused only on SMEs entities located in South Africa with a population size of 85,891 organisations based SEDA report estimates (SEDA, 2021).

3.3.2 Sample and sampling method

This research study used a purposive sampling strategy, this method was necessary due to the constraint imposed by a criterion of SME entity types which is difficult to reach (Swanson & Holton, 2005). The sample population was based on a sample of 162 randomly selected survey participants, and targeted demographics include participants having roles above middle management level, those employees who are assumed to be involved in decision making structures within ICT; including entities that are considered SMEs, based on a staff total count that falls between 50-249, as defined by the Department of Small Business Development (SBI, 2018).

The survey was hosted online based on a randomly generated list of 162 participants obtained from network of contacts from ICT industry including online sources that maintain SME and ICT organisations for marketing and business development purposes. This included a set of active entities that fit the definition of SMEs collated from business directory listings and online directories, this non-probabilistic sample design and strategy gave us a sample that was representative of the target population.

3.4 The Research Instruments

The research instrument was an online survey hosted on a platform called Qualtrics, made up of 21 questions, grouped into three sections covering research question topics as follows:

- To what extent does Big Data Analytics technology influence SME differential competitive advantage?
- What type of relationship exists between the adoption rates of Big Data Analytics technology and SME's growth?

- What is the impact of resource constraints on the success of an SME's growth strategy?

The research instrument was aligned to key constructs adopted from the UTAUAT model, and included a section for demographics, as shown in Appendix A. The survey was completely anonymous and did not keep any personal or identity-based questions. The advantage of using the Qualtrics platform was to help speed up the data analysis process. The research survey also included a disclaimer cover letter notifying candidates of their rights and what the study would do with the data collected.

In this study, there are a total of three independent variables; Big Data Analytics, adoption, resource constraints and two dependent variables which are SME success and SME performance.

The UTAUAT-TAM research instrument is widely accepted and predominately used in assessing technology adoption (Venkatesh & Davis, 2003), therefore deemed appropriate for this research study, given the context of trying to measure perceptions regarding BDA influence on SMEs growth.

Listed in Table 3, is a breakdown of research instrument detailing sources and research constructs aligned to adoption model constructs from UTAUAT-TAM model:

Table 3: Breakdown of research instrument detailing Constructs, Measurement Scales and Sources.

Source	Construct	Adapted Measure
Yang (2010)	UPE Utilitarian Performance Expectancy	- The degree to which an individual believes that using the data analytics technology will enable him or her to easily/efficiently draw insights from organisation's data

Featherman and Pavlou (2003)	PR – Privacy Risk	The degree to which an individual perceives that data security and privacy in big data analytics technology is properly managed
Jarvenpaa, Tractinsky, and Saarinen (1999)	PT – Perceived Trust	The degree to which an individual has confidence in using the big data analytics technologies
Venkatesh et al. (2003)	SI – Social Influence	The degree to which an individual perceived those peers in the industry believe he or she should use the big data analytics technologies
Venkatesh et al. (2003)	EE – Effort Expectancy	The degree of ease associated with the big data analytics technologies
Compeau and Higgins (1995)	SE – Self Efficacy	The degree to which an individual believes in his or her ability to implement big data analytics technology successfully.
Venkatesh et al. (2003)	FC – Facilitating Conditions	The degree to which an individual believes he/she has the resources necessary to implement BDA technologies

3.5 Data collection process

This research study's data collection made use of primary data and used it to examine the impact and extent of influence that Big Data Analytics have on growth strategies of SMEs. The survey developed was closely aligned to the UTAUT-TAM model that is predominantly used in assessing technology adoption (Venkatesh & Davis, 2003).

Data collection was done using an online survey in the form of a questionnaire. The research survey was distributed through email to a sample of randomly

selected medium-sized enterprises sourced from variety of professional network of contacts within ICT industry and online business directories and databases.

The questionnaire was hosted online using a survey platform called Qualtrics. The survey was developed online in a form of a questionnaire and randomly distributed to a sample of respondents via email. The survey included the disclaimer on privacy and anonymity of the questionnaire and the objective of the study.

3.6 Data analysis and interpretation

Data analysis of the research report included descriptive statistical analyses to understand various statistical attributes of sample data such as mean, standard deviations, distribution; correlation analysis to establish the degree of relationships between the independent and dependent variables through the studying of the correlation coefficient value, as this examination of relationships is central when using surveys and experiments to answer research questions and hypotheses, as argued by Creswell (2014).

This study employed an Exploratory Factor Analysis technique in measuring construct validity, with an objective of examining the structure of highly intercorrelated variables, and in the absence of preconceived assumptions on the structure of research data, an explorative method of factor analysis was deemed appropriate for this study (Hair et al., 2010).

Data analysis was done using a multiple regression analysis because this analysis explores relationship across multiple independent variables and a single metric dependent variable, as Hair's (2010) guidelines on multivariate data analysis suggest.

With regards to demographic data, frequency distribution was observed to determine a fair distribution and representation was achieved across variables, such as industry sector and management level.

3.7 Limitations of the study

The data collection exercise depended on the availability and sample size of senior IT resources that are involved in digital initiatives and the number of SMEs involved in such programmes such as Big Data initiatives; there may only be a few in South Africa and this could lead to overfitting or the study not being generalisable to the population.

3.8 Validity

Survey research studies involve a margin of measurement error, and it is assumed that most research studies should expect some degree of measurement error from “true” values being represented by scores, and aresearch needs to identify and minimise such errors (Hair et al., 2010). Measurement errors can be classified into two groups, validity of the study which measures the accuracy of measurement, and reliability which measures consistency and dependability of the research instrument used if the study was to be conducted several times (Creswell, 2014).

3.8.1 External validity

To establish the external validity, this research study sample population was made up of senior IT resources who have experience and are directly involved in Digital Transformation initiatives that include Big Data projects or have influence on technical direction and the strategy of such digital initiatives and hopefully would provide a more accurate and reliable assessment of their organisations with regard to the adoption and state of big data strategies and most importantly, can be generalised to other groups who have influence and are involved in digital initiatives.

3.8.2 Internal validity

To ensure internal validity, the study’s survey questions were adopted from Khalilzadeh's (2017) research instrument which is widely accepted in academia,

but the instrument was adapted for this study's by including dependent variables and independent variables, and which aligns to the research model's key constructs and this alignment is shown in Table 4 below:

Table 4: Conceptual framework aligned with UTAUAT-TAM model constructs.

Hypothesis	Model Constructs	Questionnaire
(H1) BDA technologies have positive influence on SMEs differential competitive advantage (DV1).	Utilitarian Performance Expectancy (UPE) + Privacy Risk (PR) has an influence on Attitude towards usage.	Q1 TO Q6
(H2) Poor adoption and assimilation of Big Data Analytics technology has a negative impact on the success SMEs growth (DV2).	Perceived Trust (PT) + Effort Expectancy (EE) + Social Influence (SI) influences Attitude without a mediating construct.	Q7 to Q15
(H3) Resource constraints have a negative impact on the success of SMEs Big Data Strategy.	Facilitating Conditions (FC) influence on Behavioural Intention and Self Efficacy (SE) influence on Effort Expectancy.	Q16 to Q21

3.9 Reliability

One of the disadvantages with surveys as a research technique is the fact that reliability measurement is largely dependent on the design of the survey and the accuracy of the responses, but the benefits trade-off include low cost and high coverage of population (Queirós et al., 2017). To measure reliability, this research report made use of Cronbach Alpha to determine the level of internal consistency and reliability across the attributes, with an intention of examining general acceptable alpha coefficient value above 0.60 (Hair et al., 2010). This research study avoided participant error because the survey was taken at participants' convenience online. To avoid participant bias, the survey was anonymous and had no organisational and personal details of the participant exposed, which often discourages participants from being honest and open about their responses. No researcher error is anticipated because the survey questions are consistent through the online survey for all participants. In order to avoid the researcher bias, all survey questions are objective and do not include any of the researchers' subjective insinuations or leading observations.

For a quantitative study to establish consistency and reliability, the number of questions contained in an instrument should be proportional to the number of dependent and independent variables contained in the research study.

3.10 Ethical considerations

The research survey included a cover letter with details explaining the confidentiality clause that provided assurance that the survey was anonymous, did not collect or share any personal and identity information, and participation in the survey was completely voluntary.

Wits Business School Ethics HREC application form was completed with details regarding ethical conduct considerations and actions to be taken to meet all relevant compliance measures for this research work and data collection exercise. WBS HREC Ethics form was signed and submitted to the Post-Graduate Committee to be reviewed and approved before data collection is carried out for this research study.

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the results from the study conducted by the survey search method described in chapter 3, and the outline of this chapter is presented as follows: discussion on the techniques followed in cleaning of sample data with an objective of addressing missing and incomplete observations; a review of sample data characteristics; use of the factor analysis technique to measure construct validity; measure reliability and internal consistency; factors are reduced into independent and dependent variables; validate pre-assumptions made, based on previous literature review and also testing of the relationship across the variables; final section involves testing of hypotheses.

A total of 162 responses were collected, and 52 incomplete and missing entries were found and when those issues were addressed, the sample had a total of 98 responses.

4.2 Data screening and quality

This section is a discussion of the techniques followed in the cleaning of sample data with an objective of addressing missing and incomplete observations.

Exploring the sample data through a missing value analysis exercise, a total of 52 incomplete entries were discovered and that led to an investigation to try and determine the practical implications and significance of those missing values with respect to sample size and whether these missing values were due to the collection process or completely missing at random. Due to the sample target being reduced by 34% with incomplete and missing values, a decision was made to take a more pragmatic approach that would preserve the target sample size of 98, from an initial total of 162 responses captured, by employing an imputation technique called ‘pairwise’ approach of determining missing values based on all available valid cases, that addressed the issue of missing values (Hair et al., 2010).

Incomplete entries were removed from the sample and all missing fields were replaced using a mean series transformation technique. and sample data was exported directly from Qualtrics and there were no coding errors on the import data. This study did not include any reverse questions in the survey, but unengaged respondents were removed from the sample and the study used the low score of standard deviation of 0 as an exclusion criterion.

4.3 Sample characteristics

This section is a review of sample data characteristics to gain insights on structure and demographics of the sample data by leveraging descriptive statistics and the frequency table.

The study results show that more than 57% of the respondents are made up of specialist and management levels, which are generally involved in technical decision making which makes our sample more appropriate in generalising to the target population.

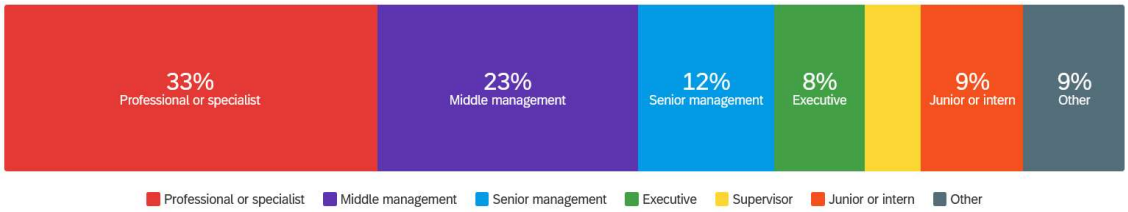

Figure 2: Levels of employment

With regard to total count of employees, the sample shows a considerable number of 40% respondents as being employed in the SME sector that includes micro, small and medium enterprises.

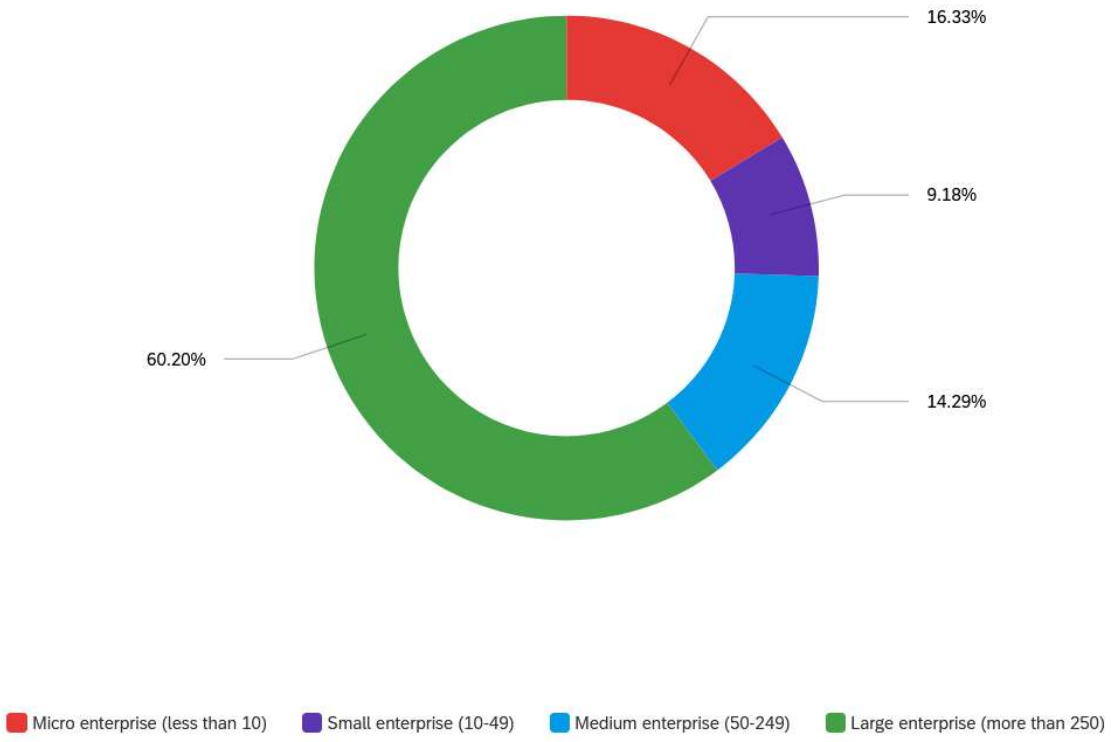

Figure 3: Number of employees in an organisation

When considering organisational turnover demographics, the sample shows that almost 50% of the respondents are employed by entities that fall within the revenue threshold for R220 million for SMEs, where anything above that is considered large entity turnover, therefore this makes the sample generalisable to the target population of SMEs in South Africa.

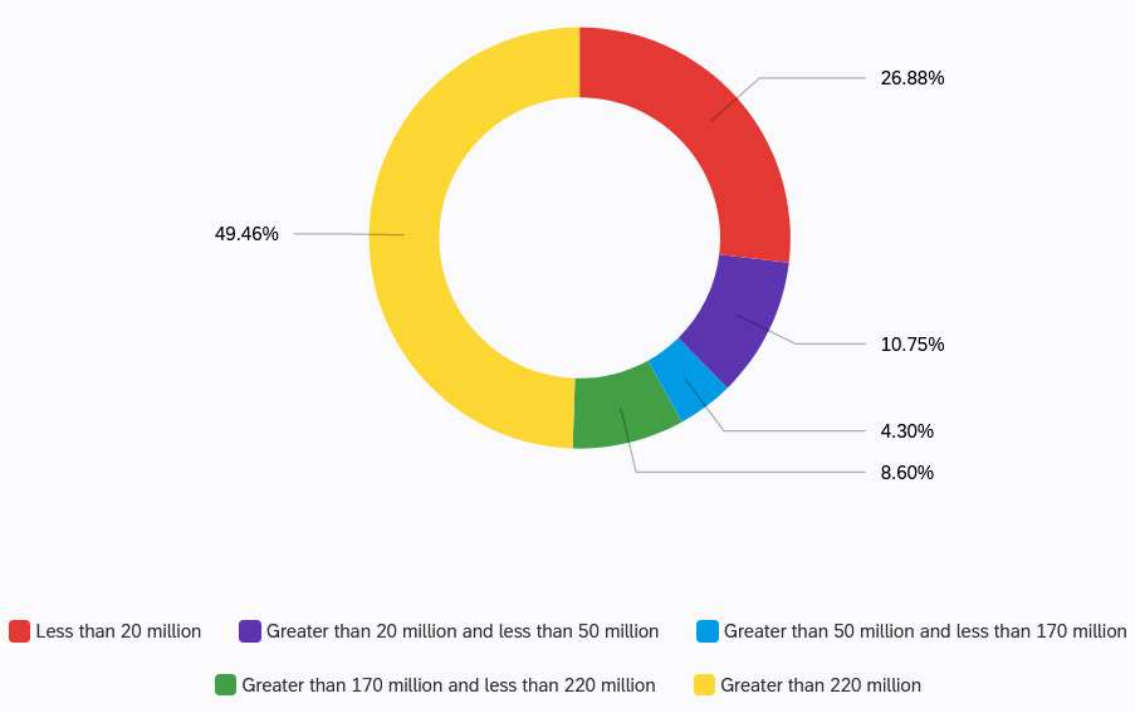

Figure 4: Breakdown of Annual turnover

4.4 Construct Validity

The study explores the construct validity by use of Exploratory Factor Analysis (EFA) that includes all scales for both dependent and independent variables.

This study used a principal axis factoring method to extract valid factors. The choice of technique was motivated by the fact that literature suggests there are possible existing relationship across the factors.

4.4.1 Sample adequacy

To determine whether the sample was big enough to run EFA, the Kaiser-Meyer-Olkin method was employed which requires adequacy value to be above .5 (Kaiser, 9174) and the analysis results are shown in Figure 5, with a value of .723 which confirms the sample size as being adequate for factor analysis (Field, 2009). The results showed Bartlett's Test of sphericity being significant at *p* value of .000 which is less than 0.05, which indicates that correlation across items was strong enough for factor analysis (Hair et al., 2010).

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.723
	Approx. Chi-Square	1423.903
	Df	190
	Sig.	.000

Figure 5: KMO and Bartlett's test results

The results also show the value of the determinate at 1.232 across factors in the correlation matrix which is considered valid when measured above .30.

a. Determinant = 1.232E-7

Figure 6: Determinant value

4.4.2 Extraction method - PAF

The extraction method chosen was Principle Axis Factoring, and the promax rotation method was selected, based on the presumption made that there is strong relationship across the variables.

4.4.3 Total variance

Total Variance Explained in Table 5 confirms the analysis performed was based on an Eigenvalue greater than 1, which suggested that all factors above are considered valid as shown in the table below, with total variance explained by five factors measuring a cumulative percentage of 75% which is considered excellent. From the seven factors suggested by literature from the research conceptual framework, results data from the SPSS study ended up with five factors.

Table 5: Explained Variance

Total Variance Explained							
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.950	29.750	29.750	5.660	28.302	28.302	4.544
2	3.108	15.541	45.291	2.818	14.088	42.390	3.982
3	2.554	12.771	58.062	2.236	11.182	53.572	3.175
4	2.089	10.444	68.507	1.791	8.957	62.528	3.023
5	1.390	6.951	75.457	1.046	5.229	67.758	2.130
6	0.793	3.965	79.422				
7	0.696	3.480	82.902				
8	0.616	3.079	85.981				
9	0.499	2.493	88.474				
10	0.446	2.231	90.704				
11	0.343	1.715	92.420				
12	0.287	1.434	93.854				
13	0.275	1.375	95.228				
14	0.242	1.210	96.438				
15	0.178	0.888	97.326				
16	0.151	0.756	98.082				
17	0.140	0.701	98.783				
18	0.101	0.505	99.288				
19	0.088	0.442	99.730				
20	0.054	0.270	100.000				
Extraction Method: Principal Axis Factoring.							
a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.							

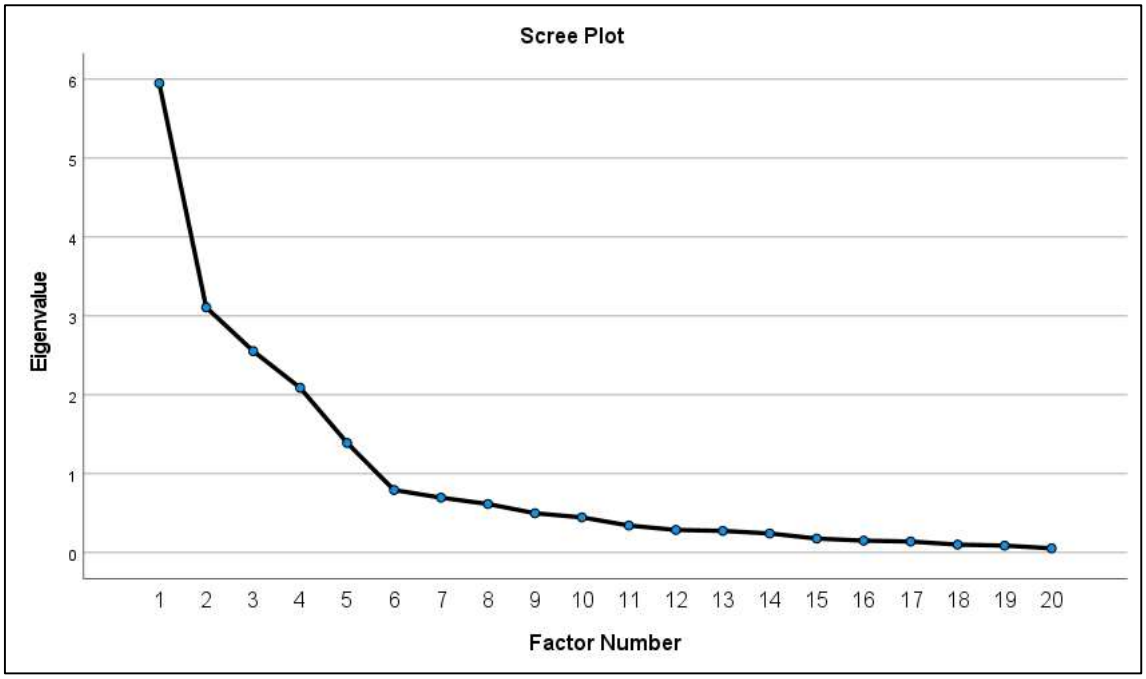

Figure 7: Scree Plot

4.4.4 Rotation method - Promax

Table 6 reflects the five factor loadings that are considered valid for our construct, as opposed to the seven factors, as suggested by the research instrument discussed in chapter 3.

Factor loadings shown below on the Pattern Matrix in Table 6 are an indication of the relationship of each of the variables across the five factors (Field, 2009). During the initial iteration of factor analysis, there were seven factors extracted, but in order to preserve variables with high correlation coefficients across factors, which is an indication of strong relationship, some factors and variables were excluded using a factor rotation technique:

- two factors that loaded with items less than three variables were excluded
- variables that loaded showed negative and cross-loadings were excluded

Table 6: Pattern Matrix

	Pattern Matrix[a]					
		Factor				
Construct		1	2	3	4	5
BDA Technologies	Using Big Data Analytics technology helps my organisation draw valuable insights more quickly.	0.955				
	I find Big Data Analytics technology useful in the decision-making process.	0.904				
	Using Big Data Analytics technology enables my organisation to accomplish things that are important to me in the decision-making process.	0.858				
	Using Big Data Analytics technology enables my organisation to accomplish competitive advantage against our competitors.	0.800				
	I can save time when I use Big Data Analytics technology in order to draw valuable insights from organisational data.	0.539				
Resources	Our organisation has the knowledge necessary to implement and use Big Data Analytics technologies.		0.896			
	Our organisation has the resources necessary to use Big Data Analytics technologies.		0.853			
	I can get help from colleagues when I have difficulties using Big Data Analytics technologies.		0.842			
	Big Data Analytics technologies are compatible with other technologies our organisation uses.		0.767			
	Our organisation has a clear and understandable Big Data strategy necessary to execute the implementation of Big Data Analytics technologies.		0.702			
Competitive Advantage	Our organisation could use Big Data Analytics technology if consultancy firms could help us get started.			0.864		
	Our organisation could use Big Data Analytics technology if consultancy firms could demonstrate how to do it first.			0.803		
	Our organisation could use Big Data Analytics technology if only there is a built training facility for assistance.			0.614		
	We would use Big Data Analytics technology for competitive advantage in our organisation because of the proportion of peer organisations data-driven business processes.			0.537		
Growth	I believe Big Data Analytics technology service providers will do everything to secure the organisational data.				0.837	
	I believe Big Data Analytics technology service providers are trustworthy.				0.788	
	I believe Big Data Analytics technology service providers keep customers' interests in mind.				0.775	
Adoption	Our implementation and using Big Data Analytics technology would lead to a loss of privacy because sensitive information would be used without our knowledge.					0.860
	I think Big Data Analytics technologies cannot not keep personal and sensitive information from exposure.					0.830
	The chances of using the Big Data Analytics technology and losing control over my organisations' information privacy is high.					0.487

	Extraction Method: Principal Axis Factoring. Rotation Method: Promax with Kaiser Normalization.
	a. Rotation converged in 6 iterations.

4.5 Scale reliability

Study measures the reliability scales using Cronbach measurement and the results across all five factors show a Cronbach Alpha value above .70, which is considered good, statistics are presented below (Hair et al., 2010):

Reliability results for all scales were measured at a Cronbach value above .70 which is considered very good as shown in Table 7 below.

Table 7: Construct reliability

Construct	N of Items	Cronbach's Alpha	Reliability
Resources	5	0.909	Very Good
BDA Technologies	5	0.902	Very Good
Growth	6	0.874	Good
Competitive Advantage	5	0.801	Good
Adoption of BDA Technologies	4	0.714	Good

4.6 Composite score

The study reduces the dimensions of our sample data by following a transformation method that uses mean reduction technique to create a composite mean score from several factor variables defined in the previous section. Items were grouped according to factors by calculating an average mean score of grouped items, with composite scores culminating into independent and dependent variables as follows:

- Resources (independent variable)
- BDA Technologies (independent variable)
- SME Growth (dependent variable)
- Competitive Advantage (dependent variable)
- Adoption (independent variable)

4.7 Assumption testing

The section is a discussion of how the study avoided and validated some of the assumption made with respect to normality, linearity, homogeneity, and details methods used in order to eliminate outliers to avoid statistical bias.

4.7.1 Outliers

The observation outliers identified across the variables in Figure 13, indicated by values with asterisks, the sample data was cleaned of those observations using a method called winsorizing by replace extreme cases values with second highest values or removing those cases, as shown in Figure 13. Outliers, which are extreme cases, can distort the mean and lead to statistical bias, so it is important that we exclude those extreme values from the distribution of scores (Field, 2009).

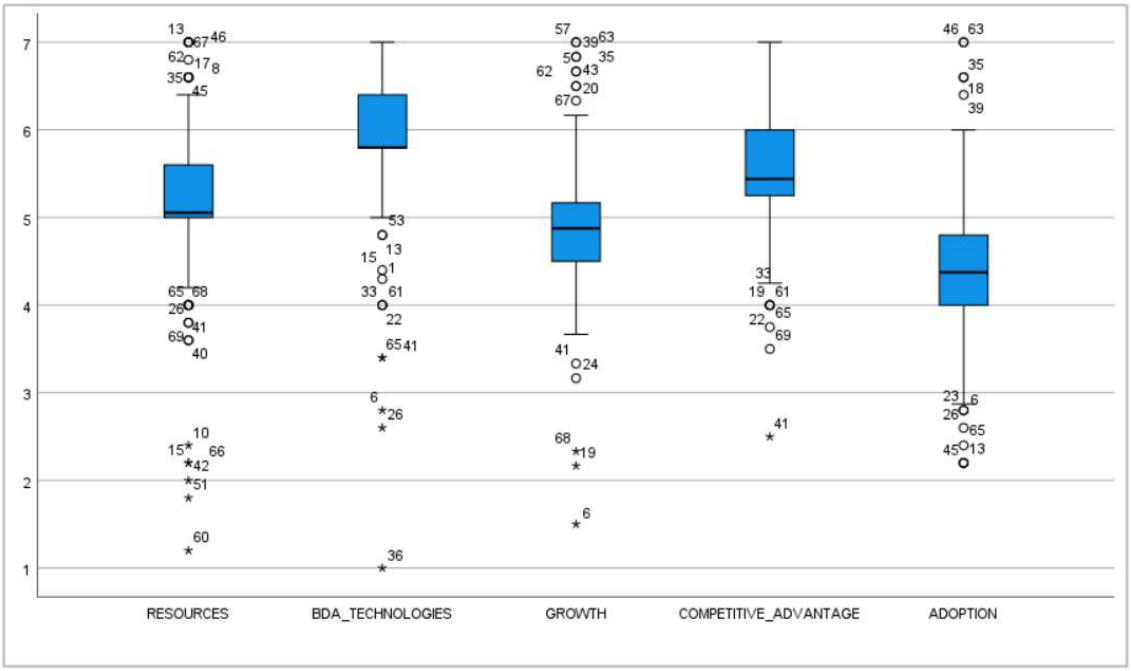

Figure 8: Outliers identified across variables

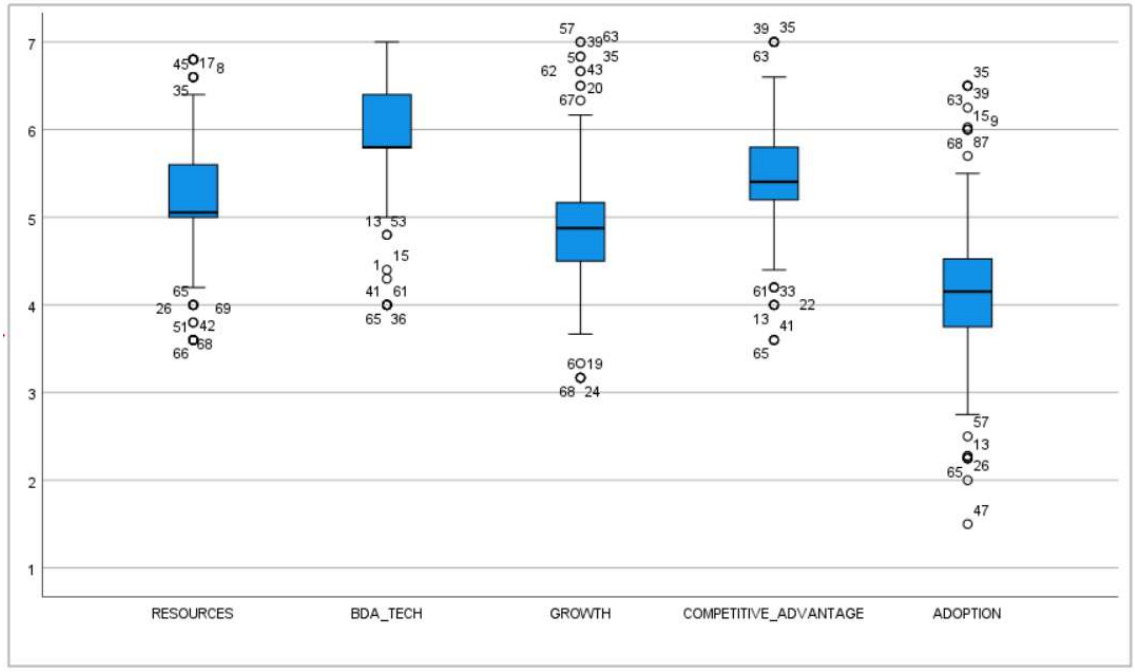

Figure 9: Outliers removed across the variables

4.7.2 Normal distribution

According to Hair et al. (2010), one of the key assumptions in multivariate analysis is based on the sample distribution being normal; it is important that we do not violate this assumption. We can visually test this assumption by observing the skewness of the sample distribution in a histogram, and we can also measure sample variables by calculating the Kurtosis value. Kurtosis value of +- 2.58 considered to represent violation of normality according to Hair et al. (2010); as shown below, the sample can be considered to resemble normally distributed data as no violation of that assumption when one considered values presented in Table 8 and also taking into account the distribution shape presented in Figure 17.

Table 8: Normality statistics across sample variables

Statistics

		RESOURCES	BDA_TECH	GROWTH	COMPETITIVE_ADVANTAGE	ADOPTION
N	Valid	98	98	98	98	98
	Missing	0	0	0	0	0
Mean		5.0534	5.7903	4.8746	5.4039	4.1529
Median		5.0534	5.8000	4.8746	5.4039	4.1529
Mode		5.05	5.79	4.87	5.40	4.15
Skewness		-1.015	-1.942	-.347	-.538	.268
Std. Error of Skewness		.244	.244	.244	.244	.244
Kurtosis		2.117	5.679	1.971	1.145	.589
Std. Error of Kurtosis		.483	.483	.483	.483	.483
Minimum		1.20	1.00	1.50	2.80	1.50
Maximum		7.00	7.00	7.00	7.00	7.00
Sum		495.24	567.45	477.71	529.58	406.98

The histogram shown below does confirm our assumption with regards to normal distribution of our H1, H2 and H3 as if fits the bell curve.

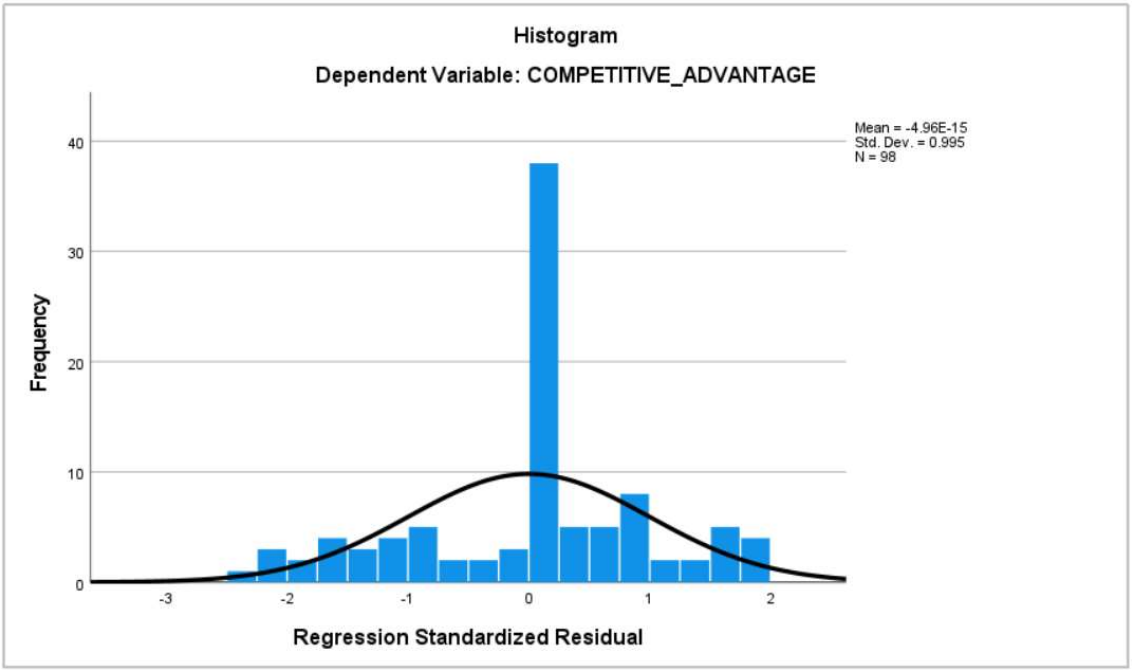

Figure 10: Historgram of Competative Advantage

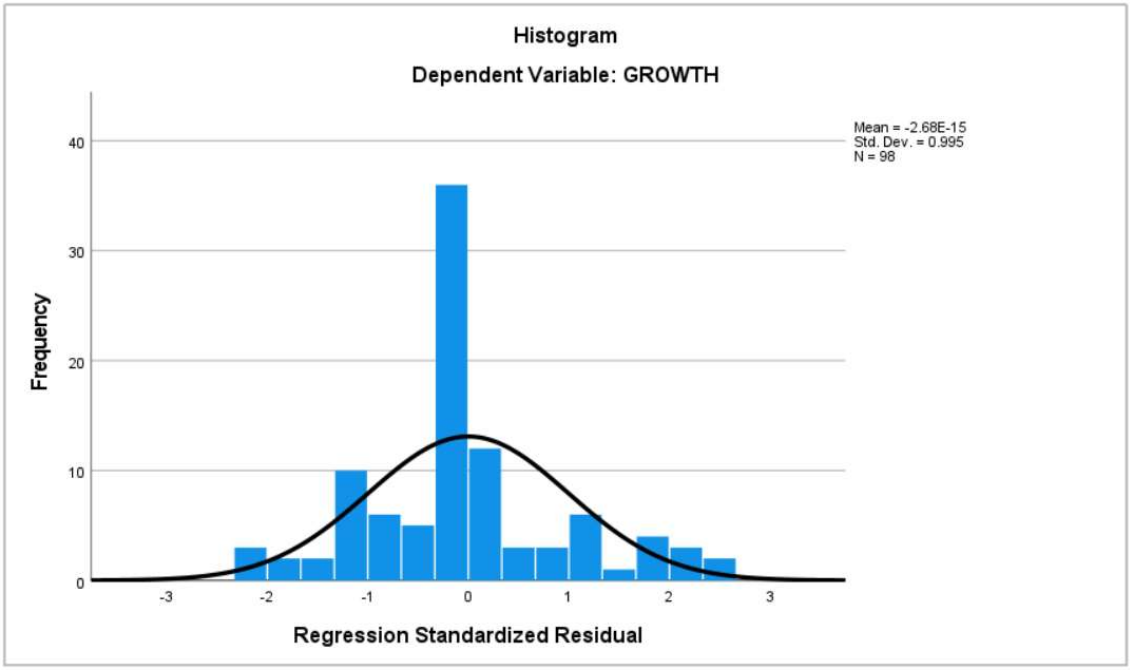

Figure 11: Historgram of Growth

4.7.3 Linearity

The study measured linearity using a bivariate correlation method that suggests that measurement of less than .3 represents weak correlation, where value greater than .5 is considered good correlation. The correlation coefficient technique chosen is Pearson, because our normality assumption has been demonstrated in the previous section and the study results below show a relationship between variables as significant, as shown on Table 9. When exploring the existence of multicollinearity across independent variables, if a measure is greater .9, no issues of multicollinearity were found.

Table 9: Linearity measured on bivariate correlation method

Correlations

		1	2	3	4	5
1. RESOURCES	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	98				
2. BDA_TECH	Pearson Correlation	.336**	1			

	Sig. (2-tailed)	0.001				
	N	98	98			
3. GROWTH	Pearson Correlation	.453**	.476**	1		
	Sig. (2-tailed)	0.000	0.000			
	N	98	98	98		
4. COMPETITIVE_ADVANTAGE	Pearson Correlation	0.131	.336**	.452**	1	
	Sig. (2-tailed)	0.200	0.001	0.000		
	N	98	98	98	98	
5. ADOPTION	Pearson Correlation	0.070	.280**	0.039	0.196	1
	Sig. (2-tailed)	0.494	0.005	0.701	0.053	
	N	98	98	98	98	98

**. Correlation is significant at the 0.01 level (2-tailed).

Linearity is also confirmed with the P-Plot diagram below, with respect to three hypotheses, and the two dependent variables, Competitive Advantage and Growth, that were used on regression analysis exercise.

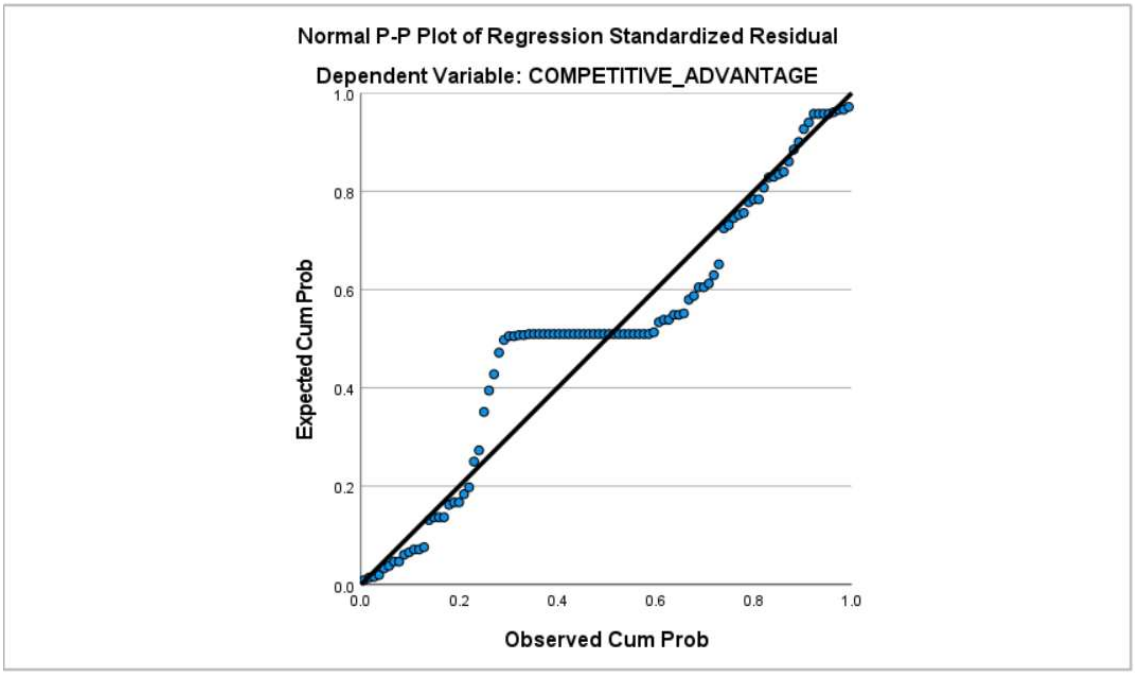

Figure 12: Normal P-P Plot of Competitive Advantage

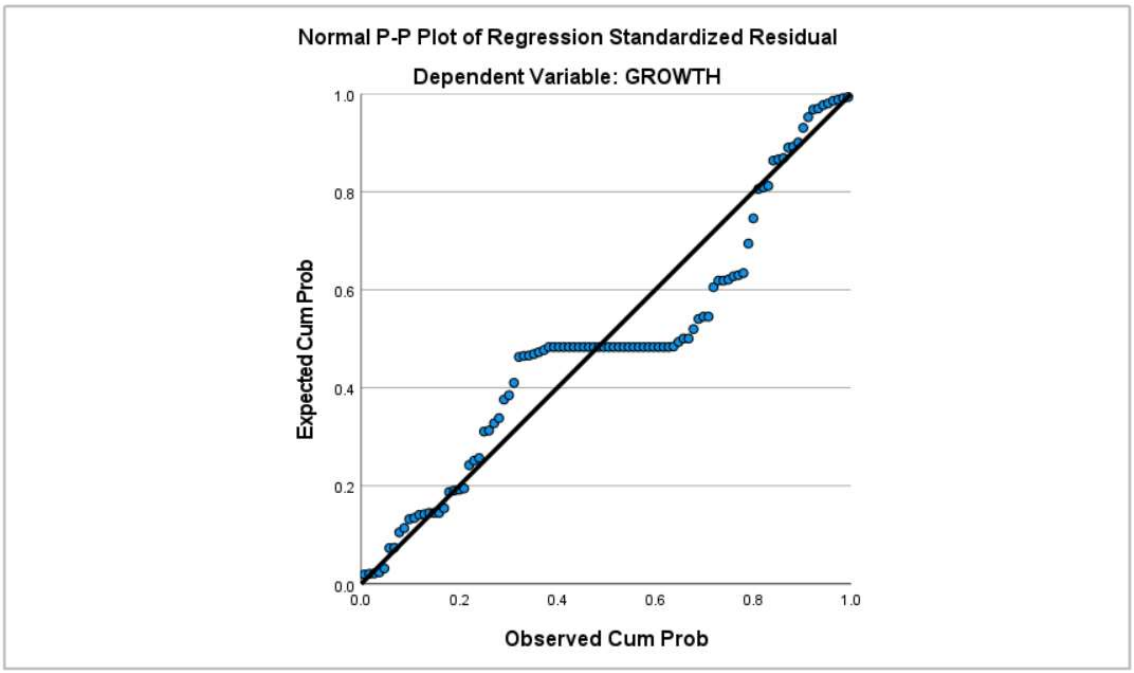

Figure 13: Normal P-P Plot of Growth

4.7.4 Homogeneity

The homogeneity assumptions are also reflected in Figure 19 and confirms our assumption that all observations as they related to DV1 and DV2, competitive advantage and growth, are indeed independent and homogeneous.

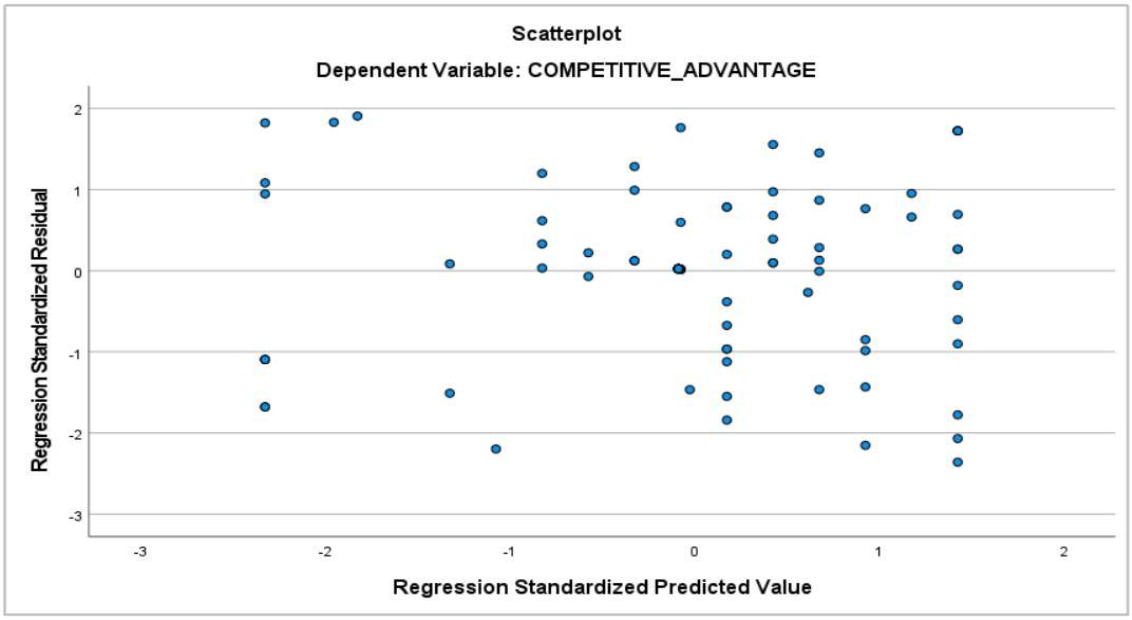

Figure 14: Scatterplot of Competetive Advantage

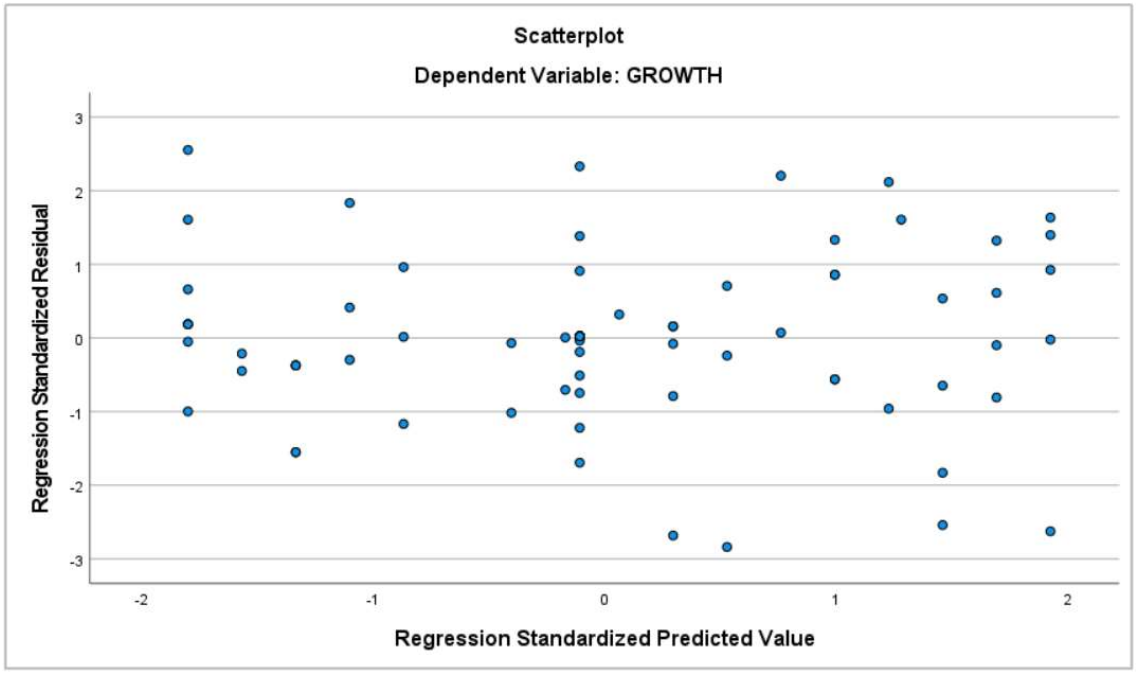

Figure 15: Scatterplot of Growth

4.8 Hypotheses testing results

*4.8.1 **Hypothesis 1:** BDA influences on competitive advantage*

R-Square value defines variance explained in this model is at 14.8%.

Table 10: Linear regression summary for Hypothesis 1 testing

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.385[a]	.148	.139	.68555	1.635

a. Predictors: (Constant), BDA_TECH

b. Dependent Variable: COMPETITIVE_ADVANTAGE

The ANOVA table summary shown on Table 11 explains whether the study's model's R square value of 14.8% is significant, by determining if p-value is lower than .05, the results below confirm that variance explained is significant and measured at .000.

Table 11: ANOVA table summary for Hypothesis 1 testing

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.859	1	7.859	16.721	.000[b]
	Residual	45.119	96	.470		
	Total	52.977	97			

a. Dependent Variable: COMPETITIVE_ADVANTAGE

b. Predictors: (Constant), BDA_TECH

The regression analysis performed confirms the study Hypothesis 1 that the two dimensions, UPE and PR, relating to BDA technologies do positively influence Competitive Advantage of SMEs. Results show that hypothesis 1 does have predictability capacity and therefore appropriately supports what was discovered in literature.

When considering multi-collinearity, with cut-off values being 10, VIF value measured is less than 10 which indicates an absence of multi-collinearity issues. When examining the standardised Beta coefficient value, with an objective of measuring the degree to which an independent variable is linearly correlated to the dependent variable (Hair et al. 2010), this essentially explains the impact the BDA Technology variable has on Competitive Advantage. The study results show that there is a positive influence of the independent variable (BDA_TECH) on the dependent variable as shown in Table 12 below.

Table 12: Coefficients table for Hypothesis 1 testing

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.327	.514		6.468	.000	2.306	4.349		
	BDA_TECH	.356	.087	.385	4.089	.000	.183	.528	1.000	1.000

a. Dependent Variable: COMPETITIVE_ADVANTAGE

*4.8.2 **Hypothesis 2**: Poor adoption of BDA has a negative influence on SME growth*

R-Square value defines variance explained in this model is at 0.1%.

Table 11: Linear regression summary for Hypothesis 2 testing

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.025[a]	.001	-.010	.85707	2.207

a. Predictors: (Constant), ADOPTION

b. Dependent Variable: GROWTH

The ANOVA table below explains whether the study's model 0.1% is significant, by determining if the p-value is less than .05, results below confirm that variance explained is not significant as it measures at a value of .810.

Table 13: ANOVA table summary for Hypothesis 2 testing

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.043	1	.043	.058	.810[b]
	Residual	70.518	96	.735		
	Total	70.561	97			

a. Dependent Variable: GROWTH

b. Predictors: (Constant), ADOPTION

The regression analysis performed confirms the study Hypothesis 2 that poor adoption and assimilation of BDA technologies has a negative influence on SME

growth. Our hypothesis does have very weak and insignificant predictability capacity and there is no strong support for what was discovered in the literature.

Considering multi-collinearity, with cut-off values being 10, VIF values measured are less than 10 which indicates an absence of multi-collinearity. When we examine the standardised Beta coefficient value of .025 for the predictor variable, the research results show that there is positive influence of the Adoption variable towards the Growth dependent variable, but it is a weak and insignificant relationship as shown in Table 14 below with *p* value above .05.

Table 14: Coefficients table for Hypothesis 2 testing

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	4.828	.352		13.711	.000	4.129	5.527		
	ADOPTION	.020	.082	.025	.241	.810	-.144	.183	1.000	1.000

a. Dependent Variable: GROWTH

*4.8.3 **Hypothesis 3**: Resource constraints impact on SME growth*

R-Square value defines variance explained in this model is at 32.6%.

Table 15: Linear regression summary for Hypothesis 3 testing

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.571[a]	.326	.319	.70393	2.086

a. Predictors: (Constant), RESOURCES

b. Dependent Variable: GROWTH

The ANOVA table explains whether the study's model's R Square value of 32.6% is significant, by determining if the *p*-value is less than .05, results below confirm that variance explained is significantly measured at .000.

Table 16: ANOVA table summary for Hypothesis 3 testing

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22.992	1	22.992	46.400	.000[b]
	Residual	47.569	96	.496		
	Total	70.561	97			

a. Dependent Variable: GROWTH

b. Predictors: (Constant), RESOURCES

The regression analysis performed confirms the study hypothesis 3 that resources have a significant influence on organisation growth (IOA, 2018). Our hypothesis does have predictability capacity and therefore appropriately supports what was discovered in literature.

Considering multi-collinearity, with cut-off values being 10, VIF values measured are less than 10 which indicates an absence of multi-collinearity issues, taking into consideration tolerance levels above .2 and measured for both factors at .9. When examining the standardised Beta coefficient value of .571 in order to measure the impact of the independent variable on the dependent variable, the results show that there is a positive and significant influence as shown in Table 17 with a *p*-value less than .05.

Table 17: Coefficients table for Hypothesis 3 testing.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.995	.434		4.597	.000	1.134	2.856		
	RESOURCES	.567	.083	.571	6.812	.000	.402	.732	1.000	1.000

a. Dependent Variable: GROWTH

4.9 Summary of the results

The analysis of the data collected with the research instrument included the measurement of scales in terms of reliability and internal consistency, and based on results, Cronbach Alpha scores for all constructs ranged between 0.714 and 0.909, above minimum valid score of 0.6, which proved the reliability of the instrument to be very good.

The analysis also measured construct validity with an explorative factor analysis method, the results based on the KMO measure presented a score of .723, which proved the adequacy of sample data.

The study initially identified six constructs on the instrument, (Implementation of BDA technologies, Adoption for BDA, Resource constraints, Growth of SMEs, Competitive Advantage and BDA Strategy), but when the analysis was done using EFA, some items related to the Competitive Advantage scale reflected other factors which resulted in the study having five variables and excluded Competitive Advantage as a construct.

The analysis also tested the three hypotheses through regression analysis, and results showed that only H1 (BDA positively influences SME differential competitive advantage) and H3 (Resource constraints have a negative impact on SME growth strategies) were proven but H2 (Adoption of BDA technologies positively influences SME growth) was not supported, as shown in Table 18.

Table 18: Summary of Results

Main Construct	Hypothesis		Outcome
BDA Technology	H1	BDA positively influences SME differential competitive advantage	Supported
Adoption and Assimilation	H2	Poor adoption and assimilation of BDA technologies has negative influence on SME growth	Not supported
Resource constraints	H3	Resource constraints have negative impact on SME growth strategies	Supported

CHAPTER 5. DISCUSSION OF RESULTS

5.1 Introduction

This chapter is a discussion of the results and findings, based on the data analysis carried out on the previous chapter. The discussion outline is presented as follows; a brief overview of the demographics; a critical analysis of the findings based on all three hypotheses that the study identified and tested: H1 - BDA positively influences SME differential competitive advantage, H2 - Adoption of BDA technologies positively influences SME growth, H3 - Resource constraints have a negative impact on SME growth strategies; and the last section is a conclusion of this chapter.

5.2 Demographic profile of respondents

The study results show that only half of the respondents operate within the SME sector; this can be attributed to the participation volume and reach of the survey instrument because it is inconsistent with the official number of SME entities compared to large corporates in a South African context. According to the Banking Association of South Africa (BASA, 2021), SMEs make up 91% of formal businesses.

Level of employment distribution based on the results reflects a majority of 57% employment concentrated across Professionals, Specialists and Middle Management. This is consistent with resources requirements for projects related to BDA technologies, as argued by Aljehane (2020), when he points out that well-trained professionals are one of the key elements in effective application of BDA technologies.

SMEs are considered the largest employers within developing economies and that also hold true for the South African economy and are measured at over 60% (BASA, 2021). The sample respondents, according to the employment distribution, reflected large entities as the largest employer; this can be attributed to the response rate of respondents who operate within the SME sector.

5.3 Discussion pertaining to Hypothesis 1: BDA and SME differential competitive advantage

The results indicate a positive relationship between BDA technologies' influence on SME competitive advantage and that relationship has been found to be significant, thus supporting the hypothesis.

BDA technologies have demonstrated effectiveness in enabling and supporting digital initiatives across various industries, including marketing, human resources, and banking (Ncube, 2017; Matsimbi, 2020; Maharaj, 2017), and have proven to be strategic levers that are propelling data-driven business models as suggested by Lukitz at BMI (2021) and by aligning data with the value proposition (Kühne & Böhmann, 2019). SME entities can leverage BDA technologies and achieve positive ROI; they also have an opportunity to gain differential competitive advantage over their peers (Iqbal, 2018).

The BDA technology construct also showed strong reliability with Cronbach Alpha score of 0.902 and the Competitive advantage construct also reflected a good measure of 0.802, an indication of a strong and positive relationship based the study findings that are consistent with literature reviewed on the Chapter 2.

SMEs that make a deliberate investment in BDA technologies and are able to harness that capability can realise and sustain a competitive advantage and gain market share.

5.4 Discussion pertaining to Hypothesis 2: Poor adoption of BDA technologies has a negative influence on SME growth

The results indicate a positive relationship between Poor adoption of BDA technology and SME growth but that relationship is very weak and insignificant thus the findings do not support the hypothesis.

Adoption of BDA technologies has been largely seen amongst large corporates due to specialised resource requirements and capital needed to provision and operationalise BDA technology infrastructure (Matsimbi, 2020; Aljehane, 2020),

and lack of proven business cases related to BDA made SMEs reluctant to make the investment in unproven BDA technology stacks and other organisational related barriers to adoption as suggested by Elhusseiny and Crispim (2021). SMEs that have embraced BDA technologies have seen growth, start-up entities regarded as digital natives, have achieved exponential growth over their peers by leveraging cost effective open-source technologies.

Findings extrapolated from the results are not consistent with the literature reviewed in Chapter 2 that suggested that there is a strong correlation between the adoption of BDA and SME growth. Thapelo (2020) observed a similar finding when he investigated whether innovation adoption has a positive influence on SME performance, and results did not support that hypothesis.

The majority of SMEs are considered laggers when it comes to the adoption and assimilation of new technologies compared to larger businesses; this can be attributed to the preference by SMEs of focusing their limited investments on their core capabilities and proven business models. This can also be attributed to the high failure rate of 70% of digital initiatives, according to the Boston Consulting Group (2020) study, that poses a risk for smaller entities that lack capital reserves. Given the maturity and cost effectiveness of open-source technologies, that are foundational elements behind BDA ecosystems (Gökalp et al. 2019), SMEs can afford to take risks and pilot the most viable business cases and scale up when those initiatives prove to be profitable, alternatively they can leverage cloud based big data services referred to as Big Data-as-a-Service (BDaaS) if they can address technological and organisational challenges associated with BDaaS (Wessels & Jokonya, 2021). Another advantage that SMEs have is being nimble and more agile than big businesses that have complex organisational structures; this puts SMEs in a better position to adapt quickly and to reconfigure business capabilities and business models on demand.

5.5 Discussion pertaining to Hypothesis 3: Resource constraints have a negative impact on SME growth strategies

The results indicate a positive relationship between resource constraints and SME growth and that relationship is shown to be strong and significant, thus the findings do support the hypothesis.

The challenge of resource constraints, within SME organisations is widely documented, and considered the biggest contributing factor in the SME failure rate in South Africa (Leboea, 2017). Access to investment and funding channels is also cited as a reason for early exit and the stagnant growth of SMEs in South Africa (Thapelo, 2020) as SME are not able to acquire and sustain infrastructure requirements that enable scale, and without the ability for smaller entities to scale operations, growth is adversely constrained.

These findings are consistent with literature reviewed in Chapter 2 that suggests that there is a strong correlation between resources and SME growth.

SMEs contribution towards employment and the wider economy is crucial for South Africa's sustained development objectives as reflected in the National Development Plan (NDP): Vision 2030 (Stats SA, 2019). SMEs need financial, regulatory, and infrastructural support from the state through policy, access to funding agencies and policy interventions (Zama, 2017), and in addition, SMEs need private sector intervention through accessible investment models, incubation and strategic partnerships.

5.6 Chapter Conclusion

The results obtained from the study revealed a demographic profile of respondents as being consistent with previous studies about the distribution of the employment levels that is concentrated across professionals and specialists, but it failed to support literature reviewed in terms of SMEs' contribution towards the overall labour market, and the study also failed to support the literature on SME entities as the majority of participants in the overall economy.

The study does suggest resource constraints and SME growth as two constructs that showed the strongest correlation and the most predictability capacity out of the five factors explored through the research instrument. The findings support hypotheses H1 and H3 but fail to support hypothesis H2 due to a positive but weak relationship between the independent and dependent variables.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

This final chapter is a discussion on the summary of the findings and conclusions that emanated from the following research questions:

- To what extent do Big Data Analytics technologies influence SME differential competitive advantage?
- What type of relationship exists between the adoption rates of Big Data Analytics technology and SME's growth?
- What is the impact of resource constraints on the success of an SME's growth strategy?

The following three sections in this chapter are broad discussions on conclusions regarding each of the research questions mentioned above, and the last section makes recommendations and presents suggestions for further research.

6.2 Conclusions regarding research question 1

To what extent do Big Data Analytics technologies influence SME differential competitive advantage?

Results from the study showed that effective use of BDA technologies has a strong and positive influence towards SMEs' ability to gain competitive advantage in the market. This finding supports the literature review done in Chapter 2, that highlights the importance of harnessing BDA technologies with a strategic intention of augmenting business models and delivering value; the conclusion is that SMEs can realise competitiveness and inevitably, sustain growth.

However, previous studies have shown that SMEs that have achieved the largest growth and differential competitive edge are those entities with core business models that are data-driven. Market research has shown that there is an

opportunity for SMEs to exploit these BDA technology advances by developing dynamic capabilities that can draw insights for internal operational efficiencies, and personalised services.

Given the South African context where most SMEs are found in the manufacturing sector, this explains why early adopters that managed to improve on internal efficiencies across the value chain, by leveraging BDA, have seen growth in client acquisition and retention as a result of improved data-driven decision making and client-centric services.

6.3 Conclusions regarding research question 2

What type of relationship exists between the adoption rates of Big Data Analytics technology and SMEs' growth?

Results from the study have shown a positive relationship between adoption rates of SMEs towards BDA technologies but the influence is very weak and insignificant, at best. This finding does not support the reviewed literature, of successful business use cases, which links improved growth with successful adoption of BDA technologies.

In a South African context, previous studies reviewed, predominantly focused on big businesses, consultancy survey research supported similar findings and drew similar conclusions, based on same sample frame. This explains why the study's findings regarding SME adoptions rates are inconclusive, and why SMEs show reluctance in their adoption strategy and some level of resistance in investing in BDA technologies.

What the study does reflect correctly is that a weak adoption of BDA technologies within the SME sector exists, and some of the key challenges, such as capital and human resources, do have an influence on this low adoption rate and inevitably, SMEs will not be in a position to improve growth.

6.4 Conclusions regarding research question 3

What is the impact of resource constraints on the success of an SME's growth strategy?

Results from the study have shown that resources have a significant influence towards the success and growth of an SME entity. These findings are closely aligned to literature reviewed and support the argument that resources are the biggest contributor to the success of any SME business model, and should be prioritised accordingly.

The resource challenge cannot be over-emphasised as it is a catalyst element for executing and realising any business strategy. This critical requirement is relevant for smaller entities with scarce capital and limited access to funding, and organisations who are yet to prove and scale their business cases. Though previous research has focused on SMEs operating in traditional sectors, such as manufacturing and last-mile service SMEs, most of those SMEs did not have digital initiatives that were leveraging BDA technologies. This study contributes to the body of knowledge by highlighting the advantages associated with cost efficiencies prevalent with the advent of open-source infrastructure resources that are far more accessible than traditional technology stacks that require huge capital investments.

Advances in BDA technologies, largely propelled by the open-source community and other significant contributions made by private technology corporations, offer SMEs an opportunity to offer differentiated and competitive services that leverage data as key strategic assets, and enables these smaller and agile entities to pivot with more creative and engaging business models.

6.5 Recommendations and Implications

Conclusions drawn from the study indicate that, for SMEs to improve and sustain growth, consequently contribute towards the macro economy, they must invest in BDA technologies:

- SME need to identify viable and non-traditional business use cases and business models that are driven through insights and data.
- SME must not limit their data sources to internal data sets but explore external sources and data brokers that can provide them with a 360-degree view of their customers.
- SMEs should mitigate issue of resource constraints, SMEs must consider cloud based BDaaS offerings that can expedite their piloting and gradually scale when their business use cases are proven, without requiring a lot of capital expenditure.
- Government intervention through policy, funding, regulatory interventions that are constantly evolving and keeping pace with industry dynamics.
- Big corporates and the private sector also have a role to play and need to support SME entities through investments, incubation and collaborative programmes.

Overall implications of SME entities adopting some of these recommendations could lead to sustained growth and development of SME sector:

- Decrease the failure rate of SMEs in South Africa; develop a robust SME sector that makes considerable contributions towards the macro-economy.
- SMEs' contribution towards employment would lead to improved socio-economic conditions for the public.
- Government needs to be an active partner that develops dynamic capabilities that constantly support SMEs with accessible funding models, access to infrastructure, and the market.

6.6 Suggestions for further research

The majority of previous research done on the use and adoption of BDA, and how this capability influences performance and growth in general, have been focused on big businesses. SMEs have unique key challenges that include capital, human resource, infrastructure, market reach and scale; further studies are needed to

determine the extent to which all these can be mitigated through big data strategies.

Technology advances at a phenomenal pace, and BDA technologies are no exception, further studies on to what extent the deployment of BDA technology infrastructure either through cloud-based BDaaS or open-source technology stacks influences the adoption by SMEs and to determine if cost efficiencies are indeed an incentive towards adoption.

Some literature review on successful use cases across SMEs who have made investments and engaged on BDA initiatives would be of assistance in gauging the effectiveness for SMEs of supporting and augmenting their business models towards growth.

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APPENDIX A: Research Instrument

Questionnaire

Source	Construct	Adapted Measure
Yang (2010)	UPE - Utilitarian Performance Expectancy	**The degree to which an individual believes that using the data analytics technology will enable him or her to easily/efficiently draw insights from organisation's data.**
	UPE1	I find Big Data Analytics technology useful in the decision-making process.
	UPE2	Using Big Data Analytics technology enables my organisation to accomplish things that are important to me in the decision-making process.
	UPE3	Using Big Data Analytics technology helps my organisation to draw valuable insights more quickly.
Featherman and Pavlou (2003)	PR – Privacy Risk	**The degree to which an individual perceives that data security and privacy in big data analytics technology is properly managed.**
	PR1	The chances of using the Big Data Analytics technology and losing control over my organisations' information privacy is high
	PR2	Our implementation and using Big Data Analytics technology would lead me to a loss of privacy because sensitive information would be used without our knowledge
	PR3	I think using Big Data Analytics technology could not keep personal sensitive information from exposure.
Jarvenpaa, Tractinsky, and Saarinen (1999)	PT – Perceived Trust	**The degree to which an individual has confidence in using the big data analytics technologies.**
	PT1	I believe Big Data Analytics technology service providers keep customers' interests in mind
	PT2	I believe Big Data Analytics technology service providers are trustworthy

	PT3	I believe Big Data Analytics technology service providers will do everything to secure the organisational data.
Venkatesh et al. (2003)	SI – Social Influence	**The degree to which an individual perceived those peers in the industry believe he or she should use the big data analytics technologies.**
	SI1	Consultancy firms and industry experts who influence our technology decisions think that we should use Big Data Analytics technology in our organisation.
	SI2	We would use Big Data Analytics technology for competitive advantage in our organisation because of the proportion of peer organisations data-driven business processes.
	SI3	Leading industry experts who are important to our organisation think that we should use Big Data Analytics technology in our organisation.
Venkatesh et al. (2003)	EE – Effort Expectancy	**The degree of ease associated with the big data analytics technologies.**
	EE1	Our organisation's engagement with Big Data Analytics technology would be clear and understandable.
	EE2	It is easy for our organisation's resources to upskill at using Big Data Analytics technology.
	EE3	Our organisation finds Big Data Analytics technologies easy to use.
Compeau and Higgins (1995)	SE – Self Efficacy	**The degree to which an individual believes in his or her ability to implement big data analytics technology successfully.**
	SE1	Our organisation could use Big Data Analytics technology if only there is a built training facility for assistance.
	SE2	Our organisation could use Big Data Analytics technology if consultancy firms could help us get started.
	SE3	Our organisation could use Big Data Analytics technology if consultancy firms could demonstrate how to do it first.

Venkatesh et al. (2003)	FC – Facilitating Conditions	**The degree to which an individual believes he/she has the resources necessary to implement BDA technologies.**
	FC1	Our organisation has the resources necessary to use Big Data Analytics technologies
	FC2	Our organisation has the knowledge necessary to implement and use Big Data Analytics technologies
	FC3	Big Data Analytics technologies are compatible with other technologies our organisation uses

APPENDIX B: Participant Information Sheet

Good day

My name is Siviwe Xegwana and I am a Masters student at the University of the Witwatersrand, Johannesburg. As part of my studies, I have to undertake a research project, and I am investigating the influence of big data usage on SMMEs in South Africa under the supervision of Dr Jabulile Galawe. The aim of this research project is to find out the impact and use of big data by SMMEs on sustaining and supporting growth.

As part of this project, I would like to invite you to take part in answering a questionnaire, sustaining and supporting the use of big data by SMMEs in South Africa. This activity will involve completing an online survey and will take around 7 minutes.

This survey is completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely and not disclosed to anyone else.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za

Yours sincerely,
Siviwe Xegwana

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APPENDIX C: Ethics Approval Notification

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB330612/935
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below

Project title	Sustaining and supporting the use of big data by SMMEs in South Africa
Investigator / Researcher	Mr Siviwe Xegwana
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed anonymity and confidentiality.
Issue Date of Certificate	2021-09-26
Expiry date	Date of submission of the project report
Chairperson	Prof Anthony Stacey ☎ +27 11 717 3587 +27 82 880 4531 anthony.stacey@wits.ac.za

APPENDIX D: Consistency Matrix

TITLE							
Main Objective Here : To measure the influence of Big Data Analytics technology in sustaining growth strategies of small and medium enterprises in South Africa							
Sub-Aims/Objectives	**Literature Review**	**Hypothesis**	**Research questions**	**Variables(Independent & Dependent)**	**Source of data**	**Type of data**	**Analysis**
To examine the **influence** of Big Data Analytics technology on SMEs differential competitive advantage	Lederer et al, 2017 (Stats SA AFS, 2019) Leboea, 2017 McKinsey & Company, 2020 Obuokiri et al. 2015 Mikalef et al. 2019 Oracle, 2019 Barney, 2011 Armstrong and Lee, 2019	Big Data Analytics technology has a **positive influence** on SMEs differntial competitive advantage.	To what extent does Big Data Analaytics technology influence SMEs differntial competitive advantage?	IV1= Big Data Analytics technology DV1=Differntial Competitive Advantage	Questionnaire [UPE + PR] - Q1 TO Q6	Ordinal Data (7 likert Scale)	1. Descriptives 2.Correlation 3. Multiple Regression
To examine how the level of adoption and assimilation of Big Data Analytics technology impact on the success of SME growth	Hrustek et al. (2019) Ulas (2019) Erboz, 2018 Willetts et al. (2020) Burtosik-Purgat et al. (2018) Muller et al, 2018 Iqpal et al. (2018)	Poor adoption and assimilation of Big Data Analytics technology has a **negative impact** on the success SMEs growth.	What type of relationship exist between high adoption rates of Big Data Analytics technolgy and success SMEs growth?	IV2=Adoption of BDA DV2=Growth	(PT + EE + SI) - Q7 to Q15	Ordinal Data (7 likert Scale)	
To examine the impact of resource contraints on the success of SME big data strategy	Gupta and Gourge, 2016 Mikalef et al, 2019 Willetts et al. (2020) Armstrong & Lee (2021) Mikalef et al. 2016	Resource constraints have a **negative impact** on the success of SMEs Big Data Strategy.	What is the impact of resource constraints on the success of an SME big data strategy?	IV3= Resource Constraints DV3=SMEs big data strategy	Questionnaire [SE + FC] - Q16 to Q21	Ordinal Data (7 likert Scale)	
digital strategy, big data and analytics, small and medium enterprise							