

BINDURA UNIVERSITY OF SCIENCE EDUCATION

IMPROVING CONSTRUCTION BUSINESS PERFORMANCE THROUGH INNOVATIVE TECHNOLOGIES IN ZIMBABWE: A CASE OF KARO MINE CONTRACTORS

BY

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DECLARATION

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DEDICATION

I dedicate this dissertation to my wife, Thrive and to my children, Carol, Daryl, and Anashe.

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I would like to acknowledge all the people who made a positive contribution towards my completion of this dissertation. These include my wife Thrive, Bindura University's Graduate School of Business, my Research Supervisor Dr R.M. Rusike and colleagues including Mr Gumbi.

ABSTRACT

Improving efficiency in business operation is linked with the overall enhancement of business performance and operations sustainability. This study was based on the four research objectives that were focused on the effect that virtual reality, prefabrication and modular designs, drone technology use, robotics, and automation have on the performance of business of mining construction companies in terms of cost minimization, profitability, efficient utilisation of resources, and productivity. The results that are presented in this chapter were collected from diverse groups of respondents from diverse age groups, which indicates the level of familiarity they might have with various technologies that are relevant in the construction industry. The respondents were categorised in terms of their working experience within the construction and mining industries. It was essential to understand the profiles of respondents who have a detailed appreciation of specific technologies that might enhance the overall performance of construction companies operating within the mining industry. The results also showed that most respondents in this research were males, which might indicate the existence of metal determination within the construction companies operating within the mining sector. Research results from this study indicated that, from the four research objectives, virtual reality, drone technology, and robotics/automation are all positively associated with construction business performance. On the contrary, prefabrication and modular design technology may have a negative effect on construction business performance. These findings can help construction companies operating at Karo Mine and similar organizations make informed decisions regarding the adoption and implementation of these technologies.

Keywords: Business performance, Cost minimization, Karo Mine, Virtual reality

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LIST OF ACRONOMN

AR	**:**	Augmented reality (AR)
BMI	**:**	Building Information Modelling
BP	**:**	Business Performance
DIT	**:**	Diffusion of Innovation
DT	**:**	Drone Technology
GDP	**:**	Gross Domestic Product
PC	**:**	Personal Computer
PD	**:**	Prefabrication and Modular Design
RA	**:**	Robotics & Automation
RBV	**:**	Resource Based View
R&D	**:**	Research and Development
RBV	**:**	Resource Based View
3D	**:**	Three Dimensional
UAVS	**:**	Unmanned Aerial Vehicles
VR	**:**	Virtual reality
VUCA	**:**	Volatile Uncertainty Complex Ambiguous

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter serves as an introduction the study's introduction, highlighting the background of the study and its context. It states the research problem, questions, and study's objectives, its importance, and lastly, the study limitations.

Construction business performance is crucial for the development of the country and should be enhanced by various ways including innovative technology strategies. various value chain industries for example those that supplies cement and timber benefits directly from the improvement of construction business. Furthermore, jobs are created, directly from the construction activities or indirectly through the operation of completed infrastructures. The role of innovative technologies in improving construction industry performance is a contentious issue that can be discussed from various angles. Innovative technologies help in improving the performance of the construction industry by increasing production efficiency, product quality, and sustainability of the business. Innovative technology alone may not be enough to enhance construction business performance, demanding inclusion of additional aspects such as leadership, culture, management, and organisational teamwork. Additional research is needed to enhance knowledge sharing practises to encourage businesses to become more innovative and technologically driven, as the findings of previous studies (Psomas, Kafetzopoulo *et al*, 2020; Assad & Alshurideh, 2020) were inconclusive due to factors like the financial crisis.

1.1 Background of Study

Innovative technologies have a huge impact on the social and economic growth of countries. The impact of innovative technology in the economic development and long-term growth is important, and its contribution to social development and industrialisation is indisputable (Hu *et al*. 2020). Innovative technologies implementation has been important in promoting structural transformations in economies at various phases of development.

On the contemporary economy, innovative technology serves as the foundation for economic development and have a significant impact on business performance (Prifti & Alimehmeti, 2017).

Innovative technology has become a crucial part of company strategies that assists companies gain an edge over rivals, enter emerging markets, and increase their market share (Hayajneh et al., 2021). The capacity to evaluate an organization's efficiency using variables like higher productivity and better business performance as performance leading indicators is known as business performance. How successfully a construction company meets its objectives determines how successful it is. A construction company's business performance can be attained by connecting and overseeing at least four elements (Kaplan, Norton, 2001): By tracking and evaluating these data, construction companies may evaluate their performance and make improvements.

1.1.1 Worldwide Perceptive

According to (Hatzl *et al*. 2020), the importance of innovative technology to the Canadian construction sector is to enhance productivity, sustainability, and overall business performance. Furthermore, the (Canadian Construction Association,2018) study investigates the use and effect of technologies such as Building Information Modelling, or BIM, drones, prefabricated construction, and automation on the construction process, productivity, and project outcomes. According to a recent survey, three-quarters of Canadian construction companies believe their technological maturity is still low, so companies must adopt cutting-edge technologies to simplify work streams and bring innovation to their operations to improve business performance (Denton, 2021).

Brazil's construction industry has faced issues such as instability in the political and economic climate, allegations of corruption, a lack of productivity, and environmental consequences. However, the sector has showed signs of recovery and expansion in recent years, owing to the adoption of new technologies and innovations, as well as the enhancement of education and skills (Reynolds *et al.*, 2019). The use of Building Information Modelling (BIM), 3D printing, drones, robotics, and smart materials are some of the innovative technologies that have been used or researched in the Brazilian construction industry.

Implementing these technologies has resulted in benefits including improving the construction business performance by enhanced efficiency and quality of construction processes, lowering costs and waste, improving safety, enhancing consumer satisfaction, creating fresh opportunities for business, fostering cooperation, and contributing to social and environmental sustainability (Xichen *et al*., 2022).

Adoption of sustainable innovative construction practises was still in its preliminary stages in Sri Lanka, and construction innovations were not being completely utilised to attain sustainability (Gunawardhana, 2017; Somachandra & Sylva, 2018). Addressing the current gap in research is critical because it is essential to understand the challenges involved in applying construction innovations that can enhance construction business performance. In Malaysia, the construction sector was one of the sectors that contribute to the country's economic development. This contribution is frequently linked to the level of innovation and technology invested by industry organisations. The industry's performance in terms of innovation is among the lowest when compared to others (Megat Zuhairy *et al* 2015). The construction industry represents less than 5% of Malaysia's GDP, yet its performance has a significant impact on total economic growth.

African countries lag in terms of innovation and growth (Cornell University *et al*. 2018). The construction industry is one of the world's biggest revenue-generating businesses, producing nearly $10 trillion in construction-related products and services each year; however, construction has lagged other industries in its business performance in regard to productivity (McKinsey Global Institute, 2017). Economic growth, social development, and climate action are strongly dependent on infrastructure investments, sustainable industrial development, and technical innovation (The Sustainable Development Goals Report,2023), opening the door for construction prospects. In comparison to other developing countries, Nigeria has a low adoption of innovation and technology, which poses a significant obstacle to diversifying the economy (Dimnwobi,2011).

1.1.2 The Zimbabwean Perceptive

The construction sector in Zimbabwe contributes significantly to economic development by supplying mining infrastructure, housing, as well as other necessary structures (Dang and Low, 2019). Mining construction firms, on the other hand, face various challenges, including serious competitors, project complexities, and budget restraints.

In such a context, the importance of innovative technology in improving the performance of businesses becomes increasingly vital. Because of innovative technological advancements, the concept of competitive advantage has evolved over time. The organization's innovation capability is currently a standout amongst the most important tools for development and long-term competitive advantage, according to (Leonidou *et al*. 2020).

1.2 Statement of the research problem

From the early to mid-2010s many new entrants into the construction sector offered point or basic innovative solutions to the existing market. The initially adopted innovative technology solutions solved fundamental construction and customer needs. Due to significant operating challenges such as high operating costs, time constrains and complexity nature of construction projects, by the start of 2020s, construction firms began to adopt integrated innovative construction solutions,(McKinsey Global Institute, 2017),although currently the adoption of innovative technology in the construction industry is still low.

The global construction sector faces challenges such as global warming, climate change, and resource scarcity, which require smarter and more effective methods of managing existing resources (Chen *et al*., 2022). The sector has experienced rapid transformation, driven by innovative technologies, which can improve business performance and competitiveness. However, there is a lack of comprehensive understanding of the types, rewards, and challenges of technology adopted by construction projects globally (O'Connor 2021). The integration of innovative technologies is crucial for construction companies to survive in the global market. The ageing population in Europe and North America also presents challenges, as many companies may opt to innovate and use technology to improve operational performance. The Zimbabwean construction industry faces challenges such as low productivity, delays, high costs, and subpar quality is expected to develop by only 5% on average over the next five years (BMI Research, 2018). To solve these issues and improve the performance of Zimbabwean construction companies, a study on the strategies to improve construction business performance through use of innovative technologies especially in the mining area where most significant construction projects has been taking place is needed.

1.3 Purpose of the Study

The main purpose of this study is to come up with strategies to improve construction business performance through innovative technologies in Zimbabwe: A case of Karo Mine Contractors.

1.4 Main Research Objective

To improve construction business performance in Zimbabwean mining sector using a case study of Karo Mine. This is supported by the following secondary objectives.

i. To ascertain the current usage of virtual reality on the cost minimisation by the construction companies operating at Karo mine in Zimbabwe.
ii. To examine the effect of using prefabrication and modular designs on the profitability of construction companies operating at Karo mine.
iii. The assess the influence of applying drone technology on the resource efficiency of construction companies operating at Karo mine.
iv. To assess the use of robotics and automation on the productivity of construction companies operating at Karo mine.

1.3 Main Research Question

How to improve Construction Business Performance in Zimbabwean mining sector using a case study of Karo Mine? To achieve the aim of the research, the research question is supported by secondary research questions.

i. How does the current usage of virtual reality influence the cost performance of the construction companies operating at Karo mine?
ii. What is the effect of using prefabrication and modular designs on the profitability of construction companies operating at Karo mine?
iii. To what extent does applying drone technology influence efficient resource utilisation by construction companies operating at Karo mine?
iv. Do the use of robotics and automation influence the productivity of construction companies operating at Karo mine?

1.4 Statement of Hypotheses

The study was based on the following hypotheses:

H_0: Application of innovative technologies does not improve construction business performance.

H_1: Application of innovative technologies improves construction business performance.

1.5 Research Assumptions:

According to Price and Kirkwood (2010), the researchers' appraisal methodologies are based on assumptions. The changes that occur during the study, such as operating environment challenges, differences in innovativeness, and company technology adoption, are outside the scope of this study. The following research assumptions considered by the author.

- There would be no disease pandemic for example during the study period.
- Construction companies operating at Karo mine in Zimbabwe are willing to adopt and implement innovative technologies on their operations.
- Collaboration among industry stakeholders, including construction companies operating at Karo mine, technology providers, policymakers, and industry associations in promoting the adoption and utilization of innovative technologies.
- There are no barriers and challenges that hinder the widespread adoption of innovative technologies on the Zimbabwean construction industry.

1.6 Justification of the Research

To improve construction company performance through innovative technologies is a contentious topic that can be widely debated around the world; thus, more research must be conducted to advance understanding in this field (Xicheng Chen et al., 2022). Some recent research produced inconclusive results because of factors like crises in the financial sector (Psomas et al., 2018; Assad & Alshurideh, 2020).

Another study, (Ploscaru,2010), examined the impact of the financial and economic crisis on the European construction industry and discovered that the crisis affected construction business performance differently depending on the country, industry, and type of construction. Some authors, such as (Yuan et al. 2010), proposed conducting future research to authenticate previous research findings.

The vision 2030 agenda of leading Zimbabwe into a middle-income economy by 2030 is achievable if the construction sector in the country contributes significantly to the economy through enhanced business performance. Construction Sector opens other industries including suppliers, mining, and transportation business by providing them with the necessary infrastructure.

Improvement in construction business performance is crucial as it provides crucial employment opportunities in Zimbabwe which is crucial in reducing poverty in the country by providing a source of income to various stakeholders including the local community.

There is a need for investigation on how to improve construction business performance through innovative technology in the Zimbabwean mining construction industry, as existing literature focuses on other regions or nations or does not give an in-depth analysis of diverse types of innovative technologies and does not focus on mining construction segment. There is a gap in the literature about how to evaluate and enhance the innovation skills of Zimbabwean construction firms, as well as how to develop an innovation culture that encourages both gradual and radical improvements. In the Zimbabwean context, there is a lack of empirical knowledge on the impact of various innovative technologies on many areas of construction business performance, including quality, price, time, safety, consumer satisfaction, and environmental sustainability.

1.7 Significance of the Study

The significance of the study can be discussed in respect of theoretical relevance, contribution to academia, to the construction industry and other stakeholders.

1.7.1 Significance to Theory

This research can help to further construction innovation theory by giving a comprehensive and contextualised understanding of the role of innovation and technology in the business performance of construction enterprises operating at the Karo mine. This study contributes to the idea of competitive advantage by investigating how innovation and technology might improve the efficiency, competitiveness, and sustainability of construction enterprises operating at the Karo mine. This research could potentially contribute to the notion of smart or innovative building processes by studying how innovative technology improve the efficiency, quality, safety, and sustainability of Zimbabwean construction projects.

1.7.2 Significance to Academia

This study could contribute to the academic literature on innovation and technology by offering a systematic and empirical investigation of the influence of innovation and technology on construction business success.

The research could potentially add to the academic literature on competitive advantage and firm performance by investigating how innovation and technology can improve the efficiency, competitiveness, and sustainability of construction enterprises operating at the Karo mine.

1.7.3 Significance to Construction industry

By offering a systematic and empirical investigation of the influence of innovation and technology on construction company performance, this study contributes to the practise of innovation and technology in the construction industry. This study on the exploration of how innovation and technology might boost the productivity, competitiveness, and sustainability of construction enterprises working at the Karo mine in Zimbabwe benefits the practise of competitive advantage and firm performance.

Other Stake holders

This study can offer a detailed understanding of how construction business performance is improved through innovative technologies and provide the resulting implications of adoption. The stakeholders can be empowered by the study in identifying the diverse types of innovative technologies that be implemented at various stages in construction as to achieve the desired outcomes thus assisting in making well-informed decisions regarding innovative technology adoption and investment.

To facilitate the effective use of innovative technologies, it recommends making the required adjustments to the operating systems of the construction industry, including building regulations, education, and training, contracting, and procurement. The study also highlights the knowledge gaps and potential avenues for future research on the adoption and spread of technology in the construction industry,

1.8 Delimitations

Delimitations of the study are as follows.

1.8.1 Geographical Delimitation

i. The study is geographically limited to the Karo Platinum Mine in Zimbabwe, which is a platinum mine located west of Harare in the Mhondoro-Ngezi platinum belt.
ii. The study is also geographically limited to the Karo Mine development projects, which include a concentrator project, an open pit mine, and tailings construction.

iii. The study is also restricted to construction businesses operating at the Karo Platinum Mine that are participating in construction projects at the Karo Platinum Mine, such as Masimba Holdings and Topspin International.

1.8.2 Theoretical Delimitation

The study is theoretically confined to the influence of innovation and technology on the business performance of construction businesses operating at the Karo mine in Zimbabwe. The research is also limited to the technology used at the Karo Platinum Mine.

1.8.3 Time Delimitation

i. The study focuses on the impact of innovative technologies on the business performance of construction businesses operating at the Karo Platinum Mine in Zimbabwe in the fiscal year 2023. The time span includes both recent and ongoing construction projects.
ii. The analysis is limited to technologies that were installed or used during the fiscal year 2023.
iii. The study is confined in time to the effects of innovative technologies on the business performance of construction businesses operating at the Karo Platinum Mine during the fiscal year 2023.

1.8.4 Conceptual Delimitation

i. The study is delimited to the types or sources of innovative technologies that are relevant for business construction, such as product, process, organizational, or institutional innovation.
ii. The study is delimited to the impacts of innovative technologies on business construction performance, such as productivity, profitability, cost management.

1.8.5 Methodological Delimitation

i. The study is delimited positivism. The role of the researcher is limited to data collection and interpretation in an objective way. Positivism can be used to examine the quantitative aspects of business performance, such as financial indicators.
ii. In this study the researcher is delimited to quantitative approach in analysing the role of innovation and technology on construction companies operating at Karo mine in Zimbabwe. The quantitative component can examine objective performance metrics, such as financial data.

iii. The study is delimited to data collection methods or techniques that will be used to gather relevant information from the sources which are internal documentation, document analysis, observations, and case studies.

1.8.6 Limitations

The sample representativeness was employed. Masimba Holdings Limited and Topspin International, both construction businesses operating at the Karo mine, were used in this case.

Short Timeframe:

The research was constrained by the 2023 fiscal year and the contract duration period for Masimba Holdings Limited and Topspin International. Innovation may necessitate a long-term outlook and a continual learning process, which may be incompatible with the project-based nature of construction.

Resource Constraints:

The research was hampered by limited resources such as time to collect data from contractors, financing, and access to data, all of which required more sophisticated procedures from both Karo Mine and the Contractors, which took time to complete.

1.9 Organisation of the Study

The this organised as follows:

Chapter 1 (Introduction)

1.1) Background, 1.2) Statement of Research Problem, 1.3) Main Research Objective, 1.3.1) Secondary Research Objective

1.4) Research Question, 1.5) Research Proposition, 1.6) Research Assumption, 1.7) Justification of Research, 1.8) Purpose of Study, 1.9) Significance of Study, 1.10) Delimitations, 1.11) Limitations, 1.12) Definition of Key Terms

1.13) Organization of Study



Chapter 2 (Literature Review)

2.1) Literature Review 2.2) Theoretical Framework 2.3) Conceptual Framework



Chapter 3 (Research Methodology)

3.1) Research Methodology 3.2)) Theoretical Framework



Chapter 4 (Research Methodology)

4.1) Philosophy 4.2) Research Design 4.3) Sampling 4.4) Data Collection



Chapter 5 (Data Analysis & Interpretation)

5.1) Data Analysis 5.2) Discussion of Results

1.10 Chapter Summary

Innovative technology adoption by the construction sector in the entire world in general and Zimbabwe in particular has constantly been increasing on the quest by construction companies to improve their business performance in terms of productivity, profitability, and cost management. However, the implementation of these innovative technologies is not without challenges especially in the context of developing countries such as Zimbabwe. This research aimed to explore the role of innovation and technology on construction business performance at Karo Mine, a platinum mining company in Zimbabwe.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This literature review explores the role of innovative technologies on construction business performance as defined by different authors. In this chapter, both empirical and theoretical literature is scrutinised from similar studies and theories conducted in different countries. The theoretical framework and conceptual framework are encompassed in this study. Construction technologies, according to (Sepasgozar and Davis,2018), are emerging tools, machinery, and alterations such as equipment, drones, and software for construction management that can assist in accomplishing an objective, carrying out a particular task, or resolving an issue. The effectiveness with which a construction company is accomplishing its goals and objectives can be assessed by its construction business performance. The business's operational, financial, and strategic components can be evaluated through a range of key performance indicators (KPIs).

2.1 Definition of key terms

Innovative Technology

The development and use of new or enhanced technologies, instruments, systems, and procedures that result in notable breakthroughs or advances across a range of industries. It entails utilizing resources, knowledge, and experience to create creative solutions that address issues, boost productivity, advance the cause, and add value.

Innovation

The process of introducing new or improved products, services, processes, or methods that create value for customers, stakeholders, or society. (Jones, A. 2020). Innovation can be defined as the implementation of a new organizational improved product, process, a new marketing technique. (International Journal of Education and Research ,2020)

Technology:

The collection of tools, machinery, software and many more, that enable advancement in field construction methods, including semi-automated and automated construction equipment. (Higgins.P. 2020)

Construction business performance:

The measure of how well a construction company achieves its objectives, such as quality, safety, profitability, productivity, customer satisfaction.

2.2 Theoretical Framework:

The figure below shows the Resource Based View (RBV) framework.

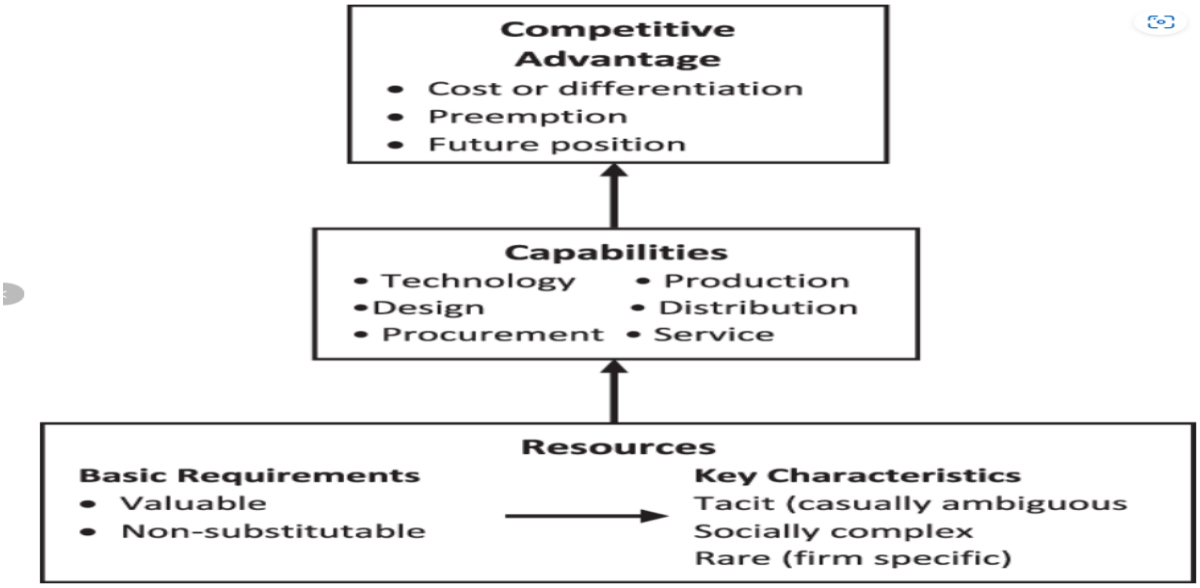


Figure 2.1: Resource Based View (RBV) framework.

Source: (Bamgbade, J.A et al 2019)

2.3 Theories and Models related to the research study.

This literature review is anchored on four theories related to the study of innovative technologies on business performance of an organisation, which are the Schumpeterian Theory of Innovation, Resource-Based View (RBV), Diffusion of Innovation Theory and the Dynamic Capabilities Theory. This study is underpinned by the Resource Based View framework.

2.3.1 Schumpeterian Theory of Innovation

According to the theory, innovation is the main factor influencing both business performance and economic growth (Schumpeter & Moeller, 2010). Schumpeter highlighted the significance of creative destruction, in which new inventions and technologies upend established markets and establish new ones, boosting the performance and productivity of businesses that implement them.

Schumpeter distinguished five categories of innovation, which are the development of a new good or a new quality of a good, the implementation of a new method of manufacturing or an innovative method of handling a commodity commercially; the opening of a new market; the acquisition of a new source of raw materials or intermediate goods; and the establishment of a new organization within any industry.

There are two distinct stages of innovation: invention and diffusion. Diffusion is the dissemination and acceptance of the innovation among various businesses and consumers, whereas invention is the creating of a new concept or product. Diffusion necessitates imitation and learning, but invention demands creativity and knowledge.

2.3.1.1 Strengths of Schumpeter's theory

The theory provides a dynamic and realistic view of the economy, where innovation and competition are constantly creating new opportunities and challenges for businesses. Additionally, it acknowledges the function of entrepreneurs as change agents who provide novel goods, procedures, marketplaces, and organizational structures that upset the status quo (Mehmood, 2019).

2.3.1.2 Weaknesses of Schumpeter's theory

The theory ignores other factors like supply, demand, and prices and overemphasizes innovation's position as the only driver of economic development and trade cycles (Farrokh Langrood,2021). Empirical measurement and testing are challenging due to its reliance on an imprecise and subjective definition of innovation.

2.3.1.3 Implication

In the contemporary economy, Schumpeter's theory is widely acknowledged and applied to ascertain the variations in an organization's finances. It is also credited with originating the current growth theory, which is predicated on the unavoidable byproduct of innovation and development (Bailey N, 2018). It is pertinent to the modern, technologically, and knowledge-driven global economy, where the growth and transformation of the economy depends heavily on entrepreneurial innovation.

2.3.2 Resource-Based View (RBV):

The Resource-Based (RBV) managerial framework concentrates on the strategic resources that a company might use to gain a long-term competitive advantage (Howe-Walsh et al., 2023). Businesses are seen as diverse because they have various capacities and resources, and the direction and rate of a firm's growth are dictated by these resources and capabilities (Bocken & Geradts, 2020). According to the RBV, a company's performance is determined by its special resources and skills, including innovation and technology (Davis & Dewitt, 2021).

This paradigm states that businesses can get a lasting competitive advantage and achieve better performance by acquiring valuable, rare, and hard-to-imitate technology resources (Mong et al., 2021). Businesses now face intense competition due to technological breakthroughs and ongoing workplace improvements. Today, every business wants to create value propositions for customers in order to stay relevant in the face of ever shifting market trends (Barney, 2018). Managers must thoroughly assess their pool of resources and capabilities and make the most use of them as to implement this approach.

2.3.2.1 Strengths of RBV theory

The RBV focuses a strong emphasis on developing the company's unique resources and competencies to add value for stakeholders and clients.

It offers a framework for determining the strategic resources of the company and how best to use them to gain a competitive advantage in the marketplace (Barney, 2018). By enabling the company to utilize its core skills and unique capabilities in various ways, the RBV also promotes innovation and creativity (Madushanka & Sachitra, 2021). Through the RBV, businesses may combine their internal strengths with external opportunities and match their resources and capabilities with their vision, mission, and goals.

2.3.2.2 Weakness of RBV theory

The RBV disregards how the firm's performance and strategy are shaped by the industry and the external environment. Additionally, it ignores the difficulties and threats that could come from rivals, clients, vendors, regulators, as well as other stakeholders (Furnival et al., 2019). Various intangible resources and competencies, such as human capital, corporate culture, and reputation, may be challenging to evaluate and quantify in RBV (Bocken & Geradts, 2020).

Maintaining the VRIO features of the company's resources and competencies over time may also be difficult because they could be undermined, rendered outdated, or copied by rivals or newcomers (Deng et al., 2020). It may also cause construction companies operating at Karo mine to become more reliant on their current capabilities and resources, which makes them resistant to modifying or adapting to new circumstances. This can lead to complacency and inertia (Reimann et al., 2021).

2.3.3 Diffusion of Innovation Theory (DIT)

The diffusion of innovation theory is a social science theory that explains how new ideas, products, or behaviours spread through a population or social system (Rogers, 1962). The notion of diffusion of innovations describes how new developments in technology and other disciplines permeate societies and cultures, through their introduction to their widespread acceptance (Leonard et al., 2019). The goal of the diffusion of innovations theory is to provide an explanation for the adoption of innovative ideas, including why they can take a long time.

2.3.3.1 Strength of Diffusion of Innovation theory (DIT).

The adoption and spread of innovations are influenced by several factors, including the innovation's qualities, its adopters, and its communication routes (Genlott et al., 2023). The spread of innovation theory can help us better understand these factors.

It is also possible to design and implement effective strategies for promoting and spreading inventions. Among these approaches include the use of diverse media, the customization of messaging, and the concentration on demographic segments. DIT assesses the effects and outcomes of innovations by measuring their diffusion curve, rate of adoption, and social and economic benefits. It aids in the identification of impediments and challenges to the adoption and dissemination of innovations, such as compatibility issues, change aversion, or a lack of awareness. In marketing, this approach can assist launch new products or services and grow market share by identifying potential customers' requirements and preferences and crafting convincing communications.

However, the main weakness of the diffusion of innovation theory is that it is more effective when behaviours are adopted than when they are ceased or avoided. It disregards a person's ability to embrace the new behaviour (or innovation) or their social support system.

2.3.4 Dynamic Capabilities Theory (DCT)

Dynamic capacity theory (DCT) provides a framework for understanding how organisations may innovate and adapt to changing surroundings. 'dynamic capacities' is a phrase (Teece, 2018). Dynamic capabilities refer to a company's capacity to integrate, develop, and restructure internal and external competencies in response to rapidly changing conditions (Bocken & Geradts, 2020). The theory has evolved and been applied in a variety of contexts and domains over time. This notion focuses on a company's ability to adapt and respond to changing technological environments (Sasmoko et al., 2019). It indicates that firms with dynamic capabilities, such as the ability to recognise, seize, and rearrange resources in response to technological opportunities, are more likely to prosper (Linde et al., 2021).The dynamic capability theory's primary advantages are that, it is simpler to understand how organisations can build and retain a competitive edge in volatile and uncertain situations by focusing on the mechanisms and processes of change rather than permanent positions or resources (Liu et al., 2019).

Sensing, seizing, transforming, learning, and cooperating are examples of dynamic capacities. It is useful to specify sources and categories, as well as how different players within and across enterprises may develop and use them (Scarpellini et al., 2021). It is beneficial to investigate the micro-foundations and variety of dynamic capabilities, such as the impact of individual talents, team relationships, organisational structures, and environmental factors, and how they affect dynamic capability performance and evolution (Furnival et al., 2019).

Due to the lack of a specific and uniform definition and assessment of dynamic capabilities, the fundamental shortcoming of the dynamic capability hypothesis is that it is difficult to compare research across studies and undertake empirical testing (Bocken & Geradts, 2020). Another challenge it faces is explaining how dynamic capabilities may be unique and essential in a context where competitors or other capabilities may replicate or replace them (Bocken & Geradts, 2020). It has limited power to explain the situation when the shift occurs too rapidly or slowly, or when the surroundings are too tidy or chaotic (Reimann et al., 2021).

The Implications of the dynamic capability theory are that the dynamic capability model has several implications for the current investigation. For starters, it can be useful in determining the key elements influencing business performance in various situations and industries.

It can provide a framework for assessing how firms might use their resources and expertise to provide value to stakeholders and clients. It can also inform firms about how to integrate internal and external knowledge to boost their capacity for innovation and success.

2.4 Virtual reality in the construction industry

Virtual reality (VR) and augmented reality (AR) are becoming more popular in the construction business. The innovative technologies has the potential to revolutionise various elements of the building process, ranging from design and visualisation to project management and cooperation (Lucena & Saffaro, 2022). While the potential benefits are substantial, there are several limitations and obstacles that must be addressed (Chen & Wang, 2023). One of the most important applications of virtual reality in building is in the design and visualisation phases (Becker & Schuetz, 2018). Architects and engineers can use virtual reality to produce immersive visualisations of building and infrastructure projects. Before building begins, stakeholders may walk through virtual models, scrutinise every aspect, and make informed decisions.

VR helps discover design problems and potential disputes early on by giving a realistic and participatory experience, which can save time (Arowoiya et al., 2023). AR is a technology that superimposes virtual information and objects on top of the real-world surroundings (Vieira et al., 2017). AR is utilised on-site in the construction sector to project 3D models, plans, and other pertinent information onto physical constructions. This enables workers to visualise complex systems such as electrical or plumbing installations and ensures correctness throughout the construction process (Chen & Wang, 2023). By comparing actual progress to the virtual plan, AR aids in quality control checks. VR facilitates collaboration among various parties in a construction project. Virtual reality allows project teams to hold virtual meetings regardless of their actual location. This allows for more effective communication, decreases the need for travel, and allows for quicker decision-making. Similarly, employing AR on-site can assist contractors and workers in better understanding and following instructions, resulting in increased productivity and reduced errors (Vieira et al., 2017).

However, adopting VR and AR in the construction business has constraints and obstacles. For starters, the initial cost of the gear and software required for these technologies can be prohibitively expensive, particularly for smaller construction firms.

Furthermore, the knowledge and expertise required to operate and integrate modern technologies into current processes can be difficult to obtain. Furthermore, greater computer capacity and improved modelling approaches are required to enable real-time rendering and accurate representations of huge and complicated construction projects. To avoid any errors or misunderstandings, the correctness and dependability of the virtual representations must be ensured (Zhao & Lucas, 2019).Despite these obstacles, the importance of VR and AR in the construction industry cannot be overstated. They are valuable tools because they allow you to visualise and experience designs before they are implemented, improve collaboration and communication, and increase on-site accuracy and productivity. As technology advances and costs fall, the construction sector's adoption of VR and AR is likely to rise, benefiting both the industry and its stakeholders.

2.5 Robotics and automation in the construction industry

Robotics and automation have the potential to revolutionise the construction business. Their importance stems from the enhancement of productivity, safety, and efficiency in numerous construction processes. However, there are several restrictions and obstacles to consider (Jallow et al., 2022). The potential for increased productivity is one of the primary advantages of robotics and automation in construction. Robots can do repetitive and labour-intensive operations with pinpoint accuracy and speed, decreasing the demand for human labour.

Autonomous bricklaying robots, for example, can lay bricks faster and more correctly than people, resulting in shorter construction durations. Similarly, automated technology can be utilised to optimise the efficiency of tasks like as concrete pouring, demolition, and excavation. In addition to increasing productivity, robotics and automation can improve safety in the construction industry by replacing humans with machines for hazardous tasks such as working at heights or in confined spaces (Kirner et al., 2021). Autonomous machines and robots equipped with advanced sensors and AI capabilities can navigate complex construction sites and avoid potential hazards, which helps improve overall site safety and reduces the risk of accidents and injuries. Additionally, robotics and automation can improve construction quality and precision. The widespread use of physical labour can result in human errors, particularly in repetitive jobs (Yap et al., 2022). Robots, on the other hand, can deliver exact results on a consistent basis, guaranteeing that construction components are assembled precisely. This can contribute to increased structural integrity, enhanced energy efficiency, and superior overall quality in construction projects.

However, deploying robotics and automation in the construction business is fraught with difficulties. For starters, the initial cost of obtaining and maintaining robotic equipment can be prohibitively expensive, particularly for smaller construction enterprises. Furthermore, integrating these devices into current construction processes and workflows necessitates meticulous planning and coordination.

Another problem is the adaptability of robots and automation systems. Construction sites are different, and tasks differ greatly from one project to the next (Arowoiya et al., 2023). Developing versatile and flexible robotic systems capable of performing multiple building tasks effectively is a continuing industrial challenge.

Furthermore, the complexity of building sites, with their constantly changing environs, poses difficulties for autonomous robots. Humans continue to excel in navigating uneven terrain, adapting to unanticipated barriers, and dealing with unpredictable events. It is a big technological challenge to develop robots with advanced perception and decision-making ability to handle these changing settings (Oswald et al., 2021). Despite these obstacles, the importance of robotics and automation in the construction sector cannot be overstated. The opportunity to boost productivity, safety, and quality outweighs the drawbacks. As technology advances and costs fall, the use of robotics and automation in construction is projected to rise, revolutionising the sector and opening up new avenues for efficiency and innovation (Oke et al., 2022)

2.6 Prefabrication and modular designs in the construction industry

The relevance of prefabrication and modular designs in the construction industry cannot be overstated. These approaches offer significant benefits in terms of cost-effectiveness, quality control, and sustainability. However, there are also limitations and challenges associated with its implementation (Arowoiya et al., 2023). One of the key advantages of prefabrication and modular designs is their ability to streamline the construction process, resulting in time and cost savings. Prefabricated components are manufactured off-site in controlled environments, allowing for greater efficiency and shorter construction times (Chen & Wang, 2023). By standardising and assembling modules in a factory setting, construction projects can be completed more rapidly and with reduced labour costs (Aiyetan & Das, 2023).Furthermore, prefabrication and modular designs enable improved quality control (Oke et al., 2022).

In a factory-controlled environment, materials can be carefully selected and optimised for durability and performance. Quality can be consistently assessed and monitored throughout the manufacturing process, reducing the risk of construction defects or structural deficiencies. This leads to higher-quality construction projects with fewer issues and longer lifespans (Ninan et al., 2022). Additionally, prefabrication and modular designs offer opportunities for sustainable construction practices. The controlled manufacturing environment allows for better waste management and resource utilization. Precise material calculations result in reduced waste generation, and component production can be optimised to minimise environmental impact. By utilising standardised designs and efficient manufacturing processes, energy consumption can be reduced, and sustainable materials can be incorporated more easily (Ninan et al., 2022).

However, there are challenges and limitations associated with prefabrication and modular designs. Firstly, the initial investment in factory facilities and equipment can be substantial, especially for smaller construction companies (Yap et al., 2022). The cost of setting up and maintaining a factory may deter some firms from adopting prefabrication as a construction method. Additionally, the flexibility of design and customisation can be restricted in prefabricated and modular construction projects. Standardised module sizes and designs may not accommodate complex architectural features or unique site conditions. Customisation often requires additional engineering and design work, which can offset some of the time and cost advantages of prefabrication (Kirner et al., 2021).

Transportation logistics also pose challenges in prefabricated construction. Moving large modules or components from a manufacturing facility to the construction site requires careful planning and coordination. Access limitations, safety concerns, and higher transportation costs can arise with oversized or heavy prefabricated elements (Kim et al., 2020). Furthermore, prefabrication and modular designs may face resistance from traditional construction practices and stakeholders. A shift towards off-site manufacturing methods may require changes in construction processes, workforce skills, and regulatory frameworks. Overcoming resistance to change and promoting industry-wide adoption can be a significant obstacle (Zhao & Lucas, 2019).

Despite these challenges, the relevance of prefabrication and modular designs in the construction industry remains high (Li & Liu, 2019). The benefits, including cost savings, improved quality control, and sustainable practices, make these approaches attractive to the industry.

As technology advances and the industry becomes more receptive to off-site construction methods, prefabrication and modular designs are expected to play a growing role in meeting the demands of the construction sector (Magistretti & Dell'Era, 2019).

2.7 Drone technology in the construction industry

Drone technology's importance in the construction industry cannot be emphasised. Drones could transform various elements of construction, such as surveys, inspections, and monitoring. However, there are several restrictions and obstacles to consider. One of the most significant advantages of drones in construction is their capacity to acquire precise, high-resolution airborne imagery (Li & Liu, 2019). Drones outfitted with cameras and sensors can survey building sites swiftly and efficiently, providing extensive data for project planning and design. This information can be utilised to generate accurate topographic maps, 3D models, and point clouds, which will aid in visualisation and decision-making during the construction process.

Drones can also be used for inspections, especially in regions that are difficult or dangerous for humans to access. Drones can detect possible problems with roofs, facades, or infrastructure systems using thermal imaging cameras or other specialised technology (Hanssen, 2019). Drone inspections can save time and reduce worker safety concerns by eliminating the need for scaffolding or climbing at heights (Magistretti & Dell'Era, 2019). This results in increased safety and lower costs compared to previous inspection methods. In addition, drones can also be used to monitor building projects in real time, allowing for real-time assessment of progress and quality (Hanssen, 2019). They can take photographs and videos at regular intervals to follow changes on the site and determine whether development is in accordance with plans and specifications. This aids in the early identification and resolution of challenges, resulting in better project management and timely decision-making.

However, there are several drawbacks to drone technology in the building business. For starters, the usage of drones may be subject to regulatory limits and legal considerations (Aiyetan & Das, 2023). When flying drones on building sites, operators must follow airspace restrictions, obtain relevant permits, and consider privacy considerations. These restrictions can be complex and vary among countries, providing barriers to widespread implementation.

Furthermore, interpreting and analysing data gathered by drones might be difficult. Large volumes of aerial imagery and sensor data require sophisticated software and experience to process and analyse (Strieder et al., 2023). To extract valuable insights from drone-generated data, construction companies may need to invest in suitable equipment and personnel, which can be a hurdle for smaller firms. Furthermore, inclement weather, such as high winds or heavy rain, can hinder the use of drones on building sites. High winds or precipitation might impair flying stability and decrease data collecting quality. When considering drone utilisation in building projects, seasonal limits and restrictions on drone operations may need to be considered.

Despite these obstacles, drone technology has a considerable impact on the building business. Capturing aerial data, performing inspections, and monitoring building sites effectively and safely adds enormous value to the industry. Drones are likely to become more popular in construction as rules evolve and technology and data analysis skills advance, altering how projects are planned, executed, and monitored (Yap et al., 2022)

2.8 Empirical Framework

Various empirical studies were carried out, examining the role of innovative technology on construction company performance. These include the following.

2.8.1 Study by (Rajapathirana and Hui 2018)

(Rajapathirana and Hui, 2018) investigated the relationship between company performance, innovation type, and innovation capability in the Sri Lankan insurance business. The study used a quantitative research methodology, with structural equation modelling used to evaluate the research hypotheses. To assess innovation capability, innovation kind, and corporate performance, multiple variables collected from earlier literature were used. The study used a survey that was conducted between 2013 and 2016 and included 379 senior managers from insurance companies.

According to the study, innovation capabilities have a favourable impact on innovation, market, and corporate financial performance. These competencies included advances in organisational, product, process, and marketing.

It was proposed that efficient management of innovation capabilities, which might help develop more innovative outputs, could result in improved performance for the business's operations. Measurement of innovation activities focused on both organisational and technological factors. The conceptual framework of the study used four aspects to measure innovative activities: insurance product innovation, process innovation, marketing innovation, and organisational innovation. Businesses that manage their innovation capacity well, according to the study's findings, can develop more inventive solutions that lead to higher performance.

2.8.2 Study (Khan et al. 2022)

A research paper by (Khan et al. 2022) aimed to demonstrate that companies that generate innovative products can improve their performance in Indonesia and that companies with advanced technological capabilities can moderate the effects of product innovation on firm performance. Panel data from 261 annual reports of companies that revealed spending on R&D in Indonesia between 2015 and 2020 was used in the study. Khan et al. (2022) discovered that product innovation has a major impact on corporate performance but that technological capabilities can mitigate its impact. Efficient technological capability management can boost company performance. The study also emphasised the significance of various levels and types of product innovation, as well as technology capabilities, in satisfying various performance KPIs. However, the cross-sectional design made determining causal correlations difficult and neglected other elements influencing a company's performance.

2.8.3 Study by (Xichen et al.2021)

The research article by (Xichen et al.2021) examines twenty-six technologies used in construction projects and their benefits. The study examined 175 articles published between 2001 and 2020, with an emphasis on analytics, visualisation, communication, data collecting, and automation. The primary advantages include increased production, quality, sustainability, health and safety, and job efficiency. The study also discovered that, while innovation entails major costs and risks, it has the potential to increase corporate performance. The study encourages future research on the causes and contingencies of innovation but criticises its failure to consider other elements influencing a company's performance.

2.8.4 Study by (Agustia et al.2022)

The study by (Agustia et al.2022), looked at the relationship between firm performance and product innovation in the Australian construction industry. The study, which included two hundred businesses, employed STATA 14.0 in a structural equation modelling approach. The findings revealed that organisations with more R&D spending tend to be more profitable, whereas product innovation has a beneficial impact on company performance. However, technological capabilities can have a negative impact on corporate performance, with firms with more patent applications having poorer profitability. According to the study, while product innovation is important for enhancing performance, it must be balanced with technological capabilities. According to the study, future research should investigate different areas of innovation and performance, employ different measurements, and examine more moderating variables.

2.9.5 Study by (Ramadan et al. 2023)

(Ramadan et al. 2023) investigated the impact of technology use on workforce performance and information availability in the construction industry. The study included 2,780 front-line supervisors and employees in the United States. According to the study, numerous technologies, including information technology such as PCs, tablets, and smartwatches, increased worker performance and access to information. Material technology such as prefabricated components and modular buildings outperformed equipment technologies such as drones, robots, and 3D printers. The study suggests investing more in technology adoption to boost productivity and competitiveness. However, the study's dependence on self-reported data raises the possibility of bias and fails to account for other factors influencing performance and information access.

2.8.5 Study by (Van Wyk et al. 2021)

(Van Wyk et al. 2021) conducted research on the adoption of innovative technology in the South African construction industry. Data from twelve interviews and 101 questionnaires were used to examine the factors influencing technology adoption. The study discovered that organisational variables such as leadership, culture, strategy, and resources had the most impact.

Technology adoption was also influenced by technological criteria such as relative advantage, compatibility, and complexity. The research proposed a four-stage paradigm for increasing technology adoption.

2.8.7 Study by (Mazikana. 2019),

A study by (Mazikana,2019), looked at the impact of technology on Zimbabwean business performance across multiple industries. The study used secondary sources and a qualitative technique to discover that technology has a favourable impact on productivity, quality, customer satisfaction, and competitiveness. It did, however, disclose negative consequences such as higher prices, dangers, complexity, and cybercrime.The study concluded that technology is critical to corporate growth and profitability but urged businesses to be aware of potential risks and take proper precautions. Critics contend that the study relied on secondary data and failed to consider other factors influencing corporate success.

2.9 Literature Gap

On the empirical studies carried out, no study was carried out on the (Volatile, Uncertainty, Complex, Ambiguous) VUCA environment for example under the Covid Pandemic or economic recession. These empirical studies were carried globally in different countries focusing on variety of industry setup including construction industry but on the Zimbabwean context, few studies on that aspect were done and non was done on mining construction projects. Current literature either ignores the mining construction segment or concentrates on other regions or countries without providing a thorough analysis of various innovative technology types.

2.10 Conceptual Framework

The conceptual framework of this study is based on two variables, which are innovative technologies as the independent variable and Company performance as the dependent variable.

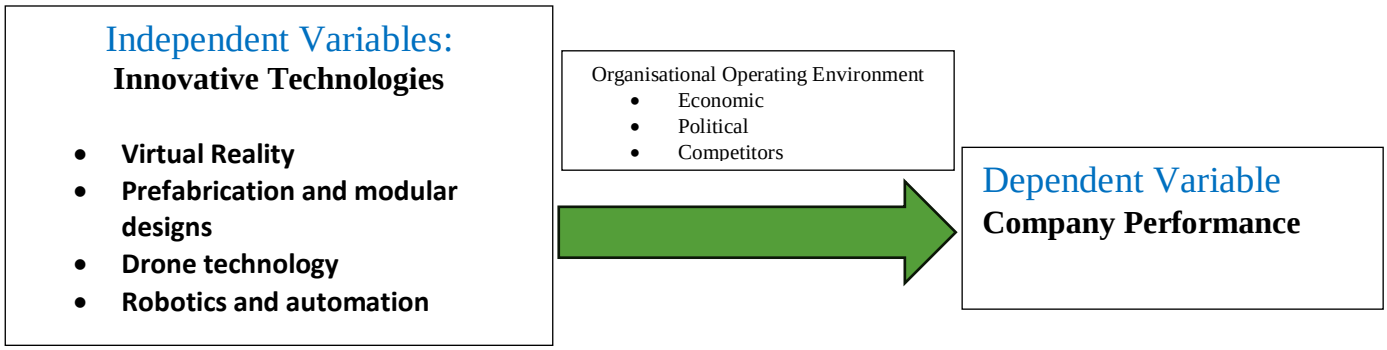


Figure 2.2 Relationship between innovative technologies and company performance
Source: Author (2023)

Innovative technologies affect the performance of companies. The input is the Innovative technologies which are the technical resources and capabilities that companies invest in to generate and implement innovative ideas, products, processes, or business models.

The output to the model is the results and achievements that companies obtain from their innovation and technological activities, these include financial performance, Operational performance, and Customer Satisfaction. The framework assumes that there is a positive relationship between innovation and technology inputs and performance outcomes.

2.11 Chapter summary

The chapter highlighted the various literature including theories related to this study. The Literature review explored empirical studies highlighting the different views from various authors on the role of innovation and technology on company performance. The Conceptual framework was also developed through the literature related to the study.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

The previous chapter focused on literature relating to the concept of innovative technology and how it influences the level of business performance in various industries and sectors of the economy most importantly mining construction. Literature was discussed from theoretical and empirical perspectives. The contribution of this chapter to the research is to provide a detailed methodological foundation for the empirical guidelines that determine the way in which data is collected, measured, and analysed. The chapter begins with a discussion of the research philosophy, which determines the appropriate research strategy and design to apply. The research population and the sampling strategy in terms of the sampling frame, sampling size, and sampling procedures are then analysed. The chapter goes further to critically analyse the data collection procedures, ethical considerations, research methodology limitations, and areas for improvement.

3.1 Research Philosophy

This research was meant to establish how leveraging innovative technology can enhance the business performance of companies in the construction industry. It implies that this study is abductive in nature as it combines quantitative and qualitative aspects. This research was looking at innovative technology application as the predictor variables and business performance as the dependent variable. It was considered necessary to apply positivism as an appropriate research philosophy to evaluate the relationship between these two research variables (Greener, 2022).

The philosophical foundations of positivism are based on the application of objectivity and empirical evidence in the determination of the relationship between innovative technology, and business performance. The utilisation of objectivity is instrumental in gathering data through the use of empirical measurements and observations (Schindler, 2022). It is essential to ensure that the study is based on factual evidence that can be confirmed by independent researchers. The use of evidence implies that the study minimises the use of personal subjective perceptions and opinions in establishing the relationship between research variables (Saunders et al., 2019).

Moreover, a positivism was selected since it encouraged the generalisation of research outcomes, which allows the research community to generate and grow broader conclusions about the impact of innovative technologies on business performance within the construction industry at large. In addition, the application of a positive research philosophy provides the structure for the approach to conducting the research through the facilitation of clarity of the relationships between research variables and ensuring that a systematic process of data collection, measurement, and analysis is undertaken (Bougie & Sekaran, 2019).

Nevertheless, in applying positive reasoning, the researcher was cognizant of the following shortcomings: Positivism assumes of a linear cause-and-effect association between innovation and business performance. This relationship might not fully capture the complexities of other contextual features that might affect the level of innovativeness or technology adoption within a business. Moreover, positivism tends to focus primarily on observable and measurable phenomena, potentially overlooking subjective experiences or qualitative aspects of the impact of technology on business performance in the construction industry (Bergh, 2021).

3.1.1 Research strategy

A research strategy is a mechanism that are put in place to ensure that relevant data is collected in a study which can enable the resolution of research objectives (Easterby-Smith et al., 2021). Within the context of this research, a survey research strategy was selected since it allows an efficient approach towards the collection of data from a sizable sample (Saunders et al., 2019). This made it suitable for the study to ascertain the impact of innovative technology on business performance through the collection of data from several respondents within the construction companies at Karo mine. Moreover, surveys are influential in the collection of data from a wide range of respondents which might include corporate representatives, contractor representatives and other stakeholders were interested in the operations of the construction industry in Zimbabwe.

Another merit associated with the use of a survey-based research strategy is that it provides opportunities for self-reporting which enables research participants to freely express their perspectives and opinions as well as experiences regarding technological innovation, its adoption, and the effects it has on the business performance of company's construction industry.

Moreover, surveys capture quantitative data which allow the study to analyse responses from a statistical perspective and draw precise conclusions about the impact of technological innovation on the business performance in the construction industry (Clark et al., 2021). By using a survey strategy, the collection of data might pinpoint specific aspects of innovative technology that might contribute to either an improvement or deterioration in the overall level of business performance in the construction industry.

Notwithstanding these benefits, the survey research strategy has some limitations. To start with, the fact that stuff is rely on self-reporting might introduce biased responses or the generation of inaccurate data (Bougie & Sekaran, 2019). Research participants might inaccurately recall or report their experiences which impairs the validity of research findings. In addition, the self-reporting perspective also suffers from targeting respondents who are outside the sampling frame (Walliman, 2021). Moreover, a survey strategy provides limited depth of understanding given that they are constrained by pre-determined questions and responses in terms of a structured research instrument. This implies that some important aspects regarding the impact of technology innovation on business performance might be left out when using standardized survey questions.

3.1.2 Research design

A research design provides guidelines that have to be followed in order to allow a study to generate outcomes that can resolve research objectives (Starostin, 2021). That can be applied in a study, which includes an explanatory research design, a descriptive research design, an exploratory research design, and an experimental research design. This study is based on the application of an explanatory research design since it is aimed at finding the cause and effective relationship between innovative technologies and business performance within the construction industry. This research design will enable the standard to investigate how innovative technologies can either positively or negatively affect different business performance metrics within the mining construction companies in Zimbabwe. This analysis is enabled by the ability of an explanatory research design to permit the utilisation of mathematical principles in the determination of the relationship between research variables.
In addition, the application of an explanatory research design assists in the establishment of a sound theoretical foundation that focuses on explaining why certain research findings might be okay, especially when focusing on the link between innovative technology and business performance in the construction industry.

Through the exploration of these relationships, they can uncover valuable insights with respect to the magnitude and direction of the relationship that exists between innovative technology and business performance. This is again assisted by the utilisation of statistical techniques such as correlation and regression techniques in the determination of the magnitude and direction of statistical significance between the research variables under consideration.

Despite the usefulness and relevance of applying an explanatory research design within the framework of this study, it has some shortcomings that might limit its apparent relevance. To start with, the explanatory research design might be limited with respect to the real-time applications or longitudinal insights that it fails to create. This is because the explanatory research design emphasises explaining the causes of relationships. The research design fails to capture changes or evolving dynamics over time. The scope of an explanatory research design is also limited, especially when it comes to undertaking complex investigations with multiple interconnected factors. Within the context of this research, the impact of innovative technology on business performance in the construction industry might be influenced by a multitude of factors. This makes it difficult to isolate cause-and-effect relationships, as explained by the explanatory research design.

3.2 Research Population

A research population is composed of the total number of elements of people who are of interest to a researcher (Smith, 2020). Within the context of this research, the research population is composed of 258 number of employees who are both permanent and non-permanent at the four construction companies at Karo mine that may be asked about company business performance through innovative technology implementation. This includes the management team, supervision team, operational staff `and supporting staff.

Table 1: Research population, target population and sample for the study.

	Masimba Holdings Limited	Topspin International	Tensor Systems	JRG Contracting
Total Employees(Permanent &Non Permanent	415	312	136	206
Target Population (Permanent Employees eg Managers ,Supervision and Artisans)	113	79	57	63
Sample per Company	88	66	50	54
(i) Interviews of Site Management	8	6	4	4
ii) Questionaires for non managerial staff	80	60	46	50

3.3 Target Population

In research, the group of individuals or items that are the focus of a study is referred to as the target population. It can also be referred as the unit of analysis, in this study the target population is the permanent employees of the respective companies, which are the management, supervisory and artisan employees.

3.3.1 Sample size

A sample is a representative of the population which is selected since it is similar characteristics and distribution is they are configured in the population (Mexon & Amanda, 2020).

A sample size was determined through the use of statistical methods, which were meant to ensure that all elements within the unit of analysis had a mathematical chance of being selected to represent the population (Patel & Patel, 2019). The sample size was determined based on statistical considerations such as the desired confidence level, effect size, and the level of precision required. It was important to ensure that the sample size was sufficiently large to provide adequate statistical power and representativeness. The application of statistical computation of the sample size was operationalized using the Yamanne formula, which is depicted as follows:

$$\text{Sample size} = N \div (1 + N \times (e)^2)$$

Where, N = the population of the study
e = the margin error in the calculation

$$\text{Sample size} = 425 \div (1 + 425 \times 0.05^2)$$

Sample size = 206 respondents

3.4 Sampling Frame

A sample from the sampling frame is the unit of analysis for research (Atkinson et al., 2021). Broadly, the unit of analysis is composed of individual employees from four companies that are engaged in construction activities at Karo Platinum Mine. In determining the sampling frame for this research, the researcher developed a comprehensive list of potential participants from the target population.

This involved consulting company databases and Karo mine attendance registers. The ultimate result of determining the sampling frame culminated from the selection of companies, including Masimba Holdings Limited, JRG Contracting, Topspin International, and Tensor Systems Construction. The research variables in this study, namely innovative technology, and business performance, were assessed as they relate to these four mining companies operating at Karo platinum mine in Ngezi-Mhondoro district. More specifically, the unit of analysis incorporates the actual respondents, who are the employees extracted from these four mining companies. These employees were the focus of attention regarding the actual collection of data.

3.4.1 Sampling strategies.

There are two main sampling strategies that can be used in research: the probability sampling approach and the non-probability sampling approach (Saunders et al., 2019). Probability sampling techniques, such as stratified random sampling or cluster sampling, can be used to maintain the integrity of the study and ensure that all members of the target population have an equal chance of being selected (Bougie & Sekaran, 2019). Given the strong quantitative foundations of this research, a probability sampling approach was utilised to select representative elements within the population. Probability sampling, which was operationalized through the application of a stratified sampling strategy that required the categorization of respondents into different classifications,

3.4.2 Sampling procedures

Respondents from Masimba Construction, Topspin International, Tensor system and JRG Contracting comprised the categories of construction companies operating at Karo mine that formed the basis for the operationalization of stratified random sampling. The sampling procedure involved selecting a proportional number of representatives from each of the four construction companies operating at Karo mine, which was used for the purposes of determining the sampling quota.

Part of this approach was necessary to ensure that there was proportional representation from each of the four companies in relation to their size in terms of the number of employees they have. The use of the proportional sampling approach was also necessary to minimise bias in the presentation of representatives from either of the two construction companies operating at Karo mine.

3.5 Instruments piloting

It was essential to pre-test the questionnaire prior to its distribution to a cross-section of employees in the construction companies operating at Karo mine under consideration. Pretesting was done in order to ensure that there were no misconceptions that might arise from responding to the questionnaire (Sreejesh et al., 2014). It was also essential to ensure that the questionnaire was clear and concise and used appropriate language that could be clearly understood by perspective research participants. To conduct (Adams et al., 2012)a pilot study, an example of the questionnaire was distributed to 10 construction workers. Their input and feedback with respect to the type of questions and whether they had any misunderstandings on any question were taken into consideration to further improve the questionnaire so that it could relate to the targeted respondents. Finally, the questionnaire was designed so that it could resonate with and relate to the diversity of construction workers who have various levels of education, working experience, gender, and technology aptitude.

3.6 Data collection procedures

For the purpose of this research, data was collected through a variety of methods that comprised the use of observations, key informant interviews, and the distribution of questionnaires (Schindler, 2022). Observations were instrumental in assisting the researcher in appreciating the extent of innovative technological advancement with respect to the equipment that was used by construction companies operating at Karo mine in their operational activities. The extent of technological advancement was decided upon on the basis of comparing the type of equipment that construction companies operating at Karo mine use in relation to the modern equipment that is available to do such activities (Sepasgozaar et al., 2017).

Upon making observations, it was necessary for the interviewer to undertake key informant interviews with site management team which comprises of project managers, engineers, surveyors, supervisors and SHEQ officers who are responsible for construction activities at the Karo mine. Key informant interviews were considered essential since they provided key insights into the detailed nature of construction activities that take place within the mining environment and the type of sophisticated equipment that construction companies operating at Karo mine were using. These interviews also informed the study with regards to the state of preparedness of the construction companies operating at Karo mine towards using advanced technologies that can enhance the overall performance of their business activities (Hamidreza et al., 2018).

In addition, it was also essential to distribute a structured questionnaire, which was used as the template for assessing the extent of awareness of different technologies that are used in mining construction. The questionnaire was able to gather data that could help in classifying the state of preparedness of construction companies operating at Karo mine for the application of innovative technologies within the construction industry.

Moreover, the questionnaire was instrumental in helping the study understand the demographic backgrounds of respondents in terms of their level of education and level of training in awareness of the use of various technologies in construction. These factors were considered useful as they can potentially affect the proclivity with which the construction industry is prepared to make use of recent technological innovations.

Overall, the study utilised three approaches in the collection of data, which included observations of operational activities that are being done with regards to how mechanised they are in relation to the application of recent technologies and innovations. The use of key informant interviews to get deep insights into the state of preparedness of the construction companies operating at Karo mine regarding the utilisation of recent technological innovations Thirdly, the application of questionnaires that were distributed to employees who worked for the construction companies operating at Karo mine at Karo Mine with the view of appreciating their aptitude levels and technology literacy with respect to the application of various innovations essential to enhancing the competitiveness of their business activities

3.7 Hypothesis testing

In this research, hypotheses were tested at a 95% confidence interval to ascertain the extent to which the adoption of technology and innovation within the construction industry is attributed to changes in business performance and key performance indicators. In terms of profitability, market share, revenue generation, and cost minimization, a combination of correlation and regression statistics were used since these generated a significance level that is compared to the critical value of 0.05, the result of which was used as the basis for either refuting or confirming the research hypothesis or whether technology and innovation adoption have statistically significant effects on the magnitude of business performance within the construction industry.

3.8 Ethical considerations

Part of this study required interaction with human beings to collect data. It was therefore of paramount importance for the researcher to observe acceptable research ethics in the conduct of collecting data involving people. The first ethical consideration that was taken in was the need to get express authorization to undertake this study. Karo mining environments are highly regulated and require that anyone who is willing to conduct business or research within the mind get express authorization from management. This authorization was applied for and was granted by management. That was the first ethics of access that was considered in this research.

3.8.1 Informed consent

The second ethics of access was to gain access to the actual respondents within the Karo mining construction companies operating at Karo mine, who included employees and management. In this regard, ethical consideration of informed consent was sought. These ethical considerations demanded that the researcher head clarify the justifications behind undertaking the study and seek the express consent of perspective research participants (Eisend & Kuss, 2019). The researcher also had the duty to explain the expected roles and responsibilities that different research participants had to play in the entire data collection process (Saunders et al., 2019). This included explaining the need for employees to fill out questionnaires and for selected members of management to undertake key informant interviews upon reaching an agreement with the participants. Data was collected by using questionnaires and interviews.

3.8.2 Protection against harm

The researcher had an ethical responsibility to protect research participants against emotional and physical harm associated with their decision to take part in the data collection process. Mining environments are inherent with a lot of risks. It was the responsibility of the researcher to ensure that research participants, particularly employees, were not expected to respond to the questionnaire whilst conducting their duties since this could potentially result in occupational hazards and risks to the life and welfare of the research participants (Bougie & Sekaran, 2019). The researcher assured that the research participants could only respond to the questionnaire at their convenience and in their spare time.

So that they are not exposed to any form of harm aid, such as bodily injury or sanctions at work, is a result of undertaking the data collection process, and in addition, it was the responsibility of the researcher to distribute and collect the completed questionnaires from the research participants. This was necessary so that participants were not expected to make any financial commitments after the completion of the research process.

3.8.3 Protection of privacy and confidentiality

The researcher had the duty to respect and protect the privacy of research participants (Chivanga & Monyai, 2021). This ensured that the data collection instruments were not supposed to collect any personal information that was beyond the scope of the research objectives. As such, the questionnaire in the interview did not collect personal information such as the name, the same name, or the contact details of respondents since this was not considered essential for the completion of research objectives. Categorical data questions were asked, such as the collection of data on the edge groups of respondents rather than the stipulation of a specific age and the collection of data on the experience level of research participants rather than a specific degree or diploma qualifications. This was an essential search to ensure that the privacy of research participants was maintained. In the data analysis stage, particularly for interviews, pseudonyms were used with respect to the actual names and designations of respondents.

The agreement between the researcher and research participants was based on the principle of confidence (Eisend & Kuss, 2019). It was imperative for the researcher to protect the rights of research participants to their confidentiality. This meant that any data that was collected or any information that was shared by research participants for the purposes of completing this study was not shared with any other person or third-party organisation without the express consent of the research participants.

3.8.4 Justice

The ethical principle of justice specifies that the researcher has to use overt methods of undertaking the research and not embark on deceptive approaches to collecting data (Saunders et al., 2019). It was implied that the collection of data was done in stages, and all the participants were aware of each of the stages. The first stage in the data collection process included observations by the researcher on various equipment and technologies that mining companies used.

The second stage incorporated key informant interviews with management, and the final stage included the collection of data using a questionnaire involving employees. The principle of justice was meant to ensure that no one had to take the study without knowing the reasons for undertaking the research and the actions they were supposed to perform.

3.8.5 Research methodology limitations

One of the main limitations of the research methodology applied in this study was that it was specifically focused on certain mining environments, which implied that the research results that we generated in this specific mining environment may not necessarily apply to the general construction environment. Platinum is a high-value mineral and requires sophisticated methods of mining and construction. Therefore, the state of technology and innovation that construction companies operating at Karo mine are in such an environment which is expected to differ from those operating in other sectors of the economy. This limitation is intended to affect the generalizability of research results.

3.9 Recommendations for improvements

To improve the applicability of research findings, it may be necessary to undertake cross-sectional research that focuses on the comparative analysis of different technologies that are required in different sectors of the economy. Such a competitive analysis will make it possible for the research to derive more valid and reliable outcomes with regards to the minimum base technology and innovations that a competent construction company is supposed to possess and utilise to enhance their level of business performance within the area of construction.

Moreover, conducting a longitudinal study can enhance the level of understanding regarding the different technologies that are required to enhance the dynamic capabilities of construction companies operating at Karo mine. This comes out of the realisation that new technologies are being launched and order technology is being faced out; therefore, understanding the full impact of technology and innovation requires a longitudinal study, which also falls in line with the dynamic capabilities' principle, which specifies that the competitive advantage arising from the utilisation of technologies is not static but evolving.

3.10 Chapter summary

The principle of contribution of this chapter to the research was to establish a research methodological framework guided by the application of a positivist philosophy to select appropriate research design and research strategy. This culminated in the generation of research findings that are a valid and reliable account of the state of technology and innovation adoption within the construction industry in Zimbabwe. The chapter also articulated the methods that we utilised in the selection of a representative sample and the measures that we took into consideration for the research instruments as a quality control mechanism to enhance the validity and reliability of research findings. The research ethics we also considered in this chapter is that they set up the key parameters that had to be observed in the generation of data, which respects the sanctity of human beings that participated in this study. The one-coming chapter is responsible for the presentation analysis in discussions of research findings relating to the impact that technology and innovation have on business performance amongst mining companies.

CHAPTER 4

DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

4.0 Introduction

The last chapter was a comprehensive methodological framework that provided guidance to this chapter regarding the utilisation of empirical approaches in collecting, measuring, and analysing data. This chapter follows up to present, analyse, and discuss research findings with respect to a study focusing on the influence of innovative technologies on the business performance of companies in the construction industry. The chapter begins with an outline of the responses that were received from respondents to the study. Descriptive statistics in the form of the biodata of respondents with respect to their age groups, highest level of education, profession, gender, and working experience were then analysed. The relationship between innovative technologies and business performance amongst construction companies operating at Karo mine was explained using a combination of regression and correlation tests. This culminates in the summary of research hypotheses, the discussion of research findings in relation to existing literature, and a chapter summary.

4.1 Analysis of responses

An analysis of the responses to the questionnaire provides an overview of the type of responses that we received in respect of the question is that were distributed. This is used as an indication of the overall validity of research results. Overall responses to the questionnaire are shown in table 4.1.

Table 4.1: Questionnaire responses

		Responses received	Response rate
Questionnaire distributed	236	196	83.05%
Interviews requested	22	17	77.27%

The overall questionnaire response rate of 83.05% and that of interviews of 77.27% indicates that a substantial proportion of the target population (from construction companies operating at Karo mine in Zimbabwe) participated in the study.

This increases the likelihood that the findings and conclusions drawn from the study will accurately reflect the views and experiences of the population. With a high response rate, the results obtained from the study can be considered more representative of the broader population. The findings can be generalised to other construction companies operating in Zimbabwe as well as to construction industries in other countries with similar contexts.

Higher response rates improve the reliability and validity of the study's findings. A greater number of responses means a larger pool of data, which increases statistical power and decreases the possibility of chance findings. This enhances the confidence researchers can have in the results obtained. Non-response bias occurs when participants who decline to participate in a study differ systematically from those who do, leading to biased results. A high response rate reduces the potential for non-response bias, as the proportion of non-respondents is smaller. This strengthens the validity of the study and the accuracy of the conclusions drawn.

A higher response rate translates to a larger dataset with more responses. This provides researchers with a broader range of data points and potentially more diverse perspectives, which can lead to deeper insights and more robust conclusions. Higher response rates improve the statistical power of the study. A larger sample size obtained from a higher response rate can help detect significant relationships or effects that might have gone unnoticed with a smaller sample. This strengthens the study's ability to detect meaningful associations between variables.

Overall, a high response rate boosts the confidence researchers can have in the study's findings. It demonstrates that research participants were engaged and motivated, thereby increasing the likelihood that the data collected is reliable and representative. It is important to note that while a high response rate is desirable, it does not ensure the absence of bias or guarantee the study's findings are applicable in all contexts. Researchers should consider other factors, such as the representativeness of the respondents, potential non-respondent characteristics, and limitations of the study, to fully assess the research implications.

4.2 Demographics of research participants

The purpose of using demographics of research participants was to understand the profiles of respondents from construction companies operating at Karo Mine in relation to their age groups, highest levels of education, working experience and the gender dimension.

4.2.1 Age groups

The research implications of the distribution of respondents in different age groups in a study focusing on the influence of innovative technologies on the business performance of the construction companies operating at Karo Mine can provide some insights:

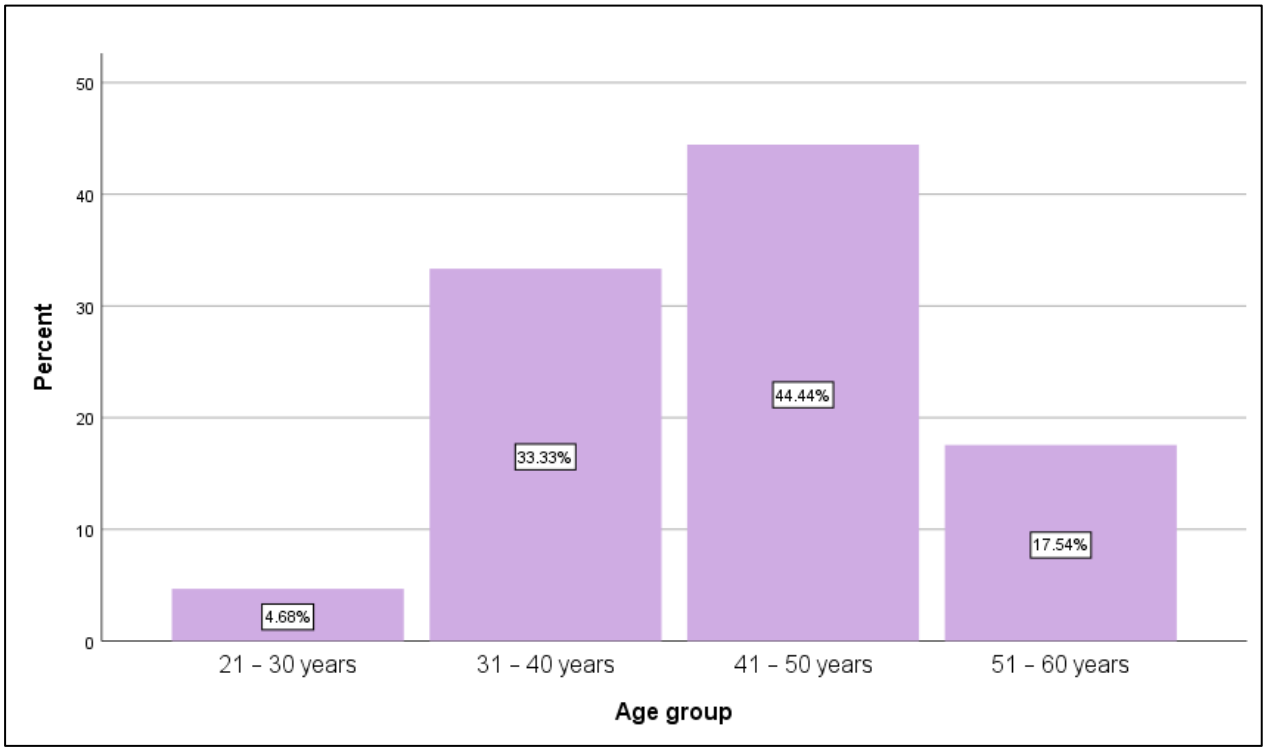


Figure 4.1: Age group

According to the distribution, the study may require addressing the potential impact of age on perception and adoption of innovative technology in the construction business. Different age groups may have different amounts of exposure, experience, and attitudes towards innovative technology, which may influence the research outcomes. The higher percentage of responders aged 41 to 60 years old shows that the study can benefit from their skills and experience. Their opinions and recommendations on the usage of innovative technology and their influence on corporate performance of construction companies operating at Karo Mine.

The significantly lower percentage of respondents between the ages of 21 and 30 shows a potential gap in comprehending the younger generation's involvement with or opinion on emerging technologies. Investigating the causes for this lower representation can aid in identifying any impediments or issues that younger workers find when embracing or utilising technology amongst construction companies operating at Karo Mine. The existence of a sizable number of senior respondents (aged 41 to 60 years) may provide an opportunity to investigate the Karo mine construction industry's lifespan and adaptability in absorbing innovative technologies. Understanding how these technologies have evolved and how workers have adapted to them over time can provide valuable insights for future strategies and implementation plans. The research might also look on the availability and effectiveness of recent technology training programmes in the construction industry. A broad age distribution can assist in determining if training courses cater to the various learning styles and preferences of different age groups, ensuring successful implementation and performance improvement.

The age distribution of respondents in the study implies the importance of considering generational differences, experience, expertise, and training as key factors that may influence the adoption and impact of innovative technologies in the construction companies operating at Karo Mine.

4.2.2 Gender

It is crucial to determine if the gender distribution of respondents has an influence on the research's findings regarding the effect of innovative technologies on business performance.

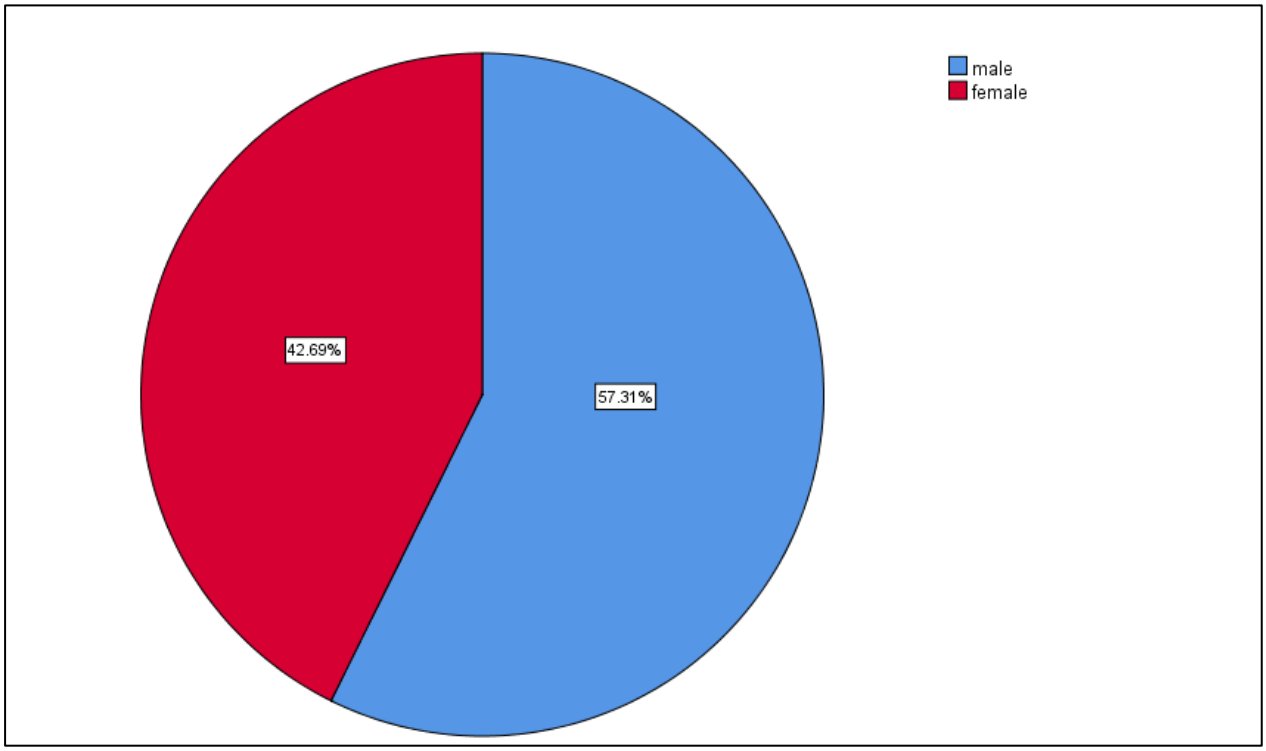


Figure 4.2: Gender

The research implications of males constituting 57.31% of respondents in the study sample may limit the generalizability of the findings to the total population of construction enterprises. To guarantee that the results are representative and applicable to a broader context, a diverse range of participants must be included. The male-dominated sample could have consequences for understanding gendered perspectives on the adoption and use of innovative technologies in construction companies. This could have an impact on how the data is interpreted, either masking or ignoring the unique obstacles or possibilities that women face in the field.

The findings of the study may necessitate additional research to see whether the Impacts of innovative technologies on corporate performance are constant across genders. Analysing the potential gender-specific effects of these technologies can assist in identifying areas where actions or support are required to close any existing gaps. The mismatch in gender representation emphasises the importance of future research focusing on creating a more representative sample with a higher proportion of females.

By considering the different viewpoints and experiences of both men and women, this would allow for a more thorough understanding of how innovative technologies effect business performance in construction organisations.

To enhance the robustness and applicability of the study's findings, researchers should consider making efforts to achieve a more balanced gender representation in the sample. Additionally, future studies could explore the reasons behind the gender disparity in participation and seek to identify any underlying social or cultural factors that may contribute to it.

4.2.3 Education

The distribution of education levels among participants in the study highlights the significance of various educational qualifications. While bachelor's degrees and certificates hold the highest proportions, the inclusion of other levels of education ensures a diverse range of perspectives and expertise, contributing to a more comprehensive analysis of the subject matter.

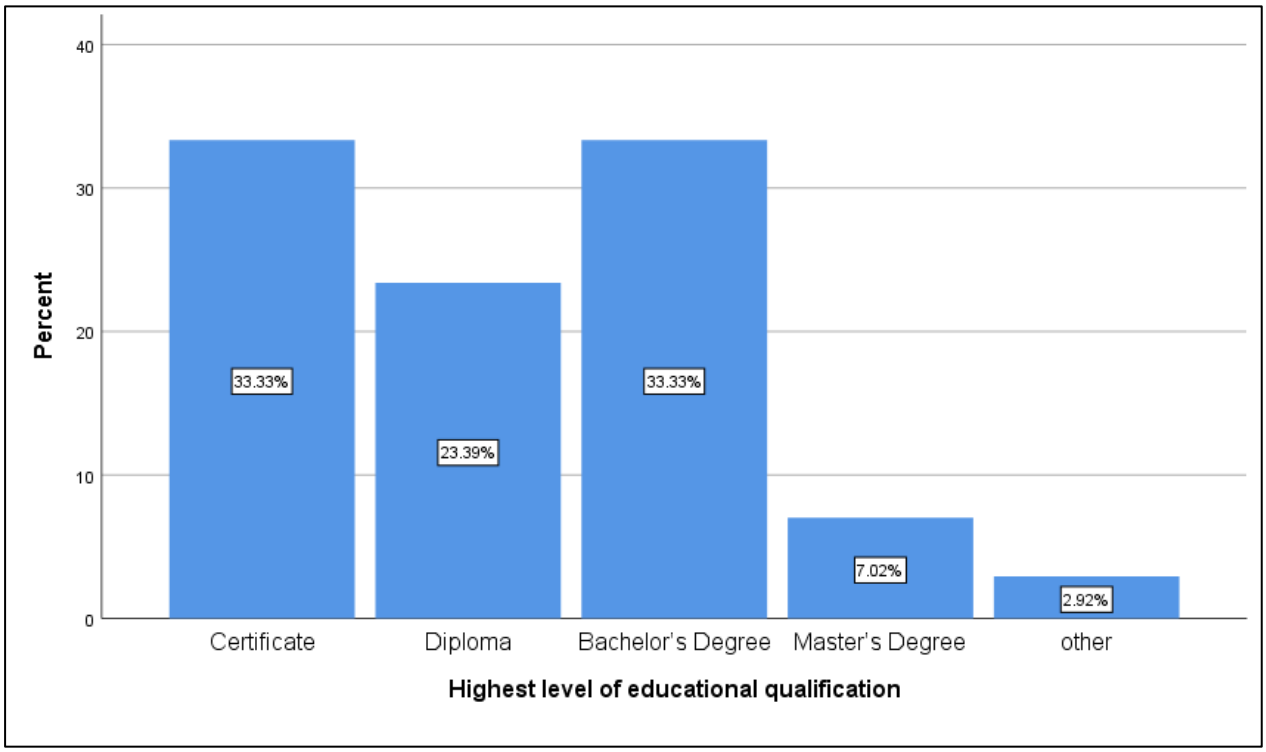


Figure 4.3: Education levels

Research results indicate that 33.33% of research participants held a certificate. This level of education indicates that a sizeable portion of participants have obtained specialised training or education in a specific area of construction or technological innovation.

While not as comprehensive as higher degrees, certificates can still signify a certain level of proficiency and understanding of the subject matter. Diploma holders (23.39%) suggest that a portion of participants have received formal training in construction or related fields. Diploma programmes often provide more in-depth knowledge and practical skills compared to certificates, making them valuable in the context of the study.

A bachelor's degree (33.33%) implies that a considerable number of individuals have completed a higher education programme in construction or related disciplines. This level of education typically reflects a broader academic foundation and a more comprehensive understanding of the field. Master's degrees (7.02%) were likely to have specialised knowledge and expertise in construction and innovative technologies. Master's programmes offer advanced coursework and research opportunities, indicating a higher level of competence and potential for in-depth analysis in the study.

Other (2.92%) categories may include participants with diverse educational backgrounds, such as professional certifications or industry-specific training. Although the percentage is small, participants with "other" qualifications could bring unique perspectives or specialised knowledge to the study, which can be valuable in understanding the impact of innovative technologies on business performance in the construction industry.

4.2.4 Experience

The experience of research participants is an indication of the extent to which they are familiar with the application of different innovative technologies in the construction industry that can be leveraged to improve the overall level of business performance amongst construction companies operating at Karo mine. The presentation of results with respect to the experience of research participants are shown in Figure 4.4

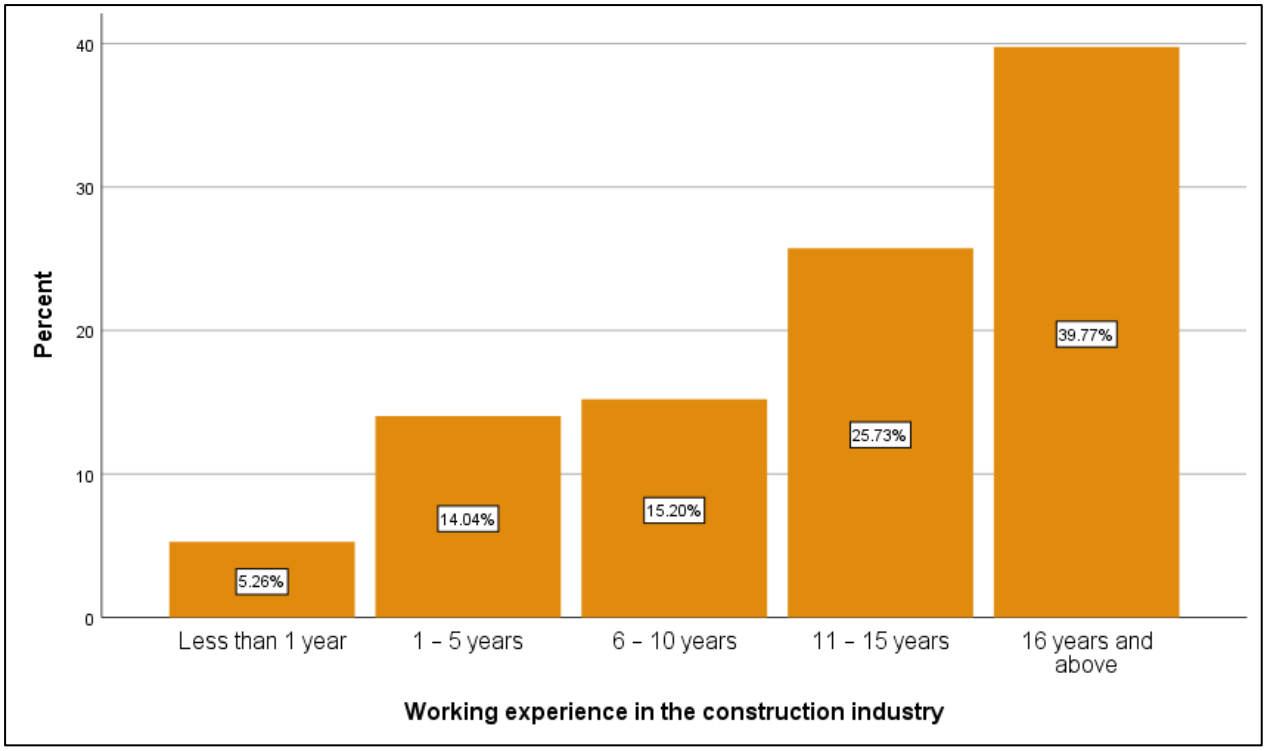


Figure 4.4: Experience

The frequency of respondents in terms of the longevity of working experience in the construction industry appeared to rise proportionally with the increase in the number of years. Must research participants, who made up 39.77%, indicated that they had 16 years and above of experience in the construction industry.

Responses from these research participants can provide a longitudinal appreciation of the different innovative technologies that are launched in a in construction to improve the operational viability and performance of companies in the construction industry. Only 5.26% of research participants indicated that they had less than one year of experience in the construction industry. These were graduate trainees and other new employees who are yet to appreciate and build familiarity with different technologies that are used in the construction industry.

4.3 Key informant interview insights

4.3.1 Theme 1: current state of technology adoption in the Zimbabwean construction industry

The main imports from the first theme highlight that the Zimbabwean construction industry is embracing modern technologies to improve collaboration, reduce errors, and optimize project scheduling and costs. Building Information Modelling (BIM) is gaining momentum, with prefabricated building components and modular construction techniques becoming more prevalent. Sustainable construction practices are also being incorporated, with green building technologies and materials minimizing environmental impact. Construction management software and tools are being adopted, enabling real-time data access and remote project management. However, Zimbabwe's technology adoption still lags that of more developed countries, with barriers such as limited capital, lack of awareness, and resistance to change. Skilled professionals in the industry are also needed for technological applications. Government initiatives, industry associations, and educational institutions can promote technology adoption through incentives, capacity-building programs, and knowledge-sharing platforms. As awareness grows and barriers are addressed, there is potential for significant advancements in technology to drive positive change and innovation in the Zimbabwean construction sector.

4.3.2 Theme 2: The extent of using virtual reality

The main imports from the second theme highlight that construction companies at Karo Mine in Zimbabwe are increasingly using virtual reality (VR) technology to improve design visualization, collaboration, safety training, and project planning. VR allows for immersive 3D visualization of construction designs, enabling stakeholders to experience and interact with the design before physical construction begins. It facilitates better communication with stakeholders, allowing for informed decisions based on shared vision. VR also provides immersive safety training experiences for construction workers, allowing them to practice safety protocols and navigate complex construction environments. Remote collaboration among construction teams and architects is also possible. VR can also be used for marketing and pre-sales, showcasing planned infrastructure in a realistic and interactive manner. Factors influencing VR adoption include industry awareness, technology infrastructure, project scale and complexity, and regulatory and operational considerations.

To assess the current extent of VR utilization, it is essential to engage with construction companies, stakeholders, and technology providers to understand their specific use cases, challenges, and successes in implementing VR solutions.

4.3.3 Theme 3: The use of prefabrication and modular designs in construction

The main imports from the third theme highlight that prefabrication and modular construction methods can significantly improve efficiency, cost-effectiveness, and sustainability in construction projects, such as those at Karo Mine in Zimbabwe. These methods allow for faster construction, reduced on-site work, and improved quality control. They also contribute to environmental sustainability by reducing material waste, optimizing energy use, and minimizing site disruption. Modular designs offer flexibility and scalability, allowing for rapid customization and adaptation to specific project requirements. Off-site prefabrication can improve on-site safety by reducing high-risk construction activities and minimizing labour exposure to hazards. The effectiveness of these methods depends on factors such as technology and manufacturing capacity, project scale and complexity, supply chain and logistics, and regulatory considerations. A comprehensive evaluation of ongoing construction projects, engagement with construction companies, and insights from industry experts and stakeholders can provide a deeper understanding of the impact and potential of prefabrication and modular construction in the context of Karo Mine.

4.3.4 Theme 4: the use of drone technology

The main insights from the fourth theme highlight that drone technology had significantly improved resource utilization in construction companies at Karo Mine in Zimbabwe. These drones offer enhanced surveying, monitoring, and data collection capabilities, enabling efficient planning and allocation of resources. They facilitate regular site inspections, enabling real-time assessment of resource utilization. Drones also optimize resource deployment, leading to greater efficiency and cost-effectiveness. They aid in project planning and coordination, providing accurate spatial data and 3D modelling. They also contribute to safety and risk mitigation by enabling remote inspection of hazardous areas. Drones also aid in environmental monitoring, enabling better management of natural resources and mitigating environmental concerns. To fully utilize drone technology, construction companies operating at Karo Mine invest in technology integration and training, develop robust data management systems, comply with local aviation regulations, and maintain clear communication between teams, drone operators, and stakeholders.

Scalability and adaptability are also crucial for drone technology to remain scalable and adaptable to changing project requirements. The adoption of drone technology has transformed resource utilization, enhanced project efficiency and making informed decisions that contribute to the overall success of construction projects.

4.3.5 Theme 5: The current state of robotics and automation among construction

The main import from the fifth theme highlights that the adoption of robotics and automation in construction at Karo Mine in Zimbabwe is a growing trend, aiming to improve operational efficiency, safety, and productivity. This includes the use of robotic construction equipment, 3D printing technology, unmanned aerial vehicles (UAVs), autonomous vehicles and machinery, Building Information Modelling (BIM) and automation software, prefabrication, and modular construction techniques, and IoT and smart construction technologies. These technologies are enabling faster, more accurate fabrication of building components, reducing material waste, and maximizing resource utilization. To fully utilize these technologies, companies should consider strategic planning and investment, workforce training and skills development, collaboration with technology providers, regulatory compliance and safety standards, and continuous innovation and adaptation. By embracing these technologies, construction companies operating at Karo mine enhance their competitive edge, improve project outcomes, and contribute to the overall advancement of the construction sector in Zimbabwe. By embracing these technologies, construction companies operating at Karo mine enhance their competitive edge and contribute to the overall advancement of the construction sector.

4.4 Descriptive statistics

Descriptive statistics were instrumental in explaining the current situation regarding the level of innovative technologies that are used by construction companies operating at Karo mine to improve business performance. This included the application of virtual reality, prefabrication, and modular designs, during technologies as well as robotics and automation.

4.4.1 Virtual reality influences the cost performance.

VR can revolutionize various aspects of the construction industry by enabling immersive experiences and simulations.

Table 4.2: Virtual reality

	Mean score	Mean	Std. Dev
Virtual and augmented reality technology has significantly improved the visualization and design analysis capabilities in the construction industry.	Agree	3.68	1.088
The use of virtual and augmented reality has enhanced collaboration among different construction disciplines, leading to more efficient project management.	Agree	4.14	.870
Virtual and augmented reality have increased safety awareness and improved safety training for construction workers.	Agree	3.76	1.082
The implementation of virtual and augmented reality technology has positively impacted the construction industry in terms of reducing errors and rework during the construction process.	Agree	4.41	.725
Valid N =171			

Descriptive statistics indicate that most respondents agreed with statements that were meant to measure the extent to which feature reality can contribute towards business performance amongst construction companies operating at Karo mine.

This is shown by the mean scores that ranged from 3.68 to 4.41, with the standard deviation arranging from 0.725 to 1.088. These statistics imply that virtual and augmented reality technology has enhanced visualization and design analysis in the construction industry, facilitated collaboration among disciplines, improved safety awareness, and reduced errors and rework, thereby enhancing project management and safety.

4.4.2 Prefabrication and modular designs and the profitability

Prefabrication and modular designs involve constructing components off-site in a controlled environment, then assembling them on-site.

Table 4.3: Prefabrication and modular designs

	Mean score	Mean	Std. Dev
The use of prefabrication and modular design has improved the efficiency and speed of construction projects in the industry.	Strongly Agree	4.56	.703
Prefabrication and modular design have enhanced the quality and consistency of construction processes and outcomes.	Agree	3.97	1.026
The adoption of prefabrication and modular design has led to cost savings and increased profitability for construction projects.	Agree	4.47	.849
Prefabrication and modular design have streamlined the construction industry and reduced the environmental impact of construction activities.	Agree	3.92	.908
Valid N =171			

Most respondents agreed that prefabrication and modular design have significantly enhanced construction efficiency, speed, quality, cost savings, profitability, and environmental impact, thereby reducing the environmental impact of construction projects. The business implications of these research findings indicate that prefabrication and modular designs approaches offer various advantages, such as reduced construction time, improved quality control, cost savings, and less disruption to local communities. Prefabricated elements can be manufactured more efficiently using automation and robotics, ensuring precise dimensions and high-quality construction. This approach is particularly relevant in fast-paced urban environments where minimizing on-site construction time and disruption is essential. Current research findings are in support of existing literature which indicates that.

4.4.3 Drone technology and efficient resource utilisation

Descriptive statistics shown in table 4.4 indicates the description of situation regarding the use of drone technologies amongst construction companies operating at Karo mine.

Table 4.4: Drone Technology

	Mean score	Mean	Std. Dev
Drone technology has significantly improved the efficiency and speed of surveying and mapping in the construction industry.	Agree	3.92	.929
The use of drone technology has enhanced the safety and security of construction sites and workers.	Agree	3.65	.871
Drone technology has led to cost savings and increased productivity in construction projects.	Indifferent	3.42	.993
The adoption of drone technology has improved the accuracy and quality of data collection and analysis in the construction industry.	Indifferent	3.32	.956
Valid N =171			

Overall, the respondents tend to agree that drone technology had a positive impact on the construction companies operating at Karo mine, with the highest agreement on the efficiency and speed of surveying and mapping. There is a slightly lower level of agreement on the cost savings and increased productivity aspect, and a more indifferent attitude towards the improvement of accuracy and quality of data collection and analysis. The use of drone technology enhancing safety and security also received a prominent level of agreement.

4.4.4 Robotics and automation and the productivity

Robotics and automation technologies have the potential to revolutionize construction processes, especially for repetitive tasks with high accuracy requirements.

Table 4.5: Robotics and automation

	Mean score	Mean	Std. Dev
The use of robotics and automation has increased the speed and efficiency of tasks in the construction industry.	Agree	3.66	.896
Robotics and automation have improved safety and decreased the number of workplace accidents in the construction industry.	Agree	3.95	1.013
The adoption of robotics and automation has led to cost savings and increased productivity in construction projects.	Agree	4.29	.692
Robotics and automation have enhanced the accuracy and precision of construction tasks, leading to improved quality of work.	Agree	3.74	.998
Valid N =171			

The construction industry has seen significant improvements in efficiency, safety, cost savings, and quality of work due to the adoption of robotics and automation, which have also enhanced the accuracy and precision of tasks.

4.5 Inferential statistics

The use of correlation tests and regression tests we use this the basis for operationalizing inferential statistics in this research.

4.5.1 Correlation tests

Correlation tests were instrumental in ascertaining the cause-and-effect associations between elements that make up innovative technologies namely virtual reality, prefabrication and modular designs, the use of drone technology as well as robotics and automation and the effect they have on business performance amongst construction companies operating at Karo mine.

Table 4.6: Correlation tests

		VR	PD	DT	RA	BP
Virtual Reality (VR)	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	171				
Prefabrication and Modular Design (PD)	Pearson Correlation	.346**	1			
	Sig. (2-tailed)	.000				
	N	171	171			
Drone Technology (DT)	Pearson Correlation	.651**	.286**	1		
	Sig. (2-tailed)	.000	.000			
	N	171	171	171		
Robotics and Automation (RA)	Pearson Correlation	.652**	.389**	.689**	1	
	Sig. (2-tailed)	.000	.000	.000		
	N	171	171	171	171	
Business Performance (BP)	Pearson Correlation	.640**	.244**	.667**	.712**	1
	Sig. (2-tailed)	.000	.001	.000	.000	
	N	171	171	171	171	171

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

Correlation statistics show that the use of virtual reality was considered to have a moderate, positive, statistically significant effect on improving the level of business performance amongst construction companies operating at Karo mine, given the Pearson correlation coefficient of 0.640 with a significant level of 0.000. These correlation statistics indicate that leveraging virtual reality can enhance the cost performance of construction companies operating at Karo mine.

It has been demonstrated that the utilisation of prefabrication and modular design has a weak but positive statistically significant correlation with business performance, given a Pearson correlation coefficient of 0.244 and a significance value of 0.001. The significance of these statistics is that even though the utilisation of prefabrication and modular designs can contribute to the improvement of the business performance of mining companies in terms of profitability, the relationship is weak.

Correlation results indicate that the use of drone technology by construction companies operating at Karo mine has a positive and statistically significant correlation with business performance, given a Pearson correlation coefficient of 0.667 and a significance value of 0.000.

These correlation statistics indicate that leveraging the use of drone technologies by construction companies operating at Karo mine is a demonstration of efficient resource utilisation in quantity surveying, which reduces the amount of time that is taken in pre-construction phases, during the construction phases, as well as the post-construction phases. The application of drone technologies has significantly lowered the financial and resource requirements of construction companies operating at Karo mine, leading to an overall improvement in efficiency in the utilisation of resources.

Correlation statistics show that the application of robotics and automation by construction companies operating at Karo mine has a strong positive and statistically significant Pearson correlation with business performance in terms of productivity. This is demonstrated by a Pearson correlation coefficient of 0.712 and a significance level of 0.000. The implications of these statistics are that leveraging robotics and automation improves the operational efficiency of construction companies operating at Karo mine in terms of the amount of time that it takes to complete tasks that are usually conducted manually.

4.5.2 Regression tests

Regression statistics were used to predict the relationship between the use of innovative technologies and the business performing amongst construction companies operating at Karo mine operating at Karo mine.

4.5.2.1 Model summary

The model summary shows that linear regression that provides information about the accuracy and goodness of fit of the model. As demonstrated in Table 4.7.

Table 4.7: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.770[a]	.593	.584	1.70564

a. Predictors: (Constant), Robotics and Automation, Prefabrication and Modular Design, Virtual Reality, Drone Technology

In the regression model summary, R =.77, this represents the correlation between the predicted and actual values. It indicates a strong positive combined linear relationship between robotics and automation, prefabrication and modular design, virtual reality, drone technology, and the outcome variable. R Square =.593:

This is the coefficient of determination, which indicates the proportion of the total variation in the outcome variable that can be explained by the predictors. In this case, approximately 59.3% of the variation in business performance can be explained by the predictors. Adjusted R Square =.584: This adjusted coefficient of determination accounts for the number of predictors in the model, penalising overfitting. It indicates that approximately 58.4% of the variation in business performance can be explained by robotics and automation, prefabrication and modular design, virtual reality, and drone technology. The standard error of the estimate is 1.70564. This measure estimates the average distance between the predicted and actual values. A smaller value indicates a more accurate model.

4.5.2.2 Regression Coefficients

The standardized coefficient measures the strength and direction of the relationship between the predictor variables (Virtual Reality, Prefabrication & Modular Design, Drone Technology, and Robotics and Automation) and the dependent variable (business performance).

Table 4.8: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.419	1.051		2.302	.023
	Virtual Reality	.241	.075	.228	3.220	.002
	Prefabrication & Modular Design	-.071	.055	-.069	-1.278	.203
	Drone Technology	.245	.072	.251	3.423	.001
	Robotics and Automation	.401	.072	.417	5.544	.000

a. Dependent Variable: Business Performance

Based on standardized coefficients Virtual Reality (VR) has a coefficient of 0.228. This suggests that a one standard deviation increase in VR is associated with a positive 0.228 standard deviation increase in business performance. Prefabrication & Modular Design has a coefficient of -0.069. This indicates that a one standard deviation increase in Prefabrication & Modular Design is associated with a negative 0.069 standard deviation decrease in business performance. Drone Technology has a coefficient of 0.251. This implies that a one standard deviation increase in Drone Technology is associated with a positive 0.251 standard deviation increase in business performance.

Robotics and Automation has the highest coefficient of 0.417. This means that a one standard deviation increase in Robotics and Automation is associated with the largest positive impact on business performance, with an increase of 0.417 standard deviations.

Robotics and Automation has the strongest positive relationship with business performance, followed by Drone Technology and Virtual Reality. Prefabrication & Modular Design, on the other hand, has a weak negative relationship with business performance. On standardized bitter coefficients were used to compare a multi-regression equation which was depicted as follows:

$$\text{Business performance} = 2.419 + 0.241 - 0.071 + 0.245 + 0.401$$

4.6 Summary of hypotheses

The summary of research hypothesis was used in the level of statistical significance of specific research variables with respect to the relationship between the adoption of innovative technologies and business performance amongst mining companies operating at Karo mine.

Table 4.9: Summary of hypotheses

Model	Sig.	decision
H_1: The application of virtual reality influences the cost performance of the construction companies operating at Karo mine at Karo Mine	0.05 > 0.002	Accept
H_2: Using prefabrication and modular designs has a positive effect on the profitability of construction companies operating at Karo mine at Karo Mine	0.05 < 0.203	Reject
H_3: Drone technology has a positive influence efficient resource utilisation by construction companies operating at Karo mine at Karo Mine	0.05 > 0.001	Accept
H_4: The use of robotics and automation influence the productivity of construction companies operating at Karo mine at Karo Mine	0.05 > 0.000	Accept

Based on the hypothesis statement (H1: The use of virtual reality affects the cost performance of building enterprises at Karo Mine), The p-value (0.002) is less than the level of significance (0.05), indicating that there is sufficient evidence to reject the null hypothesis (H0) and accept the alternative hypothesis (H1). As a result, we can conclude that the use of virtual reality has an impact on the cost performance of the building businesses at Karo Mine. The statistical significance is substantial, with a p-value of 0.002.

This suggests that the observed effect of virtual reality on cost performance is unlikely to have happened by chance. The correlation between virtual reality application and cost performance is statistically significant.

The research hypothesis states that using prefabrication and modular designs has a positive effect on the profitability of construction companies operating at Karo mine at Karo Mine. The p-value (0.203) is less than the level of significance (0.05), indicating that there is sufficient evidence to reject the null hypothesis (H0) and accept the alternative hypothesis (H2). As a result, we can conclude that the use of drone technology has an impact on the efficient resource utilisation of the construction businesses at Karo Mine. The statistical significance is great, with a p-value of 0.001. This suggests that the observed effect of drone technology on resource efficiency is unlikely to be due to chance alone. The association between the use of drone technology and efficient resource utilisation is statistically significant.

The use of prefabrication and modular designs in construction can have multiple advantages. These methods involve assembling different components of a structure off-site before transporting them to the construction site. This reduces construction time, improves quality control, minimizes waste, and enhances safety. Additionally, it allows for better planning and coordination, leading to cost savings and increased profitability.

Based on the hypothesis (H3: Drone technology has a favourable impact on effective resource utilisation by construction enterprises at Karo Mine), The p-value (0.001) is less than the level of significance (0.05), indicating that there is sufficient evidence to reject the null hypothesis (H0) and accept the alternative hypothesis (H2). As a result, we can conclude that the use of drone technology has an impact on the efficient resource utilisation of the construction businesses at Karo Mine. The statistical significance is great, with a p-value of 0.001. This suggests that the observed effect of drone technology on resource efficiency is unlikely to be due to chance alone. The association between the use of drone technology and efficient resource utilisation is statistically significant.

Based on the hypothesis statement (H4: The usage of robotics and automation influences construction company productivity at Karo Mine), The significance threshold (0.05) is less than the p-value (0.000), indicating that there is sufficient evidence to reject the null hypothesis (H0) and accept the alternative hypothesis (H1).

As a result, we can conclude that the use of robotics and automation affects the productivity of construction businesses at Karo Mine. The statistical significance is great, with a p-value of 0.000. This suggests that the observed effect of robots and automation on productivity is unlikely to have happened by chance. The link between virtual reality applications and productivity is statistically significant.

4.7 Discussions of research findings

This section's contribution to the research is to address research findings in relation to what has been discovered in existing literature containing the link between the use of innovation and the performance of the construction sector. The goal of this debate is to find locations where research results from this study may be compared to those from previous studies to uncover areas of agreement as well as points where results diverge. This is also necessary to contextualise and locate this research and its findings within the body of knowledge on the relationship between innovative technologies and company performance, with a specific emphasis on the construction industry.

4.7.1 Virtual reality influences the cost performance.

The regression results from this study suggested that virtual reality has only a statistically significant affect or cost minimization among enterprises operating at the Karo mine. Current research findings support current literature by (Chen and Wang,2023) demonstrating that the use of visual reality in business provides benefits such as virtual walkthroughs, design visualisation, and collaborative planning. The works of (Zhao and Lucas,2019) reiterate that virtual reality can assist architects, engineers, and contractors in identifying and correcting design faults prior to the building phase, reducing errors and rework. It also helps with customer presentations and approvals, as well as improving communication and decreasing misunderstandings. As a result, the importance of virtual reality in the construction sector cannot be overstated.

4.7.2 Prefabrication and modular designs and the profitability

According to regression statistics, the use of prefabrication and modular designs has no statistically significant effect on the profitability of construction businesses operating at the Karo mine.

This result differs from previous research which has shown that the use of prefabrication and modular design technology improves the overall business performance and profitability of construction companies that leverage the use of artificial intelligence systems in design and reduces material waste (Aiyetan & Das, 2023). Differences in research findings could be attributed to the realisation that construction companies operating in the mining sector may not have a competitive advantage over the use of prefabrication and modular designs because mining companies may require some customised plants that are not possible to build offsite.

4.7.3 Drone technology and efficient resource utilisation

According to current findings, using drone technology related to more efficient resource utilisation. These findings support current literature, which shows that the use of drone technology has greatly decreased resource requirements, particularly in terms of cost-effective surveillance and progress monitoring (Li & Liu, 2019). Existing literature indicates that utilising a drone pilot and drone technology to conduct mine surveillance is less expensive than using sophisticated hardware such as helicopters (Magistretti & Dell'Era, 2019). As a result, the use of drone technology has exploited the available resources at mining firms' disposal, which can now be allocated for other productive objectives, improving the overall performance of construction companies operating at the Karo mine.

4.7.4 Robotics and automation and the productivity

The findings of a study on the relationship between robotics and automation and construction company productivity revealed that robotics and automation have a considerable beneficial influence on construction companies' ability to increase productivity. These findings will support previous literature by demonstrating that the employment of robotics has increased the operational unpredictability of construction enterprises. According to the literature, construction robots can handle tasks such as bricklaying, concrete pouring, and heavy lifting, decreasing labour costs and time while increasing productivity and safety (Kirner et al., 2021).

Automation can also help with the precision manufacturing of prefabricated components, which reduces waste and improves material utilisation. Autonomous trucks for material distribution, drones for surveying, and AI-based solutions for project management and scheduling optimisation can all help construction sites (Yap et al., 2022).

4.8 Chapter summary

This chapter presents research results that were collected from diverse respondents from different age groups with the highest level of education and gender. Research results were analysed by correlation and regression statistics as well as using descriptive statistics. The main outcomes of the research indicated that the utilisation of virtual reality drone technology as well as robotics and automation had a significant effect on improving the performance of construction companies operating at Karo mine. On the other hand, the utilisation of pre-fabrication and modular designs was found not to have a significant effect on the performance of construction companies operating at Karo mine. The next chapter has the responsibility to provide a comprehensive analysis of the entire research by providing a summary of the main findings, articulating the extent to which the research was able to achieve research objectives, and proposing recommendations on the basis of the best practices that must be followed by mining companies to enhance their overall business performance.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter continues from the previous chapter, whose contribution was to present, analyse, and discuss research findings. The chapter begins by providing a comprehensive summary of research results and a holistic analysis of the extent to which this research has been able to achieve its intended objectives, as stipulated in the introductory chapter, as well as the ability to reach the situations that have been satisfactorily resolved. The chapter is also responsible for proposing plausible causes of action and recommendations that might be taken by the management of construction companies to improve their overall business performance through leveraging innovative technologies. The chapter sums up by providing proposed areas of further research that emanated from the research but might not fall within the scope of his objectives.

5.1 Summary of research findings

Undertaking this research was inspired by the realisation that the innovative technologies and digitalization of business processes was taking centre stage in many industries as a way of optimising organisational resources and improving operating efficiency, which is associated with the overall enhancement of business performance and sustainability of operations. This study was based on four research objectives that were focused on the effect that virtual reality, prefabrication and modular designs, the use of drone technology, robotics, and automation have on the business performance of mining companies in terms of cost minimization, profitability, efficient utilisation of resources, and productivity. The results that are presented in this chapter were collected from diverse groups of respondents from different age groups, which indicates the level of familiarity they might have with various technologies that are relevant in the construction industry. Respondents were categorised in terms of their working experience within the construction and mining industries. It was essential to understand the profiles of respondents who have a detailed appreciation of specific technologies that might enhance the overall performance of construction companies operating within the mining industry.

It also showed that most respondents were male, which might indicate the existence of metal determination within the construction companies operating within the mining industry. Research results from this study highlighted that, from the four research objectives, virtual reality, drone technology, and robotics/automation are all positively associated with business performance. However, prefabrication and modular design technology may have a negative effect. These findings can help construction companies operating at Karo Mine make informed decisions regarding the adoption and implementation of these technologies.

Interview transcripts highlight that the construction industry in Zimbabwe is embracing innovative technologies to improve collaboration, eliminate errors, and optimize project schedule and costs. BIM and sustainable practices are gaining traction, while construction management software and tools provide real-time data access and remote project management. However, Zimbabwe's technology adoption still lags developed countries due to constraints like low money and opposition to change. Virtual reality, drone technology, and robotics are improving industry efficiency, safety, and productivity.

5.2 Conclusions

This section analyses the extent to which this research was able to resolve research objectives and provide answers to research questions that way stipulated in the introductory chapter. This is analysis is done on each of the four research objectives as follows.

5.2.1 Virtual reality influences the cost performance.

Regression statistics show that the coefficient of VR suggests that a one-unit increase in the use of virtual reality technology is associated with a 0.228 unit increase in the business performance of construction companies operating at Karo mine. This implies that implementing VR technology is positively related to improved business performance. Construction companies operating at Karo mine leverage the application of virtual reality to enhance their operational performance by investing in state-of-the-art building technologies that utilise artificial intelligence, feature engineering, and the internet of things to ensure that they construct quality structures that enhance safety within the mining environment at Karo mine.

Construction companies can use virtual reality to create realistic 3D models of their building designs, allowing them to identify potential issues and make necessary changes before construction begins. This can help minimize costly rework and change orders during the construction process.

5.2.2 Prefabrication and modular designs and the profitability

Regression statistics show that the coefficient of prefabrication and modular design suggests that a one-unit increase in the use of this technology is associated with a -0.069 unit decrease in the business performance of construction companies operating at Karo mine.

This negative coefficient indicates that the implementation of prefabrication and modular design technology may have a detrimental effect on business performance. This might be linked to the customised nature of construction projects that take place within a mining environment, which might not require the use of prefabricated materials and designs that have been constructed outside the unique mining environments.

5.2.3 Drone technology and efficient resource utilisation

Regression statistics indicates that the coefficient of drone technology suggests that a one-unit increase in the use of drones is associated with a 0.251 unit increase in the business performance of construction companies operating at Karo mine. This positive coefficient indicates that implementing drone technology is likely to have a positive impact on business performance.

5.2.4 Robotics and automation and the productivity of construction companies operating at Karo mine

Regression statistics indicates that the coefficient of robotics and automation suggests that a one-unit increase in the use of these technologies is associated with a 0.417 unit increase in the business performance of construction companies operating at Karo mine. This coefficient indicates that incorporating robotics and automation into construction processes is highly relevant and beneficial for improving business performance.

5.3 Recommendations

The study was based on four research objectives that were focused on.

5.3.1 Virtual reality influences the cost performance.

Virtual reality can used to conduct virtual site inspections, allowing construction companies working at the Karo mine to discover potential safety dangers and construction issues without physically being on-site physically all the time. This can help to lessen the time requirement for on-site visits thus safety issues can be discussed in meetings and analysed in real time, so travel costs from the head offices to sites can be reduced. Construction businesses at the Karo mine can utilise virtual reality to deliver realistic training simulations for its staff, allowing them to practise construction processes and safety protocols in a virtual setting. This can help to cut training expenditures while also lowering the likelihood of on-the-job injuries.

Virtual reality can support virtual collaborative meetings and design reviews, allowing construction teams to collaborate regardless of their actual location. This can help to reduce the need for in-person meetings and travel, saving the firm time and money. Furthermore, Karo mine construction businesses can offer immersive virtual reality experiences to market their projects to potential clients and investors. This can help to decrease the requirement for physical showrooms and sales centres, allowing businesses to reach a larger audience while reducing costs. Leveraging virtual reality in construction can help minimise costs by improving efficiency, reducing the need for physical resources, and enhancing collaboration and communication within the company.

5.3.2 Prefabrication and modular designs and the profitability

To expedite the production and assembly processes, construction companies working at the Karo mine must create a library of standardised modular designs and components that may be used across various projects. Building Information Modelling (BIM) and other innovative technologies must be used by construction companies working at the Karo mine to design, visualise, and coordinate prefabricated pieces. This can aid in the identification of conflicts and the streamlining of the construction process.

Construction firms working at the Karo mine must collaborate closely with suppliers and manufacturers to simplify the procurement and delivery of prefabricated components, lowering lead times and inventory costs. To decrease waste and improve efficiency in the fabrication and installation of modular components, construction companies working at the Karo mine must use lean construction concepts. Construction firms working at the Karo mine must develop excellent relationships with architects, engineers, and other construction experts in order to design integrated, modular solutions that match project objectives while minimising costs.

Construction companies working at the Karo mine must make the most use of off-site manufacturing facilities to produce prefabricated components in a controlled environment, decreasing dependency on on-site personnel and shortening construction time. Furthermore, construction firms working at the Karo mine must: develop and implement modular buildings using sustainable materials and technology, lowering long-term operational costs and appealing to environmentally concerned clients. Furthermore, construction companies working at Karo Mine must constantly assess modular construction methods and look for ways to enhance them to boost efficiency and profitability.

5.3.3 Drone technology and efficient resource utilisation

Construction businesses working at Karo Mine must step up their efforts. Drones can be used to record site survey data quickly and accurately, monitor the construction progress, and inspect hard-to-reach locations, which can enhance efficiency and minimise the need for physical labour. To standardise building components such as wall panels, floor systems, and roof trusses, they must use modular designs. By improving resource use, this can streamline building processes and eliminate material waste.

Use aerial inventory management drones to monitor material inventories, track equipment, and manage construction supplies, resulting in better resource allocation and less surplus inventory. Drones must be used to plan and manage the movement of equipment, supplies, and humans on building sites, thereby reducing congestion, and enhancing resource utilisation. Construction companies working at the Karo mine must use drone technology to collect data on construction processes and site conditions, as well as real-time analytics, to make educated decisions that optimise resource utilisation and avoid waste. They must investigate the use of drones outfitted with payloads such as LiDAR or thermal imaging for thorough mapping, surveying, and monitoring, which can aid in resource allocation and management.

The integration of drone technology and modular designs can improve resource utilisation by providing real-time data, streamlining construction processes, and optimising logistics for construction companies.

5.3.4 Robotics and automation and the productivity

Robotics and automation equipment should be purchased by construction organisations to speed up repetitive processes such as bricklaying, concrete pouring, and excavation. This can assist boost productivity and lower labour costs. Drones can be used for site surveys, progress monitoring, and structure inspection. They can give real-time data and aerial imagery, allowing for better decision-making and reducing the need for human surveying.

By standardising components and shortening construction time, modular construction systems can considerably increase production. Modular designs enable prefabricated building elements to be assembled off-site and then transported for speedy installation, saving time and resources. Digital tracking and monitoring technologies allow for real-time visibility into construction progress and resource utilisation. This assists in identifying and addressing bottlenecks, optimising scheduling, and improving resource management. Construction enterprises use self-driving trucks and equipment to improve material delivery and handling. Automated trucks can move items throughout the plant, decreasing the requirement for manual labour and increasing overall efficiency. Construction organisations must provide proper training to their personnel on how to use robotics and automation technologies. This can assist employees in adapting to new working techniques, improving their abilities, and ensuring the efficient use of innovative technologies. Robotics and automation can dramatically increase productivity and resource utilisation in building processes, resulting in cost savings and better project efficiency.

5.4 Research contributions to Education 5.0

The main contribution of this research within the framework of heritage-based education is that it recognises the importance of innovation and industrialization by leveraging innovative technologies that construction companies can use to improve their overall business performance. The construction industry also encourages individuals to invest in infrastructure for development, which is critical in supporting many sectors of the economy through economic development promotion.

It makes sense that if the construction industry in Zimbabwe is automated using innovative technologies, this will result in more efficient resource utilisation, which will boost industry

productivity and contribute to the economy's GDP. In general, other sectors of the economy that rely on the construction industry to build adequate infrastructure and the built environment can profit from the construction industry's greater efficiency to increase their own operational variability through lower costs. More specifically, by automating the construction business, the sector's contribution to the mining industry increases the mining industry's productivity, which is one of Zimbabwe's primary foreign currencies.

As a result, by encouraging innovation and technological advancements in the construction industry, an indirect contribution will be made to improving the economy's capacity through the generation of foreign currency, which is critical to sustaining economic growth and development activities.

5.5 Areas of additional research

This research was specifically focused on the utilization of innovative technologies by construction companies operating at Karo mine in trying to enhance their business performance, future research cab focus on the application of the internet of things in the construction industry in general.

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APPENDIX A: Questionnaire

October 2023

Dear respondent

I am Lawrence Gwara, a Master of Business Leadership student from Bindura University of Science Education. I am carrying out scholarly study on the ***Improving construction business performance through innovative technologies in Zimbabwe: A case of Karo Mine Contractors.*** Please take the time to answer the following questions. Mark your preferences by clicking on the selected response that most closely matches your preferences. You are under no need to identify yourself in any manner. Please rest assured that your replies were utilised solely for scholarly reasons and as grouped data.

Position /Job Title …….

Section A: Demographics.

1. Gender

Male	☐	Female	☐

2. Age group

21 – 30 years	☐	31 – 40 years	☐	41 – 50 years	☐
51 – 60 years	☐	61 years and above	☐		

3. Period of working experience

Less than 1 year	☐	1 – 5 years .	☐	6 – 10 years	☐
11 – 15 years	☐	16 years and above	☐		

4. Highest level of education.

Certificate	☐	Diploma	☐	Bachelor's Degree	☐
Master's Degree	☐	PhD	☐	other	☐

Key

Symbol	Item
SA	Strongly Agree
A	Agree
IN	Indifferent/Neutral
D	Disagree
SD	Strongly Disagree

Virtual reality	**SA**	**A**	**IN**	**D**	**SDA**
Virtual and augmented reality technology has significantly improved the visualization and design analysis capabilities in the construction industry.					
The use of virtual and augmented reality has enhanced collaboration among different construction disciplines, leading to more efficient project management.					
Virtual and augmented reality have increased safety awareness and improved safety training for construction workers.					
The implementation of virtual and augmented reality technology has positively impacted the construction industry in terms of reducing errors and rework during the construction process.					
Prefabrication and modular design	**SA**	**A**	**IN**	**D**	**SDA**
The use of prefabrication and modular design has improved the efficiency and speed of construction projects in the industry.					
Prefabrication and modular design have enhanced the quality and consistency of construction processes and outcomes.					
The adoption of prefabrication and modular design has led to cost savings and increased profitability for construction projects.					
Prefabrication and modular design have streamlined the construction industry and reduced the environmental impact of construction activities.					
Drone technology	**SA**	**A**	**IN**	**D**	**SDA**
Drone technology has significantly improved the efficiency and speed of surveying and mapping in the construction industry.					
The use of drone technology has enhanced the safety and security of construction sites and workers.					
Drone technology has led to cost savings and increased productivity in construction projects.					
The adoption of drone technology has improved the accuracy and quality of data collection and analysis in the construction industry.					
Robotics and automation	**SA**	**A**	**IN**	**D**	**SDA**

The use of robotics and automation has increased the speed and efficiency of tasks in the construction industry.					
Robotics and automation have improved safety and decreased the number of workplace accidents in the construction industry.					
The adoption of robotics and automation has led to cost savings and increased productivity in construction projects.					
Robotics and automation have enhanced the accuracy and precision of construction tasks, leading to improved quality of work.					
Business Performance	**SA**	**A**	**IN**	**D**	**SDA**
"Innovative technologies, such as Building Information Modelling (BIM) and virtual reality, have improved our overall business performance."					
"The adoption of innovative technologies has positively impacted the efficiency and productivity of our construction projects."					
"The use of innovative technologies has helped us to reduce costs and enhance profitability in the construction industry."					
"Innovative technologies have improved the quality and accuracy of our work, leading to greater customer satisfaction and better business outcomes."					

APPENDIX B: Interview Guide

Dear respondent

I am Lawrence Gwara, a Master of Business Leadership student from Bindura University of Science Education. I am carrying out scholarly study on the ***Improving construction business performance through innovative technologies in Zimbabwe: A case of Karo Mine Contractors.*** Please take the time to answer the following questions. Mark your preferences by clicking on the selected response that most closely matches your preferences. You are under no need to identify yourself in any manner. Please rest assured that your replies were utilised solely for scholarly reasons and as grouped data.

1. What is the current state of technology adoption in the construction industry in Zimbabwe?
2. To what extent are construction companies operating at Karo mine making use of virtual reality?
3. How effective has been the use of prefabrication and modular designs by construction companies operating at Karo mine?
4. How has the use drone technology influenced an efficient resource utilisation by construction companies operating at Karo mine?
5. What is the current state of robotics and automation among construction companies operating at Karo mine? How does it influence the productivity?