Factors Influencing the Adoption of Artificial Intelligence Technologies in the South African Construction Industry

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1 DECLARATION

I, **Pumza Portia Mgolombane**, declare that this research article is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Pumza Portia Mgolombane

Signed at Mafikeng

On the 23rd ……. day of ……February…… 2023….

2 DEDICATION

I would like to dedicate this research to my parents. Your prayers have brought me this far, thank you for your unwavering love and support. My dad, who went to heaven in 2021, your love for education will forever continue through me. I had wished you would become part of the graduation ceremony, but God had other plans. I felt your support during this journey, your love and your presence consumes me daily. “I love and miss you daddy”.

Mummy, thank you for taking the reins, your love and prayers keep us strong. Your strength moves mountains and I pray to the Lord Almighty to keep you for a very long time, I want to love you for a very long time. “I love you mummy”

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To the panel thank you for defining this path of my research, even though some of your criticisms were a hard pill to swallow however, it is through criticism that we grow stronger.

To the NHBRC, thank you for giving me an opportunity to further my studies, for that I will forever be grateful and a special thank you to Connie Fusi for her patience and enthusiasm to always assist.

To my fiancé Bogosi Seate, thank you for choosing me and believing in my dreams even during these trying times. For proofreading my work and being my alarm in times when I could not even awake, I will forever be grateful. You have been my greatest pillar of strength and support in this journey and your understanding did not go unnoticed. I will forever cherish you and I love u.

To my family thank you for understanding when I could not answer your calls nor attend family events. Thank you for lending me your ear and for your encouragement when it was hard to carry on, I will forever cherish you and I love you.

To my friends and my study buddies “my gang” who walked this journey with me and gave me their undivided attention and support, I would not have made it this far without your support and assistance, thank you.

I would like to send a special gratitude to each participant who took time out of their busy schedule to complete this survey, this study would not have been possible without your valuable inputs, “Mazan’ethole”.

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4 SUPPLEMENTARY INFORMATION

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5 LIST OF ABBREVIATIONS

Abbreviation	Meaning
AI	Artificial Intelligence
CI	Construction Industry
SACPMP	South African Council for the Project and Construction Management Professions
SPSS	Statistical Package for the Social Sciences tool

6 ABSTRACT

The study aimed to evaluate factors influencing the adoption of artificial intelligence technologies within the South African Construction Industry. The focus was to employ AI technology adoption strategies to enhance the construction industry's' performance in ensuring effectiveness and efficiency on productivity through organisational development. Since the construction industry is notorious for its resistance to integrating new technology; for example, it is more likely to continue working manually than to apply digitalisation.

As a result, the slow adoption of technology is likely to have an impact on the effectiveness and efficiency of the construction industry building practices. Therefore the studies objectives were to assess, the adoption of AI technology strategies and its impact on effectiveness and efficiency within the construction industry. Moreover, opportunities and constraints of AI adoption by the construction industry to help improve its productivity. Also, the organisational development phenomenon within the construction industry and its effect on AI Technology adoption.

This study employed a case study research method to obtain a comprehensive understanding and empirical questions were established in the literature based on the study's' aims and objectives. The quantitative data was administered through the Qualtrics tool whereby a survey link was obtained and then emailed to the participants. The data was analysed using Statistical Package for the Social Sciences tool (SPSS) version 27. 51 Respondents participated in the survey however, 9 were excluded because of incomplete surveys.

According to the results of the data analysis, it was concluded that the employment of AI technology techniques may have an impact on the effectiveness and efficiency of the building sector, making this objective relevant to this study. Moreover, AI adoption by the construction industry may increase productivity by understanding the opportunities and limitations of adopting AI. Also, the phenomena of organizational development within the construction industry may impact on the adoption of AI Technology was found to be significant.

Keywords: *The Construction Industry; Artificial intelligence; Professional Construction Project Manager; Organizational development; Organizational architecture and Technology.*

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Dear Miss Pumza Mgolombane

Master of Business Administration: Approval of Title

We have pleasure in advising that your proposal entitled *Factors influencing the adoption of artificial intelligence technologies in the South African construction industry* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Marike Bosman
Faculty Registrar
Faculty of Commerce, Law and Management

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8 CHAPTER ONE: INTRODUCTION

1. Introduction

This study assessed the factors influencing the adoption of artificial intelligence technologies in the South African Construction Industry. The purpose of this chapter is to outline the research structure. Overall, this study looked at the purpose of the research, background of study to build a structure, followed by the literature review assessing AI technology adoption strategies in accordance with the objectives of study. Ultimately the research design and methodology prompted by the gaps in the literature review were discussed including ethical strategies and mitigation factors of study.

1.2 Purpose of the research

The purpose of this research was to assess the factors influencing adoption of Artificial Intelligence Technologies (AI) strategies within the South African Construction Industry. The scope of the works for this study was limited to the South African Professional Construction Project Managers in all Provinces. The focus was to employ AI technology adoption strategies to enhance the construction industry's' performance in ensuring effectiveness and efficiency on productivity through organisational development.

1.3 Background to the Study

The construction sector is notorious for its aversion to adopting new technologies; for instance, it is more likely to continue working by hand rather than implementing digitalized outputs, (Windapo & Cattell , 2013). The sector employs many unskilled workers, contributing fairly to the GDP and employment. It can impact long-term growth as well as national development (Giang & Pheng, 2011). However, each industry must improve its methods of operation to stimulate growth, productivity, and a global competitive advantage. Figure 1 illustrates that the construction industry is lagging in the adoption of technologies compared to other sectors like the Financial Services, High tech and Communications that are in the lead.

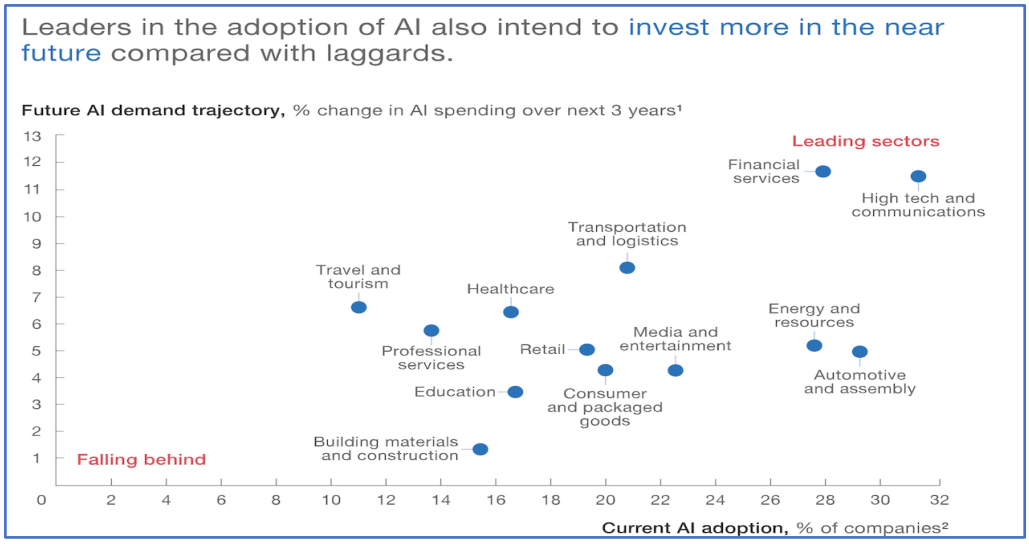

Figure 1 : Industry leaders AI Adoption
Source: (McKinsey Quarterly , 2018) https://www.mckinsey.com/business-functions/quantumblack/our-insights/what-ai-can-and-cant-do-yet-for-your-business

There appears to be a paucity of measures to bring the construction industry up to speed with technology use. This could be because of most project lifecycle stages roles and functions still being manually operated and inspected, due to the lack of employment of AI technologies. To ensure accuracy and quality in such work, the adoption of AI may bring with it benefits entailing but not limited to: -

a) Construction safety that will ensure risk mitigation b) Enhanced productivity because of digital designs c) Increased accuracy due to efficiency of project plans to accurately capture information d) Improved communication because of clear and transparent communication (Baum, Barrett, & Yampolskiy, 2017). Even though there have been significant studies on AI however, there is limited research on the factors influencing the adoption of AI technology strategies within the South African construction industry.

1.4 Statement of the Problem

The construction industry contributes a considerable amount of GDP to the global economy, making it a very important sector (Delgado, et al., 2019). The world has progressed and absorbed most technology because of disruptive technologies. Consequently, traditional roles may become obsolete due to inefficiencies. The construction business exists in pleasing its clients by executing projects on schedule, on budget, and to the highest possible standard.

The sector is arguably the most labour-intensive, with most roles still being performed by hand instead of through automation. The sector has experienced a 37% drop in growth from 2017 to

2020, primarily due to Covid-19, the sector is expected to rebound in 2022 with a growth of roughly 9.1% and then grow gradually at 3.1% between 2023 and 2025. (Khplant, n.d).

Without digitalisation, this expansion may be difficult to attain, and the construction industry may need to develop strategies to integrate AI technologies. South Africa is lagging in adopting AI technologies to enhance and advance the construction industry. The slow adoption of technology is likely to have an impact on the effectiveness and efficiency of the construction industry building practices. Figure 2. depicts the impact of Covid-19 in 2020, as evidenced by the substantial fall in growth rate. This further indicates that the industry may have to reform its organizational structure before its traditional roles become obsolete given the fact that growth has been slow since 2017.

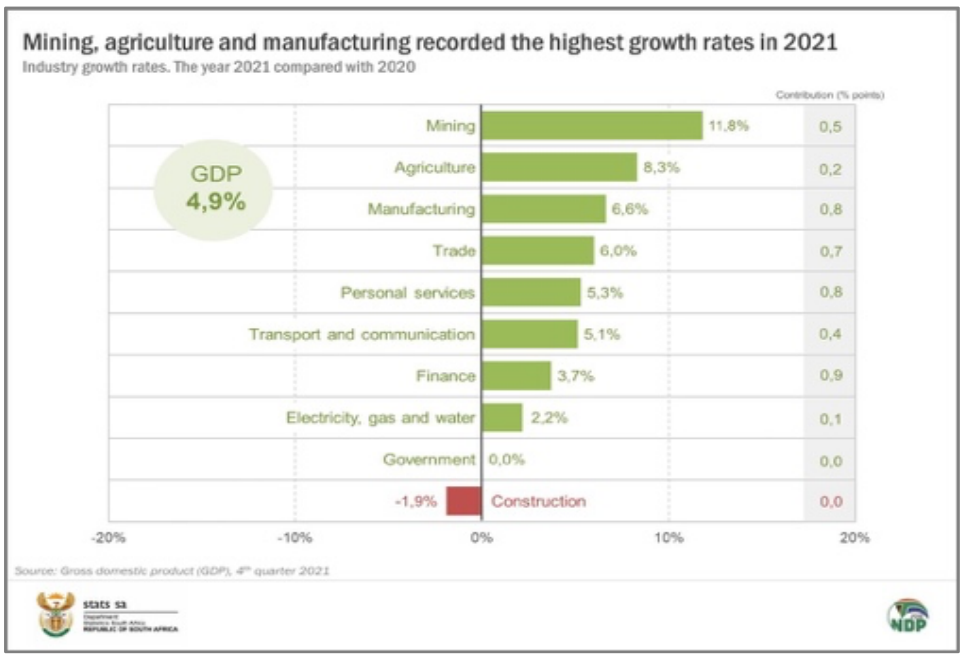

Figure 2 : GDP Industry Growth Rates
Source: (Mahlakoana, 2022) https://ewn.co.za/2022/03/08/maluleke-sa-not-yet-out-of-the-woods-despite-gdp-growth

1.5 Research Objectives

From the purpose of the study the following three primary objectives were identified:

Objective 1: To assess the adoption of AI technology strategies and its impact on the effectiveness and efficiency within the construction industry.
Objective 2: To identify opportunities and constraints of AI adoption by the construction industry to help improve its productivity.

Objective 3: To examine the organisational development phenomenon within the construction industry and its effect on AI Technology adoption.

1.6 Research Questions

The primary research question emanates from the factors influencing the slow and/or lagging adoption of AI technology strategies by the construction sector as well as the efficacy of AI in the functions and processes that exist in the body of knowledge, including barriers that inhibit the construction sector from embracing AI technology. The following research main question and sub-questions were formulated to achieve the research objectives through seeking participants responses:

Main Research Question: How does the adoption of AI technology strategies impact on the effectiveness and efficiency within the South African Construction Industry?
Sub Question 1: What is the impact of opportunities and constraints of AI adoption by the construction industry on productivity?
Sub Question 2: How does AI technology adoption affect organisational development within the South African Construction Industry?

1.7 Delineations

The study will focus primarily on the Professional Construction Project Managers (PcPMs) within the Construction Industry, instead of all stakeholders. It will look at AI adoption approaches based on the sectors overall organizational development. Even though there are many different types of technologies, the study will only look at AI technologies and not all other forms of technology. The research will not look at all the activities that occur during the project lifetime. To thoroughly examine AI's potential in the construction industry, the study will evaluate it holistically however stating a few components.

1.8 Research Assumptions

Professional Construction Project Managers (PcPMs) recognize the value of AI technology adoption. The construction industry seeks to increase its overall effectiveness and efficiency on production. The trait of individuals chosen are experts and based on their qualifications they will be able to close the gap that exists in this study.

9 CHAPTER TWO: LITERATURE REVIEW

2 Introduction

This chapter aims to discuss available literature on the factors that influence AI adoption by the construction industry (CI), assess the efficacy of AI in the body of knowledge functions and processes, as well as the barriers that prevent the construction sector from adopting technology and opportunities available. The **resource dependent theory** will be discussed as the theory underpinning the need for adoption of AI technologies.

2.1 Definition of Topics

This study will highlight and define keywords. **The Construction Industry** is defined as an industry that creates value by investing in assets and supporting numerous sectors in achieving economic success, (Alaloul, Liew, Zawawi, & Mohammed, 2018). **Artificial intelligence** is referred to, as a computer systems ability to execute tasks that normally require human intelligence such as Artificial Narrow Intelligence, Artificial General Intelligence and Artificial Super Intelligence predicted to be smarter than humans (Baum, Barrett, & Yampolskiy, 2017). **A Professional Construction Project Manager** oversees the entire lifecycle of a construction project, from inception to finish, as well as any professional services required. This entails completing the project within the specified budget, resources, quality, time, and specification (SACPCMP, n.d.). **Organizational development** is a strategy or method used to help organizations improve and strengthen their plans, structures, and procedures through the development of their human resources (Rhydderch, Elwyn, Marshall, & Grol, 2004); promoting effective teamwork for optimal organisational performance. **Organizational architecture** is a model that assesses ways businesses operate, factoring the entire company, functional departments, and initiatives, (Lee, 2019). Considering that there is no clear description of what **technology** is, (Carroll, 2017) terms it as “people know technology, people know that natural is different from human-made, and technology is human-made and, therefore, not naturally occurring”.

2.2 Theoretical Framework

The theoretical framework introduced and explained the theory, that elaborates the research problem existence within the study. This study intends to explain the ***resource dependent theory***. According to the resource dependent theory**,** organizations require a range of resources

to thrive and achieve competitive advantage (Freeman, Dmytriyev, & Phillips , 2021). The aim of this theory is for the organisation to gain competitive advantage over its incumbents, hence profit maximization is at the core (Barney & Harrison, 2020). Further, resource maximization authority over certain resources by the organisations will ensure the organisations success.

Considering the macroenvironment, executives are once again challenged with locating crucial resources. In principle, automation may improve construction industry processes to achieve increased efficiency. However, investment in scarce resources is the greatest limitation to increased efficiency as outlined in the literature. These are the reasons the sector needs to be aware of scarce resources needed to improve organisational performance such as AI technologies (Wisskirchen, et al., 2017). (Jayalath & Gunawardhana, 2017) further, argue that prioritizing resource conservation, limiting environmental deterioration, and creating a healthy built environment are key components of sustainable practices. Thus, emphasizing the importance of varied skill sets among executives in procuring vital resources, might help the management in the construction industry obtain the essential knowledge to put AI adoption strategies into practice.

9.1.1

2.3 Objective 1: To assess the adoption of AI technology strategies and its impact on the effectiveness and efficiency within the construction industry.

2.2.1 Origins of AI

Although the origin of AI is difficult to pinpoint, they can be traced back to the 1940s, specifically to 1942, when Isaac Asmov published a novella titled Run-around about the Three Laws of Robots (Haenlein & Kaplan, 2019). On the other hand, (Dick, 2019) claims that AI was established in 1955, when early military computing veterans funded a workshop for a summer project called the Rockefeller foundations. The idea was that cognitive capacities might be isolated from the brain that supports physical action, allowing for a more formal explanation of human mind. Although AI was initially developed to mimic a human brain, it has progressed to the point that it now seeks to outperform human intelligence.

AI has been around for decades, and its advancement has meant a shift in how things are done. AI is still being researched and no one can predict the kind of disruption it might continue to cause. The industry's willingness to invest in personnel, training, remuneration, and human resources may result in the aforementioned AI functions (Ahuja, Sawhney, & Arif, 2018). AI enhances productivity effectiveness and efficiency by decreasing costs, giving businesses a

competitive edge thus, the way data is stored is of utmost importance. The construction industry components need be well integrated for an easy transition from traditional methods to AI adoption.

2.2.2 AI adoption within the South African Context

Technological advancements make it possible to now create construction procedures and systems that can speed up the process of building construction (Fonseca, 2021). The construction sector must find a cost- and time-saving approach to fostering infrastructure growth, local economic development, cost reduction, and construction efficiency (Pheng & Hou, 2019). Infrastructure is necessary for South Africa's economy to thrive; however, this depends on how well-functioning and fruitful the construction industry is (Li, Greenwood, & Kassem, 2019).

The Global Competitiveness Report placed South Africa at 60th place in the world in 2019 with a score of 62.4 in technology and innovation. In 2019, the Global Innovation Index placed South Africa as the 63rd most innovative country in the world, making it the first African country to appear on the list. South Africa moved up the list in 2020, ending up in position 53. Even so, South Africa is still lagging with the adoption of AI in the construction industry. According to (Tjebane, Musonda, & Okoro), the performance of the construction industry can be improved by implementing emerging digital advances like AI, however underdeveloped nations like South Africa are still underperforming in this regard.

2.2.3 AI adoption within the International Context

The organisation management and construction projects internationally seem to be frequently using AI. This might be because AI encompasses all dimensions and processes of a business within a model, allowing for more accuracy and efficiency in collaboration amongst all parties involved than with traditional procedures. (Regona, Yigitcanlar, Xia, & Li, 2022) argue that Global construction AI is expected to increase productivity from 0.8% to 14% annually, with a predicted growth of 85% to USD 15.5 trillion by 2030 based on technology innovation within the construction lifecycle stages. Additionally (AllTheResearch, Semptember, 2021) with a CAGR of 36.5% during the projected period (2021-2027), the Global AI in Construction Market was estimated to be worth USD 0.4 Bn in 2020 and is anticipated to reach USD 3.5 Bn by 2027 as shown in figure 1 below:

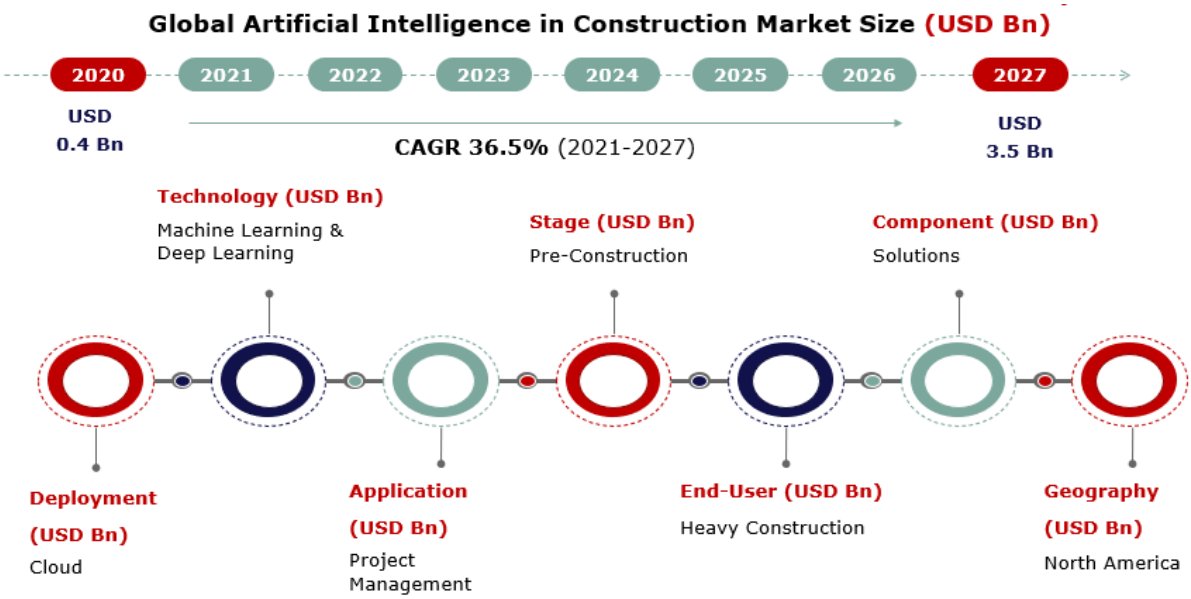

Figure 3 : Global AI in the Construction Market Size
Source: (AllTheResearch, Semptember, 2021)

Figure 3 further illustrates that, given the increasing investments in AI-based construction technology by organizations like Oracle Corporation and IBM Corporation, North America currently holds a relatively large share of the global market for construction AI. Moreover, due to increased investments in AI-based technology, the Asia-Pacific region is expanding at the highest CAGR. In this region, the key nations are China, South Korea, India, and Japan. Below are key trends in AI in construction market showing a positive impact:

Table 3 : Key trends in the AI construction market
Source: (AllTheResearch, Semptember, 2021) & (Kapliński, 2018)

No.	Trends	Impact
1	The pattern of using AI-powered construction equipment to continuously collect 3D and scans of construction site data is what is driving the global market for AI in construction.	**Positive**
2	The market for geographical AI and drones for land survey and mapping to expedite survey times is driving the market for AI in construction.	**Positive**
3	The growing trend of off-site building factories powered by autonomous robots to speed project delivery is what is driving the market for AI in construction.	**Positive**

Hypothesis 1:

Null Hypothesis: Adoption of AI technology strategies has no impact on the effectiveness and efficiency within the construction industry.

Alternative Hypothesis: Adoption of AI technology strategies may have a positive impact on the effectiveness and efficiency within the construction industry.

2.4 Objective 2: To identify opportunities and constraints of AI technology adoption by the South African (SA) Construction Industry (CI) to help improve its productivity.

2.2.4 AI technologies functions and challenges

Due to the low rate of digitization, most of the challenges that the construction industry currently faces are likely to be practically impossible to overcome. This is perceived as a lengthy ethos of reluctance to change according to (Abioye, et al., 2021). The general resistance of construction workers to adopt innovation is a concern according to (Akinosho, et al., 2020). Moreover, these professionals are less interested in sophisticated equipment that could be difficult to learn, instead prefer traditional ways of doing things.

On the other hand, manufacturing and telecommunications are thriving, likely owing the growth to their utilisation of current digital technology, which incorporates AI (Abioye, et al., 2021). (Baum, Barrett, & Yampolskiy, 2017), further suggests that in comparison to the construction industry, the manufacturing sector, retail, and telecommunication are primarily digitalized. As a result project management is more difficult and excessively time-consuming due to the sector's absence of digitization and excessive dependence on traditional work. According to (Chui, 2017), businesses which incorporate AI technologies generate more revenue whilst also achieving digital transformation. However, AI technology adoption entails some challenges as illustrated in Table 1.

Table 1 : AI Technologies and its function to the CI
Source: (Regona, Yigitcanlar, Xia, & Li, 2022)

AI Types	Function	Challenge
Reactive Machines	This machine has neither a past nor a memory, its decisions are based on the immediate. It is not coded, but rather learns through experience.	Can be easily outsmarted.

Limited Memory	It entails a restricted recall of the past and a pre-programmed outlook.	Interim or impermanent memory.
Theory of Mind	Human intellect and emotion are comprehended.	The human unauthorized disclosure regarding the inner self could be difficult for a robot to comprehend.
Self-Awareness	Conscious machines that can predict how others feel.	The machine may misinterpret the feelings and so interpret them incorrectly.

(Haenlein & Kaplan, 2019), suggest that managers might need to consider the regulation of AI since there is a lack of standards, considering that AI might always be evolving, may be a challenge. Also, when AI technology is employed, human employment may be low as AI takes over most jobs. To satisfy the demands of digitalization, re-skilling may be necessary. Since the construction sector is labor intensive most people might be left unemployed, and reskilling might be necessitated to close this gap which could be costly. Also, since automation requires a huge initial investment, it might be a challenge to adopt AI instantly. The application of AI may be slowed by high costs and lengthy time requirements to set it up (Paschen & Kietzmann, 2020). Furthermore, as AI systems are trained using data, human mistake and ambiguity may lead to data that is skewed, prejudiced, or lacking, preventing AI from reaching its full potential. Given how sensitive the data is, privacy controls may need to be developed.

2.2.5 AI technologies and opportunities

Activities AI can perform outweigh the constraints, particularly in the construction business, where productivity is critical to profitability. There are endless opportunities to the construction industry including more defined processes; elimination of repetitive work, birth of newly skilled personnel and automated equipment (Yogesh K, et al., 2021). Table 2 below depicts the goal of AI functions as well as their opportunities.

Table 2 : Type of AI and its opportunity to the CI
Source: (Hintze, 2016)

AI Technology Type	Opportunities to the Construction Industry
Machine Learning	**Automated Scheduling** may assist in finding the most effective crucial construction method to meet objectives, forecasting, examines alternative project delivery methods, and enhance overall project readiness by evaluating endless

	data configurations and alternatives based on similar projects. Forecasting will further estimate material to be delivered on site in line with production output therefore reducing time and cost delays due to material production and delivery. **Design optimization** requires supervised learning techniques that group crucial data using segmentation. Thus, stakeholders in a project can benefit from these programs since they provide information based on a variety of factors, including pricing, time required for project completion, and the likelihood of construction defects.
Automation	Coordinated **supply chain** will assist the CI to be more effective in controlling the project costs and cash flow. **Digital twin** technology captures real time data therefore stakeholders may be able to compare progress from initial design. This promotes transparency as the lack of transparency can inhibit productivity. Through the aggregation of data, **automated image recognition** gathers video footage on-site that assists in identifying dangers and risky working practices and so prioritizes safety education. Unregistered workers at that specific construction site can also be located using video footage.
Pattern Recognition	**Predictive AI Algorithms** using linear/quadratic discriminant algorithms can increase the value of the project and increase construction profits by decreasing uncertainty. Also, by using pattern recognition and machine learning techniques, it can also detect hazards before they arise. **Storing Space** using a digital map means it is possible to store materials in an accurate, digital manner that saves time as opposed to manual counting or locating materials. Improved **Analytic Platforms** comprehend signals and algorithm patterns through data collection from sensors to

	implement unscheduled outages, risk mitigation strategies, lower costs, real time solutions.
Deep Learning	The move by the construction sector to manufacturing-like processes allow for large scale production. Also, to promote on-site safety and efficiency, robotic technologies inclusive of wearable robots should be utilised to increase worker mobility.

Hypothesis 2:

Null Hypothesis: Productivity will not be improved by identifying opportunities and constraints of AI technology adoption by the CI.

Alternative Hypothesis: Identifying opportunities and constraints of AI technology adoption may improve productivity within the construction industry.

2.5 Objective 3: To examine the organisational development phenomenon within the construction industry and its effect on AI technology adoption.

2.5.1 Organisational Development

It is no longer business as usual since the way of doing things has evolved from what it was roughly ten years ago, mandating a redesign of businesses to conform to the ever-changing environment (Walsh & Volini , 2017). Therefore, organisational development is meant to create high performance in the organisation. Agile leadership might be a highly important skill to acquire as it may prove beneficial for the construction industry to integrate AI with Human Resources Management. Agile leadership, according to (Thompson, 2018), requires leaders who are inquisitive and can integrate prior knowledge to company flaws and prospects. Leaders who are visionaries and can adapt to change since the digital age is all about implementation and seizing possibilities. Also, (Schwab, 2017) considers digital leadership as key for organisation development and digital transformation, as leaders have authority. Hence, leaders should advocate organisational development to enhance profitability, efficiency and effectiveness of the organisation as illustrated in Table 3 below.

Table 3 : Organisational Redesign
Source: (Walsh & Volini , 2017)

No.	Organisational Development	Benefit to organisations
1.	Organising for speed agility and mobility	Competitive advantage enhancing business continuity positioning for future expansion and optimization of operations.
2.	The power of team networks	High preforming companies form smaller teams that rotate, encouraging a high level of innovation and promote team centricity.
3.	Agility and collaboration	High Impact leadership with an adaptable mindset.
4.	Building the organisations of the future	Building organisational networks to develop patterns and create business relationships and increased value for stakeholders
5.	Building in accountability	Promoting transparency and ease of embracing changes.

To simplify AI adoption, the construction industry may need to employ organizational development initiatives. While construction sector executives may need to assess themselves and analyse their leadership styles. Is it possible that they are resistant to change and therefore prohibiting industry development?

2.5.2 The Organisational Architecture

Organizational architecture can be utilized for the entire organization; however, it is shown to be more functional in smaller areas instead of the entire organization. Implementation become a little more structured and controlled in this approach (Lee, 2019). This method might also be used to examine a firm flaw to better understand difficulties, and it could be a valuable model for the construction industry to help assess and build AI adoption strategies.

Although there are numerous components to the organizational architecture framework, as indicated in Figure 4, the focus of this study will be on the technology component as new technologies are compelling organizations to adapt their business and operating paradigms.
The focus being specifically on AI technology to evaluate AI adoption tactics in the construction industry to improve performance, efficiency and gain a competitive edge.

Figure 1-2: The basic shell of my proposed organizational architecture

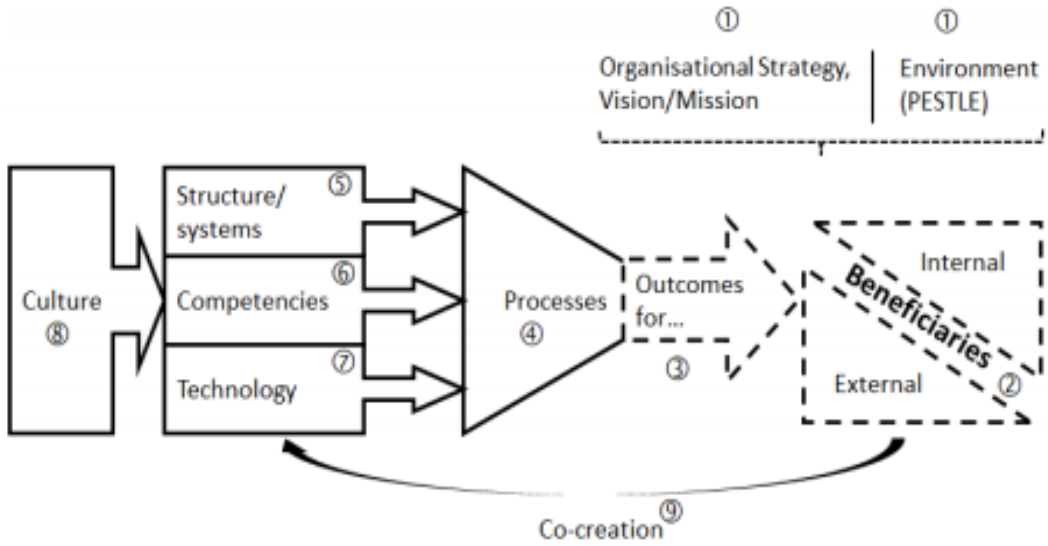

Figure 4 : The components of an organisational architecture
Source: (Lee, 2019)

Additionally, the organizations' strategy is a critical component to consider because it is the foundation of the firms' success. External factors such as the environment, industry, competition, and markets, for example, drive changes in existing strategies (Whittington, Regnér, Angwin, & Scholes, 2020). The construction sector appears to have overlooked all these warning flags, as seen by their slow adoption of technology. Could the construction industry's aversion to AI adoption be because of the lack of agile leaders in the sector? The world has changed and become more unpredictable, particularly since Covid, necessitating industries to find solutions regardless of the challenges. Ultimately, volatility, uncertainty, complexity, and ambiguity (VUCA) of the digital era exemplifies the value of agile leadership (Akkaya , Panait , Apostu , & Kaya , 2022).

It is apparent that the construction business might thrive if the organizational architecture is executed fully. Workplace operations could improve, particularly in the construction business, where conventional functions are still heavily performed.

Hypothesis 3:

Null Hypothesis: Examining the organisational development phenomenon within the construction industry will have no effect on AI technology adoption.

Alternative Hypothesis: Examining the organisational development phenomenon within the construction industry may have an effect of AI technology adoption.

2.5.3 Cost Benefit Analysis for AI Adoption

(Akinosho, et al., 2020) states that utilizing cutting-edge technology always has a cost. Given that the cost of adopting AI technology depends on business needs, determining the precise prices may not be feasible for this study. Therefore, for organisational development, the CI within the SA borders may need to consider the **Financial Costs** adopted from (Ivanov & Webster, 2017) stipulated in table 4 below, as a guide in adopting AI technologies. For instance, the use of AI powered robots that are equipped with cameras to capture 3D pictures through the construction site, for capturing on site progress and identifying errors.

Table 4 : Financial Costs for AI adoption
Source: (Ivanov & Webster, 2017)

Acquisition costs	Initial costs for AI investment in robots and testing.
Installation costs	Software installation for instance the internet of things to predict machine breakdown and maintenance dates.
Maintenance costs	For electric consumption and periodic maintenance.
Software update costs	To keep the systems updated to avoid system glitches.
Costs for facilities	The implementation of a new unit or expansion of the IT department to embrace the new AI technology.
Costs for specialist hiring	This could be the under-IT department or a separate entity.
Costs for staff training	For improved efficiency and effectiveness.

Although it can be challenging to estimate the precise cost of implementing AI, the CI should be aware that it is quite expensive and significant upfront investments are inevitable. Perhaps professionals may help to identify strategies that are affordable and appropriate for business needs.

10 CHAPTER 3: RESEARCH DESIGN

3 Introduction

This chapter will outline the research design and methodological approaches that will be used in this study. It is composed of the research philosophy and approach, methods, methodology, data and data sources, limitations, validity and reliability and ethical risks and mitigation methods. This study followed the research onion fundamentals to clearly outline its research design.

"The research onion provides a rather exhausting description of the main layers or stages which are to be accomplished in order to formulate an effective methodology" (Raithatha, 2017). A methodology is a comprehensive research technique that outlines the proper way to do research. It includes a collection of views and philosophical principles that shape how the research topics are perceived and influence the methodology choices (Melnikovas, 2018). Furthermore, the description of the main philosophy, approach to theoretical development, methodological choices, strategies, time horizon and techniques and procedures prompt the research design of research as illustrated in figure 5.

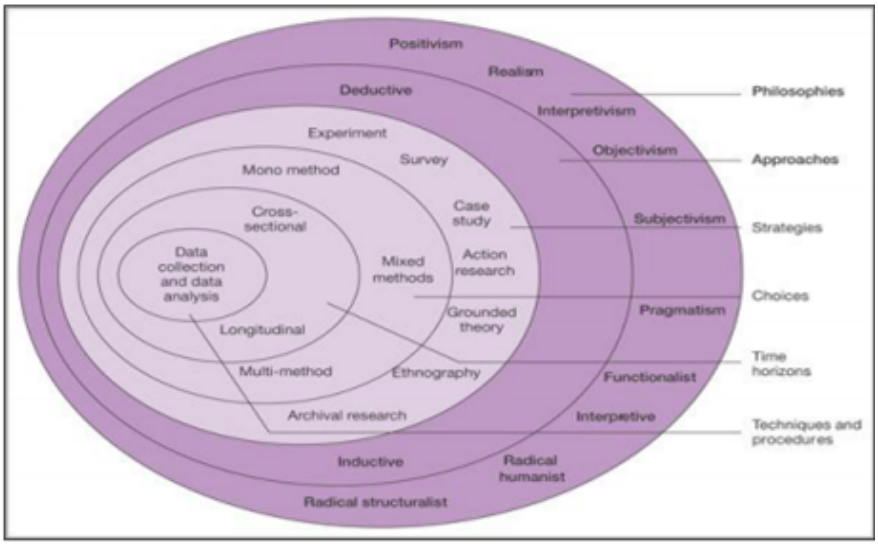

Figure 5 : Research Onion
Source: (Melnikovas, 2018)

3.1 Research Philosophy and Approach

The term paradigm describes the worldviews, assumptions, and methodologies the researcher embodies including the way they explain and engage with the world (Kamal, 2019). As a result, data collection and analysis methods formed part of the researchers' examination, therefore

choices made during the research study were highly impacted by the paradigm. This study adopted an objectivism epistemological philosophy that is grounded on the positivist paradigm. This research is exploratory in nature, and the research aims and objectives, attempted to examine the awareness and attitudes of the Professional Construction Managers (PcPMs) on factors that influence AI adoption through the construction organizational development and supported those findings with data. As a result, the quantitative research approach was deemed suitable for this type of study, as evidenced by its use in other studies such as (Darko, et al., 2017).

3.2 Research Methodology

This study employed a case study research method to obtain a comprehensive understanding of factors that influence AI technology adoption within the SA construction industry, through organisational development. The research study design is empirical in nature; thus, its variables were numerically expressed as frequencies. Thereafter, statistical methods were used to investigate these frequencies hence the study employed a quantitative approach.

The quantitative method has the advantage of making it simple and quick to collect data from a large sample in systematic and impartial manner (Queirós, Faria, & Almeida, 2017). There are three subcategories of the quantitative approach: inferential, experimental, and simulation. Moreover, using the inferential approach, a sample of the population was observed to determine its characteristics or relationships. As a result, generalizing results can be done with better accuracy (Rahman, 2020). Furthermore, impartiality and reliability can be improved because the survey mostly comprises of closed-ended questions. As technology is used to get results, the process might be quicker and simpler to use. Finally, statistical techniques were used to analyze numerical data; these programs frequently include SPSS, R, or Stata (Queirós, Faria, & Almeida, 2017) .

The limitations included the issue of a less in-depth, more broad perspective, which was discovered by employing open-ended questions. Now the concern became whether the participant would have enough time to respond. Also, the results may not have accurately reflected the situation and might be rather ambiguous since dependent on the participants response, (Queirós, Faria, & Almeida, 2017)).

3.3 Data and Data Sources

The target population for this study were the Professional Construction Managers within the SA boarders, enrolled on the SACPCMP website. According to the SACPMP annual report (for the years 2020 to 2021), there are 2,720 professional registered construction managers. The research was focused on individuals relevant to the research topic. Due to the limited population of the respondents in general and the uncertainty of everyone responding, SA borders were used rather than a specific province.

The study aimed to get at least a minimum of 105-120 fully completed questionnaires for this research as supported by other similar studies such as (Manzoor, Othman, Durdyev, Ismail, & Wahab, 2021). However, due to time constraints the researcher could not test the entire population and therefore, 42 fully completed responses were used to represent the entire population of PcPMs. The researcher was able to detect parallels in the replies that were transmitted to the entire population, permitting to validate the hypothesis.

The non-probability sampling was the preferable sampling design strategy in this study since the sample was chosen at the discretion of the researcher rather than using random sampling. The study aimed at proving that this trait of individuals who can help the study in assessing factors that influence AI technology adoption with the South African Construction Industry exists. According to (Andrade, 2021) "A purposive sample is the one whose characteristics are defined for a purpose that is relevant to the study", hence purposive or judgmental sampling being a component of non-probability sampling was utilized for this study. These respondents were chosen based on their knowledge and understanding of the construction industry.

3.4 Research Instrument (s)

Empirical questions were established in the literature based on the study's' aims and objectives; however, these questions could not be answered in the literature review, prompting the creation of research instruments in the form of questionnaires. The relationship between empirical and secondary research questions is better understood when empirical and secondary research questions are linked. The structured questions were answered using the measurement score termed the 5-point Likert scale of one to five ranging from "Low to Very High" respectively as seen in a study by (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020).

3.5 Data Collection and Protocol

The data reviewed in literature was found to be inadequate in this study, therefore an empirical questionnaire was used to get expert perceptions and opinions on factors that influence AI adoption within the SA construction industry through organizational development for this study. A questionnaire is a valuable method of gathering a wide range of information from many individuals. Also, previous studies such as (Alaloul, Liew, Zawawi, & Mohammed, 2018) have used the survey method to assess AI use in construction.

The purpose of demographics in this study was to learn about the participants' backgrounds and to make sure that the data collected from the participants is relevant and that it adequately fulfills the study's objectives. The participants were not asked to disclose their names, and any personal information or identifiable information but rather questions to assess the groups willingness in assessing factors that influence the adoption of AI strategies within the construction industry.

These questions gave context to the survey, allowing for improved participant descriptions and data analysis. A closed ended questionnaire was used in the survey. Closed-ended questionnaires attempt to identify professionals' awareness and perceptions of AI adoption strategies, to meet the research aim and objectives and eliminate ambiguity. The questions were administered using Qualtrics tool, whereby a survey link was obtained and then emailed to the Professional Construction Project Managers registered on the South African Council for the Project and Construction Management Profession (SACPCMP) website in South Africa. The email addresses of professionals were obtained from the SACPCMP website. The survey consisted of 15 questionnaires, comprising three demographics and thirteen closed-ended questions.

On December 12, 2022, the questionnaire was distributed to the professional construction project managers in the building sector. On January 3, 2023, a follow-up email was sent to the intended audience, considering the annual builders' holidays from December 15 to January 15. The survey was stopped on February 07th since it was determined that there were enough responses for the study.

3.6 Data Analysis

The data was analysed using Statistical Package for the Social Sciences tool (SPSS) version 27 as provided by the University of the Witwatersrand. This tool organized the data and provided data based on statistics utilities such as Frequencies, Descriptive, Reliability and Correlations to test the effectiveness of the *Hypothesis*. The fundamental purpose of descriptive analysis was to provide absolute statistics, such as mean, median, mode, percentage, frequency, or range, for demographic questions. Inferential analyses were used to demonstrate the links between various variables to generalize the findings and create predictions but were also utilized to explain the reasoning behind the absolute numbers for demographics and open-ended questions.

3.7 Validity and Reliability

According to (Sürücü & MASLAKÇI, 2020), in quantitative research the accuracy with which an idea is assessed determines its validity. Therefore, to ensure validity for this study each question was correlated to an objective, and the questionnaire included all necessary information. This was done to ensure that the measuring tool used in this study fulfills its purpose by measuring the behavior or quality that it is designed to assess. To further determine the validity of a concept, the coefficient alpha was used to measure internal dependability using Cronbach Alpha where the construct reliability was further tested (Nawi, Tambi, & Samat, 2020).

Although sample size could affect validity, Cronbach alpha was considered adequate for testing dependability even for limited sample numbers (Ercan, Yazici, Sigirli, Ediz, & Kan, 2007). Hence the study's constructs' internal consistency is measured by reliability. Alpha (x) greater than 0.70 indicates that a construct is dependable (Hair et. Al., 2013). (Bhatnagar, Kim, & E Many, 2014), also concurs that an Alpha of 0,70 or higher indicates strong acceptable reliability.

The intent was to determine if correlation between a set of scores exists, based on the respondents' responses. This determined whether the study's' stated goal and objectives closely match the respondents' perceptions and opinions. The reliability was strengthened further by removing items which had a detrimental effect on it, such as redundant responses. Moreover,

according to (Tavakol & Dennick, 2011), homogeneity may contribute to enhance the utilization of Cronbach alpha. (Nawi, Tambi, & Samat, 2020, p. 4)

The sample size was of 51 respondents at the time however, 9 were excluded because of incomplete surveys. The number of respondents for this study is in line with the recommended sample size of 30 respondents according to (Conroy, 2015). The results in table 6 revealed a reliability of 0.697 which suggest that the internal consistency is acceptable. Table 8 further shows the item corporate executives within the construction industry buy into technological advancement with two items (x =0.699) and the construction sector is lagging in the adoption of AI technologies with two items (x=0.70) were found reliable. Similarly, importance of organizational development impact and its effect on business evolvement to create high performance with two items (x=0.70) was also found reliable. Reliability outcomes are summarized in table 6 below.

Moreover, it must be noted that in table 8, Q4, Q6, Q11, Q12, Q13, Q14 measured through the Likert scale of 1 to 5 were reverse coded to achieve more reliability. This is line with (Jain & Angural, 2017) view that consequently, items may need to be changed or deleted to achieve reliability, this may be due to the partial association of some items with one another, insufficient number of items or differences in the instrument's design.

Table 5 : Evaluating Missing Data

Case Processing Summary

		N	%
Cases	Valid	42	82.4
	Excluded[a]	9	17.6
	Total	51	100.0

a. Listwise deletion based on all variables in the procedure.

Table 6 : Cronbach's Alpha

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.697	.683	12

Table 7 : Summary Item Statistics

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	2.938	1.190	4.929	3.738	4.140	1.695	12
Item Variances	.715	.068	1.721	1.653	25.333	.304	12

Table 8 : Reliability outcomes

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q4. Has your organisation adopted AI technologies within the building construction?	33.90	21.942	.348	.326	.681
Q5. In your opinion, do you think there is resistance in AI technology adoption by the construction industry?	33.93	22.751	.171	.530	.696
Q6. Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?	32.71	19.868	.280	.362	.690
Q7. In your opinion would you say the construction sector is lagging in the adoption of AI technologies?	34.07	23.190	.107	.478	.700
Q8. Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?	31.55	16.351	.536	.678	.638
Q9. Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?	31.86	17.784	.510	.658	.645

Q10. Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages?	31.50	16.793	.745	.849	.601
Q11. In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?	30.33	23.106	.234	.344	.694
Q12. Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?	31.57	21.178	.293	.346	.683
Q13. In your opinion do you think corporate executives within the construction industry buy into technological advancement?	33.83	22.874	.132	.595	.699
Q14. Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.	31.31	21.731	.175	.323	.700
Q15. In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?	31.31	18.609	.388	.599	.670

3.8 Ethical Considerations

This study understood the importance of ethical consideration and therefore outlined mitigation methods to ethical risks that could have been imposed by this research.

Table 9 : Ethical Risks and Mitigation Strategies

ETHICAL RISKS	MITIGATION METHODS
Risk of harm	To mitigate the impact of any risk, the surveys were accompanied with an informed consent letter, approved by the university, and signed by the research supervisor. Participants had an option of agreeing or disagreeing to participate in the survey. The letter explicitly explained the participants' rights, including their right to withdraw from the survey if they no longer chose to participate. It was stipulated that they also, had the option to withdraw their consent if they no longer wanted to be a part of the study anytime. Furthermore, the consent form stated that the survey is for study purposes only and will not be used for anything else either than that.
Research Integrity	To maintain research integrity, no judgment, deceit, or rewards of any kind were entertained or included in this study.
Informed Consent	To achieve informed consent, the research's goal, nature, and objectives were clearly communicated, allowing participants to choose whether to participate or not. To enhance transparency, the risks and benefits of study were explicitly communicated. In addition, a disclaimer was put that by continuing with the survey, it will be concluded that the participant understands and agrees to the informed consent as stipulated. It was clearly stated that participation is entirely voluntary and not coerced.
Privacy and protection of anonymity	This study will remain in the school's property for a period of five years and will only be used for academic purposes. Furthermore, no questions about the participants' names or identities, including their geographic area, were required in this study, therefore participants were not required

	to provide such information. The participants' comments cannot be aligned to a name should they be made public; also, they will be stored securely in a password-protected folder on the researchers' laptop for a period of five years.
Confidentiality	The study did not ask for any personal information from participants because the objective was for them to remain anonymous just so their replies can be kept hidden and not connected back to them. However, absolute confidentiality could not be guaranteed.
Friendship	The researcher did not form relationships with participants as that might have undermined the integrity of the data quality and findings.
Data Interpretation	The SPSS software and the data analysis method specified in the study were used to analyse the data collected from the participants. It was not tampered with, to maintain honesty and integrity and protect findings of study.
Deceptive practices	To cultivate accountability, trust, and honesty, the details of the researchers', supervisors', and school administrators', and the study purpose, were clearly stipulated.
Well-beings of Participants	This study did not include those from the vulnerable group. (Children, mentally ill people, and the aged).

11 CHAPTER FOUR: PRESENTATION OF RESULTS

4 Introduction

The construction industry seems to be famous for lagging in the adoption of technologies as opposed to other sectors like the Financial Services, High tech and Communications that are in the lead. The construction industry as an organisation therefore has a responsibility to change their old ways of working, which mostly are too labour intensive as witnessed within the project lifecycle stages.

This chapter, therefore, includes data analysis obtained from the questionnaire that was generated as quantitative data. The questionnaire aimed to get expert perceptions and opinions on factors that influence AI adoption strategies within the SA construction industry through organizational development for this study. The questionnaire was administered through the Qualtrics software with a link for participants to participate in the survey. Attached in the email was the brief description of the topic including contact details of the school, supervisor, and researcher. The data was analysed using the SPSS tool. To ensure validity and reliability data integrity is discussed under demographics and under all three objectives.

The purpose of this chapter is therefore to discuss participant responses. Conclusions and suggestions for the chapters to come will consequently be aided by the findings. These results will help determine whether the study's goals and objectives were achieved. The questionnaire analysis discussed in this chapter answered the following three research questions:

Table 10 : Questionnaire analysis

Question	Literature Review	Source of data	Type of data	Analysis
Main Question: How does the adoption of AI technology strategies impact on the effectiveness and efficiency within the South African construction industry?	2.3.1 Origins of AI 2.3.2 AI adoption within the South African Context 2.3.3 AI adoption within the International Context	Survey questions 4-7	Survey Questionnaire	Descriptive Analysis
Sub Question 1: What is the impact of opportunities and constraints of AI adoption by the construction industry, on productivity?	2.4.1 AI technologies functions and challenges 2.4.2 AI technologies and opportunities	Survey questions 8-12	Survey Questionnaire	Descriptive Analysis
Sub Question 2: How does AI technology adoption affect organisational development within the South African construction industry? do they have on organisational performance?	2.5.1 Organisational Development 2.5.2 The Organisational Architecture	Survey questions 13-15	Survey Questionnaire	Descriptive Analysis

11.1

The questionnaire consisted of 15 questions in total. The first part of the questionnaire entailed three questions of a demographical overview of the participants with reference to the sector they are in, age profile and years of experience. The second part of the questionnaire referred to the main question and sub questions illustrated in table 10 above.

4.1 Overview of the respondents' profiles (Demographics)

The study's population was based on a non-probability sample targeting a participation of one hundred and five to one hundred and twenty (105 -120) PcPMs, to examine the awareness and attitudes of PcPMs on factors influencing AI adoption through organizational development. However, only forty-two (42) about two thirds (2/3) out of 105 participants completed a survey. The demographic profile of the people who participated in the research will be discussed in the section that follows.

4.1.1 Objective of demographics

The objective of this section was to create a demographical overview of participants to learn about the participants' backgrounds based on the sector they are in, their age profile and the years of experience in the industry.

The goal was to make sure that the data collected from the participants is relevant and that it adequately fulfills the study's objectives.

4.1.2 Results

An overview of the respondents who answered each question is shown in table 11. There were 50 responses for the sector, 49 for age, and 44 for the years of experience. However, only 44 respondents were considered relevant for this question because others were regarded redundant because of incomplete questionnaires.

Table 11 : Population Descriptive Statistics

	N	Mean	Std. Deviation	Variance
Q1. Which sector do you represent?	50	1.620	.485	.236
Q2. In which age category do you fall under?	49	2.612	.751	.564
Q3. Years of experience: How many years of experience do you have?	44	3.045	.878	.771
Valid N (listwise)	44			

Std. Deviation and Variance use N rather than N-1 in denominators.

Sector

Table 12 : Q1 - Participants' sector they represent

Sector: Which sector do you represent?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	19	37.3	38.0	38.0
	Private	31	60.8	62.0	100.0
	Total	50	98.0	100.0	
Missing	System	1	2.0		
Total		51	100.0		

The results shown in table 7 indicated that out of 51 respondents (n=51), the private sector was represented by majority of respondents thus, 60.8% (n =31), whilst 37.3% (n-19) respondents were in the public sector. However, a representation of 2.0% (n=1) did not declare their sector.

Age Profile

Table 13 : Q2 - Participants' years of experience

Age Profile: In which age category do you fall under?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Age 20 - 29	2	3.9	4.1	4.1
	Age 30 - 39	21	41.2	42.9	46.9
	Age 40 - 49	20	39.2	40.8	87.8
	Age 50+	6	11.8	12.2	100.0
	Total	49	96.1	100.0	
Missing	System	2	3.9		
Total		51	100.0		

Furthermore, table 13 indicated that most respondents thus, 41.2% (n=21), were between 30 and 39 years of age followed by 39.2% (n=20) between the ages of 40 to 49, whilst 11.8% (n=6) were 50 plus years of age and 3.9% (n=2) were below 20 to 29 years. However, a representation of 3.9% (n=2), did not declare their age categories.

Years of experience

Table 14 : Q3 - Participants' age profile

Years of experience: How many years of experience do you have?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 5 years	2	3.9	4.5	4.5
	5 - 10 years	10	19.6	22.7	27.3
	10 - 15 years	16	31.4	36.4	63.6
	15 - 20 years	16	31.4	36.4	100.0
	Total	44	86.3	100.0	
Missing	System	7	13.7		
Total		51	100.0		

Table 14 stated that most respondents thus, 31.4% (n=16) representing two groups between 15 and 20 years of experience and 10 to 15, followed by 19.6% (n=10), with 5 to 10 years' experience and 3.9% (n=2) with below 5 years of experience. However, a representation of 13.7% ((n=7), did not declare their years of experience.

Findings of demographics

The demographic overview of respondents in this study revealed that most of the population were within the private sector (60.8%). The most represented age group (41.2%) was between the ages of 30 to 39 years. Moreover, most respondents were between 15 to 20 and 10 to 15 years of experience in the industry (31.4%x2).

Data revealed that the private sector was fairly represented with participants who have been working within the construction industry for several years and are considered as highly likely to provide a clear view and understanding of the industry. Moreover, the participants were of mature age, making them very likely to provide reliable information. The findings further imply that the respondents had knowledge and understanding of the construction industry. They were also relevant to the research topic and could represent the entire population.

As a result, it can be said that this study's demographic findings demonstrated the external validity of the population in terms of the sector, age, and years of experience. This is in line with (HR & Aithal, 2022) who states that external validity is the degree to which a measurement tool seems to measure what it is supposed to measure.

4.2 Descriptive Statistics

The below section will examine **the descriptive statistics of t**he data that were obtained based on the three objectives established in **Chapter 1** to accomplish the goal of this study.

Objective 1: To assess the adoption of AI technology strategies and its impact on effectiveness and efficiency within the construction industry.
Objective 2: To identify opportunities and constraints of AI adoption by the construction industry to help improve its productivity.
Objective 3: To examine the organisational development phenomenon within the construction industry and its effect on AI Technology adoption.
The research objectives matrix in relation to the literature review and survey questionnaire is shown in table 15 below.

Table 15 : Research Objective Consistency Matrix

Objectives	**Literature Review**	**Survey Questionnaire**	**Analysis**
Objective 1: To assess the adoption of AI technology strategies and its impact on effectiveness and efficiency within the construction industry.	2.3.4 Origins of AI 2.3.5 AI adoption within the South African Context 2.3.6 AI adoption within the International Context	***Survey questions 8-12*** 8.Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry? 9.Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery? 10.Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages? 11.In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance? 12.Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?	Descriptive Analysis

Objective 2: To identify opportunities and constraints of AI adoption by the construction industry to help improve its productivity.	2.4.3 AI technologies functions and challenges 2.4.4 AI technologies and opportunities	***Survey questions 4-7*** 4.Has your organisation adopted AI technologies within the building construction? 5.In your opinion, do you think there is resistance in AI technology adoption by the construction industry? 6.Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry? 7.In your opinion would you say the construction sector is lagging in the adoption of AI technologies?	Descriptive Analysis
Objective 3: To examine the organisational development phenomenon within the construction industry and its effect on AI Technology adoption.	4.2.1 Organisational Development 4.2.2 The Organisational Architecture	***Survey questions 13-15*** 13.In your opinion do you think corporate executives within the construction industry buy into technological advancement? 14.Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance? 15.In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?	Descriptive Analysis

Table 16 below displays the proportion of participants who responded to each question using the Likert scale, from the lowest to highest values. The standard deviation reveals how far a sample mean deviates from the actual population mean, and the mean displays the average of values for a given variable. Based on the results of the survey questionnaire, the research objectives will be outlined below.

Table 16 : Descriptive Analysis pertaining the research objectives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Q4. Has your organisation adopted AI technologies within the building construction?	45	1	2	1.38	.490
Q5. In your opinion, do you think there is resistance in AI technology adoption by the construction industry?	44	1	2	1.34	.479
Q6. Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?	44	1	5	2.59	1.085
Q7. In your opinion would you say the construction sector is lagging in the adoption of AI technologies?	44	1	2	1.20	.408
Q8. Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?	45	1	5	3.69	1.311
Q9. Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?	43	1	5	3.35	1.152
Q10. Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages?	42	1	5	3.76	.983
Q11. In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?	42	4	5	4.93	.261
Q12. Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?	42	3	5	3.69	.749

Q13. In your opinion do you think corporate executives within the construction industry buy into technological advancement?	42	1	2	1.43	.501
Q14. Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.	42	2	5	3.95	.825
Q15 In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?	43	1	5	3.98	1.144
Valid N (listwise)	42				

4.1.1 Results based on Objective 1

Objective 1 assessed the adoption of AI technology strategies and its impact on the effectiveness and efficiency within the construction industry. To effectively achieve objective 1 five questions were developed as follows 1) AI technology adoption enhancement of productivity and efficiency, 2) Eliminating working by hand and using AI functions for project delivery, 3) incorporating AI technologies within the project lifecycle stages, 4) AI provision of opportunities for effectiveness and efficiency in CI performance, 5) AI technologies bringing in more opportunities rather than constraints.

Table 17 below provides a summary of objective 1 findings and valid responses for items, Q8, Q9, Q10, Q11, and Q12 all have responses of (n=45), (n=43), (n=42), and (n=42) respectively. The data is also primarily negatively skewed, with only one positively skewed item and four items with negative values of skewness. To get a conclusion on Objective 1, the results will be further discussed for each question.

Table 17 : Objective 1 Data Analysis Overview

Statistics

		Q8. Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?	**Q9.** Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?	**Q10.** Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages?	**Q11.** In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?	**Q12.** Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?
N	Valid	45	43	42	42	42
	Missing	6	8	9	9	9
Mode		4[a]	4	4	5	3
Skewness		-.781	-.444	-.947	-3.453	.585
Std. Error of Skewness		.354	.361	.365	.365	.365

a. Multiple modes exist. The smallest value is shown

Table 18 shows that out of 45 respondents, the majority 29.4% (n=15) each, strongly and somewhat agree that AI technology adoption will enhance productivity and efficiency within the construction industry, whilst 11.8% (n=6) somewhat disagree. Similarly, 9.8% (n=5) neither agree nor disagree and a small 7.8% (n=4) feels extremely uncomfortable. The Likert Scale ranging from 1 strongly agree – 5 strongly disagree was used to measurer responses for this item.

Q8: AI adoption enhancement productivity and efficiency

Table 18 : Q8 – AI adoption enhancement of productivity and efficiency

Q8. *Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	4	7.8	8.9	8.9
	Somewhat disagree	6	11.8	13.3	22.2
	Neither agree nor disagree	5	9.8	11.1	33.3
	Somewhat agree	15	29.4	33.3	66.7
	Strongly agree	15	29.4	33.3	100.0
	Total	45	88.2	100.0	
Missing	System	6	11.8		
Total		51	100.0		

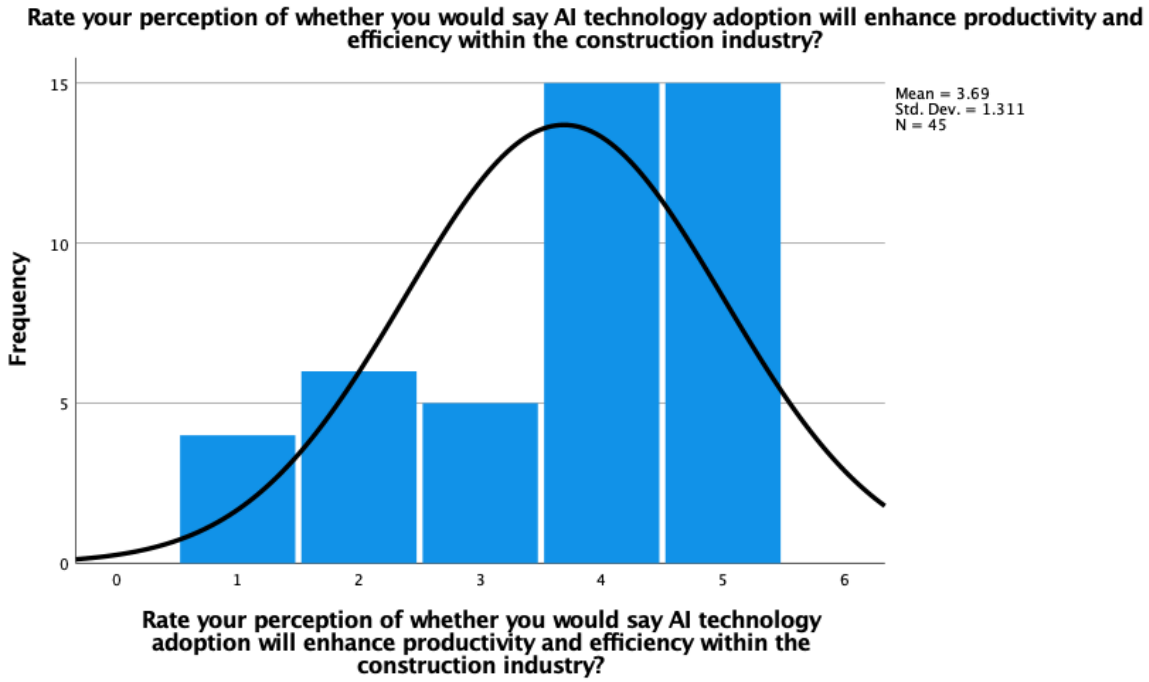

Figure 6 : Q8 – AI adoption enhancement of productivity and efficiency

The data as shown in figure 6 is left-skewed, thus it is not evenly distributed as indicated with the negative value (-0.781) in table 17. This can be concluded that out of 45 respondents the majority had consensus that *AI technology adoption will enhance productivity and efficiency within the construction industry* (Mean = 3.69). The standard deviation of higher than 1.0 also

indicates that the data results are more spread out and not closer to the mean. Thus, the respondents “strongly agree” to the statement.

Q9: Eliminating working by hand and using AI functions for project delivery

Table 19 shows that out of 43 respondents, the majority 33.3% (n=17) would feel somewhat comfortable in eliminating working by hand and using AI functions for project delivery, whilst 17.6% (n=9) feels neither comfortable nor uncomfortable. Similarly, 15.7% (n=8) feels somewhat comfortable and a few 5.9% (n=3) feels extremely uncomfortable. The Likert Scale ranging from 1 extremely uncomfortable – 5 extremely comfortable was used to measurer responses for this item.

Table 19 : Q9 – Eliminating manual labour and incorporating AI for project delivery

Q9. *Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely uncomfortable	3	5.9	7.0	7.0
	Somewhat uncomfortable	8	15.7	18.6	25.6
	Neither comfortable nor uncomfortable	9	17.6	20.9	46.5
	Somewhat comfortable	17	33.3	39.5	86.0
	Extremely comfortable	6	11.8	14.0	100.0
	Total	43	84.3	100.0	
Missing	System	8	15.7		
Total		51	100.0		

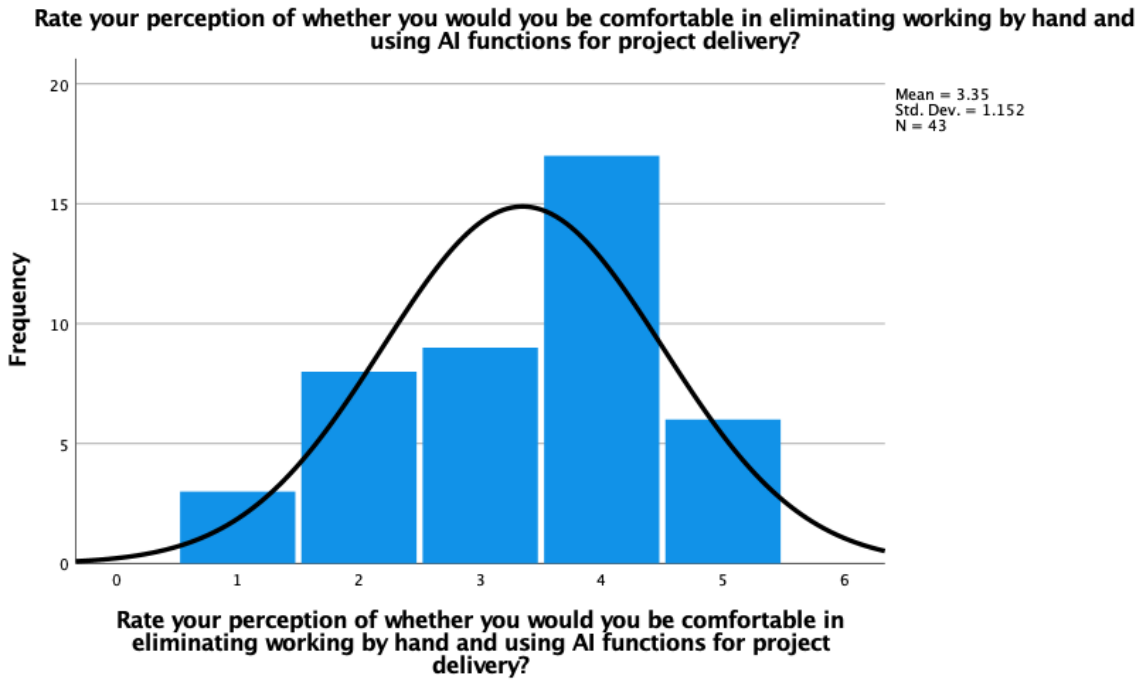

Figure 7 : Q9 – Eliminating manual labour and incorporating AI for project delivery

The data as shown in figure 7 is left-skewed, thus it is not evenly distributed as indicated with the negative value (-0.444) in table 17. This can be concluded that out of 43 respondents most agree that they would you *be comfortable in eliminating working by hand and using AI functions for project delivery* (Mean = 3.35). The standard deviation of higher than 1.0 also indicates that the data results are more spread out and not closer to the mean. Thus, the respondents "agree" to the statement.

Q10: Incorporating AI technologies to the Project Lifecycle Stage

Table 20 shows that out of 42 respondents, the majority 45.1% (n=23) would feel somewhat comfortable in incorporating AI technologies within the project lifecycle stages, whilst 15.7% (n=8) feels neither extremely comfortable. Similarly, 9.8% (n=8) of two categories feel somewhat comfortable and neither comfortable nor uncomfortable respectively, whilst a few 2.0% (n=1) feels extremely uncomfortable. The Likert Scale ranging from 1 extremely uncomfortable – 5 extremely comfortable was used to measurer responses for this item. Thus the respondents feel "comfortable".

Table 20 : Q10 - Incorporating AI to the Project Lifecycle Stage

Q10. *Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely uncomfortable	1	2.0	2.4	2.4
	Somewhat uncomfortable	5	9.8	11.9	14.3
	Neither comfortable nor uncomfortable	5	9.8	11.9	26.2
	Somewhat comfortable	23	45.1	54.8	81.0
	Extremely comfortable	8	15.7	19.0	100.0
	Total	42	82.4	100.0	
Missing	System	9	17.6		
Total		51	100.0		

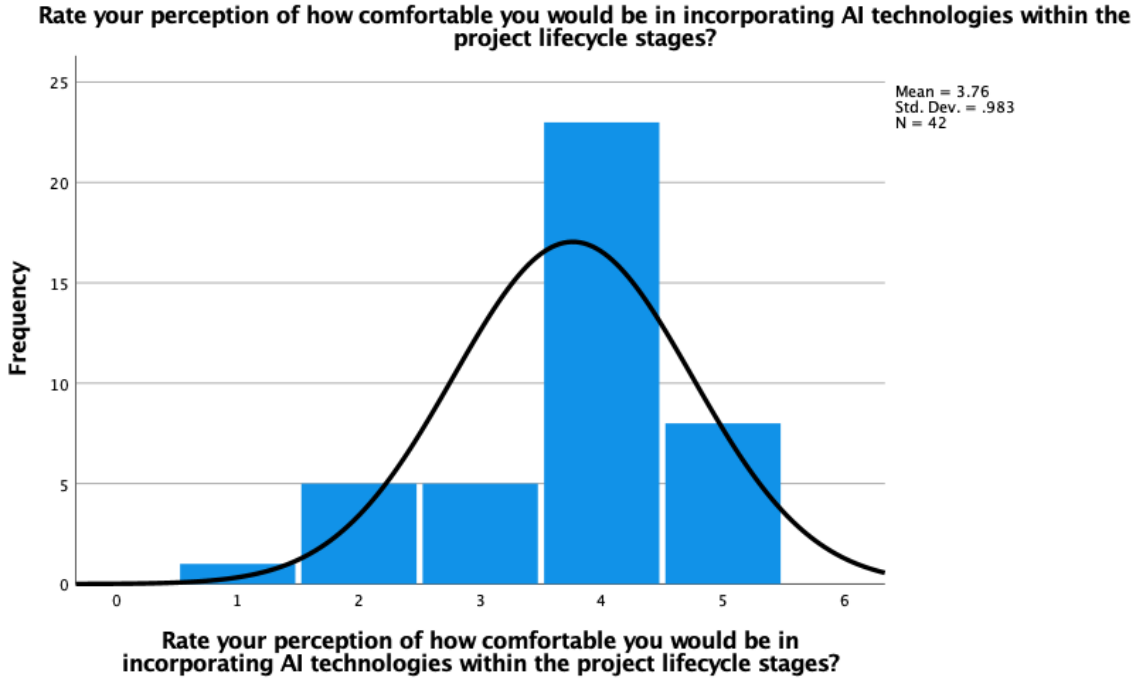

Figure 8 : Q10 - Incorporating AI to the Project Lifecycle Stage

The data as shown in figure 7 is left-skewed, thus it is not evenly distributed as indicated with the negative value (-0.947) in table 17. This can be concluded that out of 42 respondents most had consensus that *they would be comfortable in incorporating AI technologies within the project lifecycle stage*s (Mean = 3.76). The standard deviation is lower than 1.0 however closer to 1.0 than 0 which indicates that the data results are more spread out and not closer to the mean. Thus, the respondents "agree" to the statement.

Q11: AI gives an opportunity for effectiveness and efficiency in the CI performance

Table 20 shows that out of 42 respondents, the majority 76.1% (n=39) agree that AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance, whilst 5.9% (n=3) do not agree. The scale with a yes and no categories was used for this item.

Table 21 : Q11 – AI gives an opportunity for effectiveness and efficiency

Q11. *In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	3	5.9	7.1	7.1
	Yes	39	76.5	92.9	100.0
	Total	42	82.4	100.0	
Missing	System	9	17.6		
Total		51	100.0		

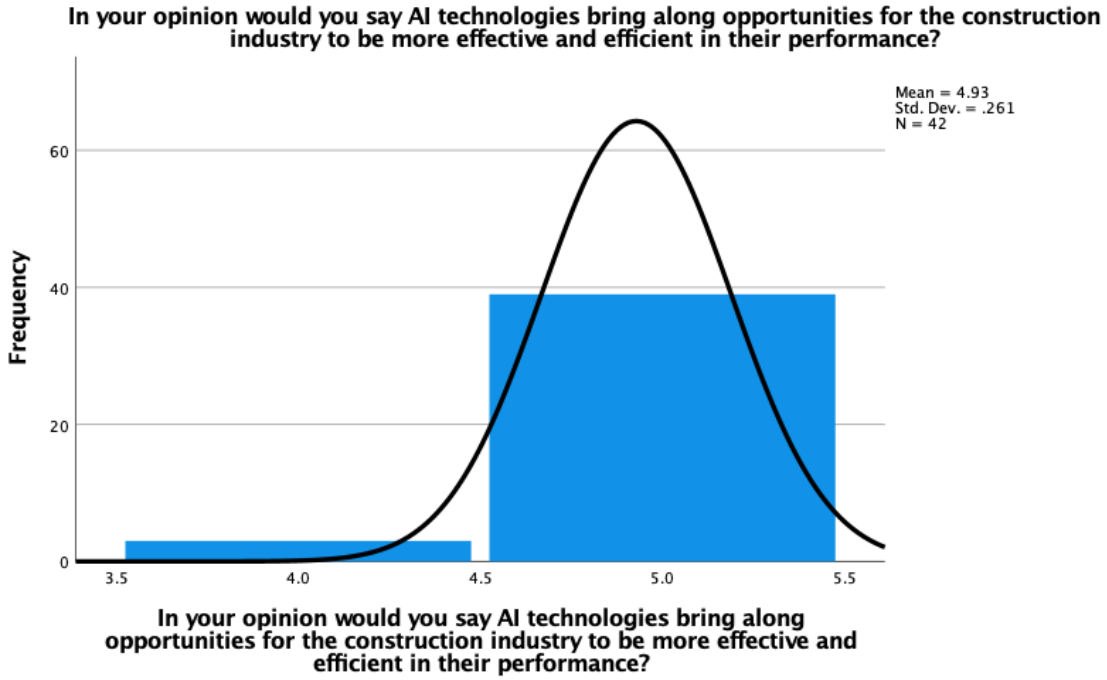

Figure 9 : Q11 – AI gives an opportunity for effectiveness and efficiency

The data as shown in figure 9 is left-skewed, thus it is not evenly distributed as indicated with the negative value (-3.453) in table 17. This can be concluded that out of 42 respondents most had consensus that *AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance* (Mean = 4.93). The standard deviation is

lower closer to 0 which indicates that the data results are closer to the mean. Thus, the respondents "agree" to the statement.

Q12: AI bringing in more opportunities rather than constraints

Table 20 shows that out of 42 respondents, the majority 39.2% (n=20) are undecided whether AI technologies will bring in more opportunities within the construction industry rather than constraints, whilst 29.4% (n=15) feels low opportunities will come with AI. Similarly, 13.7% (n=7) feel very low opportunities will come with AI technologies. The Likert Scale ranging from 1 very high – 5 very low was used to measurer responses for this item.

Table 22 : Opportunities rather than constraints

Q12. *Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Average	20	39.2	47.6	47.6
	Low	15	29.4	35.7	83.3
	Very Low	7	13.7	16.7	100.0
	Total	42	82.4	100.0	
Missing	System	9	17.6		
Total		51	100.0		

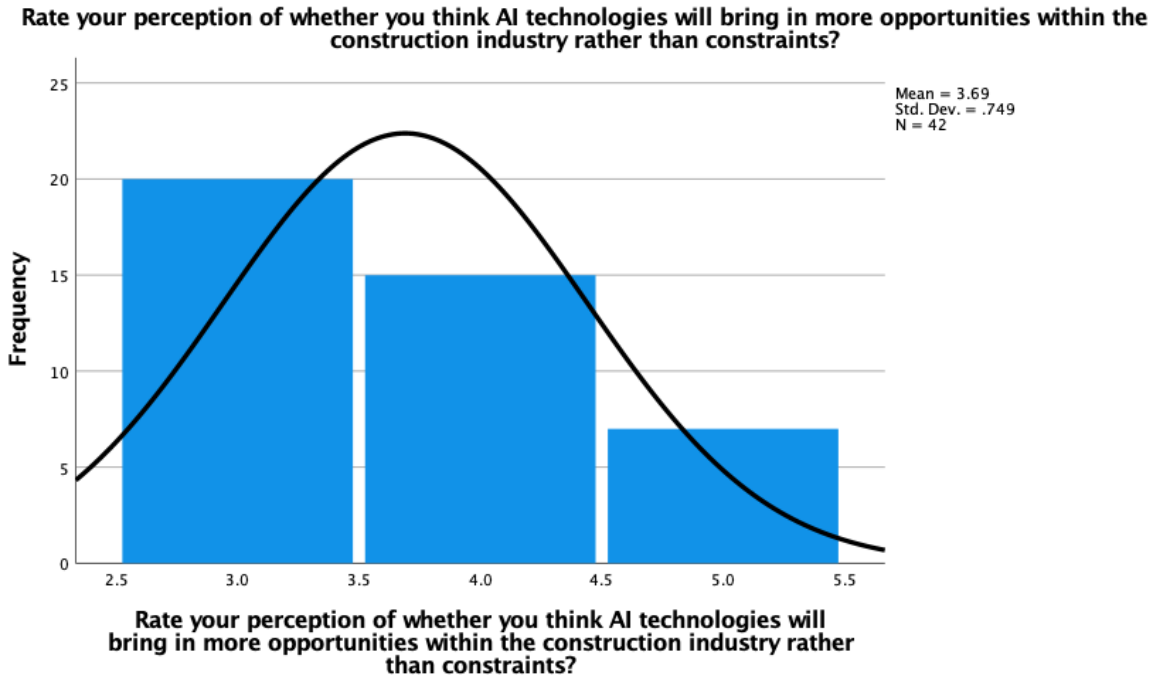

Figure 10 : Q12 – Opportunities rather than constraints

The data as shown in figure 10 is right-skewed, thus it is not evenly distributed as indicated with the positive value (0.585) in table 17. This can be concluded that out of 42 respondents most are undecided *whether AI technologies will bring in more opportunities within the construction industry rather than constraints* (Mean = 3.69). The standard deviation is high closer to 1.0 which indicates that the data results are more spread out and not closer to the mean. Thus, the respondent's perception "disagrees" with the statement.

Correlation Analysis – Objective 1

In this section, to assess the relationships between the items and test the findings the Pearson correlation coefficient was used. The correlation between signals and random variables is commonly measured by the Pearson correlation coefficient (Šverko, Vrankić, Vlahinić, & Rogelj, 2022, p. 1). Therefore, to determine whether two variables are positively, adversely, or not at all related to one another, correlation entails measuring the association, relationship, or correlation between them. If changes in one variable have an impact on or influence changes in the other, then the two variables are said to be linked (Obilor & Amadi, 2018, p. 2). Correlation coefficients are essentially high or low in terms of magnitude, positive or negative, ranging from -1 to +1 signifying a perfect negative and positive respectively, while a correlation of 0 indicates zero correlation. In addition, correlation coefficients lower than 0.40 are low, higher correlation coefficients are higher than 0.60, and everything in between 0.40 and 0.60 is considered moderate (Obilor & Amadi, 2018).

This aims to find out if a correlation exists between variable (Q8) about the adoption of AI technology and its impact on effectiveness and efficiency within the construction industry, with independent variables ((Q9) Eliminating working by hand and using AI functions for project delivery, (Q10) incorporating AI technologies to the Project Lifecycle Stage, (Q11), AI gives an opportunity for effectiveness and efficiency in CI performance, (Q12) AI bringing in more opportunities rather than constraints.

Table 23 shows that a strong positive significant relationship between Q8 and Q9, Q10, Q11 and Q12 exists. This means that adoption of AI technology may have a positive impact on the effectiveness and efficiency within the construction industry (Q8) if eliminating working by hand and using AI functions for project delivery (Q9) can be decreased and the construction industry incorporate AI technologies to the Project Lifecycle Stage (Q10); then AI technologies

will bring along increased opportunities for the construction industry to be more effective and efficient in their performance (Q11) and further bring in more opportunities within the construction industry rather than constraints (Q12). The results therefore imply that the adoption of AI technology strategies may have a positive impact on the effectiveness and efficiency within the construction industry.

Table 23 : Correlation Analysis Results - Objective 1

Correlations

		Q8. Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?	**Q9.** Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?	Q10. Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages?	**Q11.** In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?	**Q12.** Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?
Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?	Pearson Correlation	1	.514**	.721**	.295	.131
	Sig. (2-tailed)		<.001	<.001	.057	.407
	N	45	43	42	42	42
Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?	Pearson Correlation	.514**	1	.719**	.103	.420**
	Sig. (2-tailed)	<.001		<.001	.517	.006
	N	43	43	42	42	42
Rate your perception of how comfortable you would be in	Pearson Correlation	.721**	.719**	1	.218	.262
	Sig. (2-tailed)	<.001	<.001		.166	.094

incorporating AI technologies within the project lifecycle stages?	N	42	42	42	42	42
In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?	Pearson Correlation	.295	.103	.218	1	.134
	Sig. (2-tailed)	.057	.517	.166		.398
	N	42	42	42	42	42
Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?	Pearson Correlation	.131	.420**	.262	.134	1
	Sig. (2-tailed)	.407	.006	.094	.398	
	N	42	42	42	42	42

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

4.1.2 Results based on Objective 2

Objective 2 assessed identifying opportunities and constraints of AI adoption by the construction industry to help improve its productivity. To effectively achieve objective 1 four questions were developed as follows 1) Organisation adoption of AI technologies, 2) Resistance in AI technology adoption, 3) Awareness of AI technologies, 4) The construction sector lagging in the adoption of AI technologies.

Table 23 provides a summary of objective 2 results and valid responses for items, Q4, Q5, Q6 and Q7, all have responses of (n=45), (n=43), (n=42), and (n=42) respectively. The data is also primarily positively skewed. To get a conclusion on Objective 2, the results will be further discussed for each question.

Table 24 : Objective 2 Data Analysis Overview

Statistics

		Q4. Has your organisation adopted AI technologies within the building construction?	**Q5.** In your opinion, do you think there is resistance in AI technology adoption by the construction industry?	**Q6.** Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?	**Q7.** In your opinion would you say the construction sector is lagging in the adoption of AI technologies?
N	Valid	45	44	44	44
	Missing	6	7	7	7
Mode		1	1	3	1
Skewness		.522	.695	.441	1.517
Std. Error of Skewness		.354	.357	.357	.357

Q4: Organisation adoption of AI technologies

Table 20 shows that out of 45 respondents, the majority 54.9% (n=28) agree that their organisation adopted AI technologies within the building construction, whilst 33.3% (n=17) do not agree. The scale with a yes and no categories was used for this item.

Table 25 : Q4 - AI enhancement on productivity & efficiency

Q4. *Has your organisation adopted AI technologies within the building construction?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	54.9	62.2	62.2
	No	17	33.3	37.8	100.0
	Total	45	88.2	100.0	
Missing	System	6	11.8		
Total		51	100.0		

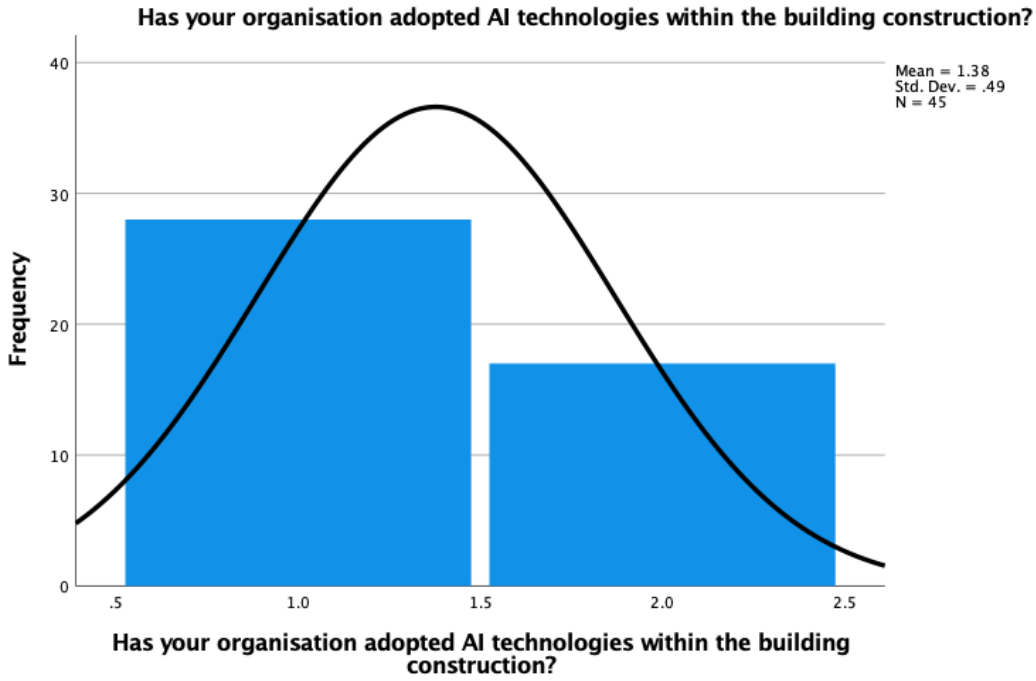

Figure 11 : Q4 - AI enhancement on productivity and efficiency

The data as shown in figure 11 is right-skewed, thus it is not evenly distributed as indicated with the positive value (0.522) in table 23. This can be concluded that out of 45 respondents *most agree that their organisation adopted AI technologies within the building construction* (Mean = 1.38). The standard deviation is low less than 1.0 and closer to 0 which indicates that the data results are low spread out. Thus, the respondent's confirmed AI adoption by their organisations.

Q5: Resistance in AI technology adoption

Table 25 shows that out of 44 respondents, the majority 56.9% (n=29) *think there is resistance in AI technology adoption by the construction industry*, whilst 29.4% (n=15) do not agree. The scale with a yes and no categories was used for this item.

Table 26 : Q5 - Comfort in eliminating manual labour

Q5. *In your opinion, do you think there is resistance in AI technology adoption by the construction industry?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	29	56.9	65.9	65.9
	No	15	29.4	34.1	100.0
	Total	44	86.3	100.0	
Missing	System	7	13.7		
Total		51	100.0		

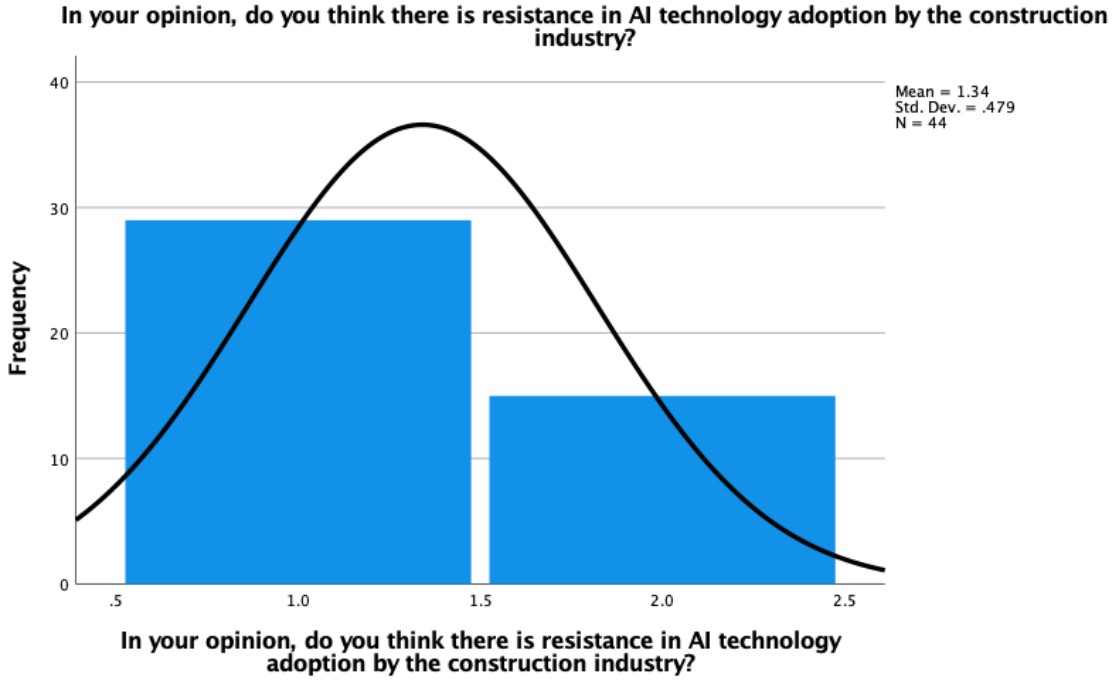

Figure 12 : Q5 - Comfort in eliminating manual labour

The data as shown in figure 12 is right-skewed, thus it is not evenly distributed as indicated with the positive value (0.695) in table 23. This can be concluded that out of 44 respondents most think that *there is resistance in AI technology adoption by the construction industry* (Mean = 1.34). The standard deviation is low less than 1.0 and closer to 0 which indicates that the data results are low spread out. Thus, the respondent's confirmed resistance in AI technology adoption by the construction industry .

Q6: Awareness of AI technologies

Table 20 shows that out of 42 respondents, the majority 31.4% (n=16) think that the *awareness of AI technologies within the construction industry is average;* 27.5% (n=14) think there is high awareness of AI technologies. Similarly, 13.7% (n=7) there is very high AI awareness whilst 7.8% (4) think there is low AI awareness and 5.9% (n=3) think there is very low AI technology awareness within the construction industry. The Likert Scale ranging from 1 very high – 5 very low was used to measurer responses for this item.

Table 27 : Awareness of AI Technologies

Q6. *Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very High	7	13.7	15.9	15.9
	High	14	27.5	31.8	47.7
	Average	16	31.4	36.4	84.1
	Low	4	7.8	9.1	93.2
	Very Low	3	5.9	6.8	100.0
	Total	44	86.3	100.0	
Missing	System	7	13.7		
Total		51	100.0		

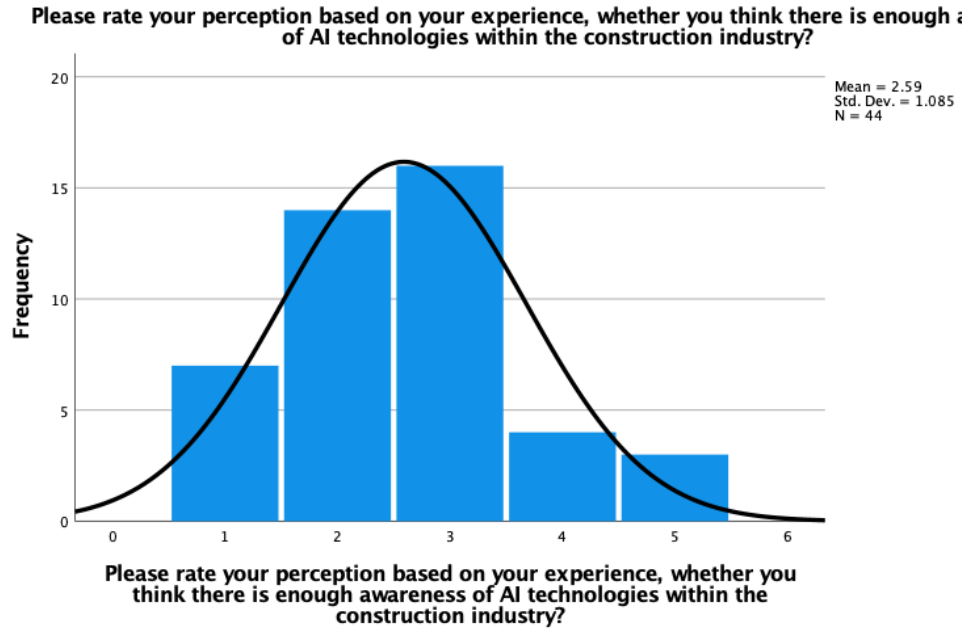

Figure 13 : Q6 - Awareness of AI Technologies

The data as shown in figure 13 is right-skewed, thus it is not evenly distributed as indicated with the positive value (0.441) in table 23. This can be concluded that out of 44 respondents most are undecided whether *whether there is enough awareness of AI technologies within the construction industry* (Mean = 2.59). The standard deviation of higher than 1.0 also indicates that the data results are more spread out and not closer to the mean. Thus, the respondent's confirmed that *the awareness of AI technologies within the construction industry is average.*

Q7: The construction sector lagging in the adoption of AI technologies.

Table 27 shows that out of 44 respondents, the majority 68.6% (n=35) *think that the construction sector is lagging in the adoption of AI technologies*, whilst 17.6% (n=9) do not agree. The scale with a yes and no categories was used for this item.

Table 28 : Q7 – CI lagging in AI adoption

Q7. *In your opinion would you say the construction sector is lagging in the adoption of AI technologies?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	35	68.6	79.5	79.5
	No	9	17.6	20.5	100.0
	Total	44	86.3	100.0	
Missing	System	7	13.7		
Total		51	100.0		

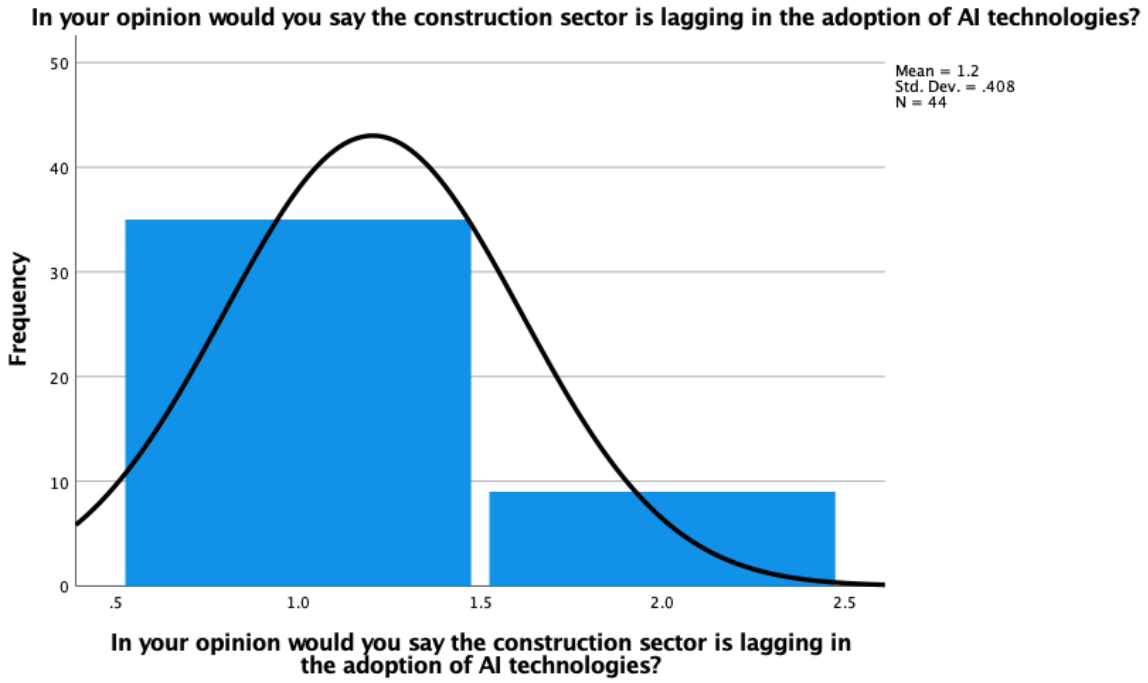

Figure 14 : Q7 – CI lagging in AI adoption

The data as shown in figure 14 is right-skewed, thus it is not evenly distributed as indicated with the positive value (1.517) in table 23. This can be concluded that out of 44 respondents most think that *the construction sector is lagging in the adoption of AI technologies* (Mean = 1.2). The standard deviation is low less than 1.0 and closer to 0 which indicates that the data results are low spread out. Thus, the respondent's confirmed the construction sector is lagging in the adoption of AI technologies.

Correlation Analysis – Objective 2

Table 28 shows that a positive significant relationship between Q4 and Q5, Q6, and Q7 exists. This means that if organisations adopt AI technologies within the building construction (Q4), resistance in AI technology adoption by the construction industry may decrease(Q5), and with enough awareness of AI technologies (Q6), the construction sector may decrease the lagging in the adoption of AI technologies (Q7). Therefore, the results imply that identifying opportunities and constraints of AI technology adoption may improve productivity within the construction industry.

Table 29 : Correlation Analysis Results - Objective 2

Correlations

		Q4. Has your organisation adopted AI technologies within the building construction?	**Q5.** In your opinion, do you think there is resistance in AI technology adoption by the construction industry?	**Q6.** Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?	**Q7.** In your opinion would you say the construction sector is lagging in the adoption of AI technologies?
Has your organisation adopted AI technologies within the building construction?	Pearson Correlation	1	.316*	.346*	.292
	Sig. (2-tailed)		.037	.021	.055
	N	45	44	44	44
In your opinion, do you think there is resistance in AI technology adoption by the construction industry?	Pearson Correlation	.316*	1	.185	.467**
	Sig. (2-tailed)	.037		.230	.001
	N	44	44	44	44
Please rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?	Pearson Correlation	.346*	.185	1	.246
	Sig. (2-tailed)	.021	.230		.108
	N	44	44	44	44
In your opinion would you say the construction sector is lagging in the adoption of AI technologies?	Pearson Correlation	.292	.467**	.246	1
	Sig. (2-tailed)	.055	.001	.108	
	N	44	44	44	44

*. Correlation is significant at the 0.05 level (2-tailed).

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

4.2.3 Results based on Objective 3

Objective 3 assessed the adoption of AI technology strategies and its impact on effectiveness and efficiency within the construction industry. To effectively achieve objective 1 four questions were developed as follows 1) corporate executives buy in into technological advancement, 2) organizational development impact and its effect on business evolvement to create high performance, 3) competitive advantage and maximize its production through organizational development.

Table 27 provides a summary of objective 2 results and valid responses for items, Q13, Q14, and Q15, have responses of (n=42), (n=42), and (n=43) respectively. The data is also primarily negatively skewed. To get a conclusion on Objective 3, the results will be further discussed for each question.

Table 30 : Objective 3 Data Analysis Overview

Statistics

		Q13. In your opinion do you think corporate executives within the construction industry buy into technological advancement?	**Q14.** Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.	**Q15.** In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?
N	Valid	42	42	43
	Missing	9	9	8
Mode		1	4	5
Skewness		.299	-.457	-1.153
Std. Error of Skewness		.365	.365	.361

Table 25 shows that out of 42 respondents, the majority 47.1% (n=24) *think corporate executives within the construction industry buy into technological advancement*, whilst 35.3% (n=18) do not agree. The scale with a yes and no categories was used for this item.

Q13: Buy into technological advancement by corporate executives

Table 31 : Buy into technological advancement by corporate executives

Q13. *In your opinion do you think corporate executives within the construction industry buy into technological advancement?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	47.1	57.1	57.1
	No	18	35.3	42.9	100.0
	Total	42	82.4	100.0	
Missing	System	9	17.6		
Total		51	100.0		

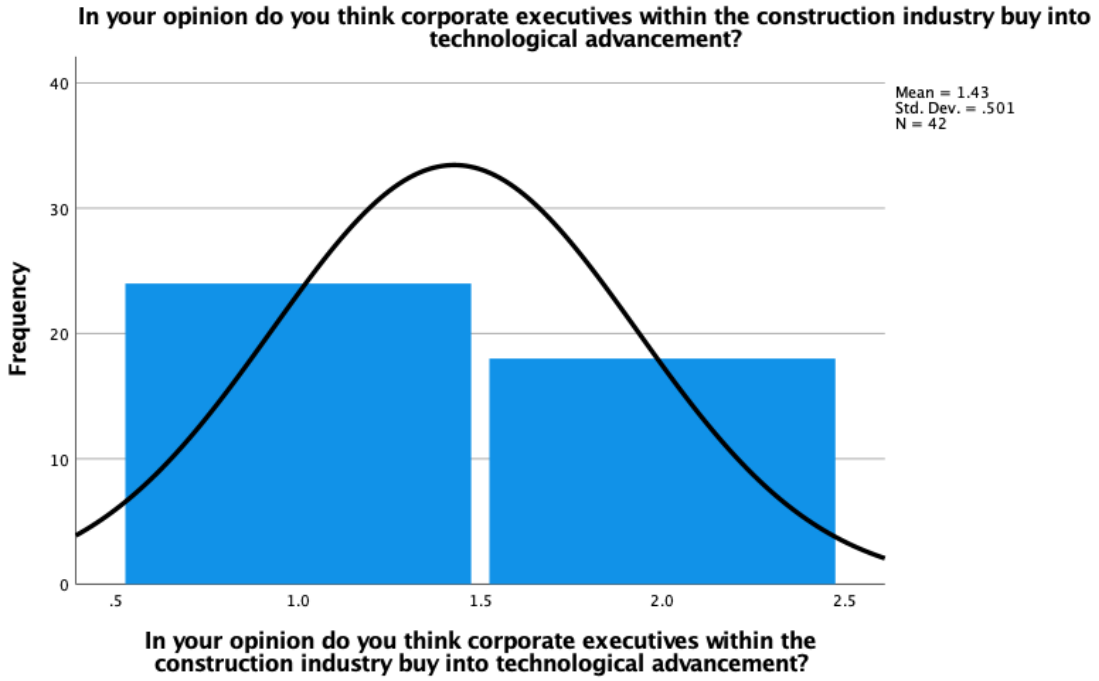

Figure 15 : Buy into technological advancement by corporate executives

The data as shown in figure 15 is normally distributed, thus it is evenly distributed as indicated with the positive value (0.299) in table 27. This can be concluded that out of 42 respondents most think that *corporate executives buy into technological advancement within the construction industry.* (Mean = 1.42). The standard deviation is low less than 1.0 and closer to 0 which indicates that the data results were considerable spread even though more respondent's confirmed corporate executives buy into technological advancement within the construction industry.

Q14: Organisational development impact

Table 29 shows that out of 42 respondents, the majority 39.2% (n=20) feel that *organizational development impact, and its effect on business evolvement to create high performance is low*, followed by 21.6% (n=11) responses who also feel it is very low. Similarly, 17.6% (n=9) feel the statement is generally true and 3.9% (n=2) feel it is highly true. The Likert Scale ranging from 1 very high – 5 very low was used to measurer responses for this item.

Table 32 : Organisational development impact

Q14. *Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	2	3.9	4.8	4.8
	Average	9	17.6	21.4	26.2
	Low	20	39.2	47.6	73.8
	Very Low	11	21.6	26.2	100.0
	Total	42	82.4	100.0	
Missing	System	9	17.6		
Total		51	100.0		

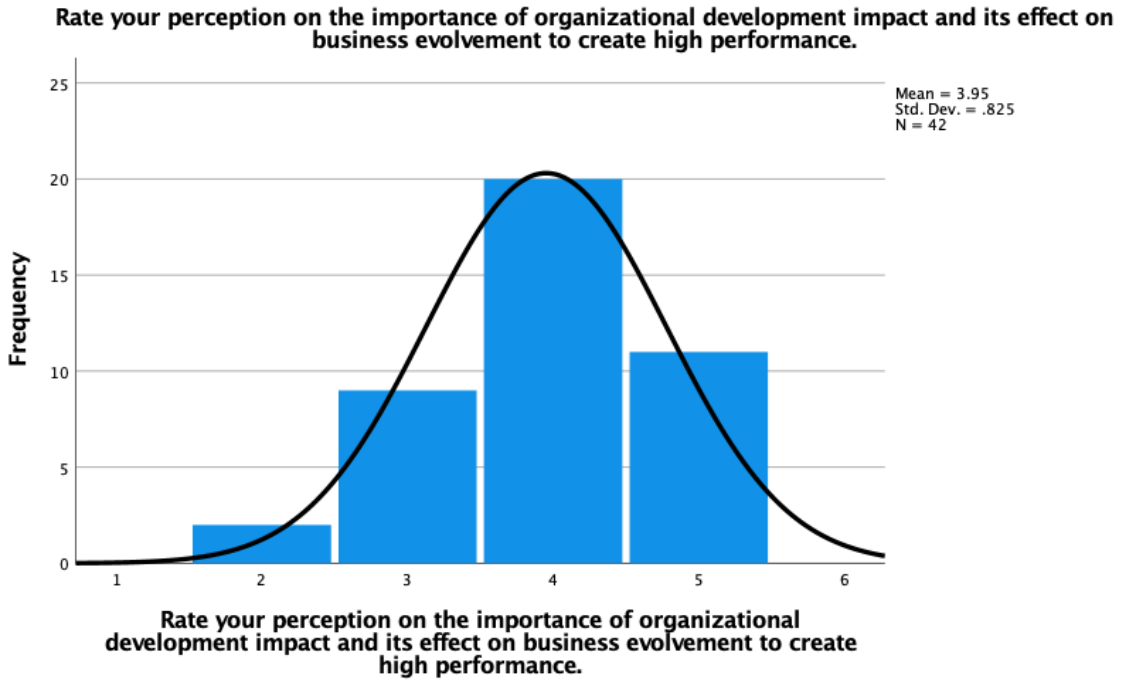

Figure 16 : Organisational development impact

The data as shown in figure 16 is left-skewed, thus it is not evenly distributed as indicated with the negative value (-.457) in table 29. This can be concluded that out of 42 respondents most

had consensus that feel that *organizational development impact, and its effect on business evolvement to create high performance is low* (Mean = 3.95). The standard deviation is high closer to 1.0 which indicates that the data results are more spread out and not closer to the mean. Thus, the respondents "disagree" to the statement.

Q15: Competitive Advantage for profit maximization

Table 30 shows that out of 43 respondents, the majority 33.3% (n=15), strongly agree and 31.4 (n=16) somewhat agree that *the construction industry might gain competitive advantage and maximize its production through organizational development*, whilst 7.8% (n=4) neither agree or disagree and 7.8% (n=4) somewhat disagree. Similarly, 3.9% (n=2) strongly disagree. The Likert Scale ranging from 1 strongly agree – 5 strongly disagree was used to measurer responses for this item.

Table 33 : Competitive Advantage for profit maximization

Q15. *In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	3.9	4.7	4.7
	Somewhat disagree	4	7.8	9.3	14.0
	Neither agree nor disagree	4	7.8	9.3	23.3
	Somewhat agree	16	31.4	37.2	60.5
	Strongly agree	17	33.3	39.5	100.0
	Total	43	84.3	100.0	
Missing	System	8	15.7		
Total		51	100.0		

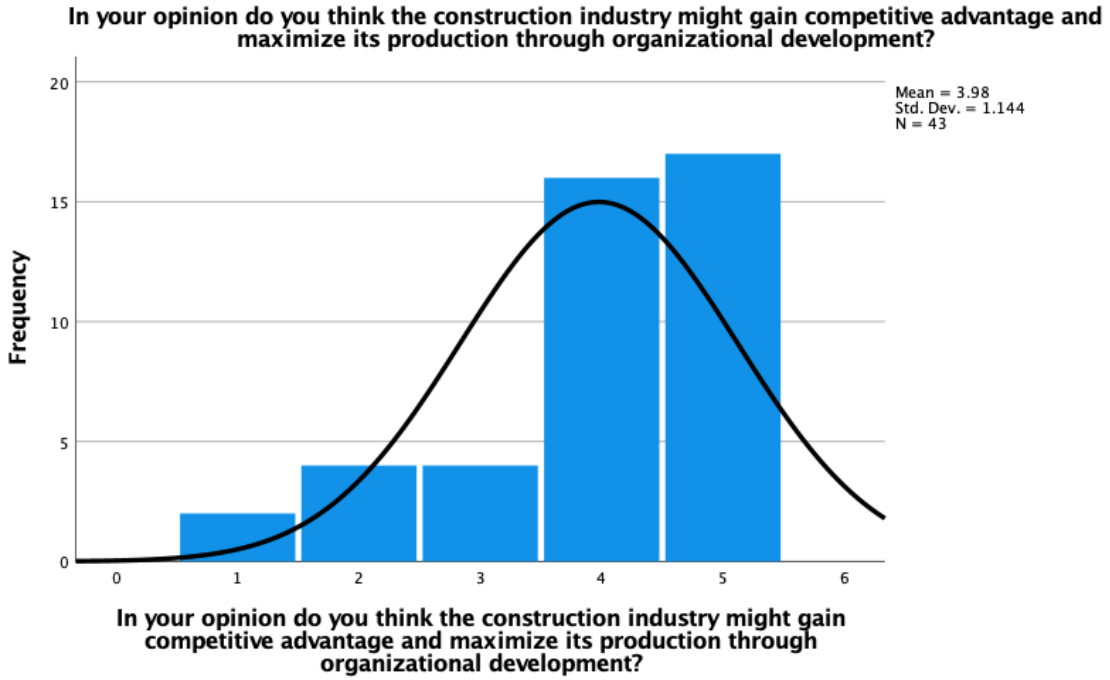

Figure 17 : Competitive Advantage for profit maximization

The data as shown in figure 16 is left-skewed, thus it is not evenly distributed as indicated with the negative value (-1.153) in table 29. This can be concluded that out of 43 respondents most had consensus *that the construction industry might gain competitive advantage and maximize its production through organizational development* (Mean = 3.98). The standard deviation is higher than 1.0 which indicates that the data results are more spread out and not closer to the mean. Thus, the respondents "agree" to the statement.

5.5 Correlation Analysis – Objective 3

Table 28 shows that a positive correlation exists between Q13, and Q14 and Q15. This means that buying into technological advancement by corporate executives has a high significance (Q13) on the importance of organizational development impact (Q14). Moreover, buying into technological advancement by corporate executives (Q13) shows a positive correlation that the construction industry might gain competitive advantage and maximize its production through organizational development (Q15).

Table 34 : Correlation Analysis Results - Objective 3

Correlations

		Q13. In your opinion do you think corporate executives within the construction industry buy into technological advancement?	**Q14.** Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.	**Q15.** In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?
Q13. In your opinion do you think corporate executives within the construction industry buy into technological advancement?	Pearson Correlation	1	-.067	.036
	Sig. (2-tailed)		.671	.819
	N	42	42	42
Q14. Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.	Pearson Correlation	-.067	1	.152
	Sig. (2-tailed)	.671		.336
	N	42	42	42
Q15. In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?	Pearson Correlation	.036	.152	1
	Sig. (2-tailed)	.819	.336	
	N	42	42	43

11.2 CHAPTER FIVE: DISCUSSION OF FINDINGS

1. Introduction

This chapter will analyze and evaluate the study's findings to evaluate if the study's objectives have been met. The purpose of this research was to assess the factors that influence the adoption of Artificial Intelligence Technologies (AI) within the South African Construction Industry. The focus was to employ AI technology adoption strategies to enhance the construction industry's' performance in ensuring effectiveness and efficiency on productivity through organisational development. Considering the three hypotheses that were tested using quantitative data, the purpose of this chapter is to discuss the results of the hypothesis test.

5.1 Demographic profile of respondents

To better understand the backgrounds of the participants and ensure that the information gathered from them is relevant and meets the study's aims, demographics were used in this study. Thus, the findings of the data analysis demonstrate that the respondents had familiarity and expertise of the construction industry. They were also representative of the entire population and relevant to the goals of the study.

5.2 Discussion pertaining to Hypothesis 1

In literature the below hypothesis was formulated from objective 1 of the study.
Null Hypothesis: *Adoption of AI technology strategies has no impact on the effectiveness and efficiency within the construction industry.*
Alternative Hypothesis: *Adoption of AI technology strategies may have a positive impact on the effectiveness and efficiency within the construction industry.*

The data analysis results found out that the efficacy and efficiency of the construction sector may be improved through the deployment of AI technology solutions. In other words, if the construction sector adopts AI technology to the Project Lifecycle Stage, the cost of reducing manual labour and applying AI functions for project delivery can be decreased. This is in line with (Tjebane, Musonda, & Okoro), who claim that integrating new technological advancements like artificial intelligence might boost the performance of the construction industry, yet undeveloped countries like South Africa continue to perform poorly in this area. AI includes all business processes and aspects into a model, making collaboration between all parties more accurate and effective than using conventional methods.

Additionally, the study findings also stated that more chances for the construction sector to perform more effectively and efficiently will be brought about by AI technologies, which align with the survey that professionals would feel at ease implementing AI technology into the various stages of the project lifecycle and do away with manual labor. A study by (Regona, Yigitcanlar, Xia, & Li, 2022), concurred that AI includes all business processes and aspects into a model, making collaboration between all parties more accurate and effective than using conventional methods frequently in construction projects, internationally. Furthermore, artificial intelligence (AI) gives businesses a competitive edge by enhancing productivity, effectiveness, and efficiency while reducing costs (Ahuja, Sawhney, & Arif, 2018). However, the researchers strongly advise that the components of the building industry must be properly integrated for a smooth shift away from a conventional strategy.

Based on the findings discussed in the study, the null hypothesis i.e., *adoption of AI technology strategies has no impact on the effectiveness and efficiency within the construction industry* is rejected and therefore the alternative hypothesis is accepted.

5.3 Discussion pertaining to Hypothesis 2

Null Hypothesis (HO): *Productivity will not be improved by identifying opportunities and constraints of AI technology adoption by the CI.*
Alternative Hypothesis (H1): *Identifying opportunities and constraints of AI technology adoption may improve productivity within the construction industry.*

According to (Abioye, et al., 2021), there has been a lengthy tradition of resistance to change. As a result, due to the industry's reliance on traditional work and lack of digitization, project management is more challenging and time-consuming. On the other hand, industries like manufacturing and telecommunications are thriving, probably as a result of their use of recent digital technology that incorporates AI. (Baum, Barrett, & Yampolskiy, 2017), further the authors contend that in contrast to the construction sector, manufacturing, retail, and telecommunications are largely digitalized.

These opinions agree with the data analysis results that the construction business is having trouble adopting AI technology. However contrary to this the results concur that most organizations use AI technologies during building development. To resolve this ambiguity,

suggestions have been made that the construction industry offer workshops and technology trainings so that the staff can distinguish between various types of technologies. Additionally, businesses that have access to AI technology should use it to maximize effectiveness and efficiency and boost growth.

Moreover, the data analysis results found awareness of AI technology in the construction industry to be average. This corresponds with the concern that has been raised about construction employees' apparent reluctance to adopt innovation by (Akinosho, et al., 2020). Additionally, the author states that experts are less interested in complicated machinery that could be challenging to learn and instead favor conventional methods of accomplishing things. Additionally, if AI technology is used, human employment may decline as AI takes over most jobs (Haenlein & Kaplan, 2019). It can be difficult to implement AI immediately now because automation demands a significant upfront investment. Recommendations have been made for universities to increase awareness and educate professionals within the construction industry about technology to close the knowledge gap and/or reluctancy regarding AI technology.

Based on the findings discussed in the study, the null hypothesis i.e., *Productivity will not be improved by identifying opportunities and constraints of AI technology adoption by the CI* is rejected and therefore the alternative hypothesis is accepted.

5.4 Discussion pertaining to Hypothesis 3

Null Hypothesis: *Examining the organisational development phenomenon within the construction industry will have no effect on AI technology adoption.*
Alternative Hypothesis: *Examining the organisational development phenomenon within the construction industry may have an effect of AI technology adoption.*

(Schwab, 2017), views digital leadership as essential for organizational development and digital transformation since leaders have authority. Consequently, since the digital age is all about implementation and maximizing opportunities, leaders who have a vision and can adapt to change are vital, (Thompson, 2018). Also, (Schwab, 2017), considers digital leadership as key for organisation development and digital transformation, as leaders have authority. These opinions were in line with the data analysis results done in chapter four which shows that business executives in the construction sector do support technology innovation.

Furthermore, to achieve excellent performance within the organization, organizational development is intended. Since the way things are done has changed from how they were approximately ten years ago, it is no more business as usual and requires that businesses be redesigned to accommodate the constantly changing environment (Walsh & Volini , 2017). This authors further argue that organizational development also assists in incorporating accountability, encouraging openness and comfort in accepting change. Consequently, a high-performing businesses quickly develop smaller teams that cycle, which fosters high levels of invention and encourages team centricity.

Additionally, a crucial factor to consider is the organization's strategy, which is the cornerstone of the firms' success. Changes in existing strategies are influenced by a variety of elements, including the environment, industry, competition, and markets, (Whittington, Regnér, Angwin, & Scholes, 2020). Therefore, organisational development is meant to create high performance in the organisation. The construction sector may have to use organizational development activities to make AI adoption simpler. However, the data analysis results have a contradictory view as they believe that organizational development and its impact on corporate evolution to produce high performance are not having much of an impact. To create high performance, it is advised that organizations emphasize their influence and effect on business evolution through workshops or trainings.

The study found out that having a competitive advantage improves business continuity and positions it for future growth and operational improvement (Walsh & Volini , 2017). (Barney & Harrison, 2020), also make the case that giving organizations the power to maximize specific resources will guarantee their success. (Jayalath & Gunawardhana, 2017), add that important elements of sustainable practices include emphasizing resource conservation, reducing environmental deterioration, and providing a healthy built environment. Thus, highlighting the significance of a variety of executive skill sets in acquiring crucial resources may assist management in the construction business in acquiring the necessary expertise to put AI adoption strategies into effect. This concurs with the data analysis that organizational development could give the construction industry a competitive edge and increase output.

Based on the findings discussed in the study, the null hypothesis i.e., *Examining the organisational development phenomenon within the construction industry will have no effect on AI technology adoption* is rejected and therefore the alternative hypothesis is accepted.

12 CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6 Introduction

The purpose of this study was to assess the factors that influence the adoption of Artificial Intelligence Technologies (AI) strategies within the South African Construction Industry. The focus was to employ AI technology adoption strategies to enhance the construction industry's' performance in ensuring effectiveness and efficiency on productivity through organizational development. The problem statement, therefore, outlined that the slow adoption of technology is anticipated to have an influence on the effectiveness and efficiency of building procedures used in the construction industry.

Consequently, the research question wanted to find out if the adoption of AI technology strategies impact on the effectiveness and efficiency within the South African Construction Industry. To substantiate the problem statement and address the research question, the study's objectives had to fill in the gaps in the literature from practice through collecting data from the professionals in the industry. Therefore, the findings analysed from previous chapters had led to the summary, conclusions discussed per objective and recommendations.

6.1 Summary of the findings

Based on the data analysis this research concludes that the research instrument utilized for this study is reliable in evaluating the views of the participants based on the accepted minimum reliability of 0.697 for Cronbach Alpha. The findings also show that both the dependent and independent variables have fairly good distributions.

According to the study's ***demographic*** breakdown of respondents, most of the population (60.8%) worked in the private sector. The age group from 30 to 39 years old was the most well-represented (41.2%). Additionally, 31.4% for each category of respondents had between 10 and 15 years of industry experience and 15 and 20 respectively. The data in conclusion implies that the respondents were knowledgeable about and familiar with the construction sector. Additionally, they had relevance to the study's objectives and were representative of the overall population.

With reference to ***objective 1*** the analysis of the questionnaire and correlation test found out that most respondents (29.4% x 2) concur that implementation of AI technology strategies will

increase production and efficiency in the construction sector. Whilst 45.1% of the respondents would feel at ease implementing AI technology into the various stages of the project lifecycle, 33.3% would feel at ease doing away with manual labor and adopting AI functions for project delivery. Moreover, 76.1% concur that prospects for the construction industry to perform more effectively and efficiently are brought about by AI technologies. On the other hand, 39.2% were unsure about whether AI technology would increase potential for the building sector rather than create constraints. However, it can be said that objective 1 has been found to be pertinent because there is general agreement that the use of AI technology techniques may affect the efficacy and efficiency of the building sector.

In terms of ***objective 2*** findings emanating from the survey and correlation test, show that most responds 54.9%, concur that their organization use AI technologies during building development. While 44 respondents, (56.1%) believe that the construction business is having trouble adopting AI technology, and 42 respondents, (31.4%) believe that awareness of AI technology in the industry is on par. Thus, it can be argued that the objective has been determined to be pertinent given that there is a general opinion that the construction industry may increase productivity by understanding the opportunities and limitations of adopting AI.

In terms of ***objective 3*** most respondents (47.1%) believe that business executives in the construction sector support technological innovation. Yet, 39.2% believe that organizational development and its impact on corporate evolution to produce high performance are not having much of an impact. The other 33.3% concur that organizational development could give the construction industry a competitive edge and increase output. Hence, it can be stated that the objective has been found to be significant because it is widely believed that the phenomena of organizational development within the construction industry, may have an effect of AI technology adoption.

This study further analyzed and evaluated the findings and academic journals to evaluate if the study's objectives have been met. It took into consideration the three hypotheses that were tested using quantitative data, to discuss the results of the hypothesis test. The findings were therefore to accept the alternative **hypothesis 1** i.e., adoption of AI technology strategies may have a positive impact on the effectiveness and efficiency within the construction industry.

Additionally, to accept the alternative **hypothesis 2** i.e., identifying opportunities and constraints of AI technology adoption may improve productivity within the construction industry.

Lastly, to accept the alternative **hypothesis 3** i.e. examining the organisational development phenomenon within the construction industry may have an effect of AI technology adoption.

6.2 Conclusion on Objective 1:

The objective aimed at assessing the adoption of AI technology strategies and its impact on effectiveness and efficiency within the construction industry. The following five topic areas were assessed in order to successfully address objective 1. 1) The adoption of AI technology to increase productivity and efficiency; 2) Manual labour to be eliminated in favour of using AI functions for project delivery; 3) AI to be incorporated into project lifecycle stages; 4) AI to provide opportunities for effectiveness and efficiency in CI performance; and 5) AI technologies to present more opportunities than limitations. According to the results of the data analysis, it was concluded that the employment of AI technology techniques may have an impact on the effectiveness and efficiency of the building sector, making objective 1 relevant to this study.

6.3 Conclusion on Objective 2

This objective identified opportunities and constraints of AI adoption by the construction industry to help improve its productivity. To effectively achieve objective 2 four research topics were developed as follows 1) Organisation adoption of AI technologies, 2) Resistance in AI technology adoption, 3) Awareness of AI technologies, 4) The construction sector lagging in the adoption of AI technologies. Thus, it can be argued that the objective has been determined to be pertinent given that there is a general opinion that the construction industry may increase productivity by understanding the opportunities and limitations of adopting AI.

6.4 Conclusion on Objective 3:

The objective examined the organisational development phenomenon within the construction industry and its effect on AI Technology adoption. To effectively achieve objective 3 three questions were developed as follows 1) corporate executives buy in into technological

advancement, 2) organizational development impact and its effect on business evolvement to create high performance, 3) competitive advantage and maximize its production through organizational development. Hence, it can be stated that the objective has been found to be significant because it is widely believed that the phenomena of organizational development within the construction industry may impact on the adoption of AI Technology.

6.5 Limitations

Limitations that could have jeopardized the effectiveness of this study include:
Respondents not having enough time to answer all the questions due to *time constraints and power cuts*. The unwillingness of the targeted population to participate. *Cost of data* - The cost of data may have caused respondents to disregard the survey. *Constraints imposed by Covid-19* – Since most people suffer from depression as per the reports, they might choose to focus their energies on things that matter to them instead. *Loadshedding* - This may result in users not replying to save battery power on their portable devices. *Participants lacking knowledge of AI technologies* - Due to the researchers limited knowledge of the AI phenomenon leading to participants not being asked the relevant questions. Limited time for data collection.

6.6 Overall Conclusion

Chapter 1, the chapter concentrated on introducing the core topic by providing a rationale for the study, followed by a backstory that supported the problem statement. Ultimately, the problem statement indicated a gap in the construction industry's' lack of AI adoption methods within the SA context. As a result, the scope, objectives, delimitations, and assumptions of the study outlined the gap in the construction industry, justifying the necessity for a literature analysis and research methodology. **Chapter 2,** the chapter examined prior academic research founded on the goals of this study. In order to create keywords, secondary questions, research propositions, and the study's' premise, it was important to ascertain what existing knowledge there was on AI adoption approaches. **Chapter 3,** the study methodology is described in detail in this chapter, along with the rationale behind the decisions made on methodologies to justify conclusions of research. It also described the ethical issues involved in the study to guarantee that there is no risk of harm to participants and that this research is for study purposes.

Chapter 4, this chapter covered participant responses that were gathered through a survey using the Qualtrics software and analyzed using the SPSS software. The study's goals and

objectives were assessed utilizing statistics that included descriptive, frequency, and correlation analysis of the data. **Chapter 5,** to fill the gap that could not be filled in the literature, conclusions based on quantitative data gathered through surveys were discussed in this section. The results of the data analysis show that the respondents were knowledgeable about the construction sector. Also, they were applicable to the study's goals and were the representative of the total population. Three hypotheses were outlined to reach findings and conclusions to the research question. Based on the findings discussed in the study, the three null hypotheses were rejected, and the three alternative hypotheses were accepted. **Chapter 6,** based on the research findings, conclusions and recommendations were made in this chapter. Conclusions were presented in relation to each study objective. The study's contributions to the body of knowledge, recommendations, and suggestions for additional research were addressed.

6.7 Contributions to the body of knowledge

Although the study cannot confidently or statically generalize from the small sample to the broader population, the demographics' shape suggests that there are many similarities with the bigger population. The study has demonstrated that even though there maybe various factors that influence AI adoption within the SA construction industry, however, the adoption of AI technology strategies may have a positive impact on the effectiveness and efficiency within the construction industry. Furthermore, identifying opportunities and constraints of AI technology adoption may improve productivity within the construction industry. Lastly, examining the organisational development phenomenon within the construction industry may have an effect of AI technology adoption.

6.8 Recommendations

It is recommended that professional may need to take advantage of the individualized development plan offered at their place of employment to familiarize themselves with emerging trends and technology in the construction sector. Additionally, for competitive advantage and to increase efficiency and effectiveness in the workplace, the construction sector may need to stay abreast of emerging trends and technology. The construction industry should alter its current work cultures of working by hand to encourage the adoption of AI. This is due to the value it may bring to construction organizations and projects in terms of improving efficiency, sustainability, and productivity in the long term. Top management should involve

staff when developing AI adoption strategies as pprofessionals may help identify strategies that are affordable and appropriate for business needs.

To encourage technology acceptance within the South African context, more study on innovative advancing technologies from international construction project must be conducted. The construction industry may offer workshops and technology trainings so that the staff can distinguish between various types of technologies. Universities may need to increase technology awareness by dedicating a module to building courses. To create high performance, organizations need to emphasize their influence and effect on business evolution through workshops or trainings. Organizations need to consider implementing training materials and methods to educate staff members about AI.

6.9 Suggestions for future research

There are restrictions on the conclusions drawn from the data, despite the study's goals being met. The research examined expert perceptions and opinions on AI adoption strategies within the SA construction industry through organizational development. Therefore, the results were analysed only within the South African context. Furthermore, the study looked only into the perceptions and opinions of the Professional Construction Project Managers and perhaps future studies could focus into expert perceptions and opinions of all the professions within the construction industry. Furthermore, future research might need to interview companies rather than use surveys to minimize ambiguity. Further, to include as many people as feasible, the study may need to devote additional time to data collection.

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8. APPENDICES

8.1 Appendix A: Questionnaire

RESEARCH QUESTIONNAIRES

Factors Influencing the Adoption of Artificial Intelligence Technologies in the South African Construction Industry.

Respondent No:

Please answer by marking with an "X" in the **blue** box.

QUESTIONNAIRE

Definition:

Artificial intelligence refers to a "computer system's ability to execute tasks that normally require human intelligence such as Artificial Narrow Intelligence, Artificial General Intelligence and Artificial Super Intelligence predicted to be smarter than humans".

Background Information Questions

1. **Sector: Which sector do you represent?**

Public		**Private**	

2. **Age Profile: In which age category do you fall under?**

Age 20 - 29	
Age 30 - 39	
Age 40 - 49	
Age 50 +	

3. **Years of experience: How many years of experience do you have?**

Below 5 years	
5 – 10 years	
10 – 15 years	

Research Sub-Questions

4. **Has your organisation adopted AI technologies within the building's construction?**

Yes		**No**	

5. **In your opinion, do you think there is resistance in AI technology adoption by the construction industry?**

Yes		**No**	

6. **nPlease rate your perception based on your experience, whether you think there is enough awareness of AI technologies within the construction industry?**

Level of AI awareness	Very High	High	Average	Low	Very Low

7. **In your opinion would you say the construction sector is lagging in the adoption of AI technologies?**

Yes		**No**	

8. **Rate your perception of whether you would say AI technology adoption will enhance productivity and efficiency within the construction industry?**

Enhanced Productivity	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewh at agree	Strongly agree

9. **Rate your perception of whether you would you be comfortable in eliminating working by hand and using AI functions for project delivery?**

Using AI Functions	Extremely uncomfortable	Somewhat uncomfortable	Neither comfortable nor uncomfortable	Somewhat comfortable	Extremely comfortable

10. Rate your perception of how comfortable you would be in incorporating AI technologies within the project lifecycle stages?

Lifecycle stages	Extremely uncomfortable	Somewhat uncomfortable	Neither comfortable nor uncomfortable	Somewhat comfortable	Extremely comfortable

11. In your opinion would you say AI technologies bring along opportunities for the construction industry to be more effective and efficient in their performance?

Yes		**No**	

12. Rate your perception of whether you think AI technologies will bring in more opportunities within the construction industry rather than constraints?

AI opportunities and constraints	Very High	High	Average	Low	Very Low

13. In your opinion do you think corporate executives within the construction industry buy into technological advancement?

Yes		**No**	

14. Rate your perception on the importance of organizational development impact and its effect on business evolvement to create high performance.

Organisational Development	Very High	High	Average	Low	Very Low

15. In your opinion do you think the construction industry might gain competitive advantage and maximize its production through organizational development?

Competitive Advantage	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewh at agree	Strongly agree

8.2 Appendix B: Participant Consent Form

PARTICIPANT CONSENT FORM

Study title:
Factors Influencing the Adoption of Artificial Intelligence Technologies in the South African Construction Industry.

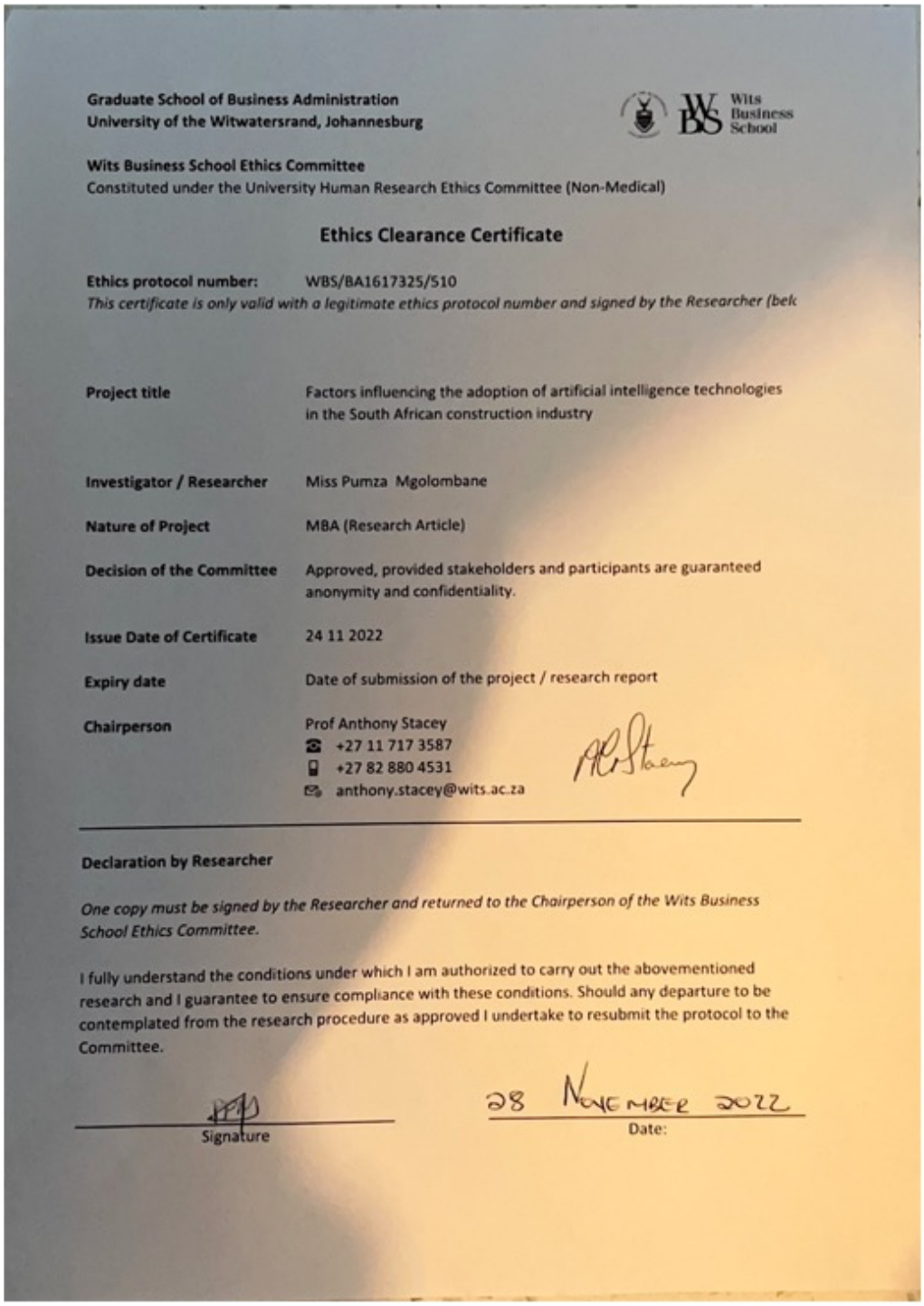
a) I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions.
b) I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.
c) I understand there are no foreseeable risks to myself by agreeing to take part in the study.
d) I understand that there are no costs involved with this research.
e) I understand confidentiality and anonymity will be guaranteed for this study.
f) I understand and agree that data is stored in a secure facility where no unauthorized access is available.
g) If I have any queries I have been informed of who I need to contact.
h) I understand that the data collected from my participation will be used for the purpose of this study, and I consent for it to be used in this manner.
i) I agree to take part in the questionnaire for the above study.

Signature: ……

Date: …….

NB: By continuing with the survey, it will be concluded that the participant understands and agrees to the informed consent as stipulated.

8.3 Appendix C: Ethics Clearance Certificate



Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School

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

Ethics Clearance Certificate

Ethics protocol number: WBS/BA1617325/S10
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (bel

Project title	Factors influencing the adoption of artificial intelligence technologies in the South African construction industry
Investigator / Researcher	Miss Pumza Mgolombane
Nature of Project	MBA (Research Article)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed anonymity and confidentiality.
Issue Date of Certificate	24 11 2022
Expiry date	Date of submission of the project / research report
Chairperson	Prof Anthony Stacey ☎ +27 11 717 3587 +27 82 880 4531 anthony.stacey@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

28 November 2022
Date:

8.4 Topic Approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax:
Tel:

Reference: Ms Jennifer Mgolodela
E-mail: jennifer.mgolodela@wits.ac.za

06 January 2023
Person No: 1617325
PAG

Miss PP Mgolombane
G8, Mmabatho Palms, Nelson Mandela Drive
Mafikeng
2745
South Africa

Dear Miss Pumza Mgolombane

Master of Business Administration: Approval of Title

We have pleasure in advising that your proposal entitled *Factors influencing the adoption of artificial intelligence technologies in the South African construction industry* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Marike Bosman
Faculty Registrar
Faculty of Commerce, Law and Management

8.5 Participants Reponses

../Participants Responses .pdf