The adoption of intelligent robot automation by auditors within South Africa

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ABSTRACT

To automate, or not to automate, that is the question? The use of disruptive technologies has changed, and in many instances, has replaced traditional business operations and models. The auditing profession has been burdened with high costs and reputational damage as a result of false results due to a high dependency on manual tasks that are susceptible to errors or manipulation. The use of robots to help minimise these errors, achieve efficiencies and reduce costs, provides a convincing theoretical case to automate. The objective of this research is to apply the Unified Theory of Acceptance and Use of Technology (UTAUT) model to understand the views of audit professionals determine the factors that would influence organisations to use robot technology for performing audits in South Africa.

The study adopted a quantitative approach, where a survey questionnaire consisting of 39 questions, aligned with the UTAUT model, was used to gather data. The sample comprised 59 auditors and 26 non-auditors who were involved in audits performed in South Africa. The non-auditors comprised of a Chief Information Officer, Finance Managers, Heads of Product, and various Senior Risk Management Professionals. A purposive sampling technique was used to select individuals who had an understanding of the capabilities of robots, and the potential use of robots to support business operations.

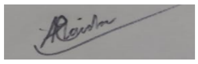
The results of the study highlighted that performance expectancy and facilitating conditions were the key factors that influenced the adoption of robots in audits. Auditors and clients were more likely to use robots if they felt it would improve their performance. The respondents were more likely to use robots if it enabled the quicker completion of tasks, reduced errors, increased the number of tasks that could be completed and delivered better value than manual processes. The study also highlighted that sufficient investment and management support would be provided to ensure that an enabling environment is established for using robots to perform audit tasks. This would include acquiring management support as well as finding hardware, software, and skills to support the robotics development initiatives.

The study provides more insight on how leaders and management in the auditing field can use insights attained through this study to successfully influence and support the use of robots to perform audits. Furthermore, the study contributes to an increased used of robotics in auditing which could improve the quality and efficiency of the auditor's work. The study contributes towards the body of knowledge in the accounting and robot fields of study.

Keywords: Robots, Auditing, Automation, Unified Theory of Acceptance and Use of Technology, UTAUT, Audit, Auditor

DECLARATION

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

Name: Evaashan Naidoo Signature: 

Signed at Johannesburg.

On the 28th day of April 2021

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LIST OF ACRONYMS

ACRONYM	MEANING
AI	Artificial Intelligence
CA	Continuous Auditing
CAATS	Computer Assisted Audit Tools and Techniques
CSIR	Council for Scientific and Industrial Research
DST	South Africa Department of Science and technology
EY	Ernst and Young
IBM	International Business Machines Corporation
IEE RAS	Institute of Electrical and Electronics Engineers Robotics and Automation Society
IIA	Institute of Internal Auditors
IoT	Internet of Things
IRPA	Intelligent Robotics Process Automation
ISACA	Information Systems Audit and Control Association
OCR	Optical Character Recognition

PWC	PriceWaterhouseCoopers
RPA	Robotics Process Automation
SPSS	Statistical Package for the Social Sciences tool
TAM	The technology acceptance model
TRA	Theory of reasoned action
UTAUT	Unified Theory of Acceptance and Use of Technology

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

Over the years, there has been a significant use of technology by organisations to improve business operations. The auditing profession was no exception, and also used emerging technologies such as data analytics, to derive insights from large volumes of data when providing audit assurance. The introduction of disruptive technology such as robotics automation presents even greater efficiency and capability options for the audit profession. The purpose of this study was to perform a quantitative exploration of the factors that influence the adoption of robotic automation technology by auditors in South Africa.

1.2 Context of the study

As we enter the fourth industrial revolution, new disruptive technology innovations are having a profound impact on how business operations are performed. These technologies include the Internet of Things (IoT), Cloud Computing, Robotics Process Automation (RPA) and Big Data Analytics and are being adopted exponentially. Moore's Law, which predicted the exponential growth of computing power in conjunction with the decreasing costs of these technologies has resulted in the exponential adoption across various industries globally (Mollick, 2006).

Westerman, Bonnet and McAfee (2014) emphasised the importance for organisations to transform by taking advantage of digital technologies that are disrupting the marketplace. Organisations are using these technologies to enhance existing operations, streamline unnecessary 'waste', and seek new business models.

Technologies are no longer only used to achieve competitive advantages in the short term, but also to ensure they remain relevant in the long term. The effects of not embracing digital technology were demonstrated through the example of the photographic giant ‘Kodak’, who was the market leader of the photo industry, up until its demise in 1997. Kodak had been aware of the emergence of digital photography equipment which was going to render the traditional photographic equipment and consumables obsolete but did not make any effort to consider the adoption of this digital technology to be more successful, and instead remained focused on their traditional technology that supported its historic successes. This failure to adapt, resulted in its eventual demise. Visualcapitalist (2019) reported that as of 22 May 2019, the top five companies with the largest market capital, were technology companies namely Microsoft, Amazon, Apple, Alphabet and Facebook. The examples of Uber and Airbnb also demonstrate the power of disruptive technologies as these have become global taxi and accommodation companies that own no physical taxis or rooms. These are a few examples of how the traditional world has changed, demonstrating the importance for adapting to technology advancements in the digital era.

A survey that was performed in 2017 by McKinsey estimated that by 2022, there will be a 20% decrease in jobs globally due to AI and automation, and that 800 million workers will be replaced by robots by 2030 (Ungureanu, 2019). Unugureanu (2019) also stated that a 2017 World Economic Forum survey finding confirmed that 25% of the survey respondents believe that new jobs will be created, whilst 38% were of the belief that it will present opportunities for entrepreneurs to take advantage of these technologies.

Shan, Wade and Noronha (2017) presented the digital vortex in which they highlighted that all key industries have been impacted by digital technologies, some more than others. The media, technology services, telecommunications, retail, and financial services industries are those that were most impacted by these technologies. The auditing profession, being part of financial services, is also impacted by the use of these technologies.

Whilst the fundamental purpose of auditing remains consistent, the manner in which audit test procedures are performed has changed with the advancement of technology. Auditing is a task that requires a lot of repetitive collection and processing of data which auditors use to apply their professional judgment and derive insights. Audits take can take months to complete and is usually based on historical or outdated information. The audit tests to determine the effectiveness of controls that were implemented by business to manage risks is also limited to samples from which an auditor is expected to derive an audit opinion on the effectiveness of those controls. These audits add to organisational costs. Despite these challenges, the role of auditing is a very important one, that ensures the independent reporting of an organisation's financial performance and risk management initiatives.

Audit failures of not being able to identify irregularities, as in the case of Enron (Eulerich and Kilinichenkco, 2018) and also KPMG (Reuters, 2018), has proven the importance of auditors being able to detect potential fraud or financial misstatements.

The use of robots' present opportunities to improve the accuracy and consistency of audit results as it can perform routine tasks efficiently whenever it is requested and analyse full populations of data much quicker than auditors. Whilst the potential of robotics presents great opportunities, there has been a limited adoption of robotics in the South African industry (Naude, 2017). Gartner (2019) also reported that South Africa is lagging behind in the adoption of these technologies and there is limited data available on the adoption of robotics in South Africa. Frey and Osborne (2017) reported that this impact on the auditing and accounting industries was that 94% of work could be automated. It is therefore important for South African auditors to adopt robotics within their audit functions and develop the new skills that will be required of auditors to work with robots.

Janse van Rensburg, Telukdarie and Dhamija (2019) indicated that South Africa has the potential and infrastructure to be able to operate in the digital world but would need to ensure it is leveraged at a fast pace or face the risk of being cut-out by the digital divide.

Whilst the potential use of robots presents fears such as job losses and the lack of control or transparency of what the robot does, there are also a range of new opportunities that have been identified e.g. allowing auditors to spend more time applying their judgment and not performing repetitive tasks. Therefore, the purpose of this study is to get an understanding of what factors need to be considered for auditors to adopt the use of robotics.

1.3 Research problem

Shan et al. (2017) demonstrated how digital technologies are disrupting business industries, where the financial services sector was one most affected. In addition, Kaivo-oja, Roth and Westerlund (2016) demonstrated how the advancement of people and robots are starting to shape the future. The use of robots has evolved from those that are used in factories, to those that are able to provide knowledge based professional services (Friedman, 2017).

The concept of continuous auditing (Marques and Santos, 2017), and increasing demands from stakeholders for quicker, frequent, and reliable audits (Tiberius and Hirth, 2019), is prompting auditors to relook at traditional audit models. The use of robotics automation presents the possibility of providing regular, quick, accurate, and consistent results as the testing is not prone to human challenges such as time constraints, falling ill and interpretation or computation errors. The failure of auditors not being able to highlight financial misconduct, have also affected stakeholder confidence in their integrity and ability to provide reliable assurance (Eulerich and Kilinichenkco, 2018; Reuters, 2018). Robotics automation presents the benefits of reducing time to perform audits, increased coverage from testing samples to testing the full data population, covering more areas without increasing the size of the team, and also the decrease in costs (Syed, Suriadi, Adams, Bandara, Leemans, Ouyang, Hofstedea, van de Weerd, Wynn and Reijers, 2020; Huang and Vasarhelyi, 2019; Kokina and Blanchette, 2019).

Traditional auditing procedures are time consuming, repetitive, and prone to human error. The digitally mature countries are adopting robotics technology at a fast pace, and the adoption gap is increasing between these countries and those that haven't, which will inevitably increase the global disadvantage. Prior studies have focused on the adoption of robotics in organisations, however the majority of studies relating to the adoption of robotics in auditing have been theoretical in nature. That research has also been predominantly in China, Europe, and the United States of America (Lois, Drogalas, Karagiorgos and Tsikalakis, 2020; Zhang, 2019; Tiberius and Hirth, 2019). The results of those studies have demonstrated that the results could differ based on different regions, which presents a need to understand how the adoption of robotics affects South African auditors. This study obtained data from auditors in South Africa to empirically investigate the factors that affect the adoption of robotics automation to perform audits.

1.4 Research objectives

Through the application of the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis and Davis, 2003), this study addressed the following research objectives:

- **RO1:** To determine the factors that could influence auditors in South Africa to accept the use of robotics automation technology through the application of the UTAUT model.
- **RO2:** To determine how these factors are influenced by the age, gender, experience, and voluntariness of auditors in South Africa.
- **RO3:** To determine the potential barriers for using robotics automation in auditing in South Africa.
- **RO4:** To determine the potential enablers for using robotics automation in auditing in South Africa.

1.5 Significance of the study

Existing studies demonstrate that the use of robotics has the ability to automate routine tasks which will enable auditors to use more of their time to apply their professional judgement. Further, most of these studies have been theoretical in nature, and not many empirical studies were performed due to the emerging use of robotics in auditing. As far as it could be establish, no study has been conducted to date to investigate the use of robotics in the auditing profession from a South African context.

The result of this study provides South African organisations with insights into the factors that will potentially influence the use of robotics, including the barriers and enablers for using robotics in audits. The study also contributes toward the existing academic knowledge available on the adoption of robotics automation within the South African auditing profession.

1.6 Delimitations of the study

This study was limited to a sample of external and internal auditors across various South African organisations.

1.7 Definition of terms

- **Artificial Intelligence (AI):** Machines having the ability to mimic human functions such as speech recognition, machine learning, vision, natural language processing and problem solving.
- **Continuous Auditing (CA):** the approach being able to continuously perform audits and issue audit reports instantly, or very shortly thereafter. This is enabled through the use of technology.

- **Intelligent Robotics Process Automation (IRPA)**: robots that are given cognitive and artificial intelligence to perform cognitive abilities.
- **Robotics Process Automation (RPA):** the automation of processes by using technology to imitate or replicate human interaction. This is normally used to perform repetitive tasks.
- **Unified Theory of Acceptance and Use of Technology (UTAUT):** A model for identify the factors that influence employees to use technology.

1.8 Assumptions

As robotics automation is a disruptive technology that has seen a recent increase in adoption by business operations, the adoption rate within South Africa could be low. Therefore, some respondents may not have had practical experience working with robotics, and only have a theoretical understanding of robotics.

The opinions or influence of legislations, regulators and auditing professional bodies has not been considered for purposes of this research.

1.9 Chapter outline

Chapter	**Content**
Chapter 1 – Introduction	This section explores the problem and problem statement. It highlights the significance of the study and the research objectives the study aims to achieve.

Chapter 2 – Literature Review	This chapter provides a summary of the existing research that has been performed on the subject of robots, automation and auditing.
Chapter 3 – Research Methodology	The research methodology applied for this study is described. This includes the approach for acquiring and analysing the data, and details of the questionnaires used for the study.
Chapter 4 - Analysis	The findings of the analysis are presented.
Chapter 5 – Discussion of Results and conclusion	The results of the findings are discussed and compared with the findings that were highlighted in the literature review. The conclusion of the study is also reported in this chapter.
Chapter 6 – Recommendations, limitations, and future research	This chapter provides recommendations on how organisations can use the findings of the research to successfully ensure robot technology is adopted when auditing in South Africa.

Table 1.1: Chapter Outline

CHAPTER 2. LITERATURE REVIEW

2.1. Introduction

This section will highlight the key themes relevant to the study. The first area is a background of auditing and the function that it plays within an organisation. The second area explores robotics automation, including basic and intelligent robotics automation, that uses artificial intelligence. The third area looks at the use of robotics by organisations and also explores the use of robots in the auditing profession. The fourth and final area explores user adoption models for the use of new technology. The conclusion will highlight key insights attained out of the literature review.

2.2. Auditing

Auditing was derived from the Latin words, “audition” and “audire”, meaning “audience”, or “Listening” (Drylie, 2018; Lee and Ali, 2005). It is a profession that dates back to early civilisation in Egypt where auditors were used to find harvest storages along the Nile river so that a portion could be seized for the ruling state duties (Drylie, 2018). This role of auditors was primarily used to detect fraudulent or dishonest events that could affect the financial reporting of financial status (Ajao, Jayeoba and Ajibade, 2016). It provided independent assurance to the investors with reliable information on the financial status of an organisation to assist in financial decision making (Hermanson, Hermanson and Hermanson, 2020). Seago (2017), further indicated that audit includes an assessment of the organisation’s controls that have been implemented to protect the organisation from risks, resource allocation and makes provision for an evaluation of opportunities. This also includes an assessment of the business transactions, compliance to regulations, and operational fraud controls.

Auditing provides assurance of financial performance and also of the non-financial risk position of an organisation (Gurama, Usman and Murtala, 2019). Auditing involves an assessment of historic data to predict the future performance of organisations and to provide insights into what could be done to improve performance (Gurama and Mansor, 2018).

Auditing is divided into two functions, namely external and internal auditing. Sexton and Rudman (2019) described external audit as the analysis and validation of processes or records to provide an independent opinion on the organisations financial position. Internal audits focus on verification of controls within the operational processes (and not limited to financial reporting), that are used for managing the risks to which those processes are exposed (Gurama et al., 2019). Internal audit is focussed on identifying areas for improving the efficiency or effectiveness of operational process (Gurama et al., 2019).

As time evolved, the transaction volumes increased significantly which led to the concept of providing audit opinions through the use of sampling techniques (Ajao et al., 2016). This required the evaluation of a part of the population of data in order to provide reasonable assurance.

The introduction of technology impacted majority of businesses, including the auditing profession, as audit transactions were no longer recorded on paper trails, but in an electronic audit trail (Ajao et al., 2016; Krahel and Titera, 2015). This resulted in the increased use of technology within audits to evaluate large volumes of data through the use of computer assisted audit tools and techniques (CAATS) (Bierstaker, Janvrin and Lowe, 2014). These tools are used to perform tests on financial data, reconciliations, matching of transactions, sample selection, and performing complex tests (Appelbaum, Kogan and Vasarhelyi, 2017).

The use of technology to perform audits resulted in the concept of continuous auditing, where assurance is provided at the point when an event occurs or soon after the event (Marques and Santos, 2017). The IIA defines continuous auditing as "any method used by auditors to perform audit-related activities on a more continuous or continual basis" (The Institute of Internal Auditors, 2017). Continuous Auditing also makes provision for the regular performance of the audit testing (Marques and Santos, 2017). The use of these technologies provides the ability to perform audits more frequently than the full population of data instead of samples, as indicated by traditional audit methods (Wang and Cuthbetson, 2015). Gonzalez and Hoffman (2018) emphasised that the frequent and wider coverage of transaction analysis by auditors also effectively deters or detects fraud.

As we enter the fourth industrial revolution, major advancements in technology that are providing growth opportunities for traditional business operations, are being introduced (Lee, Yun, Pyka, Won, Kodama and Zhao, 2018). Friedman (2017) also indicated that this was applicable to auditing and that the function would need to also change in order to survive the digital world. This is due to the potential for improved efficiency and quality of work that could be performed through audits.

The audit failures of not being able to identify irregularities as in the case of Enron (Eulerich and Kilinichenkco, 2018), further demonstrated the vulnerabilities of relying on sampling and manual techniques for performing audits. This resulted in an increased focus on improved techniques and governance when performing audits, as demonstrated by Sarbanes Oxley act of 2002.

2.3. Robotics automation

Lanfranco, Castellanos, Desai and Meyers (2004) stated that "The word robot was derived from a Czech word "robota" which translates into forced labour and further evolved from dumb machines to machines that perform menial, repetitive tasks to the highly intelligent anthropomorphic robots of popular culture".

Robots are comprised of software that is able to interact with systems by imitating human actions to perform tasks (Syed et al., 2020). The use of robots has evolved from those that are used in factories to those that have a higher degree of intelligence, such as providing professional services (Friedman, 2017). Robots can perform tasks from moving or assembling objects (Lacity and Wilcocks, 2015), providing customer service through chatbots (Hyken, 2017), legal services (Krause, 2017), detecting medical conditions (Lay, 2019), detecting hazards in physical environments (Cheng, 2019), to offering financial advisory services (Avery, 2019).

2.3.1.Robotics Process Automation (RPA)

Moffitt, Rozario and Vasarhelyi (2018) defines RPA as "a form of process improvement using technology; when applied to auditing, RPA is expected to not only replace manual and mundane audit tasks, but also to motivate the re-engineering of audit processes". Ansari, Diya, Patil and Patil (2019) further described RPA as the automation of tasks and routines that already exist and are performed by humans so there is more efficiency, lower errors, and more consistency achieved due to the automated nature of the task being processed.

Operations that are labour intensive, repetitive, and mundane are identified as key candidates for automation (Lacity and Wilcocks, 2016). RPA has been effectively applied in automating functions such as automatic loan application credit scoring, to the processing of invoices (Moffitt et al., 2018). RPA is increasingly being used by organisations and there are software tools that enable users to develop their own automated procedures, namely BluePrism, Automation Anywhere and UlPath (Syed et al., 2020). Syed et al. (2020) estimate that 90 % of Small and Medium sized organisations will indicate an interest in RPA solutions so they can take advantage of the opportunity to automate tasks and better utilise their human resources elsewhere.

Kokina and Blanchette (2019), reported that the use of RPA decreases time to complete tasks and the costs associated with processing data, which effectively improves the accuracy and consistency of the data and in turn results in better decisions.

Whilst these benefits are projected, Ansari et al. (2019) highlighted the disadvantages of RPA adoption as being costly, people not having the necessary skills to use them easily and not fully understanding how to implement RPA, and also the fear of humans being replaced by robots. Kokina and Blanchette (2019), reported that there is an RPA project failure rate of between 30 and 50% which makes it important to fully understand the reasons for the adoption, and failure thereof.

2.3.2.Intelligent Robotics Process Automation (IRPA)

The use of RPA and Artificial Intelligence (AI) technologies has disrupted the manner in which business operations are performed. RPA provides a machine with the capability to 'do' whilst the use of AI provides the machine with the ability to 'think' (Ansari et al., 2019). Ansari et al. (2019) further confirmed that the use of any of these technologies have the ability to complement, or even replace humans from performing certain tasks, thereby changing the way business operations are performed. This presents possibilities for organisations to use robots to perform low-level, labour intensive tasks to apply cognitive abilities to problems, or apply both in order to achieve Intelligent Robotics Process Automation (IRPA).

IRPA is the evolution of RPA with the ability to understand, apply intelligence and precision to tasks (Joshi, 2019). Zhang (2019) stated that the combination of RPA and AI increases the capabilities of robots through intelligence process automation. Zhang (2019) stated that this intelligence is achieved through the use of AI techniques such as machine learning and data analytics. Lin and Hazelbaker (2019) stated that the combination of RPA and AI presents opportunities for better performance and productivity. This is through the use of robots for counting inventory, reading and inspecting documents.

Paschen, Pitt and Kietzmann (2020), defined Artificial Intelligence (AI) as "computational agents that act intelligently and perceive their environments in order to take actions that maximize chances of success". Rossi (2018), further revealed that AI provides systems with human-like capabilities such as interpreting graphical images, understanding text, converting voice to text so that it can be applied to problem solving and reasoning.

Kokina and Davenport (2017), stated that AI will significantly change the future of auditing, specifically the process of gathering data to be audited. According to Paschen et al. (2020), AI makes use of six fundamental building blocks, namely structured data (input data), unstructured data (input data), pre-processing, main processing, knowledge management, and output capabilities. This therefore enables the AI agent to process data through problem solving, machine learning and reasoning techniques so that it can interact with the environment via speech, insightful reports (natural language generation), generating images from data (image generation), and perform physical or electronic actions (Robotics).

2.4. Impact of robotics on Auditing

2.4.1.Theoretical research of robots in auditing

The auditing profession has a strong history, and the role of a modern auditor remains just as important since the start of the 19th century. The failure of audits not being able to detect irregularities in companies such as Enron and Tyco (Yang, Jiao, and Buckland, 2017) indicated the vulnerabilities that audits are prone to, and the importance of maintaining good quality audits to sustain the relevance of auditing. This resulted in improved governance regulations being instituted, such as the Sarbanes Oxley (SOX) act of 2002 in the USA, that required a strengthening of auditor governance (Manita, Elommal, Baudier and Hikkerova, 2020). Whilst these regulations improved auditing practices, there were some limitations due to the auditing methods being based on samples of past results/data without providing valuable insight for the business. Zhang (2019) demonstrated that auditors experience pressures with having to work with tight timelines, high quality expectations of the work performed and increased workloads whilst having to perform these audits at a low cost.

Lois et al. (2020), highlighted the need of having continuous audits performed that can provide real-time insights at any point in time (also known as on-demand auditing), as opposed to providing an audit report after months of work on historic data. Huang and Vasarhelyi (2019) described Continuous Auditing as "a methodology for issuing audit reports simultaneously with, or a short period of time after, the occurrence of the relevant events". Chan and Vasarhelyi (2011) highlighted that auditors are constantly looking for application of continuous auditing techniques to replace traditional methods of auditing as it has the ability to enhance audit effectiveness and efficiencies due to its ability to provide almost instant results (known as real-time assurance), as opposed to audits done on request, which are lengthy and based on historic data.

According to Porter and Heppelmann (2014), this increased the need to provide reliable real-time insights, that are relevant and present a key opportunity for audit functions to digitise the auditing processes using the disruptive technologies provided by the fourth industrial revolution. This will enable auditors to automate the repetitive tasks of extracting and preparing data to be tested (Moffit et al., 2018; Gotthardt, Koivulaakso, Paksoy, Saramo, Martikainen and Lehner, 2020) so that they can apply their efforts on more value-added functions such as evaluating the data. (Lombardi, Bloch and Vasarhelyi, 2015; Gotthardt et al., 2020). Gotthardt et al. (2020) also highlighted that auditors will be able to test against full populations which presents more accurate results due to all of the data being analysed as compared with the traditional approach of testing a sample of the data.

The other immediate benefits would be the ability to reduce the time taken to perform audits, increase the scope of audit coverage across business functions without the need to increase resources, and performing the work quickly and when requested (Syed et al. 2019; Huang and Vasarhelyi (2019). This change would also result in a change of the profile and skills of the auditor as he or she would be required to have capabilities in programming to build, update and maintain the robots (Cooper, Holderness, Sorensen, and Wood, 2019). Cooper et al. (2019) iterated that the future auditor will require finance, auditing, analytics, and robotics skills which is an extension of the traditional auditor profile.

Chakraborty and Vernocchi (2018) reported that approximately 90% of business leaders expect digital technologies to change businesses and will have an effect in the industry, similarly to that of the Internet. The transformation of industries, and introduction of new platform businesses (such as Uber and Airbnb), present a need to adopt these technologies. Tang , Norman and Vendrzyk (2017) and the Institute of Internal Auditors (2013) also acknowledged the impact that technology was having on the profession, which resulted in the standards being updated from indicating "In exercising due professional care internal auditors should consider the use of technology-based audit and other data analysis techniques", to "In exercising due professional care internal auditors must consider the use of technology-based audit and other data analysis techniques" (Tang et al., 2017) (Institute of Internal Auditors, 2013). The World Economic Forum also predicted that at least 30% of audits will be conducted through the use of AI enabled tools (World Economic Forum, 2015).

Crump (2015) further emphasised that audits are expensive and present ‘waste’ of internal resource times (as both the auditors and the staff from the other departments are involved in the audit). Crump (2015) also indicated that through the implementation of lean processes, audits can provide more productivity and reduce operational costs similar to the manner in which other operations derived these benefits.

Huang and Vasarhelyi (2019) highlighted examples of automation in auditing where contract reviews were performed by robots using optical character recognition (OCR), and drones to perform inventory stock counts. These manual intensive tasks of validating data, accessing databases, documenting the work performed and general administration of filing audit documents, were reduced from a few days to 30 minutes. This in conjunction with the ability to continuously work for 24 hours a day, software that is easy to use (UI Path, BluePrism and Automation anywhere), and costs up to nine times less than a human employee, makes automation of tasks a viable option for consideration (Huang and Vasarhelyi, 2019).

Whilst all of these benefits have been demonstrated in such cases, research with the ‘Big Four’ audit organisations, (EY, KPMG, Deloitte and PWC), revealed that its implementation within the auditing industry has been low (Cooper et al., 2019). It was stated that this was potentially due to auditor perceptions that audit procedures will not be properly executed in accordance with the standards and will hence present a low appetite to automate the auditor’s professional judgment. McCollum (2017); and Kokina and Davenport (2017) also supported the notion that the auditing profession will not disappear, as the robot technologies would augment the auditors, as opposed to replacing them.

Rose, Rojhani and Rodrigues (2018) reported that in 2016, over 2.6 quintillion bytes of data was generated on a daily basis. It was further noted that 90 percent of data that was created since the existence of man, was generated in 2015 and 2016. These figures would have drastically increased with the exponential adoption of these technologies. This data provided good insights for business which places considerably more strain on the auditors who have to analyse this increased volume of data. This, in conjunction with tight time constraints, reduced audit fees/costs, increasing workloads and the need for insightful quality audits and excessive workloads, will require the use of technology to increase the efficiency and effectiveness of auditors (Zhang, 2019). Huang and Vasarhelyi (2019); Kokina and Davenport (2017); and Issa Sun and Vasarhelyi (2016) highlighted some examples of implementation of automation in auditing:

- KPMG has created an auditing platform, Clara, which, is capable of cognitive decision making and predicting trends. KPMG also partnered with IBM to determine how the AI Tool Watson can be used in the audit profession.
- EY used AI to convert unstructured data from images and documents into information that could be used for analysis. EY also started to use machine learning to identify fraudulent trends from large datasets.
- Deloitte is working with a vendor, KIRA systems, to use cognitive technology when auditing the terms within contracts and legal agreements. The auditors would use this for further analysis and investigation.

- PWC is building robots with a technology company that specialised in AI, ‘H20.ai’, to build robots that analyse transactions to detect general ledger irregularities (the robot was named ‘Halo’) and these results assist with the manual investigations.
- Auditing algorithms are used to present forecasts of financial performance using historic data and predictive analytics.
- The use of robots and drones to perform audits of inventory by using image recognition software and then analysing the images. An example was demonstrated where a robot was able to take a picture of cars in a parking lot, and then used AI technology to count the number of vehicles in the image.
- Using Natural Language processing and deep learning to understand emotions demonstrated in documents and social media. This can assist in the identification of aspects to be investigated and demonstrate auditor judgment.

2.4.2.Prior studies on auditing and robotics

Lois et al. (2020) performed a survey, where 105 respondents across Greece Institutions examined the perceptions that auditors have on the impact digital technologies have on continuous auditing, the factors that will influence its use, and the techniques that can be implemented in auditing. The respondents were given questionnaires, and the results were analysed using the multiple regression method. The key finding from the survey was that robots contribute toward the efficiency and effectiveness of audits; however, it could not replace the professional skills of auditors. It was also confirmed that despite the moderate use of robotics in some organisations, the costs were high, and there was a need for developing skills through training so that auditors could use the robots.

Zhang (2019) performed a simulation test whereby an audit of an e-commerce site was performed through a combination of a manual audit and through robotics automation. The experiment was to determine which keywords were most effective in presenting the Cetaphil face cleanser product on the first page of the Amazon website.

The manual process required the human auditor to manually open the browser, visiting the e-commerce website, searching for the product using the keyword, and then visually confirming whether the product appeared on the first page of the search results or not. The robot automated these operations. The subsequent findings confirmed that the robot took an average of 1 minute and 13 seconds to perform ten keyword searches, whilst the human took 5 minutes. The results from the robot were accurate with no errors. This demonstrated the effectiveness of robots in performing repetitive tasks. The paper also concluded that whilst these tasks demonstrated benefits, it should be used by auditors, and not replace auditors.

Tiberius and Hirth (2019) used the two-stage Delphi research method to obtain views around the impact of digital on auditing from experienced audit professionals in Germany. The purpose of a Delphi study is to use questionnaires listing potential future scenarios spanning a horizon of five to ten years, and the respondents' auditors to predict the likelihood of those probabilities. This study asked the auditors for their perceptions of how digitalisation would impact the future of auditing.

The findings surprisingly revealed that whilst technology will change how auditors perform their work, the auditors experience, judgment, and discretion will still be needed, and cannot be automated. The expectation of clients is that automation will be used to improve the quality and coverage, whilst also presenting cost-savings for the auditors and that the audit fees should be reduced due to automation of repetitive tasks. Whilst there is support for automation by regulators, they are still of the opinion that the responsibility for providing an audit report should not be automated. The overall view was that auditing knowledge will be complemented with that of IT knowledge, as the discretion would need to be applied to the audit findings.

In summary, the study confirmed that auditors do not predict significant changes to the role of the auditor, however, it was noted that digital technology will change the manner in which audits are done and this necessitates the need for auditors to have an increased set of skills.

2.5. Adoption of technology

2.5.1. Technology adoption model

The advancements of digital technology over the years have been exponential, providing the ability to process high volumes of data at high speeds (Tiberius and Hirth, 2019). This, in conjunction with the decreasing costs of technology, has resulted in these technologies being used to complement business operations and individual lifestyles. Kane, Phillips, Copulsky and Andrus (2019) explained that a key element of technological disruption is not the technology development itself, but how people adopt it. Kane et al. (2019) demonstrated the principles of technology change, adoption, adaption, and assimilation (highlighted in Figure 1 below).

- **Technology change:** the rate at which new technology innovations and capabilities are being introduced into the environment.
- **Adoption:** the rate at which users start using technology innovations as part of their personal lives and daily routines.
- **Adaptation:** the rate at which organisation have starting using technology innovations within the organisation.
- **Assimilation:** the rate at which organisations, regulators and legislations have governed the use of the technology within society.

Whenever technology is introduced, it is generally first adopted by users who would use it in their daily lives, and then followed by the adaption by employees in an organisation, who are able to apply their experience of these technologies with business processes (Kane et al., 2019).

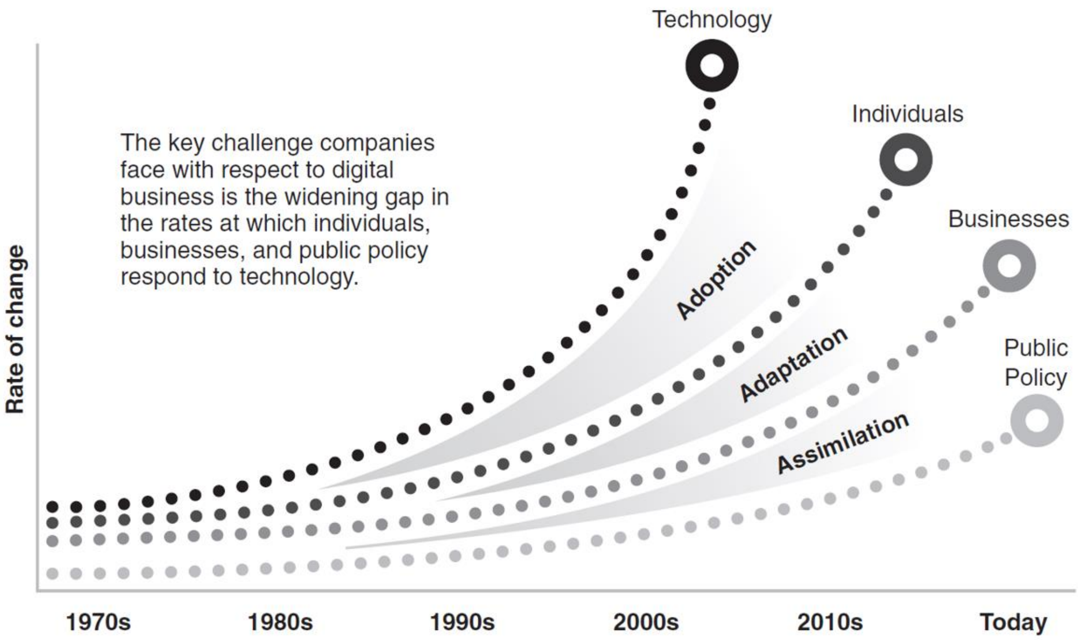

Figure 1: Technology adoption model

Source: Based on Kane et al., *The Technology Fallacy,* MIT Press, 2019

2.5.2. User adoption models

There have been a several models that were studied and experimented with to understand the factors that influence users to adopt technology, of which four were frequently used to explain those factors that drive user adoption of technology and are highlighted below:

2.5.2.1. Theory of reasoned action (TRA)

TRA is formed on the basis that individuals use information in a rational manner to inform their decisions (Fishbein and Ajzen, 1977). The persons intention to engage in a behaviour is based on his or her feelings or attitude (which could be positive or negative) toward performing a certain behaviour which will inform their attitude to perform the behaviour or not. TRA also took into consideration that individuals behaviours are influenced by subjective norms, whereby their perceptions of what others, whom they deem are important thinks that they should or should not do, will influence his or her behaviour.

2.5.2.2. The technology acceptance model (TAM)

TAM explained that the adoption of technology was based on two factors, namely the users perceived ease of use, and perceived usefulness of the technology (Davis, 1989). According to Davis (1989), perceived usefulness considered the extent to which the user believes that his or her work performance would be improved as a result of using the system. The perceived ease attribute relates to the extent that the user would be able to use the system, with minimal or no additional effort being required.

2.5.2.3. The theory of planned behaviour

This theory is an extension of TRA through the introduction of the third element called perceived behaviour control (Ajzen, 1991). In addition to the person applying his or her attitude and subjective norms, the user would assess the perceived ease or difficulty of performing the behaviour. The perceptions are context specific and would be different for each individual and task they are faced with.

2.5.2.4. Unified Theory of Acceptance and Use of Technology (UTAUT)

This model was developed to determine factors that influence the adoption of technology by organisations (Venkatesh et al., 2003). It was formed through an integration of eight IT Acceptance models that were used, specifically the theory of reasoned action (TRA), Technology Acceptance Model (TAM), the motivational model, Theory of Planned Behaviour (TPB), Combined TAM and TPB, Model of PC Utilisation, Social Cognitive theory, and Innovation Diffusion Theory. Venkatesh et al. (2003) based the theory on four factors that determined technology use, namely facilitating conditions, performance expectancy, social influence and effort expectancy. All these factors are influenced by moderating factors, namely gender, voluntariness of use, experience, and age.

2.5.2.5. Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

The UTAUT model evolved into a second version where it was adapted to understand the use of technology by consumers, and introduced three new factors outlined below (Venkatesh, Thong and Xu, 2012):

- **Hedonic Motivation:** is the extent to which users derive fun and enjoyment from using the system. This concept was obtained predominantly to explain the use of customers using the technology; however, it is worth noting that employees would also prefer to use organisational tools that create a positive experience.
- **Price Value:** is the extent to which a user would derive a cost saving from using the system. This is seen as a more effective driver for individual consumer users, where cost savings are directly linked to individual savings of the consumer, as opposed to employees where the costs of the system are covered by the organisation.
- **Experience and Habit:** Experience is linked to time in that the longer a user has exposure to the technology, the more familiar he or she becomes with it. Habit relates to people automatically demonstrating a specific behaviour as a natural result of learning.

2.5.2.6. Unified Theory of Acceptance and Use of Technology (UTAUT) model explained

The UTAUT model is the most commonly applied model for determining user intention. This model was used as part of this research, and the theory was explored in more detail. Venkatesh et al. (2003) indicated that four key factors (also referred to as constructs) for affecting adoption of technologies and its actual usage areas follows and depicted in refer figure 2 below:

- **Performance expectancy:** considers the extent to which users believe that his or her work performance would be improved as a result of using the system. This would include the completion of more tasks, increase in productivity, making it easier to perform the job, or an improvement to the current way of doing things (such as being able to do things quicker or of a better quality). If they feel that the technology will also help them achieve goals beyond the task itself, then they will likely be extrinsically motivated to use it (they will be able to earn more or get promoted).
- **Effort expectancy:** considers the extent to which the user would be able to use the system with minimal, or no additional effort required. This attribute focuses on how easy or difficult it would be for the user to learn, operate, understand, and interact.
- **Social influence:** is the extent to which the individual believes that those influential people, or individuals that are important, think that the individual should use the new technology. This factor is influenced by the user's belief that his or her use of the system would be encouraged if it were viewed

positively by these important people. Social influence can also be linked to mandatory compliance, such as having to perform the task as per management's expectations, or to perform the task out of a voluntary nature due to social acceptance.

- **Facilitating conditions:** relates to an individual's belief that there is support in the organisation and technical infrastructure for using the system. This will include consideration of the user's self-efficacy of using technology (his or her confidence in using the technology), the training and support that is provided to use the system, and the compatibility of using the system with his or her work responsibilities and style.

The above constructs are key determinants to affect behavioural intention to use technology which leads to technology use. UTAUT identified four moderating variables that affect the relationship between these constructs and the behavioural intention or use of technology, namely voluntariness of use, experience, gender, and age. Venkatesh et al. (2003) highlighted that the moderating variables had the following effects:

- The **performance expectancy** construct for adopting technology is strongly influenced by gender and age. Younger men were found to be more influenced by the performance benefits of using technology when adopting it.
- The **effort expectancy** construct for adopting technology is strongly influenced by a combination of age, gender, and experience. It was found that young women, with less experience, consider the ease of use and learning the technology when considering its use.

- The **social influence** construct for adopting technology is strongly influenced by age, gender, experience of the user and their levels of voluntariness. It was found that these factors were strongest amongst older women that have mandatory requirements to comply with and have relatively less experience.
- The **facilitating conditions** construct for adopting technology is strongly influenced by the age and experience of the users. It was found that older and experienced workers were strongly influenced by this condition.

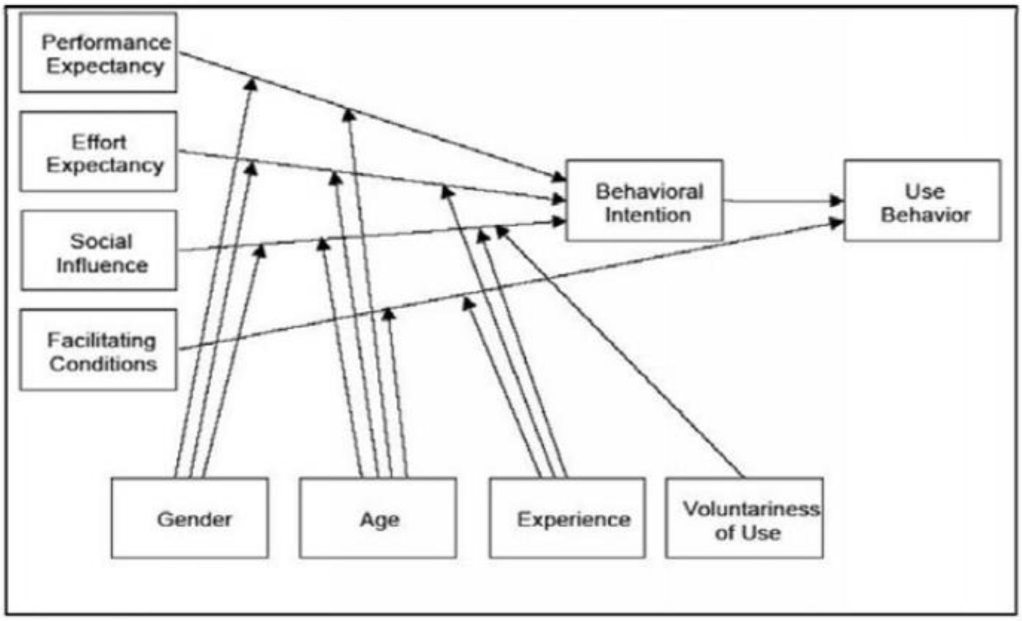

Figure 2: UTAUT Research Model

Source: Based on Venkatesh et. al, User Acceptance of Information Technology: Toward a Unified View, MIS Quarterly, 2003

2.6. Conclusion of literature review

Audit is important in providing shareholders with confidence on the financial results presented by the organisations, and the controls environment it has implemented to manage risks. There were cases in the past where audit firms suffered the consequence of providing incorrect assurance on the true status of the companies that were audited, resulting in brand damage and closure of auditing organisations. Therefore, it is key that auditors give accurate assurance, and ensure that as much factual data as possible can be audited and human errors minimised or removed completely.

Robotics have the capabilities to improve business operations and make our lives easier. Whilst there are some perceived fears of the abilities of robots, and the possibility of humans losing their jobs to robots, there are also views that these robots will present opportunities for the current workforce to enhance their abilities. This presents the need for employees to improve their robotics skills in order to prepare for the changing world.

The auditing industry has recognised the value of using robotics to assist with repetitive and manual intensive work, which is more efficiently performed by robots. Robots are able to perform advanced analytics on large populations of data, scan documents and perform repetitive reconciliation checks. This would enable auditors to perform more value-adding tasks such as investigating exceptions and providing insights. There has been a slow adoption of robotics in auditing, however there is an increasing use by the 'Big 4' audit organisations.

The UTAUT is a model was applied to determine the factors that drive the adoption of technologies by users. The model considers the value that e technology will provide for the user, the ease of using the technology, the factors within the organisation that support the use of the technology, and the social impacts of using the technology.

Lois et al. (2020) further emphasised that whilst the auditing profession is adopting disruptive technologies, each country differs in their strategy and adoption of trends. Therefore, it is important for such a study to be performed in South Africa to determine the motivations of South African auditors in adopting the technology to increase its adoption and likelihood of achieving the theorised benefits.

It is also important for organisations to determine how they will use automation, whether to replace repetitive mundane tasks, or to perform high level skilled work. There is a high potential value to be derived from automation, and this study will determine what those factors that will need to be considered are, when encouraging adoption amongst auditors.

Through the use of the UTAUT model (Venkatesh, Morris, Davis and Davis, 2003), this study aims to address the following research objectives:

- **RO1:** To determine the factors that could influence auditors in South Africa to accept the use of robotics automation technology through the application of the UTAUT model.
- **RO2:** To determine how these factors are influenced by the age, gender, experience, and voluntariness of auditors in South Africa.
- **RO3:** To determine the potential barriers for using robotics automation in auditing in South Africa; and
- **RO4:** To determine the potential enablers for using robotics automation in auditing in South Africa.

CHAPTER 3. RESEARCH METHODOLOGY

3.1. Research approach

This is an empirical study that tested the hypothesis as derived from the UTAUT model. Therefore, a quantitative research approach (Creswall, 2014) was used to get a generalised view of auditors, which required a large volume of responses. A quantitative survey approach was adopted in an attempt to obtain a maximum number of responses, in a cost-effective manner. The survey was distributed across various locations in South Africa, and the data collection phase was obtained in a shorter period than would have been the case with qualitative approaches.

The analysis was based on facts to determine the correlation between the auditors' perceptions of what drives the intention to use robotics, and its subsequent adoption by the auditors. The larger number of responses gives a true reflection of these perceptions amongst the population. The use of a quantitative survey allowed for anonymity which provided data that was honest and reliable, thereby yielding valuable results of the factors for adopting robotics in auditing.

The method adopted ensured that responses were free from intimidation or bias thereby retaining the credibility of the data that was obtained. The survey also allowed the respondents to complete the survey at their own convenience, in an environment and time that was convenient for them.

The use of surveys limited the study from probing responses, or from getting clarification of the responses from respondents, such as a more in-depth understanding of the barriers and enablers that they highlighted as the factors for adopting robotics technology. It also limited the opportunity for respondent to clarify any questions that formed part of the survey.

3.2. Research design

This empirical quantitative study used surveys to allow for the analysis of data across a large sample of the auditor population across South Africa. The first section of the survey captured the demographics and different levels of experience of the respondents so that the results could be analysed according to the grouping and UTAUT variables (age, experience, voluntariness, experience). The second section was a customised questionnaire that gained insights into the respondent's trust, attitude and understanding of robotics in auditing. The third section was taken from the UTAUT model (Venkat et al., 2003) which determined the factors that influence the adoption of robotics technology by auditors. The last section consisted of two open-ended questions that requested participants to enter the top three barriers and enablers for using robotics in auditing. This quantitative model was tested and used in prior research for determining those factors that influence the adoption of new technology by all users across different industries.

This survey approach was intentionally selected for the study to get a generalised view of auditors' adoption of technology. This required responses from large volumes of people, who confirmed their understanding of robotics technology, to a structured set of questions. The topic of discussion has many uncertain implications for the future of auditing, and this approach allowed for anonymous responses which will provide an honest view from the auditors, free of bias and intimidation that could exist in qualitative methods. This survey also allowed the auditors to answer the survey at their convenience, which was important due to the social distancing limitations that were experienced during the Covid-19 pandemic, and also to get responses within the timeframe that was assigned for this survey.

3.3. Data collection methods

An online survey was used to get insights of the UTAUT constructs and variables. Since the study required a generalised view from auditors and professionals that had interacted with auditors, it required data from many professionals with differences in the variables above. An online survey (shared via Qualtrics Survey Software) allowed for a wider reach to the participants, and the electronic storage of data that was used for the analysis. The survey was easy to complete as it was designed with a five-degree Likert scale (ratings of 1 for ‘Completely Disagree’ to rating 5 of ‘Completely Agree’). There were two open ended questions at the end that was limited to three text boxes each, allowing the auditors to capture the top three enablers and barriers for using robotics so that the key themes could be identified, and also serve as areas for further research.

The data was collected by requesting auditors and professionals that have interacted with auditors during audits performed in South Africa. The data was collected from auditors that are within my network. The participants were identified and their understanding of robotics was gauged through verbal discussions to confirm that they were awareness of robotics technology and its possible implications, prior to their participation. This ensured that insights were obtained from individuals whose participation would be valuable for the research. Once verified, they were provided a link to the survey via email.

All data collected, is primary data, and also includes demographic data. No personal data was requested or retained to ensure compliance with data privacy requirements. This data was collected electronically by Qualtrics, which was then analysed on the Statistical Package for the Social Sciences (SPSS) tool. The text analysis to identify the barriers and enablers of robotics technology (research objectives three and four) was performed using data analysis techniques on Python and Excel software.

3.4. Population and sample

3.4.1.Population

The population consisted of professionals that interacted with auditors in audits, internal and external auditors:

- Auditors that work for South African external auditing organisations (SNG Grant Thornton, KPMG, EY, Deloitte and PWC).
- A community of auditors and professionals in my personal professional network.

3.4.2.Sample and sampling method

The approximate number of all auditors in South Africa was unknown and was therefore difficult to reach all auditors in South Africa. For this reason, the non-probability approach was used, consisting of a purposive sampling method (Greener, 2008). This approach was used as the individuals that were required to participate had to have some awareness of robotics technology, which required confirmation prior to their participation in the research. These participants consisted of my colleagues, former colleagues, representatives within the industry, employees of internal and external audit companies to ensure there was a fair representation of participants across South Africa. The sample size used in the research was 85 individuals, which was sufficient to provide for meaningful analysis.

3.5. The research instrument

The personally administered online questionnaire approach was used. The questionnaire contained a combination of customised questions, and those that were aligned with the UTAUT approach (Venkat et al., 2003) and constructs. The questionnaire started with Section A that obtained information relating to the participants experience in auditing and robotics, demographic data, type of auditing that they do and voluntariness of using robotics. This enabled the analysis of the trends between each of the moderating variable.

Section B measured the perceptions of auditors towards the use of robotics in auditing. The questions used a five-degree Likert scale. This approach was used so that auditors were able to respond using a standard and consistent response pattern for each of the questions. This also allowed for a standard method of analysis to obtain a generalised view of the population. This section consisted of six sub-sections, each of which will be described below.

Section B1 focussed on gaining and understanding of the awareness, attitude, and trust that auditors have towards robots. This was a key section to determine the initial perceptions of auditors towards robots.

Sections B2 to B6 of the questionnaire focused on obtaining the auditors perceptions of using robotics against the UTAUT constructs. These constructs were:

- **Performance expectancy:** this is an independent construct that measured the extent of the auditor's belief that the robot will improve the manner in which they perform their work. It considered whether the auditor felt that robotics increased his or her productivity, efficiency, and career growth.
- **Effort expectancy:** this is an independent construct that measured the degree of ease for learning and using the robot in performing audit tasks.
- **Social influence:** this is an independent construct that measured the extent to which the individual considered those people or associations that influence his or her actions viewed the use of robotics in auditing.
- **Facilitating conditions:** this is an independent construct that measured the extent that the auditor felt there was an appropriate level of support and infrastructure within the organisation to use robots when performing audits.
- **Behavioural intention:** this is extent to which the auditor will be influenced to use robotics in auditing. It is a construct that was dependant on the interaction with each of the independent variables above. When a user intends to use a specific technology, it positively influences the use of that technology. This variable was key for understanding how this variable related to the independent variables above.

These questions were aligned with the UTAUT model and determined the correlation between these constructs to determine how they impacted the adoption of robotics by auditors. It is a well-established model, that was used in various empirical studies previously, to assess the use of different technologies. Therefore, this model was included in this questionnaire.

Section C consisted of two open-ended questions that requested the participants to share their views of the top three enablers and barriers for adopting robotics. This allowed for the identification of common trends that would be useful for further research. The use of a survey made provision for the respondent to complete the survey at his or her convenience as they were able to complete it at any time and place that suited them. It also allowed them to answer in a confidential environment where an honest and well thought of response was provided. It will also ensure that the responses were free from bias or influence of the researcher.

This questionnaire was done online on Qualtrics Survey Software and the results stored electronically for analysis. The survey is included in **Appendix A**.

3.6. Procedure for data collection

This survey was designed as an internet-based survey (Creswall, 2014; Greener, 2008), using Qualtrics Survey Software, which had a link that will direct respondents to the survey.

The identified sample population was contacted and the research objectives that it was going to provide to the audit industry in South Africa was discussed. They were asked if they were willing to participate and then verbally confirmed that they had participated in audits in South Africa and that they had an understanding of robotics and its uses in the auditing profession. A video was also shared with the participants to confirm their understanding of how robots were used in auditing. After the participants had positively confirmed that they had an understanding of robotics in auditing, a link to the survey was shared via email to their personal email addresses.

Attempts to contact audit partners of the External Audit companies were made to obtain participation in the research, however the accessibility to these organisations were restricted during the Covid-19 pandemic as many meetings were restricted to business-critical meetings. This also presented additional challenges of employees within these organisations needing clearance from their learning development and marketing teams before participating in the survey. Therefore, the assistance from External Audit firms could not be obtained to the degree intended at the start of the research.

These emails were sent in the period between 18 September 2020 and 31 December 2020. The number of responses were tracked on a weekly basis. Monthly reminders were also sent to the participants to complete the survey.

3.7. Data analysis and interpretation

The responses were analysed using SPSS. As the UTAUT model is able to identify the relationship between independent constructs and variables with the dependant variable (Behavioural Intention), the regression analysis approach was used (Creswall, 2014; Greener, 2008). This enabled the study to determine the correlation between the independent constructs (performance expectancy, effort expectancy, social influence and facilitating conditions), and the dependant construct (Behavioural intention) to determine how they influenced each other to result in the adoption of robotics in auditing. These constructs were also assessed in relation to the variables (age, gender, voluntariness, and experience) to determine how each construct was affected by the variables.

As the research focussed on obtaining the perceptions of auditors and the business professionals that engaged with auditors during audits (auditees), it was important to establish the difference between the two categories. The t-test could not be used, due to the fact that the data is not normally distributed, and the sample of non-auditors (auditees) were less than 30. As a result, the central limit theorem could be applied to assume normality. Therefore, the Mann-Whitney U-test was adopted to determine the degree of the difference in responses from each group. This approach was used to determine the difference of the results between auditors and non-auditors (those participants that have been audited but not in an auditing position at the time of the survey).

This enabled the study to determine if the results differed between auditors and non-auditors.

A text analytics approach was used to determine the word frequency and keyword analysis of the responses, to the two open-ended questions that were included, to demonstrate the barriers and enablers for adopting robotics technology. These results were used to highlight common themes from all the responses so that the barrier and enablers for adopting robotics could be identified. This was done using Python and Excel.

3.8. Limitations of the study

It was difficult to contact and meet senior members of the IIA, ISACA, EY, KPMG, PWC, Deloitte and Grant Thornton organisations due to social-distancing requirements that were implemented as part of the Covid-19 lockdown measures.

These organisations also required lengthy clearance processes to be followed in order to participate in the survey, which was not aligned with the timelines for this research.

The use of robotics within the South African auditing profession is potentially very limited, which impacted the results of the survey. The responses were based on theoretical knowledge for majority of the respondents, and not a practical application of the robotics concepts.

There are not enough empirical studies done on the use of Robotics in auditing, both globally and within South Africa, to compare or contrast the results of this study.

3.9. Validity and reliability

The UTAUT model has been based on established theories such as TAM and TPB. It has been used and adopted by various researchers over the years, thereby demonstrating the reliability and validity of the model.

3.9.1.Validity

The UTAUT model is a well-used model and has been used in various studies to determine the adoption of new technologies. This model was tested across multiple auditors with different responsibilities, demographic characteristics, organisations, experiences, and perceptions. The questionnaire was structured so that it was relevant to the auditing environment. The questionnaire used the same constructs and variables that were used in previous studies, with the only exception being that it was worded within the context of auditor's perceptions of using robotics.

An internal pilot was performed with ten auditor colleagues, who completed the questionnaire to test if the reliability and validity concepts were met. This was done with a small group auditor to confirm that the questionnaire was accessible, and that the content was clear. The results were assessed, and suggestions were incorporated into the survey (specifically around the grammar or clarification of items and inclusion of the video that was shared when confirming the respondent's participation in the survey). After all feedback was incorporated and the accessibility of the questionnaire and storage of data was confirmed, the survey was shared with the wider group of participants.

I also worked under the guidance of a supervisor that had prior experience in research of using new technology in auditing.

3.9.2.Reliability

The UTAUT model has been used across various industries and technologies over many years and continues to be used by researchers to determine the intention of users to adopt new or emerging technology. Therefore, the research can be replicated to determine trends and areas for future research. This model is a previously created model which is a key reason for its use in this research. The reliability of this model was tested with the Cronbach Alpha coefficient method. Since this is a study for which there was limited data in South Africa available, the results were difficult to validate in this context with a high degree of accuracy. The results were validated against results where the conceptual UTAUT model was used.

3.10. Demographic profile of respondents

154 questionnaires were sent, with 94 responses received. Of the 94 responses, 85 were coherent and used as the basis of this study. A detailed breakdown of the demographics is presented in Chapter four of this paper.

3.11. Ethical considerations

An online survey was used for the research and participation was voluntary. The survey had a cover page where the participant was able to provide his or her consent before participation or withdraw from participation. The survey also made provision for the participant to withdraw from the survey at any point in the survey. The cover letter also clearly indicated my contact details, should clarity be required. The survey required respondents to be anonymous, therefore they were not required to share any personal data. Data attained from the study, was used for this research only. The research was performed in accordance with the Wits Business School guidelines and a WBS ethics clearance was obtained.

3.12. Consistency matrix

Research Problem: The traditional auditing procedures are time consuming, repetitive, and prone to human error. Analyse the process of adopting new technologies as defined in the UTAUT, and to determine how it can be used to determine how robotics can be used in auditing.				
Research Objective	Literature Survey	Source of data	Type of data	Analysis
RO1: To determine the factors that could influence auditors in South Africa to accept the use of robotics automation technology through the application of the UTAUT model;	Venkat et al. (2003)	Questionnaire: Sections B2-B6.	Quantitative	Multiple linear regression. T-test

RO2: To determine how these factors are influenced by the age, gender, experience, and voluntariness of auditors in South Africa;	Venkat et al. (2003)	Questionnaire : Sections A; B2-B6.	Quantitative	Multiple linear regression. T-test
RO3: To determine the potential barriers for using robotics automation in auditing in South Africa;	Lois et al. (2020) Tiberius and Hirth (2019) Kokina and Davenport (2017) Ansari et al. (2019)	Questionnaire : Sections B1; C (Question 1)	Quantitative	Text analytics

RO4: To determine the potential enablers for using robotics automation in auditing in South Africa.	Lois et al. (2020) Tiberius and Hirth (2019) Kokina and Davenport (2017) Ansari et al. (2019)	Questionnaire : Sections B1; C (Question 2)	Quantitative	Text analytics

Table 3.1 : Consistency Matrix

CHAPTER 4. : PRESENTATION OF RESULTS AND FINDINGS

4.1. Profile respondents

This study focussed on obtaining responses from professionals that worked as, or with auditors in South Africa. The study obtained a view across a diverse range of characteristics, including gender, age, educational background, management and non-management, auditing experience, computer experience, and understanding of robotics. A total of 154 questionnaires were disseminated, with 94 responses received. Of the 94 responses, 85 were usable and used as the basis of this study.

4.1.1.Age

The age of participants varied. 50 (58,8%) of the respondents were in the 31- to 40-year-old age group, followed by 24 (28,8) of the respondents being between 41 to 50 years old. Therefore, the majority (74 participants representing 87%) of respondents were between 31 and 50 years old.

Please refer to table 4.1 below for an indication of the distribution of the ages of the respondents.

Age	**Frequency**	**Percent**
21 - 30 years old	4	4.7
31 - 40 years old	50	58.8
41-50 years old	24	28.2

51-60 years old	5	5.9
Under 20 years old	2	2.4
Total	85	100.0

Table 4.1: Age of respondents

4.1.2.Gender

The study aimed to get responses from males and females. From the 85 usable respondents, 48 (56,5%) were male, and 37 (43,5%) were female.

Please refer to table 4.2 below for the distribution of the gender of respondents.

Gender	**Frequency**	**Percent**
Female	37	43.5
Male	48	56.5
Total	85	100.0

Table 4.2: Gender of respondents

4.1.3.Education

All respondents had a good education, with 84 (98,8%) that obtained a diploma or degree after matric. Of these 84 respondents, 12 were in possession of a diploma, and 14 with an undergraduate bachelor's degree. There were 58 (68,2) respondents who held post graduate degrees, including Doctorate (3), Honours (31) and Masters

(24) degrees holders. This implied that the respondents were well qualified to participate in the research.

Please refer to table 4.3 below for a distribution of the respondent's level of formal education.

Education	**Frequency**	**Percent**
Bachelor's Degree	14	16.5
Diploma	12	14.1
Doctorate	3	3.5
Honours Degree	31	36.5
Master's Degree	24	28.2
Matric	1	1.2
Total	85	100.0

Table 4.3: Respondents level of education

4.1.4. Auditor categories

The respondents comprised of auditors and individuals that had been audited (also referred to as auditees), both providing important insights to the research. The auditors comprised of 59 (69,5%) respondents and of 26 (30,6) auditees (non-auditors). The non-auditors comprised of professionals across various business roles that engaged in audits, including Senior Risks Officers, Heads of Risk and Business Departments, Financial Managers, and a Chief Information Officer. This demonstrated that the respondents were relevant and knowledgeable in the auditing discipline so were suitable to participate and contribute towards this research.

Please refer to table 4.4. below.

Type of auditor	Frequency	Percent
External Audit	2	2.4
Internal Audit	57	67.1
Not an Auditor	26	30.6
Total	85	100.0

Table 4.4: Respondent categories

4.1.5.Management profile

The majority of respondents were in a management position, with 67 (78,8%) of them indicating they held management positions. This demonstrated that the respondents were of a management level and would be able to incorporate experiences of managing teams. In addition, they would also have a degree of influence for adopting new practices and technologies in their organisations.

Please refer to table 4.5 below.

Management Position	Frequency	Percent
Non-management	18	21.2
Management	67	78.8
Total	85	100.0

Table 4.5: Respondent management or non-management details

4.1.6.Years of auditing experience

There were 69 (81,2%) respondents that had experience in auditing, with 16 (18,8%) having never worked as an auditor. This indicates that the majority of the participants understand the principles of auditing as having performed actual audits and were not limited to only being audited by them. They would therefore understand the technical concepts of auditing. This also indicated that whilst the respondents may not have been working as auditors at the time of participating in the research, some of them had worked as auditors in the past (10 respondents were not auditors at the time of the survey but were previously auditors). They would therefore understand the concepts of auditing.

Please refer to table 4.6 below for a distribution of the respondents based on auditing experience.

Years of auditing experience	**Frequency**	**Percent**
I never worked as an auditor	16	18.8
2 - 3 Years	6	7.1
3 - 5 Years	10	11.8
5 - 10 Years	13	15.3
More than 10 Years	40	47.1
Total	85	100.0

Table 4.6: Years of auditing experience

4.1.7.Computer Literacy skills

The respondents confirmed they were all computer literate and were therefore suitable candidates to participate in the research. All respondents understood using computing technology, with 83 (97,6%) having a moderate or higher level of understanding of using technology. There were also 73 (85,9%) respondents that had advanced technology skills such as being able to do independently perform analytics and write their own programmes. Please refer to table 4.7 below for a distribution of the respondents based on level of computing experience.

Computer Skills	Frequency	Percent
Basic (I am able to use the internet, email and office applications)	2	2.4
Moderate (I am able to perform basic functions and also use systems or applications with minimal online guidance)	10	11.8
Good (I am able to perform basic and moderate functions with no guidance in addition to performing my own basic data analytics tests in tools such as Excel)	47	55.3
Excellent (I am able to perform the Basic, Moderate, Good functions in addition to writing more advanced scripts or programme code)	26	30.6
Total	85	100.0

Table 4.7: Respondent level of computer literacy skills

4.1.8.Robotics Awareness

The respondents were aware of the uses of robotics and familiar with the topic and its uses. This supported the pre-confirmation with participants that they were aware of robots are being involved in an audit as an auditor or client that was audited, before commencing with the research. There was one respondent who was not familiar with robotics, whilst the other 84 (98,8%) respondents understood robotics and its uses. 51

(60%) were actively researching the topic, with 8 (9,4%) respondents actually using it. This demonstrates that the respondents were aware of using robotics. Please refer table 4.8 below for a distribution of the respondent's awareness of robotics technology.

Robotics Awareness	**Frequency**	**Percent**
Do not know about it (you have not heard of robotics used in the workplace)	1	1.2
General awareness (you read and saw videos of robotics and have a basic understanding of its uses in the community and workplace)	33	38.8
Good (you read, research, and have an interest in robotics. You are aware of and seen practical uses of it in the workplace and community. You are able to recognise concepts of Robotics Process Automation (RPA) and Artificial Intelligence (AI))	43	50.6
Excellent (You understand the theoretical aspects of robotics and also used or implemented a robot through the use of Robotics development technology such as UI Path, Blue Prism)	8	9.4
Total	85	100.0

Table 4.8: Respondent level of robotics awareness

4.1.9.Experience in the number of years using robotics.

There were 45 (52,9%) respondents who had not used robotics previously, with 40 (47,1%) of them using it. This demonstrated there is an increased use of this emerging technology. Please refer table 4.9 below for an overview

Number of years of experience of using robotics	**Frequency**	**Percent**
0 - 1 Years	22	25.9
2 - 3 Years	9	10.6
3 - 5 Years	5	5.9
5 - 10 Years	3	3.5
More than 10 Years	1	1.2
Never	45	52.9
Total	85	100.0

Table 4.9: Respondent years of robotics experience

4.1.10. Respondent recognition of value provided by robots

There were 82 (96,4%) respondents who had indicated that robots would add value to auditing. This demonstrated there is that the respondents found that robots would be valuable to auditing.

Please refer table 4.10 below for an overview

Robots will add value to audits	**Frequency**	**Percent**
Disagree	1	1.2
Neutral	2	2.4
Agree	37	43.5
Strongly Agree	45	52,9
Total	85	100.0

Table 4.10: Respondent recognition of value provided by robots

4.1.11. Respondent intention to use robot for audit tasks

There were 80 (84,1%) respondents who had confirmed that they would like to use robots to perform audit tasks. This demonstrated there is a willingness to use robots in audting. Please refer table 4.11 below for an overview

Users wanting to use robots to perform audit tasks	**Frequency**	**Percent**
Neutral	5	5.9
Agree	30	35.3
Strongly Agree	50	55.8
Total	85	100.0

Table 4.11: Respondent intention to use robot for audit tasks

4.1.12. Respondent trust and comfort in using robots

There were 79 (93%) respondents who had indicated that they would trust the results of the robot and 81 (95,3%) of respondents were comfortable working with robots.

Please refer tables 4.12(a) and 4.12(b) below for an overview

Trust results of robot	**Frequency**	**Percent**
Strongly Disagree	1	1.2
Neutral	5	5.8
Agree	52	61.2
Strongly Agree	27	31.8

Total	85	100.0

Table 4.12(a): Respondent trust in use of robots

Comfortable working with robots	**Frequency**	**Percent**
Disagree	1	1.2
Neutral	3	3.5
Agree	45	52.9
Strongly Agree	36	42.4
Total	85	100.0

Table 4.12(b): Respondent comfort of working with robots

4.1.13. Robot complementing work of auditors in the future

There were 78 (91,8%) respondents who felt that robots would complement the work performed by auditors in the future. Please refer table 4.13 below.

Robots complementing the work of auditors in future	**Frequency**	**Percent**
Disagree	4	4.7
Neutral	3	3.5

Agree	36	42.4
Strongly Agree	42	49.4
Total	85	100.0

Table 4.13: Robot complementing work of auditors in the future

4.1.14. Frequency of using robotics.

It was noted that there was a low uptake of using robotics in audits despite the levels of awareness highlighted above. 55 (64,7%) respondents did not use robotics in auditing, with 23 (27,1%) of them rarely using it. There were 7 (8,3%) of respondents that made more frequent use of robotics in their audits. Refer table 4.14 below. distribution of respondents that used robotics in audit assignments.

Frequency of use of robotics	**Frequency**	**Percent**
Never	55	64.7
Rarely (less than 5 assignments a year)	23	27.1
Moderate (between 5 – 10 assignments a year)	2	2.4
Frequently (More than 10 assignments a year)	2	2.4
Always (On every assignment)	3	3.5
Total	85	100.0

Table 4.14: Frequency of robotics usage

4.2. Reliability analysis

A reliability analysis was performed using the Cronbach’s Alpha method. The Cronbach Alpha values range between zero and one. The closer the value is to 1.00, the more consistent and reliable the constructs. The ideal range for reliability should have a Cronbach Alpha of 0.7 or above. From the analysis, it confirmed that constructs were reliable as all statistics were above 0.7. Further, the lowest and highest values were 0,800 and 0,931, respectively. Please refer table 4.15 below for the results:

UTAUT Construct	Cronbach Alpha	Number of items
Performance Expectancy	0.931	6
Effort Expectancy	0.800	6
Social Influence	0.835	7
Facilitating Conditions	0.814	5
Behavioural Intention	0.813	3

Table 4.15: Reliability analysis: Cronbach Alpha

4.3. Descriptive analysis

A descriptive analysis was performed to obtain insights from the respondents' perceptions of the constructs. The results from the analysis of these variables were recorded as articulated below.

4.3.1.Performance expectancy

The respondents felt that the robot would be useful in improving their performance as it could assist auditors to be more efficient, reduce errors, allow the auditors to perform other tasks, and deliver more valuable audits. The responses to these constructs were favourable as the majority of the responses demonstrated agreement.

Please refer table 4.16 below for a distribution of the responses to the Performance Expectancy constructs.

Number	**Construct**	**Mean**	**Std. Deviation**
B11	Robots are useful in the audit environment	4.39	0.619
B12	A robot would enable auditors to accomplish tasks more quickly	4.45	0.627
B13	I could save much time at work by using a robot	4.45	0.627
B14	I would improve my performance in using robots as it will reduce errors	4.38	0.707

B15	Robots will increase the value that I provide in my work	4.36	0.633
B16	Having a robot could allow me to use my time to accomplish other tasks	4.49	0.666

Table 4.16: Descriptive analysis: Performance expectancy

4.3.2.Effort expectancy

The responses to these constructs indicated a positive confirmation that the respondents would like to learn about robots and feel that it would make their work easier to perform. However, whilst there was an acknowledgment of the value that robots can provide and respondents demonstrating a willingness to learn, there is still a perception that learning and using robots is not easy. This was demonstrated through the neutral responses on the ease of learning and use of robots.

Please refer table 4.17 below for a distribution of the responses to the Effort Expectancy constructs.

Question Number	**Construct**	**Mean**	**Std. Deviation**
B17	I like learning about robotics	4.36	0.784
B18	Robotic technology is easy to use.	3.33	0.918

B19	learning to use robots to perform audits is easy	3.24	0.972
B20	I have the technical skills needed to use a robot in performing audits	3.06	1.238
B21	Applying the use of a robot to perform audit tasks would be easy	3.49	1.019
B22	Using a robot will make my work easier	4.24	0.630

Table 4.17: Descriptive analysis: Effort expectancy

4.3.3.Social Influence

This construct revealed that most of the responses were within the neutral mean. Respondents did not feel that the use of robots would contribute towards their career progressions or improvement in status as this is not seen as important amongst their peers or by the clients that they work with. Although the responses were low, it was important to note that there was general support from the organisation, management, and auditing associations to use robots in auditing.

Please refer table 4.18 below for a distribution of the responses to the Social influence constructs.

Question Number	Construct	Mean	Standard Deviation
B23	B23 My organisation supports the use of robots for auditing	3.89	0.873
B24	Using a robot at work would indicate me having a higher status than those who do not	3.19	1.118
B25	My friends/family support the use of robots	3.40	0.966
B26	My Manager supports the use of robots	4.09	0.895
B27	Using a robot will advance my career progression (promotions, opportunities, remuneration)	3.69	0.913
B28	The auditing communities that I participate in supports the use of robotics in auditing (IIA, ISACA or any other auditing communities to which you belong)	3.93	0.842
B29	The expectations of my business partners or clients are that auditors should use robotics in performing audits?	3.65	0.909

Table 4.18: Descriptive analysis: Social influence

4.3.4.Facilitating conditions

A majority of the responses to these constructs were neutral, indicating there was limited funding, insufficient organisation structure for developing and supporting robotics solutions, and limited availability of skills within the organisation to develop or use robots. As this was one of the foundational building blocks for ensuring the use of robots, it is important that there is more investment in training and obtaining support to harness the skills of using robots.

Refer to table 4.19 below for a distribution of the responses to the Facilitating Conditions constructs.

Question Number	**Construct**	**Mean**	**Standard Deviation**
B30	My organisation has structures to support learning and using robotics	3.64	1.010
B31	There are government and country-wide initiatives across South Africa that supports the use of robotics in auditing	3.20	0.961
B32	My organisation has the necessary funds available for me to learn or use robotics for auditing	3.67	0.968
B33	My organisation has the necessary skills to start using robotics in auditing	3.36	1.100

B34	I have access to the relevant support should I need help when problems are encountered when using robotics	3.27	1.084

Table 4.19: Descriptive analysis: Facilitating conditions

4.3.5.Behavioural Intention

Without considering any of the independent variables, it was noted that the respondents are expecting the use robotics in the next 12 months, and that their organisations will be performing audits in the next 24 months. Despite this, the responses as to whether the respondents will use robotics in actual audit work in the next 12 months were neutral.

Refer to table 4.20 below for a distribution of the responses intention to learn or use robotics in the next 12 months.

Question Number	**Construct**	**Mean**	**Standard Deviation**
B35	I intend using robotics in performing audit work in the next 12 months	3.61	0.901
B36	I predict that robots will be used in my organisations for performing audits in the next 24 months	3.91	0.934

B37	I intend learning to use robotics in the next 12 months	4.06	0.836

Table 4.20: Descriptive Analysis: Behavioural Intention

4.4. Correlations

4.4.1.Correlation Analysis

A Spearman Correlation Analysis test was performed to determine the relationships between all the independent variables. Table 4.21 below indicates the results of the correlation analysis. From above, it is clear that all correlations were positive; with Behavioural Intention and Social Influence demonstrating the higher correlation at 0,671. Despite this high correlation, these coefficient intervals were in the medium to strong range, thereby indicating that these constructs did not match (discriminant validity). This supported the validity test.

	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions	Behavioural Intention
Performance Expectancy	1.000 -				
Effort Expectancy	.448** .000	1.000 -			
Social Influence	.604** .000	.537** .000	1.000 -		
Facilitating Conditions	.361** .001	.558** .000	.578** .000	1.000 -	
Behavioural Intention	.661** .000	.514** .000	.671** .000	.549** .000	1.000 -

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

Table 4.21: Correlation Analysis

4.4.2.Mann-Whitney U-Test

As the research focussed on obtaining the perceptions of auditors and the business professionals that engaged with auditors during audits (auditees), it was important to establish the difference between the two categories. The t-test could not be used, due to the fact that the data is not normally distributed, and the sample of non-auditors (auditees) was less than 30. As a result, the central limit theorem could not be applied to assume normality. Therefore, the Mann-Whitney U-test was adopted to determine the degree of the difference in responses from each group.

There were 59 auditors and 26 non-auditors that participated. The summary of the results of this test performed between the auditors and non-auditors across each of the variables are outlined below.

When analysing the Mann-Whitney U-test results of the null-hypothesis test, the p-value was used to determine if the hypothesis was true (i.e., that the auditors and non-auditors had the same responses across the constructs) or if they had difference responses. The p-value of < 0,05 would support the retention of the null hypothesis, whilst any value exceeding this would indicate the hypothesis is not true (i.e., that the auditors and non-auditors had different responses across the distributed sample). The results indicated that the auditors and non-auditors did not have the same level of responses for the Performance Expectancy, Facilitating Conditions and Behavioural Intention variables.

Refer to table 4.22 below for the results of the Mann-Whitney test.

Null Hypothesis	**Test**	**p-value.**	**Decision**
The distribution of Performance Expectancy is the same across categories of Auditor.	Independent-Samples Mann-Whitney U Test	0.009	Reject the null hypothesis.
The distribution of Effort Expectancy is the same across categories of Auditor.	Independent-Samples Mann-Whitney U Test	0.969	Retain the null hypothesis.
The distribution of Social influence is the same across categories of Auditor.	Independent-Samples Mann-Whitney U Test	0.044	Reject the null hypothesis.
The distribution of Facilitating Conditions is the same across categories of Auditor.	Independent-Samples Mann-Whitney U Test	0.646	Retain the null hypothesis.
The distribution of Behavioural Intention is the same across categories of Auditor.	Independent-Samples Mann-Whitney U-Test	0.021	Reject the null hypothesis.

Table 4.22: Mann-Whitney U-Test between Auditors and Non-Auditor categories

A further observation of the detailed results is highlighted in table 4.23 below.

These variables indicated a higher mean rank amongst the auditor category, therefore highlighting that auditors tend to agree more with the constructs in these variables, when compared to the results of the auditees. The Mann-Whitney U-Test also indicated that the responses of auditors and non-auditors for the Effort Expectancy and Facilitating Conditions variables were similar. This was also confirmed through the detailed results in Table 4.23, where the Mean Ranks are similar between these categories.

Variable	**Category**	**Number**	**Mean Rank**	**Sum of Ranks**
Performance Expectancy	Auditor	59	47.53	2804.00
	Non-Auditor	26	32.73	851.00
	Total	85		
Effort Expectancy	Auditor	59	43.07	2541.00
	Non-Auditor	26	42.85	1114.00
	Total	85		
Social Influence	Auditor	59	46.56	2747.00
	Non-Auditor	26	34.92	908.00
	Total	85		
Facilitating Conditions	Auditor	59	43.81	2585.00

	Non-Auditor	26	41.15	1070.00
	Total	85		
Behavioural Intention	Auditor	59	47.04	2775.50
	Non-Auditor	26	33.83	879.50
	Total	85		

Table 4.23: Mann-Whitney U-Test between Auditors and Non-Auditor categories (Mean Rank Breakdown)

4.5. Regression analysis

In order to test the research objective one (To determine the factors that could influence auditors in South Africa to accept the use of robotics automation technology through the application of the UTAUT), a regression analysis was performed to determine the relationship between the independent variables and the dependant variable and behaviour intention that will influence the use the robot technology in auditing. This regression model would be able to determine the degree to which the dependant variable can be predicted by the independent variables (R2), the significance of the relationship (depending on the p-value) and the Beta coefficient (B-value), which demonstrates which of the independent variables affect the dependant variable the most. The regression model used for this test is as follows:

Y (Behavioural intention) = a +β1* Performance expectancy + β2* Effort expectancy + β3* Social influence+ β4* Facilitating conditions, where:

- a= constant
- b =Beta, regression coefficient

The results of the analysis indicated that the independent variables predict the dependant variable (behaviour intention) by 63 percent (R2). The model also demonstrated the significance of the relationship between the dependant and independent variables, as the p-value is< 0.0001, which is lower than 0,05 ($p < 0.05$). Refer to table 4.24(a) below.

R	**R Square (R2)**	**Adjusted R Square (R2)**	**Std. Error of the Estimate**	**Significance (p) Anova.**
0.794a	0.631	0.612	0.47342	0.000

Table 4.24(a): Regression analysis summary

The regression model, as highlighted above, was applied and the results are highlighted below.

Variable	**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig. (p)**	**Collinearity Statistics**	
	B	**Std. Error**	**Beta**			**Tolerance**	**VIF**
(Constant)	-0.750	0.424	-	-1.770	0.081	-	-
Performance Expectancy	0.588	0.123	0.432	4.789	0.000	0.567	1.765
Effort Expectancy	0.031	0.109	0.027	.281	0.779	0.501	1.995
Social Influence	0.231	0.118	0.201	1.963	0.053	0.439	2.276
Facilitating Conditions	0.305	0.088	0.312	3.470	0.001	0.573	1.745

Table 4.24(b): Regression analysis detailed analysis

From the results in table 4.24(b), the equation is expressed as: Behavioural intention= -0.750+0.588*Performance expectancy+0.031*Effort expectancy+0.231*Social influence+.305*Facilitating conditions.

A detailed analysis of the independent variables within the model indicated that only the Performance Expectancy and Facilitating conditions were significant predictors to drive the user's Behaviour Intention to use robots in auditing, as denoted by the p-values of that were less than 0.001 (the p-values were less than 0,05). Performance expectancy variable demonstrated the strongest positive relationship, as denoted by the beta coefficient (β value) of 0,588. The Facilitating conditions variable also reflected a strong positive relationship with a beta coefficient of 0,305. Therefore, if these independent variables are increased positively, it would also have an incremental positive influence in the user's behaviour intention to use robotics in auditing. Refer to table 4.24(b) above, for the detailed breakdown of the relationship between the variables.

Based on the regression analysis, it can be concluded that:

- Performance Expectancy has a strong positive influence on the Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.
- Facilitating Conditions has a strong positive influence on the Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.
- There is no significant relationship between Social influence and Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.
- There is no significant relationship between Effort Expectancy and Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.

4.6. Moderated regression analysis

In order to determine how the independent variables are influenced by the moderating variable (age, gender, experience and voluntariness of auditors) in South Africa, a moderated regression analysis was performed. The results of the model highlighted that the interaction effect between all the moderating variables with the independent variables had a p-value that was greater than 0,05. Therefore, all these factors had no significant influence on the overall intention to use the robotics technology when auditing in South Africa. Refer table 4.25 below. Therefore, the following can be concluded:

- There is no significant relationship between age and the independent variables that influence the Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.
- There is no significant relationship between gender and the independent variables that influence the Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.
- There is no significant relationship between voluntariness of use and the independent variables that influence the Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.
- There is no significant relationship between work experience and the independent variables that influence the Behavioural Intention to accept the use of robotics automation technology to perform audits in South Africa.

	Performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions
Age	0.7192	0.5278	0.0507	0.4732
Gender	0.5684	0.1399	0.1823	0.0768
Voluntariness of Use	0.1647	0.3061	0.2069	0.053
Experience	0.3215 0.3626 (0.6016)	0.7070 0.7084 (0.9269)	0.7331 0.9290 (0.8330)	0.9430 0.2454 (0.2956)

Table 4.25: Moderated Regression analysis

4.7. Text Analysis

The survey asked the respondents to provide their top three enablers and barriers for adopting robotics technology in a free text field so as to identify the top thematic enablers and barriers for adopting the use of robotics for auditing in South Africa (Research objectives three and four). This data was then processed using the Rapid Automatic Keyword Extraction (RAKE) algorithm. RAKE is a machine learning algorithm that identifies and ranks keywords in text to identify those phrases that are frequently cited in the text. The RAKE algorithm removes the 'stop words' (such as 'the', 'a', 'and') to ensure that only key words are identified. Once the key words were identified, the frequency of the words were analysed to identify the thematic responses. The results of the barriers and enablers are listed in table 4.26 and table 4.27 below.

4.7.1.Barriers for the adoption of robotics technology in auditing

The thematic barriers that were highlighted related to insufficient skills and robotics training provided to drive the use and development of robotics solutions by auditors. This was followed by the high costs related to investment in the technology and training, and lack of management support to prioritise robotics. The inability to gain access to reliable data was also highlighted as a challenge since the robot would require reliable data in order to provide maximum value. Other barriers noted was the lack of time available to learn how to use robots and the users not trusting the robots.

Refer table 4.26 for an analysis of the results.

Frequency Ranking	**Keyword**	**Frequency**	**Rake Ranking**	**Rake**
1 (1)	Training *	7	23	0,2
1 (1)	Knowledge *	13	4	1,416667
1 (1)	Skill *	13	8	1,166667
1 (1)	Skills *	9	17	0,666667
5 (2)	Cost **	11	1	2,7
5 (2)	Fund **	9	22	0,2
7 (3)	Data ***	13	2	1,923077
7 (3)	Access ***	5	6	1,2
9 (4)	Support	17	9	1
10 (5)	Time	13	15	0,692308

11 (6)	Trust	5	30	0
12 (7)	Understanding	4	31	0
13 (8)	Availability	4	12	0,75
14 (9)	Strategy	3	3	1,5
15 (10)	People	3	19	0,5
16 (11)	Resource	3	26	0

Note 1: The ranking of each item is indicated in the 'Frequency Ranking' field, by its consolidated ranking as part of the thematic grouping of the terms. The value denoted within brackets is the consolidated ranking of the word.

Legend:

***** Knowledge, Skill, Skills and Training were linked keywords focussing on training and skills requirements

****** Cost and funding were linked keywords focussing on finances.

******* Data and Access were linked keywords focussing on data access and quality.

Table 4.26: Barriers for the adoption of Robotics in auditing

4.7.2.Enablers for the adoption of robotics technology in auditing

Training featured predominantly as the key enabler in ensuring adoption of robotics, which further emphasised the need for auditors to be trained in order to have the confidence and skills to use the technology. This was followed by the role that management plays in supporting the adoption of robotics. The respondents also highlighted that time is needed for the teams to experiment and learn to use the technology so that it can be adopted. Other themes, such as the need to have access to the tools, focussing on efficiency gains, and having good change management processes, were also highlighted as factors that would be enablers for adopting robotics in auditing.

Refer table 4.27 for an analysis of the results.

Frequency Ranking	**Keyword**	**Frequency**	**RAKE Ranking**	**RAKE Score**
1 (1)	Training	33	4	1,642857
2 (2)	Support *	24	2	2,2
2 (2)	Manager *	2	12	1
4 (3)	Time	15	3	1,647059
5 (4)	Availability	8	14	0,4
6 (5)	Efficiency	4	1	2,2
7 (6)	Technology	3	5	1,555556
8 (7)	Management Support *	2	6	1,533333
9 (8)	Change	2	15	0,333333

Note 1: The ranking of each item is indicated in the 'Frequency Ranking' field, by its consolidated ranking as part of the thematic grouping of the terms. The value denoted within brackets is the consolidated ranking of the word.

Legend:

* Support, Management and Manager were all linked to the enabler of management support.

Table 4.27: Enablers for adoption of Robotics in auditing

CHAPTER 5. DISCUSSION OF RESULTS AND CONCLUSIONS

5.1 Introduction

This chapter presents a summary of the research results, conclusions, and recommendations. The purpose of the research was to understand the factors that affect the adoption of robotics technology to perform audit work by auditors working in South Africa.

5.2 Summary of the study

The use of robotics technology has disrupted the environment, with various industries adopting it at varying rates of success. The digital vortex highlighted the varying impacts of disruptive technologies to the extent that industries have completely changed the way in which it operates (Shan, Wade & Noronha, 2017). The research also indicated the potential benefits of adopting robotics technology in the auditing professions where routine work could be automated to provide insights across large volumes of data, whilst the auditor could apply skills by analysing the results (Lacity and Wilcocks, 2016).

There were also varying views that robots could not replace the traditional auditor as there was a preference to work with humans (Chan and Vasarhelyi, 2011). These studies were done in China, Europe, and United States (Lois et al., 2020; Zhang, 2019; Tiberius and Hirth, 2019), however there was limited research available on the view of how robotics technology would impact the auditing profession in South Africa.

The UTAUT model is a well-used model that looks at the factors that influence the adoption of new technologies (Venkatesh et al., 2003). It utilised the independent variables (Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions) to determine how it influences the users' behavioural intention to use the technology. Therefore, the purpose of this research was to use this model to get insights of professionals that experienced auditing in South Africa to determine those factors that would influence the adoption of robotics in auditing.

The objectives of this study were to:

- Determine the factors that could influence auditors in South Africa to accept the use of robotics automation technology through the application of the UTAUT model.
- Determine how these factors are influenced by the age, gender, experience, and voluntariness of auditors in South Africa.
- Identify the potential barriers for using robotics automation in auditing in South Africa.
- Identify the potential enablers for using robotics automation in auditing in South Africa.

The research approach used was a quantitative research approach. The research population consisted of auditors, business representatives and auditees that had prior experience of auditing in South Africa, and who also confirmed that they had a general awareness of robot technology. The population was known and verified as qualifying to participate due to their roles, confirmation of robotics awareness, and the fact that they were either working, or had previously worked in auditing in South Africa.

Therefore, the purposive sampling method was used as these participants would provide useful information to address the research objectives. The number of respondents that participated were 85.

Online surveys were used to obtain feedback using the Qualtrics survey application. The participants were requested to participate in the survey after confirming they understood the use of robotics in auditing. The survey data was collected by Qualtrics and analysed using the SPSS, Python and Microsoft Excel applications. The results were presented in Chapter four.

The responses revealed that majority of the respondents were between the ages of 31 – 40 years old, and the genders were closely aligned i.e., 48 (56,5%) male respondents and 37 (43,5%) female respondents. 84 respondents (98,8%) had obtained formal qualifications after matric. 84 (98,8%) respondents also confirmed that they understood robotics and its proposed uses in the workplace. These attributes indicated that the respondents had a good degree of education and awareness of robotics to participate in the survey.

5.3 Research Objective One: The factors that could influence auditors in South Africa to accept the use of robotics automation technology through the application of the UTAUT model.

The UTAUT model was used to determine the extent to which the adoption of robotics is influenced by the four variables, namely performance expectancy, effort expectancy, social influence and facilitating conditions (Venkatesh et al., 2003). The literature confirmed that these variables have a strong positive influence on the behavioural intention to use a new technology.

The results of the survey confirmed that the strongest contributor towards the use of robotics technology was that the auditors believed that using robots would positively contribute towards their work performance as it would derive more valuable output. The survey responses indicated that robots were considered useful to accomplish tasks more quickly, reduce errors, accomplish more tasks, and increase the value from their work. This was aligned to the literature survey where it was highlighted that using robots in the auditing would be more efficient, have less errors and provide more consistent results due to automating of audit tasks (Ansari et al, 2019; Kokina and Blanchette, 2019; Syed et al., 2019; Huang and Vasarhelyi, 2019).

It was also confirmed that the facilitating conditions have a direct impact on the ability to adopt robotics. This included the provision of funding, skills development and infrastructure by the organisation and government institutions. The survey responses highlighted there was a need for improving the capabilities for ensuring robotics is used in the organisation, namely, to ensure that there is appropriate funding, skills development, and support structures such as a centralised robotics team to assist with the usage of robotics. These results are aligned with the literature survey where it was emphasised that people do not have the necessary skills or understanding when implementing robots, contributing towards a project failure rate of between 30% and 50% (Kokina and Blanchette, 2019).

The results above emphasised that the performance of the expectant benefits of improved efficiency and effectiveness in auditing would increase its adoption. It also confirmed that having the facilitating conditions was important in contributing towards the positive adoption of robotics technology. This was aligned with the literature survey results for these two variables for applying the UTAUT model (Venkatesh et al., 2003).

There was however no relationship between the social influence and effort expectancy and the adoption of robotics technology.

Therefore, the key factors to positively influence the use of robotics when auditing within South Africa would be to create an enabling environment (facilitating conditions), where there is sufficient investment in the robotics hardware and software, and to continue to create awareness of the benefits that robots provide to the auditing profession (performance expectancy). This would also require an investment in the training provided to upskill the auditors through the use of technologies. This aligns with the literature findings that auditors would need programming skills to complement their technical auditing knowledge, such as building and maintaining the robots (Cooper, Holderness, Sorensen, and Wood, 2019). Through constant implementation of robotics solutions, the practical benefits will be demonstrated, which will create more awareness to support the theoretical benefits of using robots in audits and will further contribute towards the adoption of this technology.

5.4 Research Objective Two: How these factors are influenced by the age, gender, experience, and voluntariness of auditors in South Africa.

The UTAUT model also explored how the use of robotics in auditing was influenced by age, gender, voluntariness of use, and experience of the respondents. The research by Venkatesh (Venkatesh et al., 2003), highlighted a series of hypotheses when considering the UTAUT model for analysing the usage of new technology, namely:

- The performance expectancy construct for adopting technology is strongly influenced by gender and age.
- The effort expectancy construct for adopting technology is strongly influenced by a combination of age, gender, and experience.
- The social influence construct for adopting technology is strongly influenced by age, gender, and experience.
- The facilitating conditions construct for adopting technology is strongly influenced by the age and experience of the users.

The results of the research confirmed that age, gender, experience, and voluntariness of use had no material influence on the adoption of robots in auditing. This was not aligned to the findings from the literature survey where the hypothesis from the UTAUT model highlighted that use of new technologies were influenced by these four moderating variables (Venkatesh et al., 2003).

A contributing factor could be that the sample size was relatively small, focussed on a specific profession (auditors), and the majority of respondents being fell within the age group of 31-50 years. Therefore, further research could be performed to determine if the same results are consistent for larger populations of auditors.

5.5 Research Objective Three: To identify the potential barriers for using robotics automation in auditing in South Africa.

The purpose of this objective was to identify other barriers to using robotics to support auditing in South Africa. The lack of training and skills was identified as the most significant barrier as there was not enough training or skills within organisations to initiate the robotics adoption journey. The second barrier was that there was inadequate investment in robotics technology as these were perceived as being costly. These two barriers supported the literature findings that there is a perception that the costs of implementing the robotics capabilities and training was expensive (Ansari et al., 2019; Cooper et al., 2019).

The third barrier was that it was difficult to access good quality data that the robots could analyse. As robots would need to independently work of a reliable data source, this is an important factor to consider, as poor-quality data would result in inaccurate results and robots not achieving the proposed performance benefits. The importance of having access to good quality of data is consistent with the literature where it was highlighted that the automating of auditing processes was driven by the need to test a full population of data, which required reliable processes of gathering accurate and complete data (Wang and Cuthbetson, 2015; Gotthardt et al., 2020).

These barriers are significant as they relate to facilitating conditions in the organisation, which aligned with the results from research objective one, where the importance of robotic technology was highlighted.

Therefore, management would need to consider the strategic direction of the organisation by ensuring adequate budget is allocated towards skills development, investment in robotics technology and improvement of the data infrastructure to drive a positive adoption of robotics. There is opportunity for further research into these areas to determine the extent to which South African auditors are overcoming these barriers.

5.6 Research Objective Four: Identify the potential enablers for using robotics automation in auditing in South Africa.

The survey also explored those factors that would enable the use of robotics by auditors. The key enabler highlighted was training, which also corresponded with the key barriers, thereby supporting the need for auditing departments to invest in training auditors on how to use robots.

Management support was highlighted as the second most important enabler, as auditors would use the technology in the workplace if it were supported by leadership and linked to the objectives of the function. The third enabler was around organisations allocating time for auditors to learn and use robotics. These enablers were closely linked to the barriers that were identified in objective three and also highlighted the importance for management to consider the facilitating conditions are enabling for the adoption of robots in auditing. The findings from the literature reported that there is an RPA project failure rate of between 30% and 50% due to a lack of understanding the reasons for adoption and failure (Kokina and Davenport, 2017). Therefore, there is a need for leaders to better understand and implement their robotic initiatives so that there is appropriate management support to allocate time for training and investment in robotics technology.

5.7 Conclusion

According to the research results it was also confirmed that there were 82 (96,4%) respondents that found robots valuable in performing audits with 80 (84,1%) of the respondents also confirming that they would use robots to perform audit tasks. The results of the UTAUT model, confirmed that Performance Expectancy and Facilitating

Conditions were the key factors that influence the auditors and auditees behavioural intention to use robotics technology when performing audits in South Africa. It was also confirmed that there was a strong positive correlation between these factors and the intention to use robots in auditing. The UTAUT model also indicated that these factors were not influenced by the diversity of the auditors age, gender, experiences, and voluntary use of technology. It was however noted that this could have been due to the limited sample size, or that further research using other methods would be more effective in determining this correlation.

The response from the respondents on their key barriers and enablers for using robotics further emphasised the importance of facilitating conditions as a factor that influences the use of robotics technology. Training, skills development, lack of investment in robot technology, and not having access to good quality data were identified as the key barriers to the adoption of robotics. Conversely, enablers highlighted included the provision of training, having management support and ensuring that adequate time is available to facilitate the learning of robotics. Therefore, should organisation leaders want to successfully adopt robotic technology in the auditing operations, there would be a need to invest and create an environment that is supportive of robotics technology.

CHAPTER 6. RECOMMENDATIONS, LIMITATIONS AND FUTURE RESEARCH

6.1 Recommendations

The results from this research demonstrated that there is a strong positive awareness of the benefits provided by robots in improving individual performance of audit tasks. There was however a need to improve the facilitating conditions to enable the adoption of robots when auditing.

6.1.1 *Management support and alignment*

The literature survey emphasised that 30% to 50% of projects failed at the implementation of the robotics initiatives due to lack of understanding (Kokina and Blanchette, 2019). Therefore, it is vital that leadership understand the impact that digital technologies are having on the auditing industry which will help them understand the extent to which digitisation, specifically the use of robot technology, will need to be adopted. Many leaders tend to feel that technology and digitisation of operations is a 'technology' concept of CIO responsibility, when it should be seen as a collective responsibility of all leaders. Therefore, the leaders should investigate the environment and industry that they operate in to determine the extent to which robot technology can disrupt the existing operations.

The example of Kodak's lack of foresight into the impact that digital technologies had on the photography industry, is an example of the importance of management understanding the impact of digitisation on the sustainability of organisations. Kodak had been a leader in the photography industry and chose not to advance in the digital capabilities that was emerging in the late 1990s. This resulted in Kodak not being prepared for the emergence of digital photography, which was capitalised by their competitors, leading to their eventual demise. This emphasises the importance for leaders of auditing departments to understand the impact that robots will have on the auditing profession, so as to determine the extent to which it needs to be adopted as part of their strategies.

6.1.2 *Investment in infrastructure and training*

Once the impact and extent has been established, and the business strategy updated to reflect the degree of digitisation in the auditing function, leaders should analyse the current infrastructure and robotics development capabilities, and skills that exist within the organisation. This includes understanding the technology infrastructure to confirm that the appropriate hardware and software is available, and that the data meets the minimum quality standards to provide reliable insights. Once the analysis of the infrastructure is completed, the current capabilities of developing and supporting the robotics transformation needs to be understood. Leaders would need to determine an approach of building the robotics capabilities within their organisations, which could be a combination of hiring existing robotics skills and implementing a training plan for upskilling existing auditors with using robotics.

Since this is an emerging topic in the auditing profession, it is recommended that a hybrid approach is implemented, where developers with technical robotics programming skills are hired and the existing auditors are trained to develop these skills as they would have an understanding of those audit procedures that can be automated.

Leaders are also required to create an enabling innovative culture and learning environment to support the adoption of the technology. Leaders should invest in a formalised training curriculum where auditors are provided with formal training on robotics technology that is aligned with the robotics development tools that will be purchased. All auditors should be assigned to formal training interventions, where they will be taught the basics of robotics, the methods for programming robots and maintaining robots. Leaders should also invest in subscriptions to training platforms such as Udemy, where multiple self-learning courses are available for the auditors to access and learn new robotics skills. These formal training interventions should form part of a formalised training curriculum for all auditors.

Leaders would also need to establish a culture that encourages learning and experimentation by making time provisions for the auditors to learn during business hours and not be afraid to fail when experimenting. The allocation of time for learning and experimentation allows individuals not to be distracted by the demanding business targets. This can be achieved where auditors are assigned to robotics development initiatives for a specific period, where they are dedicated to developing robotics solutions. The auditors can be rotated between robotics development initiatives and audit assignments so that each auditor is able to learn and develop robotic solutions without being distracted from their audit work. As this matures, auditors will start using these skills to solve audit problems i.e., use robotics as part of their auditing techniques.

6.1.3 *Data quality*

The lack of access to good quality data that would derive reliable results was highlighted as a barrier to robotics adoption. Therefore, an investment in the skills and tools for developing robots would not derive the intended benefits should the data be inaccurate or incomplete. This dependency highlights the importance for the organisation to prioritise initiatives to understand the data sources that exist and ensure that the data aligns to the data standards of the organisation. As business operations and models are disrupted by digital technologies, the value of data as an asset increase. Therefore, these initiatives would contribute towards the future development of other digital innovations across the organisation.

6.1.4 *Reinforcement and reward*

Leaders should reward the development of innovative solutions through performance incentives and having competitions to showcase the winning developments across the organisation. This will also create awareness of the benefits of using robots in auditing (performance expectancy), which will contribute towards increased investment in the infrastructure (facilitating conditions), thereby influencing the positive adoption of robotics in auditing as highlighted by the results of UTAUT model.

Therefore, auditors should share successful robotics implementations with the department and industry which will encourage other auditors to adopt the technology. This can be done through presentations at public events and conferences hosted by government and auditing institutions such as the Institute of Internal Auditors and Information Systems Audit and Control Association. This increased awareness of the potential benefits that can be derived from robots will also positively contribute towards increased investment in infrastructure supporting robots. This will result in a positive iterative and scalable adoption of robots in auditing across the South African auditing industry, which is consistent with the exponential growth of disruptive technologies that we have seen in the digital world. The South African government and auditing institutions across South Africa should also create industry-wide digital forums where awareness, support and learnings of robotics is shared across auditors in South Africa.

6.2 Limitations of the study

The social distancing implications that resulted from the Covid-19 pandemic limited the number of participants in the study. I intended to approach auditors at conferences and departments across South Africa to participate in the study, however these conferences were either postponed or limited to virtual conferences. Many audit organisations and functions had been working remotely and limited interactions to business operations only. Since the study required the participants' awareness and understanding of robotics to be verified before they could participate, this population was limited to auditors in my network.

The limited time and strict clearance processes that needed to be adhered to by external audit organisations were also factors that contributed towards limited participation of external auditors in the survey. External auditors have exposure to wider variety of industries and would have a wealth of knowledge for such a study and should therefore be considered as participants for future studies.

6.3 Recommendation for future research

There is a need for further research as the sample size in this research was limited to 85 respondents, a very small portion of the potential audience. There is a need to obtain the insights of more auditors in South Africa, and to also obtain the support from leading external audit organisations to support the research. These participants would contribute towards understanding the factors that would contribute towards the adoption of robots in auditing in South Africa, or confirm the results attained as part of this research. This includes KPMG, EY, PWC and Deloitte.

The UTAUT model was unable to determine how the adoption of robots in auditing is influenced by the differentiation in age, gender, experience, and voluntariness of using the robots. These insights may be derived from a larger population or through an alternate research method.

The questionnaire also highlighted barriers and enablers that could be further investigated through qualitative methods to get more insight as to how these specific attributes can contribute towards the adoption of robotics.

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APPENDIX A (Research Instrument)

Questionnaire: The use of Robotics Automation in Auditing

Section A: Participant Details

Age : ☐ 20 or under ☐ 21 – 30 ☐ 31 – 40 ☐ 41 – 50 ☐ 51 – 60 ☐ 61 and above

Gender : ☐ Male ☐ Female

Highest Educational Background?

☐ Matric, ☐ Diploma ☐ Bachelor Degree ☐ Honours Degree , ☐ Masters Degree, ☐ Doctorate,

☐ Other

Certification:

☐ CA (SA) ☐ CISA, ☐ CIA, ☐ ACCA, ☐ CMA, ☐ CFE

Are you in a Management or non-management position? ☐ Yes ☐ No

Are you in Internal or External Audit: ☐ Yes ☐ No

How do you describe your basic general computer knowledge?

☐ Very poor, ☐ Poor, ☐ Average, ☐ Good, ☐ Very Good

How do you describe your knowledge of robotics?

☐ Very poor, ☐ Poor, ☐ Average, ☐ Good, ☐ Very Good

How long have you used robotics?

☐ Never, ☐ 0-1 years, ☐ 2-3 Years, ☐ 4 – 6 Years ☐ More than 6 years

How long have you been auditing?

☐ 0-1 Years ☐ 2-3 years, ☐ 3-5 Years, ☐ 5-10 Years ☐ More than 10 years

How often do you use robotics in your audits?

☐ Never ☐ Rarely (less than 5 assignments) ☐ Moderate (between 5 – 10 assignments a year)

☐ Frequently (More than 10 assignments a year) ☐ Always (On every assignment)

Section B: The section of the questionnaire examines the respondents attitude, perceived usefulness, effort expectancy, social and facilitating conditions for using Robotics automation when performing audits. The items will be rated using a 5-point Likert scale ranging from 1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

B1	General Awareness, Attitude and Trust between Robots and Auditors	1	2	3	4	5
1	I believe that robots will provide value when performing audits					
2	I would like to use a robot when performing audit tasks					
3	I would trust the results provided from a robot when performing audit tasks					
4	I would feel comfortable working with robots?					
5	I believe that using robotics to perform audits will reduce costs?					
6	Robotics will be capable of providing real-time assurance?					
7	I believe that robots will provide reliable results for those tasks that are repetitive and those that require complication, better than a human could?					
8	I believe that robots will be able to provide reliable results that require cognitive functions such as the application of professional judgement when providing audit opinions?					
9	I believe that robots will be used to complement the work of internal auditors in the future?					
10	My organisations is currently using or planning to use robotics in auditing as part of its current strategic goals					
B2	Performance Expectancy	1	2	3	4	5
11	Robots are useful in the audit environment					
12	A robot would enable auditors to accomplish tasks more quickly					
13	I could save much time at work by using a robot					
14	I would improve the my performance in using robots as it will reduce errors					
15	Robots will increase the value that I provide in my work					
16	Having a robot could allow me to use my time accomplish other tasks					
B3	Effort Expectancy	1	2	3	4	5
17	I like learning about robotics					
18	Robotic technology are easy to use.					
19	learning to use robots to perform audits is easy					
20	I have the technical skills needed to use a robot in performing audits					
21	Applying the use of a robotics perform audit tasks would be easy					

22	Using a robot will make my work easier					
B4	Social Factors	1	2	3	4	5
23	My organisation supports the use of robots for auditing					
24	Using a robot at work would indicate me having a higher status than those who do not					
25	My friends/family support the use of robots					
26	My Manager supports the use of robots					
27	Using a robot will advance my career progression (promotions, opportunities, remuneration)					
28	The auditing communities that I participate in supports the use of robotics in auditing (IIA, ISACA or any other auditing communities to which you belong)					
29	The expectations of the my business partners or clients is that auditors should use robotics in performing audits?					
B5	Facilitating Conditions	1	2	3	4	5
30	My organisation has structures to support learning and using robotics					
31	There are government and country-wide initiatives across South Africa supports the use of robotics in auditing					
32	My organisation has the necessary funds available for me to learn or use robotics for auditing					
33	My organisation has the necessary skills to start using robotics in auditing					
34	I have access to the relevant support should I need help when problems are encountered when using robotics					
B6	Behavioural Intention	1	2	3	4	5
35	I intend using robotics in performing audit work in the next 12 months					
36	I predict that robots will be used in my organisations for performing audits in the next 24 months					
37	I intend learning to use robotics in the next 12 months					

Section C: The section of the questionnaire examines the respondents perception of the top three barriers and enablers for using robotics in auditing.

C	Barriers and Enablers for Adoption of Robotics in Auditing
38	What are the 3 barriers that would affect your use of robotics in auditing? (3 text boxes with 180 character limit)

39	What are the 3 enablers that would increase your use of robotics in auditing? (3 text boxes with 180 character limit)