# How SMEs in South Africa can implement robotics to increase competitiveness.

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**A research article submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration**

**Johannesburg, 2023**

**Protocol number**: WBS/BA418894/366

(Version February 2018)

## DECLARATION

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

Senzo Calvin Mpungose. 

(Type your name in full here, and sign in the space above)

Signed at …Parktown……

On the ……28…….. day of …February…… 2023

## DEDICATION

This research is dedicated to my amazing wife, who has been a constant source of love, support, and encouragement throughout my academic journey. Your unwavering belief in me has been the fuel that has driven me forward, and I am forever grateful for your presence in my life.

To my even more amazing daughter, you are the light of my life, and everything I do is for you. Your love, smiles, and laughter have kept me going, even during the toughest of times. Your enthusiasm, curiosity, and boundless energy remind me every day of what matters the most in life, I love you more than anything in this life and I am so proud to be your father.

To my friends and family who shall remain nameless but amazing, thank you all for always being there for me, no matter what. Your presence, encouragement, humour and motivation have been instrumental in keeping me focused and determined. I am blessed to have you all in my life.

To my work colleagues and manager, who have been a source of inspiration and motivation. Your support and encouragement have been invaluable, and I am grateful to worked alongside such amazing individuals.

I would also like to extend my heartfelt gratitude to Pali Lehohla and Ebrahim Momoniat whose guidance, mentorship, and wisdom have been instrumental in shaping not only my academic career but also my life. Your unwavering support has led me down this path, and I am truly and forever grateful.

Finally, to my supervisor, Dr. Jacques Totowa, who has been a constant source of support and guidance. Your dedication, patience, and unwavering support have been invaluable, and I am grateful to have had the opportunity to work with such an amazing mentor.

Thank you all for your love, support, and belief in me. This research is dedicated to you.

## ACKNOWLEDGEMENTS

I would like to take this opportunity to express my gratitude to all those who have contributed to the success of this research project.

Firstly, I would like to acknowledge my supervisor, Dr. Jacques Totowa, for providing me with the guidance, support, and motivation that were essential to completing this research. Your expertise, knowledge, and willingness to share your experiences have been invaluable to me, and I am grateful for your patience and understanding throughout the entire process.

I would also like to express my appreciation to Ms. Chaithram and Dr. Mtotywa, who provided me with invaluable support and guidance during the initial stages of this research. Your advice, encouragement, and insights were instrumental in shaping the direction of this project.

I would also like to thank the Small and Medium Enterprises (SMEs) who participated in this research. Your willingness to share your expertise, insights, and experiences was essential in providing a comprehensive understanding of the topic and allowed me to produce high-quality research.

I would like to acknowledge OpenAI ChatGPT technology with regards to providing structure and guidance for the Dedication section above and this Acknowledgements section.

Finally, I would like to thank all those who supported me throughout this journey, including my family, friends, and colleagues. Your encouragement, motivation, and support were essential in keeping me focused and determined to complete this project.

## SUPPLEMENTARY INFORMATION

| | |
|---|---|
| Nominated journal: | Acta Commercii |
| Supervisor / Co-author: | Dr. Jacques Totowa |
| Word count †: | 15 643 |
| Supplementary files: | Data Collection Instrument |
| | Interview transcripts |
| | National Small Business Classification |
| | Confidentiality agreement |
| | Consent Forms |

## Abstract

**Orientation**: South African SMEs face technology adoption challenges. The Fourth Industrial Revolution (4IR) technologies are no exception. However, SMEs need to gain knowledge on how these technologies affect them. More specifically, how can they benefit from the technologies.

**Research Purpose**: This article investigates the impact of robotics and automation on Small and Medium Enterprises (SMEs) in South Africa. It seeks to identify ways in which the technology could be adopted and with its adoption, improve SME competitiveness.

**Motivation:** The technologies identified as the driving forces behind the 4IR have largely been identified so based on their impact on business and industry. They have led to market convergence which has enabled businesses to operate outside of their industries and markets, thereby increasing market competition. There has been low uptake of robotics and automation in South African SMEs compared to international counterparts and even with the technology viewed as capable of improving business operations, lowering costs and driving competitiveness.

**Research Design, Approach and Method:** A narrative design with interpretivist philosophy utilizing the semi-structured interview schedule to collect data and narrate the views and experiences of participants so as to extrpolate findings was used. Knowledge in this kind of study is subjectively relative to the SMEs being analysed and hence a relativism epistemological stance was taken. The inductive qualitative approach was used to identify patterns from interviews and develop explanations for those patterns. A sample with a fair representation of SMEs that have and have not adopted robotics and automation was interviewed. The interview schedule had nine questions aimed at answering the research questions.

**Main Findings:** The primary reason SMEs adopt robotics and automation is to drive production efficiency, reduce operational costs and increase capacity. SMEs face adoption challenges that include financing, skills shortages and information scarcity. Strategies to overcome these challenges were identified and include finding alternative forms of financing, upskilling existing labour and information dissemination through planned programs.

**Practical/managerial implications and Contribution/value-add:** The study has developed a model that can be used to adopt robotics and automation as well as other 4IR technologies. Strategies that SMEs can use to increase competitivity through the adoption of robotics have been provided alongside strategies to adopt robotics and automation.

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# CHAPTER 1: Research Motivation

## Introduction

As small and medium enterprises (SMEs) continue to fight for survival in an environment where industry lines continue to become blurred, managing Information and Communications Technology (ICT) effectively and efficiently is becoming essential. The pace at which technology advances contributes to environmental changes and instability making the task more challenging (Govender & Pretorius, 2015). Technologies such as cloud computing, robotics, artificial intelligence (AI), big data analytics, internet of things (IOT) etc. have emerged and revolutionized the way in which businesses operate. They have compelled businesses to review and modify their ICT strategies through their influence on a business's learning curve and economic growth (Linton & Walsh, 2004). Lee et al. (2018) identified technologies such as cloud computing, robotics, artificial intelligence (AI), big data analytics, internet of things (IOT) etc. as not just the contributors but also the cause of the fourth industrial revolution (4IR)/ industry 4.0. These 4IR technologies have an impact on every aspect of a business's value chain (Lee et al., 2018). It therefore benefits SMEs to understand each of the technologies and identify how they impact their value chains since they have brought about an array of possible business strategies (Lee et al., 2018; Maynard, 2015). These strategies can involve aspects of market penetration, product development, market development, and product diversification (Hussain, Khattak, Rizwan, & Latif, 2013). Through integrating these strategies with technologies such as robotics and automation, businesses can improve competitiveness making technology adoption imperative (Hussain et al., 2013). South African SMEs have not embraced technology at a scale comparable to countries like the United States, Germany, and Israel (Hedley, 2018). It is imperative for South African SMEs to better understand and embrace a technology like robotics since they do not compete in an isolated market (Gambardella & Torrisi, 1998).

## Problem statement

An analysis of macro-environmental variables affecting SME competitiveness in South Africa found although some SMEs acknowledge that technological advancement affects their business, a wider number of SMEs are not aware of how these advancements affect

them (Cant, 2013). A 2018 report found that of the 400 SMEs surveyed, even when technology was viewed as beneficial, only 85% of SMEs kept up with the latest developments, and of that 85%, 45% were not doing enough to adopt technology, 52% barely kept up and 3% saw themselves as still being in the dark ages (Xero & World Wide Worx, 2018). Works by Brink, Cant, and Ligthelm, (2003), Mahohoma (2018), and Ramukumba (2014), all estimate the failure rate of SMEs in South Africa to be at an average of approximately 70% to 80%. Cant (2013) identifies technology as one of the environmental variables that need to be better understood to minimize risk of failure whilst increasing probabilities of success. Amongst barriers to adopting robotics and automation, studies by Mannan and Khurana (2012) identified SMEs low capabilities for long term investments as major concern. SMEs had higher inclinations to short-term returns even though evidence suggested that long-term returns not only outweighed the cost of the capital investment, they additionally made up for the short-term returns sacrificed to adopt (Mannan & Khurana , 2012). Through the adoption robotics and automation in India's SMEs, time consumed on major activities was reduced by 57.85%, operational costs reduced by an average of 51.67%, and costs resulting from human error reduced by 66.76% (Kumar, Balasubramanian & Raj, 2016). Without adopting, these benefits may be forgone.

Finally, due to the strong relationship between technology and innovation, failing to integrate technologies such as robotics and automation is detrimental to innovation (Mustafa & Yaakub, 2018). Blankley and Moses (2009) compared SME engagement with innovation in South Africa against 24 European countries. South Africa ranked 22$^{nd}$ , this was largely a result of South African SMEs lacking the ability to adopt technology, equipment and software that would assist with innovation (Blankley & Moses, 2009). Mustafa and Yaakub (2018) found that SMEs lagging behind on technology adoption often struggled with innovation, which in turn impacted them financially and placed them at higher risk of financial ruin. Innovations through robotics and automation allow businesses to operate in markets and sectors outside their traditional ones (Aaldering, Leker & Song, 2019). This market convergence means that competition is no longer limited to regions or industries (Aaldering et al., 2019). New rivals could therefore emerge even from international organisations or from companies that may not have previously been a competitor. It was consequently important to better understand robotics

and automation, it's impact on SMEs, and how SMEs could leverage the technology to improve their financial and competitive position.

## What are SMEs

The primary classifier of Small and Medium Enterprises (SMEs) in South Africa is the number of employees, turnover and balance sheet of the business (Cant, Erdis & Sephapo, 2014). Trade and Industrial Policy Strategies (TIPS) differentiates between medium-sized enterprise and micro enterprise as the former having a hundred and above employees and the latter being a self-employed survivalist. The National Small Enterprise Act (29 of 2004) further defines SMEs according to standard industrial sector and subsector, size of class, equivalent of paid employees and, turnover. Each sector is assigned boundaries which are the determinants of a business's classification as a SME (South Africa, 2004). In general SMEs are defined to be employing less than 250 people, and earning less than the prescribed amounts for their sector (Achanga, Shehab, Roy & Nelder, 2006; Buculescu, 2013).

## What are 4IR technologies?

The Fourth Industrial Revolution (4IR) is a result of a convergence of technologies (Lee et al., 2018). These technologies which include: "cloud computing, robotics, artificial intelligence (AI), big data, internet of things (IOT), 3-D printing, blockchain, etc. converge to make smart factories, smart cities, cyber-physical systems, self-organization, new distribution and procurement systems, new products and services, adaptation of human needs and corporate social responsibility, all possible" (Lee et al., 2018). Defining 4IR still appears to be equivocal, largely because it is defined by what the technologies can do and as a result of the convergence being ongoing, with new use cases being continually developed making the definition dynamic (Lee et al., 2018).

## What are the benefits of robotics and automation technology?

The prices for robotic equipment has steadily declined making robots more affordable for SMEs (Brumson, 2003). In addition to declining prices, the technology has reached a point whereby it is now driving profitability for SMEs (Yarlagadda, 2015). Robotics and

automation continues to radically reduce production costs and hence driving up profitability (Brumson, 2003; Cobham, 1999; Mital & Pennathur, 2004). Jackson (2018) noted in addition to driving efficiency, robotics also enabled businesses to improve productivity, reduce errors, improve workplace culture, and make the workplace safer. It is the combination of these benefits that makes robotics and automation ideal for improving efficiency and competitiveness (Jackson, 2018). A comparative analysis by Gupta, Seetharaman and Raj (2013), found some of the benefits to SMEs to be ICT cost reductions of up to 30%, increased ease of sharing and collaboration, increased technology reliability, security and privacy, and ease of use and convenience. Studies on profitability and robotics in the medical field found that, profits from surgeries that made use of robotics outperformed profits from surgeries that did not incorporate the use of robotics (Ghomi et al., 2022). Although studies focused on reducing costs, the understanding is that lowering costs avails to businesses more opportunities to better utilize funds and increase profit. Adopting even one of the 4IR technologies provides benefits far beyond cost minimization and profit maximization (Agarwal et al., 2010). It was therefore important to understand how SMEs could adopt the selected technology (robotics and automation) for their benefit.

## Research questions

### Main research question

How can SMEs in South Africa use robotics and automation to become more competitive?

### Secondary research questions

- How are SMEs in South Africa currently using robotics and automation?
- What are the stumbling blocks for SMEs adopting robotics and automation?
- In which ways could SMEs use robotics and automation to become more competitive?

## Preliminary Hypothesis

Through technology, businesses can create strategies that are production specific, market specific, and even customer specific (Satell, 2013). The importance of these strategies being to ensure continued survival (Satell, 2013). Investigations on 4IR by Lee et al. (2018) revealed that by their very nature 4IR technologies add value and competitiveness to businesses. Therefore, understanding these technologies and be able to utilize them to establish competitiveness is essential for SMEs. This paper investigated how to adopt robotics and automation to become more competitive, whether or not adoption was at all possible, and if it could yield competitive benefits to South African SMEs.

## Assumptions

This study assumed that the goal of SMEs was to improve their economic or non-economic (social or environmental impact) competitiveness so as to increase their prospects of sustainability and growth. Each SME has an objective which drives their activity, whether it be economic or non-economic (Randolph, Alexander, Debicki & Zajkowsji, 2019). This extrinsic, intrinsic or dual goal drives owners to seek success and ensure that their businesses survive (Newby, Watson & Woodliff, 2012). In this effort to grow, the study presumed that SMEs seek means such as technology to bring about this desired growth (Nguyen & Ngo, 2021). Moreover, the study presumed that SMEs seek technology, which is positively correlated to sustainability and development (Nguyen & Ngo, 2021), in order to further or advance their business goals which involve servicing customer needs (Harris & Laibson, 2013).

## Delimitation

For the purposes of manageability, the study was limited to robotics and automation technology even though 4IR technologies are often intertwined with other 4IR technologies (Grau, Indri, Bello & Sauter, 2017). A study encompassing all the 4IR technologies was not be feasible within the limited time. The study was furthermore limited to a population size as defined in chapter 3. Though technology has been critical in ensuring the survival of business during the Covid-19 pandemic (Abed, 2021), research on the extent of adoption before and during lockdown period as well as benefits to early

adopters was limited. For this reason, the impact of Covid-19 on businesses, technology adoption and endurance of adopters was omitted as it required further studies.

## Significance of the study

Through reviewing robotics and automation implementation strategies used by local SMEs, this study allows for other SMEs to learn from the early adopters. The study allows South African SMEs to gain insights on adoption challenges faced by other SMEs as well as the strategies used by the SMEs to overcome their challenges. The study aimed to provide clarity on how SMEs are using robotics and automation to improve their sustainability and to growth. Specifically, this study benefits new and lagging SMEs in better understanding 4IR technologies as well as provide a more in-depth understanding of the focus 4IR technology. SMEs possess an ability to learn from others and adapt the knowledge to resolving challenges in their own environment (Ali, Miah & Khan, 2017). Therefore, this study further assists start-ups in deciding whether to adopt robotics and automation as well as give insight on possible approaches. Finally, an understanding of local challenges and homegrown solutions may serve to provide a basis for further studies to create models for integrating 4IR technologies within local SMEs.

## Research Structure

The process which was adopted by this paper was as follows:

1. Abstract
2. Research Motivation
3. Literature Review
4. Data Collection
5. Data Analysis
6. Discussion
7. Conclusion and Recommendations

## Chapter Conclusion

Since the purpose of this paper was to identify how SMEs can adopt robotics and automation to become more competitive, it was therefore important to also identify why

robotics should invoke the concern of an SME. 4IR technologies such as robotics and automation affect all spheres of operations and can impact sustainability and growth. As a consequence, this technology impacts an SMEs ability to compete.

# CHAPTER 2: Literature Review

## Introduction

This chapter focused on understanding the technology adoption theory in the context of business. Furthermore, it defined what is understood by SMEs in relation to 4IR. It established the current known use cases of robotics and automation. Finally, It briefly explored lessons on robotics and automation from international SMEs with specific focus on addressing stumbling blocks with regards to adoption.

## Management Theories: Technology adoption theory

Nguyen (2009) suggested that businesses are pressured by external and internal forces into adopting technology. Technology adoption is inherently a complex developmental and social process influenced by internal forces such as people's perceptions (Straub, 2009). Lai (2017) noted that understanding these perceptions is vital in enabling interested and affected businesses to relate with the theoretical and practical aspects of technology adoption. Based on Rogers (1995) *Innovation Adoption Curve*, Lai (2017) presented the goal for business as being ensuring that technology perceptions are addressed and aligned at the very latest by "*The Chasm*" stage if they desire to gain a competitive edge through technology. This stage is the point between early adopters and early majority. As business seeks to find congruency between task and technology i.e. task-technology fit (Goodhue & Thompson, 1995), there is increased competition and replication of ideas as more time passes. The increase in competition often correlates with diminishing returns (Straub, 2009). For this reason, technology adoption for the sake of competitive advantage has often depended on pre-emptively and proactively addressing the cognitive, emotional and contextual concerns of impacted individuals to improve preparedness and willingness to adopt new technologies (Straub, 2009).

More than 50% of businesses fall behind the technology adoption curve (Rogers, 1995). Zamani (2022) extrapolated the cause to be the viewing of operating environment changes as static external forces that are once-off events. This view leads to failure in accounting for the current dynamic fast-changing digital era (Zamani, 2022). In contrast, innovators

and early adopters are often perfectly positioned to gain the greatest competitive advantages of any new technology (Lai, 2017; Rogers, 1995).

Ta-Tao, Nakatani & Zhou (2009) in their research on IT adoption in SMEs found that age, education, and group heterogeneity of management had a strong correlation with the perceptions and attitudes towards technology. These attitudes inform the perceived usefulness and ease of use that form the expectations and intentions to adopt technology (Davis & Venkatesh, 1996; Zamani, 2022). Through continuous evaluation and management of the internal forces, businesses are better positioned to confront external forces such as technological advancements, and are well positioned to pre-emptively adopt technologies that may impact on their operating environment (Chambers, 2004; Goodhue & Thompson, 1995; Lai, 2017).

## Sustainability and Competitive Advantage

International trade is conducted on the basis of comparative advantage (Blinder, 2006). Through their comparative advantage, gained from technological advancements, businesses are able to operate outside of their native markets (Blinder, 2006). Studies have found that companies such as Google LLC which provide internet-related services are able to operate in markets such as advertising and dominate the markets due to this comparative advantage (Srinivasan, 2020). Technology and technological abilities give Google LLC a comparative advantage that enabled their market convergence and enabled for cross-industry operations (Gambardella & Torrisi, 1998). These studies highlighted that competition is no longer restricted to industry or market a business operates in. Research by Schoenberger (1986) and later research by Hofmann and Rüsch (2017), found that changes in the intensity of competition occur when there is industrial change. Malerba (2007) noted that industrial revolutions are characterised by innovation and structural transformation which foster competitiveness. The steam engine made it possible to spin and weave cotton faster, to use coal to smelt and refine iron and to move goods between two locations faster than ever before (Kim, 2005). Through this, SMEs (particularly in manufacturing) were able to improve production speed and access more markets (Kim, 2005). In general, technological innovations in industrial revolutions bring about improved labour productivity, excess capacity and decreases in costs (Jensen, 2007). It is therefore through technological innovation that competitiveness eventuates or

is intensified. Guy (1998) and later Shepherd and Ahmed (2000) put forward that there is a strong positive relationship between innovation and competitiveness, whilst Cantwell (2005) added that competitiveness is derived from differentiated capabilities created though innovation. Distanont and Khongmalai (2018) in their study found that without innovation, SMEs could not face economic challenges at local, regional or global level and hence could not be competitive. Innovation became more prevalent through the technological convergence that has been described as the 'fourth industrial revolution (4IR)/ industry 4.0' (Maynard, 2015). The convergence enables cross integration of business platforms enabling businesses to create novel platforms for innovative human-machine interfaces which in turn transform products, services and markets (Maynard, 2015). The transformation enables SMEs to then have to contend with not only other SMEs but can also multinationals and conglomerates as they globalize, forcing the need for SMEs to stay ahead of the curve to survive (Feinberg, Wolkwitz & Goldstein, 2006).

Factors that inhibit South African SMEs from adopting robotics and automation and hence restrict innovation were identified from literature. These factors are licensing fees, information scarcity, skills shortages and politics & unionization.

*Licensing Fees*. South African SMEs have often struggled to stay ahead of the curve due to inaccessibility of relevant technology (Abor & Quartey, 2010). They have thus been forced to rely on utilizing foreign technologies through licensing which often has implications related to patents and data privacy regulations (Abor & Quartey, 2010). These fees have made it difficult for SMEs to structure finances and plan their growth (Kim & Boldyreff, 2005). As a result of these fees, technologies crucial to SME success and revenue generation continue to be dominantly controlled by external commercial vendors (Kim & Boldyreff, 2005).

*Information Scarcity.* Whilst multinationals such as Toyota and unicorns such as Uber have begun making strides in autonomous vehicles through the use of robotics and automation coupled with artificial intelligence (Somerville, 2018). At the time of this study it appeared little information was available on such ambitious use cases in South Africa, as searches from journals, libraries and the internet revealed. In an effort to address these shortcomings, having realised that 4IR technologies can facilitate networking and alliances, improve markets, and increase productivity, government has encouraged SMEs to adopt new technologies with hopes that adoption will consequently

alleviate poverty and unemployment (Kyobe, 2009). However, adoption still remains a challenge as information on adopting 4IR technologies remains scarce.

*Skills Shortage.* One possible reason for information scarcity is primarily since there is a general sense that the country has ICT related skills shortages of which the extent is unknown (Lotriet, Matthee & Alexander, 2010). On a paper on the industrial revolution, technological change and implications to South Africa, Freund (1992) noted that the quantity and quality of skills were a constraining factor in the adoption and implementation of new technologies.

*Unions and Politics.* The employment of technology for repetitive tasks has continuously sparked debates. More so when it is in relation to SMEs as they contribute over 50% to the South African GDP and proving nearly 60% of all employment (Kongolo, 2010). This phenomenon of emphasising jobs as opposed to technological advancement has continued as unions continually struggle to engage with members on topics of technology adoption and impact on employment (Hlatshwayo, 2017). Hlatshwayo (2017) argued that as businesses strive to improve margins through adopting technology, politicians and manufacturing unions (identified as mostly likely to be affected by robotics and automation) may have to adopt a position that contests managerial control over technology as they attempt to preserve jobs at the expense of growth. This position would therefore pose a threat to 4IR technology adoption efforts.

## Current use of robotics by SMEs in South Africa.

A study on 84 SMEs across South Africa by Sohal, Schroder, Uliana and Maguire (2001) found that SMEs appear to be making considerable investments in robotics and automation manufacturing technologies that impact the end-to-end value chain and production process. A driving force behind these investments was the ability of robotics and automation to improved efficiency and accuracy, scheduling and distribution (Sohal et al., 2001). However, it was noted that adoption remains more prevalent in previously labour intensive fields such as agriculture and manufacturing, with adoption goals being to replace labour intense manual tasks (Ongori & Migiro, 2010).

## Stumbling blocks to adoption of robotics and automation in South Africa

Du Plessis and Boon (2004) identified lack of leadership, lack of knowledge management and sharing, and lack of enabling technologies as stumbling blocks that affect successful adoption. Doss (2006) later added the lack of cross sectorial data required in analysing the dynamics of technology as an additional hindrance. Doss (2006) noted that these challenges are worsened when businesses lack expertise on the desired technology. Kyobe (2009) highlighted that these stumbling blocks affect an SMEs disposition to technology adoption emphasising that perceptions of compliance costs, lack of awareness, lack of training on compliance security, perceptions of unfair regulation and possession of inadequate security controls further hinder adoption efforts (Kyobe, 2009). Hlatshwayo (2017) added that in their efforts to avert job losses and keep membership stable, unions hinder robotics and automation adoption.

## Adoption lessons from SMEs that have successfully adopted robotics and automation.

The adoption of robotics and automation has resulted in increased automation of trivial tasks (Fernandez, Gutierrez, Ruiz, Perez & Gil, 2012). Scopelliti, Giuliani and Fornara (2005) found that people have a positive psychological disposition to robots when they help improve their daily lives. The implication is therefore that, employees may have a positive disposition if robotics is adopted in an effort to improve their work, workplace environment and operations ( Jacobs, Chase & Aquilano, 2004; Scopelliti et al., 2005). In the United States, barriers to adoption were overcome through multiple forms of support and incentives (Brzycki & Dudt, 2005). This means that SMEs wishing to adopt robotics would not only need to provide support for employees but also incentives (Brzycki & Dudt, 2005).

## Conclusion

This chapter reviewed where literature on robotics and automation in SMEs stands, the role of this type of technology and its impact on industries. It additionally reviewed literature on technology adoption, impact of robotics and automation on sustainability and growth as well as challenges to adoption. It was noted that literature reviewed

suggests that adoption of robotics and automation has potential to impact competitiveness.

# CHAPTER 3: Data Collection

## Introduction

This chapter highlights the data collection process that was followed by this study with focus on the design, sampling, methods, ethics considerations, and limitations.

## Research Design

This study followed an interpretivist philosophy. The philosophy is grounded in the use of methods ideal for analysis of subjective data that is interpreted by those that experience the world in which the paradigm investigated exists (Hammersley, 2012). This philosophy is ideal as data was collected from SMEs with different experiences (Hammersley, 2012). The interpretivist epistemology, referring to what constitutes knowledge in the social sphere (Hiller, 2016), in this study was identified as relativism. Relativism epistemology implies that knowledge is subjectively relative to the situation being analysed and based on the view that knowledge is not sovereign to the SMEs' situation (Dieronitou, 2014; Scottland, 2012).

The research methodology employed in this study was qualitative research. Qualitative methodology is useful when generated data is subjective and in-depth analysis is required such as in this study (Kim, Sefcik & Bradway, 2017; Leedy, Ormrod & Johnson, 2019). More specifically, the inductive qualitative approach used to identify patterns from observations and develop explanations for those patterns, was used to systematically analyse the qualitative data guided by the research questions (Leedy et al., 2019). A narrative design utilizing the semi-structured interview schedule to collect data and narrate the views and experiences of participants so as to extrapolate findings (Bruce, Beuthin, Sheilds, Molzahn & Schick-Makaroff, 2016). The interview schedule for this study was derived from and used the same structure as research by (Modimogale & Kroeze, 2009) on how SMEs in South Africa can use ICT to become more competitive. This made the interview schedule relevant since ICT is the umbrella body and technology is implemented within the portfolio of ICT in businesses (Zikmund, Babin, Carr & Griffin, 2013).

## Sampling

### Population and unit of analysis

The population of this study were the SMEs operating in different industries within the context of South Africa. The industry guideline on qualifying SMEs that was used is those outlined in the National Enterprise Act as appearing in *Table 1* of the appendix. There for the population was all businesses meeting the national parameters required to be classified as an SME (South Africa, 2019). The requirement for comparative purposes was that a minimum of 50% of SMEs need to have some experience with robotics and automation so as to attain a fair representation. The unit of analysis for the study were the SMEs, represented by the Chief Executive Officers (CEOs) or Chief Information Officers (CIOs) as knowledge regarding technology adoption in SMEs sits at the their levels and businesses are unable to speak for themselves (Zikmund, Babin, Carr & Griffin, 2013).

## Sample

The study utilized purposive sampling technique to find participants that are relevant to the study which as a benefit improves aspects of trustworthiness (Campbell, Greenwood, Prior, Shearer, Walkem, Young, ... & Walker, 2020). The sample size was 12 SMEs which according to Saunders, Lewis and Thornhill, (2016) is within the appropriate number of five to 25 for studies utilizing semi-structured interviews while studies by Hennink and Kaiser (2022) suggest sample sizes of nine to 17 are adequate.

## Methods

The instrument used for the study was an interview guide with nine open-ended interview questions (see Appendix A). Although some questions were derived from a similar study, per suggestions by Agee (2009), questions were reviewed after the first interview and refined to ensure new insights developed on the questions and structure that may help improve the quality of collected data were accounted for. The questions were based on and constructed around the factors identified in the literature review. The objectives of questions one to three of the instrument were to ascertain how SMEs viewed robotics and automation, what factors they considered when deciding to adopt it, as well as to

understand the current state of robotics adoption amongst SMEs in South Africa so as to answer the question of "How are SMEs in South Africa currently using robotics and automation?" Questions four and five were to determine the challenges to adopting robotics and provide solutions to those challenges so as to answer the research question of "What are the stumbling blocks for SMEs adopting robotics and automation?" finally the remaining four questions which were based on impact on customer value propositions, influence on market performance, future use of robotics, and ways to prepare for the future use, were aimed at answering the question "In which ways could SMEs use robotics and automation to become more competitive?"

## Data Analysis

Thematic analysis was used to analyse the data based on the guidelines by Braun and Clarke (2006). Thematic analysis involved identifying patterns and themes within the collected data through analyses and interpretation (Mayring, 2004; Clarke et al., 2015). The benefits in using this procedure were its ability to identify numerous cross-references in the themes, providing flexibility for approaching the patterns, and enabling the extraction of information to determine relationships and compare different participant data (Alhojailan, 2012; Hayes, 2013).

During the data analysis, the recordings were transcribed verbatim so as to ensure that there is an objective analysis of the data. This was followed by reading of the transcript and validation of the content which is critical to comprehend the data. This was followed by line-by-line coding to ensure that the data is analysed in totality, without filters with an assistance of a computer aid program, Atlas ti 22 (Atlas, 2022). The coded data was consolidated into subthemes, after which themes were formed. The thematic maps linked to each research question were developed to assess the relationships within the subthemes.

## Data Trustworthiness

Guba (1981) advanced that the trustworthiness in the qualitative research study should be ensured using credibility, transferability, confirmability, and dependability. These are

equivalent to reliability and validity of the research which is commonly used in the quantitative research.

*Credibility*. Gutterman (2015) argued that credibility of the sample must be obtained within relevance of the data and sufficiency of the data. In the study, relevance was obtained through participants from the SMEs which were the focus of the study. This in addition to the overall credibility of the study which was based on the use of credible design – which is qualitative research aligned to the research objectives (Mtotywa, 2019).

*Transferability.* This study meets external rationality since SMEs were not restricted to any industrial sector (Bush, 2007). Unlike quantitative study which aim for generalizability, the study achieves transferability and can be applied to other similar settings with consistency in the design and findings which are obtained from diverse SMEs. This was critical as 4IR technologies do not selectively affect sectors or businesses.

*Confirmability*. To achieve acceptable levels of confirmability, the coding process entailed segmentation of text, assessment of credibility, codebook modification, and final coding (Hruschka et al., 2004). In addition, the findings were reported using evidence-based reporting, where there were extracts of the verbatim comments from the participants. This to ensure objectivity of the findings.

*Dependability*. There was consistency in the collection of the data, as it was guided by the interview guide, attached in Appendix A.

## Limitations

The use of 4IR technologies in the South African markets has not advanced to such a point where it is clear which companies have expertese in certain technologies. Therefore there was no way to directly compare SMEs or competitors. Some SMEs are so small that they did not have a CIO and so given that predominantly strategic organizational knowledge sits at CIO level and it is their responsibility to ensure the organization keeps up with the pace of technology (Polansky et al., 2004), comparing CIO knowledge with that of persons performing a similar role was challenging. To ensure balanced

interpretation, findings were therefore focused on the strategic imperative of robotics and automation in relation to making SMEs more competitive.

Finally, some businesses felt that their strategic use of technology is a differentiator and so the picture painted by participants was distorted when vital information was withheld for this reason. Fortunately, enough data was collected to deduce generalized usage.

## Ethics considerations

To begin with participants were provided a consent form (see Appendix B) that outlined key concepts of the study and provided information relevant to the study. To reduce discomfort during the interviews, participants were assured of their anonymity as well as provided with the background for the study which is essential to establish a good rapport with participants when using a qualitative approach (Lewis, 2015). As a benefit, this also ensured participants have a clearer understanding of what is being researched which intern increased the trustworthiness of the data (Lewis, 2015). Where privacy or anonymity was required assurance was given through a signed confidentiality agreement (see Appendix C). All data was stored in a password protected device only accessible by the researcher and supervisor, if required, to further ensure privacy.

# Chapter 4: Results of the study

## Introduction

The purpose of this study was to investigate the impact of robotics and automation technologies on South African SMEs. This with intention to identify strategies which may assist the SMEs in becoming more competitive through utilizing robotics and automation. The empirical data was obtained through face-to-face interviews with the CEOs and CIOs of SMEs. The results of the study are presented, commencing with the overview of the study, which highlights the relevance of the data, developing the themes then answering the research questions.

## Overview of the study

### Profile of the respondents

Participants from SMEs operating in seven different industries took part in the research. The SMEs sizes were also noted. Information regarding their employee numbers and industry is presented below.

Table 1: Participating SMEs number of employees and industry of operation

| Participant no. | Number of employees | Industry of operation |
|---|---|---|
| 1 | 8 | Consulting in mining industry |
| 2 | 5 | Construction industry |
| 3 | 6 | Technology |
| 4 | 20 | Technology |
| 5 | 6 | Catering accommodation and trade industry |
| 6 | 18 | Manufacturing industry |
| 7 | Approx. 80 | Cleaning services |
| 8 | 5 | Consulting in electricity and water supply industry |
| 9 | 2 | Manufacturing |
| 10 | 17 | Agriculture |
| 11 | 8 | Catering accommodation and trade industry |
| 12 | 2 | Catering accommodation and trade industry |

## Relevance of empirical data

The word list from *Atlas ti 22* was used to determine the relevance of the empirical data and the alignment of data across all interviews with the purpose of the study (Figure 1). The most dominant words were SMEs, business, automation, technology, robots, companies, technologies, robotics, cost and time. These words were prevalent across all interviews and were in line with the study. The relevance of the empirical data and interviews is essential for the credibility and rigor of the findings (Guetterman, 2015).

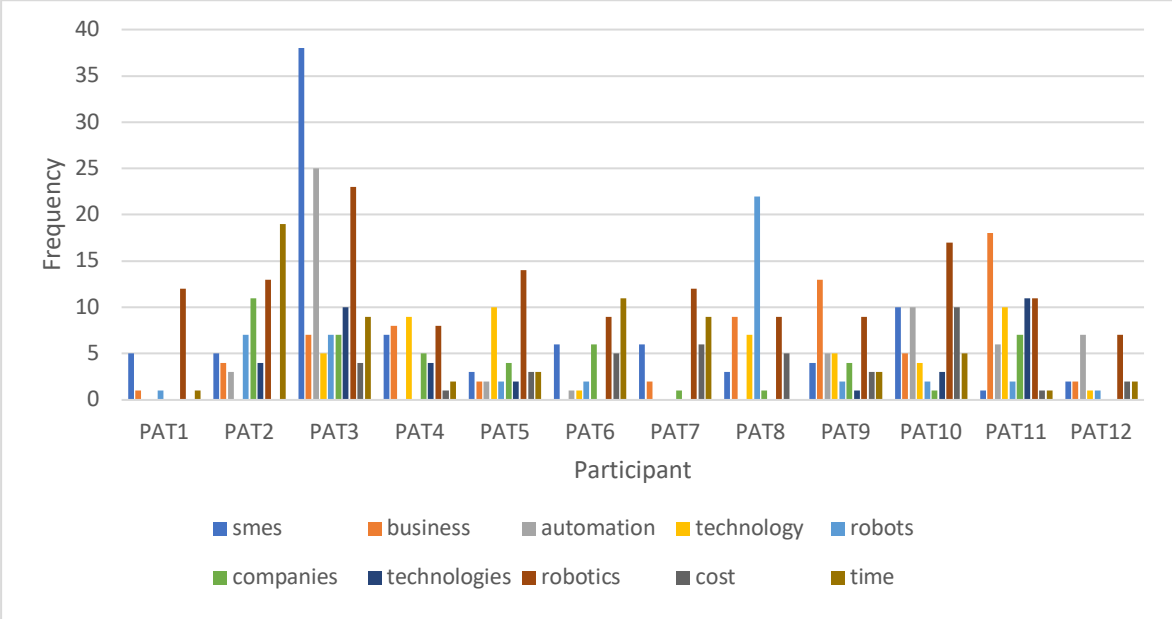


Figure 1: Prevalent words of the study across interviews

## Themes of the study

The collected empirical data was initially coded, these codes were then consolidated to form categories or sub-themes and then themes. All themes were linked to the research questions. There were 24 sub-themes that were developed from the codes which formed eight themes (Table 2). The eight themes and sub-themes are presented on the table below.

Table 2: Sub-themes and themes of the study

| Research Question | Themes | Sub-themes |
|---|---|---|
| How are SMEs in South Africa currently using robotics and automation? | Current state of robotics and automation implementation in SMEs | - Number of SMEs currently using robotics in their organizations.<br>- Reasons for not implementing robotics.<br>- Reasons for integrating Robotics in organizations. |
| | Importance of robotics and automation for SMEs | - Handling of mundane and dangerous tasks.<br>- Cost reduction and increase in competitive advantage.<br>- Expansion and development of new industries.<br>- Capacity driven robotics adoption. |
| | Factors considered by SMEs before the use of robotics and automation. | - Level of preparedness.<br>- Impact on existing operations.<br>- Financial costs.<br>- Effectiveness of the implemented/ desired robotics solutions.<br>- Adaptability of the robotics (repurposing as operations change). |
| What are the stumbling blocks for SMEs adopting Robotics and Automation? | Challenges in adopting or implementing robotics in SMEs | - Security concerns for web enabled robotics.<br>- Financing robotics and automation.<br>- Limited availability of skills to maintain the robotics.<br>- Limitations of available of robotics and automation technologies. |
| | Overcoming the challenges in implementing robotics for SMEs | - Overcoming fears about security.<br>- Overcoming financial challenges.<br>- Overcoming challenges concerning skill set.<br>- Overcoming robotics limitations. |
| In which ways could SMEs use Robotics and Automation to become more competitive? | Robotics influence on market performance for SMEs | - Increase in efficiency and decrease in production mistakes.<br>- Increase in production and customer satisfaction.<br>- Fast adaptation to growing market needs. |
| | Impact of robotics and automation on customer value proposition. | - High quality products and services<br>- High availability and low turnaround time.<br>- Cost effective products |
| | The role of robotics in the future and how SMEs can prepare themselves for that role | - Positive impact on current and future opportunities.<br>- Capacitate the SMEs for future performance |

## SMEs current use of robotics and automation in South Africa

The first research question was, How are SMEs in South Africa currently using robotics and automation? This research question was answered using three themes which were the importance of robotics and automation for SMEs, factors considered by SMEs before the use of robotics and automation, and current state of robotics and automation implementation in SMEs.

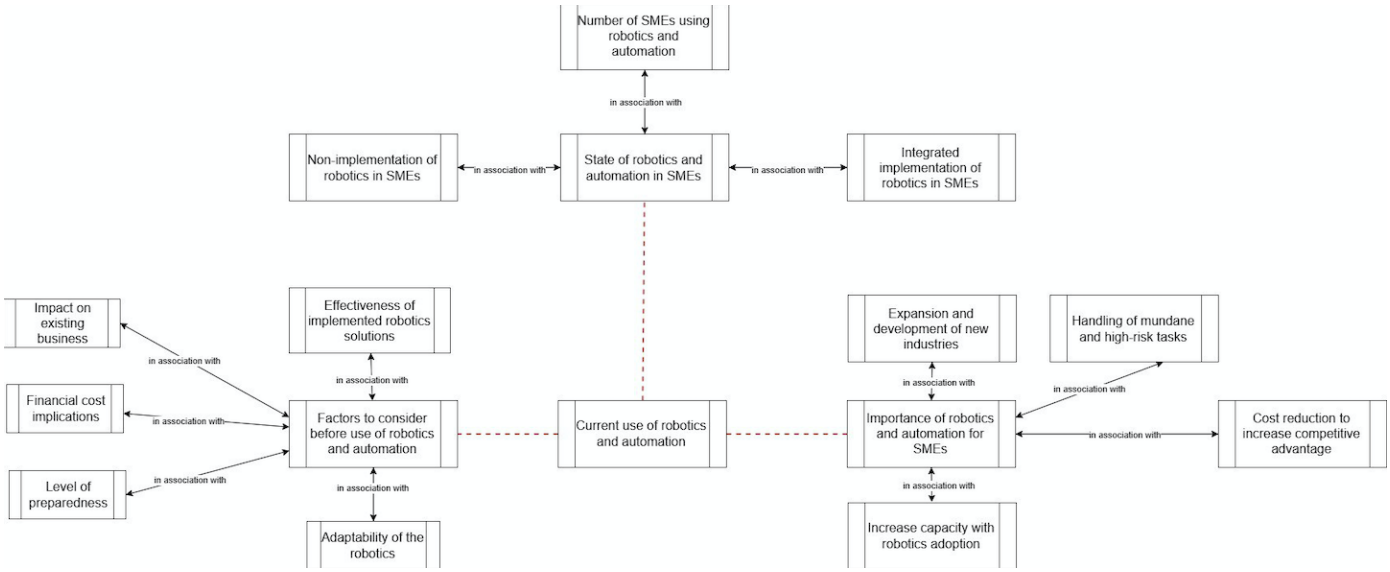


Figure 2: Thematic network of current use of robotics and automation

## Current state of robotics and automation implementation in SMEs

Six out of 12 SMEs currently have not implemented any robotics or automation, while six had begun using the robotics and automation. There are several reasons that were advanced on why some of the SMEs have not implemented. Some SMEs felt it was not feasible to invest in robotics for their businesses, while others highlighted the high costs of financing such investments. Another reason highlighted was lack of customizable technology tailored to their business needs.

"If you've got a smaller operation, there is not much need for automation because most things would be done manually because of the price of labour and employment." PAT10

"The only issue currently is just financing but over time it should work out." PAT2

"We haven't ventured into looking at how we would use it in our environment." PAT7

The SMEs that have implemented highlighted their reasons for integrating robotics and automation into their businesses. Reasons included removing tasks that required extensive manpower, to create custom solutions for third parties, while others adopted robotics to increase precision in their manufacturing processes and to increase their production capacity.

"We have not adopted physical robots but have adopted bots which perform tasks that previously required at least 10 people to complete." PAT1

"What we have implemented [is robots] for inspecting high voltage power lines. Basically, you need to inspect every single inch of a powerline for defects periodically to make sure these powerlines don't fall." PAT8

**Importance of robotics and automation for SMEs**

There is a plethora of reasons on why it is important to implement robotics and automation in SMEs. This includes handling of mundane and high-risk tasks, cost reduction for increased competitive advantage, expansion and development of new industries, service delivery improvements and increased capacity with robotics adoption.

*Handling of mundane and high-risk tasks*. It is essential for SMEs to adopt robotics as adoption enables SMEs to improve efficiency in their operations. It is important that mundane and high-risk tasks within the organization are automated. The mundane tasks are where most workers make mistakes as they reduce effort when completing repetitive tasks. Additionally, it allows people to focus their efforts on more important tasks which in turn increases employee satisfaction.

"Essentially the fundamental role of robotics is to take either the dangerous or the mundane away from humans." PAT3

*Cost reduction for increased competitive advantage.* For SMEs robotics can reduce costs by eliminating costly expertise. It allows for SME to scale and compete with large enterprises without the need for a comparable workforce and expertise. The automation of labour-intensive work also allows for SMEs to save money.

"If we can automate the labour-intensive work, we could have cost savings and it would also be empowering to people to be able to work with robotics." PAT7

*Expansion and development of new industries*. An increase in technology communities has created opportunities for SMEs through the formation of new industries with technology centred start-ups. These start-ups have expanded existing and pioneered new industries through automating various business processes. Robotics and automation eliminates operational boundaries thus allowing SMEs in different markets to collaborate on supply chains.

"We are seeing a lot of new businesses building their entire existence around these technologies." PAT3

*Service delivery improvement.* Robotics increases the efficiency of production and delivery of products to customers through enabling accelerated and more accurate production. In manufacturing, robotics and automation decrease the lead time for production and thus makes manufacturing quality products faster and easier.

"People don't understand that there is an inherent lead time because you have to build something in the manufacturing industry. Robotics do help and do allow us to reduce that time." PAT6

*Increased capacity with robotics adoption.* Adoption enabled SMEs scale up production through increased production efficiency. However, it was noted that for SMEs with low output, adoption may not be beneficial as employing labour might be more cost effective. Benefits to adopting are more so for larger SMEs with intensive human capital needs.

"If you have an Integrator/large enterprise that makes use of much more processes, then you must have robotics and automation to link things in the different operations within your entity" PAT10

**Factors considered by SMEs before the use of robotics and automation**

There are several factors that the SMEs ought to consider before the use of the robotics and automation. Participants highlighted factors such as level of preparedness for implementation, impact on existing operations, financial costs of investment, effectiveness of the implemented or desired robotics solution, and Adaptability of the robotics (repurposing as operations change).

*Level of preparedness*. It was seen as important to evaluate whether SMEs are sufficiently prepared for automation by assessing if baseline requirements for technology implementation are in place. Additionally, education and knowledge on transitioning from traditional practices to robotics and automation technology need to be evaluated. Next, SMEs should create technology awareness, teaching employees about the impact of transitioning to technology on their roles and responsibilities as well as assuring them that transitioning does not imply job displacement but rather a creation of new opportunities. SMEs ought to ensure a researched implementation strategy is developed and ready.

"It needs a clear implementation strategy and a proper plan. For every company and SMME, the adoption process will be a unique situation and there won't be an option to copy and paste." PAT2

""Education is required to help SMEs to better understand the technology." PAT3

*Impact on existing operations*. Robotics and automation processes impact on existing operations through efficiency and labour. Therefore, SMEs implementing should consider the efficient use of existing workforce, impact on job displacement and find ways to mitigate job losses. Businesses can increase employee value and reap benefits through upskilling.

"When looking at whatever kind of automation that you need, you need to have someone on site who knows how the system or the machines or the machinery works." PAT10

*Financial costs of investment*. Consideration of the financial impact of adopting the robotics and automation technologies is crucial as they are expensive to acquire and maintain. Fortunately, investing in them is becoming feasible as procurement prices are decreasing meaning it might be possible for those behind the curve to adopt.

"Most importantly how much is it going to cost me because ultimately we can have all these nice things but am I [as a small business] going to afford it and if I do end up getting it, how am I going to get it to in terms of funding and what type of funding am I going to get." PAT5

Another financial consideration is the return on investment. SMEs should consider the impact on revenue, profits and whether or not they would break even or lose money should they adopt robotics and automation. If SMEs have a need for the efficiency and

precision associated with robotics and automation, they could also outsource their requirements. Finally, a consideration on the duration the solution is required for (short-term task or long-term) can help in determining if adoption of robotics and automation is financially viable.

*Effectiveness of the implemented or desired robotics solution.* A crucial question is whether robotics and automation work for business. Businesses often overlook this question, rushing into innovation without considering whether or not the innovation processes will solve their challenges. Therefore, businesses need to assess the solution or they risk implementing innovations that perpetuate the problem or produce inadequate solutions detrimental to the livelihood of the business.

"The first one I would say is relevance. That is, whether the type of robotics or automation that a person is considering using is relevant for their company, for their objectives, and what they do." PAT9

*Adaptability of the robotics (repurposing as operations change).* Businesses must consider whether the automation can be repurposed for something else and solve other business problems or be provided as a service to create a new income stream. Furthermore, SMEs should consider whether or not repurposing the solution will impact new operations or create additional requirements such as new skills. The impact should be evaluated to ascertain value and determine whether it will hinder the businesses ability to scale or grow.

"Can the robots be repurposed for something else or can it be provided as a service to other SMEs to generate more income." PAT3

## Stumbling blocks for adopting robotics and automation in SMEs

The second research question was, what are the stumbling blocks for SMEs adopting robotics and automation? The research question was answered by two themes namely challenges in adopting or implementing robotics in SMEs as well as overcoming the challenges in implementing robotics for SMEs (Table 2). (Figure 3) Below is a network map of the stumbling blocks.

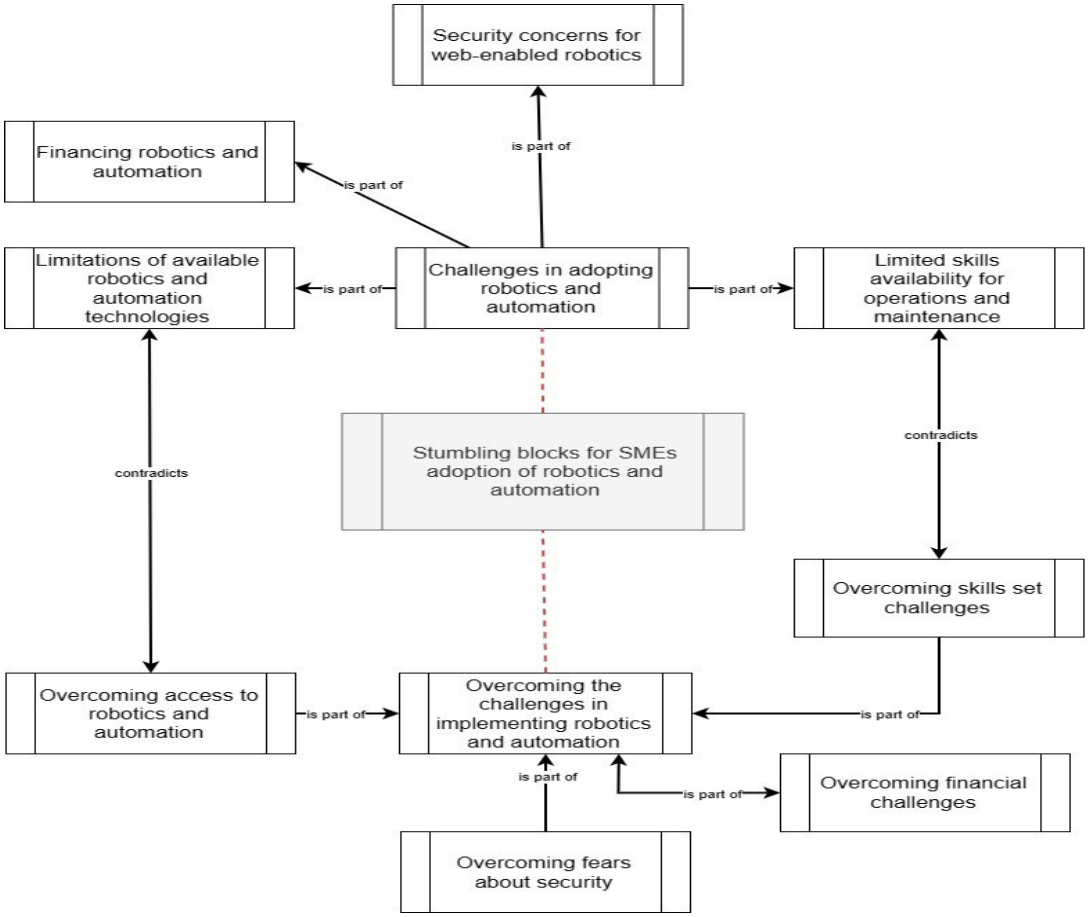


Figure 3: Thematic network of stumbling blocks for SMEs adoption of robotics and automation

Challenges in adopting or implementing robotics and automation in SMEs include security concerns for web-enabled robotics, financing, limited availability of skills to operate and maintain the robotics, and limitations of available robotics and automation technologies.

*Security concerns for web enabled robotics*. When businesses take away control from users, they become anxious about security. There are concerns on whether these automation systems could be manipulated and used for malicious purposes. However, these concerns are mostly unfounded and tend to be aligned with lack of knowledge about the systems. The reality is, users have full control over automation systems and can always override the systems should the need arise.

"Biggest challenges to adopting robotics and automation mostly has been that people are concerned about security. They want to know how I am assured that this will keep working."

PAT2

*Financing robotics and automation*. Since robotics and automation technologies are expensive, most SMEs have challenges with financing the adoption. For most participants, manual or traditional machinery are seen as still being more affordable compared to automation even with the labour cost. As a result, making such investments was seen as a challenge as businesses are currently not financially positioned to face these costs.

"Financing the technology is a problem." PAT5

"The biggest challenge to adopting robotics for my company has been cost because I [the business] can get a manual piece of equipment at a much lower rate as opposed to a roboticized one, or automated one." PAT6

*Limited availability of skills to operate and maintain the robotics.* SMEs lack skill sets required to operate and maintain the technologies meaning that most of the organizations would either have to train their own employees or hire skilled employees to replaced unskilled employees in order to fulfil their need to adopt robotics and automation. This creates potential for job losses which may lead to engagements with labour unions.

"Next is equipping people, as alluded previously, with the skillset. It is that not just about getting the robotics or the automation, you also face challenges that come getting the skill sets that are required to be able to run it." PAT10

*Limitations of available robotics and automation technologies*. Some SMEs' needs cannot be met by currently available robotics and automation technologies. This poses a challenge since the business recognises the need for technology however, that recognized need cannot be satiated by available technology. Needs for robotics capable of intuitively solving problems or interpreting information to solve problems are not being met.

"When we have a look at machines that are actually being used it is all for efficiency, time saving, and all those kind of things." PAT5

"I just don't see robots or automated processes making judgement based on intuition." PAT11

Participants also highlighted ways in which SMEs could overcome fears concerning security, financial challenges, challenges concerning skills sets as well robotics limitations.

*Overcoming fears about security*. Users should research the different levels of security and different levels of control offered by the robotics and automation technology. These levels of control could place users more at ease with regards to security risks and levels of access and control the technology has over the business.

"There are regulations, there are specifications, there are different types of controls and access so most of the time it was a matter of doing a bit of research collect all the data and show the client that their concerns are fully covered." PAT2

*Overcoming financial challenges*. Some ways noted for overcoming financial challenges include getting external funding from the government, private financial institutions, venture capitalists etc. Additionally, SMEs can collaborate on the purchase to reduce the financial burden. Leasing rather than outright purchasing could afford SMEs and option to save up capital. SMEs can also opt for lower cost entry level solutions and slowly transition to the desired solution as finances improve.

"To overcome challenges we relied on grants, venture capital and trying to corral together people of similar interests for collaboration." PAT3

"What we rather looked at then is a lower cost piece of equipment that wasn't as capable but would allow us to also train up our staff and operators, so as to upskill." PAT6

*Overcoming challenges concerning skill sets*. Internal training was noted as one of the most prevalent solutions to build capacity whilst limiting the need for retrenchments. Additionally, participants noted that the retention strategy may be more financially viable than talent acquisition. However, the issue of retrenching was seen as unavoidable though limitable.

"Inhouse training can assist in reducing skills shortage. PAT5

"Perhaps consider implementing the solution and upskilling internally …" PAT12

*Overcoming robotics limitations*. Participants noted that pre-testing can assist to ascertain if the robotics and automation solution offers the capabilities needed and ascertain the technology's fit-for-purpose. Researching the different technologies and finding out what is available in the market could assist in finding possible combinations of technologies that would better suit the business needs.

"To overcome these challenges, we would need to have the ability to test before

implementing.” PAT7

“They can consider going hybrid instead of completely switching to robotics, they can integrate them into their existing processes where they can be of benefit” PAT10

## In which ways could SMEs use Robotics and Automation to become more competitive?

The third research question was, in which ways could SMEs use robotics and automation to become more competitive? This research question was answered by three themes which were robotics influence on market performance for SMEs, impact of robotics and automation on customer value proposition and the role of robotics in the future and how SMEs can prepare themselves for that role (Table 2). (Figure 4) Below is a network of the SMEs use of robotics and automation for competitiveness.

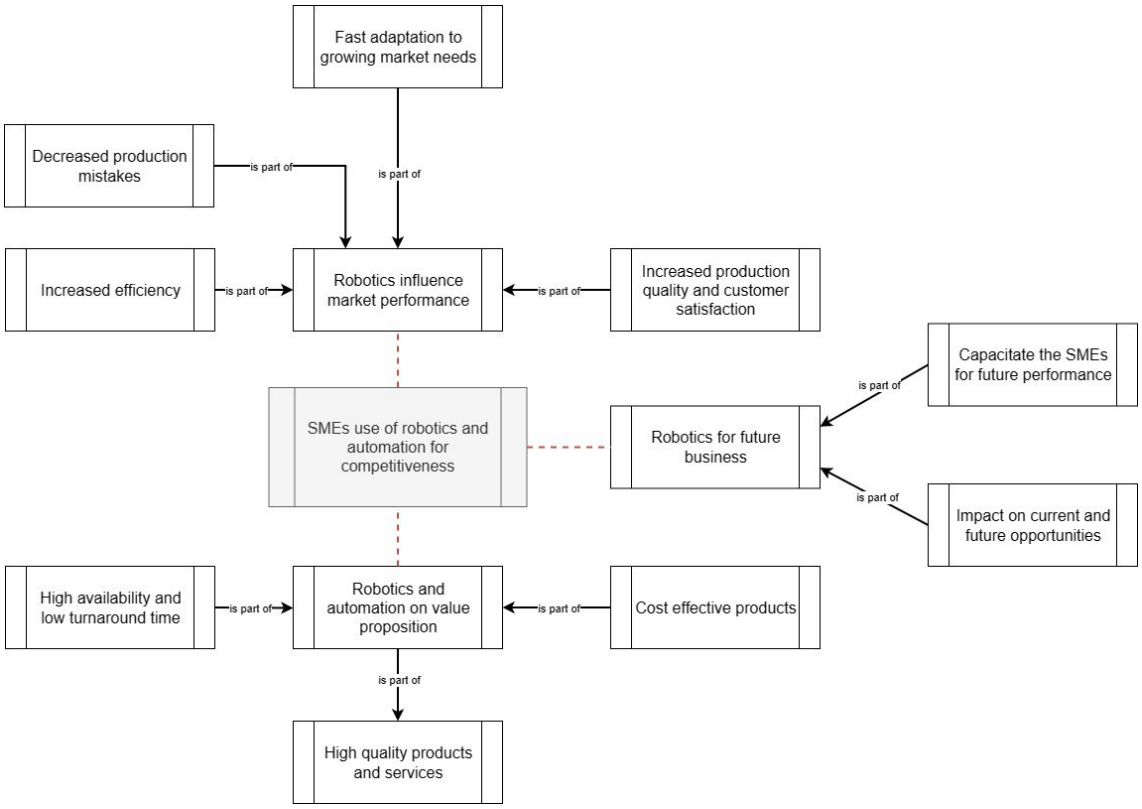


Figure 4: Thematic network of SMEs use of robotics and automation for competitiveness

*Influence on market performance:* A positive impact of adopting robotics and automation on market performance was noted by participants. Participants noted that to the influence on market performance was due to the technology increasing efficiency, decreasing production mistakes, increasing production quality, allowing for fast adaptation to market

growth, and positively impacting customer satisfaction which all contributed positively to performance and lowered costs. As a results, SMEs that adopted had a competitive advantage over those that had not. The increased efficiency also meant a quicker time to market, meaning SMEs can fail fast, improve their products, modify production and increase profit margins. For some SMEs robotics and automation has managed to shorten the distance between the business and its customers, with some SMEs now able to service clients that are different provinces or even countries.

"SMEs in developed nations have seen huge benefits from robotics adoption, they have seen increased efficiencies and less defects thereby lowering costs." PAT1

"This means less waste and less mistakes. So, at the end of the day your profit margins should slightly increase." PAT10

The decrease in production time and agility of SMEs enables them to easier adapt to changing market needs and thus giving SMEs a competitive advantage over bigger less agile enterprises. The fast adaptation allows them to break into markets first and adapt to those markets faster than rigid large enterprises.

"Because SMEs are agile, they can adapt fast and adapt quickly. They can implement newer techniques even with older equipment [robotics equipment] faster than the bigger established companies." PAT6

*Influence on customer value proposition:* Adopted automation technologies have enabled SMEs to rapid test their products in the market. This has enabled SMEs to modify and enhance their products to better suit the needs of their targeted markets. Through rapid testing and prototyping, client get a better feel for the product and thus understand better what the real and final product will be like. This process increases the customers product satisfaction. Cost savings from increased efficiency has also allowed SMEs to impact customer value as SMEs pass on some of their production cost savings to the customers.

"Automation has allowed SMEs to fail fast through quickly building products and models and testing them in the market as well as modifying them to what the market wants." PAT3

"Robotics reduces the need to hire more people unnecessarily and hence save on your payroll and those savings can be passed on to the customer." PAT5

Though the customer value proposition is highly affected by business strategy, adoption of robotics and automation has led to improvements in product or service quality, cost,

and availability with low turn-around time thus benefitting the customer. Again, through prototyping customers can test and request modifications to products and services before purchasing which ensures customers get value for money.

"I mean ultimately what the customer wants is higher quality, cheaper and faster. PAT8
"It has reduced the time taken to provide clients with service and support." PAT2
"The customer value proposition has been impacted positively because customers can see the product, test it, and request modifications before buying it.." PAT3

Participants note that front facing businesses may have issues if adopting front facing robotics and automation as the market may not be ready to fully embrace them as part of the customer journey.

"Maybe I'm just too old to relate, but I don't think that the market is ready for a fully robotized front end." PAT8

*The role of robotics and automation in the future and how SMEs can prepare themselves for that role*: The current role of robotics which includes driving efficiency, accuracy, accuracy, and consistency will continue to become enhanced. Participants note that robotics will enable employees to have more fulfilling lives with a better work-life balance through removing mundane tasks from their responsibilities, enabling employees to focus on higher cognitive order tasks and spending more time with family. Robotics and automation will drive SME profit as the technology improves in handling complex labour-intensive tasks. New features will enable robotics to identify faults, identifying features, compare things, identify opportunities, and other higher cognitive order tasks which again will drive SME competitiveness. Coupled with a better understanding of the economic and social context, robots will have a better awareness of their environment and make decisions to improve their functions or output based on the context. Self-driving cars for example will adjust their roles based on better understanding the owner to schedule trips in a manner benefitting the owner and those around the owner. People will need to learn new skills in order to secure employment. There will be an increase in adoption across different industries which will drive competition. SMEs that do not adopt will lose their competitive advantage.

"For employees of the SMMEs it will improve their quality of life in terms of giving them time to spend with their families." PAT2

"There will be an increase in adoption of more complex robotics that work on complex systems, solving problems that would normally require many humans to solve. " PAT3

"To keep up, you will need to use robotics."PAT8

To prepare themselves SMEs need to research current robotics and understand how those may change in the future. SMEs should also find out how and where the technology will fit in within their business, its intended function as well as ways in which it can be used outside of its intended function. They need to identify areas in which adoption may add value by driving efficiency. SMEs need to start experimenting with the technology through working with companies that have already acquired it. Possible collaborations and partnerships need to be investigated. SMEs can achieve this by exposing themselves to various robotics and automation products through attending roadshows and seminars. Finally, SMEs and unions need to take initiative and develop employee skills that will enable them to work with the technology as failure to do so may result in job losses.

"SMEs need to establish their business needs and identify areas where robotics can add value and drive efficiency, they need to be open-minded, adaptable and respond positively to the future of work." PAT1

"We [SMEs] need to have a plan to implement, and we need to do more research to find out what needs to be done." PAT7

"there is an opportunity for people to upskill themselves and learn new skills and ensure that they are well versed with the way technology is taking over."PAT12

## Conclusion

The empirical data analysis from the 12 participants highlighted that the main reason for adoption has been to eliminate mundane and high-risk tasks, drive cost reduction, increase competitive advantage, and allow SMEs to expand their markets. Challenges to adoption as well as potential ways to overcome them were provided by participants. Customers have benefitted from the adoption with SMEs improving their product or service quality, cost, and availability with low turn-around time through the technology. Participants noted the impact of robotics on market performance of the adopter and provided foresight on the future role of robotics and ways in which SMEs could prepare for this future role. These findings are discussed in the next chapter.

# Chapter 5: Discussion of the results

## Introduction

The following chapter is a discussion of the results emerging from the study. These results will be discussed with reference made to relevant literature and with the objective of finding connections between the information gathered from the participants and the research questions raised in this study. The discussion will unpack the views of SMEs with regards to the use of robotics and automation in SMEs, solutions to challenges faced by SMEs when adopting the technology and the impact of the technology on the SMEs market performance, customers and future.

## Discussion pertaining to the Research Questions

### SMEs current use of robotics and automation in South Africa

The collected empirical data shows an even distribution between SMEs that have adopted some form of robotics or automation and those that have not. Rogers (1995) observation that more than half of all organizations fall behind the technology adoption curve could not be validated as required population needed to have an even distribution for a relative comparison. From SMEs that have not implemented any form of robotics or automation, this study found that SMEs that operate at a small scale do not see the financial feasibility of investing in robotics and automation. The SMEs have not been in operation for long and so are still cash-strapped. Additionally, findings highlighted that for production at their scale, utilizing labour may be more cost efficient than investing in a highly capable technology that would end up underutilized. The remaining non-adopters consisted of SMEs still in the planning phase, strategizing and developing a suitable implementation plan. It is important to note that two of the 12 participants admit that they have not even considered adoption due to a lack of exposure to technology. They are of a view that change in their industry cannot be driven through the adoption and use of technology.

For the 50% of SMEs that have implemented robotics and automation, reasons for adoption include, reducing the need for labour by automating tasks that require a large labour force, adopting the technology to create custom solutions for other businesses,

adopting to increase precision, efficiency, and production capacity in the manufacturing process. From this it is evident that, as per previous studies, adoption has either been driven by necessity as the business' function is dependent on it or driven as a means to an end, required to reduce costs and increase production (Sohal et al., 2001).

The empirical data collected suggests that the majority of SMEs believe robotics and automation is important to SMEs. This view arise from their understanding of the technology's ability to handle mundane and high-risk tasks, reduce costs while increasing competitive advantage, enable SMEs to expand existing industries whilst developing new industries and improve service delivery. This is in line with literature that suggests new technologies are viewed as important if perceptions about them are positive (Straub, 2009). Participants alluded that robotics is better suited to handle mundane and high-risk tasks since humans tend to reduce concentration and effort when performing routine tasks. With the reduced effort, mistakes become more prevalent. Humans are prone to make mistakes. Robotics and automation can perform these repetitive whilst reducing errors (Jackson 2018). In addition, robotics is able to replace labour-intensive tasks. As a direct consequence, increased efficiency and cost reduction is frequently observed. The technology is also seen as important since it enables SMEs to operate in industries not native to them, thereby creating new potential sources of revenue. This further confirms studies such as that by Govender and Pretorius (2015) that suggest that 4IR technologies are blurring industry line and enabling expansion into new one. SMEs may therefore need to prepare for competition emerging from not only their native industry but additionally from other industries and markets.

Other reasons provided as to why robotics and automation is important to SMEs include its positive influence on service delivery which assists with customer retention. SMEs view the ability of the technology to improve efficiency in production and delivery of products or services to customers as core to service delivery, in line with literature suggesting that the primary reason for adoption is to improve efficiency and accuracy, scheduling, and distribution (Sohal et al., 2001).

An unexpected finding related the importance of robotics and automation in SMEs is that, although most SMEs in the study viewed the technology as being important, SMEs with a small scale production did not see the need to adopt. The importance of the technology was viewed as minimal as they were able to cater for current demand through the use of

existing labour. It is possible that these SMEs did not plan to increase scale or have not had exposure to the technology as evident in latter findings. As such, they are adverse to the impact of the technology to their businesses.

In addition to understanding the importance, it was also important to ascertain what considerations SMEs should make should they wish to adopt robotics and automation. Although there is consensus that the adoption and implementation process will be unique to each organization, the empirical data suggests that, SMEs need to first identify their level of preparedness to adopt. That is, SMEs need to be aware of systems and processes that need to be in place before they can bring in any form of robotics and automation. Therefore, there is a need to educate themselves on the technology and identify potential challenges that may exist after adopting. Furthermore, education needs to be provided to create awareness amongst employees with emphasis on the potential direct changes in processes and responsibilities. The collected data as well as literature suggest that understanding and addressing employee perceptions can help in preparing the organization to adopt technology (Lai, 2017). The implementation strategy that is part of evaluation of preparedness should therefore be clear and concise in addressing not only the process the SME will use when adopting, but also in addressing the educational needs as generic training will not suffice in ensuring organizational readiness.

Part of the organizations implementation strategy will involve understanding the impact of adoption on existing operations. Aspects of operations management such as operational planning, product or service design, quality control, forecasting, business strategy and supply chain management are often impacted directly or indirectly by any change in the business (Jacobs et al., 2004). The research data suggests that there is almost always an impact on operations when replacing physical labour with automated systems. Although participants believed the impact on labour ought to be part of the strategy, 25% of participants believe it is not the responsibility of the SME to consider the impact of adoption on employment. These participants believe that such considerations should be left to government and conglomerates with large employee numbers. However, this may be unjustifiable considering SMEs provide 60% of all employment (Kongolo, 2010). The consensus however is that, SMEs should consider upskilling employees whenever possible as the adopted technology will create new opportunities for employees to work with and alongside the technology.

SMEs then need to consider the financial costs associated with adopting. The overarching view of participants is that robotics and automation technologies are costly to procure and SMEs are not financially set to acquire the technology. Although, visible changes and improvements in pricing are slowly making acquisition realizable. With this in mind, SMEs need to evaluate the impact of adoption on their bottom line. Decisions on whether to finance outright, lease, or outsource all have varying implications. SMEs need to understand the unintended consequences of each action. As an example, owning and leasing the technology may involve additional costs such as electricity costs, maintenance costs, obsolescence, and upgrade costs etc. Therefore is it important for SMEs to understand the short, medium, and long-term financial implications, based on how long they wish to use the technology, so as to establish financial viability (Cobham, 1999).

The next consideration respondents mention is examining whether the envisioned or implemented robotics solution is or will be realistically effective. In the drive to be innovative, SMEs risk implementing new technologies that are viewed as innovative and neglect to consider whether the technologies are suitable. SMEs need to spend time understanding their fundamental problem or they risk finding innovative ways of solving the incorrect problem. Robotics and automation is not an unqualified solution.

Finally, once SMEs are content with a robotics and automation technology they have identified or adopted, They need to consider alternative used for it. That is, SMEs need to consider whether there are other benefits to be gained from their technology. Considerations such as multifunctional use may present opportunities to offer their technology as a service and thereby creating a new unintended stream of income. Some technologies require specialized skills which employees may not be able to upskill to, this may hinder the businesses ability to grow. SMEs should have an idea of whether their technology can be repurposed for new needs or whether it is a single function technology with no other use outside its intended purpose.

Figure 5 outlines the model derived from these findings that can help guide SMEs considering adopting robotics and automation technology as well as other 4IR technologies.

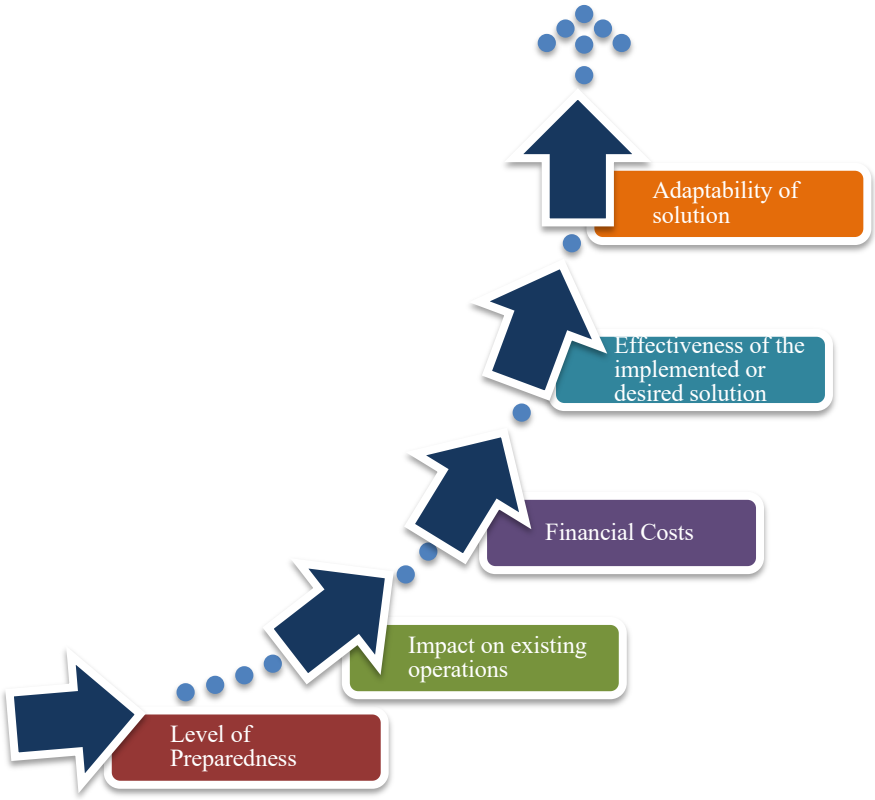


Figure 5:Process model for adopting robotics and automation, created from research findings

## Challenges related to adopting and implementing robotics and automation

Though literature suggests that licensing fees, scarcity of information regarding new developments, shortage of skills required to implement and operate technology, and politicking and unionization are the main factors inhibiting the adoption of new technologies such as robotics and automation (Abor & Quartey, 2010; Hlatshwayo, 2017; Kim & Boldyreff, 2005; Kyobe, 2009; Lotriet et al., 2010; Sommerville, 2018), this study found that there has been a shift in some of the factors. For instance, participants in the study consider the overall cost of purchasing robotics and automation instead of licensing fees as the issue. The understanding is that whatever technology is selected, the overall cost would include licenses required for it. The data confirms that there is still a scarcity of information about robotics and technology. As a result, the full capabilities of the technology may not be considered which may affect decisions to adopt. Security concerns as discussed earlier are one aspect identified as resulting from information scarcity as misconceptions caused by science fiction negatively impacts employee perceptions which may hinder adoption efforts (Ta-Tao et al., 2009). The shortage of skills persists as a

challenge. SMEs do not have readily trained employees who would be able to work with and alongside any new adopted solution. In addition, SMEs struggle to identify skills required for successful adoption as well as suitable training programs that would cultivate the required skills. However, SMEs that have an inherent relationship with technology do not view skills shortage as an issue. This is because they view graduate unemployment as an opportunity to find talented individuals that can drive their adoption and implementation. Nevertheless, the acquisition of these skills would also impact on the employee structure of the business. That is, SMEs may need to consider retrenching, upskilling or hiring additional people who have the required skills. Outsourcing the skills is not mentioned as it would inevitably lead to job displacement. The data highlights that there is a drive amongst SMEs to direct efforts at finding ways to retain employees when adopting technology even when there is little need. This is since unionization is viewed as having an influence on retrenchments even at SME level. This view may be because SMEs contribute more to GDP and employment (Kongolo, 2010), and so, government and unions are seen as likely to pay attention to operational practices affecting employment.

One unexpected finding with regards to challenges is that there is an increase in requirements for bespoke robotics and automation technologies. This means that for some SMEs, even when the need for adoption is recognized, available technology is not suitable or customizable for their needs.

**Overcoming challenges related to adoption and implementation**

Although it is noted that each organization will face its own unique challenges, SMEs still possess the ability to learn from other SMEs and adapt the knowledge to resolving their own challenges (Ali, et al., 2017). To overcome challenges in implementing, it is important for SMEs to thoroughly research technologies and not be swayed by depictions of technology in movies. Concerns regarding security can be resolved through research and dialogue. Information regarding such concerns may be obtained from reliable sources such as manufacturers.

Finance is the often viewed by small businesses as one of the predominant determinants of investing in new technologies (Cobham, 1999). For South African SMEs, avenues such as government grants, venture capital, and joint ventures remain the possible avenues for

fundraising. SMEs need to be aware of available government grants and educate themselves on processes related to applying for such grants. These grants enable SMEs to fund technology adoption through contribution in government efforts aimed at empowering the disadvantaged. Venture capitalism is an alternative option for raising funds. However, the goals of each SME owner-operator vary (Newby et al., 2012) and some SMEs may not be agreeable to conditions that may be contractual to such funding. Nevertheless, funding from venture capitalists is yet another avenue for SMEs looking to overcome this challenge. Additional financing solutions include, leasing equipment or adopting technology in smaller increments. The option of leasing allows for SMEs to use automation technology without the long-term financial commitment required for maintenance and upgrades as the technology becomes obsolete. The option of incremental adoption allows for SMEs to minimize the financial strain that would otherwise be felt if they were to purchase a complete final-product solution. Although it is noted that joint ventures may not work for all SMEs, the empirical data highlights that collaborations on purchases are seen as viable options as they allow participating SMEs to share and spread the risk, helping to minimize the financial burden. Collaboration partners with whom the SME has synergies are recognized as being essential as they may also provide opportunities to complement and improve the partners value chain. Additionally, this option provides opportunities to further reduce operational costs by sharing skilled labour resources where possible.

It is evident that although finding the necessary skills for adopting and implementing robotics remains a challenge, the option to upskill existing labour still remains the prominent choice to addressing it. The option to upskill also benefits SMEs in that it reduces the need for or extent of retrenchments. Though concern regarding labour unions is low, participants agree that any efforts made in preventing the need for them to form or intervene should still be prioritized. This may be because altercations with unions may negatively impact business.

The availability of trial-testing technology is seen by SMEs as means to alleviate the inherent limitations of the technology since it provides the SME an opportunity to modify its processes to best fit the technology's capabilities before adopting. Thus ensuring that once the technology arrives, the SME is able to utilize it with minimized unforeseen challenges. Pre-testing additionally enables SMEs to consider combinations of different

robotics and automation technologies that could work in unison in solving their problem should a single technology have limitations that hinder it from being a complete solution.

Finally, With improvements in robotics and automation technologies, it has become possible to optimize processes to such a point that an SME may be able to estimate at a low margin of error, how long they need to use the technology and how much processing power they would utilize at any given time. This means that the option to rent out excess capacity now becomes possible. SMEs owning the technology can therefore utilize this option to generate additional revenue, whilst SMEs without the capital expenditure budget for adoption can start acclimatizing through renting capacity, benefiting from using the technology without the need for capital expenditure.

## Influence of robotics and automation on market performance

Previous studies suggests that the adoption of technology in efforts to increase efficiency has a positive correlation with improved market performance (Jensen, 2007). The empirical data collected suggests that increased efficiency is achieved through adopting robotics and automation. The technology enables SMEs to reduce human-error mistakes in production. Robotics and automation technologies lower the number of mistakes and thus lower the amount of defected products that would otherwise be produced without these technologies being used. When humans perform repetitive tasks, they are bound to make mistakes as majority of all production mistakes are as a result of human error (Mital & Pennathur, 2004). Because mistakes cost money, SMEs can save on operational and production costs through limiting and eliminating mistakes. This focus on finding innovative solutions to lower production costs as opposed to focusing on innovating products such that their designs are simplified is what Shepherd and Ahmed (2000) refer to as a new paradigm for competitive advantage. Through adopting technologies for solving core problems earlier, the SMEs tend to be more efficient at bringing their product to market. This means that they receive product feedback faster and are able to modify the product, improve it and put it back on the market. Failing fast helps SMEs develop better more desired products and as a result improves how their products perform in the market.

## Impact of robotics and automation on customer value proposition

Being able to enhance and fast track prototyping means that SMEs can get products to market faster, receive customer feedback sooner, and provide customers with more suitable products and services thus improving customer satisfaction. Robotics makes it possible to fast track fabrication enabling clients to have a test product that works as, feels as, and looks as the potential final product. With this, clients can modify products to their satisfaction hence improving the products value. As SMEs adopt to reduce costs, these cost savings can be passed on to customers because ultimately customers want quality products at cheaper prices.

Technology advancements continue to be a pillar in driving the fulfilment of the customers need for instant gratification (Harris & Laibson, 2013). The innate ability of robotics to decrease production time whilst providing the agility to change production and processes has allowed SMEs to be agile enough to adapt to changing market conditions and thus improving their competitive advantage. Through the use of robotics, SMEs can halt, continue and change production pace to keep up with the market change whilst maintaining service and product quality, price, and turnaround times. This is important in situations such as the Covid-19 pandemic in which some organizations were unable to function as labour could not report for duty. Finally, the size of SMEs enables them to better adapt and adopt newer robotics and automation technologies as there are fewer moving pieces compared to large enterprises, thus granting SMEs the ability to fulfil changing customer needs more expeditiously.

## The future role of robotics and automation in SMEs

This study found that the predicted future for robotics and automation involves an increase in use of the technology. Participants foresee improvements involving an increase in the technologies ability to impact production capacity of small businesses, continually removing mundane and high-risk tasks (making such positions obsolete). Employees will therefore live more fulfilling lives as they spend more time with family or working on business problems that are of more interest to them or of higher cognitive order. Scopelliti et al. (2005) identify this as improving work and workplace environment. SMEs foresee robotics as aggressively replacing labour intensive tasks thus helping

SMEs drive down costs. This means the technology will become a tool for managing expenses and driving profitability.

As robotics and automation technology improves, adoption will increase as SMEs exploit the technology's new abilities which will involve performing tasks that require reasoning, opportunity identification and exploitation. Robotics coupled with artificial intelligence will enable robots to improve products and services by learning from their present and past roles and objectives. In examples such as self-driving cars, the cars will be able to learn from past experiences, owners behaviour and expectations and improve to deliver better services. Automated programs (bots) will continuously collect online data, learn from it, and use the new insights to improve products and services. This means that humans need to continuously learn new skills to stay relevant in the workplace or risk being replaced by robotics and automation. The data also indicates that the adoption rate will increase and those that are early adopters will have a competitive edge as they would have more experience with the technology. Companies and industries that do not adopt automation technology will struggle to keep up, as their operating costs diverge more and more, with robotics and automation continuously driving lower costs and labour continuing to increase operational costs.

## Strategies for adopting robotics to become more competitive – Preparing for the future role of robotics

The empirical data supported by literature shows that, although the adoption of a single technology coupled with rapid technology growth as well as market uncertainty serve to delay technology adoption, the ability to learn about, experiment with, and be open-minded about technologies is essential in driving early adoption of new technologies (Chambers, 2004). When SMEs develop a culture of adopting technologies, regardless of the extent at which they do it, this culture presents them with a "window of opportunity" in which future investments become warranted and thus easier to embark on (Chambers, 2004). Therefore SMEs need to start learning about and adopting robotics and automation now. SMEs need to find ways to experiment with this technology even if at a much smaller scale. This would keep SMEs updated with advancements in the field of robotics as well as help them slowly develop skills and capabilities to scale up their adoption efforts and implementation. They also need to expose themselves more to the technology

by attending seminars and conferences which may help alleviate information scarcity. Thoughtful consideration should be given to procurement collaborations should opportunities present. Training and upskilling employees for future roles and responsibilities should become part of the SMEs growth strategy to ready themselves for the eventual adoption. These efforts better position SMEs to adopt robotics when the opportunity presents, helps SMEs become more competitive as they exploit the technology, and help develop a workplace culture that welcoming and conducive to change.

## Conclusion

In conclusion to this discussion, being mindful of the impact of the technology in the business, operating environment, and across different markets puts SMEs at a better position to make decisions related to adopting technology. SMEs in South Africa are aware of the impact of robotics and automation in different markets. Some SMEs have adopted or started experimenting with robotics and automation technologies. Challenges such as financing and acquiring skills still remain. The process model for adopting robotics and automation developed can assist SMEs in making strides in adopting and implementing the technology. This as SMEs recognize the need to adopt robotics and automation due to its ability to improve efficiency, reduce cost, positively influence customer value and also enhance the SME's future ability to compete.

# Chapter 6: Conclusion and Recommendations

## Introduction

In this final chapter, a summary of the findings from the study and conclusions will be provided. Suggestions and recommendations to will be made to SMEs wishing to adopt or improve competitiveness through robotics and automation. Different strategies for adopting will be presented. The chapter will end by proposing suggestions for further research based on outstanding questions that were beyond the scope of this particular study.

## Conclusions of the study

The purpose of this study was to investigate the impact of 4IR technologies, with specific focus on robotics and automation, on South African SMEs with the purpose of identifying how SMEs can use robotics and automation to improve competitiveness. Implementable strategies for adopting robotics and automation were identified. The study was carried out through the collection of insights on current uses of the technology in SMEs, identifying adoption challenges and solutions for SMEs wishing to adopt the technology. The SMEs' perceptions on the future role of the technology were gathered with the goal of formulating strategies SMEs could use to adopt and hence be better positioned to exploit the technology to improve competitiveness. The preliminary hypothesis stating that through technology, businesses can create strategies that are production specific, market specific, and even customer specific was validated.

### Current use of robotics and automation in South Africa

For the 50% that have adopted, reasons for adopting robotics and automation given by participants include reducing the need for a large labour force, creating custom solutions for clients, and managing costs through increasing efficiency, precision, and production capacity in production and manufacturing. For the remaining 50%, reasons for not adopting include the size and scale of production, with SMEs being of the view that their size and output are too low to validate adopting automation, a lack of funds for capital expenditure, as well as being in the early adoption planning stage. Findings highlighted

that at least one SME has not had any exposure to robotics and automation and at least one other believes the technology will not affect their business or industry and hence both have not considered adopting the technology.

The study found that, with the exception of one SME, SMEs agree on the importance of robotics and automation. SMEs believe the ability replace mundane and high-risk tasks resulting in increased efficiencies, productivity, and cost reduction all contribute to make robotics and automation a valuable technology for SMEs. Robotics was also seen as additionally beneficial since its replacing of mundane tasks enabled employees to focus on more complex tasks, and as a result, production mistakes resulting from human error could be reduced along with costs associated with the errors. The technology also allows SMEs to expand operations to new markets thus increasing revenue streams.

Having identified the importance of robotics and automation in SMEs, factors needing to be considered by SMEs wishing to adopt were developed. These factors include the following:

a) *Level of preparedness* – SMEs need to create a state of readiness to implement the technology through identifying potential challenges to adopting and working to alleviate and eliminate those challenges. Education and awareness on available technologies, their capabilities, skills required for them, business impact and workplace impact is required by business and employees. Through awareness, SMEs can create environments conducive to adoption. This information should form part of the SMEs clear and detailed implementation strategy.

b) *Impact on existing operations* – SMEs need to investigate impact on their end-to-end value chain. SMEs need to investigate how the adoption will impact operational planning, product or service design, quality control, forecasting, business strategy and supply chain management (Jacobs et al., 2004). Adopting robotics and automation will have an impact on employment, thus impact on employment needs to be thoroughly investigated.

c) *Financial Costs* – Adoption has implications on already financially cash-strapped SMEs as such investments have significant impact on their bottom line. SMEs need to consider financing options best suited for their budgets. Various options such as purchasing outright, leasing, or outsourcing the technology requirement are all options available to SMEs. Each of these has a different impact on the bottom line and so SMEs need to evaluate each options.

d) *Effectiveness of the implemented or desired solution* –SMEs need to evaluate the effectiveness of the implemented system or desired solution. That is, they need to be able to quantify the value received from implementing the solution. This could be through analysing the after effect on production capacity, efficiency, morale, productivity, profitability etc.

e) *Adaptability of solution* –The identified or implemented solution needs to be assessed for alternative uses or repurposing. Should the SMEs operational model change, SMEs need to know the solutions' use options in the new strategy. This is important since the financing decisions made earlier may impact their ability to dispose of, sell, or return the technology.

The model below was then developed from the findings from this study and can be used as a guide for SMEs wishing to adopt robotics and automation technology.

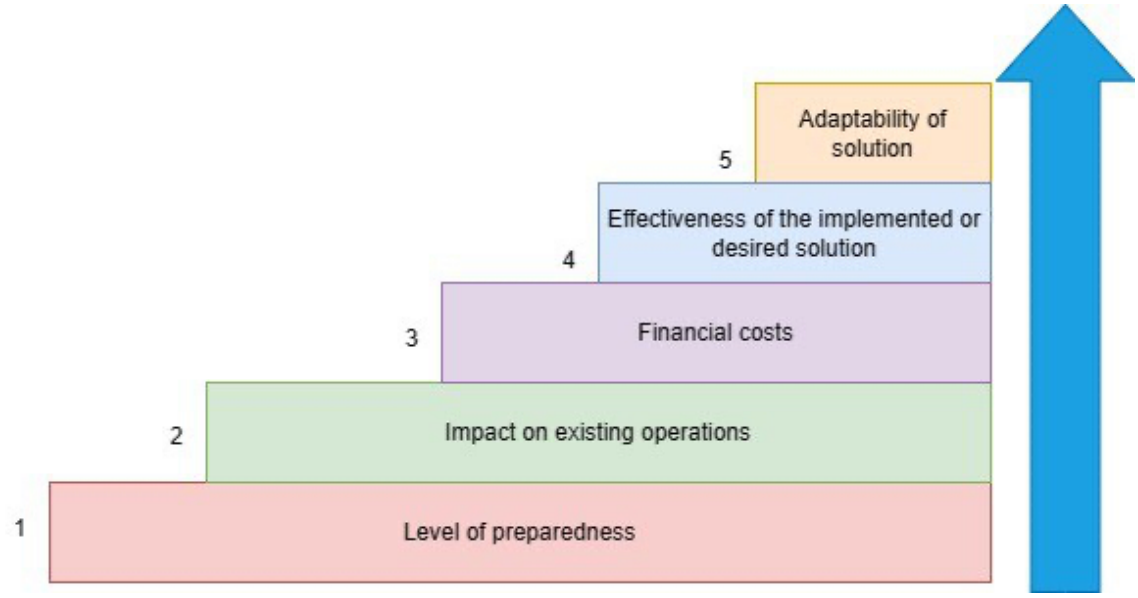


Figure 6: Process model for adopting robotics and automation

**Challenges and solutions to adopting robotics and automation**

Of the various challenges, financing and skills acquisition were amongst the most prevalent. SMEs struggle to fund adoption when it is desired. They furthermore struggle to find the right skill sets required for implementation. Part of the challenge also involved identifying training programmes that would equip employees with required skills. Other challenges included the persistence of information scarcity on robotics technology and

employment regulatory issues. Although retrenchments may be viable, SMEs note that the option could potentially present issues for larger SMEs as government and unions would likely pay attention to growing practices that impact unemployment. Finally, an unexpected challenge emerging is the need for bespoke technologies. There are growing needs for bespoke and customizable automation technologies that are not being met by the market.

To overcome challenges, the study identified that spending more time thoroughly investigating available robotics and automation is a vital step in finding the right technology for the business. Thereafter, financing options can be considered. For South African SMEs, funding from government grants, venture capital, and joint ventures exist as an option. Other options such as leasing the technology, purchasing outright, and renting access capacity from early adopters were noted. Each of these would need to be evaluated to see if it would support the SMEs short and long-term strategies. The options all have varying impacts and SMEs would need to evaluate and find options that would be in line with their growth strategy. The empirical data shows that upskilling existing employees is the ideal first step towards skills acquisition. This option was favoured since it assists in maintaining or improving employee morale. Additionally SMEs would potentially avoid large scale retrenchments. The growing graduate unemployment pool was suggested as a possible source of finding skill sets required for the adoption and implementation. Finally, the option of trial-testing technology was seen as a possible way to overcome the technology limitations as it would enable SMEs to identify ways in which they could modify their operations to enable adoption or find technology combinations that work for them.

**Impact on market performance and customer value proposition**

Robotics and automation has had a positive impact on market performance for early adopters. Data suggests that it has increased efficiency, improved production and production capacity, and reduced, thereby lowering costs. Robotics and automation adopters are seen as being more efficient in bringing their product to market, thus reducing the time taken to receive product feedback. Through prototyping and rapid testing SMEs can provide the market with a looks as, feels as, and works as product. This

enables them to received better feedback, fail fast, and improve the products and services thus re-entering the market with a more desirable product or service.

As a benefit, this process enables SMEs to improve their relationship with the client and customer by satisfying client needs. Increasing production efficiency and lowering costs also enable SMEs to attain savings that can be passed on to customers. Finally, improved production efficiencies reduce the time-to-market and have a positive impact on SMEs ability to fulfil the customers need for instant gratification. This means through adoption of robotics and automation, SMEs are able to impact product quality, price and lead time thus impacting their customer value proposition.

**Future role of robotics and automation in SMEs**

The study found that the influence of robotics and automation on SMEs is expected to grow. As the technology advances and improves, so will its ability to influence and impact different markets (Maynard, 2015). The impact of robotics and automation on business operations will continue to increase as the technology continues to replace mundane and high-risk tasks and in the process diminishing the human capital requirement for such tasks. Through automation, SMEs will be able to reduce labour costs. However, even with this impact on labour, the technology will contribute to enhancing the lives of employees as it frees them up to spend more time with family, upskill, and focus on more engaging tasks.

Some of the expected improvements in robotics and automation through integration with artificial intelligence include the ability to use reasoning, identify and exploit new opportunities that benefit the business. It is noted that one SME in the study is already implementing such a form of automation to create new flavours, eliminating the need for chemists. As bots continuously collect data, SMEs with this type of robotics implemented will be able to mine the data collected to better tailor products and services so they appeal to the market. Data collected will also be used by SMEs to develop new offerings.

The continued use of robotics and automation to drive costs, improve the business and enter new markets means that SMEs that fail to adopt when required are projected to struggle to keep up competitively.

## Recommendations

The aim of this study is to provide insight to South African SMEs on the use of robotics and how its adoption can help improve competitiveness. The findings of this study are used in this section to provide adoption strategies for SMEs wishing to adopt the technology and gain perceived benefits.

### Explore and Experiment

It is recommended that SMEs research different types of robotics and automation technologies for different areas of their value chain. SMEs should identify robotics and automation technologies that impact the businesses growth potential. Examples of such technologies include manufacturing and assembly robots, call centre bots, robotic arms for repetitive tasks etc. These types of robotics and automation can reduce manufacturing times, workplace injuries, overhead costs, product data collection, etc. through improved efficiencies. Through identifying appropriate technologies, SMEs can have a better understanding of how their competitors may utilize the technologies to gain a competitive edge or expand to new industries. Once technologies are identified, SMEs should approach suppliers so as to trial test the technologies. Testing will allow SMEs to gauge the technology's potential impact on their business or industry. With these technologies becoming more democratized, alternatives and clones are also affordable options that would enable SMEs to start exploring and experimenting with identified technologies. Through this SMEs can identify if a need to adopt robotics and automation exists.

### Ensure organizational readiness

Should the need to adopt exist, SMEs need to draft detailed implementation strategies. The strategies should identify robotics and automation technology options from the exploration and experimentation, the impact of adoption on their operations and skills required to adopt and utilize the desired technology. SMEs should also create educational and awareness campaigns. These could involve inviting expert guests, sending employees to conferences, enrolling employees for certifications etc. The goal should be ensuring that the SME has the culture and skills to implement the robotics and automation adoption.

### Find strategic and alternative ways to finance

In addition to seeking government grants and venture capital to address financing issues, SMEs should consider options such as incremental adoption, that is, building their final solution in smaller procurement and implementation stages. This would reduce the need for one lumpsum expenditure.

SMEs can also seek strategic partners that would share cost and ownership of the technology adopted. This means that each partner would own a certain percentage of the technology, utilizing it based on percentage owned. Lacking strategic partners, leasing the robotics and automation technology should also be considered. This option would eliminate the need for a large capital outlay.

Finally, the option of renting capacity is slowly gaining traction. SMEs should therefore identify other businesses that own the technology but may be underutilizing it such as only using it based on received orders, specific times of the day, or only when there is electrical power available. In this case SMEs can pay to use the technology during the times the owner is not utilizing it. In this way, the technology owner would benefit through sweating their asset for added profit whilst the SME could save money, paying only for the time they use it for.

## Suggestions for further research

### Case study on SMEs that have adopted robotics and automation

This study's aim was to identify ways of increasing competitiveness through the use of robotics and automation. The suggested study is aimed at studying SMEs that have adopted robotics alongside direct competitors that do not adopt and examining the long term impact of both decisions.

### Generating additional income from access capacity

A finding from this study suggests that a substantial number SMEs have not considered using owned technologies as means to supplement revenue. As this study was conducted during a pandemic with an increase in remote working, it is worth investigating how SMEs with resulting access capacity could have or can use the capacity to generate revenue whilst assisting other businesses to stay operational.

**The real implications of robotics and automation on employment.**

One of the recurring issues in this study was the impact of automation in relation to employment. Although the data suggests that there would be possible retrenchments resulting from adoption, there is no consensus on the severity and on whether SMEs ought to develop growth strategies aimed at retaining labour or in their interest of growth and sustainability. The suggested study would need to investigate impact on employment over extended periods and guide SME growth strategies in relation to automation.

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# Appendix A: Interview Schedule

### Proposed Interview Questions

1. How important is robotics and automation to a small to medium enterprise? Please provide an explanation and detail for your answer.
2. What factors do you think an SME should consider **before**, **during** and **after** adopting robotics and automation?
3. Are you currently integrating and implementing the use of robotics and automation in your organization? (Yes or No)
    a. If Yes, please explain how you are integrating and implementing the use of robotics and automation.
4. What have been your challenges in adopting or implementing robotics? (what do you think the challenges would be if you decided to adopt the use of robotics to automate).
5. How have you overcome the challenges? (What can a SME do to overcome such challenges?).
6. Do you think robotics and automation has had an influence on market performance of SMEs that have adopted the technology? (Yes or No)
    a. Please provide an explanation for the above selected answer.
7. How has the adoption of robotics and automation impacted your company's customer value proposition? (or what impact do you foresee if you decided to adopt the technology).
8. What do you foresee as the role of robotics and automation in SMEs in the near future?
9. How do think SMEs can prepare themselves for this future role of robotics and automation?

## Appendix B : Consent Form

*How SMEs in South Africa can implement robotics to increase competitiveness.*

**Consent to take part in research**

- I…… voluntarily agree to participate in this research study.
- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
- I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.
- I understand that participation involves discussing the implementation, challenges, strategies to overcome challenges, benefits, and potential of robotics adoption in SMEs.
- I understand that I will not benefit directly from participating in this research.
- I agree to my interview being audio-recorded.
- I understand that all information I provide for this study will be treated confidentially.
- I understand that in any report on the results of this research my identity will remain anonymous.
- This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.
- I understand that disguised extracts from my interview may be quoted in a MBA dissertation.

Participant Signature: _____

## Appendix C: Non-Disclosure Agreement

### Confidentiality and Non-Disclosure Agreement

Entered into between:

| | | |
|---|---|---|
| Name:_____ | | Name:_____ |
| Identity No._____ | | Identity No._____ |
| Address:_____ | AND | Address:_____ |
| Signature:_____ | | Signature:_____ |
| Place: _____ | | Place: _____ |
| Date: _____ | | Date: _____ |

CONFIDENTIALITY

1. This Confidentiality Agreement ("Agreement") is entered into on the date of last signature hereof ("Signature Date"), between the parties described on the cover page of this Agreement (the "Parties").
2. "Confidential Information" means the terms and conditions of this Agreement, and any other information disclosed by one Party to the other, including, but not limited to, information regarding each Party's products, services, product designs, prices and costs, trade secrets, know how, inventions, development plans, techniques, processes, programs, schematics, software, data, customer lists, financial information, sales and marketing plans, business opportunities, personnel data, research and development activities, pre-release products and any other information which the receiving Party ("Receiving Party") knows or reasonably ought to know is confidential, proprietary or trade secret information of the disclosing Party ("Disclosing Party"). The Receiving Party is obliged to treat all of the Confidential Information as confidential.
3. The Receiving Party shall keep all the Confidential Information strictly confidential, and may only disclose Confidential Information to its employees and contractors who (i) have a need to access such Confidential Information, and (ii) have been advised of the

obligations of confidentiality and are under obligations of confidentiality substantially similar to those set out in this Agreement.

4. The Receiving Party shall have no obligation to retain as confidential any information which (i) was legally in its possession or known to the Receiving Party without any obligation of confidentiality prior to receiving it from the Disclosing Party; (ii) is, or subsequently becomes, legally and publicly available without breach of this Agreement; or (iii) is legally obtained by the Receiving Party from a third Party source without any obligation of confidentiality.
5. The Receiving Party may disclose Confidential Information pursuant to a valid order issued by a court or government agency, provided that the Receiving Party provides the Disclosing Party notice of such obligation.
6. In the event that either Party terminates this Agreement, the Receiving Party shall: (i) cease using the Confidential Information, and (ii) destroy, unless specifically requested by the Disclosing Party to return such Confidential Information, and certify in writing such destruction of all Confidential Information including copies, notes or extracts thereof within seven business days of the date the Receiving Party receives the written notice of termination.
7. The obligations of each Party concerning confidentiality shall be perpetual. No Party/ies will be entitled to cede their rights or delegate their obligations in terms of this Agreement without the express prior written consent of the other Party/ies.
8. The Parties agree that they are independent contractors and have no other association.
9. The Parties choose as their address for service for all purposes under this Agreement, whether in respect of court process, notices or other documents or communications of whatsoever nature, the addresses described for such Party in the definition section, clause 1.
10. Each Party acknowledges that monetary remedies may be inadequate to protect Confidential Information and that a Disclosing Party may seek injunctive relief in the event of any threatened or actual breach of any of the obligations hereunder.
11. This Agreement is the whole, entire agreement of the Parties relating to its subject matter and may be modified only in writing and signed by both Parties; and it supersedes any other discussions or agreements in this regard.
12. Either Party may terminate this Agreement at any time and for any reason, without obligation to the other Party except as expressly provided in this Agreement.

13. If any term of this Agreement shall be held to be illegal or unenforceable by a court of competent jurisdiction, the remaining terms shall remain in full force and effect.
14. This Agreement and any matter arising therefrom shall be governed by and interpreted in accordance with the laws of South Africa. The parties hereby consent and submit to the non-exclusive jurisdiction of the High Court of South Africa (Western Cape Division) in respect of any litigation arising hereunder.
15. This Agreement may be executed in counterparts, each of which shall together constitute one and the same instrument.
16. To the extent permissible by law no Party shall be bound by any express or implied or tacit term, representation, warranty, promise or the like not recorded herein, whether it induced the contract and/or whether it was negligent or not.
17. Any provision in this Agreement which is or may become illegal, invalid or unenforceable shall be ineffective to the extent of such prohibition or unenforceability and shall be severed from the balance of this Agreement, without invalidating the remaining provisions of this Agreement.

No part of this Agreement shall constitute a stipulation in favour of any person who is not a party to the Agreement unless the provision in question expressly provides that it does constitute such a stipulation.

# Appendix D

*National Small Business Classification*

*Table 1: The new National Small Business Enterprise Act Thresholds*

| Sector or subsector in accordance with the standard Industrial Classification | Size of class of enterprise | The total full-time equivalent of paid employees | Total annual turnover |
|---|---|---|---|
| **Agriculture** | Medium | 51 - 250 | ≤R35m |
| | Small | 11 -50 | ≤R17m |
| | Micro | 0 -10 | ≤R7m |
| **Mining and Quarrying** | Medium | 51 - 250 | ≤R210m |
| | Small | 11 -50 | ≤R50m |
| | Micro | 0 -10 | ≤R15m |
| **Manufacturing** | Medium | 51 - 250 | ≤R170m |
| | Small | 11 -50 | ≤R50m |
| | Micro | 0 -10 | ≤R10 |
| **Electricity, Gas and Water** | Medium | 51 - 250 | ≤R180m |
| | Small | 11 -50 | ≤R60m |
| | Micro | 0 -10 | ≤R10m |
| **Construction** | Medium | 51 - 250 | ≤R170m |
| | Small | 11 -50 | ≤R75m |
| | Micro | 0 -10 | ≤R10m |
| **51 - 250≤R210m Retail and Motor Trade and Repair Services** | Medium | 51 - 250 | ≤R80m |
| | Small | 11 -50 | ≤R25m |
| | Micro | 0 -10 | ≤R7.5m |
| **≤R50mWholesale Trade, Commercial Agents and Allied Services** | Medium | 51 - 250 | ≤R220m |
| | Small | 11 -50 | ≤R80m |
| | Micro | 0 -10 | ≤R20m |
| **51 - 250≤R10Catering, Accommoda-tion and o/Trade** | Medium | 51 - 250 | ≤R40m |
| | Small | 11 -50 | ≤R15m |
| | Micro | 0 -10 | ≤R5m |
| **51 - 250Transport, Storage and communications** | Medium | 51 - 250 | ≤R140m |
| | Small | 11 -50 | ≤R45m |
| | Micro | 0 -10 | ≤R7.5m |
| **Finance and Business Services** | Medium | 51 - 250 | ≤R85m |
| | Small | 11 -50 | ≤R35m |
| | Micro | 0 -10 | ≤R7.5m |
| **Community, Social and Personal Services** | Medium | 51 - 250 | ≤R70m |
| | Small | 11 -50 | ≤R22m |
| | Micro | 0 -10 | ≤R5m |