Harnessing Fourth Industrial Revolution technologies for sustainable development in the South Durban Basin

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Abstract

The Fourth Industrial Revolution (4IR) heralds a transformative era characterised by the integration of advanced technologies, such as artificial intelligence, the Internet of Things, and big data analytics, into various sectors. This study explores the potential of 4IR technologies to foster sustainable development within the South Durban Basin, an area grappling with socio-economic and environmental challenges. By employing a mixed-methods approach, we examine 80 companies based in this region to assess how these technologies can support a societal transition towards sustainability. The research methodology combines quantitative surveys with qualitative interviews, providing a comprehensive analysis of the adoption and impact of 4IR technologies on local businesses. Quantitative data from structured questionnaires offer insights into the extent of technology integration, while in-depth interviews with business leaders and stakeholders provide contextual understanding of the challenges and opportunities faced in this transition. Preliminary findings indicate that while many companies have begun to adopt 4IR technologies, the extent and effectiveness of these adoptions vary significantly. Key barriers include limited financial resources, a lack of technical expertise, and insufficient infrastructure. Despite these challenges, several businesses

have demonstrated innovative approaches to integrating 4IR solutions, leading to improved operational efficiencies and reduced environmental footprints. Moreover, these technologies have facilitated new business models and enhanced community engagement, contributing to broader societal benefits. The study underscores the importance of supportive policies and collaborative frameworks to maximise the potential of 4IR technologies in driving sustainable development. Recommendations include targeted government incentives, investment in digital infrastructure, and capacity-building initiatives to equip the local workforce with necessary skills. Additionally, fostering partnerships between the private sector, government, and academia can catalyse further innovation and scale successful models. This research contributes to the growing body of literature on the intersection of technology and sustainability, offering practical insights for policymakers, business leaders, and other stakeholders aiming to navigate the complexities of the 4IR era. By highlighting the experiences of the South Durban Basin, this case study provides valuable lessons applicable to other regions undergoing similar societal transitions.

Keywords: Fourth Industrial Revolution, sustainable development, innovation, societal transition, technology adoption

introduction

According to Scherer (2022) the world has undergone three significant industrial revolutions over the last 250 years, each of which brought about profound socio-economic changes. The Fourth Industrial Revolution (4IR) is no exception to the earlier revolutions and is characterised by the integration of smart, interconnected systems encompassing cyber, physical, and biological domains, along with innovative business models that are reshaping our social, economic, and political landscapes. The focus of this study is on evaluating the ability of companies in the South Durban Basin to harness the potential of the 4IR. The 4IR has brought disruptive technologies, trends, and robotics that have disrupted the way people live and work. In his 2019 State of the Nation address the President of the Republic of South Africa, His Excellency Mr Matamela Cyril Ramaphosa, emphasised the need for South Africa to position itself as a critical contributor to the development of the 4IR. This research aims to unpack the competitive advantage and its measurement within this context by examining the impact of 4IR on the labour market, particularly the displacement of lower-skilled workers and the adequacy

of South Africa's current skill set to meet the demands of 4IR. The study looks at how the challenges of the 4IR were overcome by the companies in the South Durban Basin to achieve a competitive advantage.

Background

Peters (2019) believes that due to the scale, scope and complexity of this revolution there will be an increasing ambiguity, volatility, chaos, disruptive innovation and uncertainty in its nature and form. Naude (2017) further argues that there is a geographical advantage for South Africa to capitalise on the benefits of the 4IR. With the World Economic Forum (2016) and Peters (2019) looking at the 4IR from a global perspective, Naude (2017) looks at the 4IR from the South African perspective. South Africa is diverse and a narrower observation of the 4IR is necessary, hence the study on the South Durban Basin area in Durban. The dynamics of the 4IR call for a thorough investigation of the concept to prepare the industry role players such as labour and business to be better equipped to deal with what is to come.

The research problem

The advent of the 4IR poses unique challenges to competitive advantage, particularly in the South Durban Basin area. Unlike previous industrial revolutions, 4IR technologies are more likely to replace lower-skilled workers while complementing higher-skilled workers. This shift brings into question whether economies, including South Africa's, have the requisite skills to participate effectively in economic activities within the 4IR context. The imminent closure of the South African Petroleum Refineries (SAPREF) operations, as reported by *Business Day* (2022), following the earlier shutdown of the Engen refinery in December 2020, led to significant job losses, directly impacting the economy of the South Durban Basin. The reduced economic activities, job losses, closure of some of the businesses, and the shift in global business trends away from low-cost labour advantages pose a threat to the economy of the South Durban Basin. Addressing these issues is crucial for developing strategies to enhance competitive advantage in the area amidst the transformative pressures of the 4IR.

Literature review

According to Olaitan, Issah and Wayi (2021) the term ‘industrial revolution’ generally describes a period where technological transformations culminate in dramatic and tremendous changes in a socio-economic situation of people and countries. Gleason (2018) traces the terminology of the industrial revolution back to Arnold Toynbee's work in 1884, specifically his Lectures on the Industrial Revolution. Toynbee's insights provided a framework for understanding the sweeping changes that occurred during this epoch, laying the groundwork for subsequent scholarly analysis and debate. Building upon Toynbee's foundation, Levin (2018) expands the discourse by delineating three distinct industrial revolutions that have shaped the global economy. This conceptualisation has gained widespread acceptance, finding resonance in forums such as the World Economic Forum. Levin (2018) outlines a chronological progression, identifying key technological breakthroughs and their socio-economic ramifications. The First Industrial Revolution, spanning the period from approximately 1760 to 1840, was characterised by the harnessing of steam power and the mechanisation of textile manufacturing.

This era witnessed the emergence of factories and the mechanisation of labour, fundamentally altering the economic landscape and social fabric of society. The Second Industrial Revolution, occurring from the late 19th century to the early 20th century, introduced electricity, mass production techniques, and the division of labour. Innovations such as the assembly line revolutionised manufacturing processes, leading to unprecedented levels of productivity and economic growth. The Third Industrial Revolution unfolded during the early 1970s with the advent of electronics, information technology, and automated production. This era witnessed the proliferation of computers, telecommunications networks, and robotics, reshaping industries and labour markets on a global scale. These revolutions are not isolated events but interconnected stages in a broader narrative of human progress and transformation.

Xing and Marwala (2017) highlight the converging nature of the 4IR, where advancements in technology blur the traditional boundaries between disciplines such as humanities, social sciences, and STEM (Science, Technology, Engineering, and Mathematics). This interdisciplinary convergence necessitates a holistic approach to governance and policy formulation that transcends ordinary thinking and embraces cross-disciplinary collaboration. In the context of the South Durban Basin, the convergence of big data and the 4IR presents a transformative opportunity to address environmental and social challenges, leveraging advanced technologies to optimise industrial processes, enhance sustainability initiatives, and foster inclusive economic development. Padayachee and Mukomana (2021) argue that Durban

is the economic hub of South Africa because of its geographical location, but if the industries do not take the opportunities brought by the 4IR, the potential of the area will remain untapped. Bond (2019) affirms that the South Durban Basin is a melting pot of heavy industries that contributes 8% of the country's GDP and is one of the most highly industrialised areas in South Africa. Mpati (2022) identified the region as South Africa's second-largest economic centre after Johannesburg and the second most significant industrial region.

Despite all the positives, Mamokhere (2019), cautions that in South Africa a considerable proportion of the population lacks access to basic services such as electricity, water, healthcare, and education. This lack of access not only hampers individuals' ability to fully participate in and benefit from the digital economy but also widens the gap between the technologically empowered and the technologically marginalised. Thus, any meaningful implementation of the 4IR in South Africa must prioritise addressing these foundational issues of access and inequality. Moreover, beyond access to basic services there are broader socio-economic challenges that need to be navigated. For instance, there is a pressing need to address unemployment, particularly among the youth, who are expected to bear the brunt of technological disruptions in the job market. Additionally, there are concerns about the potential loss of traditional jobs as automation and artificial intelligence become more prevalent. Kupe (2019) argues that higher education institutions worldwide have a responsibility to contribute to the progress and development of their societies. This assertion aligns with the broader societal role often attributed to universities, which goes beyond imparting knowledge to fostering innovation, critical thinking, and societal engagement. The World Economic Forum (2018) suggests that the skills required for success in this era are dynamic and constantly evolving, driven by technological innovations such as artificial intelligence, robotics, and automation. Therefore, educational curricula must be designed to equip students with the skills necessary to thrive in an increasingly digitised and interconnected world.

Higher education plays a very important role in preparing the workforce for the challenges and opportunities of the new era of the 4IR. Gleason (2018) suggests that the impact of the emerging 4IR technologies in economic and environmental terms alone will require a drastic reconsideration of the curriculum within higher education, which will enable students to understand individual technologies in detail and to thoughtfully analyse and predict the evolution of networked systems of technology, the environment, and socio-political systems. Consequently, Gastrow (2018) suggests that skills and work are central to the global and national responses to the 4IR.

The literature has provided a comprehensive examination of the impact of the 4IR on South Africa's economic landscape, emphasising both the potential economic boosts and the cautionary aspects, such as the risk of rising unemployment. Several research gaps have emerged that necessitate further exploration to ensure a deeper understanding and effective implementation of the 4IR in South Africa, particularly in the South Durban Basin. Firstly, while there is a consensus on the need for higher education institutions and both the public and private sector to embrace 4IR and develop relevant skills, there is limited empirical research on the effectiveness of current educational programmes in meeting this need. Future studies should investigate how well these programmes are preparing the workforce for the challenges and opportunities presented by the 4IR, and whether there are gaps in skills development that need to be addressed. Additionally, there is a notable contradiction in the literature regarding the current use of the 4IR technologies in the South Durban Basin. Some studies suggest that the area has not fully utilised these technologies, while others imply that there is some level of adoption. This inconsistency points to a gap in the empirical data, necessitating further investigation to clarify the extent of the 4IR integration in the region and its impact on local industries. The recent socio-economic challenges faced by the South Durban Basin, such as the April 2022 floods and the July 2021 unrest, have also not been sufficiently addressed in the context of the 4IR. Research is needed to explore how these events have influenced the region's capacity to adopt and benefit from 4IR technologies. This includes assessing the role of strategic investment and planning in rebuilding and enhancing the region's competitiveness post-crisis.

In conclusion, while the existing literature has laid a strong foundation for understanding the potential of the 4IR in South Africa, there are significant gaps that require further research. These gaps include the effectiveness of educational programmes in equipping the workforce with 4IR-relevant skills, the specific application of the 4IR technologies in the South Durban Basin, and the region's resilience and adaptability in the face of recent socio-economic challenges. Addressing these gaps will provide a more complete understanding of the 4IR landscape in South Africa and guide the development of targeted strategies to maximise its benefits. The insights derived from the literature review underscore the evolving dynamics of technology and leadership in shaping organisational outcomes. Building on these findings, the following theoretical framework integrates key elements of technology theory and leadership theory to explore their interrelated impacts on organisational performance and competitiveness in the context of the 4IR.

Theoretical framework

This section explores the theoretical framework that guides our analysis of the 4IR, focusing on two essential theories: leadership theory and technology theory. Technology theory clarifies how new technologies spur innovation and restructure sectors, providing insights into the transformational potential of these innovations. At the same time, leadership theory offers a prism through which we may look at the behaviours, roles, and approaches used by leaders to get by in this intricately changing world. When combined, these theories provide a thorough understanding of how, in the 4IR era, leadership and technology interact to impact organisational outcomes. This paper also examines a number of characteristics related to each theoretical framework in an effort to grasp the intricate relationship between them and the 4IR.

Technology theory

Lai (2017) asserts that as technology advances, established business models face risks and new chances for innovative service offerings. As a result, top companies are able to influence the development of technological applications to their benefit. This idea informs the theories of planned behaviour, task-fit technology, innovation dissemination, consumer adoption of contemporary technologies, and technological acceptance. These are a few of the pillars on which technology theory is understood and discussed. According to Nyagadza, Pashapa, Chare, Mazuruse, and Hove, (2022), fostering a technological innovation appetite across a range of emerging economies' industries is intended to tackle, adapt to, and maneuver through the digital disruptions and complexities brought about by the new global order or, as most refer to it, the new normal. They firmly believe that the dynamics flowing from the 4IR to the industrial innovation of emerging economies are as old as human settlement. Benassi, Grinza, Rentocchini and Rondi (2022), in contrast, claim that there has been a sharp rise in the advancement of scientific and technological understanding on 4IR-related technologies in recent years.

The degree to which digital production technologies impact capital investment efficiency, both with regard to fixed and working capital, is another important factor driving its adoption. Similar to this, Lai (2017) highlights the personal influence on increased efficacy, efficiency, and/or quality, implying that task and technology must be well matched. A task-technology fit,

as defined by Spies, Grobbelaar and Botha (2020), quantifies how well developing technologies match the demands of the work. For businesses that operate in underdeveloped nations, where financial constraints can pose a significant barrier to technical advancement, this is an especially important issue.

The 4IR technologies guarantee customer satisfaction with strong, adaptable, and quick prototyping features like 3D printing, computer-aided design, and flexible machining capabilities. They also enhance new product development design thinking, customer feedback, and market research. Kim (2020) draws the conclusion that as a result of this view, automation has increased significantly and will continue to do so in the upcoming years, necessitating that businesses adapt to the rapidly advancing technology of the 21st century. According to Andreoni and Anzolin (2019) digital production technologies are the outcome of connecting hardware, software, and other components into an integrated production system. In this system, technology is successfully linked with organisational culture, structure, strategy, human resources, and leadership. This technical and organisational integration frequently necessitates the retrofitting of already-existing production facilities. An integrated strategy that takes these factors into account and is well designed can boost organisational performance.

Leadership theory

A key lens through which to view the dynamics of the 4IR in the context of information systems (IS) scholarly debate is leadership theory. The focus of leadership theory is on the part of leaders in establishing a strategic vision and promoting organisational change. A leader's position in the 4IR is crucial in helping to anticipate the future, drive innovation, and facilitate digital transformation. The 4IR is defined by rapid technology breakthroughs like blockchain, big data, the Internet of Things, and artificial intelligence. A thorough framework for comprehending and directing the integration of 4IR technologies into organisations is provided by leadership theory. Leadership theory places the study of the 4IR firmly within the IS scholarly discourse by emphasising strategic vision, change management, ethical considerations, and interdisciplinary collaboration. This highlights the crucial role of leaders in navigating and realising the potential of these transformative technologies.

According to Naidoo (2021), leadership is a highly dynamic and multifaceted phenomenon that can be described in a number of ways and explained by applying a wide range of theoretical frameworks. According to Cai (2023), leadership is a cooperative process in which the leader

inspires and favourably affects the followers to accomplish immediate goals that are consistent with the long-term vision. Shava (2021) goes on to explain that emotional intelligence, cognitive aptitude, communication prowess, and ethics are all incorporated into leadership. Given that the nature of leadership in the 4IR period would differ significantly from the conventional hierarchical structures that many organisations are used to, Gray (2016) contends that leadership must evolve and adapt to a new set of abilities in the 4IR. As a result, Uys and Webber-Youngman (2019) contend that in order to meet the challenges posed by 4IR, a new theory of leadership is needed. This theory should explain leadership in novel and quickly evolving contexts, strike a balance between the impact of leadership and work, establish a firm foundation of balance between individual leadership and prowess, and, lastly, clearly define the direction and goals of leadership as a compass for resilience while remaining adaptive and agile.

According to Deloitte (2019) this perspective indicates that the following four types of leaders will succeed in the 4IR: (a) the social supers, who are capable of both creating new revenue streams from socially useful products or services and prioritising efforts with a societal impact; (b) the data-driven decision-makers – executives who plan development using methodical, data-driven techniques and who are confident in their capacity to leverage the 4IR; (c) the disruptive technologies – the leaders who have previously made investments that have met or surpassed their targeted business outcomes and who exhibit a readiness to engage in disruptive technologies that upend their markets; and (d) the talent champions, who are executives who have consistently prepared their staff for the future before anyone else has. For them and their businesses to survive in the 4IR, Molapo and Khumalo (2018) contend that leaders must be able to adopt adaptive leadership philosophies like transformational leadership, which entails inspiring and encouraging followers to realise a common goal. They go on to say that the 4IR is making managers oversee staff members who are not based in the same physical office or location, leading to a significant change in practice that calls for managers to receive remote management training. Thus, in order to meet the demands of the 4IR effective leadership is essential. It must ensure that followers are committed to organisational objectives, influence employees to pursue organisational goals, manage challenges to pursue organisational goals, manage challenges and conflicts, deliver effective organisational performance, motivate followers, make significant changes in organisations, coordinate organisational growth, and cultivate positive attributes at work.

As a result, Alade and Windapo (2020) contend that in order for 4IR leadership to be effective, it must raise organisations' motivation and dedication to 4IR, foster an environment of open communication that allows for the exchange of information about 4IR developments, and assist in changing organisational structures and team dynamics. This suggests that companies that thrive in the 4IR era will ideally welcome change, create an ecosystem for innovation that benefits all parties involved, and understand the value of human capital. The organisational culture is greatly influenced by the leadership styles within the organisation. This in turn affects the organisation's performance, either directly or indirectly. To sum up, leaders must possess leadership intelligence, pertinent attributes, and adaptable leadership styles in order to endure the disruptive nature of the 4IR. This necessitates a readiness to pick up new skills, adjust to shifting market conditions, and innovate. Leaders may navigate the 4IR effectively and seize new opportunities by cultivating these attributes.

According to the theoretical framework mentioned above, South Africa is becoming less technologically capable, its economic competency is declining, and its readiness for digital technology is declining. According to the theoretical framework, businesses should assess if the technology they are using is appropriate for achieving their 4IR goals. This can only be accomplished if the organisation uses the right kind of leadership. These ideas, when integrated, provide a thorough framework for examining the connection between competitiveness and the 4IR. By putting these theories to use, we may gain an understanding of how the 4IR technologies affect competitiveness directly as well as the intricate interactions between decisions and diffusion processes that influence competitive outcomes in various industries. The research design and methodology that will be used to examine the hypotheses produced from our theoretical underpinnings are described in the next section.

Research design and methodology

This section carefully examines the basic framework and methodology used in the study. This crucial part, which outlines the methodologies used to answer the research questions or hypotheses as well as the project's structure and goal, acts as the project's blueprint. Research design, according to Dawadi, Shrestha, and Giri (2021), clarifies the overall strategy, whether it is qualitative, quantitative, or a combination of both, and helps the researcher choose the best techniques for gathering and analysing data. Methodology examines the particular strategies used to collect and analyse data, highlighting the dependability and validity of the results. This

provides a transparent view of the study's design, guarantees the rigour and credibility of the investigation, and illustrates the path that researchers take. The research paradigms, research design and methodology, study site, demographic and sampling strategies, research instruments, pre-testing, and validity, reliability, and trustworthiness concerns are all covered below. There is also discussion of data processing, interpretation, and gathering methods. A discussion of how ethical considerations were observed during the research process ends off the section.

Research paradigms

Held (2019) posits that a paradigm is a set of critical beliefs that are shared by researchers in a certain subject and that guide the content, methodology, and interpretation of that study. Furthermore, Kumatongo and Muzata (2021) propose that a paradigm can also be thought of as a collection of common ideologies on the interpretation of occurrences and the handling and resolution of possible issues. According to Kovacs, Kiss, Kassai, Pados, Kalo and Racz (2019) a research paradigm guides the researcher's worldview, research goals, research questions, research techniques, analysis and interpretation of the data, and study conclusions and suggestions. As a result, a paradigm directs and influences every step of the research process. Because it affects the research's outcome, selecting the appropriate paradigm for a study is regarded as the most significant and vital stage in the research process.

The four common research paradigms are positivism, interpretivism, emancipatory research, and pragmatism, according to Brown and Duenas (2019). Thus, the positivist and interpretivist paradigms serve as the foundation for the investigation. According to Heeks and Wall (2018) the axiological, ontological, and epistemological presumptions and beliefs are the fundamental components of a paradigm. In agreement, Brown and Duenas (2019) define axiology as the nature of truth, ontology as the nature of reality, and epistemology as the nature of knowledge. Epistemology, ontology, and axiology can be produced objectively, subjectively, or even by combining the ideas of both schools of thought, claim Brown and Duenas (2019). As a result, the meaning of these three phrases changes according to the selected study paradigm. Before beginning any research, a researcher should carefully consider the ontological, axiological, and epistemological suppositions of the work, according to Brown and Duenas (2019). Both quantitative and qualitative data were gathered for the study to fully meet the goals of using positivism and interpretivism.

Research design and approaches

Pardede (2015) argues that to accomplish the primary goal of a study, the research approach employed in the study needs to be directed by the goals and research questions. A research study's research design is a crucial component, according to Bloomfield and Fisher (2019). According to Bell, Bryman and Harley (2022) a research design encompasses the researcher's overall approach and plan for addressing research questions or testing research hypotheses, as well as the particular methods, procedures, tools, and techniques used for data collection, analysis, and interpretation. The quality and reliability of the research findings are determined by the research design and procedure, according to Busetto, Wick and Gumbinger (2020). For this reason, it is essential to carefully select and support the research design and method that best meet the goals and questions of the study.

The paper provides the actual study design as well as an explanation of the method or reasoning that informed the choices taken to arrive at the particular design. Ensuring that the study's objectives, paradigm, design, and purpose are all in alignment has been the goal of the research decisions. Both the document's structure and the order in which the research was conducted were determined by the study design. A research design, according to Blair, Coppock, and Humphreys (2019), is made up of the study's goals, objectives, paradigms, theoretical frameworks, data collection techniques, and data analysis techniques. The three categories of research methodology are mixed, qualitative, and quantitative, according to De Block and Vis (2019). Each of the three research philosophies, techniques, and procedures has special advantages of their own when it comes to studying phenomena.

Research method

Goundar (2012) defines research methods as a variety of techniques and scheme algorithms utilised in the research process. Andrew, Pederson, and McEvoy (2020) assert that the research method functions as the fundamental component of the investigation, offering a thorough synopsis of the tactics and techniques utilised to accomplish the research goals. Tracy (2019) goes on to say that the research method acts as a thorough manual for the methodical and exacting strategy used to look into the research problem. This means that ‘research methods’ refers to any strategy a researcher uses when conducting a study, including theoretical techniques, experimental investigations, numerical systems, and statistical approaches. The researcher used a mixed-methods approach, combining the paradigms of interpretivism and

positivism. Utilising quantitative data collection methods, the positivist approach was applied to examine the objective features of the research topic. The goal of this strategy was to offer both generalisable insights and empirical support. In addition, the researcher used an interpretivism technique, taking into account the contextual and subjective aspects of the investigated phenomenon. To improve the validity and reliability of the research findings, the study employed triangulation. According to Creswell and Plano Clark (2018) triangulation is a useful technique in mixed research because it strengthens the validity of study findings by confirming them using a variety of techniques and data sources.

Location of the study

South Africa's South Durban Basin in the KwaZulu-Natal region was chosen as a possible site for research on the 4IR because of a number of distinctive characteristics, such as a highly industrialised economy, a strong emphasis on sustainable development, and a diversified population. The study examined the possible effects of the 4IR on the South Durban Basin and the economic ramifications for South Africa. An overview of the 4IR and its possible effects on the manufacturing, hospitality, chemical, and healthcare sectors of the South African economy was given by the study. The study looked at the obstacles that could come from the adoption of contemporary technologies as well as the possibility for the 4IR to support regional economic growth and development in a sustainable manner. All things considered, the analysis of the 4IR in the South Durban Basin provided insightful information on the possible advantages and difficulties of implementing new digital technologies in a setting that is fast changing on both an economic and social level.

Target population

This study of the 4IR in the South Durban Basin focused on the people who live or work in the region, which includes the southern region of Durban, South Africa. Workers, citizens, businesses, and organisations are among the many stakeholders that make up this population. They are all impacted by the ongoing technological breakthroughs and digital change that are linked to the 4IR. The researcher was able to learn more about how the 4IR can be used to promote sustainable development, improve livelihoods, and cater to the particular needs and ambitions of the South Durban Basin community by looking at this group. It was appropriate

for members of the company's management to reply to the survey due to its design and questions. Therefore, the respondents were members of the senior management of the companies that were selected based on their capacity to offer insights into their organisations' strategic orientation.

Sampling techniques

Probability sampling, according to Bryman, Bell and Hirschsohn (2021), is crucial because it allows researchers to extrapolate results from samples to the entire population. Additionally, according to Maree (2017) the probability sampling methodology is an objective sampling strategy in which each component of the target population has an equal chance of being chosen to be included in the sample. According to Rahi (2017) there are four types of probability sampling: cluster sampling, stratified random sampling, basic random sampling, and systematic random sampling. The best sampling technique for the study was determined to be systematic random sampling because, in addition to the other advantages already mentioned, the researcher believed that it saves time and effort when compared to simple random sampling, in which each element is chosen independently.

Sample size

Considering that the research is using a mixed method, there were two samples for the qualitative and the quantitative method. For the quantitative study the researcher took a sample size of 160 from a population of 320 companies, and used a formula to calculate the sampling intervals: sampling interval (k) = N / n sampling interval. Therefore, in the case of the South Durban Basin, the sampling interval (k) = 320 / 160 and the sampling interval (k) = 2. After having identified the sampling interval the researcher selected every 2nd (k) company from the population of 320 companies to arrive at the desired sample size of 160. The sample for the qualitative study is a total of 40 medium-sized companies based in the South Durban Basin area. For calculating the qualitative sample, the researcher took a sample size of 40 from a population of 320 companies for qualitative respondents and used the same formula to calculate the sampling intervals. Therefore, in the case of the South Durban Basin the sampling interval (k) = 320 / 40 and the sampling interval (k) = 8. After having identified the sampling interval

the researcher selected every 8th (k) company from the population of 320 companies to arrive at the desired sample size of 40.

Data collection strategies

According to Saunders, Lewis and Thornhill (2019), to obtain a thorough grasp of the topic a comprehensive research study must utilise both qualitative and quantitative data collection methodologies. To gather quantitative data and provide quantifiable, broadly applicable results, structured approaches including experiments, surveys, and statistical analysis were used. The researcher chose to include only closed-ended items in the survey to collect quantitative data. This strategy guaranteed uniformity among participants and assisted in standardising data collecting. In contrast, focus groups, and observations are methods used in qualitative data collection that capture the richness and depth of participants' viewpoints and experiences. By combining these strategies the researcher strengthened the context of the data, addressed the study questions from several perspectives, and corroborated findings, all of which help to come to more comprehensive and nuanced conclusions. With a predetermined list of open-ended questions, the researcher conducted semi-structured interviews to collect qualitative data. This maintained a balance between structure and flexibility, encouraging the exchange of creative ideas while guaranteeing that all participants addressed the main points.

Ethical considerations

The participants' dignity and self-respect were preserved, the research endeavour did not cause harm to the participants, and the researcher upheld the fairness principle. No discrimination occurred before, during, or after the study. The right of the respondents to discontinue participation in the study at any time without facing any negative repercussions was guaranteed. The researcher made certain that the participants were informed of the aim of the investigation and that they verified their comprehension of it. Each participant signed an informed consent form that was connected to the study, confirming that they had read it and understood it completely.

Findings

This pivotal section guides us through the intricate network of decisions and exchanges that encapsulate our research endeavour. We create the foundation for a comprehensive disclosure of findings by reviewing the initial objective that motivated this research with a laser-like focus at the outset. We examine the fundamental issues of our study and shed light on the many revelations made possible by utilising the enormous amount of meticulously gathered quantitative and qualitative data. As we navigate the places where our discoveries and existing knowledge coincide or diverge, the literature that has previously been published will serve as a guide through the maze of findings.

The results demonstrated the advantages of using 4IR technology, which included increased efficiency from the use of digital technology, more efficient supply chain management from better inventory control and tracking, increased customer engagement from the use of remote work arrangements, with all of the above providing businesses with a competitive edge by offering services that are customised to meet the needs of individual clients. The perspectives gathered from a wide range of research participants support the body of literature already in existence by emphasising the revolutionary potential of these technologies in numerous economic domains. The results show that greater customer interaction, streamlined supply chain management, increased effectiveness, and personalised services all highlight how important 4IR technologies are to promoting competitiveness. A number of respondents mentioned the importance of operational intelligence, which highlights its many advantages from lower costs to more flexibility, and how it has transformed the manufacturing sector.

It was discovered that the 4IR technologies were essential in improving the companies' respective competitive positions. The results showed a variety of methods for implementing 4IR. The study's overall findings showed that businesses in the South Durban Basin deliberately used 4IR technologies to obtain a competitive edge. Businesses used cutting-edge technologies like automation, blockchain, the Internet of Things, and artificial intelligence to improve operational efficiency, cut expenses, and produce cutting-edge goods and services. Gaining a competitive advantage also required strategic alliances and investments. The results taken as a whole show the variety of ways in which 4IR technologies have improved numerous facets of corporate operations and increased competitiveness in the South Durban Basin's industries.

Conclusions

Examining how much the South Durban Basin has made use of the 4IR's opportunities reveals that the region's reaction is characterised by a wide range of participation from its role players. The landscape shows different levels of 4IR technology integration, from advanced acceptance to cautious research. This study explores how these different strategies affect the region's competitiveness, providing insight into the variables influencing this complex dynamic.

According to the research, upskilling and ongoing training programmes were essential for ensuring that staff members could successfully traverse the rapidly changing technology landscape. Businesses which made the investment to upskill their staff said that the adoption of 4IR went more smoothly. Reflecting the dynamic nature of the 4IR ecosystem, the focus was placed on the significance of adaptation and openness to accepting new technologies and approaches. In the data-driven world of the 4IR, the ability to analyse data is also essential for making well-informed judgements.

The growing concern for security in technological breakthroughs is highlighted by the security concerns surrounding implementation of the 4IR technologies. These worries underscore the critical nature of cybersecurity expertise to protect sensitive data and systems in the digital era of the 4IR. To successfully navigate the revolutionary changes brought about by the 4IR, teams and organisations require strong leadership. This highlights the critical role that visionary leaders play in ensuring effective implementation. The significance of ethical issues in technology breakthroughs is emphasised by the fact that ethical and legal understanding is essential for navigating the ethical dilemmas and potential legal ramifications that may arise in the 4IR. The globalised nature of technology and industry is reflected in the 4IR landscape, which emphasises the growing significance of cultural sensitivity and the capacity to negotiate cultural differences.

Recommendations

For enterprises in the South Durban Basin to successfully traverse the difficulties and seize the opportunities brought about by the 4IR, the study's recommendations are essential. The recommendations that follow are given to businesses in the South Durban Basin based on the study's findings.

The first recommendation is that training programmes should concentrate on both technical skills relevant to the operation and maintenance of the 4IR technologies and soft skills like

adaptability, critical thinking, and problem solving, based on the identified technologies and workforce skill gaps. To effectively navigate the rapidly changing technology landscape, training packages that emphasise improving communication, teamwork, adaptability, and innovation are essential. Continual employee training is a proactive approach to empower workers and improve overall organisational resilience and competitiveness in the South Durban Basin, as well as a strategic step in line with the 4IR.

To improve the utilisation of 4IR technologies in the South Durban Basin, it is imperative that businesses collaborate with one another. The study acknowledges that pooling resources, sharing expertise, and working together can have advantages. Establishing industry forums, frequent gatherings, or online venues where businesses may exchange success stories, difficulties encountered, and lessons learnt are some examples of how to do this. Every business can gain from the community's combined knowledge when it adopts a collaborative strategy.

Another important recommendations is that businesses in the South Durban Basin should collaborate with IT companies and business leaders in order to stay up to date on 4IR developments. Companies in the South Durban Basin may be able to gain a competitive edge by working together with technology suppliers and business specialists. Businesses that establish partnerships can acquire access to state-of-the-art technologies, knowledge, and perspectives that may not be easily found within their own company.

The study's recommendations highlight how crucial it is to take calculated steps to fully utilise the 4IR technologies in the South Durban Basin. Businesses can successfully navigate the complexities of the 4IR landscape by investing in ongoing employee training, fostering a culture of innovation and collaboration, fostering collaboration among companies, forming partnerships with technology providers and industry experts, and developing and implementing strategic roadmaps. Adopting these suggestions can help businesses become more competitive and have sustainable growth, as well as support the region's overall socio-economic development. Adopting these suggestions will be crucial for companies starting this revolutionary journey to create a future where innovation, resilience, and prosperity flourish in the South Durban Basin.

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