

HARNESSING THE INTERNET OF THINGS: A REVIEW OF OPPORTUNITIES AND BARRIERS FOR SMES WITHIN EMERGING ECONOMIES

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ABSTRACT

The IoT has emerged as a powerful tool for Small and Medium-sized Enterprises (SMEs) to improve performance and productivity. However, many SMEs are hesitant to embrace this transformative technology. Existing research often overlooks the specific factors influencing IoT adoption by SMEs in developing economies. This study aims to bridge this gap by identifying key drivers and barriers affecting IoT adoption among SMEs through a comprehensive literature review. By analysing both the potential benefits and the challenges faced by SMEs, we hope to accelerate the adoption rate of IoT within developing economies. Additionally, the findings can serve as a strategic guideline for SMEs in Botswana, specifically promoting the national adoption of emerging technologies. Thus, by embracing IoT, Botswana's SMEs can become more competitive and contribute to achieving national development goals enshrined in Vision 2036 strategic master plan.

Keywords: Internet of Things, IoT, Small and Medium-sized Enterprises, SMEs, Disruptive technology, Emerging economies, Botswana.

INTRODUCTION

Recently, the world is undergoing a paradigm shift as everyday objects transform into interconnected devices, intertwining a vast network of intelligent technology (Sethi & Sarangi, 2017). This phenomenon, known as the Internet of Things (IoT), allows for remote monitoring, control, and trend analysis through a seamless integration of people, processes, and sensor-equipped devices (Rangasamy et al., 2023). Experts predict significant economic benefits from IoT. Gartner estimates it will transform businesses within a decade, boosting productivity, streamlining operations, and fostering innovation (Gartner, 2018). Cisco projects a staggering \$2.4 trillion contribution to the global economy by 2025 (Cisco, 2017). McKinsey's projects a broader range of \$3.9 trillion to \$11.1 trillion by 2025 highlights the potential impact, particularly in manufacturing and healthcare (McKinsey, 2021). The market reflects this growth, reaching \$157.9 billion in 2021, a 22% increase from the prior year

(Elgazzar et al., 2022). Frontier Economics even forecasts a 10% increase in US GDP over the next 30 years driven by IoT (Ali et al., 2022). This transformative potential has captured the attention of scholars worldwide (Kiel et al., 2017). In fact, experts warn of a looming competitive disadvantage for businesses that fail to embrace IoT within the next five years (Arnold & Voigt, 2019).

Small and Medium-Sized Enterprises (SMEs) are widely recognized as the cornerstone of national economies (Abisuga-Oyekunle et al., 2020). These enterprises are renowned for their role in fostering entrepreneurship and innovation (Vojtovič, 2016). Their contributions to global growth, job creation, and new business opportunities are undeniable (Makiwa & Steyn, 2020). Underscoring this perspective, the World Bank predicts a staggering influx of 600 million new jobs will be required by 2030 to accommodate the expanding global workforce, highlighting the critical role SMEs play in economic development (The World Bank, 2023). Accordingly, governments worldwide prioritize fostering SME growth due to their pronounced impact on poverty reduction, particularly in less developed regions (Abisuga-Oyekunle et al., 2020). In the broadest sense, SMEs serve as the engines of empowerment for individuals across the globe (Weihao & Narissara, 2017).

Recently, SMEs are recognising the transformative potential of IoT (Onu & Mbohwa, 2021). This disruptive technology acts as a catalyst, unlocking a plethora of valuable insights for SMEs by enhancing customer interactions and optimizing supply chains (Okafor, 2023). In addition, this trend is amplified by a convergence of multiple factors, including the decreasing cost of IoT technology, the proliferation of user-centric platforms, and the escalating need for data-driven decision-making processes (Parab et al., 2023). Essentially, SMEs possess an inherent advantage due to their size and agility, enabling them to experiment with innovative marketing strategies at a comparatively reduced level of risk (Parkin, 2020). In this regards, by harnessing the transformative power of IoT, SMEs can aspect to achieve significant gains in operational efficiency, exceptional customer satisfaction levels, and a fortified competitive advantage (Masood & Sonntag, 2020).

While IoT adoption offers a multitude of benefits, SMEs also face challenges during its integration. These challenges include substantial initial implementation costs, data security concerns, the need for skilled personnel, and interoperability issues (Parab et al., 2023). Furthermore, empirical research demonstrates a significant disparity in IoT adoption rates between large corporations and SMEs. For instance, research indicates that large corporations have adoption rates of approximately 20%, reaching as high as 80% in certain sectors. In contrast, SME adoption remains low, hovering around 10% (Get Connected Blog, 2020). This disparity is further confirmed by data from the European Union (EU), which reveals that large corporations are six times more likely to leverage data from smart devices compared to SMEs (World Economic Forum, 2019). Furthermore, a recent UK survey by Analysys Mason found that over half (51%) of SMEs were either unsure or unaware of IoT, with another 23% expressing no interest at all (IoTNOW, 2018). This staggering adoption rates by SMEs translates to missed opportunities for automation, personalized customer experiences, and overall operational improvements (Onu & Mbohwa, 2021). Consequently, lagging behind in IoT adoption renders SMEs increasingly vulnerable within the competitive landscape (Parab et al., 2023). Hence there is a need to furnish SMEs with the necessary support for integrating disruptive technologies like IoT, particularly within the context of the fourth industrial revolution (Abdulaziz, Mad Kaidi, et al., 2023). In this manner, SMEs can bolster their

competitiveness, enhance their agility, and ultimately prolong their business survival (Okafor, 2023).

This study analyses the existing literature on determinants influencing the adoption of IoT in SMEs. Moreover, it identifies the key opportunities and barriers specific to SMEs within emerging economies. Notably, prior research has often addressed these unique considerations with limited attention (Haddud et al., 2017; Ogonji et al., 2020). Accordingly, by undertaking a comprehensive analysis, this study aspires to serve as a catalyst for accelerating IoT adoption rates among SMEs in developing economies including Botswana. Furthermore, the insights gleaned from this investigation have the potential to inform the development of rigorous frameworks that can guide the evaluation and implementation of IoT within SMEs. This aligns perfectly with the objectives enshrined within Botswana's national Information and Communication Technology (ICT) policy, which aspires to leverage technology to cultivate a knowledge-based society (Majama & Magang, 2017).

The remainder of this paper is structured as follows. Section 2 explicates the research methodology employed for conducting the systematic literature analysis. Subsequently, Section 3 presents the findings of the study. In section 4 conclusions and the potential avenues for future research are discussed.

METHODOLOGY

Literature Review strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Al-Emran & Granić, 2021) was utilised to guide the literature review analysis to ensure transparency and minimize bias (Moher et al., 2009). Applying the PRISMA framework, the study purposefully selected titles and abstracts from scholarly, peer-reviewed journals and grey literature in the fields of Business Information Systems, Knowledge management, Information Systems, Information Technology, and Computer Science. This process involved several key stages, including; defining inclusion and exclusion criteria, identifying pertinent sources and digital databases, formulating search strategies, and performing classification analysis (Al-Emran & Granić, 2021).

Inclusion criteria

We searched for a wide variety of information sources relevant to our study. (a) This included the full-text original research articles, peer-reviewed journal publications, both open access and subscription-based, empirical studies, systematic reviews, meta-analyses, book chapters, government documents, company reports, industry white papers, government publications, conference proceedings, news articles, and thesis or dissertations. (b) To ensure the information was current, we focused on sources published between January 2013 and November 2023, although some earlier relevant studies were included with little consideration. (c) Importantly, all sources needed to be written in English (d) and specifically address the adoption of the IoT in SMEs, (e) or tailored to SMEs context.

Exclusion criteria

We excluded certain sources from our review based on the following criteria: (a) Sources that primarily focused on topics unrelated to IoT adoption by SMEs. (b) Studies that didn't address the specific needs and challenges faced by SMEs. (c) Any sources not published in English. (d) Studies published before 2013, with the exception of a few highly relevant earlier works.

Data sources and search strategy

To find relevant research, we conducted a thorough literature search across a wide range of digital databases (Emerald, Science Direct, Springer, MDPI, Scopus, Web of Science, IEEE Xplore, ProQuest, etc.) including the University of Botswana Library catalogue and even general search engines like Google Scholar and Google. We used a combination of keywords and Boolean operators to ensure we captured all the relevant studies. This approach follows best practices for developing search strategies (Vítor & Monteiro, 2016). We conducted the search on August 31, 2023, using the following specific search queries (See Table 1).

Table1. Search string summary adopted by the study

Topic	Search String (Peer-Reviewed Research)	Search String (Grey Literature)
1. Factors influencing IoT adoption in SMEs	a) ("IoT adoption" OR "IIoT adoption") AND ("SMEs") AND (factors OR influences OR barriers OR challenges OR obstacles OR drivers OR enablers OR benefits)	b) ("IoT adoption" OR "IIoT adoption") AND ("SMEs") AND (grey literature OR company reports OR white papers OR government publications OR conference proceedings OR theses OR dissertations)
2. Factors influencing IoT adoption in Botswana	c) ("IoT adoption" OR "IIoT adoption") AND ("SMEs") AND ("Botswana") AND (factors OR influences OR barriers OR challenges OR obstacles OR drivers OR enablers OR benefits)	d) Same as section b). but include "Botswana" in the search
3. SMEs and the world		e) ("SMEs" OR "small and medium-sized enterprises") AND (definition OR role OR contributions) f) ("Characteristics") AND ("SMEs") g) ("SMEs") AND (economic development OR entrepreneurship OR job creation)
4. SMEs in Botswana	i) ("Botswana") AND (ICT policy) AND ("SMEs")	h) Same as section e). but include "Botswana" in the search j) (Technology readiness OR e-readiness) AND ("SMEs") AND ("Botswana")

Source: author (2024)

Data sources and search strategy

This research identified 7,001 studies through a search strategy. Using Zotero citation management software and reviewer screening (title, keywords, abstracts), duplicates were removed and irrelevant studies excluded. Reviewers then assessed the remaining studies based on set criteria, finally selecting 45 studies for further analysis. Figure 1 depicts the flowchart of the PRISMA protocol followed by the study.

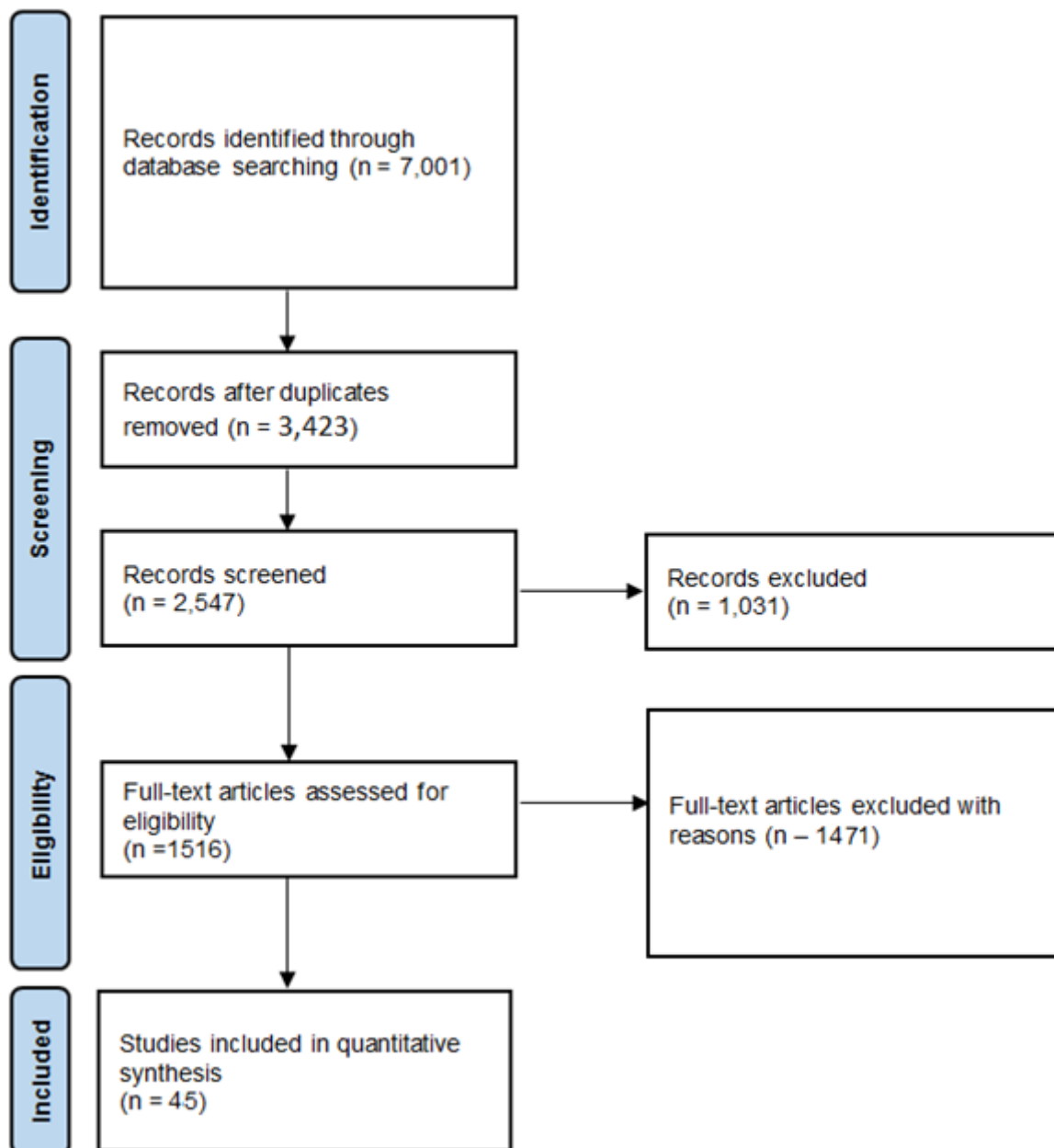


Fig.1 PRISMA flow chart for the study

RESULTS

Overview of Botswana Technology readiness

The World Economic Forum's Network Readiness Index (NRI), introduced in 2002, assesses countries' preparedness to leverage ICT for national development and competitiveness (S. Dutta & Lanvin, 2020). While Botswana ranks 9th in technology readiness within Sub-Saharan Africa (Letsholathebe, 2021), its overall NRI ranking of 108th out of 131 countries in 2022 suggests a need to bridge the gap with global counterparts (Portulans Institute, 2023). This highlights ongoing challenges of technological underdevelopment in Botswana, similar to other Sub-Saharan African nations (Uleanya, 2023). Uneven distribution, limited access, and low adoption of technological infrastructure across the country create hurdles for

economic growth, especially for SMEs. These limitations hinder their ability to foster innovation and compete effectively on a global scale (United Nation, 2021).

Botswana's national ICT policy aims to improve connectivity across various sectors, including education, healthcare, public services, and businesses (United Nations Botswana, 2016). This aligns with the country's National Development Plan (NDP11, 2017), which prioritizes reducing poverty and inequality through inclusive economic growth. To achieve these goals, the government has invested heavily in infrastructure projects like Nteletsa 2, national fiber optic initiatives, and expansion of the backbone network (NDP11, 2017). Additionally, Botswana has partnered with international submarine cable systems, East Africa Submarine Cable System (EASSy), West Africa Cable System (WACS), and private initiatives (SEACOM, Telecomm Sat 3) to strengthen its domestic and international connectivity (IST-Africa, 2023). This robust infrastructure ensures high-speed data transmission, fostering ICT literacy, streamlining processes, and ultimately enabling SMEs to play a more significant role in national development.

Definition of the SMEs

Pinning down a universally accepted definition for SMEs is tricky because factors like size, employees, and industry vary greatly across countries (Abdullah et al., 2018). Some definitions, like (Singh et al., 2019), consider location and technology alongside traditional employee and sales thresholds. Others, like Liberto (2020) focus solely on revenue, assets, or employee count. International organizations offer some guidelines: the World Bank defines SMEs as having under 100 employees (Ndiaye et al., 2018), while the OECD uses a limit of 250 (Lam & Liu, 2020). This lack of uniformity extends to Africa. In Ghana, an SME might have 100 employees and \$2 million in revenue (Gibson & Van der Vaart, 2008), while Nigeria caps it at 200 employees and excludes land from asset calculations (Ogbu & Ugwu, 2023). Definitions in Cameroon and Zimbabwe are even stricter, with employee counts below 5 and working capital under \$800,000, respectively (Mukete et al., 2021). South Africa offers a broader definition, including cooperatives and NGOs alongside smaller firms with employee and revenue limitations (Abdulkarim et al., 2022).

Botswana follows a similar employee and revenue structure. For instance, businesses with fewer than 100 employees are SMEs, further divided into micro (under 6 employees, P60,000 revenue) and small (under 25 employees, P60, 000-P1.5 million revenue). Medium-sized enterprises have 25-100 employees and P1.5-P5 million revenue (Nkwe, 2013). This highlights the challenge of defining SMEs consistently across the globe. Table 2 provides a comparison of Botswana's SME definition with those of other countries.

Table2. A comparative analysis between Botswana's SME definition and those of other countries

Economies	Upper limited number of employees	Turn over	Literature reference
Japan	300	300 million yen	(Tsuruta, 2020)
China (industrial sector)	2000	30 million Chinese Yuan	(Weihao & Narissara, 2017)
OECD	250	50 million Euros	(Jones & Lee, 2018)
EU	250	43 million Euros	(Gubinienė & Lileikiene, 2023)
UK	50	6.5 million Pounds	(Lampadarios & Kyriakidou, 2020)
USA	500	-	(Vives, 2022)
South Africa	200	50 million Rands	(Nhlumayo, 2017)
Nigeria	200	2 million Naira	(Ogbu & Ugwu, 2023)
Zimbabwe	100	800,000 dollars	(Tsarwe, 2014)
Ghana	100	2.3 million dollars	(Gibson & Van der Vaart, 2008)
Botswana	100	833,333,33 US dollars	(Nkwe, 2013)

Source: author (2024)

Characteristics of SMEs

While traditionally seen as smaller versions of large companies, SMEs have distinct characteristics and information system (IS) adoption patterns (Moeuf et al., 2018). They are more susceptible to external disruptions due to their smaller size (Etuk et al., 2014). Several key differences distinguish SMEs from larger businesses. These include the types of goods or services offered, market reach, customer service scope, and cost-cutting strategies (Makiwa & Steyn, 2020). SMEs can potentially possess advantages due to their structure. Flat organizational structures, agility, and responsive cultures can foster innovation (Parkin, 2020). However, a lack of technical expertise among employees and limited management experience in delegation can hinder these advantages (Álvarez Jaramillo & Zarthá Sossa, J. W. Orozco Mendoza, 2019). Stronger local ties compared to large corporations can benefit SMEs by fostering community relationships and reputation management (Adomako et al., 2021). However, this can also limit mobility and access to diverse markets. Additionally, securing funding for significant innovation initiatives is often challenging, leading to a focus on short-term gains (Mitake et al., 2021).

Limited market influence and financial resources make it difficult for SMEs to compete with established players and new entrants (Parab et al., 2023). However, their smaller size translates to faster decision-making due to streamlined communication and centralized decision structures (Parkin, 2020). This fosters a less formal and bureaucratic environment compared to larger enterprises, potentially leading to better communication and closer employee relationships (Lampadarios & Kyriakidou, 2020). However, reliance on informal information sources can make gathering relevant data for informed decision-making more challenging, especially for owner-managed SMEs with limited resources (Parab et al., 2023).

The role of the SMEs

SMEs are critical engines of economic growth. They account for a whopping 95% of businesses worldwide, driving job creation, innovation, and global expansion (Suttipun et al., 2020). This impact is particularly pronounced in developing economies, where SMEs can represent over 90% of businesses and significantly contribute to GDP (Van Scheers, 2016).

Studies across Africa demonstrate this, with SMEs employing a large portion of the workforce and fuelling national output (Ntiamoah et al., 2014). Beyond job creation, SMEs are innovation hubs. They're responsible for a substantial share of patents and new product development (Chen & Wang, 2021). In China alone, SMEs contribute a remarkable 60% of GDP and 68% of exports (Lam & Liu, 2020). With the World Bank estimating a need for 600 million new jobs by 2030 (The World Bank, 2023), fostering SME growth is a global priority. Their contribution to economic vitality and innovation makes them essential for a thriving future.

The economic clout of SMEs is undeniable. In developed countries like the US and UK, they comprise over 99% of the workforce and generate more than half of the GDP (Etuk et al., 2014). Their presence is similarly significant in Russia and China (Lam & Liu, 2020). SMEs are not only economic powerhouses but also vital for income distribution and stability. Their growth in Botswana, for example, is expected to accelerate economic growth and promote fairer income distribution (Majama & Magang, 2017). Their contribution to Botswana's GDP is over 35%, and they employ around 75% of the workforce (Nkwe, 2013). These figures solidify the crucial role SMEs play in driving prosperity worldwide.

IoT adoption benefits in SMEs

IoT is poised to revolutionize the service sector, boosting productivity and shaping the future internet (Onu & Mbohwa, 2021). Experts predict a surge in innovative business models for SMEs, leading to a sharper competitive edge and broader economic benefits (Okafor, 2023). Beyond efficiency gains, IoT promises exceptional customer experiences, improved facility management, and optimized resource use (Khan, 2023; Rejeb et al., 2020). This translates to sustainable growth for SMEs across various sectors, from healthcare (Hua, 2022)(Hua, 2022) to logistics (Rejeb et al., 2020). Cost-effective IoT applications empower SMEs with remote monitoring and control, boosting efficiency and resource conservation (Goodman, 2018; Masood & Sonntag, 2020).

SMEs can leverage IoT to gain a significant competitive edge. Smart technologies like "smart factories" can optimize operations, leading to cost savings and efficiency gains (Jung et al., 2021; Rejeb et al., 2020). These benefits extend beyond just profit, with potential to address environmental and social concerns (Saunila et al., 2019). IoT can also streamline processes, improve customer engagement, and leverage data for better decision-making, ultimately boosting productivity and global competitiveness (Parab et al., 2023; Sriram & Vinodh, 2021). Studies highlight additional advantages like better collaboration across departments and improved asset tracking (Madakam et al., 2015; Onu & Mbohwa, 2021). Table 3 provides an overview of key IoT adoption benefits in SMEs derived from survey literature.

Table3. Summary of IoT adoption Benefits in SMEs

Theme	Benefits	Literature reference
Operational Efficiency	<ul style="list-style-type: none"> ▪ Real-time production monitoring and optimization ▪ Predictive maintenance and reduced downtime ▪ Improved asset utilization and resource management ▪ Streamlined logistics and inventory management 	(Chege & Wang, 2020). (Goodman, 2018), (Rejeb et al., 2020), (Parab et al., 2023),
Internal Processes	<ul style="list-style-type: none"> ▪ 3D product simulations and optimized settings ▪ Increased resource utilization and waste reduction ▪ Data-driven decision making and improved outcomes 	(G. Dutta et al., 2020) , (Parab et al., 2023), (Madakam et al., 2015)
E-commerce	<ul style="list-style-type: none"> ▪ Enhanced supply chain visibility and tracking ▪ Personalized and responsive customer service ▪ Reduced operational costs and streamlined order management ▪ Improved product quality monitoring and customer trust 	(Goodman, 2018), (Khan, 2023), (Bandyopadhyay, 2011), (V. Sharma & Gandhi, 2021), (Gubbi et al., 2013)
Competitive Advantage (Market Reach and Expansion)	<ul style="list-style-type: none"> ▪ Increased adoption of e-commerce and online presence ▪ Increased customer reach and access to global markets ▪ Round-the-clock online product support and service 	(Gartner, 2017b), (Okafor, 2023), (Chege & Wang, 2020), (Parab et al., 2023), (Sriram & Vinodh, 2021),(Khan, 2023), (Gulumbe & Rahman, 2017)
Flexibility and Cost-Effectiveness	<ul style="list-style-type: none"> ▪ Agile adaptation to changing market demands ▪ Reduced operational costs and increased savings ▪ Enhanced efficiency and improved product quality 	(Hua, 2022), (Goodman, 2018), (Rejeb et al., 2020), (V. Sharma & Gandhi, 2021), (Okafor, 2023),
Sustainable Performance	<ul style="list-style-type: none"> ▪ Enhanced resource efficiency and waste reduction ▪ Proactive environmental monitoring and risk mitigation ▪ Data-driven infrastructure and utility planning ▪ Improved performance 	(Saunila et al., 2019), (Parab et al., 2023), (Madakam et al., 2015), (Ding et al., 2023),(Pandya & Kumar, 2022).
Customer Experience	<ul style="list-style-type: none"> ▪ Personalized and interactive customer engagement ▪ Improved customer satisfaction and loyalty ▪ Streamlined purchase journeys and order confirmation 	(Chege & Wang, 2020),(Gartner, 2017a), (Parab et al., 2023),(Rejeb et al., 2020), (V. Sharma & Gandhi, 2021).
Employee Empowerment	<ul style="list-style-type: none"> ▪ Increased workforce efficiency and productivity ▪ Increased employee collaboration ▪ Enhanced workplace safety and security ▪ Improved motivation, job satisfaction and understanding 	(Masood & Sonntag, 2020), (Madakam et al., 2015), (Onu & Mbohwa, 2021), (Pandya & Kumar, 2022).
Organisational and management benefits	<ul style="list-style-type: none"> ▪ Technology benefits: Flexibility, new HCI design, cost reduction, security protection, established definition of standards ▪ Organization benefits: Top management support ▪ Environment benefits: Market opportunities, government support 	(Philbin et al., 2022), (Rejeb et al., 2020), (Parab et al., 2023),

Source: author (2024)

IoT adoption barriers in SMEs

Despite the immense potential of IoT for SMEs, security concerns act as a major roadblock to widespread adoption. A 2017 Cisco survey revealed a troubling statistic: nearly 75% of IoT projects fail, likely due in part to security anxieties, especially for resource-limited SMEs (Parra & Guerrero, 2020; Reichert, 2017). Data privacy lies at the core of these anxieties. Researchers stress the need for careful data management throughout the entire IoT system,

encompassing devices, storage, communication channels, and processing systems (Haddud et al., 2017). Beyond privacy, a range of security threats loom over SMEs venturing into IoT. These include denial-of-service attacks, compromised equipment, and data alteration (Ogonji et al., 2020). Broadly, these threats fall into three categories: information gathering, service disruption, and data manipulation. Attacks can be passive (e.g., eavesdropping) or active (e.g., data manipulation or denial-of-service) (Chellappan & K. M. Sivalingam, 2016). However, SMEs face a unique challenge: a limited understanding of these complex security issues (Parker, 2020). This lack of knowledge leaves them vulnerable to a variety of attacks. Fortunately, solutions exist. By investing in employee training, robust security solutions, and awareness of social engineering tactics, SMEs can significantly improve their security posture and reduce the risk of breaches (Parker, 2020).

SMEs face a complex web of challenges integrating IoT. Internal obstacles include fragmented workflows and legacy systems (Ghobakhloo et al., 2022; Ogonji et al., 2020). Adapting business models and processes adds further complexity (Parab et al., 2023). The fragmented standards landscape makes selecting the right technology difficult, especially for resource-constrained SMEs with limited expertise (Blanchier et al., 2019; Mitake et al., 2021). This, coupled with the lack of standardized protocols, hinders data management and decision-making (Parab et al., 2023; Birkel & Hartmann, 2019). Beyond technical hurdles, costs, finding qualified vendors and unfavorable regulations all pose significant barriers (Ghobakhloo et al., 2022; Pappas et al., 2021; Stentoft et al., 2021). Table 4 provides a comprehensive summary of the IoT barriers in SMEs.

Table4. Summary of IoT adoption Barriers in SMEs

Theme	Barriers	Literature reference
Knowledge and Awareness	<ul style="list-style-type: none"> ▪ <u>Lack of awareness about IoT benefits</u>: SMEs not understanding the potential benefits and value proposition of IoT ▪ <u>Lack of clear comprehension of IoT standards and architecture</u>: Confusion about existing IoT standards and reference architectures ▪ <u>Lack of awareness about government policies supporting IoT adoption</u>: Many SMEs might be unaware of government programs, grants, or incentives specifically designed to aid IoT adoption in small businesses ▪ <u>Lack of knowledge management systems</u>: Inadequate systems for capturing, storing, and sharing IoT knowledge within the organization ▪ <u>Lack of knowledge and skills to interact with IoT</u>: Inadequate knowledge and relevant skills to manage IoT solutions 	(Birkel & Hartmann, 2019), (Abdulaziz, Kaidi, et al., 2023), (Wanasinghe et al., 2020), (Parab et al., 2023), (Stentoft et al., 2021), (Masood & Sonntag, 2020), (Hussein Magdy Elhousseiny & Crispim, 2021), (A. Sharma et al., 2021).
Financial and Resource constraints	<ul style="list-style-type: none"> ▪ <u>High implementation and maintenance costs</u>: Cost of hardware, software, installation, and ongoing maintenance of IoT ▪ <u>High cost of skilled workforce</u>: Recruitment and training costs for personnel with IoT expertise ▪ <u>Limited access to finance</u>: Difficulty in securing loans or investments for IoT projects 	(Mitake et al., 2021), (Blanchier et al., 2019), (Pappas et al., 2021), (Warrian & Southin, 2017), (Parab et al., 2023), (Stentoft et al., 2021), (Nimawat & Gidwani, 2021).
Technical and Technological Issues	<ul style="list-style-type: none"> ▪ <u>Compatibility issues</u>: Integration challenges with existing legacy systems and infrastructure ▪ <u>Complexity issues</u>: The complicated interaction of interconnected IoT devices, contributes significantly to the overall complexity of the technology adoption in SMEs. 	(Ogonji et al., 2020), (Parab et al., 2023), (Ghobakhloo et al., 2022), (Blanchier et al., 2019), (Parra &

Security and Privacy Concerns	<ul style="list-style-type: none"> ▪ <u>Interoperability issues</u>: Data exchange difficulties between different IoT devices and platforms ▪ <u>Lack of standards and regulations</u>: Absence of clear and unified standards for IoT implementation and data security ▪ <u>Limited internet coverage and IT facilities</u>: Lack of adequate infrastructure and connectivity to support IoT implementation ▪ <u>Risk of security breaches</u>: Vulnerability to cyberattacks and data breaches ▪ <u>Privacy issues</u>: Concerns about data collection, storage, and use, and potential violation of customer privacy ▪ <u>Unavailability of data security systems</u>: Lack of appropriate data security measures and infrastructure for IoT ▪ <u>Customers hesitant to share data</u>: Concerns from customers about data privacy and security when using IoT applications. 	(Guerrero, 2020), (Stentoft et al., 2021). (Varadharajan & Bansal, 2016), (Ogonji et al., 2020), (Chellappan & K. M. Sivalingam, 2016), (Parker, 2020).
Organizational and Operational Challenges	<ul style="list-style-type: none"> ▪ <u>Lack of internal digital culture and training</u>: Resistance to change and lack of employee readiness for digital transformation ▪ <u>Unstructured organizational processes</u>: Inefficient internal processes that hinder effective IoT implementation ▪ <u>Business growth barriers</u>: Uncertain business environment that hinder SMEs to adopt IoT ▪ <u>Low maturity levels for the preferred technology</u>: low technology maturity levels within SMEs presents a complex challenge, hindering their progress. 	(Parker, 2020),(Blanchier et al., 2019), (Warrian & Southin, 2017), (Raj & Prakash, 2022), (Raja et al., 2018).
Management and External Environment	<ul style="list-style-type: none"> ▪ <u>Limited top-level management buy-in</u>: Lack of support and commitment from leadership for IoT initiatives ▪ <u>Lack of strategic partnerships</u>: Limited collaboration with other IoT organizations for expertise and resource sharing ▪ <u>Unfavourable government policies and regulations</u>: Regulatory obstacles and bureaucratic hurdles to IoT adoption ▪ <u>Lack of government support</u>: Insufficient government initiatives to equip SMEs with crucial ICT infrastructure and funding opportunities. 	(Blanchier et al., 2019), , (Warrian & Southin, 2017), (Parab et al., 2023), (Stentoft et al., 2021), (H. M. Elhusseiny & Crispim, 2022), (Türkeş et al., 2019), (Weber, 2013).
Human and Workforce Factors	<ul style="list-style-type: none"> ▪ <u>Resistance to change</u>: Employee apprehension and unwillingness to adapt to new technologies ▪ <u>Lack of training for workers and managers</u>: Inadequate training provided to personnel on using and managing IoT systems ▪ <u>Generational gap in IoT adoption</u>: Differences in technology familiarity and comfort among different age groups 	(H. M. Elhusseiny & Crispim, 2022), (Gaspar et al., 2021), (Abdulaziz, Mad Kaidi, et al., 2023),(I. Ali & Aboelmaged, 2022), (Parab et al., 2023).
Vendor support	<ul style="list-style-type: none"> ▪ <u>Lack of technical support from vendors</u>: Insufficient support from IoT solution providers for installation, maintenance, and troubleshooting ▪ <u>Lack of consultants and trainers</u>: Limited availability of experts to guide and support SMEs in IoT implementation 	(Ghobakhloo et al., 2022), (H. M. Elhusseiny & Crispim, 2022), (Wanasinghe et al., 2020).

Source: author (2024)

CONCLUSIONS

The IoT holds great promise for SMEs. It has the potential to boost their competitiveness, drive innovation, increase profitability, and make their operations more agile (Ardito et al., 2019; Onu & Mbohwa, 2021; Parab et al., 2023; Rejeb et al., 2020). However, SMEs often hesitate to adopt IoT due to various challenges specific to their size and structure (H. M. Elhusseiny & Crispim, 2022; Ghobakhloo et al., 2022; Mitake et al., 2021; Parra & Guerrero, 2020; Türkeş et al., 2019). These challenges act as barriers to innovation. Research on IoT adoption in SMEs is fragmented and lacks definitive conclusions (Parab et al., 2023). This

highlights a critical gap – a need for a comprehensive study that examines all relevant factors and provides a clear understanding of how SMEs adopt IoT.

Botswana's national ICT policy and development plans prioritize improving connectivity and ICT infrastructure (MAITLAMO, 2019; NDP11, 2017). Hence, investments in projects like Ntelesta 2 and partnerships with international cable systems aim to bridge the gap (IST-Africa, 2023). This robust infrastructure could foster ICT literacy, streamline processes, and empower SMEs to contribute more to national development (NDP11, 2017). On the next hand, disruptive technologies like the IoT are assumed to transform the way people live and work in Botswana (BITRI, 2019). While research suggests that IoT can empower SMEs on a global scale (Manyika et al., 2015; Okafor, 2023), a gap exists in our understanding of whether this positive trend applies specifically to SMEs in Botswana. Therefore, there is a need for further investigation into the applicability of these findings in the Botswana context.

Despite global success stories, a staggering 75% of IoT projects fail due to a knowledge gap (Reichert, 2017). Beyond this, limited understanding of IoT benefits (Ahmad Tarmizi et al., 2020), security anxieties (Parra & Guerrero, 2020), financial constraints (Mitake et al., 2021), and a lack of trust (Haddud et al., 2017), pose challenges. However, the applicability of these challenges to Botswana's SMEs remains unclear. Further research is needed to assess their awareness of IoT and its potential. Thus, developing a practical guide or framework tailored to Botswana's SMEs context could be crucial. This would address their unique needs and challenges, empowering them to navigate the complexities of IoT adoption and achieve successful integration.

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