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Understanding IoT Adoption in Botswana's SMEs: A Research Onion Approach

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Abstract

The advent of the Internet of Things (IoT) presents a transformative opportunity for Small and Medium-sized Enterprises (SMEs), unlocking their potential for enhanced operational efficiency, productivity, and data-driven decision-making. However, harnessing these benefits necessitates a rigorous and structured methodological approach. On the next hand, selecting an appropriate research methodology can be problematic, as it demands consideration of context-specific factors. This study addresses a significant gap by theoretically evaluating and proposing a suitable "research onion" methodological approach, which can be employed to explain IoT adoption in Botswana's SMEs. This structured approach provides a comprehensive analytical lens comprising the research philosophies, research strategy, approaches, choices, time horizons, techniques and procedures. By carefully applying and justifying each element within the research onion's distinct layers, the study empowers Information Systems (IS) researchers to effectively explain their methodological decisions. Hence, findings will inform policymakers and decision-makers in Botswana, enabling them to design targeted interventions that promote widespread IoT adoption in SMEs. Future research will empirically test this framework in Botswana's SME sector using surveys, thus furthering our understanding of the IoT adoption factors in SMEs.

Keywords: Research Onion, Internet of Things, IoT Adoption, Small and Medium-sized Enterprises, Botswana

1. INTRODUCTION

An unprecedented era of networked devices known as the Internet of Things (IoT) has begun with the spread and development of disruptive technologies. This ground-breaking innovation, while reliant on technologies that have existed for some time, represents a significant development in history [1]. Paolone [2] denotes it as a vision where the internet seamlessly merges with the physical world, incorporating everyday objects. Moreover, Dlamini [3] understood it as the digital world where billions of devices will be empowered, fundamentally transforming how businesses deliver products and services. According to Wu et al. [4], the IoT

revolution boasts an unprecedented level of complexity, scalability, and scope. Nonetheless, while earlier technological constraints hindered machine-to-machine communication, advancements in mobile computing and the proliferation of smart factories have established the foundation for the development of these novel, integrated Information Systems (IS) [5]. Abd Shukor et al. [6] regarded IoT as a crucial driver of technological advancement and identified it as one of the nine fundamental technologies of the Industry 4.0 (4IR) platform. Consequently, its significance in digital business products and processes further validated its inclusion in "Gartner's 2017 Top 10 Strategic Technology Trends" [7].

Small and Medium-sized Enterprises (SMEs) are pivotal to economic growth in every nation [8]. There are typically defined by quantitative metrics like employee headcount, total capital, assets, and sales volume [9]. In mature economies, SMEs contribute over 90% of businesses, nearly 70% of jobs, and a staggering 55% of Gross Domestic Product (GDP). In less developed nations, SMEs are powerful, generating about 70% of employment opportunities and contributing up to 40% of GDP [10]. In Botswana, SMEs represent a remarkable 95% of all enterprises, driving over 35% of the national GDP and employing roughly 75% of the workforce [11]. Hence, given their prevalence and economic impact, understanding how to empower and foster the growth of SMEs is crucial for ensuring continued economic development [12].

The conception of the IoT disruptive technology, presents significant opportunities for SMEs. Hence, by adopting IoT, SMEs can gain a competitive advantage by positioning themselves as innovative and adaptable partners within supply chains for larger enterprises [13]. Moreover, strategically connected environments facilitated by IoT can enhance operational efficiency, drive process improvements, and foster collaboration with other stakeholders [14]. Likewise, the enormous volume of data produced by IoT systems can provide SMEs with valuable insights, potentially advancing their capabilities against the non-adopting competitors [15]. Nonetheless, there are hurdles associated with IoT adoption. For instance, a significant challenge is the absence of uniform standards for IoT devices and the inherent diversity of the IoT ecosystem [16]. This hinders the interoperability and manageability of IoT ecosystem, increasing complexity and maintenance costs [17]. Additionally, resource constraints, particularly for devices deployed in outdoor environments (e.g., water meters), often limit their computational power, making them more susceptible to cyberattacks [10].

Within Botswana's economic landscape, a significant barrier to progress is the limited adoption of disruptive technologies among SMEs [18], [19]. This concern is further reinforced by Letsholathebe [20] underscoring the potential risk of Botswana falling behind competitors without embracing advancements like IoT. Nevertheless, successful IoT integration necessitates a clearly defined

methodological approach [21]. On the next hand, selecting an appropriate research methodology can be difficult, as it necessitates consideration of context-specific factors [21]. Moreover, the vast array of methodologies and frameworks available in literature, each with its own strengths and limitations, further complicates the selection process [21].

The research onion framework offers a structured approach to understanding IoT adoption for Botswana's SMEs. Thus, by systematically examining layers such as research philosophy, strategies, choices, time horizons, and techniques, this framework enables a comprehensive analysis of the factors influencing IoT adoption [22]. This research aims to address a critical gap by proposing a suitable "research onion" methodology, which could be employed to explain IoT adoption in Botswana's SMEs. Thus, the study specifically addresses the following key objectives:

1) To theoretically assess the suitability of applying the research onion framework as a tool for understanding IoT adoption factors within Botswana SMEs.
2) To provide transparent guidance and rationale for selecting appropriate methodologies within each layer of the research onion framework explaining IoT adoption in Botswana SMEs.
3) To propose a research onion methodological approach that can be used to explain IoT adoption in Botswana's SMEs.

Through a rigorous application of the research onion framework, this study aims to make significant contributions to both research and policy. By carefully selecting and justifying elements within each layer, we aim to develop a comprehensive methodological guide for IS researchers investigating IoT adoption factors among Botswana SMEs. This structured approach will not only provide researchers with a reliable framework but also equip policymakers and decision-makers with valuable insights for designing effective interventions that promote IoT adoption among SMEs. Ultimately, this can drive economic growth and strengthen Botswana's competitive position in the global market.

2. METHODS

2.1. Literature Review

The IoT continues to be a focal point for research across various disciplines, driving the development and adoption of diverse methodologies and frameworks to guide its exploration [21]. One such framework, the "research onion" developed by Saunders [22], stands out for its comprehensiveness and applicability across multiple disciplines. This widely adopted framework offers a multi-layered approach, making it a versatile tool for research in various fields [23]. Several

studies have demonstrated the versatility of the research onion framework in exploring diverse IoT related contexts. Alturki [21] explored how this framework can be integrated with an IoT-enabled mobile applications to enhance understanding in this domain. Similarly, Alkhaldi [24] utilized the research to delve into what influences user behavior changes and net gains from technology integration in smart cities. Lindberg [25] employed the research onion framework to investigate support mechanisms for the sustainability and success of the European "IoT Rapid-Proto Labs" project.

In South Africa, Mokoka [26] utilised the research onion framework to explore stakeholder experiences with IoT innovation. The study was grounded in interpretivism research philosophy, and employed interviews for data collection. In another study, Rashed [27] adopted the research onion framework to investigate the potential impact of the IoT on modern supply chain management. A constructionist research philosophy was used in the investigation and a deductive approach to examine the effectiveness of IoT integration. Similarly, Suhas [28] utilized the research onion framework to explore the significance of IoT and its effective integration within Indian supply chain activities. The study adopted a post-positivist research philosophy, an inductive approach, an interview research strategy, and qualitative data analysis methods.

Scholars have demonstrated the adaptability of the research onion framework across diverse research designs. For instance, a Malaysian study, employed a pragmatic approach, abductive reasoning, and qualitative analysis to explore hospital staff's perspectives on IoT implementation [29]. Similarly, a South African study grounded in interpretivism utilised a deductive approach and the Technology-Organization-Environment (TOE) Framework to analyse qualitative interview data on potential IoT applications in retail businesses [3].

The research onion framework's versatility extends demonstrably to research within the SMEs context. For instance, studies have utilized the research onion framework to investigate the influence of Industry 4.0 (4IR) solutions, including the IoT, within manufacturing SMEs [30]. Their study adopted an interpretivist philosophy, incorporating both inductive and deductive approaches, and relied on qualitative research methods to generate a conceptual framework for 4IR integration in SMEs. Pham [31] employed the research onion framework to explore strategies for implementing IoT technology in organizations. The study utilised TOE theory, and a pragmatic research philosophy. Similarly, Kari and Kleinreesink [5] investigated IoT and cloud computing adoption within Swedish SMEs, employing a pragmatic research philosophy and a deductive approach.

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2.1.1. Literature Review Summary and Research Gaps

An analysis of the existing literature reveals that while the research onion framework enjoys widespread use in studies exploring IoT adoption in general, its application within the specific context of SMEs for understanding IoT adoption remains limited. Furthermore, to the greatest extent of the researcher's knowledge, no research was found that employed the research onion framework to investigate IoT adoption factors within Botswana's SMEs context. This study aims to bridge this research gap by adapting the research onion framework, to assess its suitability for investigating IoT adoption factors in Botswana SMEs. This structured approach will empower IS researchers in Botswana, to effectively explain their reasoning behind their choice of specific techniques within the research onion framework. Such reasoning, will inform policymakers and decision-makers in designing targeted interventions that promote widespread IoT adoption among SMEs in Botswana.

2.2. Research Framework

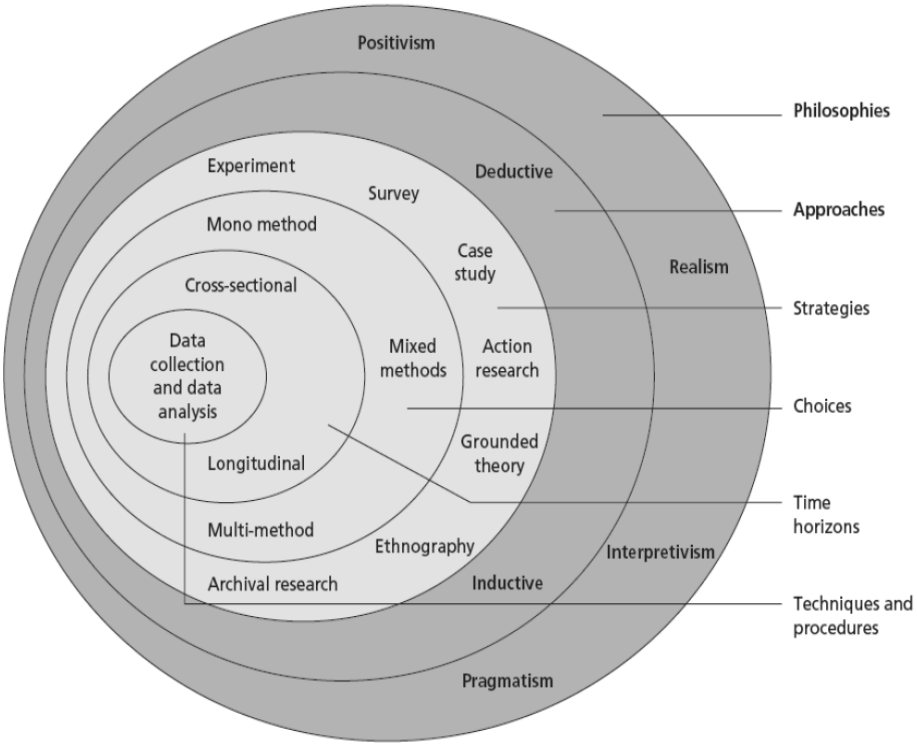

Figure 1. The research onion framework adopted by the study [22]

This study rigorously employs the research onion framework proposed by Saunders et al. [22] throughout its methodological design. By, adopting a carefully designed experiment, the study aims to assess the framework's suitability for investigating IoT adoption factors among SMEs in Botswana. The research onion framework provides a structured approach for researchers to justify their methodological choices, highlighting the strengths and limitations of each technique within the framework's distinct layers [23]. Essentially, Kothari [32] denotes research methodology as a systematic strategy for addressing research problems. Similarly, Schwardt [33] conceptualizes it as the underlying theory dictating how an inquiry unfolds, involving analysis of the underlying assumptions, principles, and procedures employed in a specific approach. The research onion framework adopted by the study is illustrated in Figure 1. This describes the spectrum of choices, paradigms, strategies, and various methodological stages that researchers encounter during the research process [22].

3. RESULTS AND DISCUSSION

This section details a step-by-step application of the research methodology used in this study. Throughout the study process, the research onion framework is used as a guide [22]. This framework allows us to effectively examine its suitability for investigating the factors influencing IoT adoption among SMEs in Botswana. Hence, we conduct a thorough exploration, analysing the rationale behind each element chosen within the six layers of the framework, namely; the research philosophies, approaches, strategies, choices, time horizon, and techniques and procedures. Through this analysis, we aim to enhance transparency and provide a deeper understanding of the methodological basis that will be employed to investigate IoT adoption factors within Botswana SMEs.

3.1. Adapting the Research Onion Framework for Understanding IoT Adoption by Botswana's SMEs

3.1.1. Layer 1: Research philosophy

The research onion's first and most ultimate layer is research philosophy. This refers to the underlying beliefs about knowledge development within a specific field [23]. It reflects the researcher's assumptions, perspectives, and understanding of the world [34]. Therefore, for the community that shares them, they serve as a set of presumptions, beliefs, values, and behaviors that make up a perspective on reality [35]. The research onion framework defines various research philosophies, which are supported by the principles of epistemology, ontology, and axiology [36]. Ontology describes the fundamental nature of reality and humanity, while epistemology defines the theory of knowledge acquisition and the axiology

describes the beliefs about the researcher's position regarding their "role of values in research"[37]. In other words, what researchers' value affects the way they conduct their research and also their value in research findings [38]. These three principles collectively define and shape how an inquiry is conducted [36], [38]. Within IS research, four primary epistemological paradigms aid as guiding frameworks; namely; positivism, interpretivism, pragmatism, and critical realism [22]. These research philosophies are discussed in the subsequent subsections 3.1.1.1 to 3.1.1.4.

3.1.1.1. Positivism

Positivism reflects the natural sciences, representing an objective research approach driven by the scientific method realism [22]. Its core values lie in value-neutrality, highlighting the researcher's independence from the data and the maintenance of an objective stance [39]. This philosophy seeks to uncover universal truth through the study of human behaviour, believing that all phenomena can be understood and proven through rigorous investigation and analysis [40]. According to Sahay [41] positivist research focuses on uncovering cause-and-effect relationships between constructs, emphasizing knowledge acquisition solely through observation and measurement. This research framework centered on standardized subjects, statistical analysis, typically associated with quantitative methods [23].

3.1.1.2. Realism

According to realism, there is an objective reality that exists apart from human perceptions and beliefs [22]. It highlights perceiving sensory experiences as reflections of genuine truth [23]. While it shares some foundational assumptions with positivism, realism presents a distinct perspective. For instance, while both philosophies advocate for a scientific approach to knowledge acquisition, realism acknowledges the need for subjective interpretation of observed phenomena [22]. Bryman and Bell [42] identify key tenets of realism; maintaining objective distance from the subject of study and employing similar data collection methods across social and scientific research. However, unlike positivism's strong emphasis on empirical evidence, realism places less weight on its predictive power in defining a theory's "truth" [43]. This nuance sets realism apart, acknowledging the complexity of human experience and interpretation within an objectively existing social reality [43].

3.1.1.3. Interpretivism

Interpretivism emerged as a critique of positivism in social sciences, emphasizing the interconnectedness between researcher and research subject [23]. It rejects the notion of an objective, singular truth, instead arguing that social constructs like instruments, language, shared meanings, and consciousness, are the only means by which the truth can be reached [44]. Interpretivist research aims to understand the participant's perspective within their environment, focusing on interpreting people's experiences and circumstances through the lens of their social lives. In contrast to positivism's emphasis on objectivity, interpretivism embraces the world's subjective nature and aligns with qualitative research methods [23].

3.1.1.4. Pragmatism

Pragmatist research is problem-driven, aiming to develop actionable solutions that inform future practice [45]. It prioritizes finding solutions over uncovering abstract truths about reality [46]. Pragmatists acknowledge the existence of diverse research methods and worldviews, rejecting the notion of a single, universal truth [23]. This philosophy allows for the flexible use of mixed methods, which combine quantitative and qualitative methodologies in a single study [46]. Essentially, pragmatism argue for researchers to navigate between objectivity and subjectivity, strategically adapting their approach based on the specific needs and demands of each unique research inquiry [23].

3.1.1.5. Justification for the chosen research philosophy

In this study, the positivist research philosophy is deemed appropriate for investigating the factors affecting IoT adoption among SMEs in Botswana. This is because; positivism aligns well with the quantitative research methods to be employed by the study such as self-administered survey questionnaires [39]. These methods aim to gather objective, quantifiable data to test hypotheses and establish relationships between variables [23]. Moreover, the positivism paradigm seeks to discover universal laws and principles that can be generalized beyond the specific context of the study [47]. This is particularly relevant to the study's aim of investigating the factors influencing IoT adoption in Botswana SMEs. This is because findings could potentially have broader implications for SMEs in other developing countries. This is crucial for ensuring the credibility and reliability of the research, particularly when making claims about the generalizability of the findings [47].

3.1.2. Layer 2: Approaches

Saunders et al. [22] classify the research approach as the second layer of their research onion framework. This can be categorized as either inductive or deductive. The inductive approach, also termed as the "bottom-up approach", starts with gathering data through observations and interviews [48]. Through analysing this data, patterns and themes emerge, helping to generate a new theory or explanation for the phenomenon under investigation [23]. Inductive studies often align well with qualitative data analysis, allowing for flexibility and deeper understanding in uncovering unforeseen aspects [49]. Figure 2 depicts the process of inductive reasoning.

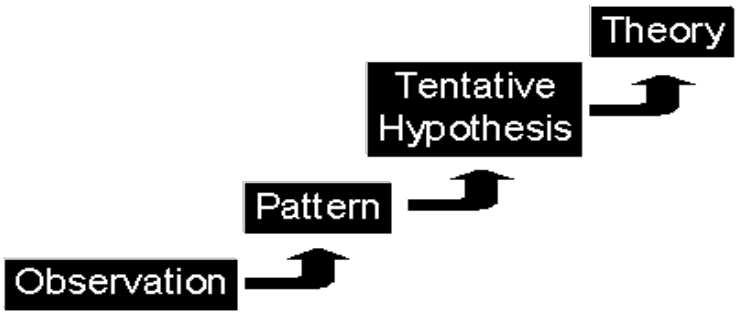

Figure 2. The inductive reasoning process [50]

The deductive approach, sometimes referred to as the "top-down approach" proceeds from the general to the specific [23]. This involves developing a theory based on existing literature and formulating hypotheses that will be tested with the data [51]. The deductive approach is frequently employed in confirmatory research when the researcher has a particular concept or hypothesis in mind [52]. In this sense, the deductive approach is often associated with positivist studies, and generally aligns with quantitative research methods [23]. Figure 3 illustrate the deductive reasoning process.

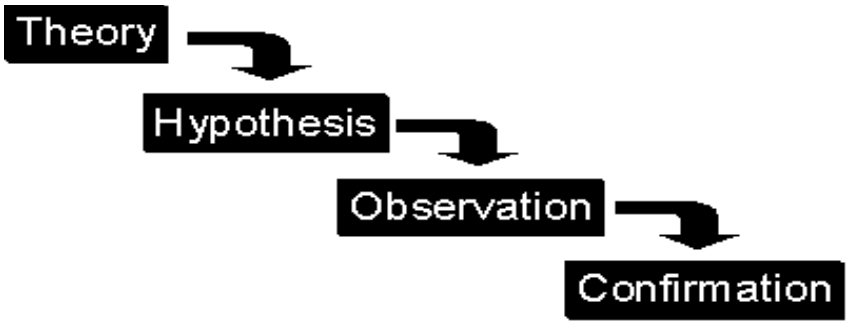

Figure 3. The deductive reasoning process [50]

3.1.2.1. Justification for the chosen research approach

Creswell and Creswell [53] argue that the positivist paradigm is reductionist in nature and employs deductive reasoning to solve problems. This approach is sometimes allied where evidence is collected and hypotheses are tested to verify a theory [54]. However, considering that the study aligns with a positivist approach, we opt to adopt a deductive research approach. This will begin by developing a theoretical framework and formulating testable hypotheses. Consequently, quantitative data will be collected in the field and analyzed statistically to evaluate the hypotheses. The rejected hypotheses will not be included in the final framework, while those supported will contribute to its validation.

3.1.3. Layer 3: Research strategies

The research onion framework positions research strategies as the crucial third layer, guiding researchers towards achieving their goals [22]. In Saunders's research onion framework, several research strategies can be employed to collect data. These include; experiments, surveys, case studies, action research, grounded theory, ethnography, and archival research [22]. The experimental research strategy is commonly used for both laboratory and field experiments [55]. Survey research involves collecting data about people's thoughts and behaviour using questionnaires or statistical surveys [56]. Case study research is primarily qualitative but can also incorporate quantitative methods for data collection and analysis [45]. Action research stands apart from other applied research approaches by its inherent focus on action and change [57]. Saunders et al. [22], describes action research as a strategy that actively seeks to instigate positive change while simultaneously gathering valuable data and insights. Creswell [46] provides an explanation of grounded theory as a research strategy that facilitates the explanation and prediction of behaviour or social phenomena. Likewise, ethnographic research focuses on investigating meaning rather than using a scientific approach to measure phenomena [22]. Lastly, the archival research involves studying historical and administrative documents of organizations as a source of data collection [45].

3.1.3.1. Justification for the chosen research strategy

The survey research strategy is deemed appropriate for this study for several reasons. For instance, surveys are an economical way to obtain data from a significant number of respondents, allowing researchers to quickly reach a geographically dispersed group of individuals [23]. Furthermore, surveys offer inherent flexibility, allowing for the systematic investigation of thoughts, preferences, and behaviour within a specific population [58]. This research strategy is aligned with a deductive approach [59]. In context of this study, the survey

approach enables the collection of a large quantity of data from numerous SMEs in Gaborone, Botswana. In addition, survey research strategy allows respondents to participate at their own convenience, respecting their time and preferences [60]. Correspondingly, anonymity is ensured throughout the survey process, encouraging honest and open responses [61]. This approach is especially valuable for our study because it might attract participants who would normally be reluctant to voice their opinions in public. Additionally, survey research is highly effective in data analysis due to its ability to subject the collected data to thorough statistical analysis. This allows for the generation of reliable interpretations and well-supported conclusions [62].

3.1.4. Layer 4: Methodological choice

The selection of research choice is a significant aspect of the research onion model, which determines the method used in a study [23]. Saunders et al. [22] suggest that research methods can be classified as a mono-method, mixed method, or multi-method approach. These methods serve as tools for researchers to gather data and address the research questions of their study [23]. A mono-method involves using a single data collection method and corresponding analysis [22]. In this sense, a researcher may exploit only quantitative methods or qualitative methods to collect and analyse data [22]. Many researchers acknowledge the limitations of solely quantitative or qualitative approaches [63]. Mixed methods research offers a compelling alternative by combining both quantitative and qualitative data collection methods within a single study [45]. This approach leverages the strengths of each method to provide a richer and more nuanced understanding of complex research problems [22]. Saunders et al. [22] differentiate between the multi-method and mixed-methods approaches, both of which employ diverse research approaches. According to Saunders et al. [22], the multi-method approach utilizes various methods within a single paradigm (quantitative or qualitative) to gain richer data. This could involve combining interviews and focus groups in a qualitative study to deepen understanding of participants' experiences [22]. On the next hand, the mixed-methods approach integrates both qualitative and quantitative methods throughout the research process [22].

3.1.4.1. Justification for the chosen methodological choice

This study adopts a mono-method, utilizing a quantitative approach, to address the primary research aim. This approach aligns with the established practice in IS adoption studies [64], [65]. This choice provides rigor and coherence in measuring and assessing internal consistency of the data [66], as well as assessing critical factors when analysing innovation adoption in SMEs [67]. In this study the researchers will employ online questionnaires with closed-ended questions to collect data from a broad sample of SMEs situated in Gaborone city in Botswana.

This approach aligns with a positivist research philosophy, aiming to generalize findings beyond the specific sample and make broader claims about the population [68]. The collected quantitative data will be subjected to statistical analysis to interpret the results and support these generalizations [62].

3.1.5. Layer 5: Time horizons

In research process, the "time horizon" explains the period in which data is collected [23]. This critical element, forming the fifth layer of the research onion framework, warrants thorough consideration [22]. Saunders et al. [45] suggest that researchers can primarily choose between two time horizons, namely longitudinal time frame and cross-sectional time frame. A cross-sectional study aims to capture a snapshot of a specific group at a single point in time [23]. In this paradigm, researchers select a topic, identify the target population, select a representative sample, and gather data from participants to answer their research questions [69], [70]. In contrast, longitudinal studies track the same participants or phenomena over extended periods, allowing for observations of change or development. These studies typically require multiple data collection points [23], [55].

3.1.5.1. Justification for the chosen time horizon

Time constraints might limit research scope, necessitating a cross-sectional design [23]. Cross-sectional studies are a popular choice in IS research, mainly due to their lower demands for time and resources [71], [72]. In this study, a cross-sectional approach is chosen because it aligns with the goal of understanding factors influencing IoT adoption in SMEs at a particular point in time. This is in contrast to longitudinal studies that require repeated data collection at multiple time points [23], cross-sectional studies gather information at a single moment. In addition, the efficiency and affordability of cross-sectional studies make them a compelling choice [73]. This advantage of a cross-sectional study is well-suited to the time constraints and budgetary limitations inherent in this study, thereby confirming the selection of a cross-sectional design as the most suitable approach.

3.1.6. Layer 6: Techniques and procedures

The sixth layer of the research onion model, aptly named "techniques and procedures", focuses on the chosen data collection and analysis [22]. Furthermore, it comprises decisions regarding the research site, targeted population, sample selection procedure, and its size. The following sub-sections will discuss techniques and procedures to be adopted in this study.

3.1.6.1. The study site

This study will focus on SMEs located South East District of Botswana in Gaborone City. Gaborone being the capital and largest city constitute a population of over 246,000 (approximately 10% of the national total) [74]. This offers a rich environment for understanding IoT adoption in SMEs. Moreover, Gaborone city was strategically chosen as the research site due to its high concentration of SMEs [75]. This dense network of businesses makes it an ideal environment to explore IoT adoption across various formal sector industries. An additional benefit is the researcher's own background as a native of Gaborone, Botswana. This familiarity with the local context can facilitate smoother data collection. In the sense, the study specifically targets SMEs in Gaborone City which have already integrated Information and communication technology (ICTs) into their operations.

3.1.6.2. Target population

The target population describes a specific group of individuals the researcher intends to investigate [62]. In this study, the target population will be ICT executives, ICT managers, Information Technology (IT) officers, IT team leaders, and owners of SMEs, operating within the Southern District of Botswana, in Gaborone city. This research will focus solely on SMEs employing between 1 to 100 employees. This description of the SMEs adheres to the recognized definition of SMEs within Botswana context [11]. The study focuses on this specific demographic due to their combined proficiency in technology and authority over its adoption within their firms. Moreover, this demographic holds instrumental knowledge due to their direct involvement with their companies' existing ICT infrastructure. Lastly, this demographic have the final say on allocating budgets and implementing new technologies [76].

3.1.6.3. Sampling techniques

Saunders et al. [45] argue that, studying "everyone, everywhere, and in all activities" is almost never achievable, regardless of the research approach (quantitative or qualitative). This is why researchers typically rely on drawing conclusions from a smaller sample representing the broader population [23]. In the context of this study, analysing all officially registered SMEs in Gaborone, Botswana would be impractical. Therefore to achieve this, two main sampling methods exist, namely, the probability sampling and non-probability sampling techniques [45]. The different categories of sampling techniques are illustrated in Figure 4.

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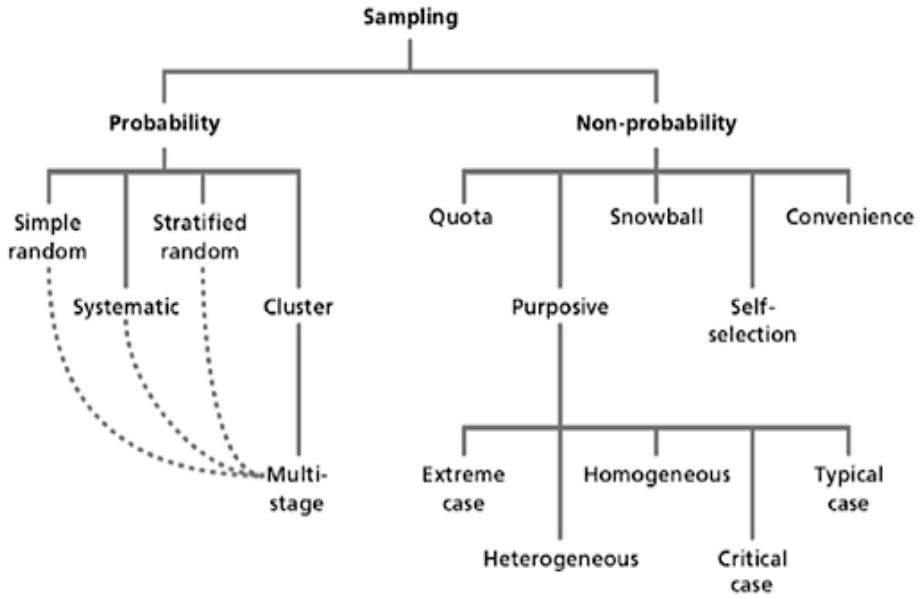

Figure 4. Sampling techniques categories [45]

Probability sampling ensures that each member of the target population has a known and equal opportunity to be selected [62]. Often achieved through random selection [77], it's ideal for surveys and experiments where generalizing findings to the larger population is crucial [23]. This allows researchers to make statistically valid inferences about the entire population based on their sample [23]. In contrast, non-probability sampling employs subjective judgment for participant selection [45]. This approach is often used when resources are limited or creating a random sample is impractical [45]. Examples include convenience sampling (selecting readily available participants) or purposive sampling (choosing participants based on specific criteria) [78]. While non-probability sampling may not be suitable for generalizing findings, it can be valuable for exploratory studies or gathering insights from a specific group [22].

3.1.6.4. Justification for the sampling technique

To ensure our survey reaches a representative sample of Gaborone's SMEs population, we will employ a probability sampling technique known as simple random sampling. This method guarantees that every SME within the population has an equal opportunity of being selected [62]. Consequently, by employing simple random sampling, we enhance the reliability of our findings when generalizing the survey results to the entire population of SMEs in Gaborone city [79].

3.1.6.5. Sample size

Determining the optimal sample size can be an intricate task for researchers [62]. Often, collaboration with a statistician is recommended, particularly when dealing with large populations [80]. This is because, collecting data from every individual in such cases might be excessively time-consuming [81]. Therefore, researchers strategically select a representative sample that offers manageable data collection while still yielding reliable findings [62]. There are 7,099 officially registered SMEs in Gaborone city [75]. To calculate the sample size for our study, we adopt Slovin [82] formula targeting a 5% margin of error. Slovin's formula offers a simpler approach, making it particularly suitable for researchers new to sample size calculations [83]. Profoundly, Slovin's formula is expressed as shown in Equation 1.

$$n = N / (1 + Ne^2) \quad (1)$$

Where;

n - Represents sample size,
N - Represents Population size,
e - Represents marginal error,
1- Represents constant value.

In substituting the relevant values into Slovin's formula, the study's required sample size is determined as follows:

Required sample size = N / (1 + Ne2)
= 7099/ (1 + 7099* 0.052)
= 7099/ (18.7475)
Required sample size = 378.67
Required sample size = 379

Based on the Slovin's formula our study arrived at a recommended sample size of 379 participating SMEs from Gaborone city in Botswana.

3.1.6.6. Data collection methods

Data collection methods describe the entire plan and process of gathering data for analysis, which addresses the research problem and questions [53]. In this study, both primary and secondary data collection methods are utilized. Primary data will be collected through self-administered online questionnaire to participants working in SMEs organizations. This method is acknowledged for its reliability and validity, as it eliminates the researcher's subjective influence by providing standardized questions to all respondents [84]. Moreover, self-administered

questionnaires empower participants to complete the survey at their own pace within a designated timeframe, potentially leading to higher participation rates [84]. In addition the study will employ secondary data collection methods. This involved reviewing relevant literature, including journals, articles, conference papers, dissertations, reports, policies, and guidelines related to SMEs and IoT adoption. This literature review process aims to extract insights on factors influencing SME adoption of IoT technologies, and to identify relevant theoretical frameworks to support our research objectives [85].

3.1.6.7. Data analysis methods

After data collection process via online questionnaires, we will extract the response data from Google Forms and export it to a Microsoft Excel file format. This facilitates further data manipulation and analysis. The Statistical Package for Social Science (SPSS) version 28 will be used for data analysis. Descriptive statistics, including frequencies, percentages, standard deviations, and means, will be employed to summarize the collected data. This will provide a foundational understanding of the key characteristics and trends within the collected data. Cronbach's alpha will be used to assess the internal consistency and reliability of the research model's constructs. This ensures that the chosen measures accurately capture the intended concepts [86].

3.1.6.8. A holistic overview of the research methodology and strategy to be adapted for understanding IoT adoption by Botswana's SMEs

To accomplish the study primary research objective, the research onion framework by Saunders et al. [22], is adapted. Figure 5 depicts the holistic overview of the research methodology and strategy that could be used to explain IoT adoption factors in Botswana's SMEs. The framework adheres to the six distinct layers of the research onion framework [22]. These layers represent the sequential choices, paradigms, strategies, and steps that researchers used to navigate throughout the research process.

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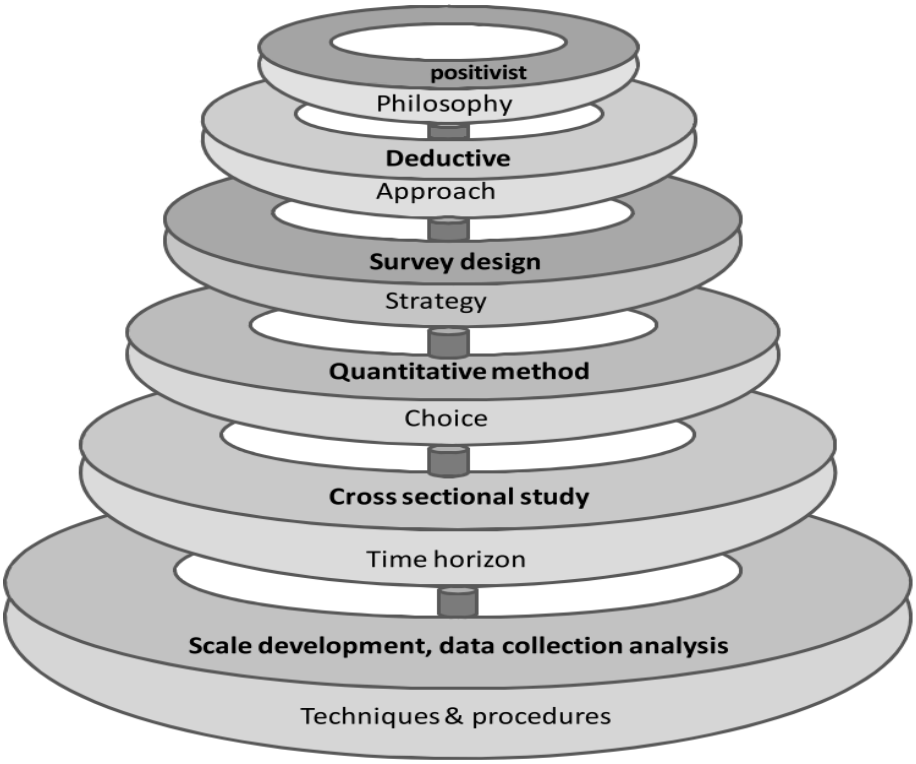

Figure 5. Overview of research methodology and strategy of the study: Adapted from Saunders et al. [22]

4. LIMITATIONS AND FUTURE STUDIES

This research offers a novel contribution to the field of IoT adoption by SMEs in Botswana. Through a rigorous evaluation of the research onion framework, it provides policymakers and decision-makers with a clear methodological roadmap for investigating IoT adoption factors. This empowers them to design targeted policy interventions that can accelerate IoT adoption within the SME sector. Despite its valuable insights, this study is subject to certain limitations. Notably, the research onion framework, while theoretically sound, has not been empirically validated in the context of Botswana SMEs. Hence, future research could address this limitation by conducting a comprehensive empirical validation of the framework through surveys or qualitative interviews with SME stakeholders in Botswana. Additionally, the sample size for SMEs was determined based on publicly available data. To enhance the study's generalizability, future research should verify the population size of SMEs through direct data collection from relevant authorities, such as the Gaborone City Council, before conducting empirical validation.

5. CONCLUSION

The IoT envisages a future where billions of interconnected devices transform how businesses operate and deliver products and services. For SMEs, IoT integration presents significant opportunities. By adopting IoT solutions, SMEs can gain a competitive edge by positioning themselves as innovative and adaptable partners within larger companies' supply chains. Besides, Botswana faces a specific challenge of a low adoption rate of disruptive technologies among SMEs. Nonetheless, to harness the benefits of IoT, a structured and rigorous methodological approach is crucial. On the next hand, selecting an appropriate research methodology can be challenging, as it necessitates consideration of context-specific factors. Moreover, the vast array of methodologies and frameworks available in literature, each with its own strengths and limitations, further complicates the selection process. This research addresses this gap by proposing the multifaceted research onion framework, to evaluate its suitability for investigating IoT adoption among SMEs in Botswana. This approach provides valuable insights for stakeholders, decision-makers, and IS researchers in Botswana, aiming to understand IoT adoption in SMEs. The findings of this study have broader implications, offering a transferable model that can be adapted to address similar challenges in other developing countries. Future research should empirically validate the research framework through surveys or qualitative interviews with SMEs in Botswana. Furthermore, future research could assess the applicability of the research onion framework to other contexts, such as investigating the influence of digital infrastructure and government policies on IoT adoption by SMEs.

REFERENCES

[1] F. Firouzi, B. Farahani, M. Weinberger, G. DePace, and F. S. Aliee, *Iot fundamentals: Definitions, architectures, challenges, and promises*. 2020.

[2] G. Paolone, D. Iachetti, R. Paesani, F. Pilotti, M. Marinelli, and P. Di Felice, "A holistic overview of the internet of things ecosystem," *IoT*, vol. 3, no. 4, pp. 398–434, 2022.

[3] N. N. Dlamini, "The potential use of the Internet of Things (IoT) in South African retail businesses," University of Cape Town, 2017.

[4] X. Wu, J. Wang, P. Li, X. Luo, and Y. Yang, "Internet of things as complex networks," *IEEE Netw.*, vol. 35, no. 3, pp. 238–245, 2021.

[5] T. Kari and W. Kleinreesink, "Internet-of-Things and cloud computing adoption in manufacturing among small to medium sized enterprises in Sweden: A multiple case study on current IoT and cloud computing technology adoption within Swedish SMEs," 2020.

[6] R. Abd Shukor, W. K. Mooi, and J. A. Ibrahim, "The future of Malaysian SMEs in the digital economy," *Qeios*, 2023, doi:

https://doi.org/10.32388/VSWNB6.
[7] Gartner, "Gartner Says the Internet of Things Installed Base Will Grow to 26 Billion Units By 2020," 2018. www.gartner.com/newsroom/id/2636073 / (accessed Nov. 12, 2023).
[8] N. A. Basyah and I. Fahmi, "Define the Role and Economic Benefits of Micro, Small and Medium Enterprises: A Literature Review," *Jambura Econ. Educ. J.*, vol. 6, no. 1, pp. 51–56, 2024.
[9] L. J. Garcia-Martinez, S. Kraus, M. Breier, and A. Kallmuenzer, "Untangling the relationship between small and medium-sized enterprises and growth: a review of extant literature," *Int. Entrep. Manag. J.*, vol. 19, no. 2, pp. 455–479, 2023.
[10] T. Mhlongo, J. A. van der Poll, and T. Sethibe, "A Control Framework for a Secure Internet of Things within Small-, Medium-, and Micro-Sized Enterprises in a Developing Economy," *Computers*, vol. 12, no. 7, p. 127, 2023.
[11] N. Nkwe, "Tax payers' attitude and compliance behavior among small medium enterprises (SMEs) in Botswana," *Bus. Manag. Horizons*, vol. 1, no. 1, pp. 113–137, 2013.
[12] R. U. Etuk, G. R. Etuk, and B. Michael, "Small and medium scale enterprises (SMEs) and Nigeria's economic development," *Mediterr. J. Soc. Sci.*, vol. 5, no. 7, pp. 656–662, 2014, doi: 10.5901/MJSS.2014.V5N7P656.
[13] M. Mnyakin, "Implementing Sustainable Supply Chain 4.0 in Small and Medium-sized Enterprises (SMEs): A Review," *Int. J. Intell. Autom. Comput.*, vol. 6, no. 1, pp. 1–16, 2023.
[14] S. Shah, S. H. Hussain Madni, S. Z. B. M. Hashim, J. Ali, and M. Faheem, "Factors influencing the adoption of industrial internet of things for the manufacturing and production small and medium enterprises in developing countries," *IET Collab. Intell. Manuf.*, vol. 6, no. 1, p. e12093, 2024.
[15] P. Okafor, *Benefits and Adoption of Internet of Things (IoT) to Nigeria's Small and Medium-Sized Enterprises (SMEs)*. 2023.
[16] C. Blanchier, E. Down, A. I. Manghi, and J. K. O'Brien, "Burden or Benefit: Do Standards Work for IoT SMEs?," 2019, [Online]. Available: Available at SSRN 3454591.
[17] D. S. Parker, "The implementation of the Internet of Things (IoT): A case study of the barriers that prevent implementation of IoT within small and medium enterprises (SME)," Northcentral University, 2020.
[18] M. Khanda and S. Doss, "SME cloud adoption in Botswana: Its challenges and successes.," *Int. J. Adv. Comput. Sci. Appl.*, vol. 1, no. 9, 2018.
[19] R. Morakanyane, "Cloud Computing: Emerging Trends for SMEs in Botswana," 2014.
[20] D. Letsholathebe, "The role of science, technology and innovation in a sustainable and resilient recovery from the COVID-19 pandemic," 2022.
[21] R. Alturki, "Research Onion for Smart IoT-Enabled Mobile Applications,"

Sci. Program., vol. 1, p. 4270998, 2021.
[22] M. Saunders, P. Lewis, and A. Thornhill, *Research methods for business students*, 5th ed. England: Pearson Education Limited, 2009.
[23] M. Saunders, P. Lewis, A. Thornhill, and A. Bristow, "'Research Methods for Business Students' Chapter 4: Understanding research philosophy and approaches to theory development," 2019, pp. 128–171.
[24] A. N. Alkhaldi, "Investigating the factors affecting the net benefits and change in user behaviour in technology push scenarios in Smart cities," University of Bradford, 2021.
[25] C. Lindberg, "The Sustainability of University-Business Innovation Clusters: The Case of IoT Rapid-Proto Labs," Haaga-Helia University of Applied Sciences, 2020.
[26] M. D. Mokoka, "An Exploration of South Africa's Innovation Ecosystem for Internet of Things Devices," University of the Witwatersrand, Faculty of Commerce, Law and Management, 2018.
[27] Y. Rashed, "Internet of Things and Modern Supply Chain Management," 2017.
[28] J. M. Suhas, "Evaluation of the Importance and Effectiveness of IOT Integration of Supply Chain Management in Mechanical Companies of India," Griffith College, 2020.
[29] F. N. F. B. M. Azlan, "The Internet of Things (IoT) in Facility Management Company," 2020.
[30] J. M. Serumaga-Zake and J. A. van der Poll, "Addressing the impact of fourth industrial revolution on South African manufacturing small and medium enterprises (SMEs)," *Sustainability*, vol. 13, no. 21, p. 11703, 2021.
[31] K. H. Pham, "Exploring Implementation Strategies of IoT Technology in Organizations: Technology, Organization, and Environment," Walden University, 2022.
[32] C. R. Kothari, *Research Methodology: Methods and Techniques*. New Age International (P) Ltd.Publishers, 2004.
[33] T. A. Schwardt, *The SAGE Dictionary of Qualitative Inquiry*, 3rd ed. Urbana-Champaign University of Illinois, 2007.
[34] J. W. Creswell, *Research Design: Qualitative, Quantitative and Mixed methods*, vol. 53. California: SAGE, 2014.
[35] S. L. T. McGregor and J. A. Murnane, "Paradigm, methodology and method: Intellectual integrity in consumer scholarship," *Int. J. Consum. Stud.*, vol. 34, no. 4, pp. 419–427, 2010.
[36] F. Tuli, "The basis of distinction between qualitative and quantitative research in social science: reflection on ontological, epistemological and methodological perspectives," *Ethiop. J. Educ. Sci.*, vol. 6, no. 1, pp. 97–108, 2011.
[37] M. R. Hill, "Epistemology, Axiology, and Ideology in Sociology," *Mid. Am. Rev. Sociol.*, vol. 9, no. 2, pp. 59–77, 1984.

[38] D. Silverman, *Doing Qualitative Research: A practical handbook*. London: Sage, 2013.
[39] J. G. Ponterotto, "Qualitative research in counselling psychology," *J. Couns. Psychol.*, vol. 55, pp. 126–136, 2005.
[40] A. A. Aliyu, M. U. Bello, R. Kasim, and D. Martin, "Positivist and non-positivist paradigm in social science research: Conflicting paradigms or perfect partners," *J. Mgmt. Sustain.*, vol. 4, no. 79, 2014.
[41] A. Sahay, "Peeling Saunder's research onion," *Res. Gate, Art*, vol. 3, no. 2, pp. 1–5, 2016.
[42] A. Bryman and E. Bell, *Business Research Methods*, 4th ed. New York: Oxford University Press, 2015.
[43] K. P. Khanna, "Positivism and Realism. In: Liamputtong," in *Handbook of Research Methods in Health Social Sciences*, Springer: Singapore, 2019.
[44] M. D. Myers, "Qualitative research in business and management," *Qual. Res. Bus. Manag.*, pp. 1–364, 2019.
[45] M. Saunders, P. Lewis, and A. Thornhill, *Research Methods for Business Students*. Harlow: Pearson, 2016.
[46] J. W. Creswell, *Qualitative Inquiry and Research Design: Choosing among Five Approaches*, 3rd ed. Thousand Oaks: Sage, 2013.
[47] C. Delmar, "'Generalizability' as recognition: Reflections on a foundational problem in qualitative research," *Qual. Stud.*, vol. 1, pp. 115–128, 2010.
[48] I. Jebreen, "Using inductive approach as research strategy in requirements engineering," *Int. J. Comput. Inf. Technol.*, vol. 1, no. 2, pp. 162–173, 2012.
[49] T. Azungah, "Qualitative research: deductive and inductive approaches to data analysis," *Qual. Res. J.*, vol. 18, no. 4, pp. 383–400, 2018.
[50] W. Trochim, "Web Centre for Social Science Research Methods," 2008. http://www.socialresearchmethods.net/kb/index.php (accessed Aug. 04, 2021).
[51] J. W. Creswell and V. L. Plano Clark, *Designing and conducting mixed methods research*. Thousand Oaks, CA: SAGE, 2018.
[52] J. Collis and R. Hussey, *Business research: A practical guide for undergraduate and postgraduate students*. Palgrave macmillan, 2013.
[53] J. W. Creswell and J. D. Creswell, "Mixed Methods Procedures," *Res. Defign Qual. Quant. Mix. M ethods Approaches*, p. pg 418, 2018.
[54] D. Crowther and G. Lancaster, *Research methods*. Routledge, 2012.
[55] U. Sekaran and R. Bougie, *Research Methods for Business:A skill Building Approach*. United Kingdom, 2010.
[56] J. Bethlehem, *Applied survey methods: A statistical perspective*. John Wiley & Sons Ltd, 2009.
[57] B. Dick, "Action research theses.," 1993. [Online]. Available: http://www.aral.com.au/DLitt/DLitt_P50arth.pdf.
[58] S. R. Hutchinson, *Survey research*. Routledge, 2003.
[59] S. F. Bahari, "Qualitative versus quantitative research strategies: contrasting

epistemological and ontological assumptions," *Sains Humanika*, vol. 52, no. 1, 2010.
[60] L. Dell'olio, A. Ibeas, J. de Oña, and R. de Oña, "Designing a survey for public transport users," *Public Transp. Qual. Serv*, pp. 49–61, 2018.
[61] A. Vomberg and M. Klarmann, "Crafting survey research: A systematic process for conducting survey research," in *Handbook of Market Research*, Cham: Springer International Publishing, 2021, pp. 67–119.
[62] U. Sekaran and R. Bougie, *Research methods for business: A skill building approach*. John Wiley & Sons, 2016.
[63] V. L. Creswell, J.W., & Plano Clark, *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications, 2007.
[64] L. T. Khrais and A. M. Alghamdi, "Factors That Affect Digital Innovation Sustainability among SMEs in the Middle East Region," *Sustainability*, vol. 14, no. 14, p. 8585, 2022.
[65] A. A. Nassani, C. Sinisi, D. Mihai, L. Paunescu, Z. Yousaf, and M. Haffar, "Towards the Achievement of Frugal Innovation: Exploring Major Antecedents among SMEs," *Sustainability*, vol. 14, no. 7, p. 4120, 2022.
[66] D. M. ElNakib, M. A. Ragheb, R. A. E. Youssef, and A. N. Ghanem, "The Effect of HRIS Adoption on Vodafone Egypt Firm's Performance," *J. Hum. Resour. Sustain. Stud.*, vol. 9, no. 2, p. 173, 2021.
[67] A. B. Jaafreh, "The effect factors in the adoption of Internet of Things (IoT) technology in the SME in KSA: An empirical study," *Int. Rev. Manag. Bus. Res.*, vol. 7, no. 1, pp. 135–148, 2018.
[68] L. R. Gay and P. Airasian, *Educational Research: competencies for analysis and application*, 6th ed. Upper Saddle River, New Jersey: Prentice Hall, 2000.
[69] P. S. Bobhate and S. R. Shrivastava, *A cross sectional study of knowledge and practices about reproductive health among female adolescents in an urban slum of Mumbai*. 2011.
[70] A. E. Springer, L. Li, N. Ranjit, J. Delk, K. Mehta, and S. H. Kelder, "School-level economic disadvantage and obesity in middle school children in central Texas, USA: a cross-sectional study," *Int. J. Behav. Nutr. Phys. Act.*, vol. 12, no. 1, pp. 1–11, 2015.
[71] E. Kademeteme, "A 4IR Framework for ICT Evaluation: a Case from South African SMEs," University of South Africa, 2020.
[72] N. V. Ngidi, "Determinants of ICT adoption by small and medium enterprises in Pietermaritzburg," University of Kwazulu Natal, 2019.
[73] A. Rindfleisch, A. J. Malter, S. Ganesan, and C. Moorman, "Cross-sectional versus longitudinal survey research: Concepts, findings, and guidelines," *J. Mark. Res.*, vol. 45, no. 3, pp. 261–279, 2008.
[74] IST-Africa, "Republic of Botswana," *IST-Africa: Research and Resources*, 2024. http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=5195 (accessed Aug. 21, 2024).
[75] Statistics Botswana, "Statistical Business Register," *Statistics Botswana*, 2023.

https://www.statsbots.org.bw/statistical-business-register.
[76] M. F. A. Zaidi and H. M. Belal, "A Preliminary Study to Understand the SMEs' Readiness on IoT in Malaysia," *Int. J. Accounting, Financ. Bus.*, vol. 4, no. 19, 2019.
[77] G. K. Mweshi and K. Sakyi, "Application of sampling methods for the research design," *Arch. Bus. Rev.*, vol. 8, no. 11, 2020.
[78] R. A. Singleton and B. C. Straits, *Approaches to social research*. Nueva York: Oxford University Press, 2005.
[79] S. Noor, O. Tajik, and J. Golzar, "Simple random sampling," *Int. J. Educ. Lang. Stud.*, vol. 1, no. 2, pp. 78–82, 2022.
[80] B. Sathian, J. Sreedharan, S. N. Baboo, K. Sharan, E. S. Abhilash, and E. Rajesh, "Relevance of sample size determination in medical research," *Nepal J. Epidemiol.*, vol. 1, no. 1, pp. 4–10, 2010.
[81] E. Bell, A. Bryman, and B. Harley, *Business research methods*. Oxford university press, 2022.
[82] E. Slovin, "Slovin's Formula Calculator," *Statology*, 1960. https://www.statology.org/slovins-formula-calculator/ (accessed Aug. 04, 2023).
[83] T. L. Chepchumba, "Evaluating Teachers' Adoption Of Digital Learning In Public Primary Schools: A Case Study Of Uasin-Gishu County Schools," University of Nairobi, 2019.
[84] A. A. Alshaikhmubarak, "The impact of high-performance human resource practices on research performance and career success in the Saudi Arabia higher education sector," University of Southampton, 2018.
[85] J. Ghauri and V. Goraung, *Primary and Secondary Data Collection Methods*. 2010.
[86] W. W. Dunn, "Validity," in *Developing norm-referenced standardized tests*, Routledge, 2020, pp. 149–168.