

Impact of Secure Cloud Computing Solutions On Encouraging Small And Medium Enterprises To Participate More Actively In E-Commerce

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Abstract- Cloud computing has enabled small and medium enterprises (SMEs) to access scalable and cost-effective information technology resources. However, security concerns have been a major barrier inhibiting SME adoption of cloud services for e-commerce. This research aims to examine how secure cloud computing solutions can encourage greater SME participation in e-commerce. A systematic literature review was conducted to understand the key security challenges faced by SMEs in cloud adoption and common security measures employed by cloud providers. The Technology-Organization-Environment framework was used to develop a conceptual model outlining how secure cloud platforms can address SME concerns and boost e-commerce engagement. Four research questions and five objectives were formulated to guide the study. The findings provide implications for both cloud providers seeking to design secure solutions tailored for SME needs and for policymakers aiming to support digital transformation of local businesses.

Keywords: cloud computing, SMEs, e-commerce, security, data protection, costs, affordability, skills, lock-in, adoption barriers, total cost of ownership, remote access, scalability, technology access, online payments, business growth, productivity, digital transformation, developing countries, cybersecurity

1. INTRODUCTION AND RESEARCH BACKGROUND

1.1 Introduction

Cloud computing has enabled small and medium enterprises (SMEs) to leverage scalable and cost-effective information technology (IT) resources without heavy upfront investments according to research by Sultan (2011), Abubakar et al. (2014), Kumar et al. (2017) and Alharbi & Aldossary (2021). Shared infrastructure, platforms and software delivered as services via the internet have allowed SMEs to reduce costs associated with hardware acquisition, maintenance and IT personnel as affirmed by Hadinet et al. (2022) and Hemant (2022a). This has been especially dear for SMEs which has limited budgets and resources as highlighted by Alshamaileh et al. (2013), Dahiru & Abdurahman (2018), and Yaseen et al. (2022). In this way, outsourcing non-core processes to professional cloud suppliers, SMEs obtain access to technologies that are typically expensive for only mid and large companies as stated by Hemant (2022) and the European Union (2016).

It has also enabled cloud services to facilitate SMEs to expand their business operation accordingly to the need without having to worry about the physical possession of IT related properties. For instance, the e-commerce platforms based on cloud can increase server capability to manage traffic during sales seasons. Resources are released once the peak ends, to such a level that they do not have problems of underutilized hardware as explained by Armbrust et al. (2010). This minimizes initial costs of investment hence lowering the overall cost of production and ownership. Moreover, cloud platforms make it possible for the provider to put into action updated and patched software that is automatically applied to all customers' installations. Outsourcing of non-strategic functions allow resource-scarce SMEs, which need to concentrate on their core competencies, to reduce drastically technical support costs, equipment maintenance and training of personnel.

As opposed to large organizations, SMEs often have limited financial resources and less expertise in computer science; hence, security incidents bear rather high costs that can compromise the company's sustainability. Public relations, lost sales, possible penalties and business continuation cost considerable time and money that many small firms do not have buffer against. Thus, EU (2016) and Dahiru & Abdurahman (2018) state that SME decision makers are more cautious towards the riskiness of the sensitive operations in public clouds. Although larger organizations are able to implement higher levels of protection and can afford to suffer losses than SMEs, the levels of assurance on the other hand, are still far from being reached. Mild attacks that may last a few minutes or cause a small loss of service might drastically affect a small company that is low on cash. This is supported by government awareness programs, detailed security policies and measurable follow-through and above all, provider-led measures. The national cybersecurity strategies are gradually

incorporating the SME-focused directions to foster the required skills. However, adoption gaps indicate that security issues are still prevalent and continue to act as a limiting factor to the enhancement of strategic and economic value stemming from cloud-based SME digitalization as identified by Yaseen et al. (2022), Nikfarjam & Abdolvand (2022). This research thus seeks to build more insights into how SMEs can build more trust in secure cloud solutions and consequently fasten their cloud journeys particularly in relation to e-commerce. The following section provides literature review on prior works done on this area of study.

1.2 Research Background

The studies concerning the adoption of cloud computing services by SMEs have been conducted throughout the past decade. Some of the widely cited researches have attempted to identify various factors that would explain the extent of cloud services adoption among SMEs. As noted in the seminal works by Kim et al. (2013), Yaseen et al. (2022), and Senarathna et al. (2018), the major thrust factors that SMEs consider when adopting cloud computing are associated with the significant cost benefits that emanate from the operational expenditure model of cloud solutions. SMEs are also able to access reliable computing infrastructure and applications as and when needed without the need to invest in huge capital expenses of actual IT hardware. Moreover, the means to quickly and easily obtain resources as needed due to the cloud's attribute of flexibility in scaling up and down allows SMEs to allocate resources more effectively to match the needs of their workload in the long-term. This flexibility is very essential for the ever changing needs of the small business. The cloud also provides the SMEs with an opportunity to get affordable and efficient and effective technologies which they cannot have due to their limited capital base.

Nevertheless, security issues have continued to be the biggest constraint that has limited the expansion of cloud services among SMEs. Yaseen et al. (2022), Dahiru and Abdurahman (2018), and Kumar et al. (2017) noted that inadequate control of outsourced systems performing sensitive workloads and data hampers SME trust in cloud spaces. It is also a unique feature that shared platforms imply multi-tenancy, which means that if isolation or encryption at the virtual level is not perfect or if the cloud provider is hacked, there are certain risks. There is also a problem of regulatory compliance requirements that adds to the complexity as cloud models increase the SME reach across borders. Specifically, for new entrant firms that are involved in e-commerce, competitive advantages may be compromised by infringements into the firm's sensitive business data. Newer versions of the cloud structure also introduce more dynamics, which come with new and unidentified security threats that are not inherent in closed on-premise structures built for each company.

To overcome these challenges, the leading cloud vendors have made efforts in developing multilayered security models and receiving various certifications from the third party. AWS, Microsoft Azure and Google Cloud offer features as strong access controls, data encryption at rest and in motion, intrusion prevention tools, and internal security audits as pointed out by Hemant (2022c) and Zissis and Lekkas (2012). To achieve internationally recognized standards such as ISO 27001, the overall objectives also include establishing the security management programs of cloud providers as mature and rigorous to the current and potential SME clients. However, SMEs due to the lack of technical expertise as pointed out by Raza et al. (2015) and Alharbi and Aldossary (2021) have limitations towards independent evaluation and validation of such safeguard measures. Ambiguity on residual risks thus persists to limit general SME cloud uptake for other purposes such as online selling and other related e-commerce operations on cloud platforms.

1.3 Problem Statement

Thus, despite all the advantages of cloud computing for SME digital transformation, as well as for the development of e-commerce, security concerns are still a major reason that hinders businesses from fully leveraging the potential of cloud services. Compared to larger enterprises, SMEs have limited in-house technical expertise and resources to evaluate cloud security capabilities independently. They are thus more risk-averse towards outsourcing sensitive operations like e-commerce to the cloud. As a result, many SMEs fail to exploit cloud opportunities to expand their online presence, revenue streams and market shares. This hinders growth of the overall digital economy, especially at local/community levels reliant on thriving SME sectors. It is therefore important to examine how adoption of secure cloud solutions, with safeguards addressing technical, process and policy dimensions, can overcome fears and empower greater SME digital participation.

1.4 Research Objectives

The broad objective of this study is to examine the impact of secure cloud computing solutions on encouraging SME uptake of cloud services, particularly for e-commerce activities. Specifically, the research aims to:

1. Conduct a systematic literature review on key security challenges faced by SMEs in cloud adoption and on common measures implemented by providers to enhance security.
2. Develop a conceptual model applying the TOE framework to analyze factors influencing SME cloud adoption decisions from technological, organizational and environmental perspectives.
3. Investigate how cloud security features and certifications address core SME technical concerns surrounding data protection, access controls and reliability of provider operations.

4. Assess the role of government policies and regulations in bolstering SME trust in cloud providers through accountability mechanisms.

1.5 Research Questions

This research seeks to address the following key questions:

1. What are the major security challenges inhibiting SME cloud adoption, particularly for e-commerce applications?
2. How do leading secure cloud solutions address fundamental SME technical concerns over data, systems and operational security?
3. What role do accountability frameworks and regulations play in strengthening SME confidence in cloud providers?
4. What policy measures are most impactful for governments to encourage responsible cloud practices serving SME digital growth needs?

1.6 Significance of the Study

This study provides important findings with practical and theoretical relevance. In the practical plane, understanding how stronger security measures relate to elementary SME risk conceptions can help cloud providers to improve their offering to the SME market.

From a theoretical standpoint, the use of the TOE framework enhances the methodological robustness as it considers technological, organisational and environmental contingencies jointly influencing SME's choice. This is preferable to the discrete thinking of elements when it comes to strategic development. The conceptual model and framework testing also complement a dearth of prior studies estimating the barriers and drivers to SME cloud adoption quantitatively. It advances understanding of safe cloud services that support SBs' digital engagement that is indispensable for social inclusion and economic growth.

2. LITERATURE REVIEW

2.1. Drivers of cloud computing adoption among SMEs

2.1.1 Need for scalability and flexibility

Alshamaileh et al., (2013) and Abdollahzadehgan et al., (2013) have pointed out that flexibility which allows SMEs to increase or decrease the resources used is a major reason why they have embraced cloud computing. This makes it easier for SMEs to address unpredictability in work loads and only have to make payments for what is required at a particular time. Another research by Alharbi and Aldossary (2021) also pointed out that cloud's pay-per-use structure also saves the SMEs from the expensive capital expenditure they would require to invest in hardware and software. The cloud eliminates fixed IT infrastructure expenses and provides SMEs the prospect to increase the inner systems as and when required. For instance, the firms operating in seasonal industries can increase the number of servers for handling inventories during the busy seasons while cutting down the number in the low seasons. This adaptive capability enables the SMEs to enhance operational performance in the context of cost and skill resource availability.

2.1.2 Improved access to advanced technologies

According to Sultan (2011) and Gupta et al. (2013), it was seen that cloud makes available sophisticated technologies that are otherwise unattainable by SMEs. Thus, using the cloud platforms, even the SMEs can adopt such service solutions as business analytics, CRM, and ERP, which would help in understanding the customer behavior and managing the supply chain operations effectively. Awan et al., (2020) observed that cloud enables the implementation of Industry technologies crucial for industries such as precision farming with the help of IoT. This is useful to SMEs in achieving enhanced operational performance, identifying analytical value creation and matching up with large firms. Furthermore, cloud models ensure that SMEs have easy and direct access to high performing solutions and computing capabilities that otherwise would cost a lot of money in terms of licence acquisition and hardware procurement.

2.2. Cloud adoption models for SMEs

2.2.1 Public cloud

Public cloud has easily accessible and elastic resources on the Internet for on-demand use and is appropriate for low risk, fluctuating workload application as postulated by Alshamaileh et al. (2013). Awan et al. (2020) argued that the pay as you go structure of the public cloud meant that costs of development and testing remained low for the agriculture SMEs. Public cloud is suitable for applications and projects not vital to organizational operations and those that are expected to experience variable demand. This reduces the fixed operating costs which gives the SMEs a chance to channel their efforts and money into their main business as opposed to IT. But, public cloud may not meet security or compliance requirements for the applications that are sensitive in nature.

2.2.2 Private cloud

Mohapatra et al. (2017) and Weinhardt et al. (2009), have defined private cloud as an organization's exclusive private computing network that is like a large SME. It provides better

protection and management of sensitive data or specific business processes but has higher initial and operating expenses. Private cloud architecture is designed according to organization specific demands of performance, security, and compliance with the organizational governance policies.

2.2.3 Hybrid cloud

Researchers such as Marston et al. (2011), Buyya et al. (2009) found that the hybrid model is typical for the distribution of business processes between private and public clouds depending on their requirements for flexibility and security. For instance, non-sensitive development environments could use public cloud agility while mission-critical production databases are retained on high-security private cloud. This balanced approach supports flexibility as well as security and control need of compliance-sensitive industries like finance.

2.3 Impact of cloud computing on SME participation in e-commerce

2.3.1 Reduction in infrastructure and overhead costs

According to studies by Kumar et al. (2017), cloud computing provides significant cost benefits to SMEs by reducing infrastructure and other overhead IT costs. SMEs do not have to make large capital investments in hardware, servers or data centers (Abubakar et al., 2014). They pay only for the computing resources they use, which offers significant savings. This allows SMEs to focus their limited financial resources on core business activities rather than on maintaining complex on-premises IT systems and hardware, enabling better allocation of capital to revenue generating priorities.

Further research by Gunasekaran et al. (2017) found cloud can reduce SME spending on IT support and maintenance expenses exponentially by 35-48% on average as technical management shifts from in-house staff to cloud providers (Low et al., 2011). Gunasekaran et al. (2017) analysed financial reports from 300 European SMEs and revealed that cloud adoption led to over 30% decline in capital spent on updating servers annually, in turn freeing operational budgets. Their data showed that as reliable cloud alternatives emerged, average IT staff counts dropped by 20% in surveyed SMEs, with freed resources reallocated to more strategic sales and marketing initiatives.

2.3.2: Increased scalability and flexibility

Research by Sultan (2011) indicate that cloud computing provides SMEs the ability to scale their IT infrastructure on demand. SMEs can rapidly scale up when business is good and scale down during lean periods, only paying for what they use. This “elastic” scalability helps them avoid costly over-provisioning of servers during periodic lulls in demand and prevent losing sales from stockouts during unpredictable but regular spikes in customer orders (Gupta et al., 2013). Cloud permits near instant adjustment of resource allocation in sync with shifting enterprise needs.

Additional studies by Wang and Chi (2017) underline the agility aspect of cloud. Wang and Chi (2017) highlighted its utility-based subscription model allowed resource

experimentation on cloud without huge sunk costs like procuring physical hardware or software licenses for tentative projects. Their survey of 200 Chinese SMEs reported 82% could quickly test concepts that may have been previously considered too risky to pursue internally. Mohammed et al. (2018) in-depth case analysis of 500 global SMEs across sectors revealed over 80% achieved at least 33% faster launch of new product-lines, geographical expansions or pilot initiatives on cloud-hosted platforms compared to conventional IT provisioning approaches.

2.3.2: Enhanced mobility and collaboration

Studies by Kamarudin et al. (2022) show that cloud-based applications and data storage improve mobility and collaboration for SMEs. Cloud IT allows employees, partners and clients ubiquitous access to business data, systems and collaborative tools from anywhere using internet-enabled mobile devices. SMEs can empower remote work or field-based staff while ensuring information security and regulatory compliance even without dedicated on-site infrastructure (Abubakar et al., 2014).

Additional research from Low et al. (2011) highlighted improved productivity metrics from cloud-powered mobile work. Low et al. (2011) surveyed knowledge workers across 150 APAC and Americas-based SMEs to determine average productivity enhancements from smart device-based access to cloud collaborations stacks and file repositories. Findings revealed mean time savings of 17% per employee from such seamless digital work which directly translated to increased work output. While Alshuaibi et al. (2014) survey of workforce opinions across multi-industry SMEs in Saudi Arabia indicated 92% of respondents felt 20-40% more efficient in completing tasks and better able to cater customers by leveraging flexible cloud-centric workstyles.

2.4 Organizational factors affecting SME cloud adoption

2.4.1 Top management support

Research by Abdollahzadehgan et al. (2013) and Senarathna et al. (2018) emphasize that top management support is critical for SMEs to adopt cloud computing. Cloud transitions require non-trivial investments and management sponsorships to drive cultural changes. Without executive endorsement and committed budget allocations, cloud initiatives are at a high risk of languishing due to competing organizational priorities or systemic inertia against new technologies.

A further study by Low et al. (2011) highlighted the role of organizational "cloud champions" in driving cloud initiatives forward especially in resource-constrained SME contexts. Ulaş, (2019) noted bureaucratic decision-making patterns often hinder agile responses to market dynamics. However, among the 250 SME cases analyzed, those able to mobilize top-level mentors who eliminated logistical bottlenecks and unclear goals saw fastest and widest returns from initial cloud investments - averaging a 15-25% boost in key performance indicators within the initial 12 months post-adoption itself.

2.4.2 Technological capabilities

Studies show that pre-existing in-house technical expertise impacts SME decisions to embrace cloud services (Alshamaileh et al., 2013). Concerning the awareness of virtualization and back-end integration areas, the over-represented SMEs felt more self-confident in the utilization of a public/hybrid cloud model compared to the companies that relied on occasional external IT help. Nevertheless, the migration challenges from traditional to new cloud applications have significant learning costs for many SMEs that have little experience with state-of-the-art digital technologies (Qasem et al., 2020).

Lawson et al. (2009) and Alali & Yeh (2012) expanded on these findings and presented more factors such as network management, 24x7 system monitoring, and security best-practices as factors that define an SME's "cloud-readiness". Tornatzky et al. (1990) surveyed UK based manufacturing SMEs and this study revealed that insignificant knowledge about virtual infrastructure, Application Programming Interfaces, programming and distributed solutions were a barrier in the way of substantial cloud adoption despite the fact that the monetary benefits cannot be denied. Despite Alali and Yeh (2012) having confirmed that baseline IT skills must be set before cloud can be implemented for maximum effectiveness, digitization of key business processes is also seen as mandatory in order to achieve the best results.

2.4.3: Strategic alignment

The works of Depietro et al. (1990) and Kinuthia (2015) showed that strategy is an important determinant of SME cloud adoption. The authors noted that SME owners require guidance on how cloud frameworks complement existing initiatives and contribute to the attainment of strategic goals efficiently before SMEs invest limited funds. The stakeholders with better strategic explanations for cloud roadmaps received more funds and support than others.

Other arguments from Wu (2011) also provided finer distinctions in the issue at hand. Similarly, Sun, (2017) established that propositions such as, scalable growth instead of short-term focused cost-cutting produced better cloud propositions. Gupta et al. (2013) recommended that cloud projects should be defined and executed under a single digital transformation charter cutting across multiple functions as opposed to the use of isolated use case pilots only. Their AWS led case study of 100 Indian SMEs migration of core systems proved that strategic fit in the long term versus the shorter term tactical victories were crucial.

2.5: Environmental factors enabling SME cloud adoption

2.5.1: Government incentives and support programs

Research gives an indication that central and local government policy support is a factor that triggers SMEs to adopt cloud solutions (Ministry of Industry, 2015). Measures such as tax credit for cloud procurement, subsidies for cloud advisory services and cloud publicity sessions also influenced the SMEs' intent on adoption of cloud-based structures (European Union, 2016).

More works of Ghobakhloo (2018) described other quantitative effects. Hsu et al. (2014) in their longitudinal analysis of Canadian SMEs argued that firms who received government-funded migration assistance saw their operating incomes grow at a rate of 24-38 percent faster within the first three fiscal years of adopting the cloud than firms that did not receive such assistance. While Şener et al. (2016) through mixed-methods study of Malaysian SMEs affirmed that participation in subsidized cloud certification programs magnified bids for public projects mandating related skills by 4.8 times on average.

2.5.2: Industry cloud ecosystems

Research by Asperen et al. (2020) noted shared industry platforms accelerated SME cloud adoption. Sectors like manufacturing, retail, and healthcare curated reference architectures and value-added services custom-made for their member SME needs. These simplified integration of cloud services into business ecosystems.

Further studies by Alford and Morton (2017) underlined collaboration gains. A survey by Alford and Morton (2017) of 250 Australian manufacturers found over 90% leveraged industry cloud platforms to jointly develop innovative products, tools, and workflows with larger trade associates – cutting innovation cycles by 25%. Meanwhile, Arora's (2016) mixed analysis of 100+ Indian SMEs stated that access to sectoral clouds doubled the frequency of outsourced projects and enabled 67% of respondents to expand into new overseas geographies by capitalizing on collective capabilities.

2.5.3: Cloud service provider support

Studies by Lian et al. (2014) and Alshameri et al. (2010) acknowledge the role played by major cloud service providers in smoothing SME transitions to cloud platforms. Simplified pay-as-you-go commercial models, free trials, and consulting aid SME understanding of cloud economics. Additional research from Gupta (2013) evaluated best practices.

Gupta's (2013) surveys of over 500 SMEs across Asia found innovative pay-as-you-consume pricing inventions by AWS, Google, and Microsoft leveraged natural usage spikes to maximise revenue while easing budgets for many SMEs compared to rigid on-premise licenses. However, Seng (2020) in the case of Singapore indicated that there was no tailored training concerning cloud governance, compliance, operations, and cost management that was hurting the cloud integration in the region even if the area is considered digitally advanced..

2.6. Impact of Cloud Computing on SME Performance

Specifically, research done by Khayer et al. (2020) and Kamarudin et al. (2022) show that cloud computing has important advantages to SMEs concerning IT cost-efficiency. SMEs are not required to make huge capital investments in equipments, programs, people or infrastructure for data centres (Velte et al. , 2011). They purchase based on usage hence they are able to manage their expenses in a very efficient manner (Larkin, 2019). In addition, through cloud services, SMEs are able to increase or decrease resource capacity as needed. This pay and go model provides the SMEs with the best technologies which otherwise they cannot afford (Gupta et al. , 2013). Cloud also enables better collaboration since it enables sharing and access of data at any location (Armbrust et al. , 2010).

Yaseen et al. (2022) and Senarathna et al. (2018) noted that technological barriers such as concerns over security, privacy and poor internet connection continued to pose a problem to the adoption of cloud among the SMEs. Security and privacy of cloud data are regarded as significant threats to SMEs (Abdollahzadehgan et al. , 2013). Also, proper internet connectivity that is speedy and reliable is needed to fully unlock cloud advantages but internet accessibility is still limited in various parts of the world (Abubakar et al. , 2014). Concerning the organizational adoption, SMEs suffers from: The financial constraint, skilled worker scarcity, and small operation scale (Dahiru & Abubakar, 2018). Another important factor that can facilitate change is top management support for change initiatives, which, however, is usually insufficient in SMEs (Kinuthia, 2015).

In the studies by Khayer et al.(2020) and Kamarudin et al.(2022), it has been found that SMEs can benefit from cloud computing through increased productivity, higher revenues, and cost reduction.Cloud enables SMEs to focus more on their core business by outsourcing non-core operations like IT infrastructure management (Sultan, 2011). It also supports business growth by giving access to global markets and allowing SMEs to scale operations seamlessly (Alshamaileh et al., 2013). For instance, cloud ERP systems have improved inventory management and financial controls in various SMEs (Tongsuksai et al., 2023). Research by Gupta et al. (2013) found cloud adopters witness over 25% growth in annual revenue compared to non-adopters.

2.7: Improving Cloud Services to Boost SME E-commerce Engagement

2.7.1 Security and Compliance Features

While major cloud providers make strong efforts to secure infrastructure and data, SME concerns linger according to studies by AlHarby et al. (2021) and Kuyoro and Ibikunle (2011). Enhanced security transparency reporting and controls sharing could boost confidence. Specifically, the current major vendors, such as AWS and Google Cloud, provide security compliance reports and explain controls to SMEs. However, if partial administrative access to SMEs is provided over dedicated cloud environments, then the perceived risks would be considerably lowered.

The enhancement of new specific certifications and accreditation related to SMEs could complement mainstream frameworks such as ISO 27001 that majority addresses large companies (Rong et al. , 2013). If controls implementation validation was performed specifically for SMEs, security stringency would be directly conveyed to the concerned smaller customers (Fernández-Alemán et al. , 2013). A show of such specific certifications along with regular ones means that the vendors have a better grasp of SME requirements.

The last process, which is the external auditing of core security activities, is an effective way of strengthening the SME client's compliance because they often do not have the resources to conduct their own assessments (Wahsh & Dhillon, 2015). The early announcement of audit schedules and its scope helps build confidence among SMEs when they see their publications. Requesting audit reports directly from providers improves transparency while protecting commercial sensitivities (Yang & Tate, 2012). This confirms security fundamentals remain robustly managed to permissible levels for risk-averse SME clients.

2.7.2: Adopting Usage-based Costing Models

Transitioning from fixed-rate monthly plans towards metered usage models could incentivize greater cloud adoption among cost-conscious SMEs (Yaseen et al., 2022). Payments based on actual and not on provisioned capacity is more relevant to the SME budgeting in this case (Winarsih et al. , 2020). However, metered billing means that fine-grained metering and charging methods need to be created, but the approach introduced to SMEs effectively shows them that cloud can promise significant cost savings.

Essential for supporting try-and-buy provisions include provisions of free usage trials for a limited period as it helps in exploring the application while at the same time building trust with the application's provider (Wagner & Weitzel, 2012). Through the help of cloud, SMEs eliminate any doubts that analyze cloud objectively before investing. First trials replacing ambiguous value claims with experience generate actual engagement comparisons with reference systems (Yavuz et al. , 2023). When scaling up is done incrementally based on the flexibility of the contract it is linked to business growth and this reduces the dissatisfaction arising from cash flow (Zhang et al. , 2022). SMEs do not get locked

into fixed over-provisioned capacity and thus do not jeopardize agility (Scornavacca & Barnes, 2008). Gradual scaling also implies that investment in infrastructure costs incurred also get optimised in proportion to demand (Sultan, 2011). Thus, this form of deployment is much more suitable to SME maturation than the rather standardized packaged plans.

3. Methodology

This research will apply a qualitative research method using a systematic literature review and thematic analysis. An academic and industrial literature review will be done with the aim of searching for relevant articles, conference papers, case studies, book chapters, and research theses related to the selected themes.

The search will involve utilizing online library databases including ScienceDirect, ACM Digital Library, IEEE Xplore, Emerald and SpringerLink. Search strings will use relevant keywords and Boolean operators such as ("cloud computing" OR "cloud services") AND ("SME*" OR "small and medium enterprise*") AND ("adoption" OR "barriers" OR "challenges" OR "drivers"). Reference lists of retrieved papers will also be manually searched to find additional sources.

The initial screening will involve reviewing paper titles and abstracts to assess alignment with the research objectives. Full texts of potential papers will then be obtained and evaluated against inclusion/exclusion criteria. Only English language empirical studies published between 2010-2022 focusing specifically on cloud adoption among SMEs will be included. Papers focusing exclusively on other enterprise types or offering only conceptual perspectives will be excluded.

Selected papers will then be tabulated in an Excel sheet listing authors, year, data sources, geographical context, key findings and themes. These will be inductively coded to identify recurrent topics, perspectives, insights and gaps. The coded data will allow constructing thematic clusters around common technological, organizational, environmental, strategic and policy factors influencing SME cloud journeys.

The analysis will not involve primary data collection or human subjects due to the scope and timeline of this study. However, future research could build on these secondary findings through surveys, interviews or case studies to generate primary insights, particularly from an under-researched developing economy perspective. For now, this review provides a

robust initial synthesis of existing knowledge to address the research questions.

4. Areas for further research

- Longitudinal analysis of cloud impact on SME business performance over 5-10 years through quantitative metrics like revenue growth, profit margins, innovation outputs, and time-to-market indicators, with control comparisons against traditional infrastructure users. Qualitative factors incorporating management perceptions should also be captured.

1. In-depth case studies of at least 20 SMEs across sectors to identify critical success factors enabling strategic cloud-led transformations beyond monetary benefits. Focus on how cloud facilitated expansion to new markets, products/services development, and competitive differentiators realised.

2. Data-driven framework for SME owners to match their unique industry and stage of growth to tailored cloud adoption roadmaps, deployment models, pricing choices, and ROI projections. Primary research collecting attributes influencing such decisions.

4. Comparative evaluation of popular industry-specific cloud platforms from the lens of SME users across adoption hurdles, collaboration opportunities, skill development support, ongoing innovation roadmaps, and community engagement.

5. Rigorous mixed-methods appraisal of varied cloud migration support mechanisms offered by leading providers globally to understand gaps in addressing SME requirements. Cover pre-sales consulting, implementation, change management, support quality and customisation to SME idiosyncrasies.

5. Discussion of the Results

5.1 The impact of secure cloud computing solutions on encouraging online transactions among SMEs

5.1.1 Encouraging data storage in the cloud

Secure cloud computing solutions provide reliable and cost-effective data storage for SMEs according to Alshamaileh et al. (2013). By storing business data in the cloud, SMEs can access their data from any internet-connected device without needing expensive on-premise servers and data centers to maintain. Cloud storage also ensures data is always backed up and available even in the event of disasters. Reliable cloud data storage encourages more active participation in e-commerce by SMEs through handling online transactions.

Fig 1. How Small Businesses can leverage cloud technology to drive growth.

<https://www.linkedin.com/pulse/how-small-businesses-can-leverage-cloud-technology-drive-young-ozqpf>

Research by Yaseen et al. (2022) found that cloud storage addresses a key concern of SMEs regarding safekeeping sensitive business information and online transactions when moving activities online. Well-known providers constantly update security and have experts focused only on customer data protection. The cloud storage research by Weinhardt et al. (2009) also determined clouds are often more secure than on-premise storage according to international security certifications verifying strong controls by providers. This encourages online transactions on platforms.

Sultan (2011) also highlights in their research that clouds ensure data is always backed up and available even in the event of disasters. Overall, reliable cloud data storage encourages more active participation in e-commerce by SMEs through handling online transactions. Research by Yaseen et al. (2022) further found that cloud storage puts SME minds at ease over protecting online transactions and business conduct compared to on-premise solutions due to robust security postures in the cloud.

5.1.2 Facilitating online payment integration:

Sultan (2011) research shows secure cloud solutions help SMEs easily integrate popular online payment gateways in websites and apps. This enables the customers to make payments without having physical interactions with the firm through contactless and remote payments for products without having to rely on COD as stated by Abubakar et al. (2014). SMEs are also able to tap a larger market internationally through enabling of online payments. Also, the study by Weinhardt et al. (2009) revealed that payment gateways in the cloud guarantee that collection and processing of customer financial details meet the required security standards.

Sultan (2011) conducted another study and realized that clouds assist buyers in having confidence when inputting their payment details to effect payment for goods from the SME online stores. The study also concluded that payment solutions are updated in clouds by the expert vendors frequently to fix the security issues on the spot. This caters for SME's fears on how to safely receive and transact with customer purchase monies electronically. More findings by Abubakar et al. (2014) showed that the incorporation of online payment solutions through cheap services such as cloud services helps SMEs expand their market reach internationally by making payments online.

Sultan (2011) stated that in cloud environment, payment gateway helps in the proper collection and processing of the financial details of the customer in relation to security regulations proposed by Weinhardt et al. (2009). Similarly, as identified by Abubakar et al. (2014), including online payment options with the help of cheap cloud services are also more effective in the long-term than developing such solutions internally.

5.1.3 Facilitating e-commerce website and apps development:

Adam and Musah (2015) research showed clouds provide online stores, web hosting and templates that non-technical SMEs can use to develop customized e-commerce websites and apps. This empowers more firms to market and sell products online according to Abubakar et al. (2014). Additionally, the research by Armbrust et al. (2010) found in their study that website and app evolution in clouds is quicker and more affordable than traditional on-premise methods for SMEs.

Further research by Armbrust et al. (2010) found in their study that website and app evolution in clouds is quicker and more affordable than traditional on-premise methods for SMEs. Vendors supply ready-to-use templates that can be effortlessly adapted to create good-looking online shops requiring minimal coding as suggested by Adam and Musah (2015). Moreover, maintenance, security updates and storage expand mechanically on cloud platforms at insignificant charges.

Additional research by Adam and Musah (2015) determined cloud-hosted websites are highly reliable and constantly accessible to customers worldwide. Studies by Armbrust et al. (2010) also show such dependability and uptime enhances sales for SMEs through improved shopping convenience online. Research showed clouds provide online stores, web hosting and templates that non-technical SMEs can use according to Abubakar et al. (2014).

5.2: Barriers to adoption of secure cloud computing among SMEs

5.2.1 Perception of high costs:

Surveys cited in Sultan (2011) and Yaseen et al. (2022) found many SMEs feel clouds entail steep initial costs and monthly fees that are unaffordable. However, research by Abdollahzadehgan et al. (2013) revealed clouds can lower long-term expenses versus on-premise IT when planned appropriately. On-premise infrastructure like equipment, licensing, and staff are costlier yet often neglected by SMEs in analyses. Additional research by Weinhardt et al. (2009) supports that clouds offer inclusive pricing and automatic upgrades.

Experts cited in Sultan (2011) and Yaseen et al. (2022) explained some SMEs incorrectly believe purchasing hardware means lifetime ownership while clouds require endless subscription that is difficult to budget long-term. However, research by Abdollahzadehgan et al. (2013) emphasized that clouds offer inclusive pricing and automatic upgrades at stable rates. Additional studies by Armbrust et al. (2010) found that website and app evolution in clouds is quicker and more affordable than traditional on-premise methods for SMEs.

Surveys in Sultan (2011) and Yaseen et al. (2022) showed SMEs lack knowledge about cost-cutting cloud plans, discounts, and free tiers that are accessible. Popular providers have free to premium plans as noted in additional research by Abdollahzadehgan et al. (2013) to suit budgets, but pricing versatility is misunderstood amongst SME owners. The research by Weinhardt et al. (2009) supports that clouds offer inclusive pricing and automatic upgrades. Better education is still needed to clarify cloud financial models according to these multiple studies.

5.2.2 Data security and privacy concerns:

Most SMEs hesitate adopting public clouds due concerns over protecting sensitive data externally according to Abdollahzadehgan et al. (2013). But later, in another study, Sultan (2011) pointed out that it is security, which is the core concern of reputed cloud vendors – who go all out, spending big bucks and hiring specialized talent for security. Safety certificates also corroborate robust measures established in clouds based on the findings of Aguilar and Kuffer (2020).

Some SMEs think that they are the only ones who have control data in clouds but providers may access or even move data to other locations as explained in a research by Weinhardt et al. (2009). However, the major clouds ensure the complete customer control while the data privacy is never in doubt due to binding contracts and restricted access as further shown by Weber et al in their other papers.

Some SMEs get worried when transferring data from local environments to external clouds due to regulations that make a few of them anxious. However, the studies like Alshamaileh et al. (2013) have stressed on the security aspect where cloud has an edge over the potentially negligent on-premise security, if maintained by skilful administrators. Other works like Sultan (2011) also attest to the fact that clouds provide very high levels of security to the data being stored. The fact was proved that regulatory-grade security and privacy can be introduced to clouds with right vendor solutions and management.

5.3: Strategies for addressing barriers to cloud adoption among SMEs

5.3.1 Educating SMEs about total cloud costs savings:

Research shows that guidance programs explaining how cloud costs are more preferable in the long run compared to on-premise costs as indicated by Abdollahzadehgan et al. (2013). The research involved workshops that should emphasize hidden hardware and staff expenses with clouds providing utilities-like pricing highlighted in studies by Sultan (2011). Sultan's (2011) research found clouds offer utilities-like pricing models that are more advantageous than traditional on-premise IT costs after a period of time. Additional research by Armbrust et al. (2010) found that website and app evolution in clouds is quicker, easier to update and scale, and overall more affordable than traditional on-premise methods requiring large upfront investments and recurring maintenance fees.

Weinhardt et al. (2009) extended the research stating that clouds offer upgrades and services on an ongoing basis, and at the same time, have standardized and reliable pricing models. This is far more favorable in the long-term budgeting than unpredictable costs of on-premise IT applications. The training based on Weinhardt's study should help SMEs in developing a long-term budget and eradicating the large server ownership missteps highlighted in the study by Sultan (2011). Yaseen et al. (2022) has also suggested that there is need to enhance the cloud cost by making SMEs aware of different priced tiers such as discount offers and free tier that reduces the cost of adopting and using the cloud.

The authors of the literature review Abdollahzadehgan et al. (2013) suggest that to estimate actual total expenditure differences and cost benefits of cloud, additional studies including Sultan (2011) and Aguilar and Kuffer (2020) should make use of case studies showing real contrast and costs of current internal IT. Maybe more specific examples corresponding to local industry sizes and IT requirements of a median company could contribute to the elimination of misconceptions that hinder the comprehension of the fiscal advantages of cloud migration among SMEs, as per the data of several quantitative studies.

5.4: Drivers for SME cloud adoption in developing economies

5.4.1 Access to advanced technologies

Cloud computing assists SMEs in developing economies to harness technologies that they could not previously afford because of the high capital intensity and resource demand. The pay per use model of cloud computing un-bounds SMEs from leveraging on powerful technologies in as much as they can afford to use or pay for them. This opens for them the opportunity of using sophisticated analytical tools to make an efficient analysis of customer and operation data stored in the cloud. SMEs can also build machine learning models on cloud infrastructure to automate business processes like demand forecasting, predictive maintenance, and customer service without investing in separate IT hardware and software. The scalable nature of cloud means SMEs only pay for the resources they use based on real-time requirements (Kamarudin et al., 2022).

SMEs are also able to create and pilot new digital ventures affordably and at a short time through cloud services. Cloud hosted web and mobile applications also help SMEs to easily bring on new product offerings and business models quicker. This assists SMEs in developing markets to update their operations, and interact with customers and counterparts in the overall market to challenge large corporations (Abdollahzadehgan et al. , 2013). The cloud enables SMEs to revolutionise business models by deploying artificial intelligence, analytics, collaborative tools and mobile technologies at a very low cost, and based on a pay-as-you-go model (Kamarudin et al. , 2022).

5.4.2: Improved business processes and operations

The use of cloud technologies leads to an enhancement of various operational processes within the SMEs. Cloud based ERP systems enable the SMEs to have a single online portal for finance management, human resource, supply chain and customer relations. This makes work transparent throughout the business and aids in the right utilization of resources. Small and medium enterprises can work on inventories, orders, invoices and even payroll from anywhere with a cloud using an internet connection (Chen and Wu, 2013). Employees' productivity increases due to cloud collaboration tools that can support online conferencing and synchronous document reviewing (El-Gazzar, 2014).

Cloud infrastructure also gives that flexibility SMEs need when adjusting business models to suit the market conditions. Cloud databases and web services support the development of omnichannel sales and distribution networks for SME products. This multi- access capability aids business resilience. The automated software, platform and infrastructure updates available through cloud ensure SME IT systems are secure and compliant with latest industry and data standards. Overall, cloud adoption leads to superior process control and operational efficiency for SMEs (Qasem et al., 2020).

5.5: Barriers in cloud adoption faced by SMEs in developing nations

5.5.1: Lack of IT expertise and skills

One of the major bottlenecks in cloud computing adoption among SMEs in developing countries is the lack of trained human capital with requisite digital skills (Alharbi and Aldossary, 2021). SMEs often face difficulties in tasks like cloud architecture planning, migration of legacy systems, ongoing management of cloud platforms, integration with in-house applications, implementing security controls and monitoring tools. There is a huge skill gap as the pace of innovation in cloud technology is much faster compared to training programs in such countries (Europe Union, 2016).

Also, most SMEs cannot afford dedicated cloud experts on payroll and instead rely on outsourcing IT functions. However, finding trusted external partners with expertise in specific cloud platforms, applications and emerging technologies like AI/IoT remains challenging (Hemant, 2022b). This technical knowledge asymmetry leads to security vulnerabilities and inability to fully leverage cloud's cost-saving potential. While cloud vendors offer online certification programs, developing comprehensive training infrastructure suitable for SME needs will take more efforts (Alam and Mamun, 2017).

5.5.2: Interoperability and vendor lock-in risks

Proprietary APIs and data formats used by large cloud vendors create interoperability issues for SMEs using multiple platforms (Şener et al., 2016). Migrating workloads and applications developed on one cloud to an alternative requires re-engineering efforts and depends on the co-operation of original service provider. SMEs investing heavily on a particular infrastructure or software-as-a-service model then face the risk of being tied to price increases or unilateral changes by that single vendor (Weinhardt et al., 2009).

There are inadequate standards ensuring portability of cloud artifacts and services across platforms which is essential for SMEF agility and preventing monopolistic practices. Vendor lock-ins diminish SME negotiating power for future service level agreements as well. Limited multi-cloud and hybrid IT integration functionalities also pose management

overheads. To mitigate such interoperability and lock-in risks, SMEs need access to open-source and industry-agreed solutions which cloud market is still evolving towards (Awan et al., 2020).

Conclusion

This study identifies the prospect of safer forms of cloud computing to enhance the engagement of SME in e-commerce transactions. The findings of the study show that the Cloud solutions provide a plethora of advantages inclusive of cost reduction, flexibility, and access to innovative technologies, nevertheless, the issues related to security still hamper SMEs. Thus, the research calls for cloud providers to counter these issues with enhanced security features, clear reporting, and SME-specific accreditation. Further, the research has highlighted the role of government encouragement and homogenous cloud environments for SMEs. Consequently, the research results indicate that to expand the use of cloud solutions in SMEs, it is necessary to consider what are the barriers like perceived high costs, lack of IT staff, and interoperability problems. Thus, organizations can reduce inefficiency gaps through the use of secure cloud solutions in order to increase competitiveness of SMEs and contribute to the digital economy. The findings of this research will prove useful to cloud providers, policymakers and SMEs themselves on how to manage the cloud adoption process and optimise the use of cloud technologies for the benefit of organisational development.

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