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CLOUD COMPUTING INFRASTRUCTURE DESIGN TO OPTIMIZE DIGITAL UMKM BUSINESSES

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Abstract

Advances in digital technology enable Micro, Small, and Medium Enterprises (MSMEs) to adapt to the digital environment to improve competitiveness and business sustainability. However, limited information technology infrastructure, high investment costs, and low technical readiness are major obstacles in the digital transformation process of MSMEs. Cloud computing offers a solution through the provision of flexible, efficient, and affordable technology services. This study aims to design a simple cloud computing infrastructure that suits the needs of digital MSMEs. Theoretical and literature reviews are used to identify the benefits, challenges, and relevant cloud service models for MSMEs. The research method used is a descriptive and design approach, with data mining through literature studies and analysis of MSME needs. The results show that the implementation of cloud computing, particularly through SaaS-based services, can improve cost efficiency, operational flexibility, and data security for MSMEs. The proposed infrastructure design emphasizes ease of use, scalability, and the utilization of built-in security features. The conclusion of this study confirms that appropriate cloud computing design can be a strategic solution in supporting the sustainable digital transformation of MSMEs.

Keywords: Cloud computing, digital MSMEs, Digital transformation, IT infrastructure, Operational efficiency.

INTRODUCTION

Rapid advances in digital technology have brought changes to many industries, including businesses, and this has also benefited Micro, Small, and Medium Enterprises (MSMEs). MSMEs, which are the economic backbone of many communities, must adapt to the digital environment to remain competitive and relevant amidst rapid market changes (Rumetna et al., 2017; Modisane & Jokonya, 2021). Unfortunately, many MSMEs face various technical challenges, such as inadequate IT infrastructure, high server investment costs, inefficient data management, and challenges in managing websites or applications independently (Kamarudin et al., 2022; Rahman & Hossain, 2024). This hinders MSMEs' ability to provide reliable and scalable online services, despite significant consumer demand for digital services (Modisane & Jokonya, 2021; Rahman & Hossain, 2024).

As a solution, cloud computing-based services offer convenience: data storage, application hosting, flexible access, and scalability without the need for physical infrastructure. For MSMEs, this means reduced initial costs, systems can be run on-demand, and technical risks can be minimized (Rumetna et al., 2017; Mardiyati et al., 2025). Therefore, adopting cloud computing has the potential to help MSMEs overcome technological limitations and accelerate digital transformation (Kamarudin et al., 2022; Rahman & Hossain, 2024).

However, adoption alone is not enough; cloud infrastructure design is needed to meet MSME needs: simple, cost-effective, secure, and scalable (Hartanto et al., 2022). Because cloud computing itself has various service models (IaaS, PaaS, SaaS), as well as different needs depending on the scale and type of business being run (Kamarudin et al., 2022; Alshamaila et al., 2013. Therefore, the right cloud architecture design is crucial so that the benefits of cloud computing can be optimized by digital MSMEs (Hartanto et al., 2022; Kamarudin et al., 2022).

Based on the conditions described above, this research aims to develop an optimal cloud computing infrastructure for digital MSMEs, encompassing system design, storage schemes, application hosting, and data security mechanisms to support online operations, improve market access, and enhance efficiency and productivity within MSMEs. Therefore, the research findings are expected to provide practical and applicable guidance for MSMEs seeking to transition to digital services without the burden of significant infrastructure investment.

This research aims to analyze the technical requirements of digital-based MSMEs and design a simple cloud architecture, using a cloud service model suitable for small and medium enterprises. It is hoped that the results of this design can offer concrete solutions to the infrastructure and technology issues that have hampered the digital transformation process of MSMEs in Indonesia (Mardiyati et al., 2025; Rahman & Hossain, 2024).

METHODS

This research uses a descriptive and design approach to produce a simple, affordable, and easily implemented cloud computing infrastructure design for digital MSMEs. This method was chosen because the research does not require complex technical implementation, but rather emphasizes gathering and analyzing information needs, and developing a cloud-based solution design tailored to the characteristics of MSMEs.

The research consisted of four main steps:

1. Literature Review,

2. MSME Needs Analysis,

3. Cloud Infrastructure Design,

4. Developing Recommendations for Cloud Computing Use for MSMEs.

These stages were arranged sequentially to ensure the research produced a cloud plan that was effective, theoretically sound, and aligned with the operational needs of MSMEs.

1. Literature Review

A literature review was conducted to obtain a theoretical basis for utilizing cloud computing to support the operations of Micro, Small, and Medium Enterprises (MSMEs). The study focused on the key benefits of cloud technology, challenges frequently encountered during the adoption process, and implementation strategies tailored to the characteristics of MSMEs in Indonesia and globally (Rumetna et al., 2017; Widyastuti & Irwansyah, 2018; Kamarudin et al., 2022). The results of the literature review serve as the basis for formulating a relevant, efficient, and easy-to-implement cloud infrastructure design.

The reviewed literature demonstrates that cloud computing offers various benefits for MSMEs, ranging from reduced hardware investment costs, easier and more flexible data access, to increased business capabilities to adjust service capacity according to business needs (Modisane & Jokonya, 2021; Rahman & Hossain, 2024). Cloud utilization also supports real-time data processing, thereby improving the speed and quality of business decision-making (Kamarudin et al., 2022).

In addition to its benefits, the literature also highlights several challenges often faced by MSMEs in adopting cloud services. These include data security, human resource readiness to operate new technologies, and the need for a stable internet network. These factors must be considered to ensure optimal cloud implementation (Widyastuti & Irwansyah, 2018; Hartanto et al., 2022).

Further studies have shown that MSMEs can implement various strategic approaches to developing cloud-based systems. These strategies include selecting services appropriate to business capacity, considering affordable operational costs, and using technology that is easily understood by MSMEs. This approach is considered effective in supporting practical cloud implementation and adapting to local MSME conditions (Hartanto et al., 2022).

Overall, the results of the literature review provide a comprehensive overview of the benefits, obstacles, and strategies for implementing cloud computing for MSMEs. This

understanding serves as a crucial foundation for analyzing needs and designing cloud infrastructure to improve the efficiency and operational performance of digital MSMEs.

2. MSME Needs Analysis

A needs analysis is conducted to understand the conditions, constraints, and primary needs of MSMEs in implementing cloud computing. This analysis serves as the basis for determining the appropriate type of service, architecture, and scale of cloud infrastructure for digital MSMEs (Kamarudin et al., 2022). The analysis focuses on operational needs, MSMEs' technological capabilities, digital literacy levels, internet infrastructure readiness, and security and cost-efficiency requirements (Hartanto et al., 2022; Rahman & Hossain, 2024).

In general, MSMEs require technology solutions that are simple, easy to use, do not require large hardware investments, and are capable of supporting business activities such as data storage, transaction management, digital marketing, and remote collaboration (Rumetna et al., 2017; Modisane & Jokonya, 2021). Furthermore, the required system must be flexible to scale with business growth. Network stability, access speed, and data protection are also crucial elements of the needs analysis, as many MSMEs operate digitally through marketplaces and social media (Kamarudin et al., 2022).

The analysis also considers the level of human resource readiness. Many MSMEs lack adequate technical skills to operate complex systems, so the required cloud solution must be user-friendly, have a simple interface, and provide process automation (Hartanto et al., 2022). Furthermore, cost is a key factor, so cloud services with flexible payment systems (pay-as-you-go) are considered more suitable than large subscription systems that burden operational expenses (Modisane & Jokonya, 2021).

Through this analysis, MSME needs can be formulated into several key points: secure data storage support, easy access from various devices, simple system integration capabilities, stable service performance, and affordable costs. The results of this needs analysis serve as the basis for designing an appropriate cloud infrastructure tailored to the needs of digital MSMEs.

3. Cloud Infrastructure Design

The cloud infrastructure design in this study focused on providing a solution that was simple, easy to implement, and did not require advanced technical skills. The primary goal of the design was to ensure that MSMEs could utilize cloud technology without having to make large investments or install complex systems (Hartanto et al., 2022). Therefore, the design was created with ease of use, cost efficiency, basic data security, and service capabilities to support daily business activities in mind.

The first step in the design was to determine the basic cloud services most needed by MSMEs. Based on the analysis, the primary needs of MSMEs include data storage, automatic backup, access from mobile devices, and document sharing capabilities for operational activities (Kamarudin et al., 2022; Modisane & Jokonya, 2021). Given these needs, services like Google Drive, OneDrive, or local cloud storage from Indonesian providers are the right choice because they are easy to use, affordable, and do not require a dedicated server installation.

Furthermore, the system is designed to enable MSMEs to manage transaction data, business documents, and sales reports more efficiently and centrally. The use of structured

folders, access permission settings, and document sharing features facilitate collaboration between business owners and employees. This simple approach allows MSMEs to immediately begin operations without the need for complex technical configurations.

In terms of security, the design focuses on utilizing built-in features of cloud services, such as password protection, two-step verification, and encrypted storage. These measures are quite effective and easy to implement without requiring a dedicated administrator (Widyastuti & Irwansyah, 2018; Rahman & Hossain, 2024). Furthermore, the automatic backup system available on the cloud platform was chosen to eliminate the need for routine manual storage.

To ensure long-term use, the design also provides flexibility so that MSMEs can increase storage capacity as their businesses grow. Nearly all cloud services offer free plans and affordable paid plans, allowing MSMEs to tailor their usage to their needs and financial capabilities.

In general, the design of this cloud infrastructure emphasizes the use of services that are practical, familiar, and readily available without complex training. This simple approach is designed to enable MSMEs to maximize cloud technology's use with realistic and easily implemented steps in the future.

4. Developing Recommendations for Cloud Computing Use for MSMEs

Recommendations are developed based on the results of a literature review, needs analysis, and the existing infrastructure design. The goal is to provide practical, easy-to-implement guidance that aligns with the real-world conditions of digital MSMEs, which generally face limitations in technical capabilities, time, and operational budget (Hartanto et al., 2022; Mardiyati et al., 2025).

Recommendations focus on simple cloud services, organized data management, built-in security features, and flexible cost models to enable SMEs to implement cloud computing gradually and sustainably (Rumetna et al., 2017; Modisane & Jokonya, 2021). This approach is intended to encourage long-term business expansion while improving operational efficiency for SMEs (Rahman & Hossain, 2024).

Some of the recommendations include:

1. Starting with easy-to-use cloud services. SMEs are advised to utilize familiar cloud storage platforms, such as Google Drive or OneDrive. These services offer a combination of ease of use, basic security features, and flexible pricing, allowing them to be used without special technical training.

2. Maintaining data organization through an organized folder structure. SMEs are advised to establish a simple storage structure, for example, folders for transactions, sales reports, financials, and operational documents. This aims to allow business owners to access data more quickly and reduce the risk of file loss.

3. Activate built-in security features to maintain data security. MSMEs are encouraged to enable account protection such as two-step verification, strong passwords, and restricting access to each file. Using built-in security features helps protect data without the need for a technology administrator.

4. Implement automatic backups. Cloud platforms generally provide automatic backups. MSMEs are recommended to utilize this feature to ensure data remains secure even in the event of device damage or accidental deletion. This eliminates the hassle of manual backups.

5. Maximize access from various devices. The cloud makes it easier for MSME owners to monitor their business from a smartphone, laptop, or tablet. This recommendation is made to allow business owners to work more flexibly, especially those who are not always at their business location.

6. Adjust storage capacity gradually. MSMEs don't need to immediately purchase a paid plan. The recommendation is to start with a free plan and then increase capacity only when absolutely necessary. This approach saves costs and doesn't burden operations.

7. Integrate cloud services with simple business activities. MSMEs can use the cloud for even the most basic tasks, such as storing product photos, transaction receipts, customer data, or daily cash reports. This kind of integration helps business activities run more smoothly without major changes to daily workflows.

8. Prioritize options that are most familiar to business owners. Recommendations are made for MSMEs to avoid services that are overly technical or require complex configuration. The focus is on utilizing technology that is already commonly used in everyday life to facilitate the adaptation process.

Overall, these recommendations are designed to enable MSMEs to adopt cloud computing in a realistic, cost-effective way that doesn't burden users' technical capabilities. This simple approach is expected to improve MSME operational efficiency while supporting long-term business growth.

FINDINGS AND DISCUSSION

This research produces a conceptual design for cloud computing infrastructure tailored to the needs and characteristics of digital Micro, Small, and Medium Enterprises (MSMEs). The research results were obtained through a descriptive and design approach, drawing on current literature and an analysis of MSME needs. Therefore, the results presented are not experimental tests, but rather conceptual findings and designs for relevant and applicable cloud computing-based solutions (Rumetna et al., 2017; Kamarudin et al., 2022).

1. Alignment of Results with Digital MSME Problems

Based on the literature review and needs analysis, it was found that the main problems facing digital MSMEs include limited information technology infrastructure, high investment costs for physical servers, unintegrated data management, and limited technical human resource capabilities (Rumetna et al., 2017; Hartanto et al., 2022). This situation hinders MSMEs from providing reliable and scalable digital services, while consumer demand for digital-based services continues to grow (Modisane & Jokonya, 2021; Rahman & Hossain, 2024).

Research shows that cloud computing can address these challenges by providing data storage, application hosting, and flexible system access without the need for complex physical infrastructure (Kamarudin et al., 2022). With an on-demand service model, MSMEs can manage the use of technological resources according to their needs, thereby reducing initial costs and technical risks (Modisane & Jokonya, 2021).

1.2 Research Findings

The study shows that cloud computing plays a crucial role in supporting the digital transformation of MSMEs. From a cost-efficiency perspective, adopting cloud services can reduce the need for hardware investment and system maintenance costs, allowing MSMEs to focus resources on core business activities (Rumetna et al., 2017; Modisane & Jokonya, 2021).

In terms of flexibility and scalability, cloud services allow system capacity to be adjusted according to business growth and fluctuations in market demand. This advantage distinguishes cloud computing from conventional infrastructure, which is static and incurs additional costs during development (Kamarudin et al., 2022). Furthermore, easy data access across devices supports flexible work patterns and accelerates decision-making.

However, cloud computing adoption still faces challenges related to data security, human resource readiness, and reliance on internet networks. However, the availability of basic security features such as data encryption, double authentication, and automatic backups allows MSMEs to minimize security risks without requiring complex technical skills.

1.3 Results of Cloud Infrastructure Design for MSMEs

The main result of this research is a cloud computing infrastructure design that emphasizes simplicity, affordability, and ease of use. The design is tailored to the needs of MSMEs, which require centralized data storage, an automatic backup system, cross-device access, and basic data security (Hartanto et al., 2022).

The infrastructure design utilizes public cloud services with Software as a Service (SaaS) and Platform as a Service (PaaS) models. The choice of these service models was based on the limited technical capabilities of MSMEs and the need to avoid complex system management (Kamarudin

et al., 2022; Alshamaila et al., 2013). Cloud services such as cloud storage, document sharing, and simple application hosting are considered most suitable for supporting MSME digital operations (Rumetna et al., 2017).

Furthermore, this design provides MSMEs with the flexibility to gradually increase service capacity as their businesses grow. This approach allows MSMEs to start cloud adoption on a small scale without significant costs, then adjust capacity according to business needs.

Discussion

The research results indicate that appropriate cloud computing infrastructure design can be a strategic solution for MSMEs in facing the demands of digital transformation. Cloud computing acts as an enabler, enabling MSMEs to overcome limitations in information technology infrastructure, reduce operational costs, and increase their ability to provide reliable and flexible digital services (Alshamaila et al., 2013; Kamarudin et al., 2022).

A simple and applicable design approach is considered more suitable for MSMEs than complex technological solutions. This aligns with the characteristics of MSMEs, which generally have limited human resources and information technology budgets.

1. Conceptual Model of Cloud Computing Implementation in Digital MSMEs

Based on research results and explanations, this model reflects the interconnectedness of issues faced by MSMEs. A conceptual model of cloud computing implementation in digital MSMEs has been developed, as shown in the figure below:

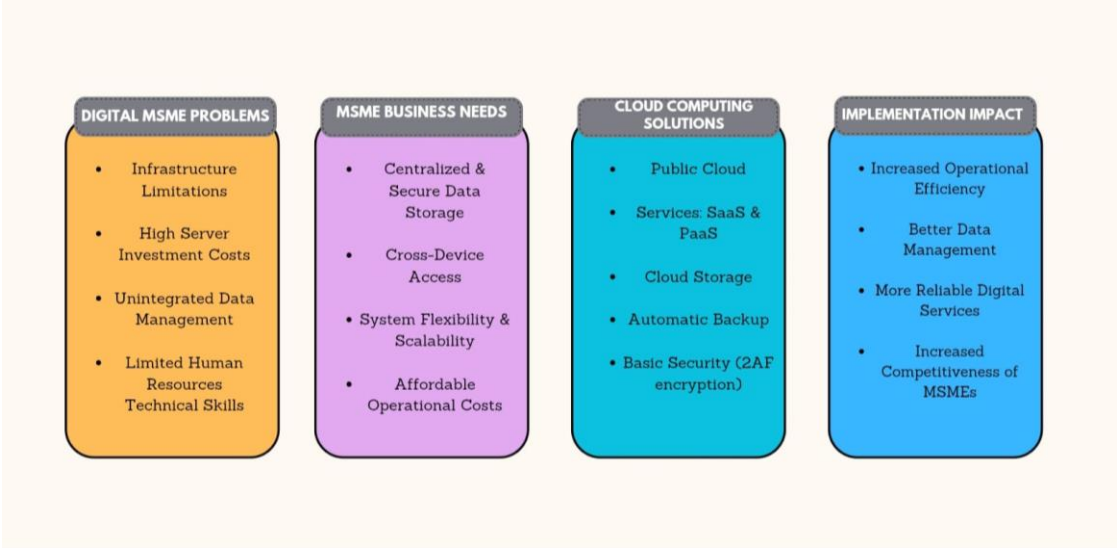

Figure 1 illustrates the relationship between digital MSMEs problems (1), business needs (2), cloud computing solutions (3), and the resulting implementation impacts (4).

This model illustrates the relationship between MSME challenges, business needs, cloud computing solutions, and the resulting implementation impacts.

The conceptual model demonstrates that digital MSME challenges drive the need for flexible, secure, and affordable systems. This need is addressed through the implementation of public cloud services with easy-to-implement SaaS and PaaS models. Future cloud computing implementation is expected to bring positive impacts in the form of increased operational

efficiency, improved information management, enhanced digital service quality, and strengthened MSME competitiveness (Modisane & Jokonya, 2021; Rahman & Hossain, 2024).

This model emphasizes that the success of cloud computing adoption is determined not only by the technology used, but also by the alignment between business needs, infrastructure design, and user readiness (Alshamaila et al., 2013).

2. Practical Implications for Digital MSMEs

The practical implications of this study's findings indicate that MSMEs can adopt cloud computing gradually without facing the burden of significant infrastructure investment. With a simple and flexible cloud infrastructure design, MSMEs can improve operational efficiency and sustainably strengthen their competitiveness (Rumetna et al., 2017; Modisane & Jokonya, 2021).

This approach allows MSMEs to focus more on core business development, while information technology management is supported by user-friendly cloud services tailored to their capabilities. Thus, cloud computing serves not only as a technical solution but also as a supporting strategy for MSMEs' digital transformation.

Overall, research findings indicate that cloud computing is an effective, efficient, and realistic technological solution for digital MSMEs when implemented through a simple infrastructure design tailored to business operational needs (Kamarudin et al., 2022; Modisane & Jokonya, 2021).

CONCLUSION

This research aims to design an optimal cloud computing infrastructure aligned with the digital business characteristics of MSMEs. Based on a descriptive and design approach supported by a literature review and analysis of MSME needs, this research produces a conceptual design for a cloud infrastructure that is simple, affordable, and easy to implement.

The results show that the main challenges faced by digital MSMEs, such as limited information technology infrastructure, high investment costs for physical servers, and limited technical capabilities of human resources, can be addressed through the use of cloud computing. Cloud services enable MSMEs to flexibly access data storage, application hosting, and operational systems without the need for physical infrastructure, thereby minimizing initial costs and technical risks.

The proposed cloud infrastructure design utilizes public cloud services with Software as a Service (SaaS) and Platform as a Service (PaaS) models. This service model is considered most suitable for MSMEs because it does not require complex technical management, offers flexible operational costs, and supports system scalability in line with business growth. With this approach, MSMEs can adopt cloud technology gradually and realistically.

Furthermore, this study develops a conceptual model for cloud computing implementation in digital MSMEs, illustrating the relationship between challenges, business needs, technological solutions, and implementation impacts. This model demonstrates that successful cloud computing adoption is determined not only by the technology used, but also by the alignment between MSME needs, infrastructure design, and user readiness.

Overall, this study provides a conceptual and efficient contribution in the form of a cloud computing infrastructure design that can serve as an initial guide for digital MSMEs in supporting digital transformation and increasing business competitiveness. For further research, empirical testing or direct implementation in MSMEs is recommended to quantitatively measure the effectiveness of cloud design and more deeply evaluate its impact on business performance.

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