UNIVERSITAS UTPADAKA SWASTIKA
Jl. KS Tubun No.11 Tangerang 15112 Banten. Telp. (021) 5589161-62 Fax. (021) 5589163
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Comparative Analysis of Cloud Service Models for Professional Use: IaaS, PaaS, and SaaS

*Moh. Alfaujianto[1], Fahmi Rizky Nugraha[2], Fajar Muttaqi[3], Lukas Umbu Zogara[4]

Utpadaka Swastika University, Tangerang, Indonesia 15112
E-mail: moh.alfaujianto@utpas.ac.id[1], fahmi.rizky.nugraha@utpas.ac.id[2], fajar.muttaqi@utpas.ac.id[3], lukas.zogara@utpas.ac.id[4]
*corresponding author: moh.alfaujianto@utpas.ac.id

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ABSTRACT

This study aims to conduct a structured comparative analysis of cloud computing service models-Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS)-for professional use across multiple sectors. A quantitative comparative approach was employed using data collected from scientific literature and semi-structured interviews involving 15 professionals from education, business, and technology sectors. Each model was evaluated based on five parameters: flexibility, scalability, cost efficiency, user control, and sector relevance using a Likert scale (1–5). The results indicate that IaaS achieved the highest score in flexibility (5.0) and user control (5.0), PaaS showed balanced performance across development-related parameters (average score 4.2), while SaaS demonstrated the highest cost efficiency (5.0). These findings highlight that no single model is universally superior, and selection should be aligned with organizational priorities. This study contributes by providing a parameter-based quantitative comparison framework to support decision-making in cloud service adoption.

KEYWORDS: Cloud computing, IaaS, PaaS, SaaS, professional, comparative, information technology

1. Introduction

In this rapidly changing digital period, cloud computing technology is supposed to be the backbone of digital transformation in many sectors, such as education, business, and public services[1]

. Cloud computing enables organizations and individuals to flexibly access computing resources over the internet instead of concentrating on expensive, hard-to-operate physical infrastructure[2]. This technology provides innovative data processing, storage, and application management solutions that enable organizations to adapt to technological changes and increasingly complex business needs.

With increasing technological advancements and the growing need for computation efficiency, cloud computing adoption remains high. In fact, in a report by Gartner (2025)[3], it is considered that with an average annual growth of 18%, cloud technology usage is increasing. This reveals a shifting paradigm from how organizations manage information technology on-premises to more flexible, scalable, and efficient cloud-based systems[4]. The most important benefit of cloud computing is dynamic service provisioning as per user demand, which cuts down operational costs and enhances efficiency in managing the IT infrastructure.

Cloud computing offers a variety of service models that can be tailored to user needs[5]. The three main models of cloud computing services are Infrastructure as a Service (IaaS)[6], Platform as a Service (PaaS)[7], and Software as a Service (SaaS)[8]. Each model has unique characteristics that differentiate it from the others in terms of the level of management, flexibility, and control afforded to users. IaaS provides access to a computing infrastructure that includes servers, storage, and networks, allowing organizations to manage and configure their resources as needed. PaaS provides an integrated development environment, allowing developers to build, test, and deploy applications without worrying about the underlying infrastructure. Meanwhile, SaaS offers software that is ready to use immediately without requiring installation or maintenance by end users, making it ideal for business applications such as customer relationship management (CRM), office software, and other web-based services.

While all three cloud computing service models offer various advantages, selecting the right model is often challenging for organizations and professionals. Factors such as the organization's specific needs, cost efficiency, the level of control required[9], and service scalability are key considerations in determining the most appropriate model. Therefore, it is important for organizations to understand the characteristics of each model and tailor them to their operational needs to optimally utilize cloud technology.

Previous studies have generally discussed cloud computing models from a conceptual or implementation perspective. However, limited research has quantitatively compared IaaS, PaaS, and SaaS using measurable parameters that reflect professional sector needs. Most existing studies focus on technical aspects or single-model evaluations without providing a structured comparative framework. Therefore, this study addresses this gap by offering a parameter-based quantitative comparison to support more objective decision-making in selecting cloud service models.

This study aims to provide a comparative analysis of three cloud computing service models, focusing on how each model can be optimally utilized by professionals in various sectors[10]. By identifying the advantages, disadvantages, and best applications of each model, this study is expected to provide practical guidance for organizations in strategically adopting cloud technology[11]. This analysis will also assist decision-makers in selecting the service model that best suits their organizational needs, both in terms of cost efficiency[12][13], operational flexibility[14], and control over used resources.

This study begins with a literature review of the basic concepts and characteristics of each cloud computing service model. Next, this study will compare the three models based on key parameters such as flexibility, scalability, cost efficiency, and user control. With a systematic approach, this study is expected to provide deeper insights into how organizations can leverage cloud computing to improve their operational efficiency and effectiveness. Ultimately, the results of this research are expected to contribute to better decision-making in selecting a cloud computing service model that suits the needs of professionals and organizations[15].

2. Research Methods

This study employs a quantitative comparative approach to evaluate three cloud computing service models: IaaS, PaaS, and SaaS.

2.1 Explaining Quantitative Analysis

Data were collected from two sources:

a. Primary data: Semi-structured interviews with 15 professionals from education, business, and technology sectors using purposive sampling.
b. Secondary data: Scientific literature, industry reports, and previous research related to cloud computing.

2.1.1 Characteristics of Quantitative Analysis:

Quantitative analysis is a research approach that focuses on processing numerical and statistical data to identify patterns, relationships, or trends in a phenomenon. Some of the main characteristics of quantitative analysis are:

a. Numerical Data-Based

Quantitative analysis uses numbers as the primary basis for evaluating a phenomenon. The data collected is in the form of numbers, whether in the form of survey results, experiments, or secondary data that can be converted into numerical form.

b. Objectivity and Replicability

One of the main goals of the quantitative approach is to produce objective results that can be retested by other researchers. The methods used in quantitative research are designed to be free from subjective bias, and the results can be replicated using the same data and analysis techniques.

c. Use of Statistical Techniques

Quantitative analysis utilizes various statistical methods such as regression, correlation, hypothesis testing, analysis of variance (ANOVA), and other statistical techniques to examine relationships between variables, identify patterns, and test the significance of data.

d. Generalizability

One of the advantages of quantitative analysis is its ability to generalize research results to a wider population. By using a representative sample and appropriate analytical techniques, quantitative research results can be applied to larger groups beyond the research sample.

e. Hypothesis Testing

Quantitative research typically begins with the formulation of a hypothesis, which is then tested using statistical methods. The results of the analysis will determine whether the hypothesis can be accepted or rejected based on the data obtained.

f. Standardized Measurement

Data in quantitative research is collected using standardized instruments, such as questionnaires with a Likert scale, measurement tools, or data analysis software. This standardization ensures that research results can be measured with a high level of validity and reliability.

g. Deductive

Quantitative approaches generally use deductive methods, where research begins with an existing theory or hypothesis, then tests it with empirical data to prove or reject it.

2.1.2 Methods in Quantitative Analysis:

Quantitative analysis uses various methods to collect, process, and analyze numerical data to identify patterns or relationships between variables. The following are some of the main methods used in quantitative analysis:

a. Data Collection Methods

This method aims to obtain numerical data for analysis. Some commonly used techniques include:

a) Surveys

Using questionnaires or structured interviews to collect data from a large number of respondents. Typically using a measurement scale such as the Likert scale.

b) Experiments

Involving the manipulation of variables in a controlled environment to observe their impact on other variables. Used in scientific and social research.

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c) Quantitative Observation

Data collection based on direct observation of a particular phenomenon by recording it in numerical or statistical form.

d) Secondary Data

Using data collected by other parties, such as industry reports, census data, or previous research results.

b. Data Analysis Methods

After the data is collected, statistical methods are used to analyze and interpret the results. Commonly used methods include:

a) Descriptive Analysis

Used to describe data characteristics, such as mean, median, mode, standard deviation, and frequency distribution.

b) Inferential Analysis

- Aims to draw conclusions about the population based on the sample studied, using techniques such as:
- b) Regression: Tests the relationship between independent and dependent variables.
- c) Correlation: Measures the degree of relationship between two variables.
- d) Hypothesis Testing (t-test, ANOVA, Chi-Square): Checks for significant differences between groups of data or specific variables.

c) Multivariate Analysis

Used when more than two variables are analyzed simultaneously, such as Factor Analysis and Cluster Analysis.

2.1.3 Hypothesis Testing

In quantitative methods, research typically begins with a hypothesis, which is then tested using statistical methods. The main steps in hypothesis testing include:

a. Formulating the null hypothesis (H_0) and alternative hypothesis (H_1).
b. Selecting an appropriate statistical test method.
c. Analyzing the data using statistical calculations.
d. Determining whether the null hypothesis can be accepted or rejected based on the significance value (p-value).

2.1.4 Data Processing Techniques

a. To accurately analyze data, data processing techniques are required, such as:
b. Data Cleaning: Removing or correcting invalid or incomplete data.
c. Data Transformation: Changing the format or scale of data to suit the analysis method used.
d. Data Visualization: Displaying data in the form of graphs, diagrams, or tables to facilitate interpretation of the results.

2.2 Comparative Analysis

Comparative analysis is a research method used to compare two or more entities (e.g., concepts, theories, policies, or phenomena) with the aim of identifying similarities, differences, and patterns that may emerge between them. This method is often used in social sciences, economics, political science, and computer science to identify factors that influence differences or similarities in a phenomenon[16].

Characteristics of Comparative Analysis:

Comparative analysis is a research method used to compare two or more entities, concepts, or phenomena to identify similarities, differences, and factors influencing variation between them. This approach is often used in various disciplines such as social sciences, economics, science, and technology to evaluate the effectiveness, efficiency, and relative advantages of various available options.

The following are some of the main characteristics of comparative analysis:

a. Focus on Comparison
   a) This analysis aims to compare two or more research objects, whether policies, methods, strategies, systems, or other variables.
   b) Comparisons can be made qualitatively (based on descriptions) or quantitatively (based on numerical data).

b. Identifying Similarities and Differences
   a) Comparative analysis identifies factors that make two or more entities similar or different.
   b) Similarities can indicate general patterns or principles, while differences can help understand the unique factors that influence each entity.

c. Using a Conceptual Framework or Specific Criteria
   a) Comparisons are made based on predetermined criteria, such as efficiency, effectiveness, cost, impact, or flexibility.
   b) This framework helps maintain objectivity and consistency in the analysis.

d. Based on Data and Empirical Evidence
   a) In a quantitative approach, comparative analysis often uses statistical data, graphs, or mathematical models to objectively compare variables.
   b) In a qualitative approach, the analysis is based on case studies, interviews, or documents that provide in-depth insights into the subjects being compared.

e. Systematic and Structured
   a) The analysis is conducted with a planned and systematic approach to ensure the results are accountable.
   b) It usually follows steps such as selecting subjects to be compared, determining variables or indicators for comparison, analyzing data, and interpreting the results.

f. Aims to Draw Conclusions or Recommendations
   a) The results of a comparative analysis are typically used to make better decisions, whether in academic research, business, public policy, or technology development.
   b) The conclusions obtained can help understand the factors that influence differences in the performance or effectiveness of one entity compared to another.

This study uses a quantitative and comparative approach to analyze cloud computing service models (IaaS, PaaS, SaaS) based on key parameters relevant to the needs of professionals in various sectors. The research method is designed to provide measurable and in-depth results through a series of systematic stages as follows:

a. Research Design

This research is an analytical study with a quantitative and comparative approach. Data was obtained from primary and secondary sources to provide a comprehensive overview of each cloud computing service model.

b. Data Collection

a) Primary Sources:

Data were collected through semi-structured interviews with professionals from various sectors, such as education, business, and technology. Questions focused on user experiences, specific needs, and challenges faced in using cloud services.

b) Secondary Sources:

Secondary data was obtained from scientific literature, industry reports, and relevant technical documents. Previous research on the characteristics and implementation of cloud computing was also analyzed.

c. Analysis Parameters

The instrument used was a structured questionnaire based on a Likert scale (1–5) to measure five parameters:

1 Flexibility
2 Scalability
3 Cost Efficiency
4 User Control
5 Sector Relevance

d. Data Analysis

Each parameter was quantified using the following scoring formula:

$$\text{Score} = \frac{\sum x_i}{n}$$

where:

- x_i = respondent score
- n = number of respondents

The results were analyzed using a comparative matrix approach and presented in tables and visual charts.

e. Comparative Approach

Each cloud computing service model (IaaS, PaaS, SaaS) was compared based on predetermined parameters. The analysis results were presented in comparative tables and graphs for easy interpretation.

f. Validation of Findings

Data validity was ensured through:

- Triangulation (primary and secondary data)
- Member checking with selected respondents

3. Results and Discussion

3.1 Results of Cloud Computing Service Parameter Analysis

Based on the comparative analysis, IaaS achieved the highest score in flexibility (score: 5), while SaaS showed the highest cost efficiency (score: 5). These findings align with previous studies [10], which highlight that IaaS provides maximum infrastructure control, whereas SaaS is designed for ease of use and affordability. This indicates that the selection of cloud models should be aligned with organizational priorities shown in Table 1:

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Table 1. Comparison Table of Three Services Based on Parameters

Parameter	IaaS	PaaS	SaaS
Flexibility	5.0	4.2	3.1
Scalability	4.8	4.5	4.3
Cost Efficiency	3.2	4.0	5.0
User Control	5.0	3.8	2.5
Sector Relevance	4.6	4.3	4.7

3.2 Discussion

The results demonstrate that IaaS provides the highest level of flexibility and control, which is consistent with previous findings [10] that emphasize infrastructure-level customization as a key advantage of IaaS. However, its lower cost efficiency score indicates higher operational complexity and resource requirements.

PaaS shows balanced performance across all parameters, making it suitable for development-oriented environments. This aligns with studies highlighting PaaS as an efficient solution for rapid application deployment.

SaaS achieved the highest score in cost efficiency, supporting findings from [15] that identify SaaS as the most accessible model for end-users. However, its low user control score indicates limitations in customization, which may not be suitable for complex organizational needs.

These findings confirm that cloud service selection should be context-dependent, particularly based on organizational scale, technical capability, and operational priorities.

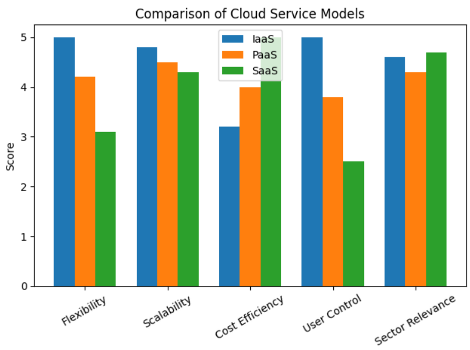

Figure 1. Comparison of Cloud Service Models Based on Evaluation Parameters

Figure 1 illustrates the comparative performance of cloud service models across key evaluation parameters. The results indicate that Infrastructure as a Service (IaaS) demonstrates superior performance in terms of flexibility and user control, reflecting its capability to provide full access and customization of underlying infrastructure. In contrast, Software as a Service (SaaS) achieves the highest score in cost efficiency, highlighting its advantage as a low-cost, ready-to-use solution that minimizes operational and maintenance overhead. This comparison underscores the fundamental trade-off between control and cost, where IaaS is more suitable for organizations requiring high configurability, while SaaS is ideal for users prioritizing efficiency and ease of use.

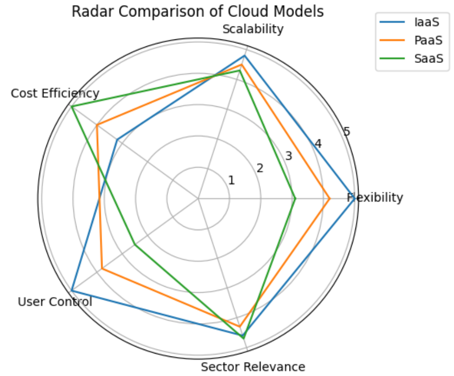

Figure 2. Radar Visualization of IaaS, PaaS, and SaaS Performance

Figure 2 presents a holistic visualization of the performance of cloud service models across all evaluated parameters using a radar chart. The figure shows that Platform as a Service (PaaS) demonstrates a relatively balanced performance in all aspects, without extreme strengths or weaknesses compared to the other models. This balance indicates that PaaS is well-suited for environments that require a compromise between flexibility, scalability, cost efficiency, and control. While it does not outperform IaaS in terms of control or SaaS in cost efficiency, PaaS offers a stable and adaptable solution, particularly for application development contexts where moderate control and efficiency are both essential.

3.3 Further Research Opportunities

This research provides a basis for further exploration, such as:

a. A detailed cost analysis for each service model based on specific usage scenarios.
b. A longitudinal study of the impact of cloud computing implementation on organizational productivity and efficiency.

4. Conclusion

This research has comparatively analyzed three cloud computing service models-Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS)-based on parameters such as flexibility, scalability, cost efficiency, level of user control, and relevance to the professional sector. Some key conclusions that can be drawn from this research are as follows:

4.1 Characteristics and Suitability of Service Models:

The suitability of services can be tailored to the needs and budget.

a. IaaS provides the highest flexibility and control, making it ideal for large organizations that require complete control over their information technology infrastructure.
b. PaaS offers an efficient and flexible development environment, particularly suitable for the creative sector and application developers.
c. SaaS is the most cost-effective and easy-to-adopt solution, relevant for sectors requiring ready-to-use applications, such as education and MSMEs.

4.2 Advantages and Challenges:

Each model has unique advantages and challenges that need to be tailored to specific user needs. IaaS requires a large initial investment, PaaS has limited infrastructure flexibility, and SaaS has limited user control.

4.3 Strategic Selection Guide:

Selecting the right cloud computing service model must consider the organization's needs, scale of operations, and available technical capacity. A strategic approach can help organizations harness the full potential of cloud technology to improve their operational efficiency and competitiveness.

4.4 Implications and Recommendations

This research provides important insights for professionals and organizations in understanding the role and applications of cloud computing. To ensure effective adoption, a thorough needs assessment is necessary before selecting a service model. Furthermore, further research that is more specific to specific sectors or use cases can provide more targeted guidance for decision-makers.

With these results, it is hoped that organizations can maximize the potential of cloud computing technology as part of their ongoing digital transformation. Provides a statement of what is expected, as stated in the "Introduction" chapter to the "Results and Discussion" chapter, so that there is compatibility.

This study contributes to the existing literature by providing a quantitative and parameter-based comparative framework for evaluating cloud service models. The findings offer practical guidance for professionals and organizations in selecting appropriate cloud solutions based on measurable criteria.

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