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Cloud Computing Environment Optimization: A Comprehensive COPRAS Methodology Approach

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ABSTRACT

Cloud computing has emerged as a transformative technology, offering diverse service models to meet varying organizational needs. This study employs the Complex Proportional Assessment (COPRAS) method to comprehensively evaluate and analyze different cloud environments, providing a nuanced approach to cloud service selection. The research investigates five distinct cloud environment types: general-purpose, service-centric, zone-centric, distance-centric, and cost-centric, examining their performance across critical parameters including quality of service, number of available services, availability zones, consumer distance, and hourly cost.

The multi-criteria analysis reveals significant variations in cloud environment effectiveness. Zone-centric environments emerged as the top performer, achieving a remarkable quality index of 0.291 and a 100% usability degree. Service-centric environments followed closely, demonstrating a 92.03% usability degree and highlighting the importance of service availability. General-purpose environments showed moderate performance with a 63.97% usability degree, indicating their versatility. Conversely, distance-centric and cost-centric environments exhibited the lowest performance, suggesting limitations in meeting comprehensive organizational requirements.

Key findings underscore that cloud computing is not a one-size-fits-all solution but a complex ecosystem requiring strategic selection. The research emphasizes that while cost is important, it should not be the sole determining factor in cloud environment selection. The study provides a robust framework for decision-makers, enabling them to align cloud infrastructure choices with specific organizational objectives. The methodology offers critical insights into the evolving cloud computing landscape, addressing the growing complexity of data management and the increasing demand for scalable, secure computing solutions. By presenting a comprehensive evaluation approach, the research contributes to a more sophisticated understanding of cloud environment selection, encouraging organizations to adopt a strategic, multi-dimensional approach to cloud infrastructure deployment.

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Introduction

Amazon emphasizes that securing tenant virtual machines is the responsibility of the tenants themselves. This means tenants must take independent measures to safeguard their virtual machines hosted in the cloud. Although they can utilize security tools like anti-virus software and host-based intrusion detection systems, these measures have inherent limitations. [1] Considering the variety of We contend that a universal trust management solution does not exist for cloud environments due to the diversity of service and deployment models. Although a trust management service can function independently from cloud services, trust techniques and evaluation methods must align with the specific cloud service models. It is crucial to explore the available trust management approaches and determine which cloud services they are best suited for. This understanding is essential for designing tailored trust management solutions that effectively address the needs of different cloud service types. [2] Cloud computing is often viewed Building on the foundation of grid computing, it emphasizes on-demand access to a shared pool of computing resources.

However, a key distinction lies in the types of applications they typically support. Grids are mainly tailored for resource-intensive batch processing tasks, while cloud computing is designed to handle computing is geared toward more versatile and interactive online applications. [3] The dynamic The commodity economy model represents the dynamic relationship between resource supply and demand within a distributed system. Resource providers act as suppliers, offering various resources to users, who function as buyers. Users must pay to meet their resource requirements.

Economic model-based job scheduling algorithms operate on the principle of creating market-like mechanisms between resource providers and consumers, using pricing strategies to balance resource availability with user demand. [4] Container as a Service (Camas) is a contemporary cloud service model based on container virtualization, offering container-based solutions. service. CaaS addresses the limitations of applications tied to specific PaaS environments, where execution is restricted by the platform's specifications. By decoupling applications from PaaS environments, Camas eliminates these dependencies, enabling container-based applications to be fully portable and executable across various environments. [5] OCTAVE includes not only a qualitative survey but also a weighted scoring system that enables a quantitative comparison for assessing threats and prioritizing assets.

It is intended to be carried out by internal staff, based on the premise that they possess a deeper understanding of the organizational context and asset value. Additionally, the implementation process allows employees to develop subject matter expertise through hands-on assessment. [6] The interface allows users to select Jet Stream offers a variety of virtual machine (VM) images, including a public library of pre-configured VMs tailored for specific analytical tasks and custom VMs designed for particular applications, which can be kept private or shared with a small team. Adari et al. has been published on the pivotal role of APIs and Open Banking in enabling seamless financial sector interoperability in the International Journal of Research in Computer Applications and Information Technology. [7] The size of data sets used in applications is expanding at an unprecedented pace.

Advances in sensor technology, improved bandwidth availability, and the widespread adoption of Internet-connected handheld devices have created an environment where even small-scale applications must handle large volumes of data. What was once rare, such as handling a terabyte of data, has now become routine. For instance, contemporary high-energy physics experiments, like XEROX, can produce over a terabyte of data daily. [8] Cloud Services such as shared computing resources, servers, data storage, applications, and networks are offered to users on a pay-as-you-go basis. In the SaaS model, licensed software is delivered to users via a subscription and can be accessed from any device with a web browser. PaaS allows users to develop their own services using cloud resources and run them on their own systems.

IaaS delivers enterprise-grade infrastructure to customers over the Internet, eliminating the need for customers to understand the underlying infrastructure. Instead of purchasing the entire infrastructure to meet business needs, customers rent it as required. When their infrastructure demands are unmet, the payment for the services is adjusted accordingly. [9] Amazon provides a range of storage options through virtual machines and private cloud software solutions like Eucalyptus. Virtual machines have access to local disks, but these disks are not persistent across instances. Additionally, instances can attach block-level storage volumes that remain intact even after the instance terminates.

Amazon Elastic Block Store (EBS) is designed to be a highly reliable storage solution, making it ideal for applications that need database storage, file systems, or raw volume-level storage access. [10] The model developed by Huynh Kim et al. for evaluating the availability of resources in the cloud and real-time scheduling shows that FIFO (First in, First Out) takes the longest time. The evaluation was based on wait time, response time, and processing time, and testing was conducted across four different environments: normal, Xin-based, GT-based, and GTX-based. The results indicated that the outcomes were entirely dependent on the type of virtualization and the scheduler employed. [11] The cloud computing model is transforming how users access and utilize technology solutions.

In this approach, cloud providers deliver infrastructure resources and computing power as a service. Users gain advantages such as resource scalability, cost-effectiveness, and streamlined management. Furthermore, cloud computing is driving a reassessment of the economic dynamics between providers and users, emphasizing service cost and operational efficiency. [12] In recent years, biomedical signal monitoring systems have advanced significantly due to developments in electronics and information technologies. Here, we present an innovative brain-computer interface capable of capturing and analyzing EEG signals in real time to monitor physiological and cognitive states, while providing alerts to users. A brain-machine interface serves as a communication system that bypasses the brain's traditional output pathways through peripheral nerves and muscles. [13] Data security is a critical challenge in cloud computing environments due to the constant threat of attackers attempting to compromise the confidential data of the Data Owner (DO).

In some cases, attackers may alter this sensitive information. As a result, the Cloud Service Provider (CSP) Robust security measures must be put in place to safeguard data against unauthorized access. Recently, DNA computing has been utilized in various fields to enhance data security. This approach uses DNA sequences, biochemistry, and hardware to encrypt genetic information within the system. [14] As previously mentioned, elasticity is The key feature of cloud computing, though beneficial, can also be a double-edged sword. It enables applications to be dynamically provisioned and resources to be released based on fluctuating demands, determining the appropriate amount of resources can be challenging. Ideally, a system would automatically adjust resources according The application manages the workload with little to no human intervention.

This concept, known as auto-scaling, is the primary focus of this survey. [15] We refer to this process as PM Candidate Selection (PMCS). It takes into account two heuristic metrics: Imbalance and volume, which encompass the multidimensional characteristics of VMs and PMs, aim to optimize resource utilization. utilization. Through our experiments, we found that by combining these two metrics, our approach significantly improves resource utilization for cloud providers. [16] We encountered the research challenge of minimizing intrusions while dynamically implementing countermeasures to run an Intrusion Prevention System (IPS) in a cloud virtual networking environment. NICE developed an attack-map-based IPS to identify and defend against attacks in the cloud.

Our focus was on utilizing attack maps to choose suitable countermeasures and reconfigure the cloud virtual networking system to either mitigate or prevent these attacks. The attack analyzer, situated in the cloud security control center, handles the alert communication and countermeasure selection. [17] In reality, Trans-disciplinary computing environments are often too complex for most users to navigate, demanding detailed, low-level programming through command lines and script execution to design tasks on each node, specifying the resources or data structures they access. This complexity leads to user frustration, hinders the adoption of service-oriented (SO) techniques, and defeats the core purpose of the cluster, with numerous specialized "cluster/grid/cloud-aware" tools that are incompatible with one another. Grid/Cloud infrastructure. [18] First, let's examine approaches to interoperability.

In practice, cloud interoperability can be facilitated through brokering or standardized interfaces. A service broker, which translates messages between various cloud interfaces, enables customers to switch between different clouds and fosters collaboration among cloud providers. Another common method for achieving interoperability is the standardization of interfaces. This study also explores various Standards and initiatives associated with technologies that govern inter-cloud environments. [19] Many hospitals are transitioning to electronic health records (EHRs), which provide a digital version of patient information ensure quick access whenever needed. EHRs play a key role in enhancing patient care, improving clinical efficiency, and advancing healthcare research. With the constant growth of healthcare data, managing it efficiently requires specialized technologies such as Distributed data networks, parallel processing, scalable storage, infrastructures, and architectures. Cloud computing, with its service-oriented architecture, addresses these challenges by providing a cost-effective solution to manage healthcare data in a virtual environment. [20]

Materials and Methods:

General-purpose environment: The environment is essential for sustaining healthy life on Earth. Our planet serves as a home for countless living organisms, and we rely on it for basic needs such as food, air, water, and more. As a result, it is crucial for each person to take responsibility for safeguarding and conserving the environment.

Service-centric environment:Being customer-centric involves understanding and anticipating the needs, desires, and communication preferences of customers, and then delivering on them effectively. Successfully doing so allows you to create impactful experiences and foster long-term customer relationships. However, a single misstep could result in losing valuable customers.

Zone-centric environment: Chicago, particularly the area where Burgess resided, serves as an example of a concentration zone. The downtown district, known as the Loop, is home to skyscrapers, museums, government buildings, and various other attractions.

Distance-centric environment:The widespread belief that climate change is a distant and abstract issue can hinder efforts to address it. According to structural level theory, an event's perceived psychological distance influences whether it is viewed as abstract or concrete—events seen as distant are often regarded as more abstract, while those perceived as close tend to be seen as more concrete.

Cost-centric environment:Being customer-centric involves understanding and predicting the needs, desires, and communication preferences of customers, and then delivering on them accurately. When done successfully, this approach helps create valuable experiences and foster long-term customer loyalty. However, a single misstep could lead to the loss of important customers.

Number of services available: A service level agreement (SLA) is a contract between a service provider and its internal or external customers that defines the services to be delivered and outlines the service standards the provider commits to uphold.

Number of the availability zones: Availability zones are They have independent power, cooling, and networking infrastructure. These are designed to ensure that if one zone experiences a failure, the remaining zones can maintain regional services, capacity, and high availability.

Distance from the consumer: Our findings on correlation and causality indicate that consumers with high power-distance trust are more inclined to favor status brands compared to those with low power-distance trust.

Cost in $/hour: Cost per hour is calculated by dividing the total fully loaded cost for a specific period by the total available hours during that period. For instance, a $100k annual cost divided by 2080 annual hours equals $48 per hour.

Copra's Method: They are equipped with independent power, cooling, and networking infrastructure, designed to ensure that if one zone. To address these challenges, it is necessary for all state and private universities to adopt and implement strategic management and planning as part of their management approach. [21] Air compressors are widely used in industries to convert compressed air, typically powered by an electric motor, diesel, or gasoline engine, into stored energy. They function by increasing pressure and pushing more air into a storage tank, with the energy from the compressed air being utilized for various applications. Given the wide variety of air compressors available, selecting the right one to suit the specific needs of a company is crucial. Choosing an air compressor involves several factors.

To evaluate overall performance, it is essential to identify the selection criteria, establish methods for assessing these criteria, and create alternatives that best meet the company's requirements. [22] The Indian technical education system is among the largest in the world. Engineering education in India began during British colonial rule initially focusing on civil engineering. Over time, several engineering colleges were established, such as the College of Engineering in Rourke, the The Poona Civil Engineering College in Pune and the Bengal Engineering College in Shipper were established in the mid-1850s.

Currently, India's technical education system is categorized into three types: centrally funded institutions, state government or government-aided institutions, and self-financing institutions. [23] In recent decades, cities around the world, including those in Europe, have undergone rapid transformation. These urban areas have become global hubs of consumption, leading to various environmental and ecological challenges. It is not acceptable to neglect abandoned lands within cities and shift their development to surrounding areas without considering the existing conditions.

Many cities have significant amounts of wasteland, and the expansion of urban boundaries is causing damage to the countryside. [24] As a result, when selecting new students for admission, it is essential for applicants to undergo various assessments, including prayer practice tests, Quran Reading tests and Quran writing tests are evaluated based on specific criteria. For the prayer practice test, the assessment focuses on correct reading and movement, while the Quran reading test is scored on fluency, pronunciation, and accurate recitation. The Quran writing test is judged based on clarity and neatness. Additionally, report card scores are determined by the overall average scores in subjects like Indonesian, mathematics, natural sciences, social sciences, and religion. [25] One of the key factors for ensuring the smooth operation of management is maintaining an uninterrupted cash flow.

While management takes steps to oversee company operations, directly influencing production quality, sales efficiency, and raw material costs when necessary, even a minor issue during the collection period—largely influenced by external factors—can jeopardize future plans. This can lead to disruptions in the cash flow. Ensuring a steady cash flow is crucial for management to make sound and effective plans. [26] We have introduced a novel approach to fuzzy multi-criteria group decision making by combining the proposed ranking method with the COPRAS method. A numerical example demonstrates the application of this method to supplier selection problems.

The proposed approach offers an effective solution for addressing fuzzy multi-criteria group decision making issues using gap type-2 fuzzy sets. [27] With the rapid growth of the medical industry in recent years, a comprehensive medical and service system has been established. However, the increasing number of hospitals and medical institutions has led to several issues, such as the uneven distribution of medical resources across hospitals of varying levels and regions, particularly given the limitations of resources. To address this challenge, the Chinese State Council has implemented a new policy called "Hierarchical Medicine." The core concept of this policy is to support primary-level medical institutions first point of diagnosis. [28] Cancer incidence and mortality trends have shown variation. While mortality rates for most cancers have generally remained stable or decreased, incidence rates have been on the rise.

Implications: Several factors may explain the recent increase in cancer incidence. Improved detection methods have contributed to higher rates of breast cancer in men and prostate cancer in women. Additionally, sun exposure patterns affect melanoma trends, HIV/AIDS has been linked to the development of Hodgkin lymphoma and Kaposi's sarcoma in young and middle-aged men, as well as cigarette smoking remains a major contributor to the rising rates of lung cancer in women. [29] In a competitive environment with limited resources, performance measurement and management are essential. Therefore, accurate and effective performance evaluation is essential.

One of the key aspects of a company's performance is its financial performance, which has traditionally been a primary focus. As for many companies, profit is the primary objective, and financial performance and evaluation are of great importance. Financial performance indicators reflect a company's competitiveness and should be thoroughly considered during the evaluation process. [30] Multi-criteria decision-making (MCDM) techniques are valuable tools for tackling decision-making scenarios that involve multiple objectives and factors in Everyday and professional contexts often involve problems that present a limited number of alternatives, identified early in the decision-making process. Each alternative is assessed based on its effectiveness across various criteria.

The complexity of the decision-making process increases when multiple criteria are used to assess the alternatives. [31] To successfully implement Business Process Management (BPM) and drive sustainable growth in the tourism industry, it is essential for all stakeholders to have a thorough understanding of customer needs and feedback. By analyzing these insights, travel agencies and hotels can enhance their performance by managing various operational factors. By integrating information from different sources and comparing options within the same city, travel agencies strive to help tourists find the best hotel choices. [32] This paper presents a novel Cobras method, based on the average, negative, and positive best solutions, to determine expert weight, marking its first introduction in the literature.

In project management and team decision-making, uncertainty is typically high due to the differing judgments of experts. To manage this uncertainty, Pythagorean fuzzy sets (PFSs) are employed in this study. [33] Since the different components in this structure, the roof frame, floor frame, and wall frame are all prefabricated in the factory. The on-site construction speed is faster than the traditional stick-built method but slower than the modular method. However, because the components are interconnected in the factory, assembling them on-site becomes more challenging, resulting in higher construction complexity compared to the previous method. [34] Cost-benefit analysis and multi-criteria analysis are the primary methods used for this purpose. Multi-criteria analysis is especially valuable in the initial stages of project development and strategic planning.

On the other hand, cost-benefit analysis is most commonly used to prioritize projects and select the final project from a range of alternatives. [35] Since components like The ceiling frame, floor frame, and wall frame are prefabricated in the factory, resulting in faster on-site construction compared to the stick-built method, but slower than the modular method. However, because the components are interconnected in the factory, assembling them on-site is more challenging, which increases the construction complexity compared to the previous method. [36] Today, many traditional materials are being substituted with innovative alternatives to reduce weight and enhance their properties.

In a competitive market, manufacturers must adopt advanced technologies to produce components that are high-quality, high-performance, and cost-effective to improve efficiency. The selection criteria for materials are intricately interrelated, making it challenging to evaluate and categorize materials for specific applications. [37] Once considered a luxury two decades ago, air conditioning is now regarded as a vital component of comfortable living and working environments. An air conditioner works by removing heat and moisture from the air during the cooling and circulation process. It to create a pleasant atmosphere. When selecting and purchasing an air conditioner, companies should take into account factors such as its capacity to improve office air quality, efficiency, reliability, ease of use, cost, and design.

Additionally, there is a wide range of air conditioner brands available in the market. [38] An expert using the RANCOM method can determine their ranking through various techniques to establish a structured relationship between the criteria. Possible strategies for this method include the ranking scoring order algorithm and the competitive approach. Each option offers the expert a formal framework for defining the criterion ranking. Additionally, when dealing with a broad range of factors in a problem, establishing a regulated relationship for these criteria can be challenging, potentially leading to errors in assessment. Therefore, adopting the proposed approaches aims to simplify this process, making it more manageable for the expert. [39]

The SWARA method is designed to determine the relative weight and importance of each criterion, enabling decision makers or consultants to express their preferences based on the current situation and the conditions for calculating the weights. On the other hand, the VIKOR method is used to rank alternatives from a set of available options while considering conflicting criteria. It also aids in selecting the best alternative. In this paper, we extend the SWARA method by calculating hierarchical weights (HF) with fuzzy ambiguities and ranking alternatives using the VIKOR method. [40]

Results and Discussion

Table .1 Cloud environment

quality of service (QoS)	Number of services available	Number of the availability zones	Distance from the consumer	Cost in $/hour
General-purpose	0.25000	0.25000	0.25000	0.25000
Service-centric	0.50080	0.16700	0.16700	0.16700
Zone-centric	0.16700	0.68200	0.16700	0.16700
Distance-centric	0.16700	0.16700	0.58700	0.16700
Cost-centric	0.16700	0.16700	0.16700	0.50000

The table presents an evaluation of cloud environments using the COPRAS method, based on five criteria: quality of service (QoS), number of available services, Available zones, distance to the consumer, and cost per hour. Each environment is assigned specific weights for these criteria. General-purpose environments allocate equal weights (0.25 each), representing a balanced approach. Service-centric environments prioritize service availability (0.5008), zone-centric environments focus on availability zones

(0.682), distance-centric environments emphasize consumer proximity (0.587), and cost-centric environments concentrate on affordability (0.500). This classification aids users in selecting the most appropriate cloud environment based on their business requirements.

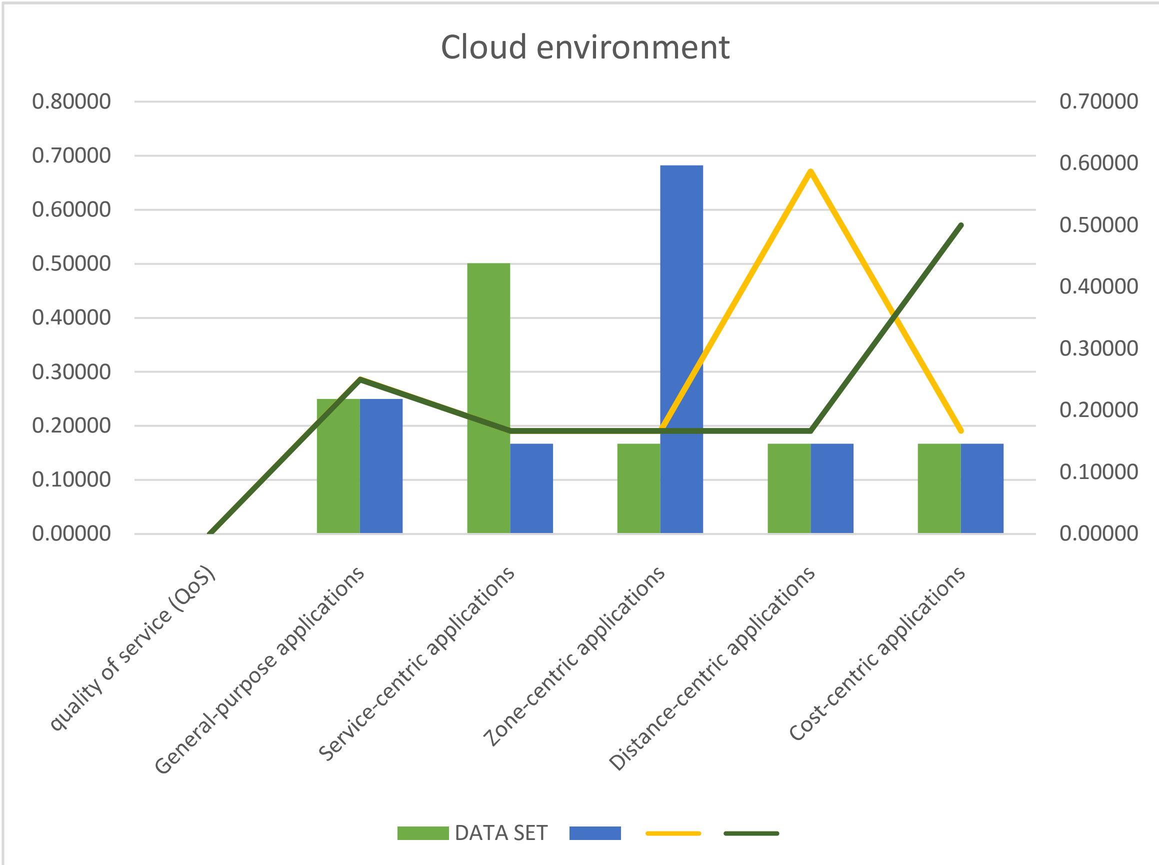

Figure 1. Cloud environment

The figure illustrates an analysis of cloud environments using the COBRAS methodology, based on five criteria. General-purpose environments allocate equal weights (0.25 each). Service-centric environments emphasize service availability (0.5008), while zone-centric environments prioritize availability zones (0.682). Remote-centric environments focus on consumer proximity (0.587), and cost-centric environments highlight affordability (0.500). Each environment is tailored to align with different user priorities.

Table .2 Normalized Data

	Normalized Data			
quality of service (QoS)	**Number of services available**	**Number of the availability zones**	**Distance from the consumer**	**Cost in $/hour**
General-purpose	0.1997	0.1745	0.1868	0.1998
Service-centric	0.4001	0.1165	0.1248	0.1335
Zone-centric	0.1334	0.4759	0.1248	0.1335
Distance-centric	0.1334	0.1165	0.4387	0.1335
Cost-centric	0.1334	0.1165	0.1248	0.3997

The table presents normalized data for cloud environments evaluated using the COPRAS method, focusing on four criteria: number of services, availability zones, distance, and cost. The highest normalized value in each criterion reflects the most significant impact. For instance, service-centric environments excel in services (0.4001), zone-centric environments lead in availability zones (0.4759), and distance-centric environments prioritize proximity (0.4387). Cost-centric environments stand out for affordability (0.3997). General-purpose environments maintain a balanced approach with nearly equal values (around 0.199). This normalization facilitates a fair comparison, allowing a data-driven method to prioritize cloud environments based on specific needs.

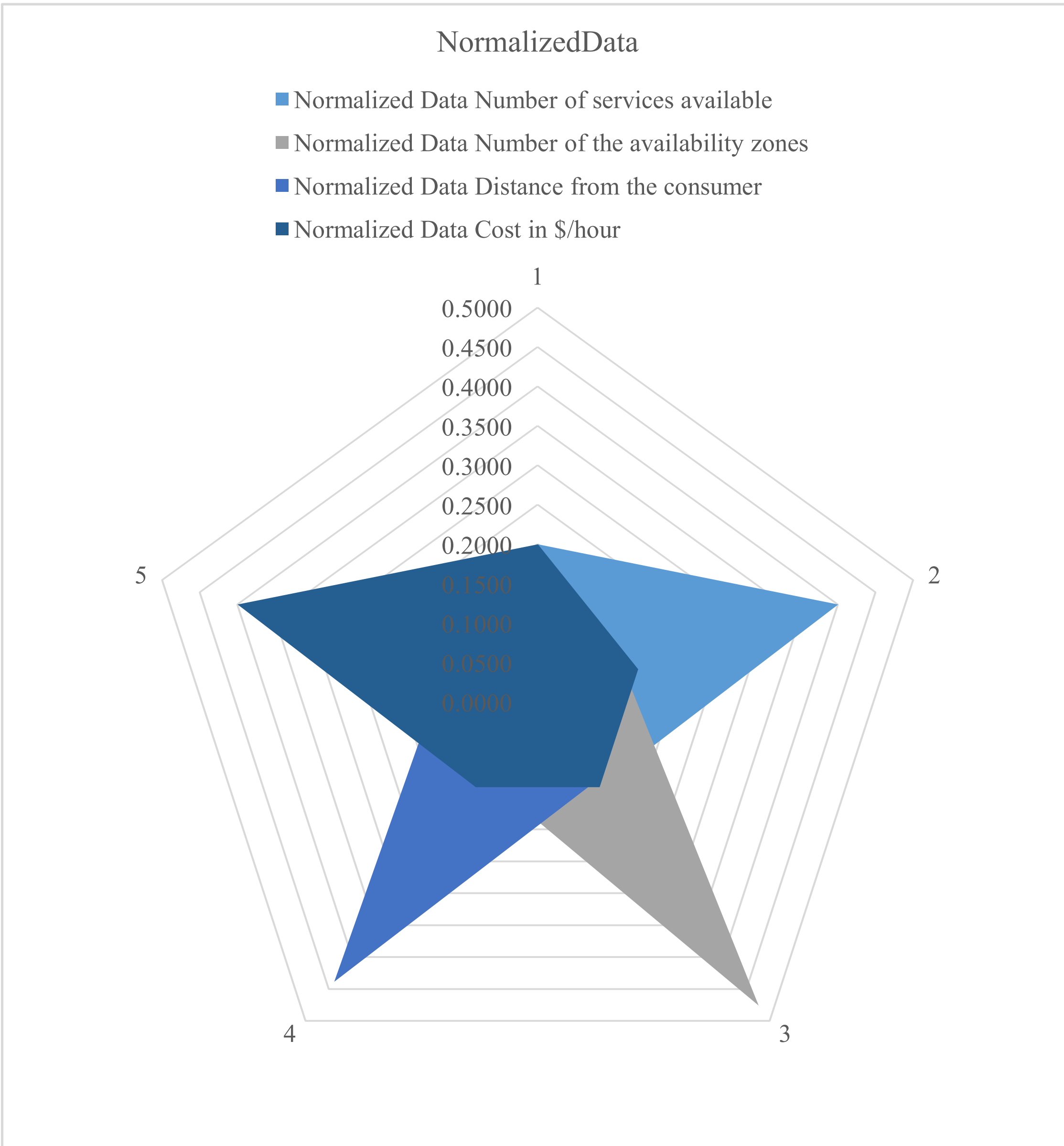

Figure 2. Normalized Data

Figure 2 presents the normalized data for cloud environments assessed using the COPRAS method across four criteria. Service-centric environments lead in services (0.4001), zone-centric environments are strongest in availability zones (0.4759), distance-centric environments emphasize proximity (0.4387), and cost-centric environments highlight affordability (0.3997). General-purpose environments maintain balanced values across all criteria, showcasing their versatility.

Table .3 Weight

quality of service (QoS)	Weight			
general-purpose	0.25	0.25	0.25	0.25
Service-centric	0.25	0.25	0.25	0.25
Zone-centric	0.25	0.25	0.25	0.25
Distance-centric	0.25	0.25	0.25	0.25
Cost-centric	0.25	0.25	0.25	0.25

Table 3 presents in the COBRAS method, weights are allocated to each criterion: number of services, availability zones, distance, and cost. Each criterion is given an equal weight of 0.25, highlighting their equal significance in evaluating cloud environments. This balanced approach ensures that no single factor outweighs the others in the decision-making process. When all criteria are of equal importance to the user or business, it promotes fairness in comparing various cloud options. The equal weight distribution simplifies the evaluation process and ensures consistency across all scenarios, supporting an impartial analysis of cloud environments.

Table .4 Weighted normalized decision matrix

quality of service (QoS)	Normalized decision matrix with weights			
General-purpose	0.05	0.04	0.05	0.05
Service-centric	0.10	0.03	0.03	0.03
Zone-centric	0.03	0.12	0.03	0.03
Distance-centric	0.03	0.03	0.11	0.03
Cost-centric	0.03	0.03	0.03	0.10

Table 4 displays the weighted normalized decision matrix for cloud environments using the COPRAS method, combining the normalized data with equal weights (0.25 for each criterion). General-purpose environments show equal values across all criteria (0.05 each), reflecting their versatility. Service-centric environments excel in service availability (0.10), while zone-centric environments prioritize availability zones (0.12). Distance-centric environments emphasize proximity (0.11), and cost-centric environments focus on affordability (0.10). The matrix highlights the strengths of each environment while maintaining consistency in weighting, allowing for a thorough and fair comparison. This method aids in selecting the most suitable cloud environment based on specific user preferences and needs.

Table .5 Bi, Ci, Min(Ci)/Ci

quality of service (QoS)	Bi	Ci	E(C) / C
General-purpose	0.094	0.097	0.6680
Service-centric	0.129	0.065	1.0000
Zone-centric	0.152	0.065	1.0000
Distance-centric	0.062	0.143	0.4514
Cost-centric	0.062	0.131	0.4925

Table 5 displays the results of the COPRAS method focusing on Bi (benefit score), Ci (cost score), and Min(Ci)/Ci (comparative efficiency). General-purpose applications maintain balanced Bi (0.094) and Ci (0.097), resulting in an efficiency of 0.6680. Service-centric and zone-centric applications achieve high efficiency (1.0000) due to their low Ci (0.065), demonstrating their optimal performance. Distance-centric applications, with a high cost score (0.143), have low efficiency (0.4514), reflecting reduced competitiveness. Cost-centric applications show a moderate cost (Ci = 0.131) and efficiency (0.4925). The table highlights how different applications perform based on user preferences and cost-benefit analysis.

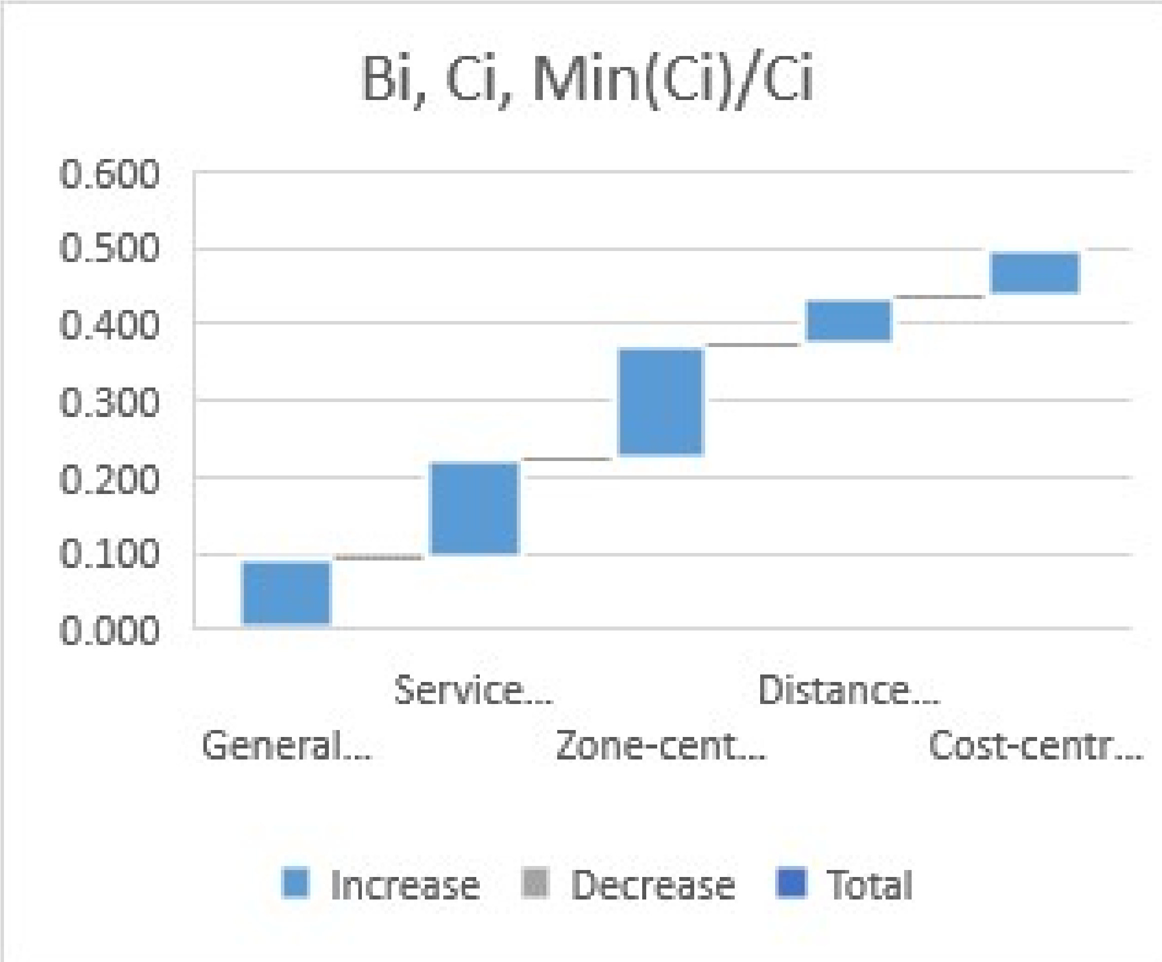

Figure 3. Bi, Ci, Min(Ci)/Ci

Figure 3 illustrates the results of the COPRAS method, displaying Bi (benefit), Ci (cost), and Min(Ci)/Ci. (efficiency). Service-centric and zone-centric applications achieve the highest efficiency (1.0000) with low costs (Ci = 0.065). General-purpose applications maintain a balanced efficiency (0.6680), while distance-centric and cost-centric applications exhibit lower efficiency (0.4514 and 0.4925, respectively).

Table .6 Qi, Ui

quality of service (QoS)	Qi	Ui
General-purpose	0.186	63.9745
Service-centric	0.268	92.0271
Zone-centric	0.291	100.0000
Distance-centric	0.125	42.9824
Cost-centric	0.131	44.9375

Table 6 displays the results of the COPRAS method, highlighting Qi (quality index) and Ui (usability degree) for various cloud environments. Zone-centric applications lead with the highest performance (Qi = 0.291, Ui = 100%), making them the top choice. Service-centric applications follow closely (Qi = 0.268, Ui = 92.03%), excelling in service availability. General-purpose applications show moderate performance (Qi = 0.186, Ui = 63.97%), offering a balanced set of capabilities. Distance-centric (Qi = 0.125, Ui = 42.98%) and cost-centric (Qi = 0.131, Ui = 44.94%) applications exhibit the lowest performance, indicating reduced competitiveness. This ranking helps prioritize cloud options based on specific user needs.

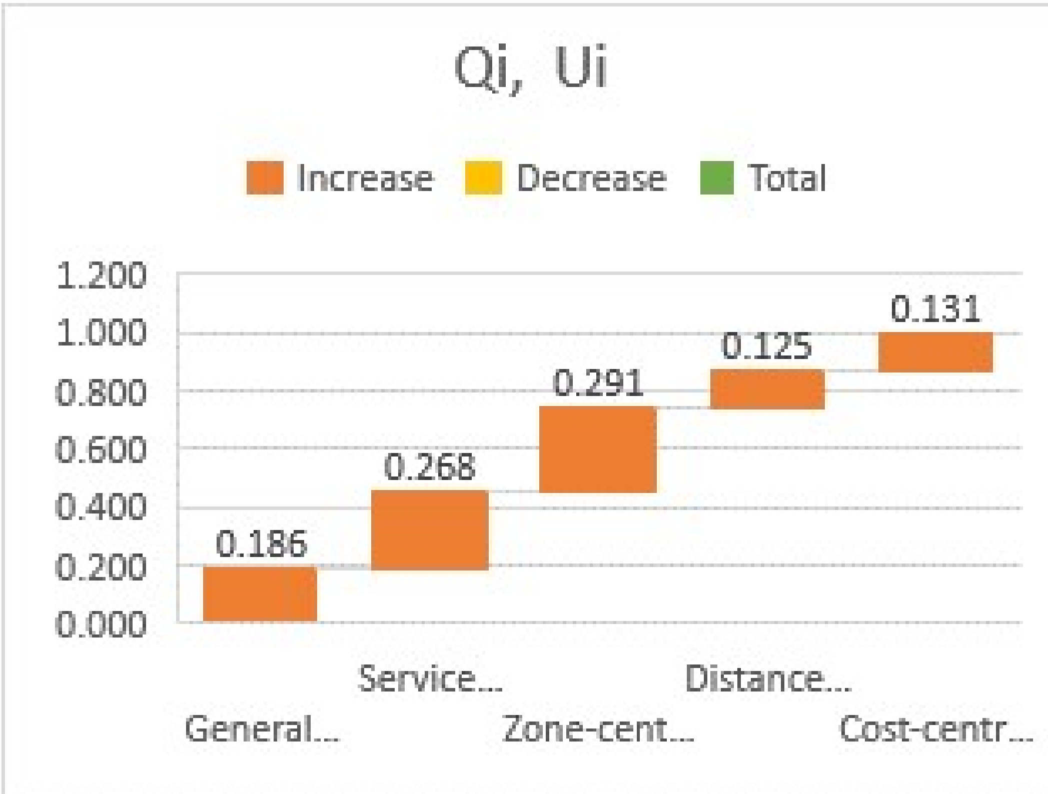

Figure 4. Qi, Ui

Figure 6 displays the COPRAS method results for Qi (quality index) and Ui (usability level). Zone-centric applications lead the rankings with Qi = 0.291 and Ui = 100%, followed by service-centric applications with Ui = 92.03%. General-purpose applications show moderate usability (Ui = 63.97%), while distance-centric and cost-centric options have lower usability (Ui = 42.98% and 44.94%, respectively).

Table .7 Rank

quality of service (Qos)	**Rank**
General-purpose	3
Service-centric	2
Zone-centric	1
Distance-centric	5
Cost-centric	4

Figure 6 presents the COPRAS method results for Qi (quality index) and Ui (usability level). Zone-centric applications lead with Qi = 0.291 and Ui = 100%, followed by service-centric applications with Ui = 92.03%. General-purpose applications demonstrate moderate usability (Ui = 63.97%), while distance-centric and cost-centric options exhibit lower usability (Ui = 42.98% and 44.94%, respectively).

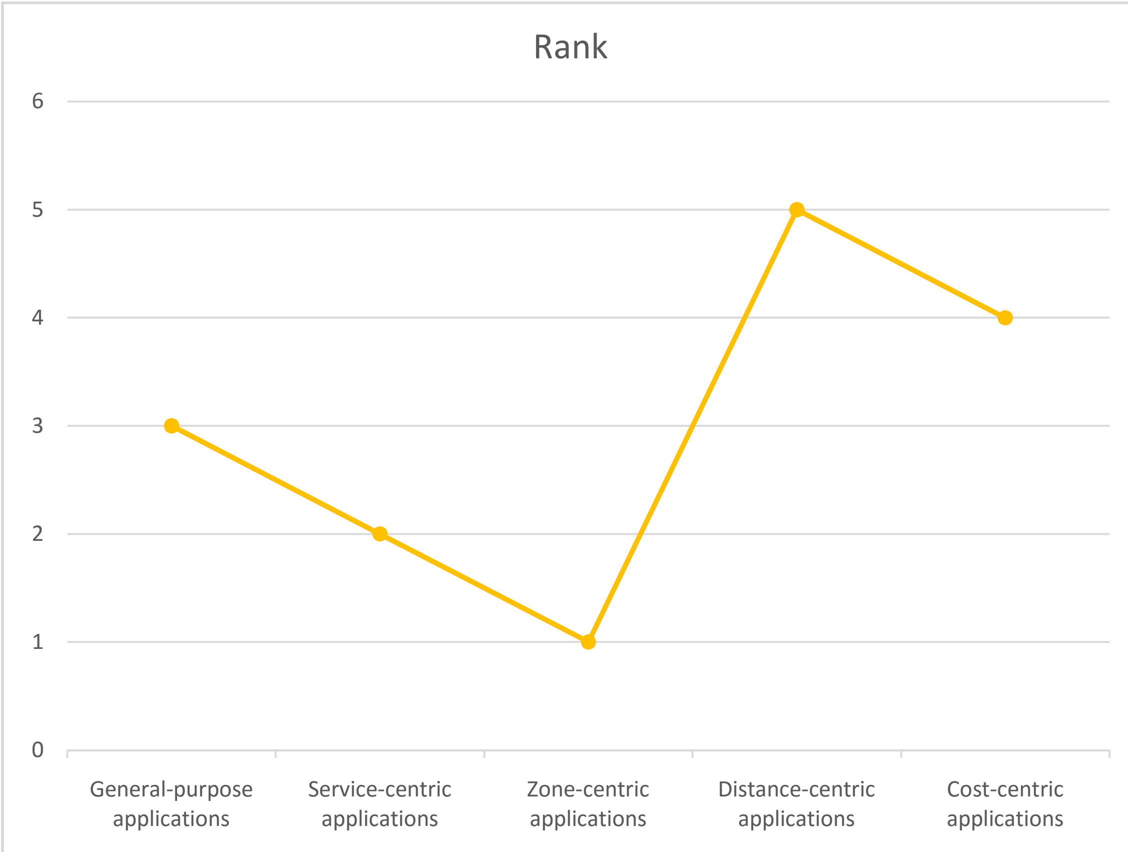

Figure 5. Rank

Figure 5 presents the quality of service (Qu's) rankings based on the COPRAS method. Zone-centric services rank highest (1), followed by service-centric (2) and general-purpose services (3). Cost-centric services are ranked fourth, while distance-centric services receive the lowest rank (5), indicating their relatively poor QoS performance.

Conclusion:

The comprehensive analysis of cloud environments using the COPRAS (Complex Proportional Assessment) method reveals critical insights into the evaluation and selection of cloud service models. This study demonstrates that cloud computing Not a universal solution but a nuanced landscape with distinct characteristics tailored to specific organizational needs. The research highlights five primary cloud environment types: general-purpose, service-centric, zone-centric, distance-centric, and cost-centric. Each environment presents unique strengths and limitations, underscoring the importance of strategic selection based on organizational requirements. Key findings reveal that zone-centric environments emerge as the most optimal, achieving the highest performance with a quality index of 0.291 and a usability degree of 100%. This suggests that organizations prioritizing robust infrastructure and availability zones will find the most value in this approach. Service-centric environments follow closely, ranking second with a usability degree of 92.03%, indicating their effectiveness in service delivery and availability. General-purpose environments demonstrate moderate performance, offering balanced capabilities with a usability degree of 63.97%. This makes them suitable for organizations seeking versatile cloud solutions without specialized focus. In contrast, distance-centric and cost-centric environments showed the lowest performance, suggesting potential limitations in meeting comprehensive organizational needs. The multi-criteria evaluation methodology employed provides a holistic approach to cloud environment assessment. By considering factors such as quality of service, number of available services, availability zones, consumer distance, and hourly cost, the study offers a robust framework for decision-making. Several critical implications emerge from this research. First, cloud service selection should be a strategic decision aligned with specific organizational objectives. Second, while cost remains an important consideration, it should not be the sole determining factor in cloud environment selection. Third, the dynamic nature of cloud computing necessitates continual reassessment of service models to ensure optimal performance and efficiency. As cloud computing continues to evolve, organizations must remain adaptable. The increasing complexity of data management, the rise of specialized service models like Container as a Service (CaaS), and the growing demand for scalable, secure computing solutions underscore the need for sophisticated selection methodologies. For future research, exploring additional criteria, developing more nuanced evaluation frameworks, and investigating emerging cloud technologies could provide even deeper insights into optimal cloud environment selection. Organizations are encouraged to apply this multi-criteria approach, considering their unique operational requirements, to make informed cloud infrastructure decisions. Ultimately, the research demonstrates that successful cloud adoption relies on a comprehensive, strategic approach that balances technical capabilities, service quality, infrastructure robustness, and organizational needs.

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