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Pricing solution for ICT services in private cloud at the Municipal Government of Fortaleza

Solução de precificação dos serviços de TIC em nuvem privada na Prefeitura Municipal de Fortaleza

Solución de precios para servicios TIC en nube privada en la Municipalidad de Fortaleza

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ABSTRACT
Background: The integration of Information and Communication Technologies (ICTs) and cloud computing is important to improve government infrastructure and services, aligning with the principles of public management. Transformations in ICTs are strategic for efficient data management, with cloud computing standing out in this context.
Purpose: This research develops a pricing solution for ICT services in a private cloud in public administration, seeking to contribute to the development of effective pricing strategies for ICT services in private clouds in public administration.
Method: Using a qualitative methodology, the study employed interviews with executives responsible for ICT management. The study population was composed of technical IT managers from the City Hall of Fortaleza, the Federal Data Processing Service (SERPRO) and the Information Technology Company of Ceará (ETICE). The methodological procedures included documentary analysis and semi-structured interviews, integrating qualitative approaches.
Results: In addition to providing valuable insights and practical solutions, this study created a conceptual pricing model for ICT services in cloud computing adapted to the context of public administration and developed a computerized system that implements this model, enabling its direct application and practical understanding.
Conclusions: The strategies developed here serve as a reference for other public organizations seeking to improve the management of ICT services. The adoption of best practices contributes to the optimization of public resources, the continuous improvement of services and the promotion of a culture of transparent and efficient management. In addition to providing an effective solution for the City of Fortaleza, it also offers a replicable and adaptable model for other public administrations.
Keywords: cloud computing; qualitative methodology; pricing; Information and communication technology; public administration.

RESUMO
Contextualização: A integração entre as Tecnologias de Informação e Comunicação (TICs) e computação em nuvem é importante para melhorar a infraestrutura e os serviços governamentais, alinhando-se aos princípios da gestão pública. As transformações nas TICs são estratégicas para a gestão eficiente de dados, com a computação em nuvem destacando-se nesse contexto.
Objetivo: Esta pesquisa desenvolve uma solução de precificação para os serviços de TIC em uma nuvem privada na administração pública, buscando contribuir para o desenvolvimento de estratégias eficazes de precificação de serviços de TIC em nuvem privada na administração pública.
Método: Utilizando uma metodologia qualitativa, o estudo empregou entrevistas com executivos responsáveis pela gestão de TIC. A população de estudo foi composta por gestores técnicos de TI da Prefeitura Municipal de Fortaleza, do Serviço Federal de Processamento de Dados (SERPRO) e da Empresa de Tecnologia da Informação do Ceará (ETICE). Os procedimentos metodológicos incluíram análise documental e entrevistas semiestruturadas, integrando abordagens qualitativas.
Resultados: Além de fornecer insights valiosos e soluções práticas, este estudo criou um modelo conceitual de precificação para serviços de TIC em computação em nuvem adaptado ao contexto da administração pública e desenvolveu um sistema informatizado que implementa este modelo, viabilizando sua aplicação direta e a sua compreensão prática.
Conclusões: As estratégias aqui desenvolvidas servem como referência para outras organizações públicas que buscam melhorar a gestão dos serviços de TIC. A adoção das práticas recomendadas contribui para a otimização dos recursos públicos, a melhoria contínua dos serviços e a promoção de uma cultura de gestão transparente e eficiente. Além

de proporcionar uma solução eficaz para a Prefeitura de Fortaleza, também oferece um modelo replicável e adaptável para outras administrações públicas.
Palavras-chave: computação em nuvem; metodologia qualitativa; precificação; tecnologia da informação e comunicação; administração pública.

RESUMEN

Contextualización: La integración entre las Tecnologías de la Información y la Comunicación (TIC) y la computación en la nube es importante para mejorar la infraestructura y los servicios gubernamentales, alineándose con los principios de la gestión pública. Las transformaciones en las TIC son estratégicas para la gestión eficiente de los datos, destacando en este contexto la computación en la nube.
Objetivo: Esta investigación desarrolla una solución de precios para servicios TIC en una nube privada en la administración pública, buscando contribuir al desarrollo de estrategias de precios efectivas para servicios TIC en una nube privada en la administración pública.
Método: Utilizando una metodología cualitativa, el estudio empleó entrevistas a ejecutivos responsables de la gestión de las TIC. La población del estudio estuvo compuesta por gestores técnicos de TI de la Alcaldía Municipal de Fortaleza, del Servicio Federal de Procesamiento de Datos (SERPRO) y de la Empresa Ceará de Tecnología de la Información (ETICE). Los procedimientos metodológicos incluyeron análisis documental y entrevistas semiestructuradas, integrando enfoques cualitativos.
Resultados: Además de proporcionar información valiosa y soluciones prácticas, este estudio creó un modelo conceptual de precios para servicios de TIC en computación en la nube adaptado al contexto de la administración pública y desarrolló un sistema computarizado que implementa este modelo, permitiendo su aplicación directa y comprensión práctica.
Conclusiones: Las estrategias aquí desarrolladas sirven como referencia para otras organizaciones públicas que buscan mejorar la gestión de los servicios TIC. La adopción de mejores prácticas contribuye a la optimización de los recursos públicos, la mejora continua de los servicios y la promoción de una cultura de gestión transparente y eficiente. Además de proporcionar una solución eficaz para la ciudad de Fortaleza, también ofrece un modelo replicable y adaptable para otras administraciones públicas.
Palabras clave: computación en la nube; metodología cualitativa; precios; tecnologías de la información y la comunicación; administración pública.

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1 INTRODUCTION

The increasing digitalization of public services, driven by Digital Information and Communication Technologies (DICTs), has profoundly transformed public administration. E-government initiatives highlight the importance of technological infrastructure to ensure the efficiency and transparency of governmental processes. The acceleration of these transformations, especially during the COVID-19 pandemic, underscored the need to understand the benefits and challenges of transitioning to a digital environment, emphasizing the financial and operational implications of implementing cloud-based Information and Communication Technology (ICT) infrastructures (Santos et al., 2023).

Cloud computing has emerged as a viable solution for government agencies, improving public services and overcoming infrastructural challenges. This technology optimizes the performance of internal activities and the services provided to the population by allowing for greater efficiency in resource management. In this sense, cloud computing aligns with the principles of modern public management, which seeks innovative, transparent, and efficient solutions (Araújo & Alves, 2019).

As cloud computing continues to grow in popularity, it is expected that nearly half of the world's digital data will be stored in public clouds by 2025, surpassing traditional data centers (Reinsel, Gantz, & Rydning, 2018). The cloud ecosystem is structured around three service pillars: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). These pillars offer flexibility and adaptability, enabling public bodies to utilize these technologies in a scalable and efficient manner.

In addition to providing an efficient technological solution, cloud computing makes digital innovations more accessible. Small and medium-sized businesses, as well as government agencies, can now access advanced technologies, such as artificial intelligence and process automation, without requiring large initial investments (Coyle & Nguyen, 2019). This contributes to a more accessible and flexible economy by eliminating barriers to adopting emerging technologies.

However, transitioning to a digital environment in public administration poses significant challenges, particularly regarding legal compliance, privacy, and information security. Control and oversight bodies, such as courts of auditors, play a crucial role in monitoring the use of public resources and ensuring the transparent and efficient acquisition and operation of ICT cloud services (Brazil, 2015).

Another important challenge is efficiently managing costs related to cloud computing. The FinOps Foundation proposes advanced financial management practices for cloud operations. These practices facilitate accurate cost allocation and promote financial accountability in strategic decisions (FinOps Foundation, 2023). For the public sector, this means ensuring that resources are used optimally and sustainably based on transparent, informed decisions.

With this in mind, this research seeks to answer the following question: How are ICT services priced in the private cloud at Fortaleza City Hall? This study focuses on understanding how these costs are determined and managed given the increasing use of cloud solutions to optimize government operations.

The general objective of this study is to propose a pricing solution for ICT services in a private cloud in public administration. Specifically, the research aims to: (i) identify the main ICT services that can be priced in public administration, (ii) review pricing models used by other organizations, and (iii) develop a model applicable to public administration.

Research into the application of information technologies in the public sector is very relevant when considering the principles of public administration. Efficiency is one of these principles and is extremely important given the scarcity of resources and the need to serve the population at the lowest possible cost. Additionally, given the wide variety of technological solutions on the market and the numerous possibilities for allocating resources, the ability to make better-informed decisions with the support of specific tools is essential for public management.

Fortaleza City Hall was chosen as the object of study for two crucial reasons. First, this capital city is relevant and can serve as a suitable reference for the objectives set. Fortaleza is the fourth largest city in Brazil, with a population of 2,428,708 according to the 2022 census (IBGE, 2024a). In terms of municipal GDP, Fortaleza is the municipality with the highest GDP in the Northeast and the eleventh highest in Brazil (IBGE, 2024b).

Second, the pricing model could be implemented within Fortaleza City Hall. Permission to conduct the research and access to the necessary documents made this applied research possible.

This research's main contribution was developing a solution based on the best development practices and relevant theoretical references for a major public agency. Another significant contribution is the ability to efficiently and effectively measure and organize the actual costs of a data center in public administration, providing greater control, transparency, and efficiency in strategic planning processes and the allocation of technological resources.

It is hoped that the developed solution will be adaptable and replicable in similar situations in other public institutions, contributing to the efficient management of information technology infrastructure.

This introduction contains the basic epistemological elements that underpin the research. This is followed by the theoretical framework, which is subdivided into three parts. The third section deals with the research's methodological aspects. The fourth section presents the results of the interviews. The fifth section presents the pricing model developed

based on previous research. The sixth section presents the conclusions of the research. Finally, the consulted references are presented.

2 THEORETICAL FRAMEWORK

This section presents the theoretical framework necessary for understanding the subject and conducting the research. First, it discusses the use of cloud computing in public administration. Next, the discussion turns to cost management and pricing of ICT services in the cloud. Lastly, FinOps practices in public administration are highlighted.

2.1 Cloud computing in public administration

Cloud computing has established itself as a robust solution for the public and private sectors, offering flexibility and infrastructure savings. In the context of public administration, one of the main advantages of the technology is the ability to adjust resources according to demand without the need for large initial investments. The widely used pay-as-you-go model enables organizations to pay only for the IT resources they use, optimizing budget allocation and preventing financial waste (Araújo & Alves, 2019).

Cloud computing can be classified into three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). According to the National Institute of Standards and Technology (NIST), cloud computing deployment models include private, community, public, and hybrid clouds (Mell & Grance, 2011), as illustrated in Figure 1.

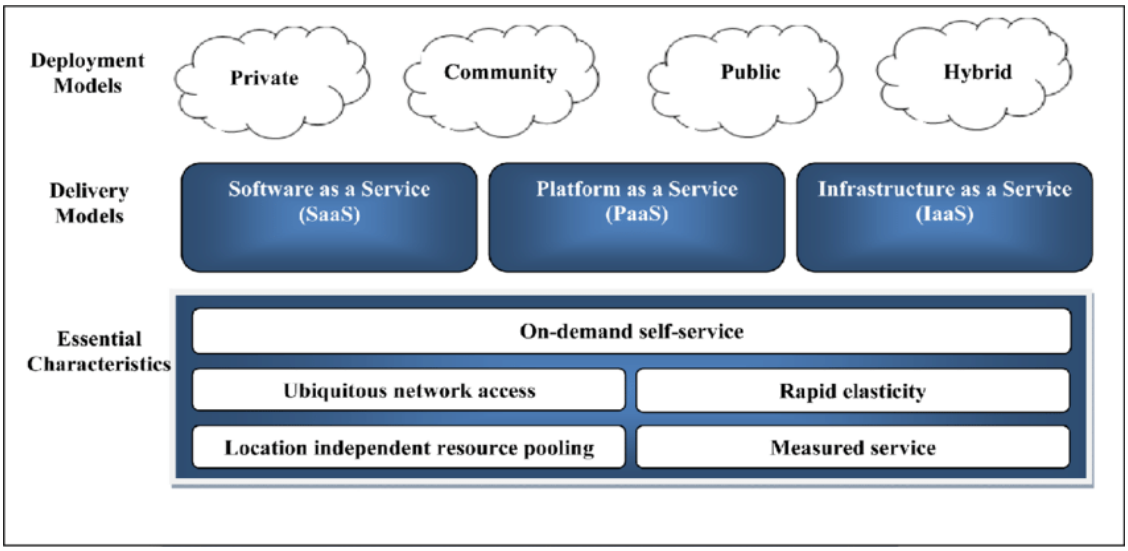

Figure 1. Architecture of a Private Cloud
Source: Adapted from NIST SP 800-145 (2011).

The three cloud service models follow a hierarchical structure in which each layer provides services to the layer above it (Mell & Grance, 2011; Veras, 2012). IaaS enables users to access and provision fundamental computing resources, including processing, storage, and networking capabilities. PaaS provides a platform for developing and deploying applications, including both generic and specific ones. SaaS, in turn, allows users to access applications hosted in the cloud by the provider. The application of these models varies widely in public administration. SaaS is suitable for internal management systems, such as those for human resources and finance. PaaS is useful for developing government applications, and IaaS is beneficial for hosting government IT infrastructures (Oliveira, Pinheiro & Oliveira, 2017).

Another feature of cloud computing is scalability, which allows public bodies to adjust storage and processing capacity according to their needs. This flexible model is especially useful during periods of variable demand, such as when public service systems are in high demand. Additionally, cloud computing offers advantages such as accessibility, enabling staff and citizens to access services remotely and promoting a culture of flexible working and collaboration between different parties (Buyya et al., 2011).

Data security and regulatory compliance are critical factors in the public sector's adoption of cloud solutions. The shift to a digital environment necessitates the implementation of rigorous data protection measures, such as encryption, authentication, and access management. Additionally, complying with government regulations, such as the General Data Protection Act (LGPD), is essential to protecting citizens' information (Tabosa, 2022).

Private cloud computing, in particular, is a widely adopted solution by governments because it allows for greater control over infrastructure and security policies and ensures that sensitive data remains under the jurisdiction of public

entities. However, IT managers must ensure compliance with security standards and risk management in private cloud environments to minimize exposure to cyber threats (Garson, 2018).

2.2 Cost management and pricing of cloud ICT services

Effective cost management in cloud environments is essential for the efficient use of public resources. Accurate pricing of ICT services in private clouds yields significant economic and financial benefits. An appropriate pricing model can reduce operating costs, optimize resource usage, and improve cost predictability. This contributes to more efficient management of public resources and improves the quality of services provided (Campos, 2016). To this end, it is essential to classify the disbursements associated with the analyzed solution.

In this context, costs can be classified as direct, indirect, or transactional (Horngren et al., 2004). Direct costs are those directly attributed to the cloud computing project, such as the acquisition of hardware and software, as well as the remuneration of the technical team. Indirect costs include administrative expenses and equipment depreciation, which must be allocated among different areas. Transactional costs, on the other hand, refer to expenses related to negotiations, contract formalization, and supplier management. These are essential for ensuring service continuity.

Another relevant cost classification is segmenting them into fixed and variable (Campos, 2016). Fixed costs remain constant regardless of the level of use (e.g., software licenses, management costs). Variable costs behave in proportion to the use of computing, storage, and network resources (e.g., CPU time, stored volume, and amount of data traffic).

Implementing cost monitoring and control tools is essential for optimizing the use of cloud resources. Cost management software enables public managers to monitor usage patterns, identify opportunities to reduce spending, and promote budget transparency and accountability. Models such as total cost of ownership (TCO) provide a comprehensive view of the costs associated with cloud operation, including system maintenance and upgrades. This allows for better-informed decisions regarding resource allocation (Almeida & Furtado, 2019).

Pricing ICT cloud services is challenging in public administration. There are different pricing models, with the two main ones being pay-as-you-go and subscription pricing. With the pay-as-you-go model, organizations only pay for the resources they use, which offers flexibility and alignment with short-term needs. However, monthly costs can vary, requiring constant monitoring to avoid budget surprises (Alzhouri, 2018).

Subscription models, on the other hand, offer greater financial predictability with a fixed monthly or annual payment for access to a specific set of services. While this model provides greater budgetary control, it may be less efficient in terms of scalability since capacity adjustments may require renegotiating contracts. Hybrid pricing models combine elements of both, allowing public organizations to adjust their usage according to demand without compromising control over fixed costs (Buyya, 2009).

2.3 FinOps practices in public administration

FinOps, short for financial management of cloud operations, is an emerging practice that optimizes costs related to cloud computing and promotes collaboration between IT, finance, and business teams. It encourages the intentional use of cloud resources by using metrics and data to optimize cost allocation and ensure efficient service usage. The concept emerged in 2019 as a framework of operational fundamentals to guide cost management practices in cloud computing (Storment & Fuller, 2019).

Cost allocation is a fundamental process that involves identifying, categorizing, and assigning the costs of cloud computing resources to specific users, departments, projects, or other relevant groupings within an organization. This practice is crucial to ensuring that costs are distributed fairly and accurately. The FinOps Foundation recommends using structural hierarchies and tags to accurately monitor and allocate costs, enabling fair distribution among departments and projects. Hierarchies allow for the logical organization of resources, and tags facilitate the description and categorization of resources. This allows for the implementation of chargeback and showback models, in which costs are charged or shown to the responsible departments (FinOps Foundation, 2023).

Additionally, the FinOps Foundation recommends allocating costs based on percentages of resource usage to allow for proportional distribution. Table 1 shows the typical percentages suggested for different categories of services.

Table 1
Cost Allocation

Service category	Allocation percentage
Processing	40%
Storage	30%
Backup and recovery	15%
Network	10%
Security	5%

Source: FinOps Foundation (2023).

FinOps provides a clear view of variable and fixed costs in cloud environments. This allows managers to adjust investments according to demand and avoid unnecessary spending. In the public sector, implementing a FinOps approach

promotes transparency, improves operational efficiency, and ensures optimal use of public resources (Mileski & Gusev, 2023).

3 METHODOLOGY

This study adopted a qualitative methodology through a single case study conducted at Fortaleza City Hall. The study focused on analyzing the perceptions and experiences of ICT managers involved in pricing private cloud services in public administration. A qualitative approach was chosen to understand the nuances and operational and financial challenges of implementing a cloud ICT infrastructure in public administration.

Following the guidelines of Severino (2002) and Creswell (2009), the study employed document analysis and semi-structured interviews to collect data. Document analysis verified contracts, financial reports, and technical reports, providing a comprehensive view of the direct, indirect, and transactional costs associated with ICT services.

Based on the theoretical framework, documentary analysis, and research objectives, a semi-structured interview script was developed to explore ICT managers' perceptions and experiences, addressing aspects such as pricing, transactional costs, and legal challenges when implementing a private cloud. A relevant portion of the questions in the interview script were based on the costs indicated in the theoretical framework and the FinOps model. Understanding which costs are generally observed in the surveyed organizations and verifying how they are currently calculated will allow for a better structured model. Thus, this stage also served as a survey of the functional requirements for developing the desired application.

Before final data collection, we pre-tested the interview script with ICT professionals who were part of Fortaleza City Hall's technical committee. The pre-test aimed to identify gaps or ambiguities in the questions to ensure they were clear and relevant. During the pretest, participants answered the script's questions open-endedly, enabling the researchers to observe and record reactions and feedback crucial for refining the script.

A small group of ICT professionals from the Fortaleza City Council's information technology technical committee participated in the pre-test. This group was selected based on criteria similar to those of the research participants to ensure adequate representation of the target audience.

During the pre-test, participants were invited to answer the scripted questions in an open-ended way. Feedback and reactions regarding the understanding and relevance of the questions were recorded. This stage was crucial for refining the script and adjusting it as necessary to ensure the questions were clear and capable of eliciting the desired information. Additionally, the instrument enabled us to estimate the time required for each interview, allowing us to adjust the script's length to optimize the efficiency of data collection during the main research phase.

Table 2 shows the relationship between research objectives and the questions in the interview script.

Table 2
Relationship between Research Objectives and Interview Script Questions

Research Objective	Section	Questions	Description of Relationship
1. Identify the main ICT services in public administration for which costs can be calculated.	1. General Information	1 e 2	Understand the roles and experience of managers in order to contextualize ICT services for pricing.
	2. Infrastructure and Resources	3 e 4	Explore the infrastructure and technologies used to identify ICT services that can be priced.
	3. Pricing and Costs	5 e 7	Focus on pricing criteria and challenges in line with identifying ICT services.
	6. Solutions and Tools	13	Investigate the tools used to identify ICT services.
2. Review the pricing models used by other organizations.	3. Pricing and Costs	6	Investigate current costing methods in line with reviewing pricing models.
	4. Regulations and Policies	9 e 10	Evaluate the impact of regulations to understand and revise pricing models.
3. Develop a model applicable to public administration.	5. Future and Innovations	11 e 12	It also considers future perspectives and areas for improvement to inform the development of an applicable model.
	6. Solutions and Tools	14	Automation tools inform the development of the model.

Source: Elaborated by the authors.

The interviews were conducted remotely via Google Meet. They were recorded and transcribed for later analysis to ensure accurate data collection. This qualitative approach allowed for a more in-depth evaluation of the strategies, practices, and challenges encountered by the professionals involved, providing a comprehensive understanding of the financial, technical, and legal aspects of cloud ICT management in the public sector.

Research subjects included members of Fortaleza City Hall's information technology technical committee, leaders of strategic sectors such as finance and planning, and specialists from ETICE, SERPRO, and DATAPREV. Nine managers from the four organizations were interviewed. Interviewing managers from different public organizations provided a broad view of the relevant elements of cloud computing costs and how they currently calculate them.

Content analysis techniques were used to analyze the obtained data, allowing patterns and recurring themes to be identified. Tags and hierarchies were used to collect and organize usage and cost data. This ensured that all resources were properly identified and categorized in a manner compatible with the FinOps model. Based on interviews and document analysis, a pricing model for private cloud services was developed that is adapted to the needs of public administration. As part of the practical solution, a computational tool in Python with Django was created to efficiently and transparently calculate and manage these service costs.

Figure 2 illustrates the stages of data collection and analysis, as well as the model's definition and development.

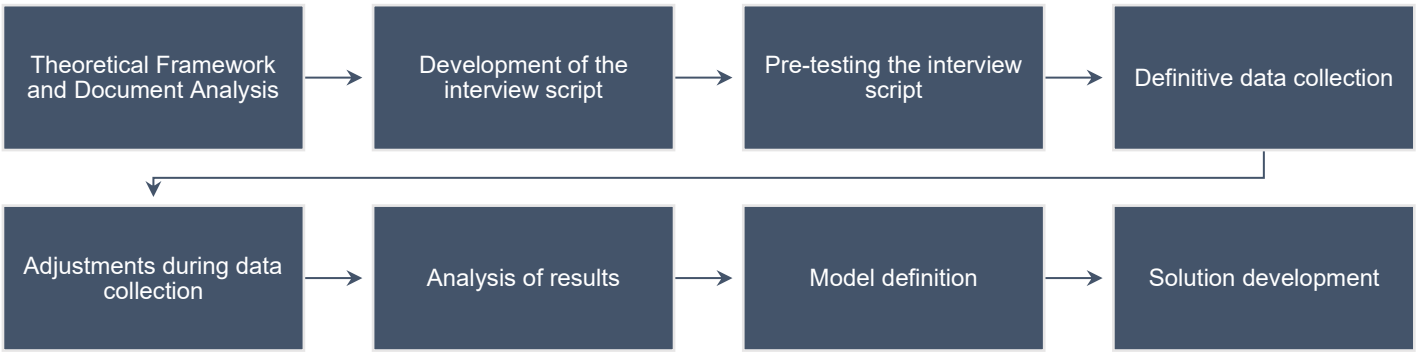

Figure 2. Details of the research's methodological procedures.
Source: Elaborated by the authors.

In summary, the methodology sought to integrate qualitative approaches to develop and implement an effective pricing model for ICT services in a private cloud that is adapted to the specific needs of public administrations.

4 ANALYSIS AND DISCUSSION OF RESULTS

The results are presented according to the two stages of data collection carried out, which were document analysis and interviews.

4.1 Document analysis

A documentary analysis revealed that Fortaleza City Hall's data centers are essential components of the information technology (IT) infrastructure and crucial for the safe and efficient operation of municipal information systems. There are two main units belonging to the Finance Secretariat (SEFIN) and the Planning, Budget, and Management Secretariat (SEPOG). These units are classified as TIER 3, which guarantees high availability and operational resilience.

SEFIN's data center hosts around 50 large systems and functions as both the main unit and a backup for SEPOG's data center. Similarly, the SEPOG data center handles large systems and serves as a backup for the SEFIN data center. Both datacenters are interconnected by a high-speed fiber optic network that provides fast and efficient communication. This increases the resilience of the services and guarantees operational continuity in the event of failures or maintenance.

The data centers have advanced security features, including protection against cyberattacks and continuous monitoring systems. They are equipped with high-capacity servers, robust data storage units, and state-of-the-art backup systems, such as LTO tape drives. They also have integrated security and management software, including UTM and AntiDDOS. These facilities guarantee data protection and ensure the efficiency and availability of public services.

Operating the data centers involves direct and indirect costs, which are detailed in the document analysis. The main cost categories include outsourcing specialized labor, software licenses, hardware maintenance, energy consumption, information security, building security, consulting, and monitoring services. These elements are essential to ensuring the continuous, secure operation of data centers.

Table 3 was created from the documentary analysis and records the costs of a data center.

Table 3
Costs of the data center according to the document analysis

Category	Description	Contracts/ Items Analyzed	Data Source	Observations/ Difficulties

Labor Outsourcing	Essential outsourced services for operating the data center	Technical support, software development, and network administration.	Service contracts and execution reports.	Restricted access to detailed contracts.
Software Licenses	The acquisition and maintenance of software licenses is also necessary.	Operating system licenses and data center management software.	License agreements and usage and compliance reports.	Divergent documentation and outdated data
Hardware Maintenance	Maintenance and repair of physical equipment	Server, storage system, and network maintenance	Maintenance contracts and service reports; hardware inventory.	Lack of complete maintenance records
Energy	Electricity consumption for operating the data center	Electricity bills, UPS (uninterruptible power supply)	Energy invoices and energy supply contracts	Implementation of energy efficiency measures.
Information Security	Data and systems protection	*Firewalls, intrusion detection systems, and antivirus software.*	Procurement contracts for security items	Restricted access to sensitive information.
Building security	Physical security of the data center	Surveillance services and physical access control	Security contracts	Difficulty tracking the cost of the data center in isolation from the rest of the building.
Maintenance of data center components	Maintenance of the data center's physical and technical infrastructure	Air conditioning, cooling systems, UPS and generators	Maintenance contracts, inspection reports and equipment inventory	Regular preventive and corrective maintenance.
Network infrastructure	Maintenance and expansion of the internal and external network	Network equipment and connectivity services	Service contracts, network maps and audit reports	Lack of up-to-date network documentation.
Consulting services	Specialized consultancies for optimizing and auditing the data center	Performance optimization consultancy, Security audits	Consultancy contracts and audit reports	Confidential consultancy reports
Other operating costs	Various other operational and infrastructure expenses.	Cleaning services, insurance, and administrative expenses.	Service contracts, invoices, and expense reports.	Difficulty tracking all expenses.
Monitoring and management software	Tools for continuous monitoring and efficient management of the data center.	Network, performance, and security monitoring software	Software contracts and performance reports.	Continuous improvement through monitoring.
Data backup and recovery	Solutions and services for data backup and recovery	Backup software and services, Cloud storage	Backup service contracts and data integrity reports.	
Technology updates and upgrades	Investments in new technologies and equipment upgrades	Purchase of new equipment and software upgrades.	Purchase contracts and upgrade reports.	
Transactional costs	Costs include tenders, technical document preparation, project preparation, and legal and financial analysis.	Projects for acquiring the data center and terms of reference Legal analysis to guarantee the legality of the processes for the acquisition of equipment.	Stored documents from tender processes.	Difficulty measuring these costs

Source: Elaborated by the authors.

The cost categories aligned with the costs outlined in the theoretical framework, particularly those in the FinOps model (FinOps Foundation, 2023). These categorizations can be applied to the collected costs, and there were no discrepancies between the costs indicated in the literature (Campos, 2016) and those incurred by the surveyed organizations.

However, challenges were revealed in the collection and analysis of costs, such as restricted access to sensitive information, inconsistent inspection records, and difficulty tracing some operating expenses. Incomplete documentation and a lack of centralized information were also identified as barriers, pointing to the need for improvements in document management to facilitate future analyses and optimize data center operations.

Given these aspects, it is important to implement stricter documentation and cost management practices, as Alzhouri (2018) pointed out. Improving the centralization of information and standardizing maintenance, security, and operating cost records are critical steps in optimizing infrastructure efficiency. These steps can be achieved through FinOps categorization mechanisms. Additionally, adopting advanced technological solutions for continuous monitoring and cost management, such as automation tools and artificial intelligence, can significantly improve cost predictability and the operational efficiency of Fortaleza City Hall's IT infrastructure.

A comprehensive view of the resources and challenges of operating data centers reinforces the importance of continuous, strategic cost management focused on security, innovation, and efficiency to guarantee high-quality public services.

4.2 Interview analysis

The analysis of the interviews with ICT managers and experts revealed valuable insights on the pricing of private cloud ICT services in public administration. The interviews provided a detailed understanding of the complexities involved and highlighted the importance of accurate cost categorization and management, as well as the need for greater transparency in the pricing process. The interviews also served as essential groundwork for the solution's requirements assessment.

The interviewees pointed out various challenges in pricing private cloud services, especially the significant variation in operating costs, including infrastructure, energy, hardware, software maintenance, and specialized labor costs. They also mentioned demand forecasting and cost variation over time as central difficulties since private cloud services require continuous infrastructure adjustments to keep up with public administration's dynamic demands. This perception aligns with the literature, which emphasizes the importance of continuously monitoring incurred costs.

Traditional pricing models were deemed inadequate, particularly in the public sector where rigid budgets and specific regulations complicate the process. Unpredictability and the difficulty of allocating indirect costs, such as administrative support and equipment depreciation, were cited as recurring barriers. Many managers believe that adopting emerging technologies, such as automation and artificial intelligence, can improve cost management and offer greater control over operating expenses.

Additionally, regulatory compliance was identified as a factor that significantly increases transactional costs due to the need to guarantee information security and adhere to specific standards. This requires continuous and significant investment in audits and monitoring. These points are relevant because the consulted literature did not focus on regulatory issues, which are central to public organizations. This gap should be explored when developing costing and pricing models for cloud services.

Another widely discussed topic in the interviews was the importance of flexible and transparent pricing models. ICT managers indicated that current models are often inflexible, which makes it difficult to adapt to changes in demand, regulations, or budgets. They emphasized that flexibility is essential to adjusting private cloud services according to the specific needs of different public administration sectors. This feedback was crucial in determining the functional requirements of the developed application.

The lack of clarity in cost allocation and the absence of an understandable pricing model for internal stakeholders were identified as sources of frustration. Many managers reported that end users, including secretariats and departments, have difficulty understanding the costs associated with private cloud services. This leads to internal conflicts over budgets and ICT investments. Adopting practices recommended by the FinOps Foundation was cited as an effective solution for improving private cloud cost management. Using hierarchies, tags, and metadata was highlighted as a key strategy for accurately allocating costs and promoting greater accountability and financial transparency. Additionally, automating pricing processes through computerized platforms was suggested as a way to speed up cost analysis and improve efficiency in resource management.

The interviews also offered recommendations for enhancing the pricing process for private cloud ICT services. Most managers recommended using real-time cost analysis tools to transform cost management. This approach would integrate artificial intelligence and machine learning solutions to predict future demand and optimize costs based on historical data and hypothetical scenarios.

Another point mentioned was the need for continuous training of ICT teams and decision-making managers. The lack of qualified professionals to manage and operate the complexities of a private cloud was identified as a significant barrier. Investing in training and skills development, particularly in cost management and new technologies, was described as essential for ensuring the efficiency and sustainability of operations.

Finally, the interviewees stressed that future private cloud ICT pricing in public administration should focus on adopting advanced technologies and automating processes. Tools such as interactive dashboards for real-time cost monitoring and personalized report generation were seen as solutions that would promote greater efficiency and transparency. They also recommended creating flexible pricing models capable of adjusting to regulatory changes and variations in resource usage.

5 ICT SERVICES PRICING MODEL

This section discusses the developed pricing model. To provide a better understanding, the conceptual aspects of the model are discussed first, followed by the technical aspects of the developed solution.

5.1 Conceptual aspects of the developed model

This work presents a solution based on documentary analysis and interviews. The solution implements a model that aims to create a cost calculator similar to those available on the market from Amazon Web Services (AWS), Google Cloud, and Microsoft Azure. This tool will enable users to compare the prices of their internal clouds with those of the market, allowing them to analyze their price competitiveness and identify opportunities to optimize and improve their data center infrastructure.

The calculator will be programmed through this model to take into account the existing infrastructure of a given data center, allowing for a detailed analysis of the costs associated with ICT services. Consequently, users will be able to not only compare their prices with market prices, but also assess their internal improvement needs. This capability provides a clear view of the competitiveness of internal costs in relation to commercial providers and identifies potential areas for optimization and strategic investments in ICT infrastructure. Additionally, the tool will facilitate identifying cost-reduction opportunities and improving service quality, aligning with the principles of efficiency and innovation in public management.

As shown in Figure 3, the afore-mentioned pricing model unfolds in two distinct and sequential phases, each with its own specificities and execution requirements.

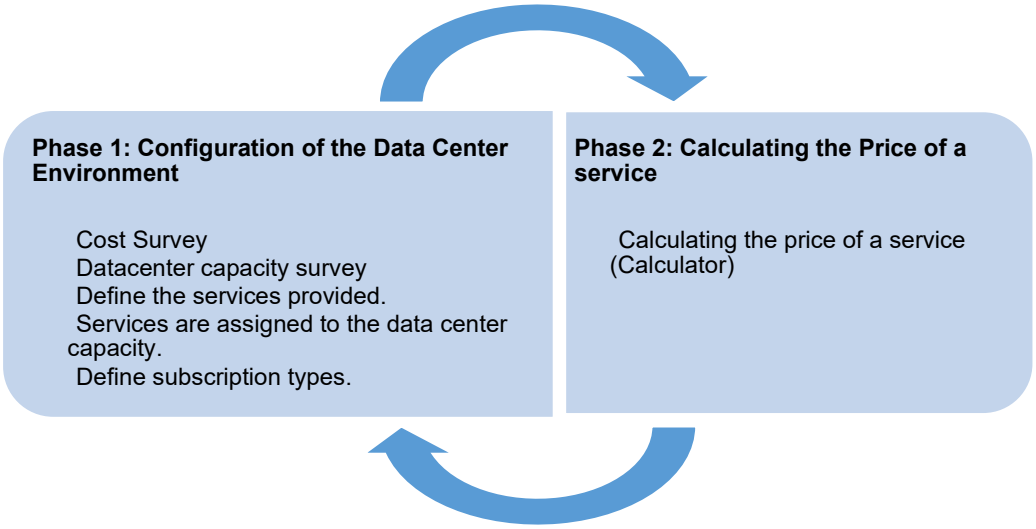

Figure 3. Graphical representation of the pricing model phases.
Source: Elaborated by the authors.

The first phase, setting up the data center environment, is carried out only once. It requires a meticulous approach to establish the basis for the pricing model. During this stage, all costs associated with operating the data center are surveyed. This includes defining the potential of technological assets (e.g., CPU and storage), determining the unit value of these assets, and structuring payment types and cloud services.

Once this configuration is established, it must be maintained and updated as necessary to ensure that the information remains accurate and reflects current operational and market conditions. Maintenance is critical to ensuring the continuity and effectiveness of the pricing model over time.

The second phase, service pricing, involves calculating prices for the services offered. This stage is triggered whenever a new service needs to be priced using the parameters and configurations defined in the first phase. Calculations are applied here to determine the final value of a service based on demand, resource utilization, and the adopted pricing strategy. This phase is dynamic and must be carried out frequently to respond to changes in service demand or the data center's cost structure.

These two phases are interdependent but have different rhythms and operational demands. The first requires detailed initial execution and subsequent maintenance, while the second is an ongoing process that adapts to evolving pricing needs. Together, they form an integrated system that covers operational costs and promotes the financial sustainability and operational efficiency of the data center in the context of public administration.

This process was structured in several stages, each of which was based on multiple sources of information. It is important to note that the cost survey used theoretical references, document analysis, and interviews to identify and detail all operating and maintenance costs. The data center's capacity was verified through document analysis and interviews, providing a comprehensive understanding of the available infrastructure. Table 4 objectively demonstrates these relationships.

Table 4
Relationship between the stages of the model and the source of information

Stages	Information	Sources of information

1 Setting up the datacenter environment	1. Cost survey	Theoretical framework, Document analysis, Interviews
	2. Survey of the capacity of the datacenter	Document analysis, Interviews
	3. Definition of cloud services	Theoretical framework, Document analysis, Interviews
	4. Attribution of datacenter capacity to cloud services	Document analysis, Interviews
	5. Definition of subscription types	Theoretical framework, Interviews
2 Pricing of services	6. Calculating the price of the service	Document analysis, Interviews, Theoretical framework

Source: Elaborated by the authors.

Theoretical references, document analysis, and interviews with experts were used to define cloud services, ensuring the offerings aligned with user needs. Document analysis and interviews were used to allocate data center capacity to services, ensuring efficient resource allocation.

The types of subscriptions were defined using theoretical references and interviews to establish flexible and attractive payment models. The allocation of FinOps percentages to data center capacity combined document analysis, interviews, and theoretical references to optimize financial management. Finally, the service price calculation integrated all these sources of information to ensure the pricing model's accuracy and efficiency. Figure 4 shows the steps to apply the pricing model.

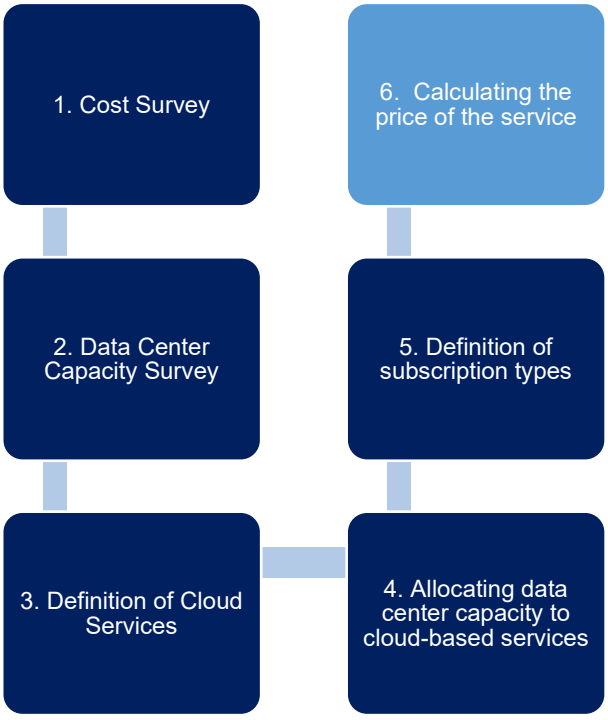

Figure 4. Process of the Cost Pricing Model
Source: Elaborated by the authors.

The process illustrated in Figure 4 begins with identifying and documenting all operating costs. Next, the total capacity of the data center is assessed. Then, cloud service models are defined, and data center capacity is assigned to these services to ensure each has the necessary resources. Then, subscription models are established and the FinOps guide is applied to allocate costs. Finally, the price of the services is calculated based on the collected data, aiming to cover the pricing costs.

According to Almeida and Furtado (2019), conducting a cost survey is essential for efficiently managing a data center. This makes it possible to identify and account for all expenses, including labor, hardware maintenance, energy, security, and other operating costs. The cost survey includes analyzing direct and indirect, as well as fixed and variable, costs to ensure the correct allocation of resources and accurate budget planning. This stage is fundamental because the collected costs will serve as inputs for the other stages of the process.

During the data center capacity survey stage, data is collected on resource usage, including CPU hours, storage, data backup and recovery, network data transfer, and monitored security incidents. This data provides a detailed overview of demand and resource utilization, enabling the efficient, optimized management of operating costs. By using total data center capacity data and applying the percentages suggested by the FinOps framework, costs can be allocated accurately.

This process reflects the strategic importance of each resource in the data center infrastructure, promoting financial efficiency and transparency in IT management.

Next, the cloud service definition identifies the ICT services offered by the data center and categorizes them as IaaS, PaaS, or SaaS, as indicated by Mell and Grance (2011). This includes a description of the services and their functionality, as well as whether they are being provided. Examples include virtual machines, database services, serverless computing, and authentication and security services.

Assigning data center capacity to cloud services involves distributing the total capacity of the data center among the various services offered in this format. This process relates the amount of resources required by each service to the available capacity. This ensures balanced and efficient use of resources, optimizing data center operation.

When defining subscription types, the types offered by the data center are structured according to "pay-per-use," "pay-per-subscription," and "hybrid" payment models (Mell & Grance, 2011). These options provide flexibility and payment choices for users, optimizing costs and increasing competitiveness.

In phase two, the total cost of a server based on a continuous workload is simulated when calculating the price of the service, using the values assigned in the previous steps. This calculation considers different payment models and applies discounts according to the chosen method, resulting in the final price of the provided services. This makes it easier to price IT services and ensures transparency and accuracy in operating costs, which the FinOps model advocates. Each stage of the model provides a structured basis for identifying, managing, and pricing data center costs, ensuring robust and efficient financial management.

5.2 Technical aspects of the developed model

The developed ICT service pricing solution is a web application designed to manage entities related to companies, resources, services, and costs, including data center costs. It was created using Django framework version 4.2 and Python programming language version 3.12. The SQLite database was chosen for data storage due to its simplicity and minimal configuration requirements. It is also lightweight and efficient, allowing basic CRUD (create, read, update, delete) operations to be carried out without complex configurations or dedicated servers. This makes development more agile and less costly while facilitating system portability.

The system is designed to be flexible and adaptable, allowing for integration with different types of services and cost structures. It can manage and monitor various entities, such as companies, technological resources, and provided services, as well as the associated costs. This flexibility is crucial since new elements and costs may emerge as part of the analyzed solutions. A key aspect of the development was the system's ability to manage and monitor various entities, including companies, technological resources, and provided services, as well as the associated costs. Another requirement was that it be a web application, which facilitates decentralized control and detailed analysis of costs, offering a clear and transparent view of expenses involved in ICT management.

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Each story describes a specific feature from the user's perspective, detailing what the user wants to accomplish, why it's important, and the acceptance criteria that must be met for the feature to be considered complete. This format helped create a shared understanding of what would be developed, allowing for quick and effective adjustments throughout the process.

Next, we developed an entity-relationship diagram (ERD), which is a graphical representation of the entities, their attributes, and their relationships. The ERD is fundamental to structuring the database because it defines how the entities will be stored, organized, and interconnected. This guarantees the integrity and efficiency of the system's operations. The ERD allows us to visualize the data architecture clearly and in detail, making it easier to develop and maintain the system.

Figure 5 shows the ERD designed for the system.

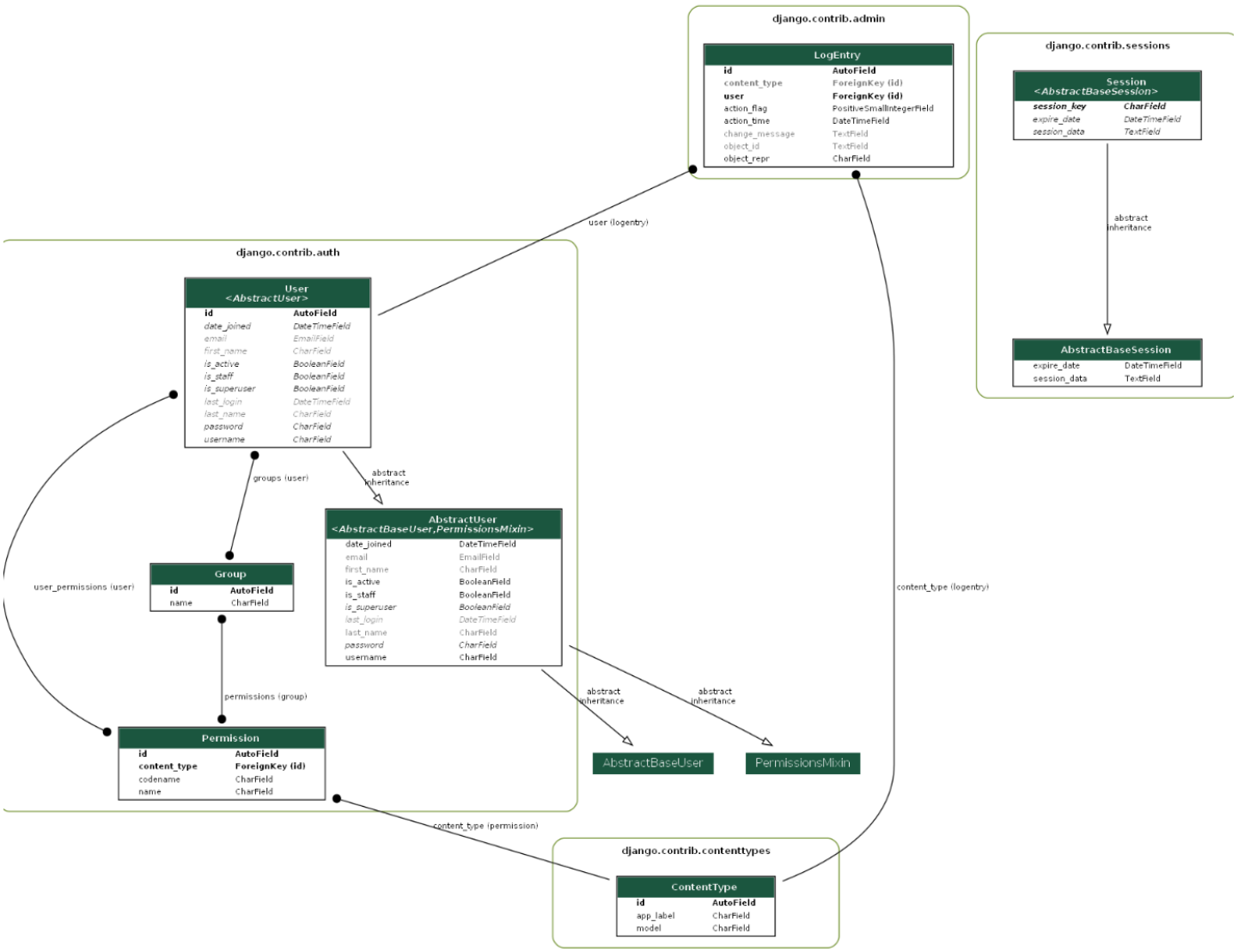

Figure 5. Entity-Relationship Diagram (ERD) of the Developed System
Source: Elaborated by the authors.

The development environment was set up, and the Django framework, database, and version control tools were installed. Next, a new Django project was started, and the necessary settings for development were configured.

Next, development began. At this stage, the Service, Resource, and ServiceResource models were defined in the models.py file, and the corresponding tables were created in the database. Then, the views for accessing other databases were developed.

Then, the forms for registering services and resources were developed and created in the forms.py file. Inline formsets were also developed to manage multiple instances of resources associated with a service. These formsets are essential for entering and updating data in the system.

View development began. Registration views were created to render the forms and process submitted data. List views were developed to display registered services and resources, serving as intermediaries between the models and templates and controlling the flow of data.

Then, the templates were developed. HTML was created for the registration forms and the list of registered services and resources. CSS classes were used for styling to ensure an intuitive, visually pleasing user interface.

System security features were also implemented. All forms use CSRF tokens to protect against CSRF attacks. Proper input data validation has been implemented in the forms to prevent invalid or malicious entries. These measures are fundamental to protecting the system's integrity and security.

Then, the tests were carried out. Unit tests were written to ensure that the models, forms, and views functioned correctly. Integration tests were performed to ensure all components of the system worked well together. Usability tests were conducted with end users to ensure the interface was intuitive and user-friendly.

The code was documented with comments and docstrings to facilitate future maintenance. A user manual was created to guide use of the system and ensure it is easily understood by other developers and users.

Finally, the system was deployed. Configuring the production environment included setting up a web server, database, and other necessary dependencies. After this configuration was complete, the system was deployed in the production environment. We carried out continuous monitoring and maintenance to ensure the system operated smoothly and resolved any incidents quickly.

Managers from the Finance Department of the Municipality of Fortaleza acted as product owners (POs). As adjustments were made, development took place to ensure that the software met the specific needs of the users. In addition to information obtained through document analysis, interviews, and the theoretical framework, assistance from individuals associated with SEFIN's data center was essential for developing the solution.

It took 25 weeks to complete the development, chronologically. The planning and requirements gathering stage took three weeks. Developing the initial prototype and system architecture took two weeks. Developing the main functionalities took six weeks. Integration with the internal environment and compatibility testing took four weeks. Usability testing and user training took three weeks. Implementation, homologation, and final testing took three weeks. Finally, post-implementation monitoring and initial support took four weeks.

6 FINAL CONSIDERATIONS

This research presented a detailed and comprehensive analysis of ICT service pricing in private clouds in public administration, focusing on Fortaleza City Hall. The growing integration of ICTs in the public sector, driven by e-government initiatives, highlights the importance of understanding the operational, financial, and legal benefits and challenges of transitioning to a digital environment.

The results showed that efficiently managing direct, indirect, and transactional costs is essential for the financial and operational sustainability of the private cloud. Analyzing indirect costs, such as administrative support, equipment depreciation, staff training, and business continuity expenses, emphasized the need for a comprehensive approach to ensure the effectiveness and efficiency of ICT infrastructure. Additionally, considering transactional costs, including expenses for negotiations, establishing contracts, monitoring suppliers, and ensuring regulatory compliance, revealed the complexity of managing cloud ICT projects in public administration. Ensuring coordination between different suppliers and compliance with applicable laws and regulations were identified as critical factors for project success.

Implementing the developed pricing model not only provided a solid basis for strategic decisions but also contributed to democratizing access to digital technologies. This facilitated the adoption of innovations, such as artificial intelligence and robotic process automation.

This study offered a thorough examination of the financial, operational, and legal ramifications of adopting cloud ICT infrastructures in public administration. Addressing these aspects contributed to developing effective strategies that promote efficiency, innovation, and transparency in public management, aligning with the contemporary needs and challenges of government agencies. Fortaleza City Hall's implementation of the developed pricing model serves as a practical and relevant example for other public administrations seeking to optimize their technological and financial resources amid increasing digitalization.

The contributions of this study extend beyond the development of a pricing model. It promotes a paradigm shift in how ICT costs are managed in public administration by encouraging transparency, efficiency, and innovation. The strategies and practices developed in this study can serve as a reference for other public organizations seeking to improve their ICT service management.

The implications for public administration are significant. Public managers can improve resource allocation, optimize operating costs, and ensure long-term financial sustainability by adopting a pricing solution based on the study's recommendations. Promoting efficient management of ICT resources also improves the services provided to the public, thereby increasing citizens' trust and satisfaction.

The applicability of the model was validated by adapting it to Fortaleza City Hall's reality. Its flexibility and adjustability allow it to be used in various organizational contexts, ranging from large public administrations to smaller municipalities with limited resources. Furthermore, integrating FinOps practices and considering direct, indirect, and transactional costs ensures a comprehensive approach to cost management.

Regarding the first specific objective of the research, in-depth interviews with ICT executives and managers from various departments revealed the critical services requiring effective cost management. Those related to network infrastructure, data storage, SaaS platforms, information security, and technical consultancy services were identified as particularly important. This identification provided a solid basis for developing the pricing model and highlighted the complexity and diversity of ICT services in public administration.

The second specific objective was to review the pricing models used by other organizations. Through analyzing successful cases and established practices in different organizational contexts, effective methods and strategies that could be adapted to public administration were identified. We reviewed models such as pay-as-you-go, subscription-based, and hybrid, highlighting their respective advantages, disadvantages, and applicability in different scenarios.

Comparing these models revealed practices that promote transparency, efficiency, and flexibility in cost management. These practices were adapted to Fortaleza City Hall's context, considering the public administration's specificities and needs. This ensured that the proposed model was applicable and effective in practice, not just theoretical.

Based on information obtained in previous stages, a pricing model specific to public administration was developed, representing the final objective of the research. The model considers technical and financial aspects, offering a practical tool for managing ICT service costs. It takes into account direct costs (hardware, software, energy, personnel, information security, and connectivity); indirect costs (administrative support, depreciation, training, redundancy, and regulatory compliance); and transactional costs (contract negotiation, ongoing contract management, and monitoring of SLAs).

In conclusion, this study achieved its objectives, resulting in an effective, applicable pricing solution for ICT services in private clouds within public administrations. Identifying ICT services, reviewing existing models, developing an applicable model, and analyzing implementation difficulties provided a solid basis for creating a tool that promotes transparency, efficiency, and innovation in managing public resources.

The strategies developed in this study can serve as a model for other public organizations looking to improve their ICT service management. Adopting the recommended practices can significantly contribute to optimizing public resources, continuously improving services, and promoting a transparent and efficient management culture. Therefore, this study provides a practical and effective solution for Fortaleza City Hall and offers a replicable and adaptable model for other public administrations. This demonstrates the model's relevance and applicability in different government contexts.

Based on the findings of this study, future research can explore several areas to deepen and broaden knowledge about the pricing of ICT services in this context. The following suggestions aim to provide directions for future work that can complement and expand on the obtained results:

a) Comparative analysis with other public administrations: A comparative study of public administrations that have implemented ICT pricing solutions could reveal best practices and common challenges. Comparing results in different contexts can help identify success factors and barriers influencing pricing solution effectiveness.
b) b) Impact of ICT Training on Pricing Effectiveness: Investigate the impact of training and continuous professional development programs on the effectiveness of implementing pricing models for ICT services. Future studies could evaluate the relationship between technical employee training and cost management accuracy and efficiency.
c) Development of Automated Pricing Tools: Explore the creation and implementation of automated tools to assist with pricing ICT services. These tools could integrate real-time data, artificial intelligence, and machine learning to improve the accuracy and efficiency of cost allocation.
d) Long-Term Financial Sustainability Study: Conduct a long-term study to evaluate the financial sustainability of ICT pricing solutions. Future research could monitor economic impacts over time and analyze the relationship between adopting the pricing model and the financial health of public administrations.
e) Evaluate the impact on the quality of services provided. Investigate how implementing ICT pricing models influences the quality of services provided to the population. Studies could analyze performance indicators and citizen satisfaction to determine if efficient cost management leads to tangible improvements in public service provision.
f) Adapt the model for small and medium-sized administrations. Develop and test adaptations of the pricing model for small and medium-sized public administrations, which may have different resources and needs than larger administrations. Future research could focus on adjusting the model to align with the unique limitations and capabilities of these entities.

Following these research directions will not only deepen the understanding of ICT service pricing in private clouds, but also contribute to developing increasingly effective, sustainable, and adaptable solutions to the dynamic needs of public administrations. These suggestions encourage continued and advancing research in this area to promote innovations that benefit public administrations and society.

REFERENCES

Almeida, W. H. C., & Furtado, F. (2019). *Análise sobre métricas nos contratos de fábricas de software no âmbito da administração pública federal.* Albatroz.

Alzhouri, F. (2018). *Dynamic Pricing Strategy for Maximizing Cloud Revenue* (Tese de Doutorado). Concordia University, Montreal, Quebec, Canada.

Araújo, C. C. L., & Alves, C. A. M. (2019). Computação em nuvem: um estudo sobre a distribuição da produção de artigos publicados no período de 2007 a 2016. *Revista de Tecnologia Aplicada*, 8(1), 20–32. https://doi.org/10.21714/22373713rta2019v8n1p20

Araújo, J., & Alves, M. (2019). Estratégias de adoção de tecnologia de computação em nuvem na gestão pública. *Revista de Administração Pública*, 53(4), 123–145.

Brasil. (2020). *Decreto nº 10.332, de 28 de abril de 2020*. https://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2020/Decreto/D10332.htm

Brasil. (2021). *Lei nº 14.129, de 29 de março de 2021*. https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2021/lei/L14129.htm

Brasil. Ministério da Economia. (2022). *Termo de Referência do Pregão Eletrônico nº 18/2022*. https://www.cofen.gov.br/pregao-eletronico-no-18-2022/

Brasil. Tribunal de Contas da União. (2015). *Acórdão nº 1.739/2015*. https://www.lexml.gov.br/urn/urn:lex:br:tribunal.contas.uniao;plenario:acordao:2015-07-15;1739

Buyya, R., Broberg, J., & Goscinski, A. M. (2011). *Cloud Computing: Principles and Paradigms*. Hoboken, NJ: Wiley.

Buyya, R., Yeo, C. S., Venugopal, S., Broberg, J., & Brandic, I. (2009). Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. *Future Generation Computer Systems*, 25(6), 599–616.

Campos, R. (2016). *Aderência do Prêmio Nacional da Qualidade às boas práticas de governança corporativa* (Dissertação de mestrado). Faculdades Metropolitanas Unidas, São Paulo, SP., Brasil. https://arquivo.fmu.br/prodisc/mestradoadm/rc.pdf

Cloud Security Alliance (CSA). (2017). *Security guidance for critical areas of focus in cloud computing v.4.0*. https://downloads.cloudsecurityalliance.org

Computação em nuvem vantagens e desvantagens. (2019). *Portal TEC em geral*. https://tecnologia-emgeral.blogspot.com

Coyle, D., & Nguyen, D. (2019). Cloud computing, cross-border data flows and new challenges for measurement in economics. *National Institute Economic Review*, 249, 30–38.

Creswell, W. J. (2009). *Research design: Qualitative, quantitative and mixed methods approaches*. Thousand Oaks, CA: SAGE Publications.

FinOps Foundation. (2024). *Cloud Cost Allocation Guide*. https://www.finops.org

Garson, G. D. (2018). Managing the total cost of ownership of ICT in government. *International Journal of Public Administration*, 41(2), 143–152.

Horngren, C. T., Datar, S. M., & Foster, G. (2004). *Contabilidade de Custos*. 11. ed. São Paulo: Pearson.

Instituto Brasileiro de Geografia e Estatística. (2025a). *Panorama da cidade de Fortaleza*. https://cidades.ibge.gov.br/brasil/ce/fortaleza/panorama

Instituto Brasileiro de Geografia e Estatística. (2025b). *Produto interno bruto dos municípios*. https://cidades.ibge.gov.br/brasil/ce/fortaleza/pesquisa/38/47001?tipo=ranking&indicador=46997

Khan, K. M., Khan, S. U., & Zomaya, A. Y. (2014). Cloud computing: A review. *IEEE Access*. https://doi.org/10.1109/ACCESS.2014.2331997

Mell, P. M., & Grance, T. (2011). The NIST definition of cloud computing (NIST Special Publication 800-145). *National Institute of Standards and Technology*, U.S. Department of Commerce. https://csrc.nist.gov/publications/detail/sp/800-145/final

Mileski, D., & Gusev, M. (2023). FinOps in cloud-native near real-time serverless streaming solutions. In *Telecommunications Forum (TELFOR)*, 31st. School of Electrical Engineering, University of Belgrade, pp. 1–4. https://ieeexplore.ieee.org/abstract/document/10372626

Oliveira, L. B., Pinheiro, L. V., & Oliveira, M. A. S. (2017). A Importância da Pesquisa Aplicada na Área de TIC na Administração Pública: Uma experiência no Governo de Minas Gerais. *IV Congresso de Gestão Pública (Congesp)*.

Reinsel, D., Gantz, J., & Rydning, J. (2018). The digitization of the world: From edge to core. *IDC White Paper*. Seagate. https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf

Santos, A., Oliveira, P., & Silva, R. (2023). Governança eletrônica e a importância da infraestrutura tecnológica na administração pública. *Revista de Políticas Públicas*, 45(1), 34-56.

Santos, M. R., Figueiredo, R. M. da C., Vasconcelos, A. M. N., & Gomes, M. M. F. (2023). E-governo e a pessoa idosa: Principais fatores críticos pré e pós-COVID-19 por meio da bibliometria e análise de conteúdo. *Contribuciones A Las Ciencias Sociales*, 16(9), 17682–17707. https://doi.org/10.55905/revconv.16n.9-231

Severino, A. J. (2007). *Metodologia do trabalho científico.* 22. ed. São Paulo: Cortez.

Storment, J., & Fuller, M. (2019). *Cloud FinOps: Collaborative, real-time cloud financial management*. 1st ed. O'Reilly Media.

Tabosa, F. G. F. (2022). *Avaliação da evolução pós-pandemia da propensão ao enfrentamento de riscos de computação em nuvem por gestores da Administração Pública Federal* (Dissertação de Mestrado). Universidade de Brasília, Brasília, DF, Brasil.

Veras, M. (2012). *Cloud computing: Nova arquitetura da TI* (240 pp.). Brasport.

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