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Efficiency and innovation in public administration with the use of AI-powered chatbots

Eficiência e inovação na administração pública utilizando chatbots com Inteligência Artificial

Eficiencia e innovación en la administración pública mediante chatbots impulsados por IA

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ABSTRACT
Background: The article explores the impact of Artificial Intelligence (AI) on public administration, focusing on chatbots as tools to improve processes and innovate service delivery. The study analyzes the application of AI to manage administrative queries, highlighting its benefits and challenges.
Purpose: To assess users' perception of the contribution of an Artificial Intelligence-based chatbot to clarifying questions and providing informational support in the administrative contracting processes involving support foundations at the Federal University of Espírito Santo.
Method: A pilot test was conducted using the chatbot with real user interactions at UFES. Indicators such as user satisfaction, response time, and information relevance were analyzed.
Results: 88.9% of users rated response time as satisfactory, and 83.3% reported an overall positive experience. The chatbot showed potential to reduce bureaucracy and facilitate communication between citizens and public institutions.
Conclusions: The use of AI, as demonstrated by the UFES chatbot, can contribute to modernizing public administration. However, improvements like expanding the knowledge base and technical adjustments are needed. The study suggests that AI-based solutions, with refinements, could support digital transformation initiatives.
Keywords: chatbots; artificial intelligence; public administration; innovation; automation.

RESUMO
Contextualização: O artigo explora o impacto da Inteligência Artificial (IA) na administração pública, com foco no uso de chatbots como ferramentas para melhorar processos e inovar na prestação de serviços. O estudo foi realizado para analisar como a IA pode ser aplicada na gestão de dúvidas administrativas, destacando os benefícios e desafios dessa abordagem.
Objetivo: Avaliar a percepção dos usuários quanto à contribuição de um chatbot baseado em Inteligência Artificial para o esclarecimento de dúvidas e o apoio informacional nos processos administrativos de contratação envolvendo fundações de apoio na Universidade Federal do Espírito Santo.
Método: Um teste piloto foi conduzido com o chatbot utilizando dados de interações reais de usuários da UFES. Foram avaliados indicadores de satisfação, incluindo o tempo de resposta e a relevância das informações fornecidas.
Resultados: 88,9% dos usuários classificaram o tempo de resposta como satisfatório, e 83,3% relataram uma experiência geral positiva. O chatbot demonstrou potencial para reduzir burocracias e facilitar a comunicação entre cidadãos e instituições públicas.
Conclusões: O uso de IA, como no caso do chatbot da UFES, pode contribuir para modernizar a gestão pública. No entanto, melhorias como a expansão da base de conhecimento e ajustes técnicos são necessárias. A pesquisa aponta que soluções baseadas em IA, com adequações, têm o potencial de apoiar iniciativas de transformação digital.
Palavras-chave: chatbots; inteligência artificial; administração pública; inovação; automação.

RESUMEN
Contextualización: El artículo explora el impacto de la Inteligencia Artificial (IA) en la administración pública, centrando su análisis en los chatbots como herramientas para mejorar procesos e innovar en la prestación de servicios. El estudio investiga la aplicación de la IA para gestionar consultas administrativas, destacando sus beneficios y desafíos.
Objetivo: Evaluar la percepción de los usuarios sobre la contribución de un chatbot basado en Inteligencia Artificial para el esclarecimiento de dudas y el apoyo informativo en los

procesos administrativos de contratación que involucran fundaciones de apoyo en la Universidad Federal de Espírito Santo.
Método: Se realizó una prueba piloto con el chatbot utilizando interacciones reales de usuarios en la UFES. Se evaluaron indicadores como la satisfacción del usuario, el tiempo de respuesta y la relevancia de la información.
Resultados: El 88,9% de los usuarios calificaron el tiempo de respuesta como satisfactorio, y el 83,3% reportaron una experiencia general positiva. El chatbot demostró potencial para reducir la burocracia y facilitar la comunicación entre los ciudadanos y las instituciones públicas.
Conclusiones: El uso de la IA, como lo demuestra el chatbot de la UFES, puede contribuir a modernizar la administración pública. Sin embargo, se necesitan mejoras como la ampliación de la base de conocimientos y ajustes técnicos. El estudio sugiere que las soluciones basadas en IA, con refinamientos, podrían apoyar iniciativas de transformación digital.
Palabras clave: chatbots, inteligencia artificial, administración pública, innovación; automatización.

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1 INTRODUCTION

Public universities, including the Federal University of Espírito Santo (UFES), face challenges in administrative processes related to contracting support foundations. Such challenges include high demand for clarifications, frequent errors in document delivery, and operational delays, resulting in user dissatisfaction and increased institutional costs. Vieira & Coelho (2022) suggest solutions grounded in Information Management, including the implementation of digital tools to facilitate access to agreement information, increased transparency from acceptance to final accountability, improved internal communication, targeted training for those involved, and administrative support in managing these processes. In this context, digital technologies such as chatbots emerge as potential solutions to enhance operational efficiency and user satisfaction (Silva et al., 2021).

Hall (2021) argues that innovation is essential for universities and that the creative use of technology can achieve better results and increase their efficiency. In addition, Mohanachandran et al. (2021) highlight that smart universities can integrate virtual assistants, automated systems, and digital infrastructures to optimize administrative tasks such as enrollment, academic records, and performance management. These technologies, based on AI, enable cost reduction, improved institutional communication, and data-driven decision-making.

Although several studies address the application of Artificial Intelligence (AI) in university contexts, they mostly focus on pedagogical and academic aspects, and the literature remains limited regarding the analysis of user perception about the use of chatbots to provide information and guidance on internal administrative processes in public universities. While Hall (2021) and Mohanachandran et al. (2021) emphasize the potential benefits of these technologies for university management, few studies investigate how users assess the use of chatbots in complex administrative procedures, such as the contracting and management of support foundations. This study aims to fill this gap by specifically examining users' perceptions of using a chatbot as an informational support tool in this context. The general objective is to assess users' perceptions of the contribution of an AI-based chatbot to clarifying doubts and providing informational support in administrative contracting processes involving support foundations at the Federal University of Espírito Santo.

The relevance of this study is related to the current digital transformations driven by the global expansion of Artificial Intelligence. Van Noordt & Misuraca (2022) point out that AI can help optimize resource allocation, analyze large databases, automate repetitive tasks, and address the shortage of specialists in certain areas. As an example, they mention chatbots as a tool to improve communication between government and citizens. On the other hand, they highlight risks related to transparency, privacy, accountability, and potential discriminatory biases, factors that directly affect the adoption and social acceptance of AI-based solutions in public administration. Silva et al. (2021) emphasize that despite the advantages of AI in the public sector, its adoption requires prepared organizational structures, clear ethical standards, and control processes. The use of technologies such as chatbots can pose risks, such as poorly transparent automated decisions, exposure of sensitive data, and bias in results. To mitigate these impacts, the authors recommend solid governance, continuous monitoring, and guidelines to ensure social trust and the true public value of AI-based solutions.

The adoption of AI in the public sector also involves strategic and institutional challenges. According to Silva et al. (2021), the successful implementation of these technologies requires structural adjustments, staff training, and adaptation of administrative regulations. Adamopoulou & Moussiades (2020a) emphasize the potential of chatbots to significantly improve internal communication in universities, enabling quick responses and enhancing the flow of information between departments.

Therefore, this article specifically analyzes the application of Artificial Intelligence in university administrative management, highlighting the practical contributions of implementing chatbots for internal administrative processes. In this way, it aims to objectively contribute to the academic debate on the use of this technology to improve public university management.

2 THEORETICAL FRAMEWORK

2.1 Impact of Artificial Intelligence in the Public Sector

Artificial Intelligence (AI) is a field of computer science primarily aimed at developing machines and systems capable of performing tasks that typically require human intelligence, such as learning, interpreting language, recognizing patterns, and making decisions using well-designed and complex algorithms (Damaceno & Vasconcelos, 2018). AI encompasses various subfields, each focusing on specific aspects and applications.

AI is described by Wirtz et al. (2019) as "the capacity of a computational system to demonstrate intelligent behaviors similar to humans, characterized by essential competencies such as perception, understanding, action, and learning."

In the same sense, Russell & Norvig (2021) define Artificial Intelligence as the field of computer science and engineering that seeks to create machines capable of performing tasks that would traditionally require human intelligence. Moreover, the authors see AI as an interdisciplinary field that includes the creation of "intelligent entities" capable of acting

effectively and safely in a variety of new situations, involving both the reproduction of human abilities and the application of rational principles to achieve more efficient results.

Machine Learning is a subfield of Artificial Intelligence that focuses on the ability of computers to learn and adapt without being explicitly programmed for each situation (Russell & Norvig, 2021). The authors point out that this is achieved by observing data, building models, and using these models to solve problems or make predictions. According to the authors, learning occurs when the system interacts with the environment, analyzing past experiences and adjusting to new information to solve problems or make predictions. Examples of this technology are recommendation algorithms, such as those used by companies like Amazon, Facebook, Netflix, Spotify, YouTube, and Walmart, which analyze user behavior to suggest personalized content such as products, movies, or music. According to Buchanan (2005), systems like DENDRAL applied these techniques to analyze specific data in chemistry, demonstrating the potential of algorithms based on specialized knowledge.

Natural Language Processing (NLP) focuses on enabling computers to interact with humans through natural language, understand written texts, and learn from the vast volume of recorded human knowledge (Russell & Norvig, 2021). As the authors mention, this technology can be applied in systems with speech recognition and reproduction, automatic translation, information extraction and retrieval, as well as question answering.

Innovations based on Artificial Intelligence in the public sector represent a promising phenomenon, although they are not yet widespread. Interest has increased as governments recognize the potential of this technology to automate processes, improve efficiency, and support decisions with accurate and relevant data (Van Noordt & Misuraca, 2022).

Artificial Intelligence presents a range of benefits and challenges that policymakers must consider when planning and implementing public actions (Lima López Valle & Gallo, 2020).

There are AI initiatives in several Brazilian cities, with each entity exploring different aspects to improve citizen experience, operational efficiency, or political decision-making (Lima López Valle & Gallo, 2020).

Artificial Intelligence technologies in the public sector are reshaping bureaucratic mechanisms, speeding up data processing, facilitating decision-making, and modernizing communication between government and citizens. This improves and, in some cases, completely transforms public service delivery. The use of AI is growing and promises significant benefits by reducing processing time, improving workflow, and increasing efficiency, thus driving economic growth (Silva et al., 2021).

AI has the potential to influence government planning and strategy, even completely replacing human functions in some cases or partially taking over activities performed by public servants in others (Silva et al., 2021).

2.2 Evolution and Functioning of AI-Based Chatbots

Chatbots, or virtual assistants, are systems based on Artificial Intelligence that simulate human conversations through textual or auditory interactions, aiming to offer automatic and interactive responses to users (Adamopoulou & Moussiades, 2020b). These systems have been widely used to optimize customer service, facilitate process management, and improve user experience.

One of the first chatbots that emerged was ELIZA in 1966, designed to simulate a psychotherapist by returning users' statements in the form of questions, using a mechanism based on pattern matching and predefined responses (Adamopoulou & Moussiades, 2020a). Despite its limited conversational capabilities, ELIZA was sufficient to confuse people at a time when interaction with computers was new. This initial impact served as a starting point for the development of new chatbots, further improved by PARRY, developed in 1972, which aimed to display a personality (Adamopoulou & Moussiades, 2020a).

In 1995, the chatbot called ALICE (Artificial Linguistic Internet Computer Entity) was developed, the first online chatbot inspired by ELIZA, which won the Loebner Prize in 2000, 2001, and 2004 and was the first computer to hold the title of "most human computer." The authors point out that ALICE was based on conversation patterns and developed in a new language created for this purpose, the Artificial Intelligence Markup Language (AIML); compared to ELIZA, which had 200 rules and keywords, ALICE had about 41,000 templates, demonstrating its enhanced capacity compared to ELIZA.

2.3 Classification, Typologies, and Practical Applications of Chatbots

Adamopoulou & Moussiades (2020b) classify chatbots into different categories based on criteria, as shown in Table 1, and understand that a chatbot may belong to more than one category:

- Domain Knowledge: Covers generic chatbots, which answer questions from any domain; open-domain, which operate in multiple domains; and closed-domain specific chatbots, limited to knowledge base.
- Main Purpose: Classifies chatbots as informative, used to provide specific information; conversational, which maintain natural dialogues; and task-based, which perform functions such as bookings.

- Response Generation Method: Divides chatbots into rule-based, response retrieval-based, and generative, capable of creating new responses.
- Human Intervention: Distinguishes autonomous chatbots and those mediated by humans, which combine human computation in parts of the process.
- Permissions: Differentiates between open-source and commercial chatbots, according to the development platform's restrictions.
- Communication Channel: Groups chatbots according to the medium used, such as text, voice, image, or combinations of these formats.

Table 1
Classification of Chatbots by Criteria and Categories

Chatbot Categories	Criteria
Domain Knowledge	Generic, Open Domain, Closed Domain
Provided Service	Interpersonal, Intrapersonal, Interagent
Objectives	Informative, Conversational, Task-Based
Response Generation Method	Rule-Based, Retrieval-Based, Generative
Human Assistance	Human-Mediated, Autonomous
Permissions	Open Source, Commercial
Communication Channel	Text, Voice, Image

Source: Adapted from Adamopoulou & Moussiades (2020b)

According to Kar & Haldar (2016), the typology of chatbots can be divided into two main categories:

- Rule-based chatbots: These chatbots use a predefined set of rules and conversation flows to respond to user queries. They are simpler and more limited, as they do not learn from interactions.
- AI-based chatbots: These use more advanced technologies, such as machine learning, deep learning, and natural language processing (NLP), to understand and generate more complex and personalized responses, learning and adapting through interaction with users. Examples of AI-based chatbots include virtual assistants like Siri, Alexa, and Google Assistant.

In the same vein, Kale (2024) states that with the growth of AI and natural language processing technologies, chatbots have evolved significantly, highlighting the GPT (Generative Pretrained Transformer) technology, whose variant developed by OpenAI, ChatGPT, has become well known and consists of a database trained with a huge number of parameters, allowing it to generate texts and respond to questions effectively.

Regarding how a chatbot works, Prajakta Jadhav et al. (2022) explain that a chatbot begins its operation when activated by a user query, which may be a question or the introduction of a new topic. From this input, the system uses NLP to interpret the message and identify the user's intent, comparing the received input with a set of predefined questions and answers stored in the system. If the input is recognized as a previously registered query, the corresponding answer is returned. When there is no direct match, the chatbot uses AI algorithms to process the text, understand the context, and generate an appropriate response based on the accumulated knowledge.

The authors highlight the following techniques as fundamental to the functioning of a chatbot:

- Text Parsing: The text is converted into a lexical or syntactic structure, analyzing words and their grammatical relationships. This initial analysis facilitates understanding the meaning of the message.
- Similarity Calculation: The chatbot uses metrics such as Path Similarity and Wu-Palmer Similarity to measure the semantic proximity between words. These metrics assess the hierarchy and distance between terms to identify which query in the system is closest to the user's input.
- AIML (Artificial Intelligence Markup Language): An XML-based language used to represent the chatbot's knowledge, allowing the creation of responses from predefined categories and topics.

Among the algorithms used, Prajakta Jadhav et al. (2022) indicate the following for textual data analysis and generating relevant responses:

- N-grams: This technique divides text into word sequences (n-grams), such as bigrams (2 words) or trigrams (3 words), to predict patterns and infer responses based on the most probable combinations.
- Cosine Similarity: Measures the similarity between two vectors representing phrases or words by using the cosine of the angle between them. It is widely used to determine the relevance between the user's query and the available answers.
- TF-IDF (Term Frequency-Inverse Document Frequency): Assesses the relevance of terms in documents, giving more weight to words that appear frequently in a query but rarely elsewhere in the database.

Chatbots have been implemented in a wide range of areas, notably in customer service, education, healthcare, human resources, and public administration (Adamopoulou & Moussiades, 2020b, 2020a). The use of chatbots in customer

service aims to automate the initial interaction with the consumer, providing quick answers to frequently asked questions, processing orders, and forwarding more complex issues to human attendants. Adamopoulou & Moussiades (2020b, 2020a) highlight that chatbots can reduce waiting times and increase customer satisfaction, providing a faster and more effective experience.

In the educational context, chatbots have been used to support students with information about courses, schedules, and administrative processes. Vázquez-Cano et al. (2021) identified that chatbots are particularly useful for improving interaction with students in distance learning environments, offering constant and personalized support.

Chatbots also play an important role in healthcare by providing information about diseases, scheduling appointments, and offering initial psychological support. Laranjo et al. (2018) point out that although healthcare chatbots still face challenges related to the accuracy and reliability of information, they have shown great potential in supporting patient care and guidance.

The implementation of chatbots in various sectors has demonstrated numerous benefits, as shown in a study conducted in Japan in 2024 (Ismail et al., 2024). The data show that 75% of e-commerce companies reduced response times by 30% and increased engagement by 40%. In healthcare, 65% of respondents reported a 20% reduction in administrative tasks. Educational institutions reduced administrative workload by 25% and saw a 50% increase in student interaction, with 70% considering chatbots useful. These results reflect the efficiency of chatbots in automating processes, reducing costs, and optimizing the allocation of human resources.

Chatbots can be accessed at any time of day, providing continuous service without the need for staff to be constantly available (Adamopoulou & Moussiades, 2020b). This is especially useful in sectors such as healthcare and customer service, where constant availability is important. In the case of AI-based chatbots, the ability to learn from interactions allows responses to become increasingly personalized, providing a more efficient and satisfactory user experience (Adamopoulou & Moussiades, 2020b).

Despite this, user acceptance can be a significant barrier, as some people still prefer interaction with human attendants, as reinforced by Oliveira et al. (2024). According to Rostami & Navabinejad (2023), participants in a study highlighted that emotionally intelligent chatbots were able to recognize users' emotions and respond empathetically, providing a sense of connection and support. However, the authors also emphasize the ethical and technical challenges in simulating genuine empathy, such as limitations in interpreting complex emotions and privacy issues.

2.4 Public Management Using Artificial Intelligence

AI-based innovations in the public sector represent a promising phenomenon, although they are not yet widely deployed. Interest has grown as governments recognize the potential of this technology to automate processes, improve efficiency, and support decisions with accurate and relevant data (Van Noordt & Misuraca, 2022).

In the same sense, Wirtz et al. (2019) argue that in the public sector, the implementation of AI-based services, besides helping to reduce processing times, workload, and improve workflows, increases efficiency and can lead to economic growth.

The study by Chen et al. (2024) analyzed the adoption and implementation of chatbots in 22 state agencies in the United States, highlighting technical and organizational factors. During the COVID-19 pandemic, the demand for services and information grew exponentially, with some agencies reporting significant increases, such as a jump from 12,000–15,000 calls per week to over 200,000 at the peak of the crisis. To cope with this pressure, chatbots emerged as an effective solution, especially due to their 24/7 availability and ability to answer frequently asked questions automatically, reducing call volumes and freeing employees for more complex tasks.

Storozhenko (2023) analyzes the integration of AI technologies into public administration, emphasizing global and local practices. He highlights how leading countries such as the USA, China, Singapore, Japan, Germany, Canada, and the United Arab Emirates are implementing national strategies to develop AI with a focus on areas such as administrative efficiency, security, public participation, and data analysis. For example, the US KAIROS program uses AI to understand real-time events, while China aims to establish itself as a global digital innovation hub through a comprehensive AI plan. In Canada, a national plan seeks to train young specialists, promoting AI education and research. In Germany, strategies promote the introduction of advanced technologies across all social spheres. In Ukraine, digital transformation policies focus on adopting AI to improve public services, such as digital identification, administrative indicator forecasting, and detection of corrupt activities.

Zuiderwijk et al. (2021) indicate that data-driven public management, powered by AI, is transforming government innovation and promoting a more efficient governance model. The ability to explore large and complex datasets through machine learning algorithms and advanced analytics enables public organizations to develop more evidence-based policies, optimize resource allocation, and enhance operational effectiveness. The application of algorithms such as

regression and clustering allows public managers to identify patterns that might previously have gone unnoticed. While clustering organizes similar data into coherent segments, regression projects potential outcomes based on historical data, enabling accurate forecasts and strategic planning aligned with emerging social demands (Zuiderwijk et al., 2021). According to the authors, these capabilities allow not only problem-solving but also a predictive and proactive approach, anticipating challenges and shaping policies with greater precision. In addition, evidence-based decisions gain greater credibility when supported by concrete data, strengthening public trust as citizens better understand the reasons behind policy choices, creating a clear link between data, decisions, and their impacts (Zuiderwijk et al., 2021).

The application of AI in the context of innovative public management aligns with the principle of the "Result-Oriented Government" as outlined by Osborne & Gaebler (1992). This principle favors the delivery of concrete results over mere process execution. AI through the tools studied can provide technological resources for performance monitoring, scenario forecasting, public policy analysis, and process automation.

In addition, this study adopts the Technology Acceptance Model (TAM) (Davis, 1989) as its main analytical lens, allowing the findings to be interpreted through the factors of perceived usefulness and ease of use. Although TAM is well established in system adoption research, its application in contexts of chatbots to support public management in universities is still limited in Brazil, which reinforces the originality of the analysis conducted here.

3 METHODOLOGY

3.1 Development and Evaluation of a Chatbot

At the Federal University of Espírito Santo (UFES), a chatbot was developed by the authors of this paper to help resolve questions and provide guidance related to support foundation project management. WhatsApp was chosen as the interaction platform due to its widespread use in Brazil, making the chatbot accessible and familiar to the target audience, academic project coordinators, staff, and contractors involved in agreements with support foundations.

The solution was implemented using Node.js and the OpenAI API, leveraging the GPT-4o-mini model to process queries and generate responses. This approach helped reduce costs related to local infrastructure while ensuring scalability and efficiency in information processing.

The pilot test database consisted of approximately 600 questions and answers extracted from manuals related to the administrative and financial management of academic projects, including teaching, research, outreach, technological innovation, and institutional development. These manuals, prepared by the UFES Directorate of Institutional Projects, cover topics such as contract formalization and amendments, responsibilities of managers and supervisors, and accountability procedures. In addition to the manuals, public guides and information available on the institutional website were also incorporated into the database, broadening the scope and relevance of the content.

The chatbot operates using word embedding techniques to evaluate the similarity between user questions and information in the database. It then uses the GPT-4o-mini model to generate personalized responses, considering the interaction history and predefined institutional guidelines. Word embeddings are vector representations that capture semantic relationships between words, making them essential for developing chatbots (Russell & Norvig, 2021). Unlike one-hot vectors, which only indicate word presence, embeddings enable chatbots to understand similarities and contexts, placing words like "cat" and "feline" in nearby positions in the vector space. Based on the principle that a word's meaning is inferred from its context, embeddings allow chatbots to perform semantic operations, such as identifying relationships between concepts like country/capital. Widely used in Natural Language Processing, word embeddings are useful for tasks such as intent interpretation, response generation, and sentiment analysis in chatbots. Models like Word2Vec, GloVe, and FastText provide pre-trained representations that make human–chatbot interaction more fluid and efficient, consolidating their role in advancing conversational AI (Russell & Norvig, 2021). Figure 1 illustrates the basic operation of the chatbot.

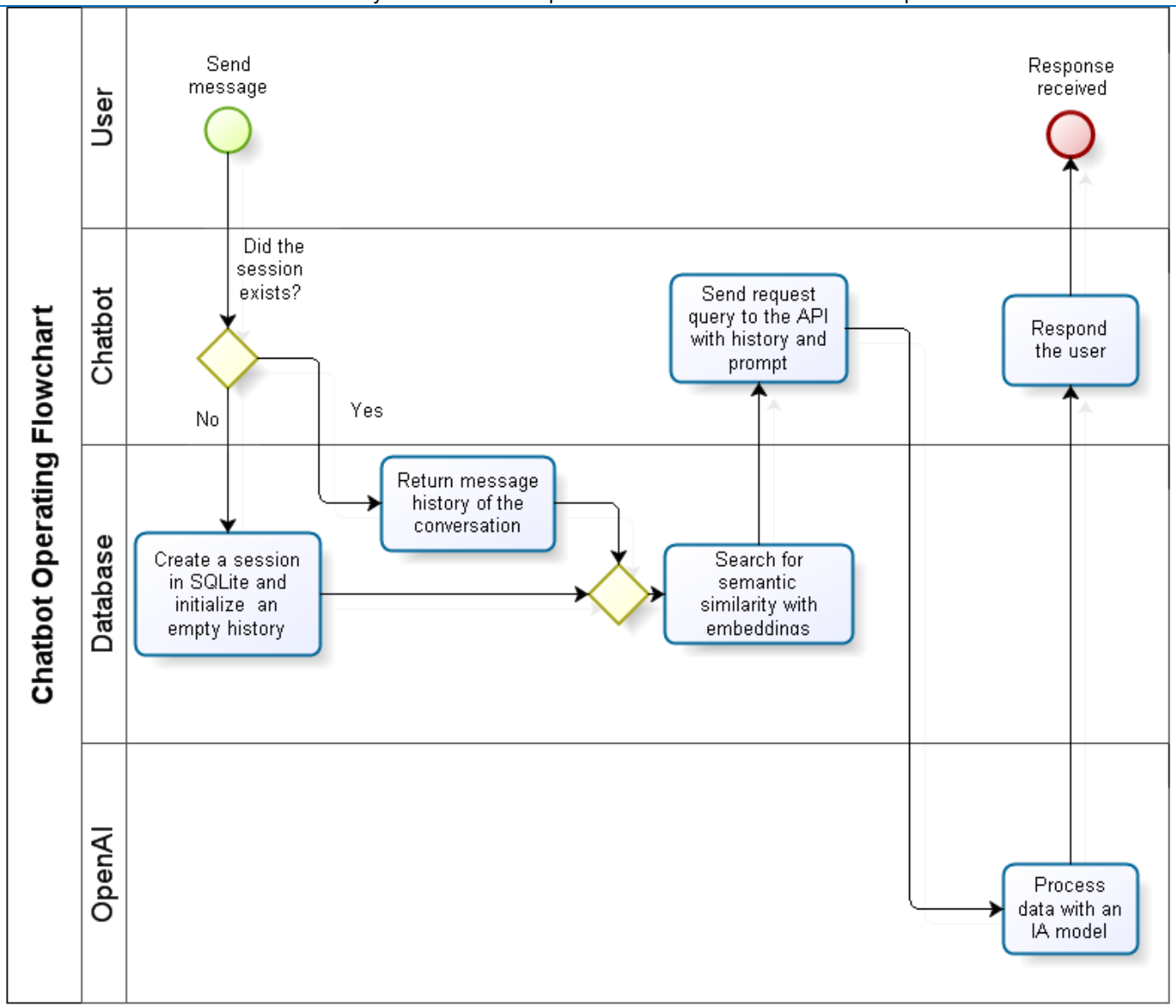

Figure 1. Chatbot Operating Flowchart.
Source: Developed by the authors.

After reading the user input, the chatbot evaluates the similarity of the query with the items present in the database, generating a list sorted in descending order and accompanied by similarity scores. For example, upon receiving the query, in Portuguese, “what are extension projects?”, the system retrieves related records from the database, such as information about the inseparability of teaching, research, and extension, the benefits of support foundations, and the characteristics of eligible projects. This procedure is exemplified by the text, in Portuguese, displayed in the chatbot’s execution log, shown in Figure 2.

```
[
  {
    pergunta: 'Como a indissociabilidade entre ensino, pesquisa e extensão se manifesta nos projetos de extensão?',
    resposta: 'A indissociabilidade se manifesta quando os projetos de extensão envolvem atividades que simultaneam
ente contribuem para a formação dos estudantes (ensino), avançam o conhecimento científico ou tecnológico (pesquisa
) e atendem às demandas da comunidade (extensão), integrando essas dimensões de forma harmoniosa.',
    similarity: 0.7393036020950514
  },
  {
    pergunta: 'Quais tipos de atividades podem ser consideradas projetos de extensão apoiados por fundações de apoi
o?',
    resposta: 'Atividades que resultam da criação cultural, da pesquisa científica e tecnológica desenvolvidas na U
FES, como programas educativos, ações culturais, projetos de inovação tecnológica, e serviços especializados que en
volvam a aplicação do conhecimento gerado na universidade em benefício da comunidade.',
    similarity: 0.7331398239538115
  },
  {
    pergunta: 'Como a criação cultural está relacionada aos projetos de extensão?',
    resposta: 'A criação cultural envolve a produção artística e cultural que pode ser compartilhada com a comunida
de através de projetos de extensão, enriquecendo a vida cultural da sociedade e promovendo o intercâmbio de conheci
mentos e expressões artísticas.',
    similarity: 0.7217231061896203
  },
```

Figure 2. Similarity Search Result.
Source: Developed by the authors.

This list is then forwarded to the OpenAI model, which performs a complementary analysis to formulate a response based on the GPT-4o-mini model for the user. Figure 3 below exemplifies the response, in Portuguese, returned to the user after the previous query.

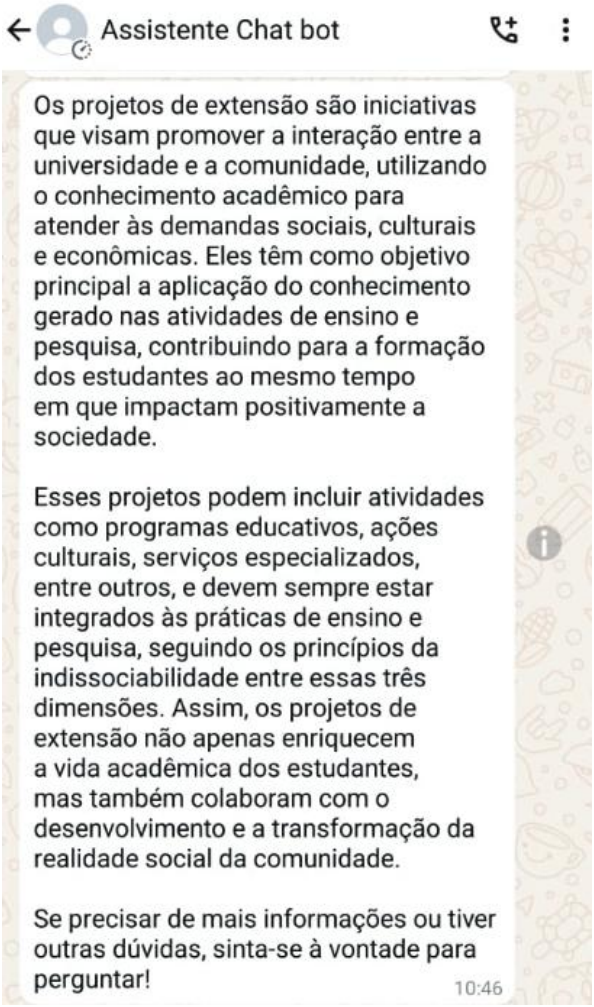

Figure 3. Chatbot Response to the User
Source: Developed by the authors.

The user's message history is also sent to the AI model to contextualize the conversation, allowing the responses to align with previous messages. The generated responses follow a set of instructions programmed into a prompt to guide the chatbot's behavior and ensure alignment with the guidelines of the Federal University of Espírito Santo (UFES).

A pilot test was conducted to assess usability and effectiveness indicators, to validate the accuracy of the responses provided and identify necessary improvements. To achieve the proposed objectives, a mixed-methods approach was adopted, integrating qualitative and quantitative methods, as suggested by Creswell (2007).

To evaluate the chatbot's performance, a structured questionnaire with thirteen questions was administered, nine closed-ended and four open-ended. The indicators analyzed included ease of use, the user's prior knowledge level, understanding of questions, accuracy and usefulness of responses, clarity and intuitiveness of the interface, ability to resolve queries without additional assistance, response time, overall satisfaction, and recommendation intent. The closed items followed five-point Likert-type ordinal scales, allowing the frequency, agreement, or satisfaction level to be classified comparably, aligning with the DeLone & McLean (2003) approach to information system success and Likert's (1932) original attitude measurement technique.

Open-ended questions were included to capture perceptions not anticipated in the fixed options, covering reports of positive aspects, suggestions for improvement, specific problems, and additional comments. This combination of formats meets the principle of methodological triangulation (Denzin, 1978) and follows Patton's (2002) guidance on the need for mixed instruments in interactive technology evaluations. Thus, the questionnaire provides a basis for integrated quantitative and qualitative analysis, ensuring greater accuracy in identifying the chatbot's strengths and limitations as a support tool.

The questionnaire's structure and analysis were based on the Technology Acceptance Model (TAM) proposed by Davis (1989), which highlights perceived usefulness, perceived ease of use, and usage intention as determinants for accepting technological systems. These elements guided the formulation of the evaluated criteria, organizing the closed and open questions to investigate the users' experience regarding the chatbot's practical utility, ease of operation, and participants' willingness to recommend or reuse it for administrative processes involving support foundations.

Additionally, quantitative data were collected through closed questions with graduated scales, allowing the tabulation of frequencies and means. Closed data were analyzed by frequency and descriptive means, without additional statistical tests. This hybrid approach was essential to balance the detailed analysis of individual opinions with the identification of general patterns, contributing to an understanding of user interaction with the system.

The target population for this research comprised project coordinators, professors, staff working in the coordination offices within the Directorate of Institutional Projects (DPI), and members of the support foundation associated with the institution. These groups were selected for their direct connection with the projects and related administrative processes, being the main potential users of the chatbot. Although the sample covered the main users of the analyzed process, it is limited to a small-scale feasibility test, not expanded to other interested groups, which is recognized as a limitation of the pilot stage.

Invitations to participate in the research were sent directly to representatives of the mentioned groups, such as project coordinators and administrative sector managers. These representatives were instructed to redistribute the invitations to other team members, such as professors and administrative staff. It is estimated that approximately 25 people received the invitation, considering the representatives and the individuals impacted by redistribution.

Of the invitations sent, 18 participants completed the evaluation form, composing the final sample. Although not all invitees responded to the questionnaire, the final sample includes participants directly related to project management activities, ensuring the relevance and adequacy of the analyzed profiles. Furthermore, the exploratory nature of the research focuses on understanding initial perceptions of the chatbot.

The pilot chatbot was made available for use and evaluation by the sample individuals over approximately fifteen days, during which they could explore the features, search for information, and receive guidance on administrative procedures related to contracting a support foundation to support teaching, research, extension, institutional development, and technological innovation projects at the University. This process includes the preparatory phases, contract formalization, execution, regarding the role of the contract supervisor and manager, and project accountability. At the end of the period, users could submit the evaluation questionnaire, sharing their perceptions and experiences with the chatbot.

The data collected during the pilot test were processed and analyzed using content analysis, a qualitative methodology used to interpret textual data, identify patterns, categories, and contextual meanings from participants' responses (Bardin, 2010). This approach is suitable for exploring user perceptions of the chatbot's usability, efficiency, and accuracy, as well as identifying suggestions for improvement.

4 ANALYSIS AND DISCUSSION OF RESULTS

The analysis of quantitative and qualitative data revealed favorable perceptions regarding the usefulness, ease of use, and effectiveness of the chatbot, in alignment with the core factors of the Technology Acceptance Model (TAM) (Davis, 1989). Among the 18 respondents, 88.9% rated the response time as "very satisfactory," reinforcing the perceived ease of use dimension by indicating that the system promptly met informational demands (Figure 4).

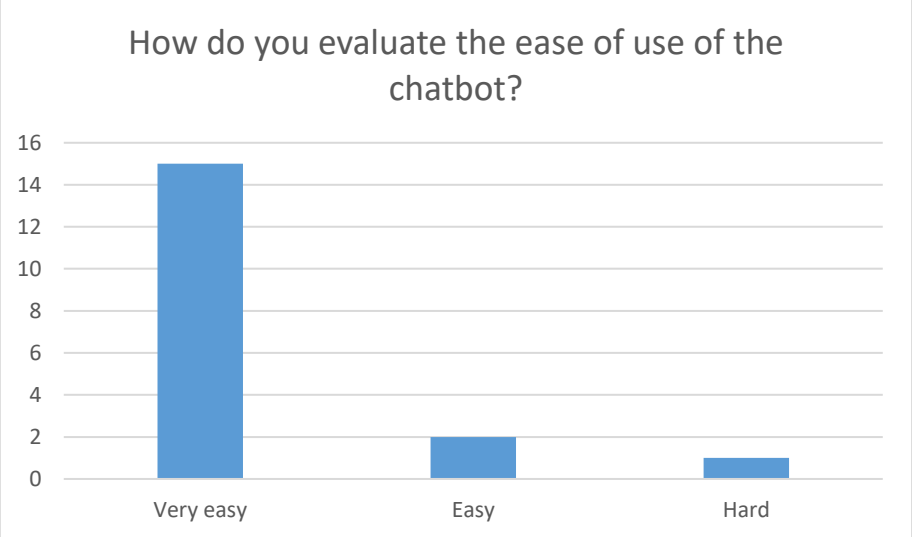

Figure 4. Perceived ease of use by the user.
Source: Developed by the authors.

In addition, 83.3% reported a "very satisfactory" overall experience, which supports perceived usefulness, showing that the chatbot met practical needs for clarifying issues related to contract formalization, addenda, endorsements, and accountability processes.

The adoption of WhatsApp as the interaction channel was well received, contributing to the system's accessibility and intuitiveness. The highlighted ease of use indicates that even individuals with limited knowledge were able to navigate the system without significant difficulty. This operational decision aligns with the principle of facilitating conditions, a concept present in both the TAM and extended models of information system acceptance.

The accuracy of the information returned was validated by 72.2% of participants who stated that the chatbot provided accurate and useful responses in all interactions (Figure 5), while 22.2% reported that this occurred "most of the time." Only one participant (5.6%) evaluated the responses as accurate and useful "sometimes," and no responses were recorded in the "rarely" or "never" categories. As highlighted by Prajakta Jadhav et al. (2022), chatbot effectiveness depends on robust algorithms and a well-structured knowledge base. In the case of UFES, the difficulties reported by 5.6% of participants in more complex questions reinforce the need to expand the knowledge base and improve GPT-4-mini model training to meet more specific demands. Consequently, the chatbot shows potential to transform user consultation and guidance flows, reducing manual steps and increasing efficiency in providing information.

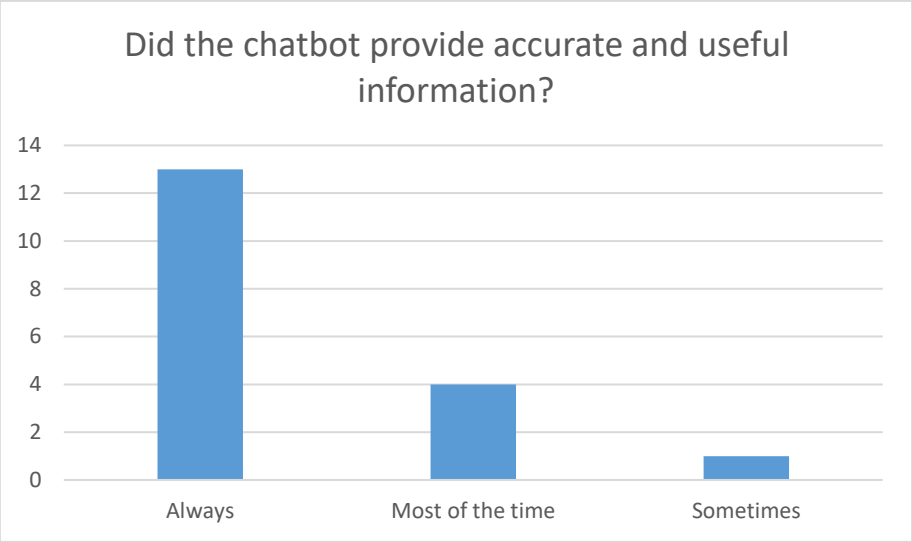

Figure 5. Accuracy of information perceived by the user
Source: Developed by the authors.

Despite the mostly positive results, the study identified challenges that need to be addressed to improve the system. One of the main points raised was the need to expand and customize the chatbot's knowledge base, enabling more detailed responses aligned with institutional standards. This aspect was highlighted by 5.6% of participants who reported occasional difficulties in the chatbot's understanding of their questions.

The analysis of the chatbot's ability to understand users' questions and provide appropriate responses indicates highly positive performance, as shown in Figure 6. Of the 18 respondents, 14 (77.8%) stated that the chatbot was always able to understand their questions and provide suitable answers. Another three participants (16.6%) considered that this happened "most of the time," while only one person (5.6%) reported that the chatbot was effective only "sometimes."

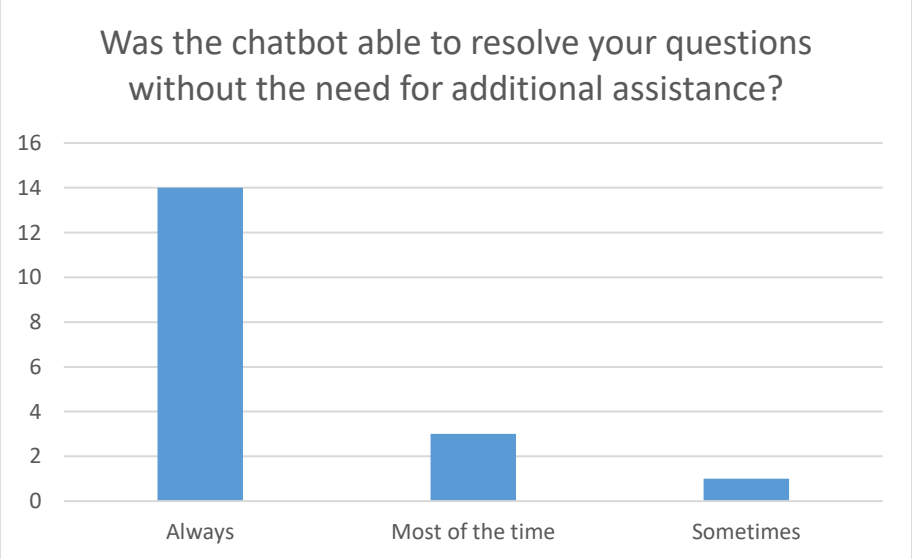

Figura 6. Chatbot effectiveness perceived by the user
Source: Developed by the authors.

The analysis of user satisfaction regarding the chatbot's response time revealed highly positive results. Of the 18 participants, 16 (88.9%) rated the response time as "very satisfactory," while one (5.6%) considered it "satisfactory" and another one (5.6%) gave a "neutral" evaluation. No user indicated unsatisfactory experiences, such as "never," "unsatisfactory," or "very unsatisfactory." Similarly, Adamopoulou & Moussiades (2020b) highlight that chatbots reduce wait times and increase customer satisfaction. In the same way, the results obtained in the pilot test indicate that the chatbot was able to improve user interaction efficiency and experience, with 88.9% rating the response time as satisfactory.

When compared to the literature, the results corroborate Hall (2021) regarding the role of innovation in optimizing internal processes in universities and align with Van Noordt & Misuraca (2022), who highlight AI as a facilitator of more agile public services. Likewise, Silva et al. (2021) point to similar benefits, but this study expands that evidence by demonstrating an applied case in a federal university environment, reinforcing the value of the chatbot as a real administrative support tool.

One identified challenge is related to interactions with less experienced users. While users with intermediate and advanced knowledge benefited extensively, individuals with limited knowledge may occasionally face barriers, such as insufficient clarity in responses to more complex queries. This suggests the need for adjustments in the interaction flow and further training of the AI model.

Among the improvements proposed by users are expanding the chatbot to other departments of the university and refining repetitive interactions, such as welcome messages and feedback requests. Taken together, these findings indicate adherence to the factors established in the TAM, validating the model's application in the context of administrative processes involving support foundations.

5 CONCLUSIONS

This study provides empirical evidence that chatbots can support administrative processes in federal universities, an area still scarcely explored in Brazilian literature.

The case of the Federal University of Espírito Santo (UFES) showed promising results, with 88.9% of participants rating the response time as "very satisfactory" and 83.3% reporting a "very satisfactory" overall experience. Silva et al. (2021) support the idea that the adoption of intelligent technologies can reduce costs, accelerate procedures, and improve the quality of citizen services. Moreover, 77.8% of users stated that the chatbot "always" managed to solve their doubts independently, reinforcing its effectiveness as an institutional support tool. These findings show that the system contributed to more agile and precise interactions, reducing the need for direct human assistance.

Van Noordt & Misuraca (2022) emphasize that AI has the potential to reshape administrative structures, enabling greater accessibility and agility in public service delivery, while repositioning government as a facilitator of inclusive and innovative solutions. While previous studies highlight the broad benefits of AI, this work presents applied data within a federal university context to support administrative guidance processes.

On the other hand, it is important to acknowledge that implementing AI in public administration presents significant challenges. Lima López Valle & Gallo (2020) point out that its adoption requires substantial investment in technological infrastructure, professional training, and regulatory framework revision. Moreover, ethical issues related to privacy, transparency, and fairness are critical and must be addressed for AI to be applied responsibly and in line with democratic principles. The development of systems such as the chatbot analyzed requires not only technical rigor but also attention to the social and legal impacts of their application.

The findings of this study may guide the adoption of chatbots in other university sectors and in public institutions with similar characteristics. In addition to offering practical evidence, the study reinforces the use of the Technology Acceptance Model (TAM) as a useful framework for understanding acceptance factors in administrative environments, an area still underexplored in national literature. Future research is recommended to investigate the long-term impact of AI use in public management and to evaluate the integration of complementary technologies, such as predictive analytics and deep learning, to expand the benefits identified.

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