

**NOVA**

**IMS**

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# MDDDM

Master's Degree Program in  
**Data-Driven Marketing**

## **Empirical Analysis of an AI-Powered Chatbot for Enhancing University Information Retrieval**

Artem Spasibukhov

Master Thesis

presented as partial requirement for obtaining a Master's Degree in Data-Driven Marketing, with a specialization in Digital Marketing and Analytics

**NOVA Information Management School**  
**Instituto Superior de Estatística e Gestão de Informação**

Universidade Nova de Lisboa

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January, 2025

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*Lisbon, 20.01.2025*

*Artem Spasibukhov*

# ABSTRACT

This thesis examines the implementation and evaluation of an AI-powered chatbot for improving information retrieval processes at Kozminski University. Leveraging the DeLone and McLean Model of Information Systems Success, the study assesses the chatbot's impact on user efficiency, information quality, and satisfaction, as well as its implications for the university's existing knowledge management practices. The empirical study involves comparative testing between the AI chatbot and Kozminski Knowledge Base, the traditional repository of institutional information. The outcomes indicate that the chatbot significantly reduces information retrieval time and improves accuracy while enhancing user satisfaction. This research not only contributes a viable AI solution for educational institutions but also provides empirical evidence of its effectiveness, potentially advancing the integration of AI applications in higher education. The research contributes theoretically by extending the application of the DeLone and McLean Model to chatbot technology and practically by providing insights into implementing AI chatbots in higher education contexts. Despite its promising findings, the study acknowledges limitations, including its focus on a single institution and a specific chatbot implementation. Future research directions are proposed to explore broader applicability, advanced AI features, and long-term impacts on knowledge management. This thesis underscores the transformative potential of AI chatbots as a key tool for improving information retrieval in academic settings.

# KEYWORDS

Artificial Intelligence; Chatbots; Technologies; Large Language Models; Natural Language Processing; Informational Systems

## Sustainable Development Goals (SDG):



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## **LIST OF ABBREVIATIONS AND ACRONYMS**

**AI** – Artificial Intelligence

**AWS** – Amazon Web Services

**FAQ** – Frequently Asked Question

**IS** – Informational Systems

**LLM** – Large Language Model

**ML** – Machine Learning

**NASA-TLX** – NASA Task Load Index

**NLP** – Natural Language Processing

**RAG** – Retrieval Augmented Generation

# 1. INTRODUCTION

Over the past decade, universities have increasingly embraced digital technologies to enhance administrative and academic processes (Man et al., 2023). This shift is evident in the widespread adoption of learning management systems, online enrollment platforms, virtual classrooms, and digital libraries (Dhandayuthapani V., 2022). These innovations aim to streamline operations, improve student engagement, and expand access to educational resources (Al-Fraihat et al., 2020). Online platforms now serve as critical interfaces for student interaction, encompassing everything from course registration and academic advising to accessing lecture materials and tracking academic progress. This growing reliance on digital tools reflects a broader trend in higher education: the prioritization of accessibility, efficiency, and inclusivity (Aldosari, 2020; Martinez-Requejo et al., 2024).

Among the digital technologies implemented by universities, information retrieval systems hold a central role (Dinh & Tran, 2023). These systems are essential for supporting a wide range of stakeholders, including students, faculty, and administrative staff. They contribute to institutional goals by ensuring that critical information like course descriptions, application procedures, scholarship opportunities, etc. is readily available (Al-Abdullatif et al., 2023). Effective information retrieval systems promote accessibility by enabling students to find relevant details quickly and inclusively, ensuring that all users, regardless of their technical expertise or background, can access the resources they need (Colace et al., 2018). For administrative staff, these systems can also reduce repetitive tasks, such as responding to frequently asked questions, allowing them to focus on more complex responsibilities (Al-madi et al., 2023).

Despite their importance, traditional university information retrieval systems face significant limitations (Rukhiran & Netinant, 2022). Hierarchical website designs, while logically structured, often require users to navigate multiple layers of menus and pages to locate specific information. This can result in excessive time spent searching, particularly for first-time users who are unfamiliar with the platform's layout. Similarly, keyword-based search functionalities, which rely on exact matches, frequently fail to deliver relevant results, due to minor spelling errors, use of informal language, or lack of domain-specific knowledge (Mischia et al., 2022; Shawar & Atwell, 2010). These limitations can lead to wasted time, leaving users without the information they seek.

These challenges are further amplified by the diversity of university stakeholders. Students come from varied cultural, linguistic, and educational backgrounds, each bringing

unique expectations and challenges when interacting with digital platforms (Kuhail et al., 2023). For international students, language barriers can make navigating websites particularly difficult, especially when complex terminology or region-specific jargon is involved. Additionally, varying levels of digital literacy among users mean that not all students are equally adept at interpreting website structures or formulating effective search queries (Abbas et al., 2022). These factors create a significant accessibility gap which traditional systems are unable to bridge.

The challenges of traditional information retrieval systems are particularly evident during high-demand periods, such as student application seasons (Gupta et al., 2023). During these times, university websites experience a surge in traffic as prospective students seek information about admission deadlines, program requirements, scholarships, and other essential details. Admission offices, already burdened with processing applications, often struggle to respond to the high volume of inquiries, leading to delays and potential dissatisfaction among applicants. These inefficiencies highlight the need for innovative, more efficient and user-friendly solutions to support students in accessing the information they need, without overburdening administrative staff.

One such solution is the implementation of artificial intelligence (AI)-powered chatbots, which have emerged as transformative tools to address these challenges (Labadze et al., 2023; Saha & Saha, 2024). Chatbots are automated systems that simulate human-like conversations using natural language processing (NLP) and machine learning (ML) technologies (Adamopoulou & Moussiades, 2020). By leveraging these capabilities, chatbots can understand and respond to user queries in a conversational manner, providing instant and accurate answers without the need for manual intervention. Unlike traditional keyword-based search systems, chatbots can interpret the intent behind a user's question, even if it is phrased informally or contains errors (Taju et al., 2023). This capability makes them particularly well-suited for the use of students, who often have diverse levels of familiarity with university terminology and processes.

The educational industry is increasingly recognizing the need for automation to streamline administrative processes and improve the student experience (Aldosari, 2020). As highlighted in recent studies, chatbots have been successfully deployed in various universities to handle repetitive tasks and answer frequently asked questions (FAQs) (Assayed & Maheshwari, 2023; Chakraborty et al., 2022). These implementations demonstrate the potential of chatbots to enhance operational efficiency and user satisfaction in educational settings (Belda-Medina & Kokošková, 2023).

However, while the development of AI-powered chatbots has been widely explored, there remains a need for strict evaluation of their effectiveness in real-world scenarios. Evaluating these systems is crucial for understanding their impact on user experience, information accuracy, and operational efficiency. Moreover, such evaluations can provide valuable insights into the challenges and opportunities associated with deploying AI technologies in educational settings, informing future developments and implementations. A study conducted at Yonsei University found that the introduction of an FAQ chatbot reduced the number of email inquiries received by administrative offices by 27.19%, while also lowering the perceived workload of staff members as measured by the NASA Task Load Index (NASA-TLX) (Lee et al., 2019). These findings underscore the potential of chatbots to alleviate administrative burdens and improve service delivery in universities.

This study contributes to this growing body of research by evaluating a custom-built AI-powered chatbot designed to enhance university information retrieval for students. The chatbot, developed as part of this research, is intended to complement traditional university information systems by providing a more intuitive and efficient way for students to access information. While the development of the chatbot is a necessary and obligatory step to its evaluation, the primary focus of this thesis is on assessing its effectiveness in real-world scenarios. By evaluating the chatbot's performance, this study aims to provide empirical evidence on its utility and benefits, as well as insights into how AI technologies can be effectively deployed to enhance student experience.

## **2. LITERATURE REVIEW**

### **2.1 The Evolution of Chatbot Technology in Education**

The development of chatbot technology in education has evolved significantly over the past decade, driven by advancements in AI, NLP, and ML (Ramakrishnan et al., 2024). Early chatbot systems were primarily rule-based, relying on predefined scripts and decision trees to generate responses (Adamopoulou & Moussiades, 2020). While these systems were effective in handling simple, repetitive queries, they struggled to provide meaningful responses to more complex or context-dependent questions (Caldarini et al., 2022). The lack of flexibility and adaptability in rule-based systems limited their utility in educational settings, where students often require personalized and context-aware support.

The advent of machine learning and NLP has transformed the capabilities of chatbots, enabling them to learn from data and improve their performance over time (Amer Jid Almahri et al., 2021; Mangotra et al., 2023). Modern chatbots, such as those powered by large language models (LLMs) like GPT-4, can generate human-like responses based on the context of the conversation. These chatbots are capable of understanding and responding to a wide range of queries, from simple FAQs to more complex academic and personal challenges (Ilagan & Ilagan, 2024; Ramalakshmi et al., 2023). The integration of retrieval-augmented generation (RAG) further enhances the capabilities of these chatbots by enabling them to retrieve and incorporate relevant information from external knowledge bases, ensuring that their responses are both accurate and contextually appropriate (Bhat et al., 2024).

### **2.2 Advantages in Education**

The unique capabilities of AI-powered chatbots offer significant advantages for the educational sector (Gayathri et al., 2024). One of the most significant benefits of AI chatbots in education is their ability to operate continuously, offering 24/7 assistance to students. Unlike human staff, chatbots do not require breaks, ensuring that students can access support at any time. This is particularly valuable for international students who may be in different time zones or for learners who prefer to study during non-traditional hours (Tian et al., 2024). This uninterrupted availability not only enhances the user experience but also reduces stress for students who require immediate assistance. It demonstrates a level of institutional commitment to accessibility and responsiveness that is increasingly expected in modern, technology-driven education systems.

Scalability is another critical advantage, especially during peak periods such as application deadlines or exam seasons when traditional support systems are overwhelmed (Hew et al., 2023). Unlike human staff, chatbots can handle thousands of simultaneous queries, ensuring that all users receive timely assistance. This scalability allows administrative staff to focus on more complex tasks, such as evaluating applications, while ensuring that no student inquiry goes unanswered.

Chatbots improve accessibility by breaking down barriers to information retrieval. They can support multiple languages, enabling international students to interact in their native language (El Hefny et al., 2021). Additionally, chatbots can simplify complex academic jargon, making university processes more comprehensible to first-time applicants or students unfamiliar with specific terminology (Oliveira & Matos, 2023; Segovia-García, 2024). Furthermore, AI-powered chatbots are accessible across various devices, including smartphones, tablets, and computers, ensuring that students can receive assistance regardless of their preferred platform (Crawford et al., 2024).

One of the most critical pain points for students is the delay in receiving feedback or responses to their queries (Zeqiri et al., 2023). Chatbots address this issue by providing instant answers, significantly reducing waiting times. The speed and efficiency of chatbots not only improve user satisfaction but also contribute to better decision-making (Elnozahy et al., 2019; Jiang et al., 2022). Students can access accurate and timely information, enabling them to make informed choices about their academic and extracurricular activities.

AI-powered chatbots also offer cost-saving advantages for educational institutions (Srinivasa et al., 2022). By automating routine inquiries and support tasks, chatbots reduce the workload on administrative staff, allowing institutions to allocate resources more effectively. Over time, the initial investment in chatbot development and integration can lead to substantial savings in operational costs. Additionally, the efficiency of chatbots in managing high volumes of inquiries can mitigate the need for temporary staffing during peak periods, further reducing expenses.

Another key advantage of chatbots is their ability to collect and analyze user interaction data (Amadeus Software Labs India Pvt. Ltd & Khan, 2017). This data provides valuable insights into student behavior, preferences, and common pain points. For instance, universities can identify frequently asked questions, areas where students face difficulties, or trends in support requests during specific times of the academic year. By leveraging these insights, institutions can make data-driven decisions to improve their services, optimize resources, and address student needs more effectively.

Finally, AI-powered chatbots play a crucial role in fostering a stronger connection between students and their institutions (Li et al., 2022; Pitts et al., 2012). By providing prompt, personalized, and reliable support, chatbots enhance the overall student experience, making them feel valued and supported. This, in turn, contributes to higher levels of student satisfaction, retention, and loyalty.

### **2.3 Research Gap and Justification**

While the potential of chatbots in higher education has been widely acknowledged, there remains a notable gap in the literature concerning the empirical evaluation of these systems. The most critical research gap lies in the measurement of user satisfaction with AI-powered chatbots in educational settings (Huang et al., 2024). While many studies investigate user acceptance and the perceived benefits of chatbots, few focus on quantitative or qualitative measures of user satisfaction, particularly from the perspective of students.

For universities, the ultimate goal of chatbot implementation is not just to reduce administrative workload but to enhance student experience. A chatbot's effectiveness is not solely determined by its ability to provide accurate answers; it also depends on how well it meets student expectations, how intuitive and user-friendly it is, and how it contributes to a positive overall experience with the institution.

Existing studies often overlook the importance of collecting and analyzing user feedback, such as satisfaction surveys or interview responses, to assess how students perceive the chatbot (Sáiz-Manzanares et al., 2023). Are they satisfied with the speed and relevance of the responses? Do they feel that the chatbot understands their queries, or do they find it frustrating and impersonal? Such insights are critical for universities to understand the impact of chatbot systems on student engagement and satisfaction.

The gap in empirical studies regarding AI-powered chatbots in universities has significant practical implications. Universities are under increasing pressure to modernize their digital infrastructure and meet the growing expectations of tech-savvy students who demand instant and personalized support (Ma & Huo, 2023). The adoption of chatbots is seen as a solution to this problem, but universities cannot afford to make implementation decisions without a clear understanding of their impact (Lucien & Park, 2024).

Addressing this research gap will provide universities with the data and insights they need to make informed decisions about chatbot adoption, integration, and optimization. It will allow them to tailor their chatbot systems to better meet the needs of their students, ensuring

that the technology contributes positively to student satisfaction, retention, and academic success.

## **2.4. Challenges and Limitations of Chatbots in Education**

Despite their potential, the implementation of AI-powered chatbots in educational settings is not without challenges. One of the primary concerns is the quality and accuracy of the information provided by chatbots (Chiu et al., 2023; Terblanche et al., 2023). While advanced models like GPT-4 enhanced with RAG can generate highly accurate and contextually appropriate responses, they are not immune to errors or inaccuracies. In some cases, chatbots may generate fabricated or misleading information, particularly when dealing with complex or ambiguous queries. This issue is compounded by the fact that chatbots rely on the data they are trained on, which may not always be comprehensive or up to date (Bhat et al., 2024).

Another challenge is the potential for bias in chatbot responses (Murtarelli et al., 2021). Chatbots trained on large datasets, particularly those sourced from online communities, may inadvertently incorporate biases present in the data. For example, a chatbot trained on discussions from a specific subreddit may generate responses that reflect the biases or perspectives of that community, which may not be representative of the broader student population. Ensuring that chatbots provide fair and unbiased support requires careful attention to data collection, preprocessing, and ongoing monitoring.

Privacy and data security are also significant concerns in the deployment of chatbots in educational settings (Flores-Vivar & García-Peñalvo, 2023). Ensuring that sensitive information is handled securely and in compliance with data protection regulations is critical to maintaining student trust and safeguarding their privacy.

Finally, the effectiveness of chatbots in addressing the nuanced and context-specific needs of individual students is limited by the data and the model's capacity to interpret complex issues (Caldarini et al., 2022). While chatbots can provide general guidance and support, they may struggle to fully understand the unique challenges faced by individual students. This limitation highlights the need for ongoing research and development to enhance the personalization and adaptability of chatbot systems.

## **2.5 Contribution to the Field**

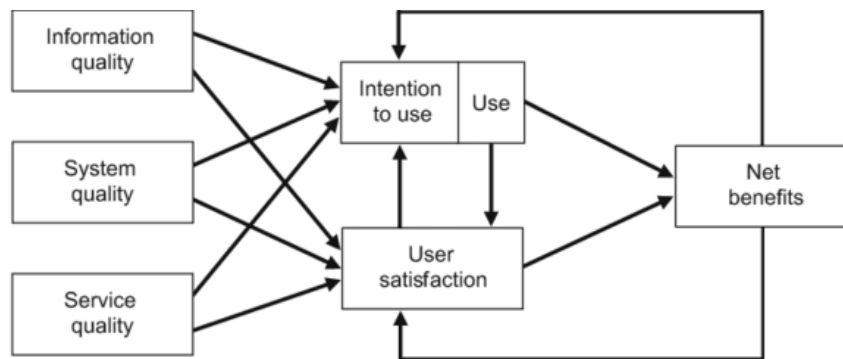
The scope of this research is confined to the domain of university information retrieval, focusing on the experiences of students as primary users. The evaluation will consider both qualitative and quantitative metrics, such as user satisfaction surveys, response accuracy rates, and system usage statistics.

On a theoretical level, this study contributes to the growing body of literature on AI applications in education by filling a critical gap in empirical research. By analyzing real-world data and user feedback, the research advances the understanding of chatbot performance in educational settings, highlighting the conditions under which these tools are most effective. This knowledge can inform future studies and innovations in the field, fostering the development of more sophisticated and user-centric AI solutions.

### 3. METHODOLOGY

#### 3.1 DeLone and McLean IS Success Model

To evaluate the university chatbot's effectiveness, this study employs the DeLone and McLean IS Success Model, a widely recognized framework for assessing the success of information systems (Mustafa et al., 2020). Originally developed in 1992 and later refined in 2003, the model identifies six interrelated dimensions of IS success: system quality, information quality, service quality, use, user satisfaction, and net benefits (“The DeLone and McLean Model of Information Systems Success,” 2003). These dimensions form a holistic approach to evaluating not only the technical functionality of an information system but also its impact on user experience and organizational outcomes (Figure 1).



*Figure 1 - D&M IS Success Mode*

The DeLone and McLean IS Success Model was chosen for this study due to its emphasis on user-centric evaluation, making it particularly suitable for assessing interactive systems like AI-powered chatbots. Chatbots, by their nature, rely heavily on information quality (accurate and relevant responses), service quality (responsiveness and ease of interaction), and user satisfaction (the perceived usefulness and enjoyment of the tool). These dimensions align well with the goals of this study, which seeks to determine whether the chatbot can effectively enhance the process of information retrieval for students.

While the full model includes additional dimensions like system quality (technical aspects such as reliability and performance), use (extent and frequency of system usage) and net benefits (financial benefits of technology implementation), these were deemed less critical for the current evaluation. Instead, the study focuses on information quality, service quality,

and user satisfaction, which are more directly relevant to the chatbot's purpose and user interactions.

By using this model, the study ensures a structured and validated approach to measuring the chatbot's success. The following sections outline the methodology, including participant selection, testing procedures, and the integration of the IS Success Model dimensions into the evaluation framework.

### **3.2 The Kozminski Knowledge Base**

Kozminski University holds particular significance for this research, as it is a highly esteemed institution known for its focus on innovation, business education, and academic excellence in Poland and internationally. The university's commitment to adopting cutting-edge technologies makes it an ideal setting for testing the integration of AI-based solutions.

Furthermore, as an alumnus of Kozminski University, I possess an intimate understanding of the challenges students face when navigating the existing university online resources. This personal connection provided valuable context for modeling the testing phase and evaluating the effectiveness of the chatbot and its potential to address the specific needs of Kozminski students.

The Kozminski Knowledge Base serves as the university's traditional repository of information, accessible through its website. It includes static content such as program descriptions, application guidelines, scholarship information, university regulations, frequently asked questions, and many more. While it is comprehensive, its structure requires users to navigate multiple pages and menus to locate specific information. This method of knowledge retrieval relies heavily on user familiarity with the website and their ability to search effectively.

The Kozminski Knowledge Base was selected for comparison with the chatbot because it represents the current standard for obtaining information at the university. It allows for an objective evaluation of the chatbot's potential to streamline and improve the information retrieval process for students (Ngai et al., 2021; Yang et al., 2022).

### **3.3 Testing Setup**

The study involved a total of 98 participants, all of whom were students from 1st, 2nd, and 3rd years at Kozminski University, enrolled in both Polish and English programs. A significant subset of participants was from the Management & AI course. The testing was

conducted during or after regular class sessions, coordinated with professors Anna Kovbasiuk, Monica Sonta, and others. Each of the three sessions accommodated over 30 participants.

To assess the effectiveness of the chatbot, the students were divided into two distinct groups. The “Test Group” interacted with the chatbot to answer a set of predefined questions. In contrast, the “Control Group” relied on the traditional method of using the university’s website and its available knowledge base to obtain answers to the same questions.

The questions asked during the testing covered two categories. Simple questions were focused on straightforward information retrieval while complex questions required more detailed and nuanced information.

#### **Group of simple questions:**

- 1.1 Please list the languages that full-time students can learn at Kozminski.
- 1.2 Please list the languages that part-time students can learn at Kozminski.
- 1.3 Is it free to study 2 foreign languages at Kozminski for full-time students?

#### **Group of complex questions:**

- 2.1 Please list the eligibility criteria for the rector's scholarship.
- 2.2 Please list the selection criteria for the rector's scholarship.
- 2.3 Please list the additional requirements for foreigners when it comes to the rector's scholarship.
- 2.4 Please create a list of step-by-step instructions (4-5 steps) on how to apply for the rector's scholarship.

### **3.4 Questionnaire Design**

Additionally, both groups completed questionnaires before and after the testing sessions to gather insights about their familiarity with AI tools and their experiences during the testing process.

- **Control Group Questions:** These were focused on the participants’ experience using the traditional knowledge base, covering aspects like ease of use, accuracy of information, trust in the system, and time efficiency.
- **Test Group Questions:** The questions emphasized the chatbot’s performance, addressing response accuracy, relevance, satisfaction with response time, and ease

of interaction. Additional questions explored the likelihood of future use and recommendations to others.

### 3.5 Integration with DeLone and McLean IS Success Model

The methodology incorporates three dimensions of the DeLone and McLean IS Success Model:

- **Information Quality:** Assessed through participants' perceptions of the accuracy, relevance, and comprehensiveness of the chatbot's responses.
- **Service Quality:** Evaluated based on user satisfaction with the chatbot's responsiveness, promptness, and ease of use.
- **User Satisfaction:** Measured through participant feedback on their overall experience, mental effort required, and likelihood of continued use or recommendation.

By adopting this structured approach, the methodology ensures a clear, empirical foundation for evaluating the chatbot's effectiveness and user experience in comparison to traditional knowledge retrieval methods.

### 3.6 Survey Questions

**Control Group** survey questions that were answered by students **before** the testing:

1. How often do you use AI chatbots or similar tools in your daily life?
2. On a scale of 1 to 5, how would you rate your general understanding of how to interact with AI chatbots?
3. What is your attitude towards chatbots?
4. Do you use the Kozminski Knowledge Base to check information about Kozminski?
5. What is your attitude towards the Knowledge Base?

**Control Group** survey questions that were answered by students **after** the testing:

6. How easy did you experience it to find relevant data?
7. How do you feel about the time it took you to find the data?
8. On a scale of 1-5, was it mentally demanding to find the relevant articles when looking through the Knowledge Base?

9. How much do you trust that using the Knowledge Base you found actual and accurate information?

**Test Group** survey questions that were answered by students **before** the testing:

1. How often do you use AI chatbots or similar tools in your daily life?
2. On a scale of 1 to 5, how would you rate your general understanding of how to interact with AI chatbots?
3. What is your attitude towards chatbots?
4. Do you use the Kozminski Knowledge Base to check information about Kozminski?
5. What is your attitude towards the Knowledge Base?

**Test Group** survey questions that were answered by students **after** the testing:

6. How would you rate the accuracy and relevance of the chatbot's responses?
7. How satisfied are you with the response time of the chatbot?
8. On a scale of 1-5, how mentally demanding was it to come up with the right prompt to get a specific answer you sought?
9. On a scale of 1-5, how likely is it that you would recommend the chatbot to another Kozminski student?
10. How likely are you to use Chatbot in your academic routine if it had more data covered?
11. How much do you trust that the Chatbot gave you actual and accurate information?
12. What is your attitude towards this chatbot?

## 4. EMPIRICAL STUDY

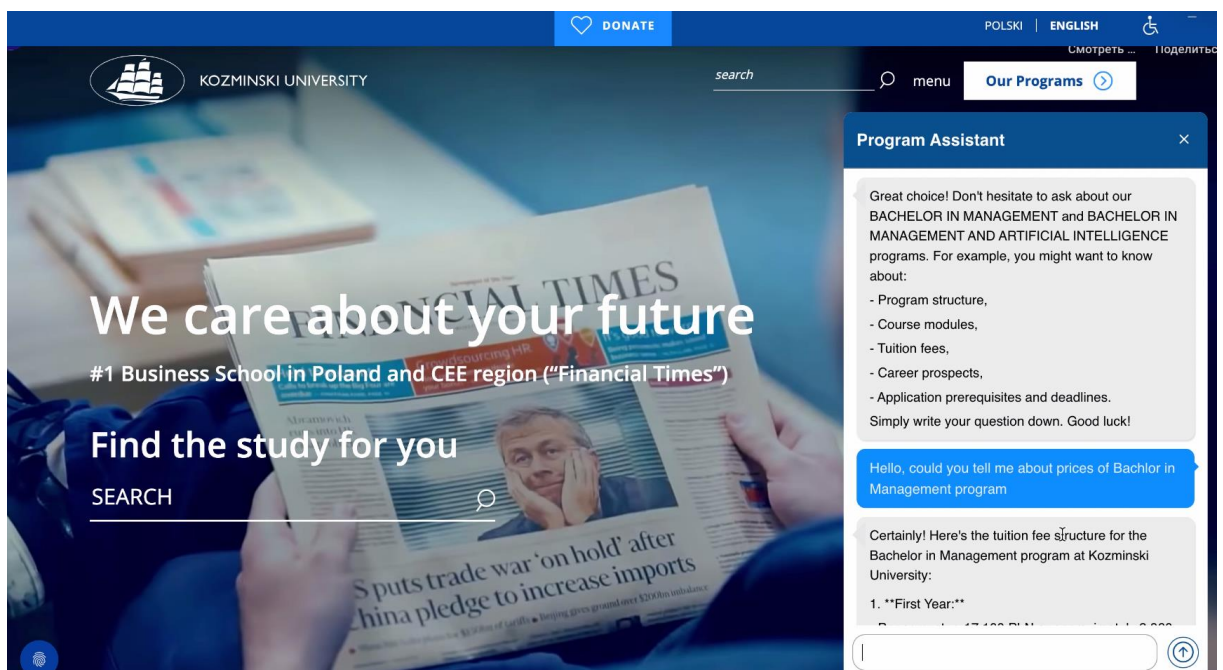
### 4.1 Chatbot Development Process

As it was mentioned earlier, particularly for this study, there was a chatbot developed to enhance the information retrieval process for Kozminski University, providing students and other users with a conversational interface to access university-related information. This section provides an overview of the technologies used, system architecture, and the stages involved in its development.

#### 4.1.1 Technology Stack

The chatbot was built using specific technologies to ensure high performance and adaptability. Key components of the technology stack include:

- **User Interface:** Provides a seamless conversational experience for users, accessible via web and mobile platforms of Kozminski University (Figure 2).



*Figure 2 - Chatbot widget on Kozminski University website*

- **Language Model Integration:** Several OpenAI's GPT models were employed to handle natural language processing tasks such as query understanding and response generation.

- **Embedding Model:** The system uses OpenAI's text-embedding-ada-002 for transforming text data into dense vector representations, capturing semantic relationships between different texts.
- **Vector Database:** Pinecone was chosen as the vector database for its capability to store and quickly retrieve vector embeddings.
- **Deployment Platform:** The chatbot was deployed on Amazon Web Services (AWS) cloud infrastructure to ensure scalability and availability.

#### 4.1.2 Development Process

The process started with requirement analysis to identify the key challenges students face when accessing information through the existing Kozminski Knowledge Base. The primary objective was to provide a conversational interface capable of delivering accurate and contextually relevant answers. Comprehensive data was then gathered from Kozminski University website and other related resources, including program descriptions, admission guidelines, and other static content. This dataset formed the foundational knowledge base for the chatbot.

The collected data underwent cleaning, formatting, and semantic chunking to ensure each chunk represented a coherent idea or information snippet, optimizing the retrieval process. These preprocessed chunks were subsequently transformed into embeddings using OpenAI's embedding model and stored in Pinecone vector database. Metadata such as document titles and chunk IDs were associated with each vector to facilitate hierarchical search.

On the back end, the query-handling logic was designed to efficiently process user queries by transforming them into embeddings, conducting similarity searches, and generating responses based on the retrieved data. This system integration with ChatGPT models allowed for the synthesis of coherent and contextually accurate answers, ensuring that responses remained grounded in the provided data.

Following development, extensive testing was conducted to validate the chatbot's accuracy, efficiency, and user experience. This involved both functional testing and user feedback sessions to identify areas of improvement. After successful testing, the chatbot was deployed on a scalable cloud platform, with continuous monitoring to ensure stable performance and user satisfaction.

## **4.2 Data collection**

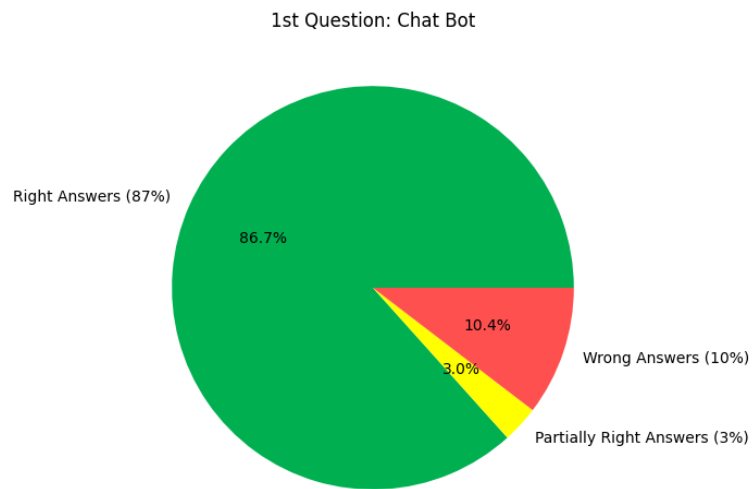
The primary data for this study was collected using the Google Forms tool. Participants from the Test and Control groups were asked to respond to a series of questions designed to evaluate their experience with either the Chatbot or the Kozminski Knowledge Base. Prior to the analysis, the raw dataset underwent a cleaning process in Excel to ensure data consistency and accuracy. Responses with incomplete or missing answers were removed to maintain the integrity and reliability of the dataset.

Once the data cleaning process was completed, the dataset was exported for analysis in Python, utilizing a range of statistical and visualization packages. These tools facilitated a thorough examination of the data, including descriptive statistics, comparative analyses, and visual representations of key findings.

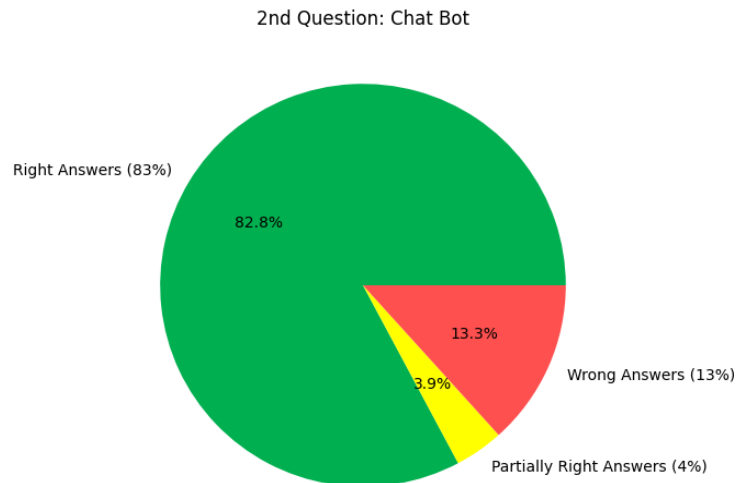
The findings from an analysis of the testing and survey results provide valuable insights into the effectiveness of the chatbot compared to the traditional Kozminski Knowledge Base, particularly in the context of user experience, response accuracy, and task completion times. The following sections present the results of the empirical study, structured around the specific previously mentioned dimensions of DeLone and McLean IS Success Model used to guide the evaluation.

### **4.3.1 General Qualitative Accuracy Comparison**

The first set of results, represented through pie charts, highlights the chatbot's strong performance in guiding users to accurate information. For the first group of questions, which were relatively straightforward, 86.7% of participants provided correct answers. For the second, more complex group of questions, the success rate was slightly lower but still impressive at 82.3%. These findings suggest that the chatbot was able to guide users effectively to the correct information, even when the queries were more specific or challenging.

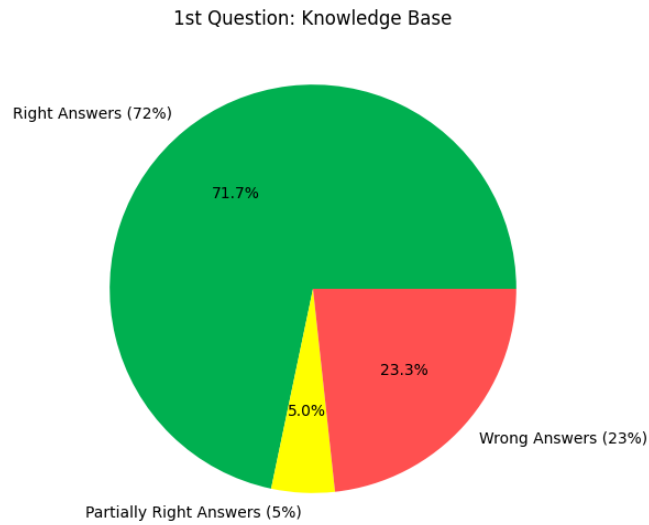


**Figure 3 - 1st Question (Test Group)**

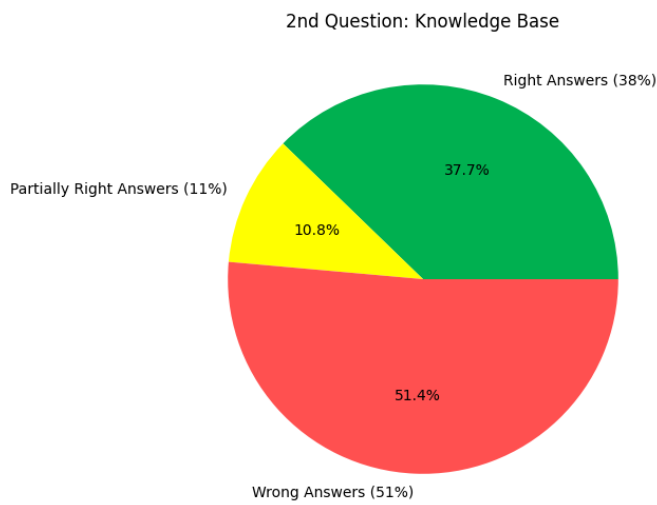


**Figure 4 - 2nd Question (Test Group)**

In contrast, the performance of the traditional Knowledge Base was notably weaker. For the simpler group of questions, the correct response rate was 71.7%, while for the more complex questions, it dropped significantly to 37.7%. This indicates that users had more difficulty finding the correct information using the knowledge base, particularly for more specific queries.



**Figure 5 - 1st Question (Control Group)**

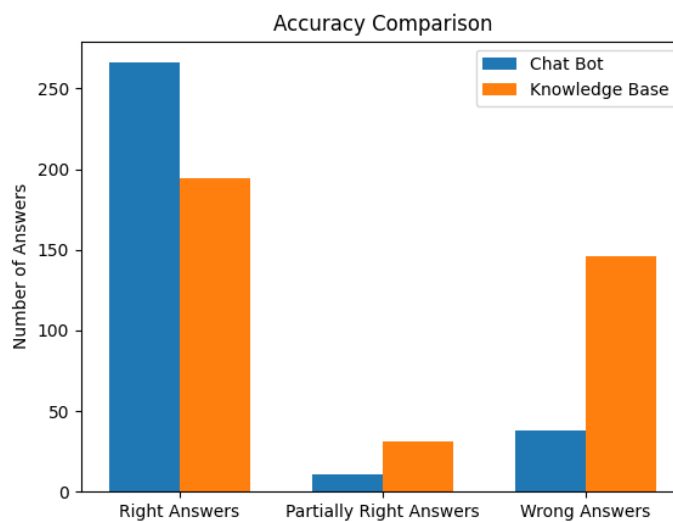


**Figure 6 - 2nd Question (Control Group)**

Additionally, error rates were significantly higher for the Knowledge Base, particularly for the complex questions where 51.5% of responses were incorrect. This suggests that there are potential issues with the structure or usability of the Knowledge Base, making it less effective as a tool for accurate information retrieval compared to the chatbot.

### 4.3.2 Summary of Accuracy Comparison

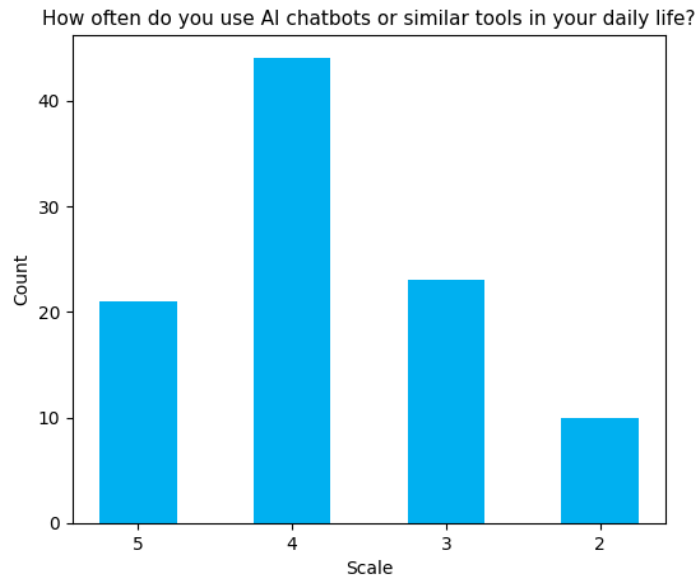
The chatbot's consistently higher percentage of correct answers demonstrates its efficiency and reliability in assisting students with their inquiries. Conversely, the Knowledge Base's higher count of incorrect responses suggests that improvements in design and structure are necessary to better meet users' needs. Overall, the chatbot emerges as a dependable and valuable resource, particularly for students seeking timely and accurate information.



*Figure 7 - Accuracy Comparison*

### 4.3.3 Frequency of AI Chatbot Usage in Student's Daily Life

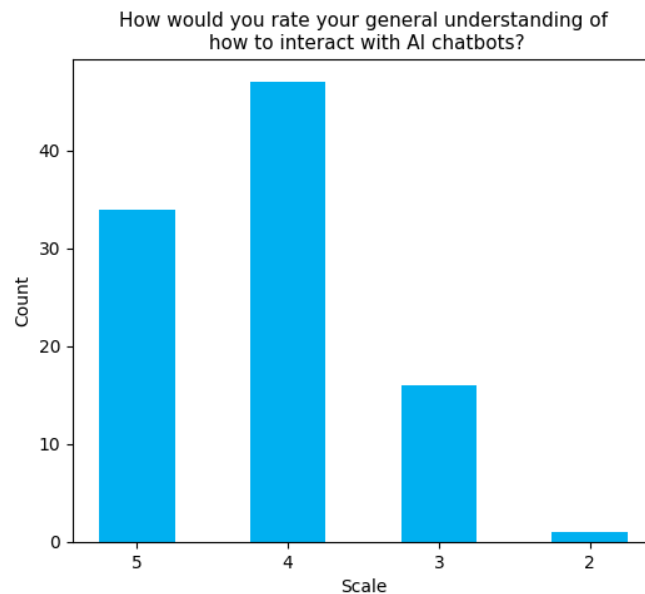
The bar graph reveals that a majority of university students frequently engage with AI chatbots, with the most common response being a 4 out of 5 in terms of usage frequency. A substantial number of students indicated a very high engagement. The data suggests that AI chatbots are widely accepted and utilized among students, potentially for educational purposes or daily tasks. The presence of lower ratings, such as 3 and 2, highlights that while some students are less frequent users, there is an overall positive inclination towards using AI chatbots in their daily lives.



**Figure 8 - Students' Frequency of Chatbot Usage**

#### 4.3.4 Proficiency in Interacting with AI Chatbots

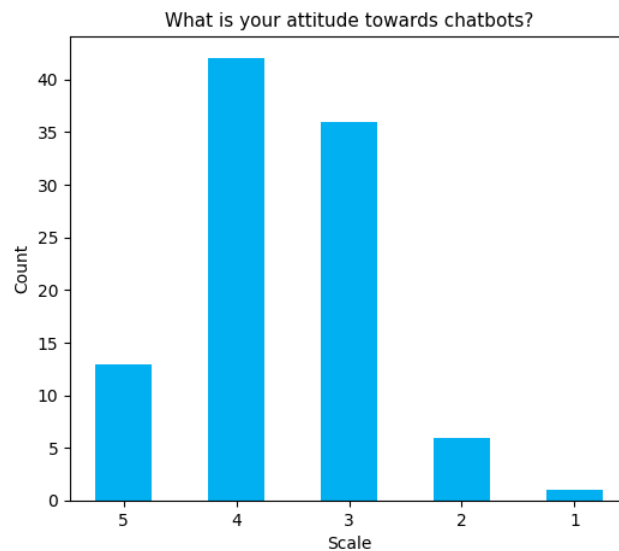
Students reported a high level of proficiency in using AI chatbots, with most participants rating their understanding as 4 out of 5. A notable portion of students also rated their understanding as perfect. The presence of ratings at 3 and 2 suggests that a minority of students might require additional guidance or education on chatbot interaction. Overall, the results imply that students are generally well-versed in utilizing chatbots, which could be indicative of the technology's integration into their daily lives and education systems.



*Figure 9 - Students' Proficiency in Interacting with AI Chatbots*

### 4.3.5 Attitudes Towards Chatbots

The majority of university students generally hold a positive attitude towards chatbots, with the majority rating their attitude as 4 out of 5. This suggests that chatbots are well-received among the student population, likely due to their utility in facilitating academic and daily tasks. The presence of a significant count of students rating their attitude as neutral (3 out of 5) indicates that while there is room for improvement in chatbot applications, the overall sentiment is not negative. Notably, very few students have expressed a negative attitude (ratings of 1 and 2), underscoring the potential for chatbots to become even more integral to student life as their capabilities expand.

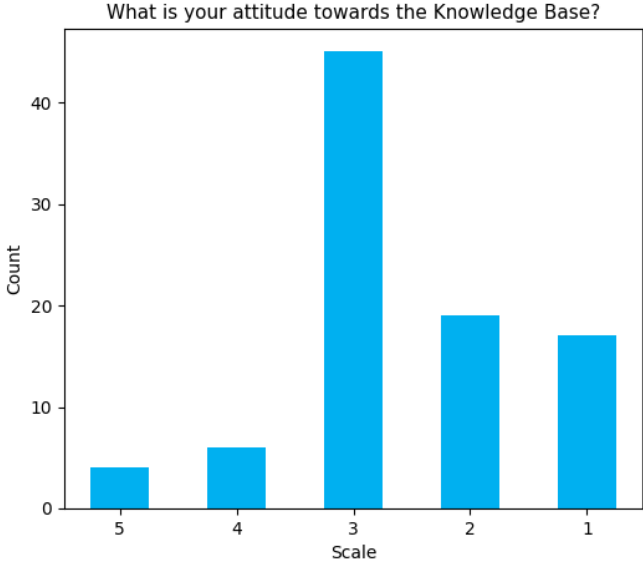


*Figure 10 - Students' Attitudes Towards Chatbots*

### 4.3.6 Perceptions of the Knowledge Base

The Knowledge Base received less favorable ratings, indicating predominant neutrality or dissatisfaction with the university's Knowledge Base, as most students rated their attitude as 3 out of 5. The lack of ratings at the highest end of the scale (5) suggests that the Knowledge Base is failing to meet the needs of the students. With a significant number of students leaning towards a negative perception (ratings of 1 and 2), it becomes clear that the Knowledge Base is

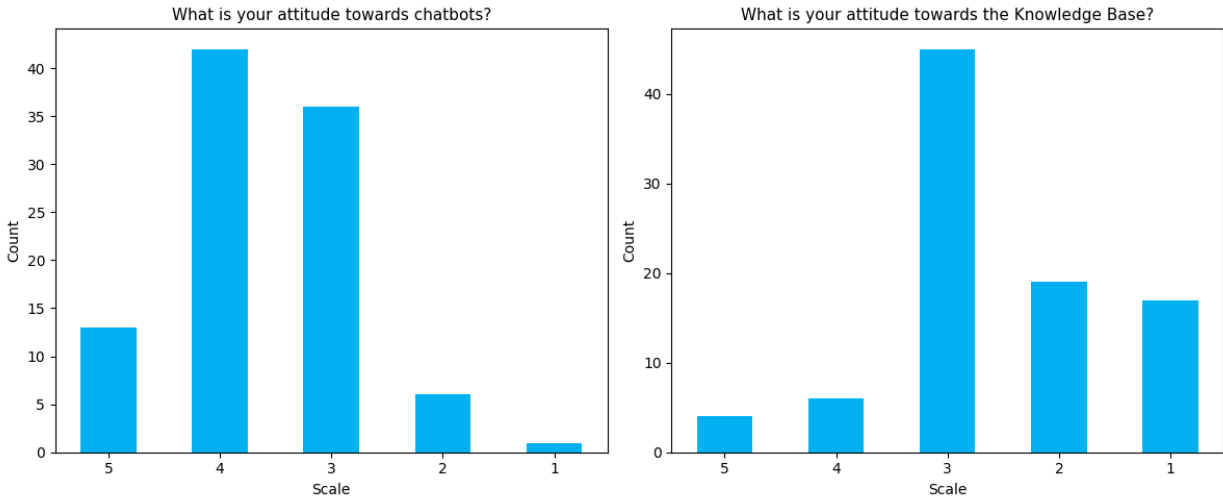
not viewed favorably, likely due to poor usability or inefficiencies in retrieving relevant information. These findings highlight a potential area for improvement in the Knowledge Base’s content or user experience, and they also suggest an opportunity for chatbots to provide a more efficient and satisfactory service to the students.



*Figure 11 – Students’ Perceptions of the Knowledge Base*

**4.3.7 Attitudes Towards Chatbots and the Knowledge Base**

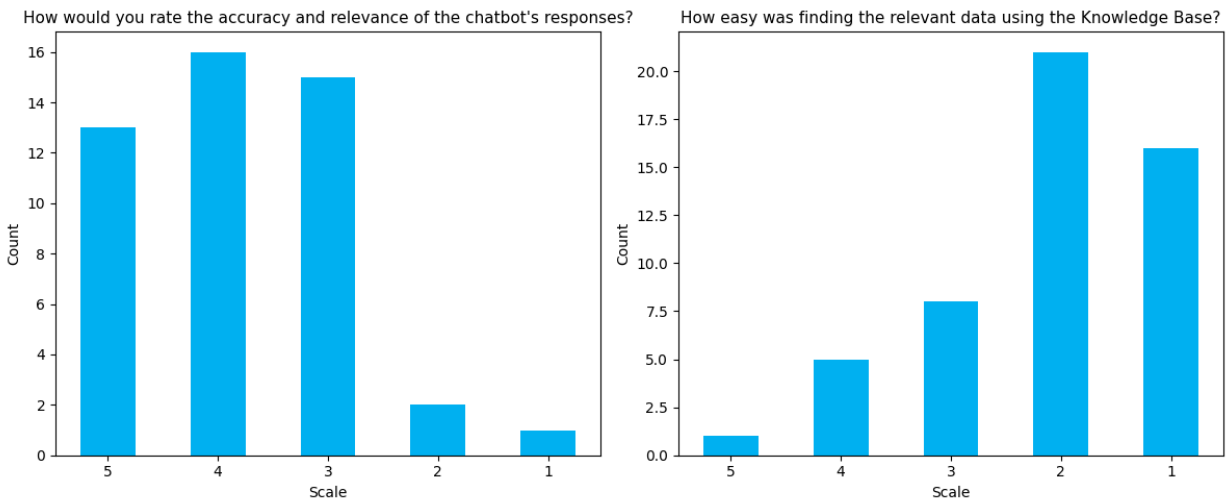
The survey results demonstrate a clear preference for chatbots among university students when compared to the university Knowledge Base. The data indicates that students perceive chatbots as more effective and approachable for their needs. On the other hand, the Knowledge Base seems to elicit a less enthusiastic response, suggesting that it may not be as aligned with the students’ expectations or requirements.



*Figure 12 - Comparative Analysis: Attitudes Towards Chatbots and the Knowledge Base*

#### 4.3.8 Chatbot Accuracy vs. Knowledge Base Data Accessibility

The survey results reveal a distinct preference for the chatbot among university students, with many finding its responses to be accurate and relevant. This suggests that the chatbot is well-received for its ability to provide timely and suitable information. In contrast, the Knowledge Base appears to be less user-friendly, with students facing challenges in locating relevant data.



*Figure 13 - Chatbot Accuracy vs. Knowledge Base Data Accessibility*

### 4.3.9 Chatbot Response Time vs. Knowledge Base Retrieval Time

The survey results underscore a strong satisfaction with the chatbot’s response time among university students, suggesting that it serves as an efficient and prompt resource for their queries. Conversely, there is a notable dissatisfaction with the Knowledge Base’s data retrieval process, indicating a need for improvement in its efficiency and user-friendliness. These findings highlight the chatbot’s superiority in speed and accessibility, which are crucial factors for students when seeking information.

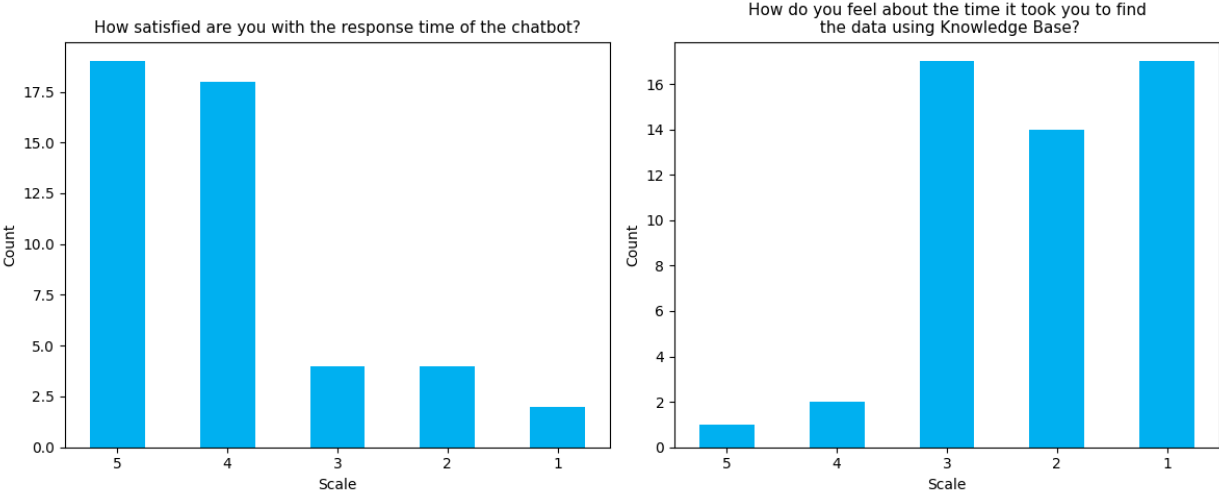
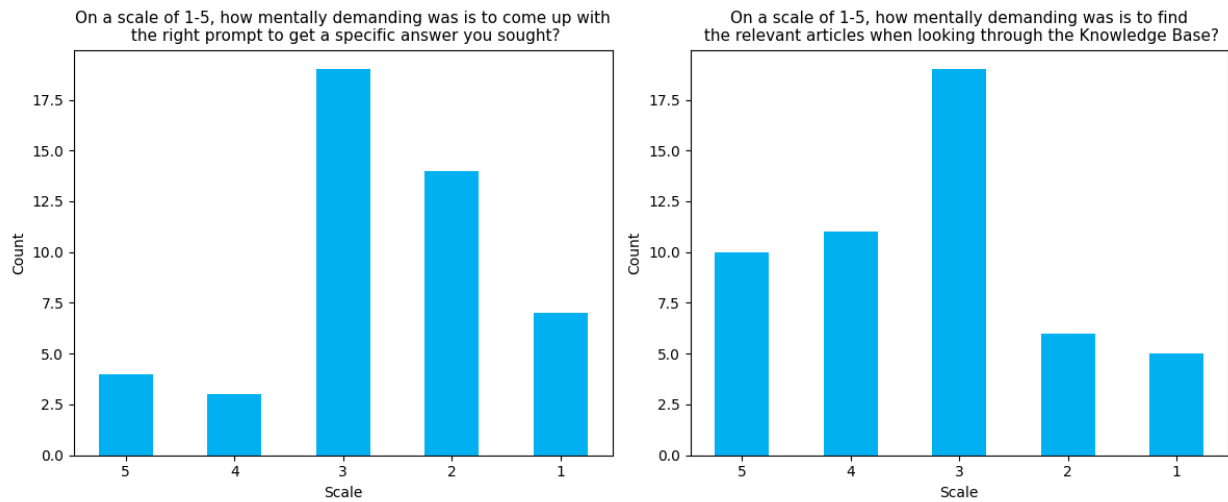


Figure 14 - Chatbot Response Time vs. Knowledge Base Retrieval Time

### 4.3.10 Mental Demands of Chatbot Interaction vs. Knowledge Base Navigation

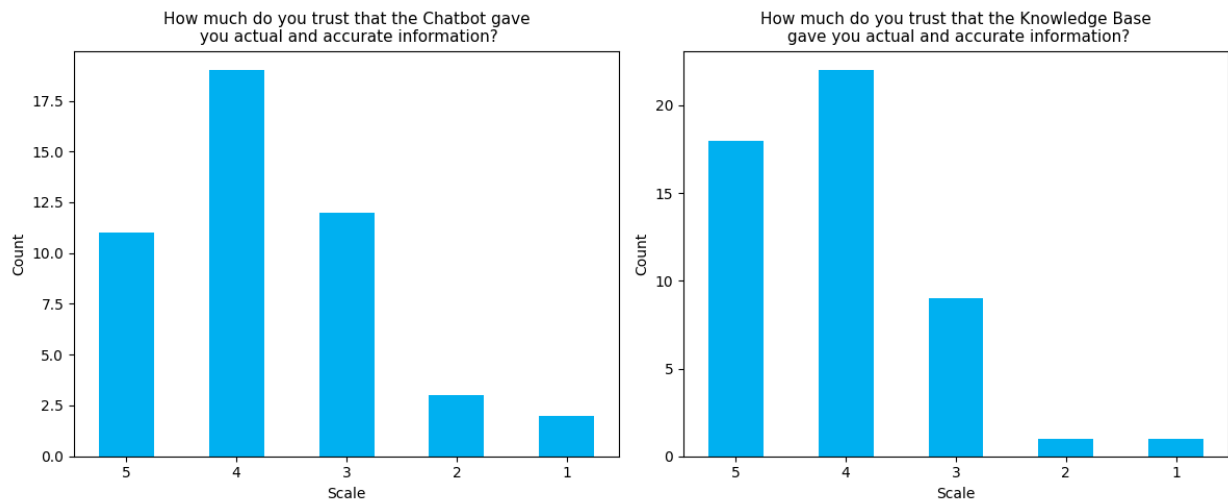
Participants found the chatbot to be less mentally demanding when seeking specific answers, compared to the effort required to sift through the university’s Knowledge Base. This suggests that the design of interaction with the chatbot is more aligned with the students’ needs for quick and straightforward information retrieval.



**Figure 15 - Mental Demands of Chatbot Interaction vs. Knowledge Base Navigation**

#### 4.3.11 Trustworthiness Comparison: Chatbot vs. Knowledge Base

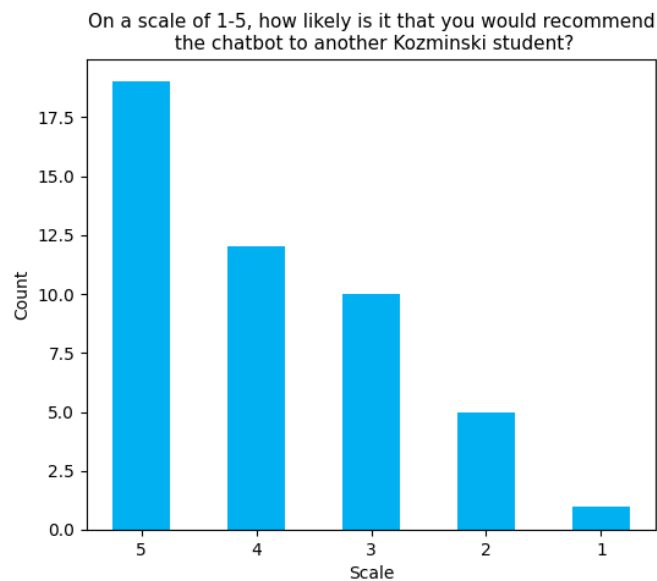
Surprisingly, the survey results suggest that both the chatbot and the university Knowledge Base are viewed as reliable sources of information by the students, with a slight preference for the Knowledge Base. The chatbot is recognized for its ability to provide actual and accurate information, reflecting its effectiveness.



**Figure 16 - Trustworthiness Comparison: Chatbot vs. Knowledge Base**

### 4.3.12 Recommendation Likelihood

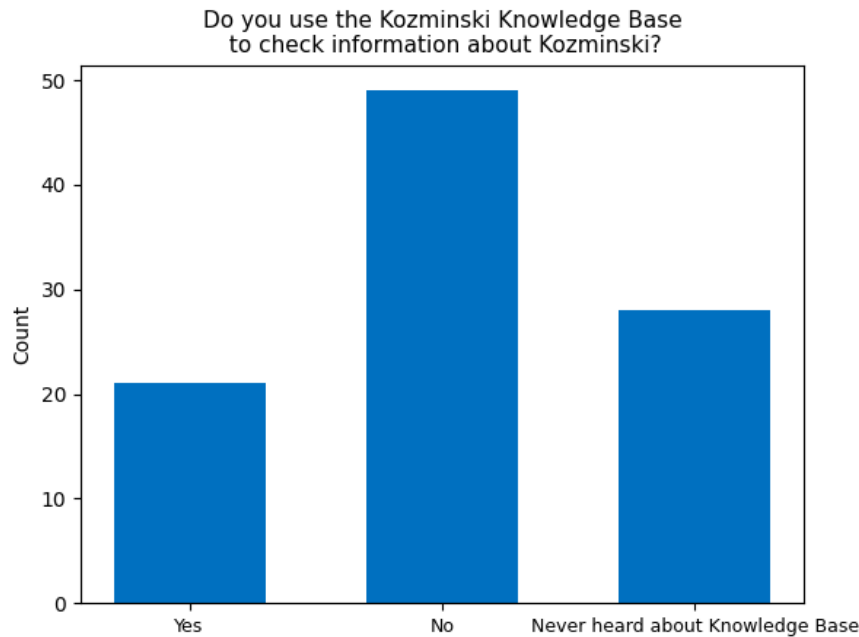
Students expressed a strong willingness to recommend the chatbot to peers, reflecting its perceived utility and effectiveness. The data underscores the possibility of chatbot's successful integration into the students' academic toolkit, suggesting its utility and effectiveness in providing assistance. Despite a few reservations, the overall sentiment leans positively towards the chatbot, highlighting its potential as a trusted academic resource.



*Figure 17 - Chatbot's Recommendation Likelihood*

### 4.3.13 Knowledge Base Usage

The survey results reveal a notable disengagement with the university's Knowledge Base among students. The predominant response indicates that the majority of students do not use the Knowledge Base to find information about Kozminski University. Furthermore, a significant portion of the students are unaware of its existence, suggesting potential underutilization of this academic resource. These findings highlight an opportunity for the university to enhance its outreach and improve the Knowledge Base's visibility and user-friendliness to better serve the student community.



*Figure 18 - Knowledge Base Usage*

#### 4.4 Statistical analysis of obtained results

Following the collection of the results obtained during the testing phase, statistical tests were conducted to assess the significance of the observed differences in performance between the first group who used a chatbot, referred to as the “Test Group” and the second group, “Control Group”, which used the Knowledge Base for the purpose of information retrieval. The analysis focuses on key metrics, providing insights into the impact of the chatbot on data extraction.

- **Efficiency:** The mean time taken by the Test Group to find answers was 309.26 seconds, significantly lower than the Control Group’s mean time of 650.04 seconds.
- **Consistency:** The standard deviation for the Test Group was 47.61, indicating less variability in response times among participants compared to the Control Group’s standard deviation of 222.02.

### Group Statistics

Group Type	N	Mean	Std. Deviation	Std. Error Mean
Test	47	309.2553	47.6128	6.9450
Control	51	650.0392	222.0234	31.0895

*Figure 19 - General Statistics*

- **Statistical Significance:** A t-test yielded a statistic of -10.30 and an extremely low p-value ( $3.33e-17$ ), confirming that the difference in performance between the two groups is statistically significant.

### Independent t-test Results

T-statistic	p-value	Significance
-10.3028	< 0.0001	Yes

*Figure 20 - T-test*

- **Levene's Test for Equality of Variances:** A significance level below 0.05, indicates that equal variances should not be assumed. This suggests that the two groups had different levels of variability in their response times, further supporting the conclusion that the chatbot provides a more consistent user experience.
- **T-test for Equality of Means:** A significance level below 0.05, further confirmed our findings. This robust statistical test validates the conclusion that the chatbot significantly improves efficiency in information retrieval.

Independent Sample Test

	Levene's Statistic	Sig. (Levene)	t	df	Sig. (2-tailed)	Mean Difference	Std Error Difference	95% CI of the Difference (Lower)	95% CI of the Difference (Upper)
Equal variance assumed	69.3388	0.0000	-10.3028	96.0000	0.0000	-340.7839	33.0770	-409.7824	-271.7854
Equal variance not assumed	69.3388	0.0000	-10.3028	54.9660	0.0000	-340.7839	31.8558	-407.2350	-274.3328

***Figure 21 - Levene's Test***

## 5. RESULTS AND DISCUSSIONS

### 5.1 Testing Highlights

The findings of this empirical study strongly indicate that the chatbot implementation significantly enhances efficiency and effectiveness in information retrieval processes for Kozminski University students. A comparative analysis between the Test Group (using the AI-powered chatbot) and the Control Group (relying on traditional navigation of the university website and Knowledge Base) demonstrates substantial differences in performance.

#### 5.1.1 Time Efficiency

One of the most significant outcomes is the reduction in time required to find answers. Participants in the Test Group were able to retrieve information in nearly half the time compared to the Control Group. This represents a marked improvement in efficiency, with users spending significantly less time searching for answers. Furthermore, the lower standard deviation in response times for the Test Group suggests greater consistency and reliability, which aligns with Gayathri et al. (2024) findings, where AI chatbots provided uniformly faster response times regardless of query complexity.

In contrast, the variability in the Control Group's response times underscores the inconsistency associated with traditional navigation methods. As highlighted by Rukhiran & Netinant (2022), websites that rely heavily on static content frequently fail to provide users with direct answers, leading to prolonged search times and user frustration.

#### 5.1.2 Answer Quality

The chatbot excelled in providing accurate and contextually appropriate responses. It performed well across a range of query complexities. This observation echoes the findings of Mangotra et al. (2023), who emphasized the capability of advanced NLP-driven systems to handle diverse user queries more effectively than traditional FAQ pages. Similarly, as noted by Ramakrishnan et al. (2024), chatbots that leverage contextual understanding significantly outperform static information repositories in terms of answer precision and user satisfaction.

In contrast, the Control Group often struggled to locate accurate or relevant information, with participants frequently encountering outdated or incomplete content on the Knowledge Base. This highlights the chatbot's strength in offering not only speed but also precision in responses, addressing the *Information Quality* dimension of the DeLone and McLean Model.

## **5.2 Survey Highlights**

The survey results further support the statistical findings and provide qualitative insights into user experiences and perceptions of the chatbot. Several key themes emerged from the survey data:

### **5.2.1 User Readiness and Adaptability**

The survey revealed a high degree of familiarity with AI chatbots among students, suggesting that they are well-prepared to adopt such technologies. Over 80% of participants indicated prior experience with AI-powered tools, underscoring a smooth transition to using the chatbot. This finding is critical in understanding the *Intention to Use* and *User Satisfaction* dimensions of the DeLone and McLean Model. The students' readiness mitigates potential resistance to adopting new technologies and facilitates seamless integration into existing workflows.

### **5.2.2 Trust and Comfort**

Participants expressed a strong sense of trust in the chatbot's ability to deliver accurate information. This trust was bolstered by the chatbot's consistent performance and error-free responses, which instilled confidence among users. Additionally, students reported feeling more comfortable interacting with the chatbot than navigating the Knowledge Base, citing its conversational interface and user-friendly design as significant advantages.

### **5.2.3 Perception of the Knowledge Base**

The university's Knowledge Base was perceived negatively by most participants. Nearly one-third of students were unaware of its existence, while others found it unintuitive. This points to a critical gap in user engagement and highlights the Knowledge Base's shortcomings in accessibility and usability. The chatbot's success in addressing these issues emphasizes its potential as a superior alternative for information dissemination.

### **5.2.4 User Experience Sentiment**

Feedback from participants highlighted a stark contrast in user experiences. The chatbot was praised for its ability to provide direct answers to specific queries, eliminating the need for extensive navigation or keyword searches. Conversely, navigating the Knowledge Base was described as time-consuming and often frustrating, with users needing to look through lengthy

articles to locate relevant information. This disparity underscores the chatbot's role in enhancing the *Service Quality* dimension of the DeLone and McLean Model.

### **5.3 Intangible Benefits**

Beyond measurable outcomes like time efficiency and answer quality, the chatbot delivers several intangible benefits that significantly impact the user experience. One key benefit is the reduction in frustration often associated with traditional navigation methods (Rukhiran & Netinant, 2022). Students frequently reported feeling empowered and in control when interacting with the chatbot, as it provided direct and accurate responses to their queries. This contrasts sharply with the traditional Knowledge Base, where users often expressed dissatisfaction due to the need to look through irrelevant or outdated content.

Another intangible benefit lies in the confidence students develop in their ability to retrieve accurate information independently. The chatbot's consistent and error-free performance fosters trust, enabling students to rely on it as a dependable source of information (Huang et al., 2024). This trust, in turn, reduces anxiety around important tasks such as meeting deadlines, understanding administrative procedures, or preparing for academic activities. By eliminating uncertainty, the chatbot contributes to a more positive and productive university experience for students.

Additionally, the chatbot promotes a sense of engagement and personalization (Pelau et al., 2021). Its ability to simulate conversational interaction makes users feel as though they are receiving tailored assistance rather than engaging with a static system. This perception of personalized attention enhances overall user satisfaction and can lead to increased adoption rates. The intangible benefits of reduced frustration, enhanced confidence, and a sense of personalization collectively elevate the chatbot from a mere tool to a valuable component of the university's digital ecosystem.

### **5.4 Long-Term Benefits of AI Chatbots in Education**

The implementation of AI chatbots in educational settings offers profound long-term benefits that extend beyond immediate gains in efficiency and user satisfaction. A primary advantage is the scalability of chatbot systems. Unlike human-operated support services, which require proportional increases in staffing to accommodate growing user bases, chatbots can handle exponentially larger volumes of queries without compromising performance (Elnozahy

et al., 2019). For universities, this means that as student enrollment grows, the chatbot can seamlessly scale its operations to meet demand, ensuring consistent service quality.

Another long-term benefit is the potential for continuous improvement through machine learning. The chatbot's ability to learn from user interactions allows it to refine its performance over time, becoming more accurate and context aware. For example, as the system processes more queries related to scholarships or course registration, it can anticipate user needs and proactively provide relevant information. This self-improving mechanism ensures that the chatbot remains a valuable resource, even as the university's information and student requirements evolve. Furthermore, the system's ability to integrate with other AI tools and databases positions it as a cornerstone of a broader digital transformation strategy.

In addition to operational efficiencies, AI chatbots contribute to enhancing the overall educational experience. By alleviating administrative burdens on students and staff, these systems enable individuals to focus more on core academic activities and personal development. For instance, students can dedicate the time saved from navigating the Knowledge Base to studying or participating in extracurricular activities. Similarly, university staff can redirect their efforts from answering repetitive queries to engaging in more strategic initiatives. These cumulative benefits not only improve institutional productivity but also foster a culture of innovation and forward-thinking within the educational ecosystem.

## **6. CONCLUSIONS AND FUTURE RESEARCH**

### **6.1 Theoretical Contributions**

This study makes significant theoretical contributions to the body of knowledge surrounding the integration of AI-powered chatbots in higher education. By leveraging the DeLone and McLean Information Systems Success Model as a framework, this research provides nuanced insights into how chatbots enhance the dimensions of Information Quality, Service Quality, and User Satisfaction in information retrieval processes. The findings contribute to the existing literature by emphasizing the relationship between chatbot adoption and the measurable improvement in efficiency and accuracy of information retrieval, particularly in the context of university environments. These results support theoretical arguments that AI-based systems can outperform traditional information dissemination tools in terms of usability and accessibility.

Moreover, the study extends the theoretical discourse on user behavior and interaction with AI systems. The observed trust and comfort levels exhibited by students highlight a shift in user expectations and acceptance of AI-driven interfaces.

Additionally, the study underscores the importance of user-centric design in AI systems. The chatbot's ability to address the limitations of websites and traditional knowledge bases, providing a streamlined user experience highlights a theoretical framework for designing more intuitive and responsive systems. This contribution not only validates the relevance of established theories on system usability but also suggests avenues for refining these theories to encompass emerging technologies like AI chatbots. Future theoretical work can build on these insights to further explore the interplay between system design, user satisfaction, and technology adoption.

### **6.2 Practical Implications**

The findings of this study hold substantial practical implications for universities and other organizations seeking to improve their information retrieval systems. The demonstrated efficiency and effectiveness of AI-powered chatbots suggest that institutions can significantly enhance user experiences by integrating such technologies into their existing infrastructure. For educational institutions, particularly, chatbots offer a scalable solution to address student queries, reduce administrative burdens, and streamline access to critical information. This is

especially beneficial in scenarios where traditional knowledge bases and websites have proven to be burdensome and inefficient.

From a managerial perspective, the study highlights the importance of investing in advanced AI tools to meet evolving user expectations. The chatbot's ability to provide accurate, timely, and contextually relevant information underscores its potential to improve service delivery and foster trust among users. Organizations can leverage these insights to prioritize the development of conversational AI solutions that align with user needs, ensuring a higher return on investment. Additionally, the consistent performance of the chatbot demonstrates the value of real-time adaptability, which can be applied across various domains beyond education.

### **6.3 Limitations**

While this study provides valuable insights, it is not without limitations. One significant limitation is the context-specific nature of the research. The study was conducted within the framework of Kozminski University, which may limit the generalizability of the findings to other institutions or industries. Differences in organizational structure, user demographics, and technological infrastructure could influence the performance and perception of AI-powered chatbots. As such, caution should be raised when applying these results to contexts beyond higher education.

Another limitation lies in the scope of the DeLone and McLean model employed in the study. While the research effectively addresses Information Quality, Service Quality, and User Satisfaction, it excludes System Quality, Use and Net Benefits due to the constraints of the research design. This partial application of the model may overlook critical aspects of system performance, such as technical reliability and long-term user engagement. Future studies could address this gap by incorporating these dimensions to provide a more comprehensive evaluation of chatbot success.

Additionally, the study's reliance on self-reported survey data introduces the potential for response bias. While the survey responses offer valuable qualitative insights, they may not fully capture the complexities of user experiences or reflect actual behavior. Combination of survey data with observational studies or usage analytics could enhance the validity of future research and provide a more nuanced understanding of user interactions with chatbots.

## **6.4 Future Research**

Building on the findings and limitations of this study, several areas for future research can be identified. First, extending the research to other institutions and industries would provide a broader understanding of the applicability and effectiveness of AI-powered chatbots. Comparative studies across diverse organizational contexts could reveal unique challenges and opportunities, thereby enriching the theoretical and practical discourse on chatbot integration.

Future research could also explore the long-term impacts of chatbot usage on user behavior and organizational outcomes. For instance, longitudinal studies could examine how sustained interaction with chatbots influences user trust, satisfaction, and reliance on AI systems. Additionally, investigating the economic implications of chatbot adoption, such as cost savings and efficiency gains, would provide valuable insights for decision-makers considering similar technologies.

Another promising direction for future research involves the integration of advanced AI capabilities, beyond natural language processing and large language models, to enhance chatbot functionality. Studies could evaluate the effectiveness of these enhancements in addressing more complex queries, personalizing user experiences, and adapting to evolving user needs. By pushing the boundaries of AI innovation, future research can contribute to the development of next generation chatbots that set new benchmarks for efficiency, accuracy, and user satisfaction.

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# APPENDIX A - ETHICS COMMITTEE APPROVAL

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This is to certify that

Project No.: **INFSYS2025-1-287281**

Project Title: **Empirical Analysis of an AI-Powered Chatbot for Enhancing University Information Retrieval**

Principal Researcher: **Mikhail Naranjo-Zolotov**

according to the regulations of the Ethics Committee of NOVA IMS and MagIC Research Center this project was considered to meet the requirements of the NOVA IMS Internal Review Board, being considered **APPROVED** on 1/28/2025.

It is the Principal Researcher's responsibility to ensure that all researchers and stakeholders associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Ethics Committee, via amendment or progress report, of

- Any significant change to the project and the reason for that change;
- Any unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role or any other change in research personnel involved in the project.

Lisbon, 1/28/2025

NOVA IMS Ethics Committee  
ethicscommittee@novaims.unl.pt

## **APPENDIX B - TEST GROUP SURVEY**

<https://docs.google.com/forms/d/15nYIxgGftP7Uik0Ndao7-hbIfSEEuclqOg0oezR-Ha4/edit>

## **APPENDIX C - CONTROL GROUP SURVEY**

<https://docs.google.com/forms/d/1nxvbg->

[ATU1ttZkOKu3pHGDELrRMYvUJu0dozZUO6m3w/edit](https://docs.google.com/forms/d/1nxvbg-ATU1ttZkOKu3pHGDELrRMYvUJu0dozZUO6m3w/edit)

## APPENDIX D – DATA VISUALISATIONS



PA\_simplestats.ipynb

## APPENDIX E – STATISTICS



t-test.ipynb



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