

Generative Indonesian chatbot for university major selection using transformers embedding

Mutiara Auliya Khadija¹, Bambang Harjito², Morteza Saberi³, Astrid Noviana Paradhita¹,
Wahyu Nurharjadmo⁴

¹Vocational School, Universitas Sebelas Maret, Surakarta, Indonesia

²Department of Informatics, Faculty of Information Technology and Data Science, Universitas Sebelas Maret, Surakarta, Indonesia

³School of Computer Science, University of Technology Sydney, Sydney, Australia

⁴Department of Public Administration, Faculty of Social and Political Sciences, Universitas Sebelas Maret, Surakarta, Indonesia

Article Info

Article history:

Received Aug 6, 2024

Revised Jun 24, 2025

Accepted Jul 13, 2025

Keywords:

AI chatbots

BERT

Gemini embedding

Transformers embeddings

University major selection

ABSTRACT

Selecting a university major is a crucial decision that impacts students' future career paths and personal fulfillment. Traditional guidance methods often lack the personalization and timeliness needed to support students effectively. This study explores the use of Indonesian generative artificial intelligence (AI) chatbots and transformer embeddings to enhance decision-making for university major selection. By leveraging advanced AI techniques, such as bidirectional encoder representations from transformers (BERT) and Gemini embeddings, the research aims to provide personalized, interactive, and contextually relevant guidance. Experiments showed that BERT embeddings achieved the highest accuracy, with recurrent neural network (RNN) and long short-term memory (LSTM) models also performing well but facing issues with overfitting. Gemini embeddings provided strong performance but slightly less effective than BERT. The findings suggest that BERT-based models with RNN are superior for developing decision-support systems in 92% accuracy. Future work should focus on further optimization and integration of user feedback to ensure the relevance and effectiveness of these AI tools in educational settings.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



Corresponding Author:

Mutiara Auliya Khadija

Vocational School, Universitas Sebelas Maret

Surakarta, Indonesia

Email: mutiaraauliya@staff.uns.ac.id

1. INTRODUCTION

Choosing a university major is one of the most critical decisions students face in their academic journey, significantly impacting their future career paths and personal fulfillment. However, the decision-making process is often complex and fraught with uncertainties, as students must navigate a multitude of factors including their interests, strengths, job market trends, and academic requirements [1]. While traditional guidance methods, such as counseling sessions and informational resources, have been widely used, they often lack personalization and real-time support, leaving students to make decisions that may not fully align with their long-term goals. Recent advancements in artificial intelligence (AI) offer promising solutions to enhance the decision-making process for students. In this study, we introduce a novel generative AI chatbot specifically designed for Indonesian students, leveraging state-of-the-art transformer embeddings (bidirectional encoder representations from transformers (BERT) and Gemini) to provide personalized, interactive, and contextually relevant guidance [2]. Unlike existing systems, our approach combines advanced natural language processing (NLP) techniques with a user-friendly interface tailored to the unique

needs of Indonesian students, enabling more accurate and meaningful recommendations. By integrating transformer-based models, such as BERT and Gemini, our chatbot can simulate human-like interactions and adapt its responses to the individual preferences and academic backgrounds of each student, offering a significant improvement over traditional method [3].

Transformers, a class of deep learning models known for their effectiveness in NLP tasks, play a crucial role in improving the accuracy and relevance of AI-driven guidance systems. Guidelines for leveraging generative AI models emphasize their capabilities in addressing academic integrity while augmenting pre-existing chatbots. Developing and refining prompts to guide ChatGPT in providing precise statistical test suggestions [4]. The study underscores the potential of AI chatbots as valuable resources for students, especially those with limited experience in statistics, by simplifying the process of selecting appropriate analytical methods [5]. Generative AI ChatGPT able to help academic contexts while stressing the need for ethical considerations and quality control [6]. The transformative potential of AI chatbots in education is further explored through the development of a blended learning framework. This framework integrates intelligent chatbots to enhance student and instructor interactions, aiming to provide a comprehensive understanding of the potential benefits and effective implementation of AI tools in educational settings. The proposed framework seeks to address the challenges of personalized learning and increased instructor workload by leveraging the capabilities of generative AI [7]. The embedding techniques used in transformers enable the representation of complex relationships between words and concepts, allowing chatbots to understand and process context more effectively [8], [9]. Integrating these advanced techniques into decision-support tools for university major selection can potentially lead to more informed and satisfying choices for students. Choosing a university major is one of the most pivotal decisions in a student's academic career, shaping their educational trajectory, and influencing future professional opportunities. Students often face this decision with limited experience and information that can be overwhelming [10]. Traditional methods of career counseling, including face-to-face meetings with advisors and standardized assessment tools, while useful, may lack the dynamic and personalized approach needed to address the individual complexities of each student's situation. This can result in students making decisions that do not fully align with their interests, strengths, or long-term career goals [11].

The integration of generative AI chatbots into the decision-making process represents a novel approach to addressing these challenges. Generative AI, particularly models built on advanced transformer architectures, offers the ability to simulate human-like interactions and provide tailored advice based on a deep understanding of natural language. These chatbots can engage students in interactive dialogues, helping them explore various majors by analyzing their responses, preferences, and aspirations [12]. This personalized interaction can potentially fill the gaps left by traditional guidance methods and offer a more nuanced understanding of the options available. Transformer-based architecture has significantly advanced natural language processing by enabling more nuanced comprehension of context and semantics [13]. These models leverage embeddings to capture semantic relationships between concepts, which enhances the chatbot's ability to provide relevant and contextually appropriate advice. By embedding knowledge from various domains, including academic disciplines and career pathways, AI chatbots can offer insights that are both comprehensive and specifically tailored to each student's unique profile [14].

There are challenges and considerations to address the chatbot. The effectiveness of AI-driven guidance systems depends on the quality of the data used to train the models and the ability of the chatbots to adapt to diverse student needs [15]. The complexity of human decision-making means that AI systems should be viewed as complementary tools that augment, rather than replace, and traditional guidance methods. The deployment of generative AI chatbots in educational settings requires rigorous testing and validation to ensure their reliability and effectiveness [16]. Research must focus on developing models that are not only accurate but also fair and unbiased [17]. Ensuring that the chatbots provide equitable guidance to students from diverse backgrounds is essential to avoid perpetuating existing inequalities in access to education and career opportunities. Furthermore, involving educational professionals in the development and implementation of these systems can help align the technology with pedagogical best practices and institutional goals [18], [19].

The primary objective of this study is to evaluate the effectiveness of Indonesian generative AI chatbots and transformer embeddings in enhancing the decision-making process for university major selection. Specifically, the research aims to assess how these advanced AI technologies can provide personalized, interactive, and contextually relevant guidance to students, helping them make more informed and tailored decisions regarding their academic paths. Advancements in chatbot architecture, specifically using transformer models, have demonstrated superior performance in generating accurate and contextually relevant responses [20]. These technical improvements facilitate more natural and effective human-machine interactions, which can be particularly beneficial in educational settings by providing personalized support and guidance [21]. The enhanced engagement and satisfaction resulting from these interactions highlight the transformative potential of transformer-based chatbots [22]. AI conversational agents have been evaluated for their ability to support the learning and well-being of university students [23], [24].

By investigating the capabilities and limitations of these AI-driven tools, the study seeks to offer actionable insights into their potential impact on educational support systems and to contribute to the development of more effective decision-support mechanisms in higher education. In relation to enhancing student decision-making in university major selection, these findings highlight the critical role of advanced AI systems in facilitating informed decision-making processes. By leveraging the personalized and contextually relevant support offered by these chatbots, students can make more informed choices about their academic paths, improving educational outcomes, and personal satisfaction. This integration of AI technologies not only enhances decision-making but also addresses cognitive, ethical, and practical challenges identified in the literature.

2. METHOD

2.1. System overview

The proposed method for enhancing student decision-making in university major selection through generative AI chatbots and transformer embeddings involves a multi-step process that integrates advanced AI techniques to provide personalized and detailed recommendations. Figure 1 shows this proposed method architecture. The flowchart outlines this process, starting from user input and ending with the delivery of a refined and contextually relevant response. Initially, the system receives input from users, which typically consists of text-based inquiries about potential majors.

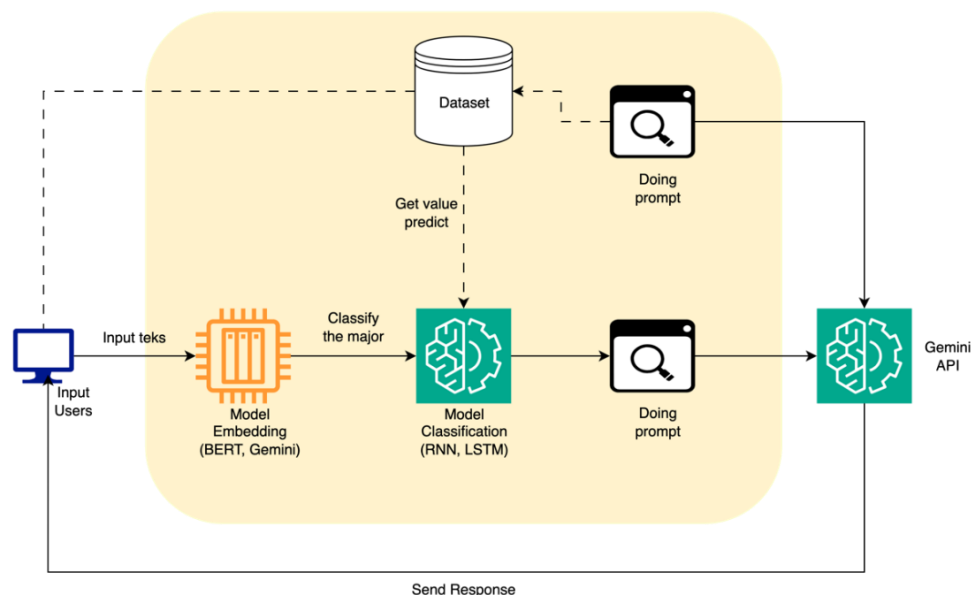


Figure 1. The architecture of the proposed method

2.2. Embedding techniques

The input is embedded using models like BERT or Gemini embedding. These models transform the text into a format suitable for further analysis. The embedding process captures the semantic meaning of the user's input, making it easier for the subsequent classification model to understand and process the information.

2.3. Classification and response generation

The next step is combined the embedding techniques with classification model using recurrent neural network (RNN) and long short-term memory (LSTM). The classification model then predicts two or three majors that best match the user's profile and preferences based on the dataset. This model is trained to analyze various factors and provide accurate recommendations. Once the potential majors are identified, the system generates prompts designed to make the chatbot's responses more natural and human-like. These prompts are sent through the Gemini API, which facilitates communication between the AI model and the user. If users seek more detailed information about the recommended majors, they can continue the conversation or initiate a new query for further recommendations. The system retrieves prediction values from the classification model and filters a dataset containing detailed descriptions of each major.

2.4. Relevance filtering

To ensure the relevance of the dataset content, the system employs term frequency-inverse document frequency (TF-IDF) for encoding the text data. It then uses cosine similarity to measure the relevance of the content to the user's query. This combination helps the system identify the most relevant information efficiently [25].

2.5. Deployment architecture

Finally, the system generates detailed prompts and sends them through the Gemini API, providing users with refined and contextually appropriate responses. This iterative process enhances the chatbot's ability to guide students in their major selection, offering personalized and detailed recommendations based on advanced AI techniques. This method leverages the power of transformer embeddings, classification models, and NLP to create a sophisticated recommendation system.

3. RESULTS AND DISCUSSION

3.1. Dataset

Data is collected using a questionnaire result from Career Development Center of Vocational School, Universitas Sebelas Maret which aims to generate user statements or stories related to interests, talents, and desired career prospects in Indonesian language. Therefore, 15,132 data statements were generated. The data appears in Figure 2. After that, the data undergoes preprocessing, including case folding to convert all letters to lowercase, cleansing (removing characters), and removing punctuation. The dataset containing information about career prospects based on interests and talents. The dataset consists of three main columns:

- Interests and talents or *minat bakat*: describe the individual's interest in specific aspects related with interest of student.
- Career prospects or *prospek kerja*: outlines potential career paths based on the stated interests.
- Major/field of study or *jurusan*: specifies that all these interests and career paths fall under the major discipline.

	Minat Bakat	Prospek Kerja	Jurusan
0	Saya tertarik dengan proses transformasi bahan...	Ahli Proses Kimia	Teknik Kimia
1	Saya suka mempelajari tentang reaksi kimia dan...	Inspektur Kualitas Produk Kimia	Teknik Kimia
2	Saya ingin bekerja di perusahaan yang berfokus...	Konsultan Teknologi Kimia	Teknik Kimia
3	Saya senang membantu dalam penemuan dan pengem...	Manajer Pabrik Kimia	Teknik Kimia
4	Saya tertarik dengan proses desain dan operasi...	Petugas Keselamatan dan Lingkungan Kerja	Teknik Kimia

Figure 2. Indonesian dataset on career prospects

3.2. Modeling

Modeling is conducted with three experiments. The first involves classification using TensorFlow's built-in embedding layer. The second uses embeddings from the Gemini API. The third employs BERT sentence for Indonesian language to embed text data. Table 1 shows the accuracy of the model.

Table 1. Performance comparison of models with different embeddings

Algorithms	Model embedding	Training accuracy (%)	Testing accuracy (%)	Training loss	Testing loss	Epoch	Name of model embedding
RNN	Layer embedding	96	65	0.1341	1.8607	35	-
LSTM	Layer embedding	78	69	0.7961	1.0645	35	-
RNN	Gemini embedding	89	89	0.3450	0.3333	50	embedding-001
LSTM	Gemini embedding	89	87	0.3289	0.3781	50	embedding-001
RNN	BERT embedding	91	92	0.3093	0.2445	25	firqaaa/indo-sentence-bert-base
LSTM	BERT embedding	93	91	0.3157	0.2831	25	firqaaa/indo-sentence-bert-base

3.3. Normal layer embedding

The RNN model with a 768 embedding dimension layer exhibited overfitting, as evidenced by the significant gap between training and testing accuracy. This highlights the limitations of traditional embeddings and underscores the need for more advanced techniques, such as BERT and Gemini embeddings, which demonstrated superior generalization and accuracy. The training history revealed that while the model achieved high performance on the training set, it struggled with generalization to the test set, as indicated by a considerable gap between the two. In contrast, the LSTM model with a standard embedding layer demonstrated better performance than the RNN. Although there were some indications of overfitting, the LSTM model exhibited more stable progress during training and testing, with improvements in both metrics compared to the RNN. The model architecture with 0.2 dropout, SoftMax activation function, Adam optimizer with 0.0001 learning rate.

3.4. Gemini embedding

Using Gemini-1.5-flash embedding model, the RNN showed significant improvement, with accuracy nearing 90% in both training and testing phases. This model demonstrated strong performance and will be considered as a viable option for selection. Similarly, the LSTM model with the Gemini embedding model achieved near 90% accuracy, paralleling the RNN's performance. Figure 3 shows the model architecture with Adam optimizer, 0.0001 learning rate with SoftMax activation function.

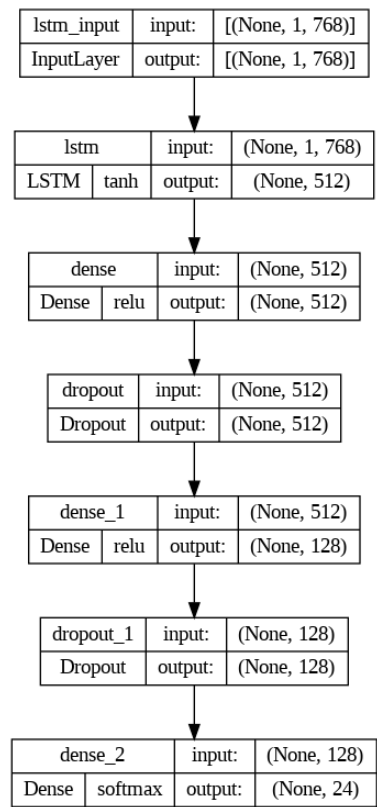


Figure 3. Model architecture of LSTM and Gemini embedding

3.5. BERT embedding

When utilizing the BERT embedding model (firqaaa/indo-sentence-bert-base) with tokenizer vocabulary size 30,522 tokens and 768 embedding dimensions, the RNN achieved even better results with accuracy reaching 90%. It can be depicted in Figure 4. The model's performance was superior to that of the Gemini embeddings, and it will be considered for selection due to its high accuracy. The LSTM model with the BERT embedding also demonstrated excellent performance, matching the RNN's accuracy at 90%. The results indicate that the LSTM-BERT model is equally effective and will be saved as a strong candidate for model selection. It can be depicted in Figure 5.

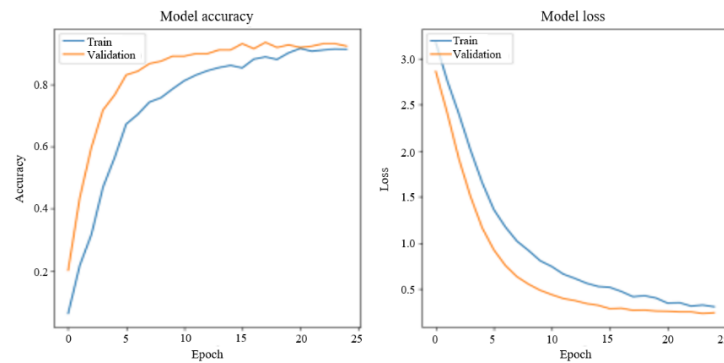


Figure 4. History training of RNN and BERT embedding

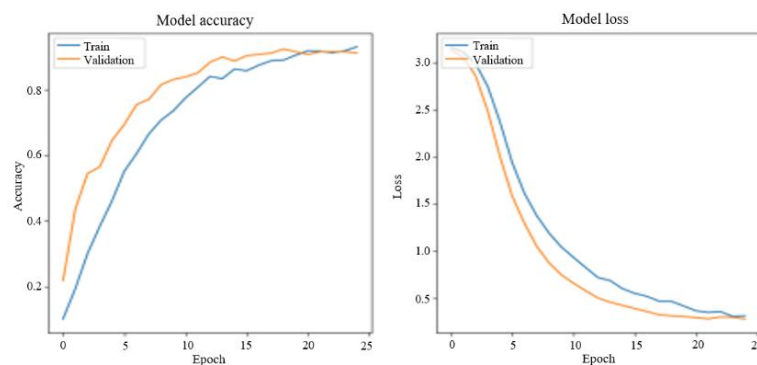


Figure 5. History training of LSTM and BERT embedding

3.6. Deployment

The following is an example program for a major recommendation chatbot for new students. The demo application uses Streamlit to facilitate application testing. Figure 6 shows the data Maya Bot, which is the name of this major recommendation chatbot for new students. In this Maya Bot, the students could write their interests and asking which major that suitable for them. If we provide an input outside the recommendation context, the Bot will automatically respond that it does not know the answer. Table 2 shows the translation in English version.

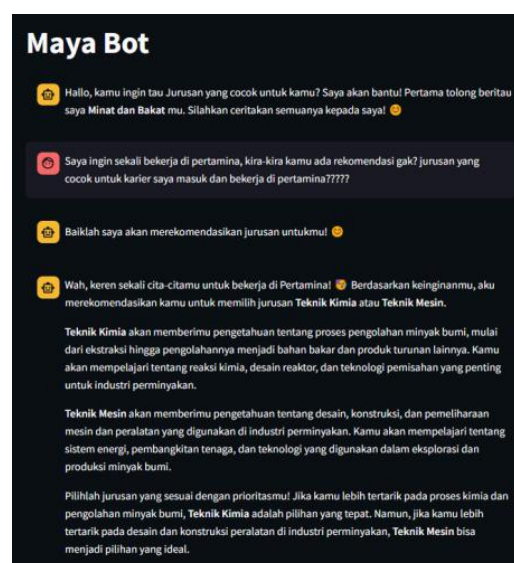


Figure 6. Maya bot

Table 2. The translation of Maya Bot (major recommendation chatbot for new students)

Maya Bot/user	Responds
Maya Bot	Hello! Do you want to know which major suits you best? I'm here to help! First, please tell me about your interests and talents. Feel free to share everything with me!
User Input	I want to work at Pertamina (Indonesia's national oil company). Do you have any recommendations for suitable majors to help me pursue a career at Pertamina?
Maya Bot	Sure! I will recommend some majors for you! Wow, that's an amazing dream — working at Pertamina! 😊 Based on your goal, I would recommend you to consider Chemical Engineering or Mechanical Engineering. Chemical Engineering will provide you with knowledge about the processing of petroleum, from extraction to refining, transforming it into fuels and other chemical products. You will study chemical reactions, reactor design, and separation technologies used in the oil and gas industry. Mechanical Engineering will equip you with knowledge about the design, construction, and maintenance of machinery and equipment used in the oil and gas industry. You will also learn about energy systems, power generation, and the technologies used in oil exploration and production. Choose the major that aligns with your priorities! If you are more interested in chemical processes and the transformation of petroleum into products, Chemical Engineering would be a great choice. However, if you are more interested in the design and construction of equipment for the oil industry, Mechanical Engineering could be the ideal option for you.

4. CONCLUSION

The experiments conducted in this study demonstrate that embedding models, particularly BERT, significantly enhance the performance of decision-support systems for university major selection. This finding has practical implications for educational institutions in Indonesia, as it suggests that AI-driven chatbots can provide more accurate and personalized recommendations, helping students make better-informed decisions about their academic futures. Among the different approaches, the BERT embedding model achieved the highest accuracy, with the RNN and LSTM models both reaching around 92% accuracy in training and testing phases. The Gemini embedding model also showed strong performance, though slightly lower compared to BERT. The standard layer embeddings for RNN and LSTM models indicated challenges with overfitting, underscoring the importance of using more advanced embeddings for improved generalization and accuracy. Based on these findings, it is recommended to utilize the BERT embedding model for developing decision-support systems, given its superior performance. Future work should focus on further optimizing these models and exploring additional enhancements such as fine-tuning and hybrid approaches. Incorporating user feedback and continuously updating the models with new data will be essential for maintaining their relevance and effectiveness in guiding students through their major selection process.

ACKNOWLEDGMENTS

Special thanks to Career Development Center of Vocational School, Universitas Sebelas Maret for their support and resources throughout this research.

FUNDING INFORMATION

This research was funded by Universitas Sebelas Maret under the research grant of *Penelitian Fundamental C* (PFC-UNS) with contract number 369/UN27.22/PT.01.03/2025.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Mutiara Auliya Khadija	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bambang Harjito		✓	✓			✓		✓	✓	✓	✓	✓		
Morteza Saberi	✓	✓	✓	✓	✓	✓				✓	✓		✓	✓
Astrid Noviana Paradhita	✓			✓		✓	✓	✓		✓			✓	
Wahyu Nurharjadmo	✓	✓		✓	✓		✓	✓		✓		✓		

- C : Conceptualization
M : Methodology
So : Software
Va : Validation
Fo : Formal analysis
- I : Investigation
R : Resources
D : Data Curation
O : Writing - Original Draft
E : Writing - Review & Editing
- Vi : Visualization
Su : Supervision
P : Project administration
Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY





Data availability is not applicable to this paper as no new data were created or analyzed in this study.

REFERENCES





- [1] M. Cancino and R. Capredoni, "Assessing pre-service EFL teachers' perceptions regarding an online student response system," *Taiwan Journal of TESOL*, vol. 17, no. 2, pp. 91–118, 2020, doi: 10.30397/TJTESOL.202010_17(2).0004.
- [2] A. Rajan and M. Manur, "Aspect based sentiment analysis using fine-tuned BERT model with deep context features," *IAES International Journal of Artificial Intelligence*, vol. 13, no. 2, pp. 1250–1261, 2024, doi: 10.11591/ijai.v13.i2.pp1250-1261.
- [3] G. Heilporn, S. Lakhali, and M. Bélisle, "An examination of teachers' strategies to foster student engagement in blended learning in higher education," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, 2021, doi: 10.1186/s41239-021-00260-3.
- [4] D. De Silva, N. Mills, M. El-Ayoubi, M. Manic, and D. Alahakoon, "ChatGPT and generative AI guidelines for addressing academic integrity and augmenting pre-existing chatbots," in *2023 IEEE International Conference on Industrial Technology*, 2023, pp. 1–6, doi: 10.1109/ICIT58465.2023.10143123.
- [5] T. Goodale, "Using generative AI to help with statistical test selection and analysis," *MSOR Connections*, vol. 22, no. 3, pp. 10–16, 2024, doi: 10.21100/msor.v22i3.1485.
- [6] P. Bhatia, "ChatGPT for academic writing: a game changer or a disruptive tool?," *Journal of Anaesthesiology Clinical Pharmacology*, vol. 39, no. 1, pp. 1–2, 2023, doi: 10.4103/joacp.joacp_84_23.
- [7] G. Ilieva, T. Yankova, S. Klisarova-Belcheva, A. Dimitrov, M. Bratkov, and D. Angelov, "Effects of generative chatbots in higher education," *Information*, vol. 14, no. 9, 2023, doi: 10.3390/info14090492.
- [8] D. Sebastian, H. D. Purnomo, and I. Sembiring, "BERT for natural language processing in Bahasa Indonesia," in *2022 2nd International Conference on Intelligent Cybernetics Technology & Applications (ICICyTA)*, Bandung, Indonesia, 2022, pp. 204–209, doi: 10.1109/ICICyTA57421.2022.10038230.
- [9] U. León-Domínguez, "Potential cognitive risks of generative transformer-based AI chatbots on higher order executive functions," *Neuropsychology*, vol. 38, no. 4, pp. 293–308, 2024, doi: 10.1037/neu0000948.
- [10] C. E. Stoian, M. A. Fărcașiu, G.-M. Dragomir, and V. Gherheș, "Transition from online to face-to-face education after COVID-19: the benefits of online education from students' perspective," *Sustainability*, vol. 14, no. 19, 2022, doi: 10.3390/su141912812.
- [11] H. Ding, K. Chen, W. Hu, M. Cai, and Q. Huo, "Building compact CNN-DBLSTM based character models for handwriting recognition and OCR by teacher-student learning," in *2018 16th International Conference on Frontiers in Handwriting Recognition*, 2018, pp. 139–144, doi: 10.1109/ICFHR-2018.2018.00033.
- [12] A. N. Aqil, B. Dirgantara, Istikmal, U. A. Ahmad, and R. R. Septiawan, "Robot chat system (Chatbot) to help users 'Homelab' based in deep learning," *International Journal of Advanced Computer Science and Applications*, vol. 12, no. 8, pp. 599–604, 2021, doi: 10.14569/IJACSA.2021.0120870.
- [13] A. Babu and S. B. Boddu, "BERT-based medical chatbot: enhancing healthcare communication through natural language understanding," *Exploratory Research in Clinical and Social Pharmacy*, vol. 13, 2024, doi: 10.1016/j.rcsop.2024.100419.
- [14] A. A. -Alrazaq, Z. Safi, M. Alajlani, J. Warren, M. Househ, and K. Denecke, "Technical metrics used to evaluate health care chatbots: Scoping review," *Journal of medical Internet research*, vol. 22, no. 6, pp. 1–15, 2020.
- [15] O. Ahaneku, M. Siegl, S. Stromberger, and R. Vidrascu, "A scalable AI-driven chatbot for real-time diagnostics in manufacturing plants: merging google dialogflow, BERT, and a self-learning module," in *2023 IEEE 12th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications*, 2023, pp. 853–858, doi: 10.1109/IDAACS58523.2023.10348738.
- [16] J. Rudolph, S. Tan, and S. Tan, "ChatGPT: bullshit spewer or the end of traditional assessments in higher education?," *Journal of Applied Learning and Teaching*, vol. 6, no. 1, pp. 342–363, 2023, doi: 10.37074/jalt.2023.6.1.9.
- [17] J. Edu, C. Mulligan, F. Pierazzi, J. Polakis, G. Suarez-Tangil, and J. Such, "Exploring the security and privacy risks of chatbots in messaging services," in *Proceedings of the 22nd ACM Internet Measurement Conference*, 2022, pp. 581–588, doi: 10.1145/3517745.3561433.
- [18] G. K. D. Gopisetty, D. E. Teja, G. V. S. Kumar, D. R. Dinesh, and C. Akhil, "Chatbot building with BERT for e-commerce," *International Journal for Research in Applied Science and Engineering Technology*, vol. 12, no. 3, pp. 2587–2592, 2024, doi: 10.22214/ijraset.2024.59449.
- [19] K. Naik, N. Lakshmi, B. H. Neha, D. Nidhi, and R. Gatti, "Design of an AI chatbot using generative AI to access local database," *Interantional Journal of Scientific Research in Engineering and Management*, vol. 8, no. 5, pp. 1–9, 2024, doi: 10.55041/ijrsrem33863.
- [20] C. K. Y. Chan and W. Hu, "Students' voices on generative AI: perceptions, benefits, and challenges in higher education," *International Journal of Educational Technology in Higher Education*, vol. 20, no. 1, 2023, doi: 10.1186/s41239-023-00411-8.
- [21] J. E. Chukwuere, "The future of generative AI chatbots in higher education," *arXiv-Computer Science*, pp. 1–15, 2024.
- [22] N. Esfandiari, K. Kiani, and R. Rastgoo, "A conditional generative chatbot using transformer model," *arXiv-Computer Science*, pp. 1–12, 2023.
- [23] H. Wang, S. Tang, and C. U. Lei, "AI conversational agent design for supporting learning and well-being of university students," *EdArXiv Preprints*, pp. 1–14, 2024, doi: 10.35542/osf.io/w4rtf.
- [24] L. J. Quintans-Júnior, R. Q. Gurgel, A. A. de S. Araújo, D. Correia, and P. R. Martins-Filho, "ChatGPT: the new panacea of the academic world," *Journal of the Brazilian Society of Tropical Medicine*, vol. 56, 2023, doi: 10.1590/0037-8682-0060-2023.
- [25] A. Mathararachchi *et al.*, "Optimizing generative AI chatbots for net-zero emissions energy internet-of-things infrastructure," *Energies*, vol. 17, no. 8, 2024, doi: 10.3390/en17081935.

BIOGRAPHIES OF AUTHORS







Mutiara Auliya Khadija     is a data analyst, data scientist, and lecturer with a solid background in Information Technology from the Faculty of Engineering, Universitas Gadjah Mada, Indonesia. Her expertise spans across machine learning, business intelligence, big data research, and smart city development. With over five years of experience in data science consulting and professional mentorship, she has successfully led and contributed to numerous AI-driven projects, including natural language processing (NLP) applications, sentiment analysis, and predictive modeling. She is also an active member of the Association of Indonesian Computer and Informatics Colleges (APTIKOM) and the Institute of Electrical and Electronics Engineers (IEEE), further demonstrating her commitment to professional and academic collaboration at both national and international levels. She can be contacted at email: mutiaraauliya@staff.uns.ac.id.







Prof. Drs. Bambang Harjito     is a senior lecturer in the Department of Informatics, Faculty of Information Technology and Data Science, Universitas Sebelas Maret, Surakarta, Indonesia. He earned his Master's degree in Computer Science from James Cook University in 2000 and his Ph.D. in Information Systems from Curtin University, Perth, Australia, in 2014. His research focuses on data protection, privacy protection, information hiding, cryptography, and cybersecurity. He is also an active member of the Association of Indonesian Computer and Informatics Colleges (APTIKOM). He can be contacted at email: bambang_harjito@staff.uns.ac.id.







Dr. Morteza Saberi     is currently a Senior Lecturer (Associate Professor) at the School of Computer Science, University of Technology Sydney. He has an outstanding research record and significant capabilities in the area of business intelligence, data mining and applied machine learning. He has published more than 230 papers in reputable academic journals and conference proceedings. His Google Scholar citations and h-index are 6100 and 38, respectively. Previously he was a lecturer at the UNSW, Business school for about three years. He has won over 35 national and international research awards and recognitions till date from his research. He has a broad interest in the emerging forms of societal-scale human-computer systems that currently govern and facilitate knowledge exchange among individuals and organizations. Existing research has primarily focused on enhancing the performance of these systems through the development of machine learning models. He can be contacted at email: morteza.saberi@uts.edu.au.



Astrid Noviana Paradhita     holds a Master of Computer Science (M.Sc.) in Universitas Gadjah Mada, Indonesia. She is currently lecturing in Universitas Sebelas Maret, Surakarta, Indonesia. Her research areas of interest include decision support system, artificial intelligent, and business intelligence. She can be contacted at email: astrid.noviana@staff.uns.ac.id.



Wahyu Nurharjadmo     is a lecturer at Faculty of Social and Political Sciences, Universitas Sebelas Maret, Indonesia. He earned his Master's degree in Public Administration from Universitas Gadjah Mada, Indonesia. His research interests focus on the application of public policy, public administration, electronic government, and smart city. He is a member of the Indonesian Association for Public Administration (IAPA). He can be contacted at email: wahyunurharjadmo@staff.uns.ac.id.