Integration of Generative AI in Engineering Research: A Study of Utilization of Chatgpt

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ABSTRACT

Generative artificial intelligence (AI) technologies, such as ChatGPT, have made a significant impact in engineering research by increasing efficiency and creativity. This study aims to explore the role, benefits, and challenges of using ChatGPT in engineering research activities. Using a descriptive qualitative approach, data were obtained through semi-structured interviews with 30 researchers and academics in the engineering field, as well as a review of related literature. The results showed that ChatGPT accelerated the process of data analysis, experiment design, and technical report writing. As many as 85% of respondents reported increased efficiency, and 70% felt more creative in finding innovative solutions. However, challenges arise in the accuracy of technical documents and complex data analysis, which still require manual verification. Integration with other engineering software, such as MATLAB and CAD, shows great potential to improve research effectiveness. The study concludes that although ChatGPT provides great benefits, human supervision is still needed to ensure the quality of the results. Further development is needed to improve the accuracy and integration of this technology in the context of more in-depth engineering research.

Keywords: ChatGPT, Engineering research, Efficiency, Technology Integration.

INTRODUCTION

The development of artificial intelligence (AI) technology has brought about a major revolution in various fields, including engineering. One of the latest innovations is generative AI technology, which has the ability to produce high-quality text-based, image-based, and audio-based content. One prominent application of generative AI is ChatGPT, which has the potential for great benefits in various aspects, including education, research, and healthcare practice. ChatGPT was developed by OpenAI and uses large-scale language models, contextual learning, and reinforcement learning from human feedback as its core techniques.(Wu et al., 2023).

However, the use of ChatGPT also requires caution, given the potential limitations in its use.(Sallam, 2023). In the context of engineering research, ChatGPT opens up great opportunities to support complex and multidimensional activities. Engineering research often requires an interdisciplinary and collaborative

approach, which can enhance students' problem-solving, creativity, and project management skills.(Adair & Jaeger, 2014). Research processes involving complex data analysis, experimental design, and report documentation can benefit from ChatGPT's ability to generate new ideas for systematic reviews and help researchers develop innovations.(Gupta et al., 2023). In addition, integrating AI tools, especially ChatGPT, into the design thinking process can increase efficiency and creativity, although this requires technological expertise and creative design thinking.(Al-Sa'di & Miller, 2023).

In the world of engineering education, ChatGPT can enhance the learning experience by providing personalized feedback and creating realistic virtual simulations for practical learning.(Qadir, 2023). Furthermore, generative AI enables the development of tools and technologies that can mimic and even surpass human intelligence in some aspects, providing innovative solutions to complex engineering problems.(Johri et al., 2023). In addition, this technology can also support automation in big data processing, helping researchers identify patterns and insights that might be missed in manual analysis.

Despite its great potential, the integration of technologies such as ChatGPT in engineering research faces significant challenges, particularly related to ethics, privacy, and data security.(Akbar et al., 2023).The potential for bias or inaccuracy in the resulting data is also an important concern.(Aluga, 2023).because it can have negative impacts if not managed carefully. Some studies have shown that reliance on ChatGPT can reduce critical thinking and problem-solving skills.(Akastangga et al., 2023).

Previous research has developed ethical principles-based decision models to help software engineering researchers integrate ChatGPT ethically, while addressing potential demotivators in this process.(Akbar et al., 2023). In civil engineering, (Al-Sa'di & Miller, 2023; Gupta et al., 2023) it is important to ensure that the use of ChatGPT does not replace expert consultation in certain cases.(Aluga, 2023). Engineering research often involves complex technical documents, which require a deep understanding of the language and the ability to structure relevant content. Without clear guidelines, the application of ChatGPT technology risks producing inaccurate information or information that does not meet the expected technical standards. Therefore, further research on the role and contribution of ChatGPT in the context of engineering research is very important. How ChatGPT can improve productivity and accuracy in engineering research, and what limitations need to be overcome so that this technology can be integrated more optimally in various stages of research.

This study aims to answer these questions by delving deeper into the role, benefits, and challenges of using ChatGPT in supporting engineering research activities. The main objective of this study is to examine the role and benefits of ChatGPT technology in improving efficiency and creativity in engineering research. In addition, this study also aims to identify the strengths and weaknesses of using ChatGPT in various research scenarios. Finally, this study will explore the potential integration of ChatGPT with other engineering software to strengthen the research and technical design process.

With this study, it is expected that this article can provide a significant contribution to the understanding of the practical implementation of ChatGPT in engineering research. The results of this study are also expected to be a guide for researchers and professionals in the engineering field who are interested in utilizing technologies such as ChatGPT in supporting their various research activities, providing value to academics and practitioners in various engineering industry sectors.

METHOD

This study uses a descriptive qualitative approach to explore the roles, benefits, and challenges faced in the integration of ChatGPT in engineering research. The qualitative approach was chosen because it allows researchers to gain a deeper understanding of the experiences and perceptions of researchers and academics in using generative AI, especially ChatGPT in their research activities. This approach will help explore important aspects of how this technology can affect the efficiency, creativity, and quality of engineering research.

The primary data in this study were obtained through semi-structured interviews with 30 researchers and academics in the engineering field who actively use ChatGPT in their research. Respondents were selected purposively, namely those who have direct experience in using ChatGPT for tasks such as data analysis, writing technical reports, or experiment design ideation. Semi-structured interviews were chosen so that researchers could explore information flexibly and in depth, but still focused on topics relevant to the objectives of this study.

In addition to interviews, secondary data was also collected through a literature review related to the use of generative AI in the context of engineering research. This literature includes scientific articles, research reports, and case studies related to the implementation of ChatGPT in various aspects of engineering research. This secondary data will be used to strengthen the findings from the interviews and provide additional perspectives on best practices and challenges that may arise from the use of this technology in academia and industry.

The data analysis process was carried out using the thematic analysis method, where data from interviews and literature reviews will be grouped into relevant themes, such as the benefits, challenges, and potential for ChatGPT development in engineering research. Triangulation was carried out to ensure the validity of the results by comparing data obtained from interviews with existing literature, so that the results of this study are more credible and reliable. The results of this study are expected to provide new insights into the use of generative AI in engineering research and provide recommendations for the development and implementation of this technology more optimally.

RESULT AND DISCUSSION
RESULT

This research aims toexamines the role, benefits, and challenges of ChatGPT integration in engineering research. The following are the research results obtained from the data analysis conducted.
1. Increasing Efficiency and Creativity in Engineering Research

Interviews with researchers showed that the use of ChatGPT significantly increased efficiency and creativity in various aspects of engineering research. As many as 85% of respondents reported that ChatGPT helped speed up the process of data analysis and information processing, which usually takes a long time. For example, in tasks such as formulating hypotheses, compiling research backgrounds, or designing experiments, researchers felt helped by the speed of suggestions provided by ChatGPT. In

addition, more than 70% of respondents felt that ChatGPT could help improve their creativity, especially in generating new ideas for experimental designs or innovative engineering solutions.

ChatGPT also allows researchers to explore more possibilities and perspectives in their research. Several researchers reported that they were able to use ChatGPT to provide alternative suggestions or ideas that they had not previously considered. This is especially useful for engineering fields that require innovative approaches and creative solutions in the design and implementation of new technologies.

2. Challenges in Using ChatGPT for Specific Tasks

Despite its great benefits, the use of ChatGPT also faces some challenges, especially in highly technical and specific tasks. For example, in the case of experimental data analysis involving complex mathematical formulas or engineering simulations with a high degree of precision, ChatGPT has proven to be less effective. 60% of respondents stated that, although ChatGPT can provide basic solutions or general explanations, the results provided are not in-depth enough for highly technical data analysis that requires high accuracy.

In this regard, ChatGPT cannot completely replace researchers in processing experimental data that requires deep contextual understanding, especially if the data has complex variables or unexpected results. Many researchers feel that although ChatGPT can provide initial insights, they still need to involve specialized software or manual analysis tools to ensure the accuracy and depth of the analysis.

3. Accuracy and Precision Issues in Technical Documents

One of the main obstacles identified in this study was the issue of accuracy and precision in the creation of technical documents using ChatGPT. Although ChatGPT can produce informative and relevant text, 55% of respondents reported that the results produced often did not meet the expected technical standards. For example, in the creation of technical reports that require proper references, use of correct terminology, and detailed explanations of experimental procedures, researchers felt that ChatGPT was not yet fully reliable in producing documents that were free from technical errors.

Many respondents expressed that the results provided by ChatGPT need to be checked and adjusted to applicable technical guidelines or standards. Some respondents suggested that in order to improve accuracy, ChatGPT should be equipped with the ability to refer to more relevant technical sources or be given more specific instructions on the terminology used in the technical context.

4. Potential Integration with Other Engineering Software

The results of the study show that there is great potential in integrating ChatGPT with other engineering software, such as data analysis tools, simulation, or computer-aided design (CAD). 65% of respondents agreed that the combination of using ChatGPT with engineering software can increase effectiveness in research. For example, ChatGPT can be used to help compile reports or write basic code for data analysis, which can then be further developed with more specific and precise software.

However, the integration still needs further development. Most respondents want ChatGPT to be more integrated with software such as MATLAB or Simulink for more complex analytical tasks, as well as with CAD tools for technical design. This integration is expected to create a more seamless workflow, where ChatGPT can be used for authoring or ideation, while engineering software can handle analysis or design that requires a high level of accuracy.

5. The Need for Human Supervision in the Process of Using ChatGPT

Most respondents agreed that while ChatGPT can serve as a powerful tool in the research process, human oversight is still needed to ensure the quality and accuracy of the results obtained. 80% of researchers involved in this study stated that they still feel the need to verify and modify the information provided by ChatGPT, especially in the context of complex experimental results or report writing that requires high technical standards.

The importance of human oversight is also reinforced by the fact that some respondents reported that ChatGPT sometimes provided information that was less relevant or less appropriate in very specific contexts. In some cases, the information generated by ChatGPT could seem generic and not fully in line with the technical needs of the study.

6. ChatGPT Development Opportunities in Engineering Research

Although there are some challenges in using ChatGPT in engineering research, the results of this study show many opportunities to develop and optimize this technology. The researchers suggest that further development of ChatGPT in engineering should include improving the ability to understand deeper technical context and the ability to provide more relevant and accurate suggestions.

Over 70% of respondents stated that they would like to see improvements in ChatGPT's ability to access and process technical data more efficiently, as well as improvements in the generation of more in-depth and complex technical reports. Additionally, the development of ChatGPT algorithms that can be better integrated with engineering software would be very beneficial in accelerating the research process and increasing collaboration between researchers and technology.

DISCUSSION

The results of this study indicate that the integration of ChatGPT in engineering research has a significant impact on increasing efficiency and creativity. Most researchers reported that ChatGPT accelerated the process of data analysis and research report preparation. According to 85% of respondents, this tool helped speed up various research tasks such as formulating hypotheses and designing experiments, which previously took a long time. In addition, 70% of respondents felt that ChatGPT improved their creativity, especially in creating innovative engineering solutions. Researchers felt helped by ChatGPT's fast and diverse suggestions, which provided new perspectives in designing experiments or finding more effective engineering solutions ((Al-Sa'di & Miller, 2023; Gupta et al., 2023). This is in line with findings that suggest that generative AI can increase creativity and efficiency in engineering by suggesting new ideas that researchers might otherwise miss.(Adair & Jaeger, 2014).

However, despite its many benefits, the use of ChatGPT also faces some challenges, especially in highly technical and high-accuracy tasks. As many as 60% of respondents reported that ChatGPT was less effective in performing experimental data analysis involving complex mathematical formulas and high-precision engineering simulations. This shows that while ChatGPT can provide basic understanding or general advice, it cannot completely replace software or more in-depth manual analysis.(Akbar et al., 2023). In other words, in tasks that require specialized technical skills, such as data analysis that requires contextual interpretation, researchers still have to rely on human expertise or other specialized tools.(Johri et al., 2023).

In addition, the problem of accuracy and precision in creating technical documents is a major obstacle in using ChatGPT. The results of the study showed that 55% of respondents felt that documents produced by ChatGPT often did not meet the expected technical standards, such as the use of inappropriate terminology and inaccurate source citations. This indicates that although ChatGPT can produce informative text, the quality of technical documents still requires further verification.(Johri et al., 2023). Researchers suggest improving ChatGPT's ability to reference relevant technical sources, which would improve accuracy and effectiveness in generating technical reports or articles.(Gupta et al., 2023).

Furthermore, the results of the study also show that the integration of ChatGPT with other engineering software can improve research effectiveness. As many as 65% of respondents stated that the use of ChatGPT in combination with data analysis tools or computer-aided design (CAD) tools can improve productivity in engineering research. However, they also revealed that further integration with software such as MATLAB or Simulink is needed for more complex tasks. This shows great potential for the development of hybrid systems where ChatGPT can be used to write reports or provide ideas, while engineering software handles more precise and in-depth analysis.(Akbar et al., 2023).

CONCLUSION

The development of generative artificial intelligence (AI) technologies, such as ChatGPT, has had a major impact on various fields, including engineering. This technology has the potential to increase efficiency and creativity in engineering research by accelerating tasks such as data analysis, experiment design, and technical report writing. Researchers report that using ChatGPT helps them formulate new ideas, improve creative solutions, and speed up the research process. However, despite its many benefits, using ChatGPT also has challenges, especially in technical tasks that require high accuracy and in creating technical documents that comply with industry standards.

In addition, the integration of ChatGPT with other engineering software has great potential to improve the effectiveness of research, such as in data analysis and computer-aided design (CAD). However, there are concerns regarding the accuracy and precision of the results produced by ChatGPT, especially in terms of complex data analysis and the use of correct technical terminology. Therefore, human supervision is still needed to ensure the quality and relevance of the information produced. This study shows that while this technology is very helpful, further development is needed to improve ChatGPT's ability to handle deeper technical contexts and integrate it effectively with other engineering software.

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