

Design and Development of a WhatsApp Chatbot-Based Expert System Using the Depth-First Search Algorithm for Thesis Topic Recommendation

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ABSTRACT – The rapid development of digital technology has encouraged the creation of various intelligent systems that can support decision-making processes, one of which is an expert system. In the academic environment, students often encounter difficulties in determining appropriate thesis topics that align with their areas of interest. Therefore, this study aims to develop an expert system integrated with a WhatsApp chatbot to assist students in identifying suitable thesis themes based on their academic interests. The system employs the Depth-First Search (DFS) algorithm as a problem-solving approach due to its flexibility in exploring decision paths within the knowledge base. The expert system is implemented through a WhatsApp chatbot interface to ensure ease of use, as the messaging interface is already widely familiar among university students. This approach allows users to interact with the system naturally without the need to learn a new interface. The results of system testing indicate that the developed expert system effectively assists students in determining thesis topics. Evaluation results show an accuracy level of 95.4%, demonstrating that the proposed system provides reliable recommendations. Furthermore, the use of a chatbot-based interface enhances user accessibility and usability. In conclusion, the integration of an expert system with the DFS algorithm and a WhatsApp chatbot interface provides an effective and user-friendly solution for supporting students in selecting appropriate thesis topics based on their interests.

Keywords – Chatbot Whatsapp; Depth-First Search; Expert System.

Desain dan Pengembangan Sistem Pakar Berbasis Chatbot WhatsApp Menggunakan Algoritma Depth-First Search untuk Rekomendasi Topik Tesis

ABSTRAK – Perkembangan pesat teknologi digital telah mendorong terciptanya berbagai sistem cerdas yang dapat mendukung proses pengambilan keputusan, salah satunya adalah sistem pakar. Dalam lingkungan akademik, mahasiswa sering mengalami kesulitan dalam menentukan topik skripsi yang sesuai dengan bidang minat mereka. Oleh karena itu, penelitian ini bertujuan untuk mengembangkan sistem pakar yang terintegrasi dengan chatbot WhatsApp untuk membantu mahasiswa dalam mengidentifikasi tema skripsi yang sesuai berdasarkan minat akademik mereka. Sistem ini menggunakan algoritma Depth-First Search (DFS) sebagai pendekatan pemecahan masalah karena fleksibilitasnya dalam menelusuri jalur keputusan di dalam basis pengetahuan. Sistem pakar diimplementasikan melalui antarmuka chatbot WhatsApp untuk memastikan kemudahan penggunaan, mengingat antarmuka pesan sudah sangat familiar di kalangan mahasiswa. Pendekatan ini memungkinkan pengguna berinteraksi dengan sistem secara alami tanpa perlu mempelajari antarmuka baru. Hasil pengujian sistem menunjukkan bahwa sistem pakar yang dikembangkan secara efektif membantu mahasiswa dalam menentukan topik skripsi. Hasil evaluasi menunjukkan tingkat akurasi sebesar 95,4%, yang menunjukkan bahwa sistem yang diusulkan memberikan rekomendasi yang andal. Selain itu, penggunaan antarmuka berbasis chatbot meningkatkan aksesibilitas dan kemudahan penggunaan bagi pengguna. Kesimpulannya, integrasi sistem pakar dengan algoritma DFS dan antarmuka chatbot WhatsApp memberikan solusi yang efektif dan ramah pengguna dalam mendukung mahasiswa memilih topik skripsi yang sesuai dengan minat mereka.

Kata Kunci – Chatbot Whatsapp; Depth-First Search; Sistem Pakar

1. INTRODUCTION

The rapid development of technology has significantly influenced various aspects of human life, particularly within academic communities. Today, almost all activities carried out by

individuals, organizations, and academics utilize various technological tools to facilitate the rapid delivery of information. The ease of information dissemination is also supported by technological advancements in the field of education. In the

modern era, technological progress increasingly demands individuals to pursue higher levels of education, one of which is through higher education institutions.

Technological advancements have also led to the development of various digital products that provide convenience in human life, one of which is expert systems. An expert system is a system that generates decisions based on a knowledge base derived from experts (Kusrini & Amikom, 2020). The fundamental idea behind expert systems is to facilitate the transfer of specialized knowledge possessed by experts into a computer system. This knowledge is then stored within the system and can be accessed by users whenever needed. Similar to human consultation processes, the computer can provide recommendations and explanations based on the stored knowledge (Turban et al., 2005). Therefore, the knowledge embedded in the system can be utilized in a manner similar to consulting an expert without requiring direct face-to-face interaction.

Various methods have been applied in the development of expert systems, one of which is the Depth-First Search (DFS) algorithm. The DFS algorithm can be used as a problem-solving approach due to its flexible exploration mechanism (Pratiwi, 2024). In addition, the DFS algorithm has linear space complexity, making it suitable for solving problems within expert systems. The working mechanism of the DFS algorithm involves exploring a data structure starting from the root node and traversing each branch as far as possible before performing backtracking when necessary (Huda, 2019).

Another technology that has been widely utilized in various fields is the chatbot. A chatbot is a computer program designed to simulate human conversation and interact with users through voice commands or text-based conversations (Putri et al., 2023). Many studies have integrated chatbots into different sectors, including healthcare, economics, Internet of Things (IoT), and education. Chatbots are designed to provide natural interactions so that users may not realize they are communicating with an automated system. The use of a WhatsApp chatbot with a chat-based interface that is already familiar to the public, particularly university students, can facilitate the implementation of expert systems. Through this approach, students can easily interact with the system to obtain recommendations regarding thesis topics that align with their academic interests. Therefore, this study is motivated by the need to develop a WhatsApp chatbot-based expert system using the Depth-First Search (DFS) algorithm to assist students in selecting appropriate thesis themes.

Kadek Darmaastawan (2024), in a study entitled *"Implementation of a Telegram Chatbot in an Expert System for Detecting Motorcycle Damage,"* stated that the development of chatbots as a medium for expert system applications demonstrates good quality. This is influenced by the chat-based interface, which is already familiar to many users, allowing them to interact with the system without the need to learn a new interface (Darmaastawan, 2024). However, the study focuses on the use of Telegram as the chatbot platform for the expert system. Despite its advantages, many users are still not fully familiar with Telegram-based expert systems. Therefore, further research is needed to explore the use of other communication platforms, such as WhatsApp, which is also a widely used messaging application that can be integrated with chatbots for expert system applications.

Laily Rohmawati et al. (2023), in their study entitled *"Development of a WhatsApp Chatbot for Server Resource Monitoring,"* stated that the developed chatbot application is capable of performing server monitoring tasks by displaying real-time information regarding server resources or services through WhatsApp chat. The testing results also indicate that the application can provide warning notifications to users or system administrators when server resources exceed their capacity or when services are not running properly (Rohmawati et al., 2023). These findings suggest that chatbot applications are capable of providing alert responses when system performance issues occur. Therefore, integrating chatbot technology with expert systems is expected to function effectively in supporting decision-making processes.

Bahar (2014), in the study entitled *"Implementation of the Depth-First Search (DFS) Method in an Expert System for Diagnosing Postpartum Diseases,"* demonstrated that the Depth-First Search (DFS) algorithm can be effectively used to search for solutions through systematic traversal. The DFS algorithm works by exploring nodes starting from the leftmost branch at each level. If a solution is not found at a particular level, the search process continues deeper into the next level until a solution is identified (Bahar & Suseno, 2014).

Arif Herwanto et al. (2013), in their study entitled *"Implementation of the Depth-First Search (DFS) Method for Mobile Web-Based City Bus Route Search in Solo,"* stated that the Depth-First Search algorithm is categorized as a blind search method, meaning that the search process is performed without prior information guiding the search path. This approach is suitable for situations where users must determine a solution within limited time despite having limited information about available routes and fares (Herwanto & Purnama, 2013).

Based on several previous studies, it can be observed that there has been no research specifically addressing the development of a WhatsApp chatbot-based expert system for selecting thesis topics for students. Furthermore, the application of the Depth-First Search algorithm within a WhatsApp chatbot-based expert system has not been widely explored. Therefore, this study is expected to contribute a novel approach in the field of decision support systems and expert system development.

This research focuses on the development of a WhatsApp chatbot-based expert system utilizing the Depth-First Search (DFS) algorithm for selecting thesis topics for students of the Adab Department at UIN Sayyid Ali Rahmatullah Tulungagung. The system is designed with a familiar chatbot interface to ensure usability and accessibility so that students can easily determine thesis topics that match their areas of interest.

2. RESEARCH METHOD

This study employs the Design Science Research Methodology (DSRM) in developing a chatbot-based expert system. DSRM serves as a standard guideline for research related to the design and development of information system artifacts ((Gregor & Hevner, 2013). The methodology consists of several stages, including problem identification, literature review, system design and development, implementation, evaluation, and communication.

The first stage of the research involves problem identification. At this stage, the researchers identify issues faced by sixth-semester students when they are required to prepare their thesis proposals. Problem identification was conducted through literature review, interviews, and field surveys in order to obtain a comprehensive understanding of the existing problems. After identifying the problems, the next step is to determine the research objectives and identify potential solutions. A literature review is also conducted to gather theoretical foundations and concepts related to the methods used in this study, particularly the Depth-First Search (DFS) algorithm and WhatsApp chatbot technology for the development of the expert system (Wahyuningsih & Jauhari, 2020). The use of a WhatsApp chatbot interface is expected to simplify user interaction since students are already familiar with the platform, while also reducing system development complexity. The theoretical foundations and concepts used in this study were obtained from books, journals, conference papers, and other relevant studies.

After completing the identification stage, the next phase involves system design and development. In this stage, the Entity Relationship Diagram (ERD) is used as a modeling tool. ERD is a diagram that

illustrates the relationships between database tables and the fields contained within them (Rukmana et al., 2023).

The ERD helps to visualize and structure data relationships clearly, enabling researchers to analyze the interconnections between entities within the system database. The fourth stage is the demonstration or system implementation phase, which aims to observe the results of the system design. If the implemented system does not meet the intended design requirements, revisions are made during the design stage until the system meets the expected functionality. Once the system operates as intended, the next step is system testing. The evaluation process is conducted using questionnaires distributed to students from the Adab Department as the research participants. This evaluation aims to measure the effectiveness and usability of the developed system. The testing process ensures that the system development aligns with the research framework that has been established (Huda, 2019).

The final stage in the research methodology is communication. In this stage, the research findings are documented and presented in the form of a research report. The report includes conclusions derived from the evaluation results, as well as an analysis of the developed system model. These findings are then prepared for dissemination and publication.

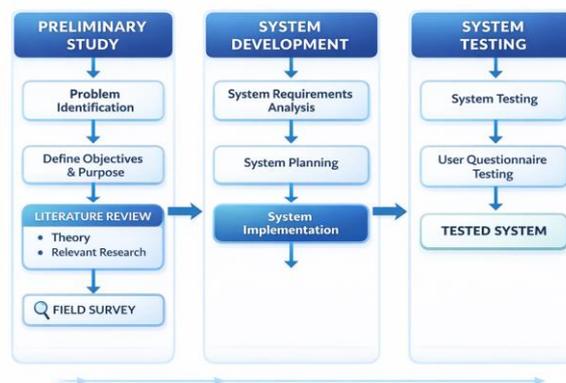


Figure 1 . Research Process

Expert systems generally consist of several main components. The first component is the knowledge base, which serves as the core of the expert system and contains the knowledge acquired from experts in a specific domain. This knowledge represents facts, rules, and relationships used by the system to solve particular problems. The second component is the inference engine, which functions as the reasoning mechanism of the expert system. The inference engine processes the knowledge stored in the knowledge base and performs reasoning to generate solutions based on the input provided by users. The third component is the user interface, which acts as the communication bridge between the

user and the expert system. Through this interface, users can provide information to the system and receive recommendations or solutions generated by the expert system (Muafi et al., 2020).

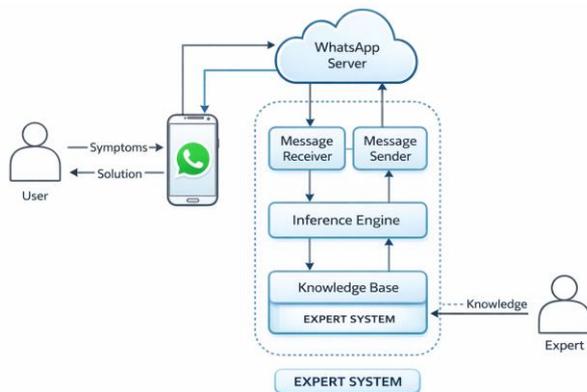


Figure 2. Components of an Expert System

The knowledge base of the expert system in this study is constructed using a set of questions tailored to the needs of the department. A total of 27 questions are included in the system to capture relevant information from users. Based on the responses to these questions, the expert system generates nine possible information outputs that can assist students in determining suitable thesis topics (Zatadini & Fatimah, 2022).

From the information table, a decision tree is developed to facilitate the implementation of the Depth-First Search (DFS) algorithm within the system. The decision tree structure enables the system to explore possible paths systematically in order to determine the most appropriate recommendation (Taufiq & Noor, 2019). The knowledge representation process begins when the user accesses the system. The system then processes the provided information to generate an initial diagnosis for determining an appropriate thesis topic. This diagnosis process starts with a series of questions answered by students, which are then analyzed by the system using the predefined knowledge base and inference mechanism.

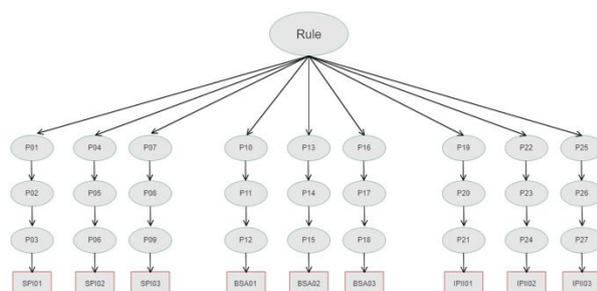


Figure 3. Decision Tree

3. RESULT AND DISCUSSION

The initial testing phase was conducted by involving validators to evaluate the developed system. The purpose of this evaluation was to assess the usability and effectiveness of the expert system application designed to assist students of the Adab Department, Faculty of Ushuluddin, Adab, and Da'wah at UIN Sayyid Ali Rahmatullah Tulungagung in selecting appropriate thesis topics. Based on the results of the preliminary evaluation, the application was found to be easy to use. The options provided within the system are clear and well-structured, enabling users to easily understand and interact with the application. This indicates that the chatbot-based interface successfully supports user interaction with the expert system.

The evaluation conducted by the validators refers to several assessment aspects, including the functionality of the system, ease of use, clarity of information, and overall system performance.

Table 1. Evaluation Indicators

No	Measured Aspect	Indicators
1	Feature Suitability with User Needs	The expert system provides features that support the entire knowledge required for selecting thesis topics. The expert system is able to meet the needs of users who experience difficulties in determining thesis topics. The features in the expert system are easy to use and relevant to user needs.
2	System Functionality Quality	All functions and features of the expert system operate properly and without errors. The expert system enables users to obtain thesis topics according to their interests. The features of the expert system are flexible and effective. The expert system interface design is easy to understand and intuitive.
3	User Interface Quality	The interface is easy to navigate and does not complicate the decision-making process. The interface design supports clarity of information and readability in each feature.
4	System Efficiency and Performance	The system runs smoothly without interruptions, including when processing knowledge input.

No	Measured Aspect	Indicators
6	Compatibility with Department Graduate Profile	The system is responsive and does not require a long time to process user input.
		Overall, the expert system is ready to be implemented.
		The expert system features assist users in obtaining thesis topics according to their interests.
	Data Reliability and Security	The expert system provides sufficient guidance to ensure users' understanding of the thesis topic they will choose.
		The reliability of the expert system is maintained without system interruptions or data loss.
		User data are securely stored within the system.

The validation results of the expert system indicate that, in terms of feature suitability, the system achieved a score of 98%, indicating that the provided features align well with user needs. In the system functionality quality aspect, the system obtained a score of 89.9%, demonstrating that the functions operate properly and effectively.

Regarding the user interface quality, the expert system received a score of 95%, indicating that the interface design meets the expected usability and interface standards. In terms of system efficiency and performance, the system achieved a score of 100%, showing that the system operates smoothly and efficiently.

In relation to the compatibility with the department's graduate profile, the validators assessed the system with a score of 98%, indicating that the system aligns well with the expected graduate competencies. Furthermore, in terms of system reliability and data security, the system received a score of 91.5%, indicating that the system is considered reliable and capable of maintaining data security.

The percentage results of the validator evaluation are presented in the following table.

Table 2. Evaluation Result

No	Aspect	Percentage
1	Feature Suitability with User Needs	98%
2	System Functionality Quality	89.9%
3	User Interface Quality	95%
4	System Efficiency and Performance	100%
5	Compatibility with the Department's Graduate Profile	98%
6	Data Reliability and Security	91.5%
Average		95.4%

Further testing was conducted with a larger group consisting of approximately 30 users. The purpose of this testing phase was to evaluate the usability and effectiveness of the expert system in meeting user needs for selecting thesis topics that align with the department's graduate profile.

Based on the results of the extended testing, the system was found to be easy to use. The available features were clear, understandable, and easy for users to operate. The results of this testing phase also indicate that the system functions properly and can be widely disseminated so that more users can benefit from the system.

In the validity test of the effectiveness variable instrument, the *r*-table value used for 30 respondents was 0.444 with a significance level of 0.05.

No. Soal	Nilai r tabel	Nilai Signifikansi	Keterangan
1	0,735	0,000	Valid
2	0,615	0,004	Valid
3	0,676	0,001	Valid
4	0,843	0,000	Valid
5	0,582	0,007	Valid
6	0,557	0,011	Valid
7	0,787	0,000	Valid
8	0,627	0,003	Valid
9	0,676	0,001	Valid

Picture 4. validity test of the effectiveness variable instrument

The results of the reliability test using Cronbach's Alpha yielded a value of 0.734 based on nine questionnaire items, indicating that the reliability of the instrument can be categorized as good. This result suggests that the items used in this study have sufficient internal consistency in measuring the effectiveness of the expert system in assisting students in determining their thesis topics.

4. CONCLUSION

The results of this study indicate that the WhatsApp chatbot-based expert system using the Depth-First Search algorithm for thesis topic selection, with a case study of students from the Adab Department at UIN Sayyid Ali Rahmatullah Tulungagung, can effectively assist students in determining thesis topics that align with their academic interests. The developed chatbot application can be accessed by users through the WhatsApp platform. The implementation of this system demonstrates that developing an expert system using a chatbot-based interface is feasible and practical. One of the advantages of this approach is the ease of system development, as the development process can be completed more efficiently without the need to design and build a separate application interface. From the user perspective, the system is also convenient because users do not need to learn a new interface, as they are already familiar with the

WhatsApp messaging environment. The evaluation results show that the expert system achieved an accuracy rate of 95.4%, indicating that the chatbot-based expert system provides reliable performance and meets user needs. Therefore, a chatbot-based expert system can be considered an effective solution for developing expert systems that are efficient in terms of time and effort while providing a familiar interface for users. For future research, the developed expert system can be further enhanced by integrating more advanced artificial intelligence techniques, such as machine learning or natural language processing, to improve the accuracy and adaptability of thesis topic recommendations. Additionally, the knowledge base of the system can be expanded by incorporating a wider range of questions and expert knowledge from multiple academic fields to provide more comprehensive recommendations. Future studies may also consider integrating the expert system with institutional academic information systems to enable automatic access to student academic profiles and interests. Furthermore, the system can be evaluated with a larger and more diverse group of users in order to obtain more comprehensive feedback regarding usability, system performance, and recommendation accuracy. These improvements are expected to enhance the effectiveness and scalability of chatbot-based expert systems in supporting academic decision-making processes.

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