EVALUATING THE USABILITY OF A QURANIC THEME EXTRACTION AND VISUALIZATION SYSTEM USING TASK-BASED USABILITY TESTING

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Article Info	Abstract
	Usability testing is crucial for evaluating the effectiveness and user experience of information retrieval systems. This study presents a task-based usability evaluation of a Quranic Theme Extraction and Visualization System, which integrates Natural Language Processing (NLP) techniques which are RAKE algorithm for keyword extraction and DistilBERT for theme classification. The system was assessed using Task-Based Usability Testing, where 20 participants completed predefined tasks while key usability metrics were recorded, including task success rate, task completion time, error rate, relative efficiency, and user satisfaction. The results indicate a task success rate of 91.25%, an overall relative efficiency of 96.12%, and a high user satisfaction score, demonstrating the system's usability and effectiveness. However, challenges in handling misspelled queries and complex synonym recognition were identified, highlighting areas for improvement. These findings underscore the importance of usability-driven evaluation in the development of Quranic information retrieval systems to enhance accessibility and user interaction.

INTRODUCTION

The Al-Quran, a sacred Islamic scripture, provides moral and ethical guidance across its 6,236 verses and 114 surahs (Ta'A et al., 2014). However, many, especially Mualaf (new Muslims), struggle to fully understand its teachings due to language barriers and a lack of structured study methods (Tamuri & Othman, 2021). Traditional learning approaches often fail to link related themes across different surahs, making it difficult to retrieve relevant information (R. Ahmad et al., 2021). Additionally, misinformation from unreliable online sources further complicates comprehension, as young Muslims often rely on social media and blogs for Quranic knowledge despite credibility concerns (Osman et al., 2021). To address these challenges, this project aims to design a web-based system that extracts Quranic themes

and visualizes their interconnections with verses and surahs. By leveraging Natural Language Processing (NLP), the system systematically maps user queries to relevant Quranic themes, improving accessibility and understanding (Humaini et al., 2019). Visual tools, such as knowledge graphs, further enhance engagement and allow users to explore Quranic teachings in a structured manner (Raharjo & Mustofa, 2014).

To achieve this, the system was developed using the RAKE algorithm and a fine-tuned DistilBERT transformer model to enhance theme extraction accuracy (Humaini et al., 2019). Built with Flask, it processes user queries, retrieves relevant verses, and presents information through interactive knowledge graphs, word clouds, and charts (Yunus et al., 2010). In addition to its technical components, this study places strong emphasis on evaluating the system's usability to ensure it effectively aids scholars, students, and general users in exploring Quranic themes. While previous research has primarily focused on improving algorithmic accuracy in Quranic theme extraction, the usability and user experience of such systems remain underexplored areas. To address this gap, this study conducts Task-Based Usability Testing to assess user experience, task efficiency, and system effectiveness, ensuring that the system is not only accurate but also accessible and user-friendly.

LITERATURE REVIEW

The concepts and approaches used by papers, journals, and articles have been explored and compared to complete this study in more detail. In addition, several subjects that contribute to the supporting evidence of the project were highlighted to validate this research.

Rapid Automatic Keyword Extraction Algorithm

The rapid growth of online text has made finding relevant information challenging, especially as readers prefer concise content (Yahya et al., 2021). Keyword Extraction (KE) helps by identifying essential words or phrases, enhancing tasks like natural language processing, text categorization, and information retrieval (Guda et al., 2023). KE can be performed using supervised or unsupervised methods, with unsupervised techniques, like Rapid Automatic Keyword Extraction (RAKE), offering more flexibility (Baruni & Sathiaseelan, 2020). RAKE uses a predefined list of stop words and phrase delimiters to

segment text, remove stop words, and generate candidate phrases (Kaushik & Thenmozhi, 2022). It then creates a co-occurrence matrix based on how often content words appear together, calculating scores for each word can be presented by the formula in Equation 1.

$$word\ score = \frac{degree\ of\ word}{frequency\ of\ word} \qquad \textbf{1}$$

Keywords are extracted based on these scores, with higher scores indicating more relevant terms, making RAKE an effective tool for KE tasks.

Bidirectional Encoder Representations from Transformers

Devlin et al. (2019) developed the Bidirectional Encoder Representations from Transformers (BERT), one of the most prominent transformer-based models for classification problems. BERT may take into account the context of both the words that come before and after a sentence because it uses bidirectional training. The model is better able to capture complex meanings thanks to its bidirectional capabilities, which makes it ideal for tasks like topic categorization, sentiment analysis, and thematic identification. BERT is very helpful for this project in categorizing user queries into themes found in the Quran. BERT's extensive contextual knowledge guarantees precise classification and retrieval of Quranic verses because users can enter both simple and complex queries, including synonyms for focused themes. BERT can also be improved for search relevance and accurate Quranic theme detection by fine-tuning it on a domain-specific dataset.

Distilled BERT

A lighter and faster version of BERT, DistilBERT was created by Sanh et al. (2019) with the goal of maintaining the majority of BERT's accuracy while drastically lowering processing requirements. Using a method called knowledge distillation, DistilBERT is taught to emulate BERT's behavior with 40% less parameters, resulting in a 60% faster inference time and decreased memory use. Even with its smaller size, it still performs well on classification tests, maintaining 97% of BERT's accuracy.

For effective Quranic theme classification in this Quranic Theme Extraction and Visualization project, DistilBERT is very helpful since it enables real-time query processing without sacrificing classification accuracy. Users looking for themes in the Quran will get

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speedy results thanks to its quick inference speed. DistilBERT is a great option for managing user queries, identifying relevant themes, and effectively retrieving appropriate Quranic verses because it is dynamic and responsive.

Data Visualization

Data visualization simplifies complex information by leveraging the brain's ability to recognize patterns quickly, making data more intuitive and engaging (Cao et al., 2021). It enhances cognitive performance by aiding pattern recognition, correlation inference, and sense-making (Bikakis, 2019). Various techniques such as bar charts, pie charts, word clouds, and force-directed graphs effectively represent different aspects of data. Bar charts help compare categorical data and track changes over time (Mukhiya & Ahmed, 2020), while pie charts illustrate proportional relationships, though they are sometimes criticized for inefficiencies in precise comparisons (Spence, 2005). Word clouds visually emphasize frequently occurring terms in a dataset (Kartikawati et al., 2021), and force-directed graphs illustrate relationships and interconnections between data points, making them ideal for network-based information (Li et al., 2022). In this project, these visualization techniques are used to analyze Quranic themes, with force-directed graphs mapping relationships between themes, surahs, and verses, while bar graphs, pie charts, and word clouds provide insights into theme distribution, prevalence, and key terms within Quranic content.

Web Application

A web application is a software program that runs on a web server and is accessed through a browser, eliminating the need for local installation (Petrenko, 2024). Its architecture consists of the front-end (user interface), back-end (server and business logic), and database, ensuring seamless interaction between components. The primary goals of web application architecture are efficiency, reliability, scalability, and security, enabling a smooth user experience while handling data and user growth effectively (Madeyski & Stochmiałek, 2005). Compared to other platforms, web applications offer fast performance, low development costs, platform independence, and code reusability, making them an ideal choice for the Quranic Theme Extraction and Visualization system. This ensures broad accessibility across devices, moderate security, and simplified maintenance, providing a cost-effective and user-friendly solution for delivering a seamless experience.

Usability Testing

Usability refers to how effectively, efficiently, and satisfactorily users can accomplish their goals within a system (A. E. Ahmad et al., 2022). Usability testing evaluates this by observing real users interacting with the system to identify potential issues and improve the user experience. Among various methods, task-based usability testing is widely used, originating from early usability studies and refined by experts like Jakob Nielsen (1993). This method involves assigning users real-world tasks while researchers observe their interactions, helping assess effectiveness, efficiency, and user satisfaction.

For this project, task-based usability testing was chosen to evaluate the system's usability. Table 1 illustrated the eight predefined tasks were designed to assess key functions, such as entering queries, navigating the knowledge graph, and exploring theme analysis. By observing users completing these tasks, potential usability issues can be identified, leading to design improvements that enhance overall user experience.

Table 1: Task Description for Task-Based Usability Testing

Task ID	Task Description
T01	Enter a query related to "Patience" and find the Quranic verses associated with the theme.
T02	Use a query containing synonyms of "Forgiveness" to retrieve the relevant Quranic verses.
T03	Enter a query that includes terms related to multiple themes (e.g., "truthfulness and gratitude") with intentional misspellings in the themes and observe the results.
T04	Generate a knowledge graph based on the theme(s) identified in your query and explore its connections.
T05	View the theme analysis for the identified theme(s) and interpret the visualizations presented on the dashboard page.
T06	Enter a long query that includes synonyms of multiple themes (e.g., "patience and forgiveness bring gratitude") and retrieve relevant results.
T07	Use a query containing an Arabic term related to a theme (e.g., "Sabr" for Patience) and retrieve the Quranic verses.
T08	Perform all functionalities on the Knowledge Graph page including searching for a specific surah, downloading a CSV file, and other available features.

After completing the task-based usability with participants, there are total 5 key usability metrics were used in the evaluation process which will be summarizes in Table 2.

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Table 2: Summarizations of Task-Based Usability Metrics

Evaluation Metrics	Objective
Task Success Rate	To measure the percentage of tasks successfully completed by users and reflects the overall effectiveness of the system.
Average Task Completion Time	To evaluate the time taken by users to complete each task and providing insights into the system's efficiency.
Error Rate	To determine the proportion of unsuccessful task completions and identifying potential usability challenges.
Overall Relative Efficiency	To assess how efficiently users complete tasks by considering both task success and time spent.
User Satisfaction	To determine users' perceptions of the system's ease of use through a five-point rating scale, where one indicates very difficult and five indicates very easy.

METHODOLOGY

This section divides the methodology for the Quranic Theme Extraction and Visualization system into development phases and the system design.

Development Phases

Figure 1 shows the five phases of developing the Quranic Theme Extraction and Visualization system using a modified waterfall methodology: requirement, design, implementation, testing, and deployment. Each phase consists of a specific task to be completed. This paper focuses on the usability test of the Quranic Theme Extraction and Visualization system.
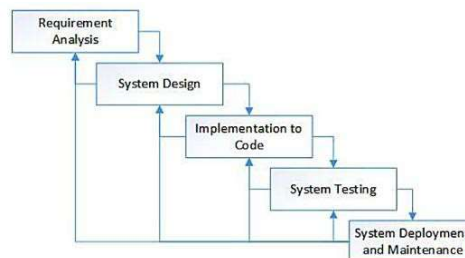
Figure 1: Phases involved in developing Quranic Theme Extraction and Visualization system

The development of the Quranic Theme Extraction and Visualization system involved a two-step approach using the RAKE algorithm for keyword extraction and the DistilBERT transformer model for theme classification. RAKE was deployed to extract meaningful keywords from a pre-processed Quranic dataset, identifying significant words based on their

PCMJ

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co-occurrence patterns without relying on predefined dictionaries. The extracted keywords were then refined and mapped to predefined themes to enhance their relevance. To improve thematic classification, the DistilBERT model was fine-tuned on a labeled dataset of Quranic verses mapped to moral themes like Forgiveness and Patience. After preprocessing and tokenization, the model was trained with optimized hyperparameters and evaluated using accuracy, precision, recall, and F1-score metrics. Finally, the fine-tuned DistilBERT model was integrated into the system's query processing module, enabling dynamic theme classification and retrieval of relevant Quranic verses. This combined approach ensured an efficient, scalable, and accurate system for extracting and visualizing Quranic themes based on user queries.

System Design for Quranic Theme Extraction and Visualization

In the design phase, a use case diagram were created to illustrate the system's functional requirements from the user's perspective. In addition, a user interface were designed to describe how users interact with the system. Then, the flowchart were used in Figure 2 to show the system's process flow.
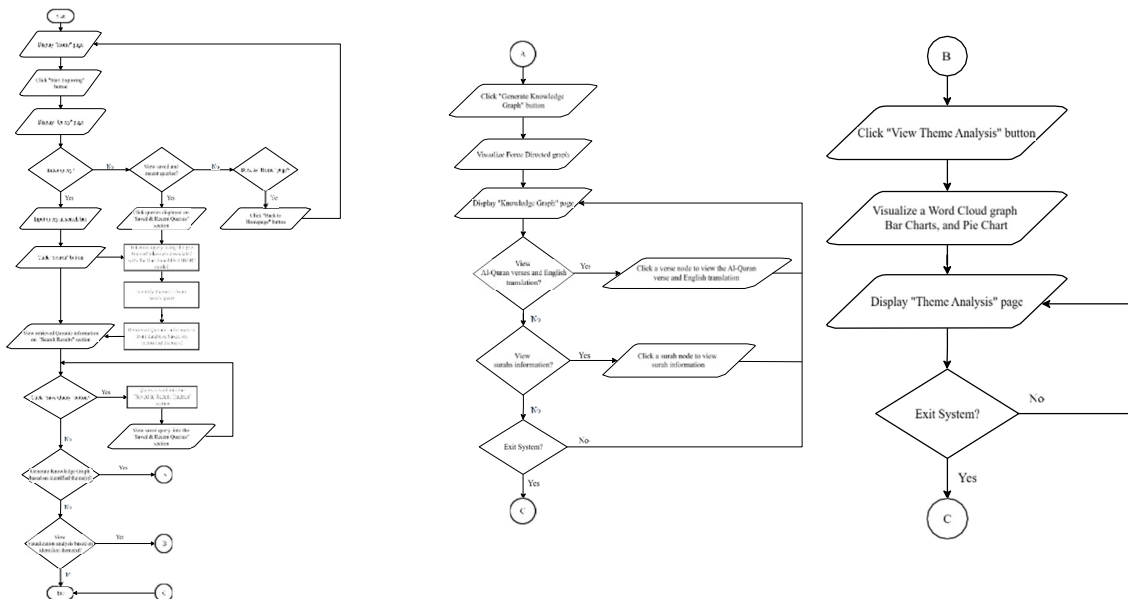

Figure 2: Flowchart of The System

The system begins on the Home page, where users can start by clicking "Start Exploring." They are then directed to the Query page, where they can enter a keyword, check saved queries, or return to the Home page. When a user submits a query, the system processes it using a fine-tuned DistilBERT model to identify relevant themes and retrieves matching Quranic content. The results are displayed, and users can either explore them further or save the query for future reference.

Users can then choose to generate a Knowledge Graph or view Theme Analysis Visualization. The Knowledge Graph visually maps connections between Quranic themes, surahs, and verses, allowing interactive exploration. Alternatively, the Theme Analysis Visualization page presents insights through word clouds, bar charts, and pie charts, showing theme distribution across the Quran. Users can refine their searches, explore different themes, or exit at any time, ensuring a smooth and insightful experience.

System Usability Assesment

In Usability testing for the system was conducted under direct observation, where participants interacted with the system on a designated computer. A total of 20 participants were involved, including 15 students, with the remainder consisting of lecturers and members of the public. A physical task-based usability testing form was utilized to gather task-specific data, capturing metrics such as ease of use ratings, task completion times, completion status, and qualitative feedback. Figure 3 illustrates the process followed to conduct the task-based usability testing.
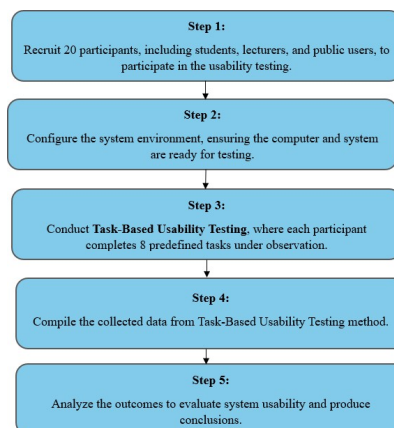

Figure 3: Process of Conducting Task-Based Usability Testing

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In task-based usability testing, participants performed 8 predefined tasks to assess system functionality and ease of use. For each task, participants rated the difficulty on a scale from 1 to 5, where 1 indicated "Very Difficult" and 5 indicated "Very Easy." Additional data, such as task completion status (Yes/No) and time to complete each task, was recorded to evaluate efficiency and identify potential usability issues. All information from the testing session is analyzed to generate a system assessment. The task based metrics enables to provide more precise information about the specific task and user satisfaction. This will make sure that there is a well rounded approach to the performance evaluation of the system.

RESULT AND DISCUSSION

This section discusses the results and findings from the proposed study on the Quranic Theme Extraction and Visualization using RAKE algorithm and DistilBERT transformer model. It is divided into two sections: the interfaces of the Quranic Theme Extraction and Visualization system and the result of the usability testing.

User Interface of Quranic Theme Extraction and Visualization

Table 3 presents a summarized overview of the user interface for the Quranic Theme Extraction and Visualization system, along with descriptions of its key components.

Table 3: Summary of the User Interface for Quranic Theme Extraction and Visualization System with Descriptions.

User Interface	Descriptiom
	The Home Page introduces the Quranic Theme Extraction and Visualization system with a minimalistic design. It features a welcome message and a "Get Started" button that directs users to the Query Page.
	Users can search for Quranic themes by entering keywords. The system retrieves relevant verses, displaying chapter, verse number, and English translation. Users can further explore themes by generating a Knowledge Graph or viewing Theme Analysis.
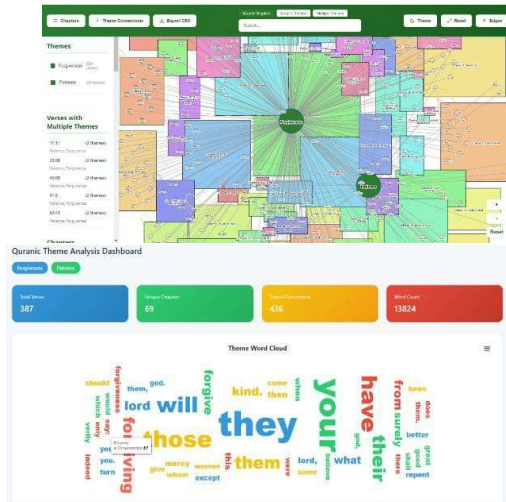
This page visually maps Quranic themes and related verses as an interactive knowledge graph. Users can zoom, pan, and click nodes to view verse details. A sidebar offers additional insights, and an "Export CSV" button enables offline reference.

The Theme Analysis Page uses word clouds, bar charts, and pie charts to visually show important keywords and how verses are distributed across chapters, making it easier to understand Quranic themes.

Usability Testing

The outcome of the task-based usability testing indicates that the system has confirmed high levels of usability across several performance metrics such as Task Success Rate, Average Task Completion Time, Error Rate, Overall Relative Efficiency, and User Satisfaction. These metrics analyzed different aspects of the system which included its effectiveness, efficiency, and overall user experience.

Task Success Rate Analysis

The results illustrated in Table 4 indicate that most tasks achieved excellent usability, with success rates of 100% for tasks T01, T02, T04, T05, T07, and T08. These tasks involved straightforward system interactions, such as retrieving queries and assigning themes, which participants found easy to complete. However, tasks T03 (85% success) and T06 (80% success) had lower success rates due to challenges in handling misspelled queries and complex synonym-based searches, highlighting areas for improvement in query processing and synonym recognition.

Table 4: Result of Task Success Rate Metric Analysis

Task ID	Number of Y	Success Rate (%)	Indicators
T01	20	100%	Excellent Usability
T02	20	100%	Excellent Usability
T03	17	85%	Satisfactory Usability
T04	20	100%	Excellent Usability

PCMJ

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T05	20	100%	Excellent Usability
T06	16	80%	Satisfactory Usability
T07	20	100%	Excellent Usability
T08	20	100%	Excellent Usability

Average Task Completion Time Analysis

Tasks with high success rates, such as T01, T02, T04, and T07, had the shortest completion times, indicating system efficiency for basic functions, as illustrated in Table 5. However, tasks T03 (142.5s) and T06 (202.5s) took significantly longer to complete due to increased cognitive load from handling misspelled words and complex queries. Reducing these completion times by improving query processing and synonym recognition would enhance overall usability.

Table 5: Result Of Average Task Completion Time Analysis

Task ID	Total Participants	Successful Completions (Y)	Total Completion Times (TTC) in Secs	Average Completion Time (Secs)
T01	20	20	1025	51.25
T02	20	20	1100	55.0
T03	20	17	2280	142.5
T04	20	20	920	46.0
T05	20	20	1600	80.0
T06	20	16	3240	202.5
T07	20	20	960	48.0
T08	20	20	1760	88.0

Error Rate Analysis

Results shown in Table 6 illustrated that most tasks demonstrated an error rate of 0%, confirming the system's reliability. However, tasks T03 and T06 had error rates of 15% and 20%, respectively, reflecting usability challenges in handling erroneous and complex inputs. Participants noted that better error-tolerant query processing and improved synonym detection could reduce these errors and improve the system's effectiveness.

Table 6: Result of Error Rate Metric Analysis

Task ID	Total Participants	Unsuccessful Completions	Error Rate (%)	Indicators
T01	20	0	0	Acceptable Usability
T02	20	0	0	Acceptable Usability
T03	20	3	15	Poor Usability
T04	20	0	0	Acceptable Usability

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T05	20	0	0	Acceptable Usability
T06	20	4	20	Poor Usability
T07	20	0	0	Acceptable Usability
T08	20	0	0	Acceptable Usability

Overall Relative Efficiency Analysis

The system achieved an overall relative efficiency of 96.12%, indicating strong usability as shown in Table 7. Tasks with simpler interactions, such as T01, T02, and T04, had high efficiency, while tasks T03 and T06, despite their high efficiency percentages, required greater user effort due to system limitations. Addressing these complexities could further enhance the balance between success rate and efficiency.

Table 7: Result of Overall Relative Efficiency

Task ID	Total Time (Secs)	Successful Time (Secs)	Success Rate (%)	Relative Efficiency (%)
T01	1025	1025	100	11.83%
T02	1100	1100	100	12.69%
T03	2280	2040	85	23.52%
T04	920	920	100	10.61%
T05	1600	1600	100	18.45%
T06	3240	2880	80	33.20%
T07	960	960	100	11.01%
T08	1760	1760	100	20.45%
Overall	**12885**	**12385**		**96.12%**

User Satisfaction Analysis

Table 8 depicted the result of user satisfaction analysis where participants rated most tasks as "Very Easy" or "Easy," with average ease-of-use (EoU) scores ranging from 4.05 to 5.0. Tasks T03 and T06 received lower scores (4.30 and 4.05, respectively), indicating moderate difficulty due to the system's handling of complex queries. Improving user experience in these areas would increase satisfaction and ensure a smoother interaction with the system.

Table 8: Result of User Satisfaction Analysis

Task ID	Sum of EoU Ratings	Total Participants	Average EoU	Indicator
T01	100	20	5.0	Very Easy
T02	95	20	4.75	Easy

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T03	86	20	4.30	Moderately Easy
T04	98	20	4.90	Very Easy
T05	90	20	4.50	Easy
T06	81	20	4.05	Moderately Easy
T07	92	20	4.60	Easy
T08	95	20	4.75	Easy

Summary Result of Usability Metrics

Table 9 illustrated the summary results of usability metrics. The usability evaluation confirmed that the system performs efficiently, with a high task success rate of 91.25% and an overall relative efficiency of 96.12%. However, challenges remain in handling misspelled queries and complex synonym recognition, highlighting areas for further improvement. The findings indicate that the system is highly usable, with a task success rate of 91.25% and an overall efficiency of 96.12%. However, areas such as query handling for misspelled words and complex synonym recognition require improvements. Compared to other Quranic information retrieval studies, this work uniquely emphasizes usability testing, providing empirical data on user interactions that can guide future improvements in Quranic search tools.

Table 9: Summary of Task-Based Usability Testing Metrics

Metric	Description	Result
Task Success Rate	Percentage of tasks successfully completed by users	91.25
Overall Relative Efficiency	Measures efficiency by combining task success with time spent	96.12
Average Task Completion Time	Evaluates the time taken to complete tasks	Assessed but not a percentage metric
Error Rate	Proportion of tasks that were unsuccessfully completed	Low error rate observed
User Satisfaction	Evaluates ease of use based on participant feedback	High satisfaction

CONCLUSION

The Quranic Theme Extraction and Visualization System was developed using the RAKE algorithm and DistilBERT Transformer Model to facilitate structured exploration of Quranic themes such as forgiveness, truthfulness, patience, and gratitude. The system enables users to retrieve Quranic information efficiently through thematic queries, presenting results via interactive Knowledge Graphs, word clouds, and statistical visualizations. Beyond

technical implementation, this study conducted Task-Based Usability Testing to evaluate the system's effectiveness, efficiency, and user experience. The results demonstrated a task success rate of 91.25%, an overall relative efficiency of 96.12%, and high user satisfaction, confirming that the system is user-friendly and accessible. However, challenges in handling misspelled queries and complex synonym recognition indicate areas for future improvement. These findings highlight the importance of usability-driven development in Quranic information retrieval systems, ensuring that such platforms are not only technically robust but also intuitive for users. Future work may focus on enhancing query processing, refining theme classification, and expanding usability testing with a more diverse user base to further improve system accessibility and effectiveness.

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