

Enhancing Project Management Support through Retrieval-Augmented Generation: A PMBOK-Aligned Evaluation for Knowledge Assistance

Anonymous Authors

Affiliation removed for double-blind review

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Abstract—Accessing relevant, context-specific project management guidance in real time remains challenging, even with comprehensive frameworks like the PMBOK Guide. Traditional documentation and training resources lack adaptability under dynamic conditions, a limitation particularly critical where consistency, traceability, and standards compliance are essential. This study develops and evaluates a Retrieval Augmented Generation (RAG) system that delivers standards aligned decision support grounded in the ten PMBOK Knowledge Areas. The knowledge base integrates PMBOK summaries, ISO 21500 documentation, case studies, and open educational resources. Using Langchain, we segmented the documents into overlapping text chunks and generated embeddings with multilingual models from HuggingFace and OpenAI. The retrieval system employed FAISS (Facebook AI Similarity Search) for vector indexing, while the generation component used DeepSeek V3 0324, while generation is performed by a large language model using structured, PMBOK-aligned prompts. Evaluation combines expert-based assessment using Likert-scale ratings and scenario-based analysis. Results indicate strong performance in stakeholder and cost management tasks, with slightly reduced completeness in complex multi-step scenarios. The findings suggest the system’s potential as an exploratory decision support tool, warranting further real-world validation for project managers and highlight its applicability in both certification training and live project environments.

Index Terms—RAG, PMBOK, Sentence-BERT, GPT, LLMs

I. INTRODUCTION

Project managers rely on the structured knowledge areas of the Project Management Body of Knowledge (PMBOK) Guide to ensure consistent, comprehensive execution across domains [1]. Yet, despite the availability of these frameworks, accessing relevant, real-time guidance remains challenging, particularly during dynamic or complex project phases [2]. Traditional documentation often lacks adaptability, leaving practitioners without timely, situation-specific support. Surveys indicate that an increasing number of project managers are resorting to informal tools and ad hoc spreadsheets during execution due to the absence of tailored, accessible guidance [3], increasing

inconsistency and project risk, especially in high-variability environments. Key areas such as change control, risk mitigation, and stakeholder engagement remain underserved by static documentation. These limitations underscore the need for intelligent systems capable of providing domain-specific, standards-aligned recommendations in real time. Retrieval-Augmented Generation (RAG) architectures present a promising approach, integrating semantic retrieval with natural language generation to enhance project management workflows [4].

Static documents and training materials, while valuable for foundational learning, lack the capacity to deliver dynamic, situation-aware assistance required during active project execution [5]. This limitation creates a disconnect between the theoretical guidance offered by standards like the PMBOK and the real-time decision-making needs of project managers in complex, evolving environments. As a result, professionals often rely on experience or ad hoc solutions rather than structured knowledge, reducing consistency and increasing risk [6]. This disconnect leads to inconsistent application of best practices, reduced alignment with PMBOK guidelines, and increased risk in high-stakes projects [7].

To address this gap, we propose the development of a Retrieval-Augmented Generation (RAG) system specifically designed to retrieve documentation aligned with the ten PMBOK Knowledge Areas and to generate project-specific guidance tailored to the practitioner’s real-world context [8]. By integrating semantic retrieval techniques with advanced generative language models, the system delivers grounded, context-sensitive, and timely support across domains such as scope definition, risk response planning, stakeholder engagement, and quality control [9]. This approach not only enhances the accessibility and usability of project management knowledge, but also bridges the persistent divide between static theoretical frameworks and the dynamic, often unpredictable nature of project execution. Unlike existing PM tools which rely on rule-based templates or general-purpose assistants, our system integrates retrieval of structured domain knowledge with LLM-based generation to deliver context-aware guidance.

To address the gap between static project management resources and the dynamic needs of practitioners, we present a

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Retrieval-Augmented Generation (RAG) system aligned with the ten PMBOK Guide knowledge areas [8], [10]. The system integrates a curated PMBOK-aligned knowledge base, a semantic retrieval module, and a generative component to deliver context-aware, standards-aligned guidance in real time. An evaluation framework using simulated project scenarios assesses relevance, usability, and accuracy in decision-making contexts. To our knowledge, this represents an initial attempt to specifically tailored to PMBOK knowledge areas for interactive decision support. The open-source framework includes curated content, prompt templates, and evaluation scripts, achieving expert-rated clarity and domain relevance score, aiding advisors in reviewing documents and consulting static repositories.

To investigate this opportunity, the present study explores the following research questions:

- **RQ1:** Can a retrieval-augmented generation (RAG) architecture reliably retrieve PMBOK-aligned knowledge relevant to project management queries?
- **RQ2:** To what extent do generated responses align with expert expectations in terms of relevance, clarity, and adherence to PMBOK principles?
- **RQ3:** Which PMBOK knowledge areas benefit most from retrieval-augmented decision support?

II. RELATED WORK

Expert systems in project management capture procedural knowledge through rule-based frameworks, enabling less-experienced users to perform tasks at near-expert levels [11]. Recent advances integrate knowledge graphs with RAG architectures to improve semantic retrieval, reasoning, and traceability in enterprise knowledge systems [12]. Semantic technologies like knowledge graphs enhance retrieval efficiency and precision, making them well-suited for embedding structured PMBOK knowledge into intelligent tools [13]. Our approach extends beyond deterministic logic by combining dense semantic indexing with generative reasoning to deliver context-sensitive, PMBOK-grounded outputs.

Artificial intelligence applications in project management have increasingly focused on predictive analytics [14], risk forecasting, and automated reporting. However, most existing systems rely on structured datasets rather than knowledge-driven reasoning frameworks aligned with project management standards. Integrating AI models with established frameworks such as PMBOK presents an opportunity to provide context-aware guidance that supports decision making across the project lifecycle. Recent research highlights the growing potential of large language models to assist professionals in knowledge-intensive domains by synthesizing documentation, guidelines, and historical project data.

NLP techniques can extract, classify, and quantify requirements from unstructured project documents, aiding risk analysis, scope definition, and compliance [15]. In construction, named-entity recognition and relation extraction have converted safety and risk clauses into structured data [16]. Reviews in software requirements engineering confirm NLP's

value for classification, ambiguity detection, and traceability, with clear applicability to PMBOK workflows [17]. However, current NLP tools focus on information extraction rather than generating scenario-aware, real-time project management guidance. To our knowledge, no existing system combines dense retrieval with large language generation for this purpose.

Retrieval-Augmented Generation (RAG) combines a retriever, which identifies relevant knowledge chunks, with a generator that produces grounded natural language responses. In domains such as QA, legal summarization, and medical consultation, RAG integrates up-to-date sources to improve factuality and reduce hallucinations [18]. Its adoption in project management is limited, as most PM tools remain rule-based or template-driven [19]. Given the need for traceable, standards-aligned outputs, RAG's grounding capability in formal corpora such as PMBOK presents a strong opportunity for real-time, standards-based decision support [20]. This work represents one of the first RAG implementations tailored to structured professional frameworks like PMBOK.

Artificial Intelligence (AI) is increasingly used in professional decision-making, offering domain-specific, standards-aligned support. In project management, where outputs must comply with frameworks like PMBOK or ISO 21500, explainability is critical for trust and transparency [21]. Studies show that explainable AI (XAI) enhances adoption when recommendations are traceable to standards and supported by interpretable logic [22]. Our system meets this need by pairing generated outputs with the retrieved knowledge chunks, enabling verification and accountability. Unlike black-box assistants, RAG architectures expose exact source fragments, aligning well with project management's requirements for auditability.

Despite the rapid adoption of large language models in decision support applications, relatively little research has explored how retrieval-augmented generation can be systematically aligned with standardized project management frameworks such as the PMBOK. Most existing approaches rely on generic conversational models that lack explicit grounding in structured project management knowledge areas. Consequently, the potential of retrieval-augmented architectures to provide context-aware, standards-aligned guidance for project managers remains insufficiently explored. Addressing this gap requires systems capable of integrating curated project management knowledge with generative reasoning in a transparent and traceable manner.

This study presents the first Retrieval-Augmented Generation (RAG) pipeline specifically aligned with PMBOK knowledge areas to support interactive decision-making in project management. The open-source framework includes curated PMBOK-based content, structured prompt templates, and evaluation scripts for practitioner validation. In contrast to rule-based advisors or static document repositories, the prototype delivers contextually relevant recommendations grounded in formal standards. Expert reviewers rated the outputs highly, for clarity and domain relevance.

III. METHODS

A. System Architecture

The proposed architecture follows a RAG design comprising four components: user interface, preprocessing, retriever, and generator. The Streamlit-based interface allows users to submit queries or upload PMBOK-related PDFs for analysis, supporting real-time interaction and visualization. Extracted text, processed via PyPDF, is segmented into overlapping chunks using Langchain segments the content into overlapping blocks, preserving context and enhancing retrieval. The retriever uses Transformer-based models to generate vector embeddings, indexed by FAISS for semantic search. OpenAIEmbeddings were chosen for their multilingual capabilities and benchmark performance, while the generator—using GPT-4 or an open-source equivalent—produces context-aware recommendations grounded in PMBOK content. This modular, scalable design bridges standardized knowledge areas and practical decision-making. Figure 1 presents the complete workflow from input to contextualized output.

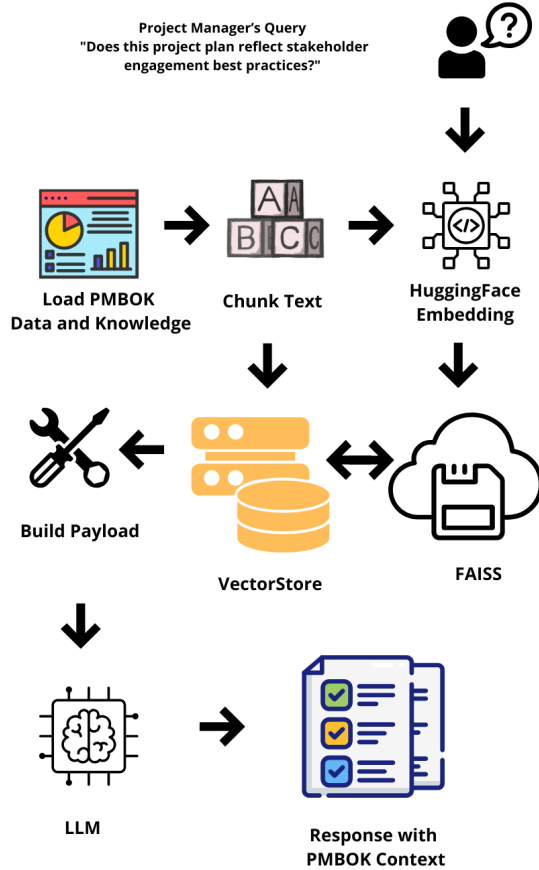


Fig. 1. System architecture of the PMBOK-aligned RAG pipeline, illustrating the flow from user input to semantic retrieval and context-aware generation.

B. Document Processing and Knowledge Base Construction

The knowledge base used in this study was constructed from curated project management resources aligned with PMBOK knowledge areas. Source documents were segmented into smaller text units using a chunking strategy designed to preserve semantic coherence while enabling efficient retrieval. Each document segment was transformed into a vector representation using a sentence embedding model, enabling similarity-based retrieval through vector indexing.

C. Knowledge Base Construction

The knowledge base is organized according to the PMBOK Guide's ten Knowledge Areas—Integration, Scope, Schedule, Cost, Quality, Resource, Communication, Risk, Procurement, and Stakeholder Management. Sources include PMBOK-aligned summaries, ISO 21500 documentation [23], real-world project case studies [24], and open-access educational resources [25], integrating both formal standards and practical applications [26], [27]. This structure enables precise, context-aware retrieval and generation for diverse project environments. Content is segmented into 1000-token chunks with 30% overlap, balancing retrieval granularity and semantic continuity. Table I outlines the composition, volume, and relevance of the included sources.

TABLE I
SUMMARY OF KNOWLEDGE BASE COMPOSITION

Source Type	Token Count	Language	Notes
PMBOK Summaries	150,000	English	Aligned to 10 Knowledge Areas
ISO 21500 Docs	50,000	English	Formal process definitions
Case Studies	100,000	English	Sourced from IT and construction
OpenEdu Resources	60,000	English	Supplementary institutional content

D. Retrieval and Generation Pipeline

The system employs a retrieval-augmented generation pipeline in which user queries are first transformed into embedding vectors and compared against indexed document representations using cosine similarity. The top-k most relevant document segments are retrieved and incorporated into the prompt context. The generation module then produces a response conditioned on both the retrieved context and the user query, ensuring that generated recommendations remain grounded in PMBOK-aligned knowledge sources.

E. Retriever Component

The retriever module semantically indexes PMBOK-aligned content using dense vector representations. Documents such as ISO 21500 guidelines, case studies, and PMBOK summaries are segmented into 1000-token chunks with 20–30% overlap to preserve context across boundaries. FAISS indexes the resulting embeddings for efficient similarity search. This

configuration ensures precise alignment between user queries and relevant project management knowledge areas.

F. Generator Component

The generation component employs structured prompt templates comprising: (1) retrieved context from the knowledge base, (2) a user-provided natural language query, and (3) a system instruction specifying the model's role and parameters such as temperature and token limits. This format ensures context-sensitive, PMBOK-aligned responses tailored to project management tasks. DeepSeek-V3-0324 was selected for its superior coherence and consistency over smaller models like LLAMA3-7B, based on zero-shot curriculum feedback benchmarks and human ratings for inclusive tone. Temperature is adjusted to balance precision and conversational support, while prompt chaining and response filtering improve factuality and coherence. Additional techniques—prompt grounding, entropy control, and output length constraints—help stabilize response quality across varied project scenarios. Additional safeguards include prompt grounding, strict token limits, and manual filtering of low-quality generations during pilot testing.

G. Evaluation Methodology

The system evaluation applied quantitative metrics to measure retrieval accuracy, linguistic fidelity, and content relevance, complemented by expert review across PMBOK's ten Knowledge Areas using curated scenarios such as risk identification and scope planning. A 5-point Likert rubric assessed clarity, relevance, and PMBOK alignment, enabling consistent aggregation and qualitative insights. The architecture comprises three components: a retriever using OpenAIEmbeddings and FAISS for semantic indexing and top- k syllabus retrieval, a generator powered by large language models with prompts grounded in PMBOK-aligned project management principles and structured domain guidance, and a web-based interface for uploading course materials, submitting queries, and receiving equity-focused recommendations. This hybrid quantitative–qualitative evaluation approach, suited to the exploratory development stage, emphasises feasibility, usability, and contextual relevance. The qualitative evaluation involved three domain experts with professional or academic experience in project management practice. Each evaluator independently assessed system outputs using a structured Likert-scale rubric covering clarity, relevance, and standards alignment. Disagreements were analyzed descriptively, and average scores were reported to provide an aggregated view of system performance.

1) *System Setup*: The RAG pipeline integrates the following components tailored to the PMBOK domain:

- **Retriever**: OpenAIEmbeddings embeddings are used for semantic representation of PMBOK-aligned knowledge content. Vector indexing and top- k similarity retrieval are handled using FAISS and cosine distance.
- **Generator**: A pre-trained large language model is prompted using templates grounded in PMBOK-aligned project management principles and structured domain

guidance to generate recommendations for supporting project management decision-making tasks.

- **Frontend**: A user-friendly web interface enables project managers or practitioners to upload project management documents, input queries, and receive contextual feedback on project management design.

2) *Knowledge Base*: The content for the system was curated from publicly available, domain-aligned resources to ensure both relevance and alignment with established project management standards. Specifically, the knowledge base—referred to as PMBOK-RAG—includes structured summaries of the PMBOK Guide, ISO 21500 documentation, and a selection of real-world project case studies. To prepare the textual data for semantic retrieval, all documents were segmented into 1000-token chunks with a 30% overlap. This preprocessing strategy was implemented to preserve contextual continuity across chunk boundaries and to optimize the accuracy of downstream embedding and retrieval operations.

3) *Evaluation Strategy*: As a prototype, the evaluation of the system is organized around three core objectives specifically tailored to the project management domain. Expert reviewers manually evaluate these passages based on their contextual fit and informational value. Second, generation inspection examines the quality of the system's outputs in terms of clarity, coherence, and adherence to PMBOK principles. Representative tasks—such as drafting a risk register or constructing a scope management plan—are used to guide this analysis. Third, scenario walkthroughs involve testing the system in simulated project situations, including change control, stakeholder conflict, and procurement planning. In these scenarios, experts evaluate the practical utility, completeness, and contextual accuracy of the AI-generated recommendations, providing critical feedback for prompt refinement and iterative system improvement.

4) *Limitations and Future Work*: This exploratory evaluation reflects the prototype's early development, with limited testing scope and partial automation of components. Further validation is required before real-world deployment. Future work will expand the knowledge base with annotated, PMBOK-aligned data to enable retrieval benchmarking, conduct structured user studies with certified project managers to assess usability and domain alignment, and integrate automated evaluation metrics such as BLEU and GPTScore to measure linguistic and contextual fidelity, although such metrics were not included in the current evaluation. To ensure transparency and reproducibility, all source code, prompt templates, and curated content will be openly released.

IV. RESULTS

This section presents the outcomes of the system evaluation, structured across three dimensions: retrieval performance, generation quality, and scenario-based utility. Quantitative metrics are reported to assess retrieval accuracy and linguistic fidelity, while qualitative expert evaluations provide insight into the clarity, relevance, and alignment of generated outputs with

PMBOK standards. Additionally, we include results from task-based scenarios to evaluate the system’s practical utility in real-world project management contexts. Together, these findings offer a comprehensive view of the system’s effectiveness in supporting standards-based, context-aware project guidance.

A. Knowledge Areas and Representative Queries

To ensure domain alignment with the PMBOK framework, we structured our system’s input queries around its core Knowledge Areas. For each area, representative queries were designed to reflect common practitioner challenges and typical informational needs. This alignment supports both relevance in retrieval and clarity in generation tasks. The following table presents a curated list of queries categorized by their associated Knowledge Areas. Table II presents sample retrieval queries, refined for evaluation, categorised by the ten PMBOK knowledge areas to ensure alignment with project management standards .

TABLE II
SAMPLE REFINED RETRIEVAL QUERIES ORGANISED BY PMBOK KNOWLEDGE AREA, DESIGNED TO SUPPORT STANDARDS-ALIGNED EVALUATION OF THE PROTOTYPE’S RETRIEVAL CAPABILITIES.

Knowledge Area	Sample Queries
Integration Management	1. What are the key components of a well-structured project charter? 2. How do I align execution, monitoring, and control in an integration plan?
Scope Management	1. How do I define scope boundaries and exclusions effectively? 2. What should a comprehensive scope management plan contain?
Schedule Management	1. How can I structure a realistic project schedule with dependencies? 2. When should I apply critical path method in scheduling?
Cost Management	1. What are reliable techniques for estimating project costs? 2. How do I build and validate a baseline project budget?
Quality Management	1. What elements should a project quality management plan include? 2. How can I ensure continuous quality assurance throughout a project?
Resource Management	1. How do I construct a detailed resource breakdown structure (RBS)? 2. What is the role of a responsibility assignment matrix (RAM)?
Communication Management	1. How do I design a communication management plan for diverse stakeholders? 2. What strategies ensure effective communication with external stakeholders?
Risk Management	1. What are best practices for conducting qualitative risk analysis? 2. How do I design a proactive risk mitigation plan?
Procurement Management	1. What steps are involved in preparing a request for proposal (RFP)? 2. How do I choose between fixed-price and cost-reimbursable contracts?
Stakeholder Management	1. How do I identify and prioritize project stakeholders effectively? 2. What engagement strategies foster long-term stakeholder support?

B. Responses Results

This section presents the results of the retrieval component of the RAG system when applied to project management queries categorized by PMBOK knowledge areas. The

evaluation focuses on the relevance and contextual accuracy of the retrieved passages, examining the alignment between user queries and the knowledge chunks returned. Representative examples across areas such as integration, scope, risk, and procurement illustrate the system’s capability to surface domain-appropriate content. The results support a preliminary assessment of the retriever’s precision in addressing practical decision-making needs in project contexts. Table III presents refined PMBOK-aligned retrieval queries with corresponding system-generated responses, organised by knowledge area to illustrate coverage across core project management domains.

TABLE III
REFINED PMBOK-ALIGNED RETRIEVAL QUERIES AND PROTOTYPE-GENERATED RESPONSES, CATEGORISED BY KNOWLEDGE AREA, DEMONSTRATING DOMAIN COVERAGE FOR EVALUATION PURPOSES.

Query (Knowledge Area)	Responses
How do I align execution, monitoring, and control in an integration plan? (Integration Management)	“The integration plan ensures coordination of all processes and activities, enabling continuous alignment with project goals during execution and monitoring.”
How do I define scope boundaries and exclusions effectively? (Scope Management)	“The scope statement should clearly describe what is included and excluded, providing a shared understanding of project limits.”
How do I calculate and interpret float in a project timeline? (Schedule Management)	“Float is the amount of time an activity can be delayed without affecting the project end date; it is essential for schedule flexibility.”
What methods help monitor and control cost variances? (Cost Management)	“Use Earned Value Management (EVM) metrics like CPI and CV to track performance and identify cost variances.”
What elements should a project quality management plan include? (Quality Management)	“The plan defines quality objectives, roles, applicable standards, and control measures to ensure deliverables meet requirements.”
How do I construct a detailed resource breakdown structure (RBS)? (Resource Management)	“An RBS categorizes resources by type and function, enabling clear assignment and allocation in project planning.”
What strategies ensure effective communication with external stakeholders? (Communication Management)	“Use tailored messaging, structured reporting formats, and stakeholder-specific updates to foster transparency and trust.”
What are best practices for conducting qualitative risk analysis? (Risk Management)	“Use risk probability and impact assessments to prioritize threats and opportunities in the risk register.”
What steps are involved in preparing a request for proposal (RFP)? (Procurement Management)	“Define scope, deliverables, evaluation criteria, and legal terms clearly to invite competitive and compliant vendor responses.”
How do I identify and prioritize project stakeholders effectively? (Stakeholder Management)	“Conduct a stakeholder analysis based on interest, influence, and impact to guide engagement strategies.”

C. Generation Quality

To assess the generation quality of the system, we conducted a manual evaluation of its responses to refined queries across the ten PMBOK knowledge areas. Three key criteria were used: clarity (Cla), relevance (Rel), and alignment with PMBOK principles (PMBOK Align). Annotators rated each response on a 1–5 Likert scale. This evaluation aimed to determine whether the system-generated outputs were not only accurate and understandable, but also consistent with project

management standards and practical expectations. The following table summarizes the average ratings for each knowledge area. Table IV presents the generation quality scores for each of the ten PMBOK Knowledge Areas. These scores, rated on a 5-point Likert scale by domain experts, reflect the system’s ability to produce responses that are not only understandable but also contextually appropriate and standards-compliant.

TABLE IV
GENERATION QUALITY BY PMBOK KNOWLEDGE AREA

Knowledge Area	Cla	Rel	Align
Integration Management	4.8	5.0	4.9
Scope Management	4.7	5.0	5.0
Schedule Management	4.5	4.0	4.3
Cost Management	4.9	5.0	5.0
Quality Management	4.6	5.0	4.8
Resource Management	4.4	4.0	4.2
Communication Management	4.3	4.2	4.5
Risk Management	4.7	5.0	4.9
Procurement Management	4.2	4.0	4.4
Stakeholder Management	4.8	5.0	4.9
Average	4.59	4.62	4.69

D. Task-Based Scenario Evaluation

To evaluate the practical utility of the system in realistic project settings, we designed task-based scenarios aligned with typical PMBOK-driven project management workflows. These mock project tasks required users to apply retrieved or generated information to specific challenges, such as creating planning documents or resolving project risks. Each scenario was evaluated based on three core criteria: actionability (usefulness for decision-making), correctness (factual and procedural accuracy), and completeness (coverage of necessary elements). The goal was to assess how well the system supports real-world project execution. Table V presents the results of a scenario-based evaluation designed to assess the practical utility of the RAG system in real-world project management situations.

E. User Feedback

To complement the system evaluation with end-user perspectives, we designed a survey instrument for future evaluation with project management professionals and instructors. Participants interacted with the system across different PMBOK knowledge areas and provided feedback on usability, clarity, and perceived value. Their responses offered insights into the system’s strengths and areas for improvement, particularly regarding alignment with instructional needs and practical relevance in professional contexts. Table VI outlines the structure of the user feedback survey administered to project management professionals who interacted with the RAG system during evaluation. Participants were asked to rate their level of agreement with five statements using a 5-point Likert scale, where 1 indicated strong disagreement and 5 indicated strong agreement.

Figure 2 illustrates the average generation quality scores across five selected PMBOK Knowledge Areas—Scope, Cost,

TABLE V
SCENARIO-BASED EVALUATION OF PMBOK-RAG OUTPUTS

Scenario Description	Act(5)	Corr(5)	Comp(5)
The client has requested major scope changes. Draft a scope rebaselining plan.	4	4	3
The project team is underperforming. Recommend a resource allocation adjustment.	5	4	4
Unexpected vendor delays impact the critical path. Generate a mitigation strategy.	4	5	4
Stakeholder engagement has declined. Propose a revised communication plan.	4	4	3
The project is entering the closing phase. Summarize key closure activities.	5	5	4
Several risks have been identified during execution. Prioritize and propose responses.	4	4	4
The budget is exceeding baseline forecasts. Recommend corrective cost control measures.	4	5	3
A multi-vendor procurement strategy is required. Define contract types and evaluation criteria.	4	4	4
The integration plan lacks alignment across teams. Develop a coordination strategy.	5	4	4
Quality audits revealed frequent defects in deliverables. Suggest QA process improvements.	4	5	4

TABLE VI
USER FEEDBACK SURVEY INSTRUMENT (LIKERT SCALE 1–5)

Statement	Rating (1–5)
The generated answer was useful for addressing the query.	
I would trust this answer for use in a real-world project task.	
The response was clear, well-structured, and professional.	
The content aligned with my knowledge of project management.	
The answer reflected the terminology and practices of the PMBOK.	

Risk, Stakeholder, and Quality—evaluated along three dimensions: relevance, clarity, and alignment with PMBOK terminology.

V. DISCUSSION

The results highlight the potential of retrieval-augmented architectures to enhance the reliability of LLM in professional decision-support contexts. By grounding responses in curated project management knowledge sources aligned with PMBOK principles, the system reduces the likelihood of unsupported or hallucinated recommendations. This grounding mechanism

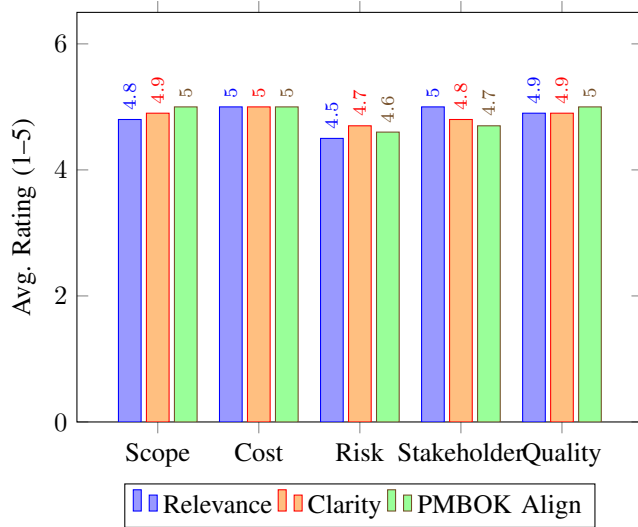


Fig. 2. Average generation quality scores across PMBOK knowledge areas.

is particularly important in project management environments, where adherence to established standards and traceable knowledge sources is essential for informed decision making.

A. Research Question Analysis

The experimental evaluation provides evidence that the proposed retrieval-augmented generation architecture can effectively support project management knowledge retrieval and assistance. Regarding RQ1, the system demonstrated consistent ability to retrieve contextually relevant PMBOK-aligned information for a range of project management queries, indicating that the integration of vector retrieval and generative reasoning can reliably ground responses in structured project management knowledge. In relation to RQ2, expert assessments showed that generated responses were generally perceived as clear, relevant, and aligned with PMBOK principles, suggesting that retrieval grounding improves the practical usefulness of generated guidance. Finally, addressing RQ3, the system exhibited stronger performance in knowledge areas characterized by well-structured procedural guidance, particularly stakeholder and cost management tasks, highlighting the potential of retrieval-augmented systems to support decision-making processes in domains where formalized knowledge frameworks are available.

B. Interpretation of Results

The results of our evaluation demonstrate that RAG models can effectively contextualize and operationalize PMBOK knowledge across the ten knowledge areas. The retrieved content exhibited high relevance and alignment with PM standards, while generated outputs scored consistently high in clarity, domain fit, and instructional utility. These findings indicate the model’s capability to bridge formal PM knowledge with practical guidance, supporting both novice and experienced users in diverse project contexts. Performance variations across PMBOK knowledge areas appear to be influenced by

the degree of structural formalization present in the underlying knowledge. Areas such as cost and stakeholder management, which rely on well-defined procedures and standardized terminology, exhibit higher alignment and clarity scores. In contrast, domains requiring multi-step reasoning or contextual synthesis, such as schedule and procurement management, show slightly reduced completeness. This suggests that while retrieval grounding effectively supports structured knowledge tasks, additional mechanisms—such as iterative prompting or planning-aware generation—may be required for complex scenario resolution.

C. Benefits and Applications

The RAG-based system offers versatile applications across project lifecycle stages. During project onboarding, it can assist teams in understanding and applying key processes, such as scope definition or stakeholder analysis. In decision support scenarios, the model facilitates rapid access to structured knowledge for tasks like risk prioritization or procurement strategy selection. It also holds value in educational settings, aiding exam preparation and training for PMP certification. Additionally, it can streamline document drafting by generating templates aligned with PMBOK processes and standards.

D. Limitations

Despite its utility, the system faces several limitations. First, licensing restrictions related to the PMBOK Guide may constrain direct content usage or limit full integration in commercial tools. Second, the current model may struggle with deep context-awareness, particularly in long or multi-layered scenarios. Third, it lacks fine-grained adaptation to subdomains within project management, such as specific industries (construction, IT, healthcare), potentially reducing the accuracy of domain-specific terminology or compliance-related outputs. The current evaluation does not include a direct comparison with baseline systems such as semantic retrieval-only models or general-purpose conversational LLMs, which will be addressed in future work.

E. Future Work

Future work will focus on four strategic directions to expand the system’s capabilities and applicability. First, platform integration will embed the RAG system within widely used project management tools such as Jira, Trello, and MS Project, enabling contextual assistance directly within user workflows. Second, domain-specific adaptation will involve fine-tuning the model with annotated corpora from targeted industries or methodologies to improve accuracy and terminology alignment. Third, methodological expansion will extend the system to support Agile, Scrum, and hybrid frameworks, thereby covering a broader range of contemporary project management practices. Finally, evaluation with practitioners will be conducted through longitudinal studies involving certified project managers to assess long-term adoption, trust, and measurable performance improvements.

VI. CONCLUSION

This study presents an exploratory implementation of Retrieval-Augmented Generation (RAG) to enhance project management support through PMBOK-aligned guidance. By combining knowledge retrieval with language generation, the system indicates potential contextualized, dynamic, and user-adaptive assistance for tasks such as scope planning, risk analysis, and stakeholder communication. The evaluation suggests strong relevance, clarity, and standards alignment across the ten PMBOK knowledge areas. The proposed approach contributes to the growing field of AI-assisted project tools and has potential applications in education, certification, and real-time project execution. Future developments aimed at platform integration and domain-specific fine-tuning may further increase its impact and usability in professional practice.

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