

Research Project Proposal

Level 4

Leveraging AI for Efficient Knowledge Management in National Research and Education Networks (NRENs)

Group 21

E/19/004	Ravindu Abeysinghe
E/19/096	Chamanga Ekanayake
E/19/100	Sahira Gihan

Department of Computer Engineering
Faculty of Engineering
University of Peradeniya
2025

Research Project Proposal

Level 4

Leveraging AI for Efficient Knowledge Management in National Research and Education Networks (NRENs)

Group 21

E/19/004	Ravindu Abeysinghe
E/19/096	Chamanga Ekanayake
E/19/100	Sahira Gihan

Supervised by:

Dr. Asitha Bandaranayake

Prof. Roshan Ragel

Department of Computer Engineering

Faculty of Engineering

University of Peradeniya

2025

Abstract

National Research and Education Networks (NRENs) are critical infrastructures that support academic and research institutions by providing high-speed internet connectivity, collaborative platforms, and specialized services. However, NRENs face significant challenges in managing and disseminating knowledge effectively due to the rapid evolution of technology, geographically dispersed teams, and diverse stakeholder needs. This research proposal explores the potential of artificial intelligence (AI)-powered knowledge management systems to enhance operational efficiency in NRENs. The study aims to investigate how AI technologies, such as machine learning, natural language processing (NLP), and generative AI, can address the unique knowledge management challenges faced by NRENs. By synthesizing current research and identifying gaps in the literature, this proposal outlines a research plan to develop and evaluate AI-driven solutions tailored for NREN environments. The expected outcomes include improved knowledge accessibility, enhanced collaboration, and proactive knowledge management, ultimately contributing to the operational efficiency and effectiveness of NRENs. This research will also provide valuable insights into the challenges and best practices of implementing AI-driven KM solutions in NREN environments, paving the way for future innovations in this domain.

Contents

1. Introduction.....	1
1.1 Background.....	1
1.2 Problem Context.....	1
1.3 Research Rationale.....	2
1.4 Research Significance.....	2
2. Problem Statement.....	2
3. Aim and Objectives.....	3
3.1 Aim.....	3
3.2 Objectives.....	4
4. Literature Review.....	4
4.1 Current State of Knowledge Management in NREs.....	4
4.2 AI Applications in Knowledge Management.....	5
4.3 Potential Impact of AI-Powered KM Systems.....	5
4.4 Challenges and Considerations.....	5
5. Proposed Approach.....	6
5.1 Research Methodology.....	6
5.2 Flow Diagram.....	7
6. Technologies to be Used.....	8
7. Expected Outcomes.....	9
8. Challenges and Mitigation Strategies.....	10
Timeline.....	11
Conclusion.....	12
References.....	12

1. Introduction

1.1 Background

National Research and Education Networks (NRENs) are specialized internet service providers that cater to the needs of academic and research institutions. They play a pivotal role in advancing education and research by providing high-speed connectivity, collaborative platforms, and access to global research networks. NRENs manage a wide range of knowledge assets, including technical documentation, administrative guidelines, training materials, and research outputs. However, the rapid evolution of technology, geographically dispersed teams, and diverse stakeholder needs pose significant challenges to effective knowledge management in NRENs.

1.2 Problem Context

The effective management and dissemination of knowledge are crucial for maintaining operational efficiency and supporting the broader academic community. However, NRENs face several challenges in this regard, including:

1. **Rapid Technological Changes:** The fast-paced evolution of networking technologies requires constant updating of technical knowledge and documentation.
2. **Geographically Dispersed Teams:** Many NRENs operate across large regions or even entire countries, making knowledge sharing and collaboration more complex.
3. **Diverse Stakeholder Needs:** NRENs must cater to a wide range of users, including technical staff, researchers, and administrators, each with different information requirements.
4. **Limited Resources:** As non-profit organizations, NRENs often operate with constrained budgets and staffing, making comprehensive knowledge management initiatives challenging.

5. Balancing Openness and Security: NRENs must navigate the tension between openly sharing knowledge and protecting sensitive network information.

1.3 Research Rationale

Artificial intelligence (AI) has emerged as a transformative force in knowledge management, offering innovative solutions for automating processes, enhancing information retrieval, and generating insights. While AI applications in knowledge management have been extensively studied in corporate settings, there is a notable gap in research addressing the unique needs of NRENs. This research proposal aims to bridge this gap by exploring how AI-powered knowledge management systems can be leveraged to enhance operational efficiency in NRENs.

1.4 Research Significance

The importance of this research lies in its potential to inform future implementations of AI-driven knowledge management solutions in NRENs, ultimately improving knowledge accessibility, collaboration, and decision-making. By addressing the specific challenges faced by NRENs, this study seeks to contribute to the broader academic and research communities supported by these networks.

2. Problem Statement

NRENs face several challenges in managing their knowledge assets effectively. These challenges include:

1. Rapid Technological Changes: The fast-paced evolution of networking technologies requires constant updating of technical knowledge and documentation. This creates a significant burden on NREN staff, who must ensure that all documentation remains accurate and up-to-date.

2. **Geographically Dispersed Teams:** Many NRENs operate across large regions or even entire countries, making knowledge sharing and collaboration more complex. The lack of centralized knowledge repositories and the reliance on email or shared drives often lead to information silos and inefficiencies.
3. **Diverse Stakeholder Needs:** NRENs must cater to a wide range of users, including technical staff, researchers, and administrators, each with different information requirements. This diversity makes it challenging to create a one-size-fits-all knowledge management solution.
4. **Limited Resources:** As non-profit organizations, NRENs often operate with constrained budgets and staffing, making comprehensive knowledge management initiatives challenging. The lack of dedicated knowledge management teams further exacerbates this issue.
5. **Balancing Openness and Security:** NRENs must navigate the tension between openly sharing knowledge and protecting sensitive network information. This balance is particularly challenging in the context of AI-driven knowledge management systems, which may require access to sensitive data for training and operation.

These challenges highlight the need for innovative approaches to knowledge management in NRENs, particularly solutions that can enhance efficiency and accessibility while addressing resource constraints.

3. Aim and Objectives

3.1 Aim

The aim of this research is to investigate the potential of AI-powered knowledge management systems to enhance operational efficiency in NRENs. Specifically, the research will explore how AI technologies, such as machine learning, natural language processing (NLP), and generative AI, can address the unique knowledge management challenges faced by NRENs.

3.2 Objectives

General Objective: To evaluate the effectiveness of AI-driven knowledge management systems in improving operational efficiency in NRENs.

Specific Objectives:

1. To analyze the current state of knowledge management in NRENs and identify key challenges.
2. To explore AI applications in knowledge management, with a focus on relevance to NREN operations.
3. To develop a prototype AI-powered knowledge management system tailored for NREN environments.
4. To evaluate the impact of the proposed system on knowledge accessibility, collaboration, and decision-making in NRENs.
5. To identify best practices and challenges in implementing AI-driven knowledge management solutions in NRENs.

4. Literature Review

4.1 Current State of Knowledge Management in NRENs

NRENs operate in a unique position within the academic and research landscape, serving as both service providers and collaborative platforms for their member institutions. They manage a diverse range of knowledge assets, including technical documentation, administrative guidelines, training materials, and research outputs. However, NRENs face several challenges in their knowledge management efforts, including rapid technological changes, geographically dispersed teams, and limited resources.

4.2 AI Applications in Knowledge Management

1. AI technologies, such as machine learning, NLP, and generative AI, offer promising solutions for automating knowledge management processes, enhancing information retrieval, and improving collaboration. Key applications include:
2. Machine Learning for Knowledge Discovery: Identifying patterns and trends in large datasets.
3. NLP for Information Retrieval: Enhancing search and retrieval systems through semantic search and automated tagging.
4. Generative AI for Content Creation: Automating the creation of technical documentation and summaries.
5. Collaborative Filtering and Recommendation Systems: Personalizing knowledge delivery and enhancing collaboration.

4.3 Potential Impact of AI-Powered KM Systems

AI-driven systems can improve knowledge accessibility, streamline content creation, and enable proactive knowledge management in NRENs. They can also enhance collaboration and decision-making, leading to significant efficiency gains.

4.4 Challenges and Considerations

Implementing AI-powered KM systems in NRENs requires addressing challenges such as data privacy, integration with existing infrastructure, and resource constraints. Ethical considerations, such as bias mitigation and transparency, must also be taken into account.

5. Proposed Approach

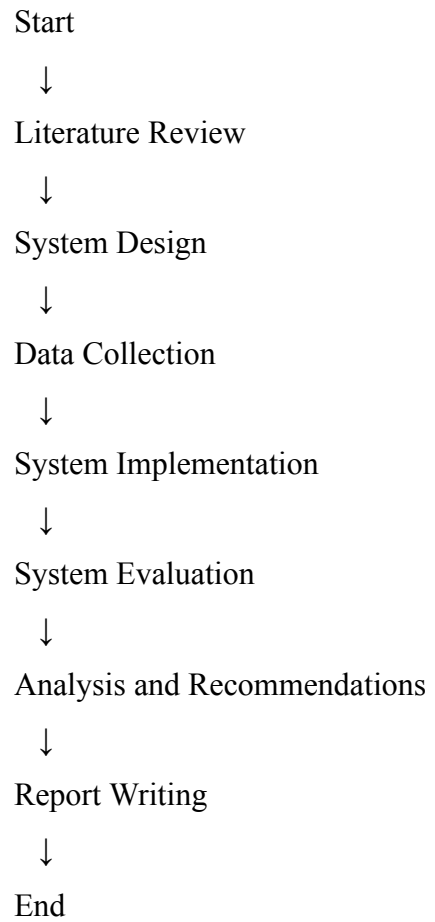
5.1 Research Methodology

The research will adopt a mixed-methods approach, combining qualitative and quantitative research methods. The proposed methodology includes the following steps:

1. Literature Review: A comprehensive review of existing research on AI applications in knowledge management and the specific needs of NRENs.
2. System Design: Development of a prototype AI-powered knowledge management system tailored for NREN environments.
3. Data Collection: Collection of data from NREN stakeholders, including technical staff, researchers, and administrators, to evaluate the effectiveness of the proposed system.
4. System Implementation: Deployment of the prototype system in a controlled NREN environment.
5. System Evaluation: Evaluation of the prototype system through user testing and feedback.
6. Analysis and Recommendations: Analysis of the results and identification of best practices and challenges in implementing AI-driven KM solutions in NRENs.
7. Report Writing: Documentation of findings, conclusions, and recommendations.

5.2 Flow Diagram

Below is a textual representation of the flow diagram for the proposed research methodology:



6. Technologies to be Used

The research will leverage the following technologies to develop and evaluate the AI-powered knowledge management system:

1. Machine Learning (ML):
 - a. Purpose: To analyze large datasets, identify patterns, and predict trends.
 - b. Application: Predictive maintenance, resource optimization, and knowledge gap analysis.
 - c. Tools: Python (Scikit-learn, TensorFlow, PyTorch).
2. Natural Language Processing (NLP):
 - a. Purpose: To process and understand unstructured text data.
 - b. Application: Advanced search and retrieval, automated tagging, and question-answering systems.
 - c. Tools: SpaCy, NLTK, Hugging Face Transformers.
3. Generative AI:
 - a. Purpose: To automate content creation and summarization.
 - b. Application: Drafting technical documentation, summarizing research papers, and multilingual support.
 - c. Tools: GPT-based models (e.g., OpenAI GPT-4), BERT.
4. Collaborative Filtering and Recommendation Systems:
 - a. Purpose: To personalize knowledge delivery and enhance collaboration.
 - b. Application: Recommending relevant resources, identifying potential collaborators, and suggesting training materials.
 - c. Tools: Apache Mahout, Surprise (Python library).
5. Intelligent Process Automation (IPA):
 - a. Purpose: To automate routine knowledge management tasks.

- b. Application: Updating documentation, routing support requests, and monitoring knowledge base usage.
 - c. Tools: UiPath, Automation Anywhere.
- 6. Data Visualization:
 - a. Purpose: To present insights and system performance metrics.
 - b. Application: Visualizing knowledge usage patterns, system effectiveness, and user feedback.
 - c. Tools: Tableau, Power BI, Matplotlib (Python).

7. Expected Outcomes

The research is expected to yield the following outcomes:

- 1. Improved Knowledge Accessibility:
 - a. AI-driven search and retrieval systems will reduce the time and effort required to find relevant information.
 - b. Enhanced self-service capabilities for NREN stakeholders.
- 2. Enhanced Collaboration:
 - a. AI-powered recommendation systems will foster better knowledge sharing and collaboration among geographically dispersed teams.
 - b. Personalized knowledge delivery will improve user engagement and efficiency.
- 3. Proactive Knowledge Management:
 - a. Machine learning and predictive analytics will enable NRENs to identify emerging issues and optimize resource allocation.
 - b. Continuous improvement of knowledge assets based on usage patterns and feedback.

4. Operational Efficiency and Cost Savings:
 - a. Automation of routine tasks will free up staff to focus on strategic activities.
 - b. Reduced support costs and more efficient use of resources.
5. Best Practices and Guidelines:
 - a. The research will provide a set of best practices for implementing AI-driven knowledge management systems in NRENs.
 - b. Recommendations for addressing challenges such as data privacy, integration, and resource constraints.

8. Challenges and Mitigation Strategies

The research will address the following challenges and propose mitigation strategies:

1. Data Privacy and Security:
 - a. Challenge: NRENs handle sensitive information related to network infrastructure and research data.
 - b. Mitigation: Implement robust data encryption, access controls, and compliance with data protection regulations (e.g., GDPR).
2. Integration with Existing Infrastructure:
 - a. Challenge: NRENs often have complex, legacy IT systems.
 - b. Mitigation: Use modular AI solutions that can be integrated incrementally and ensure compatibility with existing systems.
3. Resource Constraints:
 - a. Challenge: NRENs operate with limited budgets and expertise.
 - b. Mitigation: Leverage open-source AI tools and provide training programs to upskill staff.

4. Change Management and User Adoption:
 - a. Challenge: Resistance to change among staff.
 - b. Mitigation: Provide comprehensive training and support to facilitate smooth adoption of AI-powered systems.

5. Ethical Considerations and Bias Mitigation:
 - a. Challenge: AI systems may perpetuate biases present in training data.
 - b. Mitigation: Implement bias detection and mitigation techniques, and ensure transparency in AI decision-making.

Timeline

Phase	Duration	Activities
Literature Review	1 month	Review existing research on AI and KM in NRENs.
System Design	1.5 month	Develop a prototype AI-powered KM system.
Data Collection	1.5 month	Collect data from NREN stakeholders.
System Implementation	1 month	Deploy the prototype system in a controlled environment.
System Evaluation	1 month	Conduct user testing and gather feedback.
Analysis and Recommendations	0.5 month	Analyze results and identify best practices.
Report Writing	0.5 month	Document findings, conclusions, and recommendations.

Conclusion

This research proposal outlines a comprehensive plan to investigate the potential of AI-powered knowledge management systems to enhance operational efficiency in NRENs. By leveraging AI technologies such as machine learning, NLP, and generative AI, the study aims to address the unique knowledge management challenges faced by NRENs. The expected outcomes include improved knowledge accessibility, enhanced collaboration, and proactive knowledge management, ultimately contributing to the operational efficiency and effectiveness of NRENs.

The research will also provide valuable insights into the challenges and best practices of implementing AI-driven KM solutions in NREN environments, paving the way for future innovations in this domain.

References

- [1] D. Kudryavtsev, U. Khan, and J. Kauttonen, “Transforming knowledge management using generative ai: From theory to practice,” in Proceedings of the 16th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management - Volume 3: KMIS, pp. 362–370, INSTICC, SciTePress, 2024.
- [2] E. Chen, “Empowering artificial intelligence for knowledge management augmentation.,” Issues in Information Systems, vol. 25, no. 4, 2024.
- [3] GEANT, “National research and education networks (nrens).” ‘<https://about.geant.org/nrens/>, 2024. Accessed: February 11, 2024.
- [4] A. N. R. G. (2024), “Knowledge asset management in academic networks,” 2024. Accessed: 2025-02-11.
- [5] LEARN, “Seacren unites nrens.” <https://arteculate.asia/seacren-unitesnrens/>, 2024. Accessed: 2025-02-11.
- [6] H. Taherdoost and M. Madanchian, “Artificial intelligence and knowledge management: Impacts, benefits, and implementation,” Computers, vol. 12, no. 4, p. 72, 2023.

- [7] I. of Supply Chain Management, “Combating knowledge management challenges with ai.” <https://www.ioscm.com/blog/combating-knowledgemanagement-challenges-with-ai/>, 2024. Accessed: 2025-02-11.
- [8] M. of Technology, “Ai white paper march 2024.” [https://mot.gov.lk/assets/files/AI Government of Sri Lanka](https://mot.gov.lk/assets/files/AI%20Government%20of%20Sri%20Lanka), Accessed: 2025-02-11.
- [9] S. Thakuri, M. Bon, N. Cavus, and N. Sancar, “Artificial intelligence on knowledge management systems for businesses: A systematic literature review,” TEM Journal, vol. 13, no. 3, 2024.
- [10] S. Durst, I. R. Edvardsson, and S. Foli, “Knowledge management in smes: a follow-up literature review,” Journal of Knowledge Management, vol. 27, no. 11, pp. 25–58, 2023.
- [11] E. T. Institute, “The use of artificial intelligence in higher education.” <https://www.bookbaker.com/en/v/The-Use-of-ArtificialIntelligence-in-Higher-Education-Challenges-of-Implementing-AI-inEducation/8afdedb6-a78b-4c2e-8783-f01bc749e803>, 2024. Book Baker Publishing, Accessed: 2025-02-11.
- [12] I. Valchanov, “Ai for knowledge management.” <https://teamgpt.com/blog/ai-for-knowledge-management/>, 2024. Team GPT Blog, Accessed: 2025-02-11.
- [13] T. Insights, “Ai knowledge management in 2024.” <https://www.rapidinnovation.io/post/ai-knowledge-management-in-2024>, 2024. Rapid Innovation Blog, Accessed: 2025-02-11.
- [14] H. Singh, Y. Shi, and C. V. Toorn, “Generative ai-powered knowledge management in education: A dual perspective of design and use,” 2024.
- [15] A. Foundation, “Ap-gained project report.” <https://apnic.foundation/projects/ap-gained/>, 2024. Accessed: 2025-02-11.
- [16] S. F. Mohamed and S. B. Zaibon, “Artificial intelligence support for knowledge management in construction,” 2004.
- [17] OpenLearning, “Ai in education: Current trends and future prospects.” <https://blog.openlearning.com/ai-in-education>, 2024. Accessed: 2025-02-11.

- [18] J. Smith, “5 interesting ways ai can transform knowledge management processes.” <https://www.talkspirit.com/blog/5-interesting-waysai-can-transform-knowledge-management-processes>, 2024. Accessed: 2025-02-11.
- [19] F. Ferrari, J. van Dijck, and A. van den Bosch, “Observe, inspect, modify: Three conditions for generative ai governance,” *New Media & Society*, 2024. Accessed: 2025-02-11.
- [20] A. Twinomugisha, “Understanding nrens and key considerations for setting them up,” *Case for NRENs*, 2024. Accessed: 2025-02-11.
- [21] S. Perera, “Seizing the transformative opportunities of generative ai in sri lankan education,” *Ceylon Today*, 2024. Accessed: 2025-02-11.
- [22] O. Brown, R. M. Davison, S. Decker, D. A. Ellis, J. Faulconbridge, J. Gore, M. Greenwood, G. Islam, C. Lubinski, N. MacKenzie, et al., “Theory-driven perspectives on generative artificial intelligence in business and management,” *British Journal of Management*, vol. 35, no. 1, pp. 3–23, 2024.
- [23] A. Chen, D. Dohan, and D. So, “Evoprompting: Language models for code-level neural architecture search,” *Advances in neural information processing systems*, vol. 36, pp. 7787–7817, 2023.
- [24] J. White, Q. Fu, S. Hays, M. Sandborn, C. Olea, H. Gilbert, A. Elnashar, J. Spencer-Smith, and D. C. Schmidt, “A prompt pattern catalog to enhance prompt engineering with chatgpt,” *arXiv preprint arXiv:2302.11382*, 2023.
- [25] D. Kaczorowska-Spychalska, N. Kotula, G. Mazurek, and Ł. Sułkowski, “Generative ai as source of change of knowledge management paradigm,” *Human Technology*, vol. 20, no. 1, pp. 131–154, 2024.
- [26] Denser.ai, “Knowledge management ai: What it is and how to use it,” *Denser.ai Blog*, 2025. Accessed: 2025-02-11.
- [27] M. M. Crossan, “The knowledge-creating company: how japanese companies create the dynamics of innovation,” 1996.
- [28] Vass Company, “Ai in education: Implementation challenges and solutions,” *Vass Insights Blog*, 2024. Accessed: 2025-02-11.

[29] H. I. Shabbir and M. Moosa, “What are the challenges and opportunities of adopting ai in emerging market firms?,” 2024.

[30] S. Tambuskar, “Challenges and benefits of 7 ways artificial intelligence in education sector,” Review of Artificial Intelligence in Education, vol. 3, no. 00, pp. e03–e03, 2022.

[31] A. M. Al-Zahrani, “Unveiling the shadows: Beyond the hype of ai in education,” Heliyon, vol. 10, no. 9, 2024.



Prof R G Ragel