Proceedings of the 11th World Congress on Electrical Engineering and Computer Systems and Sciences (EECSS'25)
Paris, France - August, 2025
Paper No. CIST 115
DOI: 10.11159/cist25.115

Harnessing AI to Overcome Enterprise Architecture Challenges and Drive Innovation

Amar Deep Singh[1], Neelabh Tripathi[2]
Dallas, TX, USA
[1]amardeep.singh@gmfinancial.com; [2]itsneelabh@gmail.com

Abstract **-** This paper delves deeper into some of the challenges faced by enterprise architecture (EA) in modern organizations and highlights how artificial intelligence (AI) can provide transformative solutions to those. By leveraging AI, organizations can enhance governance, optimize costs, foster innovation, and improve overall efficiency. The paper emphasizes the critical role of EA in addressing organizational complexities, such as breaking down team silos, streamlining redundant business capabilities, and maintaining alignment across business units. AI-driven tools and strategies are presented as key enablers to simplify these complexities while ensuring robust security and operational excellence.

Key challenges discussed include maintaining end-of-life software, managing competing tools and technologies, establishing software ownership, and fostering innovation while mitigating associated risks. The paper highlights how AI-driven solutions, such as Retrieval-Augmented Generation (RAG) workflows and knowledge graphs, can enhance API governance, streamline software ownership management, and provide detailed software dependency mapping. These tools reduce manual intervention, improve decision-making, and enable faster, more reliable processes.

Keywords: Enterprise Architecture, EA, AI, GenAI, Governance, Reusability, Innovation, Architecture Governance

1. Introduction

While application architecture focuses on interactions and functionality within application boundaries, illustrating how different components of an application interact and function, enterprise architects focus on the broader interactions across the organization. This includes how different domains, such as business, IT, and security, interact and work together. Enterprise architecture addresses problems at the organizational level.

Enterprise Architecture enables you to achieve the right balance between business transformation and continuous operational efficiency. It allows individual business units to innovate safely in their pursuit of evolving business goals and competitive advantage. At the same time, the Enterprise Architecture enables the needs of the organization to be met with an integrated strategy which permits the closest possible synergies across the enterprise and beyond [1].

At the application level, teams have significantly more control over how an application should function, its delivery timeline, the technology it should use, the value it should deliver, and the results it should drive. This is largely due to the limited number of stakeholders involved.

In contrast, enterprise architecture operates at an entirely different scale, addressing far greater challenges due to the immense complexity of managing competing priorities across multiple departments, coordinating efforts among diverse and often conflicting teams, meeting the varying expectations of leadership and business units, and ensuring robust security across the organization.

The scope and magnitude of these challenges are further amplified by enterprise architecture's role in shaping the strategic direction of the business. This involves partnering with technology leaders and business stakeholders to make decisions that often result in long-term vendor partnerships and high-value commitments. Once these decisions are made, the organization must adhere to them for a significant period before considering any change in direction.

2. Enterprise Architecture challenges

Managing an effective enterprise function is far from straightforward. As an enterprise architect, you must navigate numerous challenges, often arising from limited knowledge of internal processes and systems, pressures to optimize costs, the growing demand for resource efficiency, time-to-market constraints, a lack of innovation, and cultural barriers within the organization. Overcoming these obstacles and establishing a robust knowledge base is essential for success. Some of these challenges are outlined below:

2.1 Maintaining End-of-Life Software

Running end-of-life (EOL) software in any organization poses significant risks to business continuity. Without ongoing support, there is always the uncertainty of when a component might fail, leading to critical disruptions.
Based on our industry experience, organizations often face significant risks when using outdated systems. For example, during the tenure at an institution, where one of the paper's authors worked/consulted, a hardware security module that was used to encrypt user's credentials was found to be out of support for over six months. This situation necessitated a rushed upgrade to mitigate the risk of losing sensitive customer data. Running EOL software exposes businesses to several risks, including:

- **Performance Degradation**: Reduced efficiency and reliability over time.
- **Security Risks and Increased Vulnerabilities**: Lack of updates makes systems more prone to cyberattacks.
- **Outdated Maintenance and Support Manuals**: Limited or obsolete resources to address issues.
- **Lack of Knowledge in the Support Team**: As the software ages, expertise among the support team often diminishes.

2.2 Redundant Business Capabilities

At the enterprise level, breaking team silos is one of the biggest challenges for enterprise architecture [2]. Application teams typically have dedicated goals closely aligned with their respective business units, focusing primarily on delivering those goals. This often results in the creation of duplicate capabilities across business units.

For instance, in a financial institution, multiple teams may independently create processes for retrieving customer information for home loans, auto loans, credit cards, etc. Such redundancy leads to inefficiencies and increased costs. Enterprise architecture must play a pivotal role in preventing silos and ensuring that common functionalities are built at the enterprise level and create a culture for reusing these capabilities [3]. Key challenges include:

- Each team maintains duplicate business capabilities.
- Effort duplication as each team writes services for the same capability.
- Increased costs to maintain these redundant services.

2.3 Competing Tools & Technologies

Different business units often have their own timelines and delivery pressures. To meet their goals, they frequently use different methodologies, tools, and technologies that best address their immediate needs. While this approach enables faster delivery, it often leads to a lack of standardization across the organization, resulting in higher costs and increased risks.

Enterprise architecture must strike a balance between empowering business units to deliver at their desired pace and controlling costs and risks at the organizational level. It is essential to enforce the use of strategic tools across the enterprise, rather than allowing each business unit to purchase similar, disparate tools. Key challenges include:

- **Increased Total Cost of Ownership (TCO):** The organization incurs higher costs to manage multiple tools and technologies.
- **Managing Vendor Relationships:** Different tools and technologies necessitate maintaining relationships with multiple vendors.
- **Increased Organizational Blast Radius:** As the complexity of managing diverse tools and systems increases, the organization's risk exposure grows. This is due to the need to manage, upgrade, and maintain a larger number of tools, which can lead to greater vulnerability and difficulty in ensuring consistent performance and security across the organization.
- **Skill Parity Among Resources:** If business units use different tools and technologies, it becomes challenging to move personnel across teams, limiting flexibility and efficiency.

2.4. Software Ownership Management

In large enterprises, managing software ownership and keeping documentation up to date is crucial for smooth operations and risk management. However, there is often confusion about who owns what, and ownership is not always clearly defined. Additionally, software manuals, if they exist, are often outdated, incomplete, or both. Consequences of Missing Ownership Documentation:

- **Accountability Issues**: Difficulty in identifying the responsible teams or individuals for software maintenance and issue resolution.
- **Security Risks**: Increased vulnerabilities due to unclear ownership causing delays in critical security patches being applied, if at all.
- **Operational Inefficiencies and Poor Incident Response**: Delays in addressing incidents due to confusion over ownership.
- **Challenges with Upgrades and Features Addition**: Lack of clear ownership complicates coordination and implementation of changes which can be either new features related, performing migration to another platform, or a simple library upgrade.

Enterprise architecture plays a crucial role in defining clear ownership and creating standardized documentation templates and guidelines to ensure that relevant information is always available.

2.5 Cost Optimization & Efficiency

One of the significant challenges for Enterprise architecture is to keep a winning culture for organization but balance the cost and efficiency of tools. The key challenge in this area includes:

- **Monitoring Waste and Identifying Cost Savings**: EA must proactively identify inefficiencies and streamline processes, eliminate redundancies, and optimize resource allocation.
- **Strategic Solutions and Modernization**: Upgrading legacy systems, implementing automation, and integrating new technologies to improve cost efficiency and scalability, while driving long-term savings and resilience.
- **Resource Optimization**: Reducing duplication, automating resource scaling, and ensuring effective utilization of tools to allow teams to focus on high-value activities.

Overall, enterprise architecture must continuously assess and evolve the organization’s technological landscape to drive cost efficiency, such as through cloud migration, which enables the organization to optimize costs while improving business resilience.

2.6 Innovation in Industry

One of the significant challenges for enterprise architecture is staying up to date with evolving technologies and tools [4]. This involves adopting strategic solutions to support current business operations while simultaneously keeping pace with industry innovation, tracking how business models transform over time, and preparing organizations for these changes.

For instance, leveraging artificial intelligence (AI) to optimize business processes is a hot topic in today's environment. However, while AI offers significant potential for innovation, it also introduces risks that need to be carefully managed [5]. Striking the right balance between fostering innovation and mitigating associated risks is a critical responsibility of enterprise architecture.

Key Challenges in This Area:

- **Identifying Strategic Tools and Technologies**: Ensure tools and processes are in place for seamless business operability.
- **Creating an Environment for Continued Innovation**: Foster a culture that encourages experimentation and growth.
- **Establishing Policies for Safe Experimentation**: Develop frameworks to enable risk-free trials of new technologies and ideas.
- **Exploring Industry Trends**: Stay informed about market shifts and keep stakeholders updated on the direction of the industry.

By addressing these challenges, enterprise architecture can enable organizations to remain competitive, innovate responsibly, and adapt to future trends effectively.

3. Harnessing Artificial Intelligence in Enterprise Architecture

Most of the enterprise challenges have already been identified, and the industry has made significant progress in addressing them. Our focus here is not to repeat these solutions, but rather to explore how advancements in Artificial Intelligence can simplify and streamline the process of overcoming some of these challenges.

3.1. Addressing Redundant Business Capabilities Challenge

Redundant capabilities often arise due to team silos [2], where different teams build similar functionalities to serve their specific needs instead of leveraging enterprise-level capabilities. To address this, enterprise architecture (EA) typically establishes domains and assigns domain ownership to align these core functionalities within their respective domains, guiding teams to use shared services (called Service Oriented Architecture – SOA) [6].

To ensure this process is effective, EA must implement a robust governance framework. This framework ensures that all teams adhere to a common governance process, promoting the reuse of core capabilities rather than duplicating efforts. While this approach is widely adopted across large organizations, it often creates bottlenecks, as teams must wait for EA's approval before proceeding with their projects.

With the evolution of artificial intelligence (AI), governance can be scaled to overcome such bottlenecks. AI can help enforce the standards developed by enterprise architecture, ensuring compliance and verifying that teams are utilizing core services and capabilities wherever applicable. This reduces manual intervention, streamlines processes, and enhances efficiency across the organization.

In the following diagram, you can see a reference implementation where a financial organization has implemented API governance using the Retrieval-Augmented Generation (RAG) technique with AI. In this setup, the organization's existing API catalog and owner information are fed into a knowledge database, stored in a vector database. The solution leverages publicly available API best practices and OpenAPI standards, combines them with a custom-developed knowledge base of API standards, and provides actionable insights to development teams on how closely their APIs align with the organization's standards.

An additional key feature of this solution is its emphasis on reusability. By querying the knowledge base, it identifies existing APIs within the organization that already provide similar functionality, preventing teams from creating redundant APIs for similar purposes.

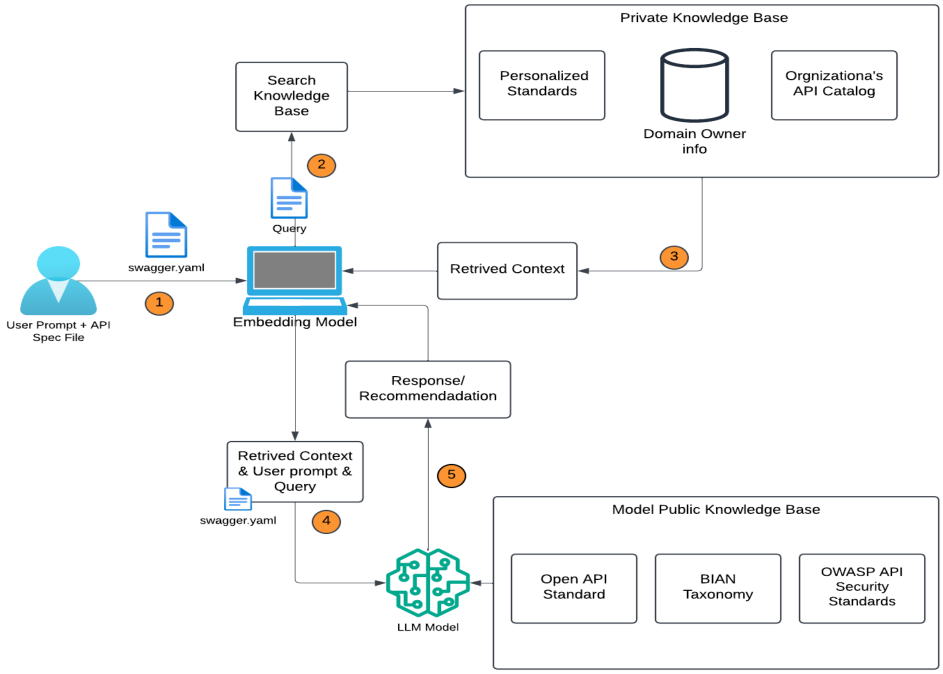

Fig. 1: Usage of Retrieval-Augmented Generation (RAG) for API Governance

The solution also helps guide teams in identifying the appropriate domain for an API based on the type of information being exchanged in the Swagger file. Furthermore, it suggests potential domain owners by referencing information available in the knowledge base (discussed in 3.2).

With this implementation, teams have been able to reduce the API review process from two days to just a few minutes. The insights provided by the application are more reliable, consistent, and easier to consume compared to traditional feedback from architects.

3.2. Addressing software ownership management challenge

Architects, operations, and security teams often struggle to identify the owner of in-house developed applications due to outdated or missing documentation [7][8]. They typically rely on old notes or contact developers, but if these methods fail, they search code repositories for matching application names. If a match is found, they verify it by checking application logs and comparing them with repository files. When no direct match is available, teams perform global searches on log patterns, narrowing down candidates. Finally, they review commit histories and organizational directories to identify the correct application owner. For large enterprises, this process becomes highly inefficient when there are numerous microservices [9] and legacy applications running for several years.

A GenAI solution leveraging LLM technology can significantly streamline the process of identifying application ownership (refer Fig. 2). By utilizing an open-source LLM model like **Llama 2** and frameworks such as **LangChain**, it's possible to build a robust Retrieval-Augmented Generation (RAG) workflow [10]. This solution ingests and processes data from various sources, including labelled log files, source code repositories (e.g., GitHub), and organizational directories (e.g., Active Directory, Okta, or internal employee databases). Through data preprocessing, vectorization, and retrieval mechanisms, the system enables quick and accurate identification of application ownership.

3.3. Addressing software dependency documentation challenge

A similar RAG-based solution developed for identifying software ownership can be extended with a knowledge graph to provide a clear and intuitive dependency map of the enterprise system [11]. The knowledge graph allows for structured representation of relationships between services, configurations, and dependencies, enabling more precise and context-aware insights.

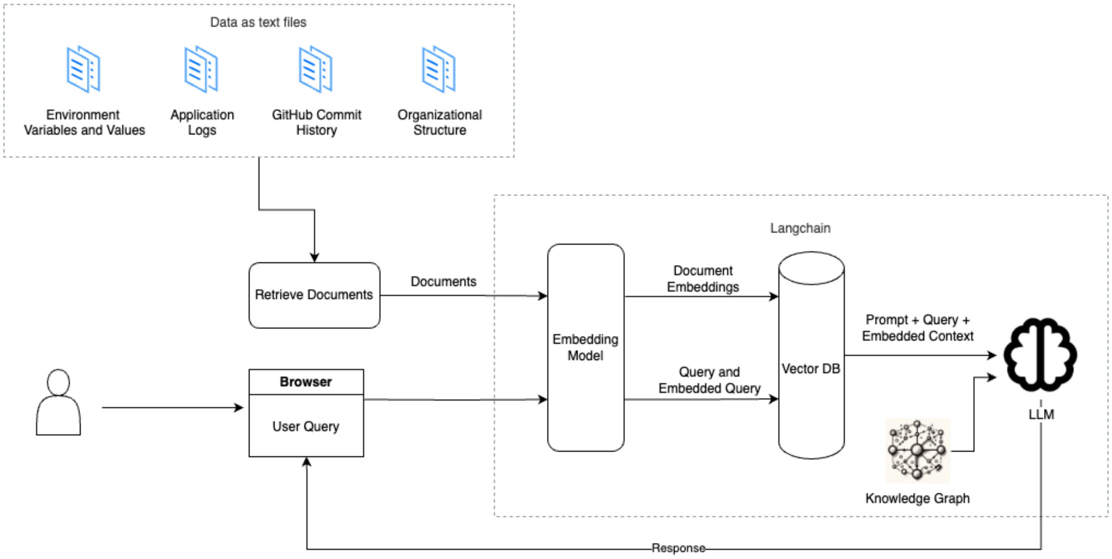

Fig. 2: Usage of AI to Draw Software Ownership and Dependency Map

This solution enhances the ability of an LLM-based system to answer complex queries, such as those related to change impact analysis and software configurations. By integrating the latest data and leveraging constant feedback from humans in the loop through reinforcement learning, the system ensures higher accuracy and relevance of responses. As a result, architects gain full visibility into the intricate web of enterprise dependencies, while operations and development teams receive actionable insights to plan deployments, troubleshoot issues, and manage configurations effectively. This not only reduces risk but also supports smoother workflows across the organization.

4. Conclusion

Enterprise architecture plays a critical role in ensuring that organizations remain agile, efficient, and prepared to navigate the complexities of modern business environments. From managing end-of-life software and breaking down silos to addressing redundant capabilities, competing technologies, and software ownership challenges, enterprise architects face significant hurdles that demand robust governance, innovation, and strategic foresight.

The emergence of artificial intelligence provides a transformative opportunity to address these challenges effectively. By leveraging AI-driven solutions, such as Retrieval-Augmented Generation (RAG) workflows and large language models (LLMs), organizations can streamline processes, enhance governance, and drive innovation. These technologies enable enterprise architects to scale their efforts, reduce inefficiencies, and foster an environment where innovation can thrive while ensuring security, compliance, and cost optimization.

This paper highlights just a few areas where AI can enhance the scalability of enterprise architecture. However, the opportunities are vast, and organizations must explore AI's potential beyond creating support agents and generating code.

References

[1] The Open Group, TOGAF Standard - https://pubs.opengroup.org/togaf-standard/

[2] https://www.cio.com/article/3603648/breaking-down-silos-strategies-for-cios-to-foster-cross-functional-collaboration.html

[3] https://www.sciencedirect.com/topics/computer-science/enterprise-architecture; Chapter: Modelling Fundamentals.

[4] https://cioindex.com/cio-training/courses/cios-guide-to-enterprise-architecture/lessons/introduction-enterprise-architecture/topic/ea-benefits-challenges-and-best-practices/#:~:text=One%20of%20the%20key%20challenges,online%20courses%2C%20and%20industry%20conferences.

[5] Nur Azaliah Abu Bakar, Abdul Hafiz Suib, Amanina Othman, Amirul Afiq Amdan, Mohd Ariffin Abu Hassan, and Surya Sumarni Hussein. "Artificial Intelligence in Enterprise Architecture: Innovations, Integration Challenges, and Ethics." International Conference on Innovation & Entrepreneurship in Computing, Engineering & Science Education (InvENT 2024). Atlantis Press, 2024.

[6] https://businessarchitectureassociates.com/wp-content/uploads/2020/10/5deecd9698d1d5cef8c9c313ea7b9316.pdf; Page – 19, 20, 21.

[7] Kleehaus, Martin & Matthes, Florian. (2019). Challenges in Documenting Microservice-Based IT Landscape: A Survey from an Enterprise Architecture Management Perspective. 11-20. 10.1109/EDOC.2019.00012.

[8] Brée, Tim & Karger, Erik. (2022). Challenges in enterprise architecture management: Overview and future research. Journal of Governance and Regulation. 11. 355-367. 10.22495/jgrv11i2siart15.

[9] Singh, Amar Deep, and Jeff Carpenter. Building and Delivering Microservices on AWS Master Software Architecture Patterns to Develop and Deliver Microservices to AWS Cloud. 1st edition, Packt Publishing, Limited, 2023, https://public.ebookcentral.proquest.com/choice/PublicFullRecord.aspx?p=30546802.

[10] https://blogs.nvidia.com/blog/what-is-retrieval-augmented-generation/

[11] https://blog.langchain.dev/enhancing-rag-based-applications-accuracy-by-constructing-and-leveraging-knowledge-graphs/