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Enterprise Application Modernization Using Agentic AI and Generative AI

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Abstract
The modernization of enterprise applications is becoming increasingly vital for companies wishing to enhance agility, scalability, and efficiency in today's rapidly changing digital landscape. The current research focuses on the use of Agentic AI and Generative AI in the modernization of legacy enterprise applications in the form of intelligent automation and autonomous decision-making. Qualitative research design was applied through the use of secondary sources consisting of peer-reviewed journal articles and industry publications. Inductive approach and thematic analysis methods were used to identify significant patterns in relation to AI-based modernization. It was found that Generative AI speeds up code transformation, refactoring, automated testing, documentation, and technical debt reduction. Consequently, it helps to achieve faster and more efficient modernization of software applications. Agentic AI contributes to the modernization of enterprises through orchestration of autonomous workflows, integration of legacy and cloud-native systems, and decision-making. Performance, scalability, predictability, and resource management in the organization will improve due to AI-driven modernization, resulting in increased business agility and reduced operational costs. Some of the other challenges faced while implementing AI technology include those related to governance, security, explainability, data privacy, organizational readiness, and skill gaps among employees. Appropriate governance frameworks, human interaction, cloud computing, and continued skills development are required to ensure the ethical utilization of artificial intelligence technology. Agentic AI and Generative AI technology offer a good starting point for the modernization of enterprise applications by cutting down on technical debts, building resiliency, and promoting digital innovation continuously.

Keywords- Enterprise Application Modernization, Agentic AI, Generative AI, Legacy System Modernization, Autonomous Workflow Orchestration, Code Refactoring, Cloud-Native Applications, Operational Efficiency, AI Governance, Digital Transformation

Introduction

The modernization of enterprise applications has become a key focus for many businesses in the light of their efforts to become agile, scalable, and efficient in the face of quickly evolving digital environments. Often, legacy software can hinder innovation while also being expensive to maintain. Agentic Artificial Intelligence (AI) and Generative AI have revolutionized the process of modernizing software systems through the capabilities of self-thinking, automation, coding, and better user experience. In turn, such technologies allow businesses to speed up the process of modernization, optimization, and development.

Related Work

As stated in Kraus *et al.,* (2022), the enterprise application modernization approach has seen many changes because of the evolution of different technologies such as Artificial Intelligence (AI), cloud computing, and automation. In earlier versions of enterprise application modernization, it was mainly concerned with moving legacy applications into the cloud architecture to increase the scalability of the application and reduce operational costs. Nevertheless, this method had many manual tasks as well as lengthy development processes. Recent studies emphasize the significance of Generative AI in software engineering. Romanchuk *et al.,* (2020) states that Generative AI tools can facilitate code generation, documentation, testing, and system refactoring, allowing companies to expedite their modernization processes at the same time simplifying their development. According to Gartner and McKinsey researches, AI-assisted software development can greatly increase developer productivity and speed up development timeframes. Agentic AI is another

step forward due to the introduction of autonomous agents, which can plan, reason, and execute actions with little or no human involvement at all. Contrary to conventional automation solutions, agentic AI technologies possess the capability to assess application contexts, find opportunities for modernization, manage workflows, and make dynamic decisions. Spring, Faulconbridge & Sarwar (2022) provides that the role of Agentic AI in terms of intelligent migration, optimization, and proactive management was highlighted in the scientific literature. Some of the major technology companies such as Microsoft, IBM, and Google Cloud introduced Generative AI along with autonomous AI technologies into modernization frameworks. The existing studies show that the combination of Generative and Agentic AI can increase application resilience, reduce technical debt, ensure higher efficiency, and foster innovation continuously.

Methods

The research methodology used in this paper involved secondary data analysis that falls under qualitative research design (Harrison *et al*., 2021). Secondary data were used due to the rapid changes that are taking place regarding the topic of enterprise application modernization through Agentic AI and Generative AI, since there is plenty of data available on this topic in the form of academic journal articles, industry reports, corporate reports, and white papers related to technology.

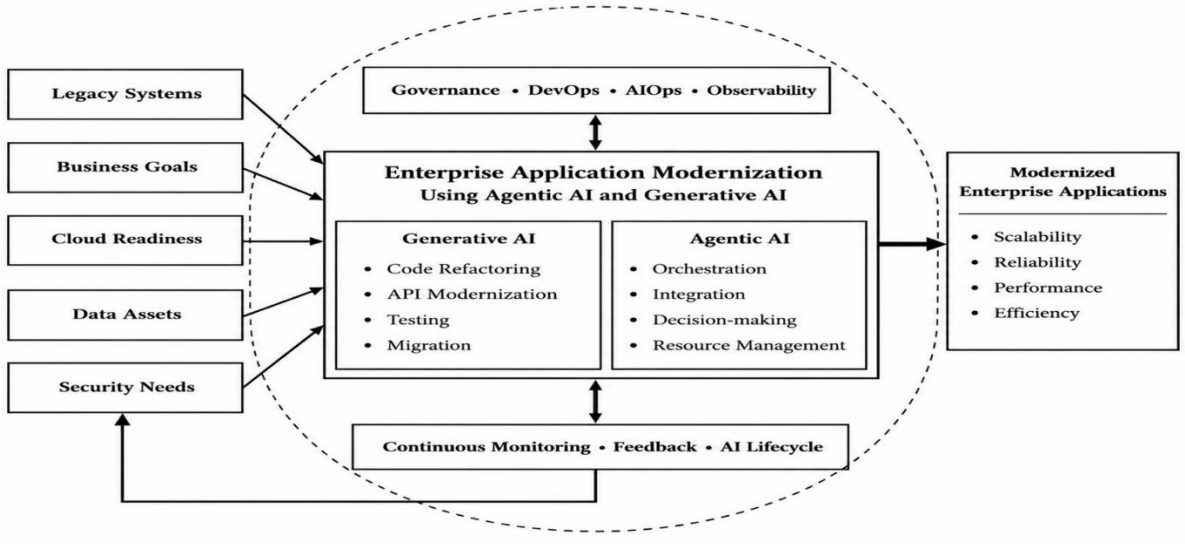

Figure 1: Conceptual Framework for Enterprise Application Modernization Using Agentic AI and Generative AI

(Source: Self-created)

Utilizing secondary sources made it possible for the researcher to have access to varied data in a shorter period of time at low cost, as compared to collecting primary data. The study adopted an inductive approach since it was exploratory in nature and aimed at developing emerging patterns, concepts, and theories from the existing literature. Thematic analysis was done for analyzing data obtained through the research (Kiger & Varpio, 2020). The major themes identified were the ones on automation, software updates, efficiency, governance, and business value. All the issues of ethics were considered throughout the process of the research. The research did not involve plagiarism, manipulation of results, or violation of the intellectual property rights.

Results

AI-Driven Legacy Application Assessment and Modernization Planning

AI-assisted assessment and modernization planning of legacy applications allows companies to discover old systems, decrease technical debt, and build organized modernization plans. As per recent research papers published by HFS Research and IBM, artificial intelligence enables automated code review, workflow analysis, and documentation, decreasing the efforts related to the application assessment process by up to 40%. The use of generative AI technology makes it easier to perform code refactoring, test generation, and application migration to the cloud environment (Kalia *et al.,* 2020). Application modernization planning becomes aligned with the 6R model, such as Retain, Retire, Rehost, Replatform,

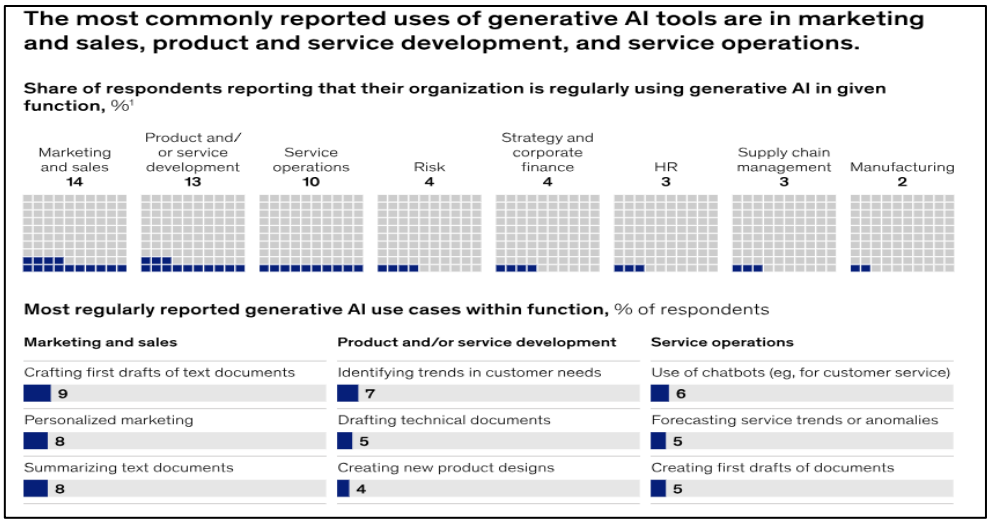

Figure 2: Most Common Enterprise Functions and Use Cases of Generative AI Adoption Across Business Operations

(Source: Mckinsey, 2023)

Refactor, and Replace. Based on application complexity, value to the company, security threats, and application migration readiness, AI makes recommendations regarding the optimal modernization strategy. Industry facts demonstrate the rapid rise in AI usage for modernization planning. Moreover, 71% of companies use generative AI in at least one business process, which indicates its growing importance in software engineering and transformation practices (Nitin *et al*., 2022). Modernization planning powered by AI enhances decision-making through the prediction of migration risks, estimation of the amount of resources necessary for the cloud and applications with high modernization value. AI-based recommendations allow organizations to focus on workloads that can offer better performance and cost reduction after migration.

Role of Generative AI in Automated Code Transformation and Refactoring

Generative AI contributes to enterprise application modernization through automation of code transformation and refactoring without losing the functionality of legacy systems. LLMs analyse the code, detect the deprecated coding patterns, and produce optimized code that adheres to the coding practices of today. This ability helps save time spent on development and speeds up the process of legacy system modernization (Baladari, 2021). Legacy modernization is facilitated through the use of generative AI by breaking down monolithic systems into microservices, upgrading deprecated APIs, and translating the code from the legacy programming language to modern language.

Planning Type	AI Function	Modernization Task	Key Benefit	AI Output	Main Risk
Code Analysis	Pattern Detection	Legacy Review	Issue Identification	Code Insights	False Detection
Code Refactoring	LLM Automation	Syntax Upgrade	Cleaner Code	Optimized Code	Logic Changes
Microservice Migration	Service Decomposition	API Upgrade	Cloud Readiness	Service Modules	Dependency Errors
Automated Testing	Test Generation	Bug Detection	Quality Improvement	Test Cases	Coverage Gaps
Large-Scale Remediation	Repository Automation	Bulk Updates	Standards Compliance	Consistent Changes	Model Hallucinations

Table 1: AI-Driven Legacy Application Assessment and Modernization Planning

In addition, the AI-based tools are capable of developing automated test cases, identifying security flaws, spotting memory leaks, and giving recommendations on how to boost performance and hence improve the quality of the software. Another important benefit of Generative AI is that it allows for automated code fix on a massive scale. Unlike traditional approaches that are limited to providing suggestions on how to write a particular piece of code, the enterprise AI solution uses the same set of transformation rules to make the necessary changes in thousands of code repositories. On the other hand, Generative AI does have some difficulties. The LLMs are known to develop hallucinations, produce bugs, and even alter the business logic (Yigit *et al.,* 2021).

Agentic AI for Autonomous Workflow Orchestration and System Integration

With the aid of agentic AI, it is possible to achieve automated orchestration and integration of systems because of collaboration between many AI agents that can plan, execute, monitor, and adapt tasks in an enterprise without human involvement. As opposed to other automation solutions, agentic AI utilizes graph-based orchestration of the agents that interact using graph nodes, condition logic, and shared memory in order to conduct complex processes of an enterprise.

Measures the percentage of workflows executed autonomously by Agentic AI.

$$\text{Workflow Automation Rate (WAR)} = \frac{\text{Automated Workflows}}{\text{Total Workflows}} \times 100\%$$

Purpose: A higher Workflow Automation Rate indicates greater autonomous orchestration, reduced manual intervention, and faster workflow execution across enterprise applications.

Formula	Measures	AI Impact
Workflow Automation Rate	Automation level	Autonomous orchestration
System Integration Efficiency	Integration success	Reliable coordination

Table 2: Relevance to Agentic AI

In this way, the agents will be able to gather data, make decisions, verify their outcomes, and execute tasks until certain objectives are achieved. In terms of graph-based orchestration, there is the contribution of enterprise integration by the integration of AI agents with legacy applications, cloud service providers, ERP systems, CRM and APIs. Furthermore, Agentic AI offers human-in-the-loop verification that offers governance, traceability, and auditability of significant enterprise processes (Parasa, 2021). Recent industry statistics show the rapid rate at which Agentic AI has been implemented in enterprises. Moreover, 90% of respondents believe that existing enterprise processes can be improved using agentic AI capabilities.

The Influence of Artificial Intelligence on Application Performance, Scalability, and Efficiency

AI plays an important role in improving the performance, scalability, and efficiency of enterprise applications by automating the system through intelligent operations and making predictions about system resources. Agentic and generative AIs monitor workloads and help detect performance issues, predict and take corrective actions in real-time before any disruption happens. In this way, downtime is reduced and efficiency is increased within the application in the cloud environment. It was reported that 48% of enterprises saw the errors and lack of control as their concerns for governance, whereas 47% stated the cost and ROI were barriers for implementation of AIOps (Mohammed, 2022).

This formula measures the total time taken for an application to process and return a request.

$$\text{Response Time (RT)} = \text{Processing Time} + \text{Network Latency} + \text{Queue Time}$$

AI-driven observability and AIOps reduce queue time and latency through intelligent resource allocation, anomaly detection, and automated load balancing, resulting in lower application response time. Lower RT indicates better application performance and improved user experience.

AI improves scalability by automating resource allocation and balancing workloads. This eliminates the need for manual scaling as AI allocates computing resources according to the needs of the application (Malempati, 2021). AI decreases the burden of routine operations, speeds up app deployment, increases productivity of developers, and shortens the process of application releases. Based on the findings of the HFS Horizons Legacy Application Modernization Services

highlights that enterprises turn to AI-based modernization in order to increase resilience, minimize technical debt, accelerate deployments, and achieve tangible results for their businesses.

This formula measures how efficiently cloud resources are utilized after AI-driven optimization.

$$\text{Resource Utilization (RU)} = \frac{\text{Resources Used}}{\text{Resources Allocated}} \times 100\%$$

This formula measures how efficiently cloud resources are utilized after AI-driven optimization. AI-based workload optimization and auto-scaling increase utilization by allocating CPU, memory, and storage according to real-time demand. Higher RU indicates better scalability, reduced idle resources, lower cloud costs, and improved operational efficiency. AI also helps orchestrate microservices, which allows enterprise apps to scale effectively and independently within distributed cloud platforms. Efficiency is further improved with the help of AI-powered monitoring, testing, incident management, and predictive maintenance (Kaul, Enslin & Gross, 2020)

. ***Implementation Challenges, Governance, and Enterprise Readiness for AI Modernization***

Effective Agentic AI and Generative AI implementation for the modernization of enterprise applications hinges on good governance, enterprise readiness, and risk management (Bag *et al.,* 2021). Most enterprises experience problems when implementing AI within legacy applications due to outdated architecture, lack of data interoperability, and poor data governance practices, which complicate the process of modernization. Shortage of skills, organizational change resistance, and the lack of modernization plans can also result in a delay in the implementation of AI.

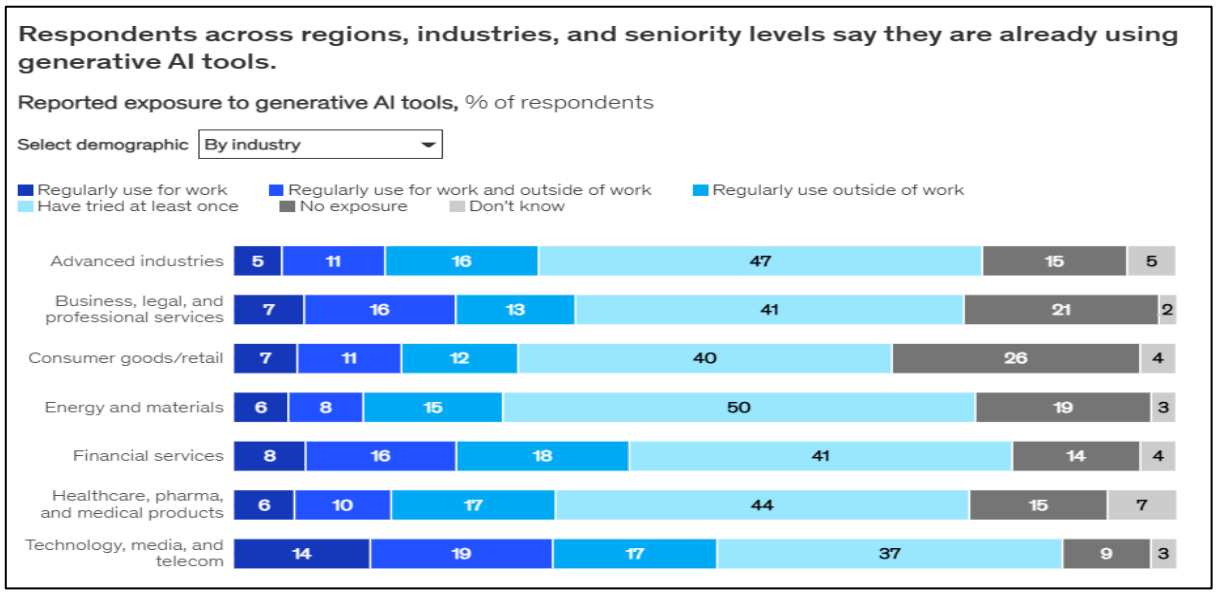

Figure 3: Enterprise Adoption of Generative AI Across Business Functions and Organizational Readiness

(Source: Mckinsey, 2023)

The main purpose of governance is to provide security, transparency, and compliance with enterprise policies within AI systems. Good practices of data governance, model monitoring, access control, explainability, and human in the loop are key to mitigating potential risks from AI outputs and autonomous actions. Enterprise readiness means that the organizations should allocate resources to implement cloud computing, AI skills, cybersecurity measures, DevOps culture, and continuous upskilling of the workforce (Letaief *et al*., 2021). Organizations need to come up with standard modernization procedures and performance measurements prior to the deployment of AI-driven modernization efforts. As per the HFS Horizons Legacy Application Modernization Services 2025 report, more and more organizations have started expecting their AI modernization initiatives to encompass guardrails for governance, explainability, security, capability transfer, and tangible business results beyond technology. These readiness components facilitate safe application modernization, enhance organizational resilience, and drive digital transformation.

Discussion

The Enterprise Application Modernization process has been influenced significantly by the complementary abilities of Agentic AI and Generative AI, allowing companies to modernize their legacy applications and turn them into intelligent cloud-based software. In conclusion, it should be mentioned that Generative AI helps improve the process of software development through code generation, code refactoring, testing, and documentation and thus helps decrease the cost of the development process and technical debt (Bag *et al*., 2021). At the same time, Agentic AI complements this process by means of orchestrating autonomous workflows, integrating enterprise applications, and making real-time decisions during complicated business processes. The discussion has also revealed the fact that modernizing enterprise applications with the help of AI helps improve the performance of these applications through predictive monitoring and automatic resource management and scaling. However, it is not possible to ensure the modernization of AI without addressing the problem of governance, including security, explainability, compliance, and human in the loop for responsible AI deployment. Cloud readiness, staffing, DevOps, and change management will be essential for sustainable AI implementation. In addition, validation of AI-produced results will be required to reduce mistakes and preserve the logic of business (Yigit *et al.,* 2021). Generally, Agentic AI and Generative AI form a robust base for enterprise application modernization since they facilitate better scalability and efficiency and innovation. The key value of these AI types is gained when intelligent automation is complemented by good governance and enterprise readiness.

Conclusion

There has been a shift in the enterprise application modernization process as a result of the incorporation of Agentic AI and Generative AI, thus offering the enterprises a chance to transform their legacy applications into intelligent, scalable, and cloud-native applications. This study identified that Generative AI makes code transformation, refactoring, testing, and documentation faster, and that Agentic AI makes workflow orchestration, autonomous decision making, and enterprise systems integration efficient. Both these technologies work together in helping the enterprises enhance their applications' performance, scalability, efficiency, and agility. The study, on the other hand, identified that AI-driven enterprise application modernization requires governance, data security, explainability, and readiness.

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