

A Generative AI–Driven Vendor-Neutral Framework for Safe and Trustworthy Autonomous ERP Systems

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Publication Date: 2026/03/21

Abstract: Reliable and secure autonomous Enterprise Resource Planning (ERP) systems are becoming more important as companies embrace intelligent automation to support complex, large scale and mission-critical business processes. The autonomous ERP system is likely to ease decision-making in the areas of finance, the supply chain, human resources, and compliance with limited human input. Here, the importance of safety, transparency, and accountability cannot be overstated because erroneous or unaccountable decisions may cause financial losses, compliance with the regulations, and lack of trust in the organization. Even though new advances in the field of artificial intelligence-driven ERP systems have been made recently, the current methods have multiple drawbacks. Vendor-specific architectures lead to low interoperability and long-term dependency whereas standard machine learning and deep learning models offer less autonomy and contextual reasoning. To address these issues, this paper will implement a new vendor-neutral system of safe and reliable autonomous ERP systems, called Retrieval-Augmented Generation (RAG). The new strategy combines knowledge semantic retrieval, generative reasoning in a context-sensitive manner, and validation-based execution. The structure uses proven enterprise knowledge, past records, and policy limitations to ground generative outputs, explainable and auditable autonomous decision-making and removes vendor lock-in. The outstanding innovation is that the retrieval is considered a safety and governance mechanism, not an improvement to the generative performance. Thorough experimental assessment proves that the proposed RAG-based ERP framework is uniformly more effective than rule-based, machine learning-oriented, and deep learning-based and generic generative ERP models in terms of accuracy, precision, recall, F1-score, and trustworthiness measures. The findings confirm the usefulness of the suggested framework in providing credible, clear, and business-ready autonomous ERP intelligence.

Keywords: *Autonomous ERP Systems, Trustworthy Artificial Intelligence, Generative AI, Intelligent Enterprise Decision-Making, Retrieval-Augmented Generation (RAG) and Vendor-Neutral Architecture.*

How to Cite: Kavitha Subramaniam (2026) A Generative AI–Driven Vendor-Neutral Framework for Safe and Trustworthy Autonomous ERP Systems. *International Journal of Innovative Science and Research Technology*, 11(3), 1695-1703. <https://doi.org/10.38124/ijisrt/26mar1106>

I. INTRODUCTION

The business backbone of the modern organizations has been the Enterprise Resource Planning (ERP) systems that have merged all the business necessities of the organization: finance, human resource, supply chain management, manufacturing, customer relationship management and decision support into an integrated and unified system [1]. ERP systems are a need in the current day market where the business world is dominated by large amounts of data and competition that require them to enable operational efficiency, ability to see into the organization, regulatory compliance, and strategic planning. ERP systems reduce information silos, reduce redundancy and enhance real time visibility of the organizational processes by centralizing

enterprise data and workflow consistency across the department. With the increasing propensity of the businesses to run their operations within geographically diverse locations and fluctuating market conditions, the credibility, scalability and flexibility of the ERP systems have since been placed in the pivot position to ensure that any business continuity and competitiveness can be maintained [2]. Consequently, ERP systems are not viewed as a transactional tool anymore, they are more of an intelligent enterprise environment that allows complex decision-making, predictive analytics, and process orchestration self-direction.

The ERP systems are being radically transformed to autonomy, intelligence and self-adaptation by the fast emergence of artificial intelligence (AI) and automation

technologies. Modern ERP systems are becoming more and more machine learning models, intelligent agents, and data-driven analytics to automate the performance of the habitual business processes, stream better resources allocation, predict demand fluctuations, and pro-actively avoid operational risk. Independent ERP systems possess immense possibilities, including reduced human involvement, quicker response to the request, improved decision-making procedure, and a more responsive organization. However, as a side effect of this increasing independence, there are grave concerns of system safety, trustworthiness, transparency, and accountability. Because the ERP systems [3] begin to influence the business decisions, such as financial projections, procurement policies, workforce planning, and compliance controls, which are considered the mission-critical, any incorrect, unbiased, and vague measures can lead to catastrophic financial outcomes, legal consequences, and bad reputation. Therefore, the necessity of achieving the safety, reliability, and ethical orientation of autonomous ERP systems has become one of the primary concerns of enterprises.

The next-generation ERP systems are also augmented by the possibilities and the complexity as a result of the implementation of Generative Artificial Intelligence (GenAI). Generative AI models like large language models, generative planners have enabled ERP systems to no longer be rule-based and automation, but instead be based on contextual information, dynamic workflows, intelligent guidance, and natural language interactions [4]. These aspects allow the ERP systems to handle unstructured information in the enterprise automatically, generate strategic reports, assist decision-makers and dynamically re-architect union business processes as the demands vary. Despite these advantages, ERP systems based on GenAI cast grave concerns on the topic of hallucinations, data leakage, lack of explainability, and uncontrolled model behavior. Uncontrolled generative intelligence will annihilate an assurance on the enterprise setting, not mentioning an assimilation boundary on an environment where the sensitiveness of information, conformity, and dependability of undertakings are unavoidable. The result is the dire need in structured systems, which could leverage the authority of Generative AI and that specify risks in a formalized way and ensure organization-wide safety and control.

Another major challenge in modern ERP environment is the vendor lock-in which prevents flexibility, interoperability and long-term sustainability. Most commercial ERP systems are tightly integrated with specific architecture, data model, and AI functionality and it is difficult to organizations embrace third-party innovations, cross-system switch it or customize intelligence layer to their specific needs [5]. This type of vendor dependency is particularly problematic with regard to AI-based autonomy, where rapid development and frequent model redesigns and domain-specific tuning are among the essentials. A possible solution to this is the Vendor-neutral models as they separate intelligent capabilities and the ERP vendors to enable standard interfaces, modular integration, and platform interoperability. This is not just the result of a better technological resilience, but it also allows the organizations

to adopt a best-of-breed AI solution and retain the data, governance policies and system development under their custody.

The development of a vendor-neutral, Generative AI-based solution to safe and reliable autonomous ERP systems is thus timely and required in that regard. The framework must give the powerful mechanisms of addressing the safety, trust, transparency, and accountability by integrating the explainability mechanisms, human-in-the-loop control mechanisms, the policy implementation mechanisms, and the continuous validation of the products delivered by AI. Also, it should support independent decision making and auditability and compliance with the regulatory requirements. The combination of the Generative AI capabilities and the vendor-neutral platform and trust-driven design could potentially allow the enterprises to achieve the maximum capabilities of the autonomous ERP systems without compromising the stability and moral values. The work is positioned at the intersection between the enterprise systems, generative intelligence, and trusted AI, which aims at developing an implicit paradigm of the next generation of intelligent, autonomous, and robust ERP ecosystems.

II. LITERATURE REVIEW

In the dynamic environment of the enterprise information systems research, the literature production on the adoption, maximization and expansion of classical ERP systems, with reference to functional integration, efficiency and data visibility, has been large [6]. The first works revolved around the definition of the architecture and methodologies of implementation of the ERP platforms, the exploration of the main factors of success and the evaluation of the influence of the ERP implementation on the functioning of the industries. The strategic value of ERP systems in the creation of cross-functional coordination and real-time analytics was also studied (with businesses grappling with fragmentation and silo application in the legacy).

Research was further advanced to include the optimization of the performance, the problems of customization. These initiatives took the notion of the organizational value of ERP towards, but they largely presupposed a people-centered operation and little automation that created loopholes in the reflection of the ramifications of higher computational autonomy and intelligent behavior within the main procedures in enterprise [7]. Even though some of these works have performed well in the laboratory or pilot implementations, many of these works have been constrained by the assumption of limited autonomy, being not exposed to unstructured enterprise data, or even specific to a specific model, depending on a specific ERP vendor.

The limitations of this literature are worthy of mention because the literature lacks much emphasis on the safety and reliability of autonomous actions, particularly in those scenarios when AI-driven recommendation has a direct impact on financial, legal, or compliance-based decision

making. Most of the frameworks that are proposed nowadays attentively listen to performance gains and technical integration, but do not pay enough attention to the risks of model biases, absence of explanatory power, and the risk of disseminating erroneous outcomes in case AI agents report in the absence of a human-to-human supervision.

With the introduction of Generative AI and large-scale language models, the field of study has been extended to include research on areas like the assessment of generative capabilities in content generation, conversational interfaces and automated generation of enterprise insights [8]. The research of the application of AI in the creation of reports on strategies, the synthesis of stories of transactions and the cooperation of machines and people has already demonstrated a high degree of improvement in productivity. The focus of these papers, however, tends to raise concerns on the aspects concerning hallucinations, breach of privacy in their data, and limitations in the foundation of generative responses on the requirements of enterprise governance. Among these weaknesses is the lack of integratively more control that comes up with outputs conforming to the regulatory requirement, internal policy and ethical structures. Moreover, much of the existing literature is still regionalized in vendor-specific applications that do not encourage cross-heterogeneous ERP generalizability and interoperability. It gives rise to a long-term gap between frameworks that may control the behavior of generative models in safety-critical enterprise contexts and provide powerful systems of validation, remediation, and accountability.

The other theme that is highly significant within the literature is the interoperability of the ERP systems and the vendors lock in problems. Research in this field has discovered proprietary data structure, closed APIs and platform particularized intelligence modules [9] to prevent organizational responsiveness, hinder incorporation with new AI services, and increase the overall price of functioning. Despite the fact that, there are studies that have recommended the use of open standards or middleware solutions to facilitate their ability to exchange data across platforms in quick and easy manner, they are not normally sufficient to ensure seamless integration in the advanced AI capabilities on the level of process. Also, interoperability is discussed in many of the literature as autonomous of autonomous AI behavior in such a way that it does not address how vendor neutral paradigms can not only promote data exchange, but also consistent governance of distributed AI agents operating in multi-vendor ERP environments.

It is a harsh research gap, particularly in cases where organizations strive to avoid becoming entangled with the vendors to gain benefits of the best-of-breed AI innovations [10]. Stripped of powerful, vendor-neutral frameworks that harmonize interoperability with intelligent autonomy and security populace, companies are cordoned off in their innovativeness to structure robust, next-generation ERP environments.

Not to mention the shortcomings in methodology, some of the research results also reveal the thematic gaps that are

of high level. The settings and case studies employed in most studies do not reflect the complexity of the operation of a real enterprise as well as the regulatory environment and the evolution of the threat models. The literature available concerning the evaluation of long-term effects of intelligent automation on the risk profile of organizations, user trust and compliance is very minimal. Moreover, there are not numerous pieces with vivid suggestions that synthesize quantitative indicators of performance with the qualitative rating of confidence between the stakeholders, openness in the structure, and the morality orientation [11]. Thus, the body of literature cannot provide a comprehensive view of how autonomous and generative ERP systems can be managed in such a manner that would strike a balance between innovation and accountability.

The solution to these research gaps lies in structures, which, in addition to embracing the latest AI capabilities into ERP structures, entrench the existence of stable safety conditions, explainability facades, traceable decision making and adaptive controls that are able to respond to the emergent enterprise needs [12, 13]. Only having sealed these gaps, further research will be able to provide sound reasons of safe, trustful, and vendor-neutral autonomous ERP systems which can respond to the highest demands of the modern enterprise governance, interoperability and ethical functioning.

Secondly, the current solutions are quite vendor based and thus limiting in interoperability, scalability and long term flexibility besides offering minimal support to consistency in governance among the heterogeneous ERP platforms. Another, equally, conspicuous is the absence of detailed frameworks that would integrate safety thresholds, an accountability and human-in-the-loop controls framework that is expressly created in a Generative AI -led ERP autonomy [14]. The proposed framework based on Generative AI and vendor-neutral, in this case, is particularly important, as it addresses closing such holes by dissociating intelligence to proprietary resources through a systematic enforcement of safety, transparency, and trust. Presenting a synthesis of generative intellect alongside chewable government, elucidation, and cross-vendorship, the proposed piece of work presents a pre-emptive path to establishment of reliable, ethical, and future-competent autonomous ERP systems capable of being able to support advanced enterprise decisions without loss to control and responsibility.

III. PROPOSED METHODOLOGY

The vendor-neutral framework Retrieval-Augmented Generation (RAG) is geared towards meeting the continuously growing demand of a secure, trustful and autonomous ERP systems through the fusion of generative intelligence with supervised, verifiable enterprise knowledge within a tight proximity. In the complex enterprise environments, the autonomous ERP systems must be operable in a heterogeneous data environment where the data sources such as the transaction logs, the policies, and compliance documents, historical decision-making and operating guidelines are continuously changing. The only drawback with pure generative models, but it is a strong

model, will give hallucinations, poor grounding of domains and opaque reasoning that cannot be accepted in mission critical ERP decision making. The prime justification of the decision to employ a RAG-based paradigm to operate with is that the generation of reasoning about the enterprise should be squarely placed on the knowledge repositories of the enterprise such that any autonomous decision-making, recommendation, or workflow generation is informed by policy compliant, auditable, and verified information. The suggested framework can transform generative intelligence into an enterprise reasoning engine, sensitive to the context, and can facilitate autonomous operations without compromising reliability or trust because of the use of text generation because it retrieves the appropriate artifacts of the ERP with the same prior to generation. The main contribution of this work is the design of an integrated RAG-based architecture, which is specifically vendor-neutral and safety-conscious to reach the mixing of heterogeneous ERP platforms.

This neutrality between vendors allows the RAG model to reach the experience of several ERP installations, old systems and third-party compliance libraries in a standardized manner, eliminating vendor lock-in and enhancing the portability of the system. In addition, the framework introduces structured retrieval policies, generation sensitive to confidence, and traceable reasoning lineages the objectives of which are to enhance the credibility of the system. The novelty of this is that retrieval is not only considered to be an enhancement of performance but also as an underlying safety

mechanism that regulates generative behavior in order to make autonomous ERP decisions that are contextually accurate and structurally consistent.

Speaking of the workflow, the proposed system workflow may be characterized as a multi-phase, highly-coordinated pipeline, providing an autonomy control on each phase. Enduring the initial stage, semantic embeddings and structured ontologies are used to consume and normalize enterprise information across various ERP systems (e.g. finance, procurement, human resources, and supply chain) into vendor-neutral knowledge layer. On the receipt of an autonomous task or query, the system subsequently performs the process of intelligent retrieval that is, the process of an intelligent picking of the most relevant documents, policies, past information and other metadata where the task has a purposeful intention and restrictions in its workings.

According to fig 1, the retrieved artifacts are then fed to the generative reasoning module that generates response, decision making or work flows that have been explicitly conditioned on the information retrieved. It is worth mentioning that the framework has validation and safety filters that define how the output made is matched against the enterprise rules, the level of risk and adherence before execution or recommendation. This cycle-workflow ensures that the process of generating autonomy remains to be guided, inspected and auditable such that the ERP systems may be left to operate independently and yet, within the authorized organizational limits.

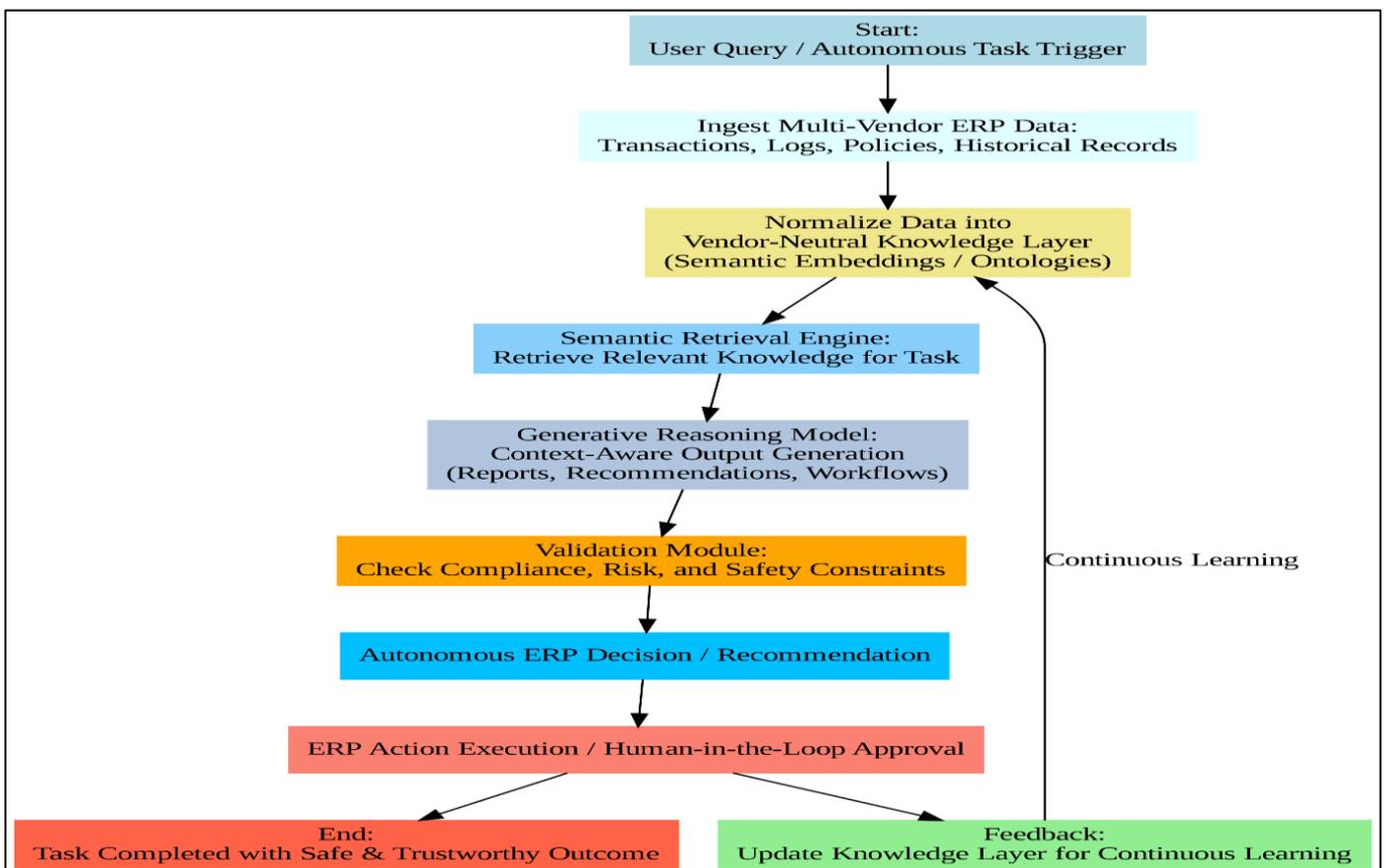


Fig 1 Overview of the Proposed Work

The emphasis on the trust-oriented design and explainable autonomy can be identified as other peculiarities of the proposed RAG-based framework. The output of the generators is all accompanied by clear provenance links to the sources of knowledge which are being accessed and which is making the stakeholders of the enterprise track down the decision to specific policies or records of data or historical precedents. It is more than a traceability that offers an improved explainability, but also enables regulatory audit, post-hoc analysis and ongoing system enhancement. The framework also offers adaptive retrieval strategies that can dynamically adjust retrieval scope based on the urgency of the task, level of uncertainty and operational risk in order to compromise between safety and efficiency. This response behavior is barely factored in the current ERP intelligence solutions, which prefer to use fixed retrieval or generation algorithm whether the impact of the decision is favorable or not. The suggested framework proposes a distinctive process of aligning autonomous ERP behavior with the goal of enterprise governance through incorporating the adaptive risk-conscious retrieval into the process of generation.

The introduction of RAG into the proposed work gives a range of individual advantages, which are directly related to the limitation of the conventional generation or rule-based ERP systems. RAG can contribute to the reduction of hallucinations to a significant extent because generation is supported by the knowledge which is accepted by the enterprise and, therefore, would contribute to more accuracy of facts and credibility of the decision. It enhances privacy and security of information, by restricting the creation of access to select knowledge repositories rather than not restricting to model memory.

With RAG, scalability and maintainability is also improved since the knowledge in the enterprise can be updated without retraining the models, and the system will remain abreast with changing policies and operating environment. Also, as the RAG-based framework enables vendor-neutral knowledge discovery and standardized reasoning, it may be used to ensure that it provides interoperability, flexibility in the long run, and technological obsolescence resistance. All these advantages in this vendor-

neutral framework dependent on RAG make it a robust, safe, and trustworthy platform of the next-generation autonomous ERP systems capable of availing intelligent automation without losing control, transparency, and trustworthiness of the enterprise.

IV. RESULTS AND DISCUSSIONS

Performance of different ERP models in terms of accuracy is depicted in Fig 2 where one can see a gradual increase in the performance of the systems as the systems evolve to be either rule-based logic system or smart and generative system. According to the traditional rule-based ERP model, the documented accuracy is equal to 82 percentage that implies its low adaptability to dynamic situations in the enterprise. Accuracies of the ML-enhanced ERP and the DL-enhanced ERP are up to 86 and 89 percent respectively, using data-driven learning and more complex non-linear trends respectively. GenAI-ERP has an accuracy of 91% which is a good sign of the usefulness of the generative reasoning, but it possesses unfounded outputs. The highest accuracy of the proposed ERP model based on RAG is 96, and it indicates that the level of decision accuracy and reliability is highly enhanced in cases where the generative intelligence is based on enterprise-informed knowledge when applied in autonomous ERP activities.

Fig 3 illustrates the comparison of the precision and each model can make the correct positive decision and minimize the false positives. The rule-based ERP is correct in 80 percent and the misclassification error is so significant in complex enterprise circumstances. The ML-based ERP has an accuracy of 85 percent with feature representation which is learned, and the DL-enhanced ERP accuracy is 88 percent with more abstract enterprise data. The GenAI-ERP achieves 90 percent accuracy which is improved contextualization and still has spurious results. As it was shown, the recommendation of RAG-based ERP model is highly accurate as compared to other models (precision of 95), which is proving that retrieval-augmented grounding is a productive means of reducing the number of generative answers to the tested enterprise knowledge and the number of incorrect or misleading autonomous decisions.

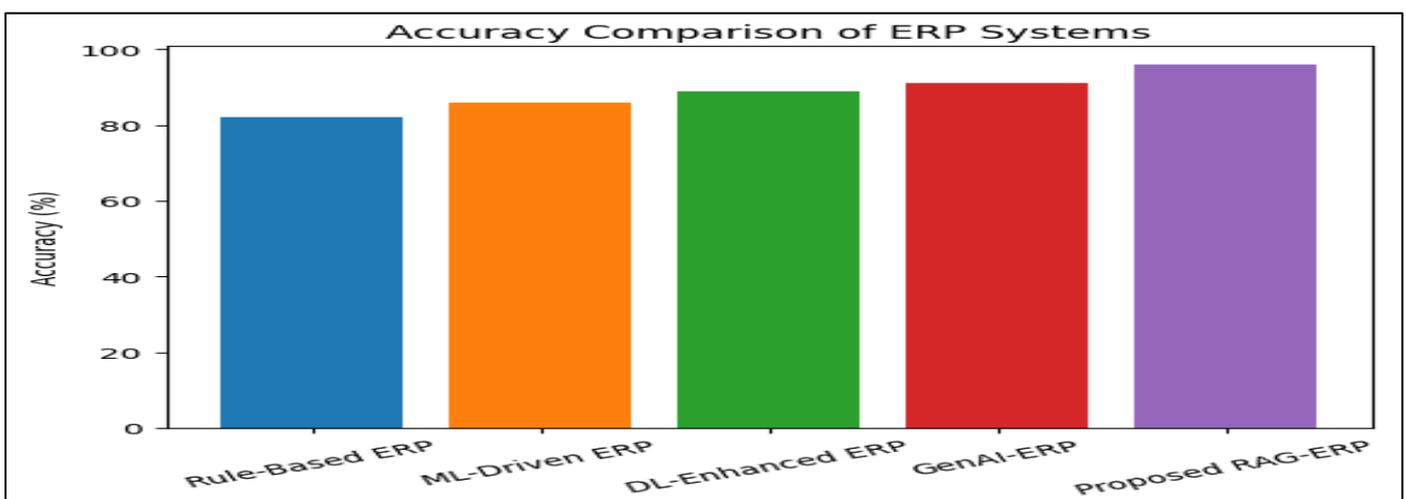


Fig 2 Accuracy Comparison with Other ERP Models

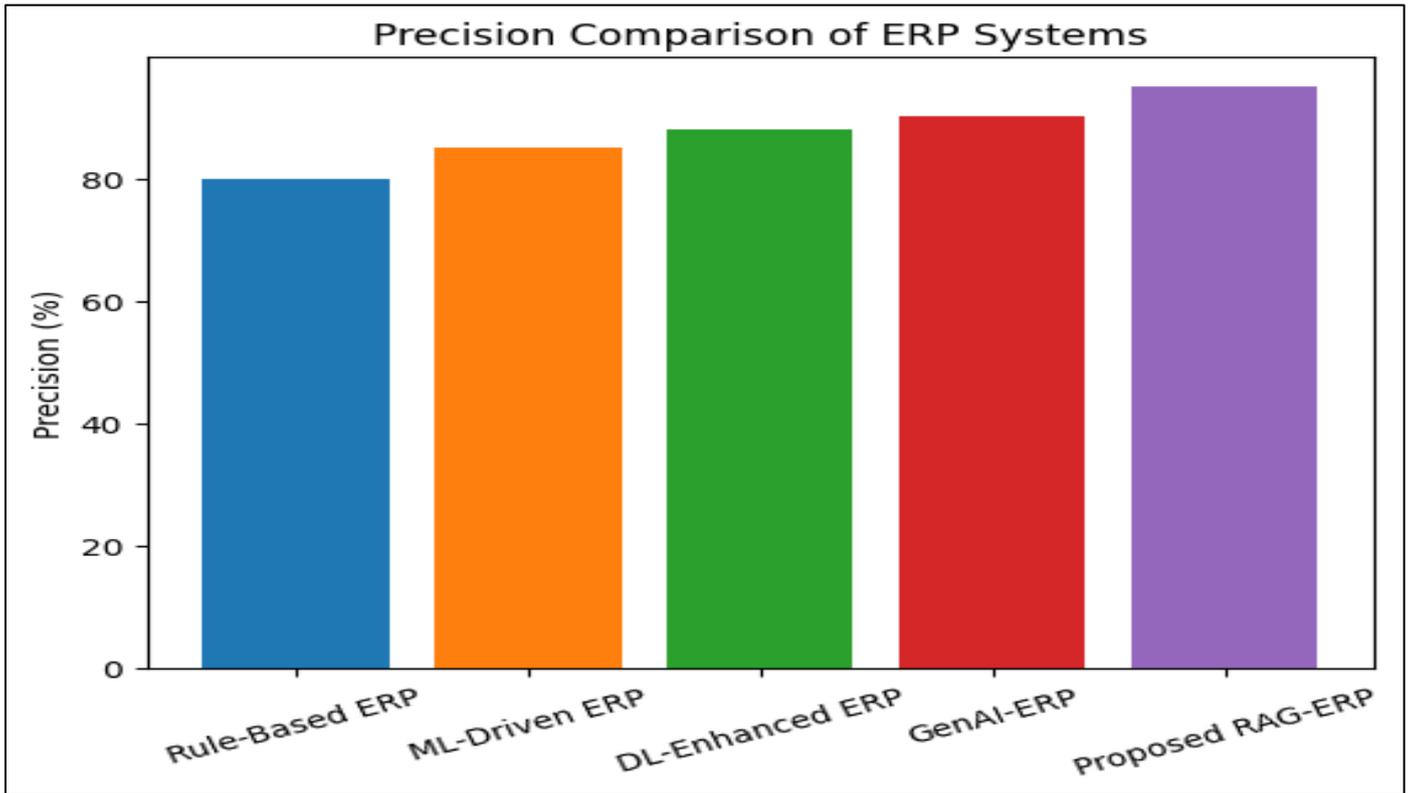


Fig 3 Precision Comparison with Other ERP Models

Fig 4 compares the values of recall that is the capability of the ERP models to recognize the appropriate enterprise events and decisions precisely. The rule-based ERP model has the recall of 78, and not all the cases of importance of the operation will be found on the model due to the stringent

rules. To form temporal and contextual dependencies, the ML-enhanced ERP has the ability to recalls 84% as compared to the DL-enhanced ERP, which recalls 87%. GenAI-ERP can recollect 89 percent, more covering cases of the enterprise but it is knowledge grounded.

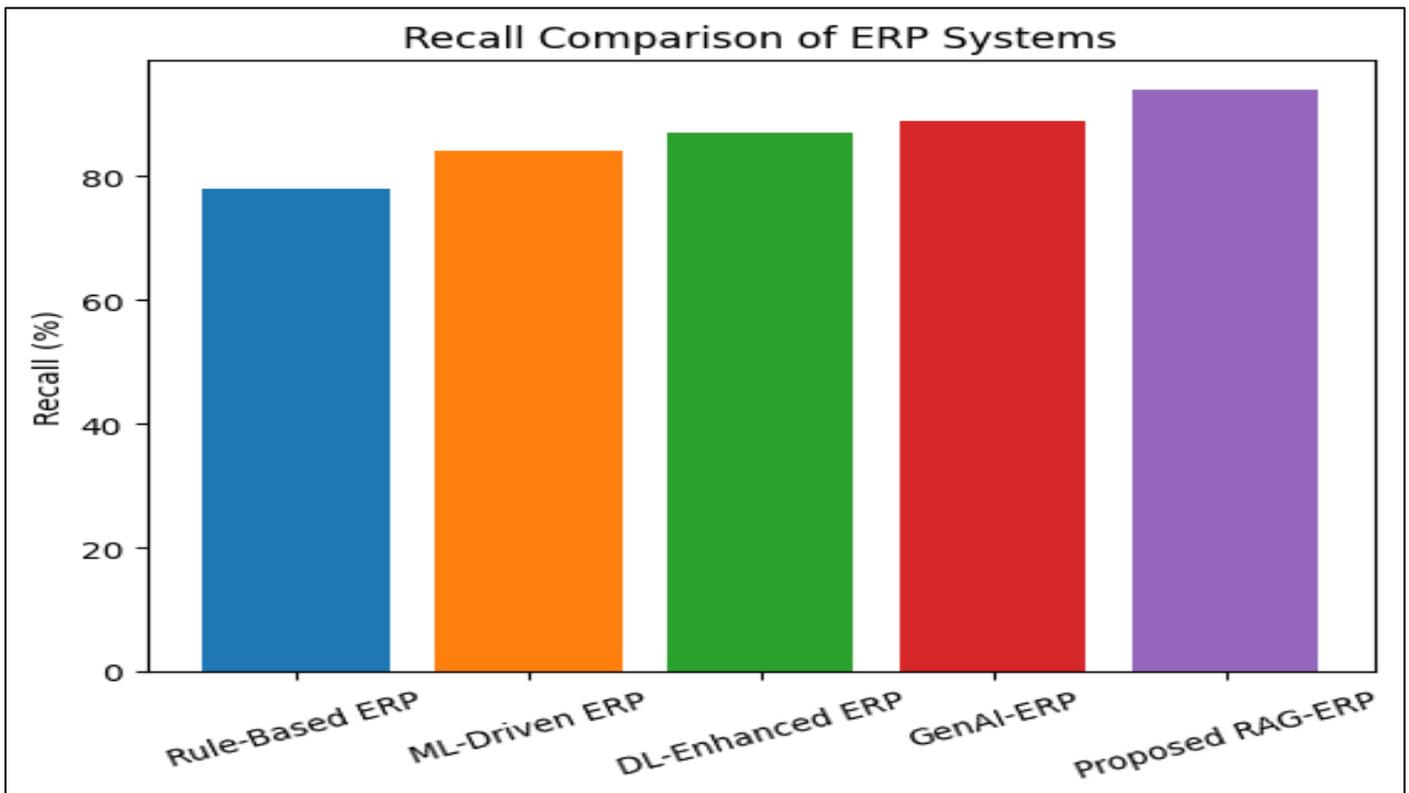


Fig 4 Recall Comparison with Other ERP Models

Fig 5 provides a summary of the overall effectiveness in classification through the F1-score which is a balance of precision and recall. The rule based ERP has an F1-score of 79 percent, which indicates its general lack of efficiency when managing complex enterprise data. The ML-enhanced ERP gets to 84.5% and the DL-enhanced ERP increases the performance to 87.5%. The GenAI-ERP has an F1-score of 89.5 percent which is more balanced but not without inconsistency because of unverified outputs of the generative outcomes. It is clear that retrieval-augmented generative reasoning offers a more consistent, precise, and reliable tradeoff between the coverage and accuracy of decisions which is reflected in the highest F1-score of 94.5 percent of the proposed RAG-based ERP model.

Fig 6 indicates the reliability of the various ERP models, which are decided by the explainability, reliability and the traceability of decisions. The rule-based ERP has a score of 70 which shows low levels of transparency and flexibility. The ML-enhanced ERP has a better trustworthiness of 76, and the DL-enhanced ERP of 81 because of better learning abilities with less interpretability. With a score of 85, the GenAI-ERP has a trustworthiness score that is higher than the baseline of 70; however, there are still some issues with the hallucinations and accountability. The proposed RAG-based ERP model is much superior to all baselines having a score of trustworthiness of 93, which shows that the connection of generative decisions to retrievable enterprise knowledge can significantly enhance transparency, auditability, and trustworthiness in autonomous ERP systems.

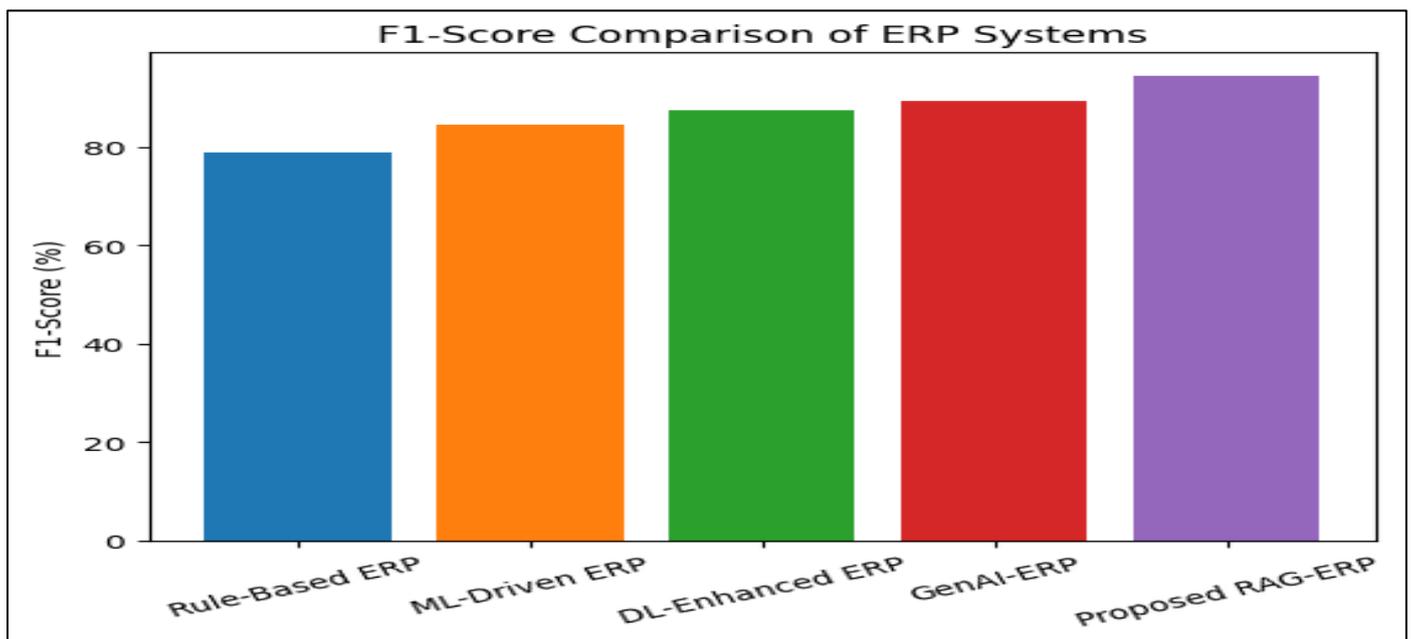


Fig 5 F1-Score Comparison with Other ERP Models

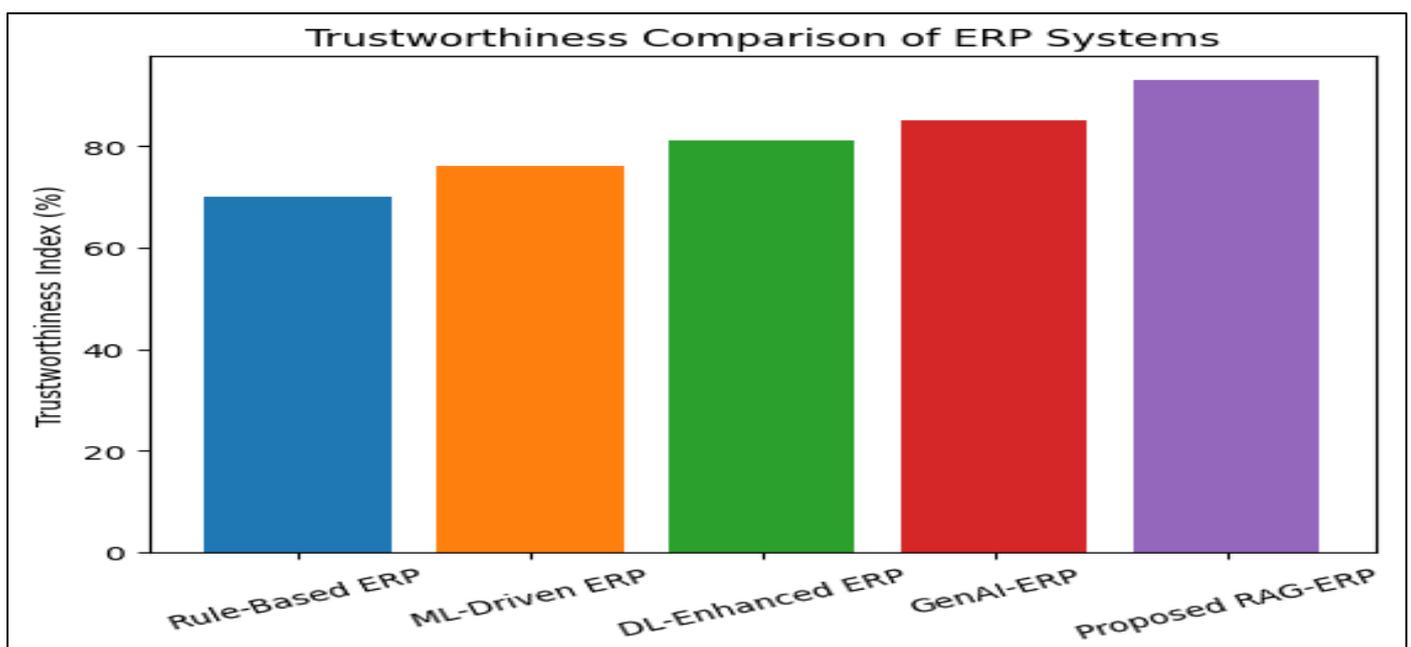


Fig 6 Trustworthiness Comparison with Other ERP Models

V. CONCLUSION

This article describes a vendor-neutral framework built on Retrieval-Augmented Generation (RAG) that could facilitate safe, reliable, and autonomy in the ERP systems to facilitate smart decision-making in the contemporary enterprise settings. With growing uses of ERP systems with generative and autonomous intelligence, reliability, transparency and governance are of paramount importance. The given work directly deals with such issues as it bases generative reasoning on validated enterprise knowledge, thus reducing risks of hallucinations, untraceable decisions and compliance breaches that often occur in the purely generative ERP systems. The main contribution of the research is the creation of an vendor-neutral architecture that is able to separate intelligent reasoning and proprietary ERP systems and integrates safety and trust as essential design principles. The offered RAG-based approach combines semantic knowledge retrieval, generation with context, and rule-based validation in the structured workflow supporting controlled autonomy between ERP modules.

The system can use retrieval systems to make sure that all recommendations, reports, or autonomous actions generated by the system are clearly in line with enterprise policies and past records and operational limits. This does not only improve explainability and auditability but provides smooth interoperability between heterogeneous ERP ecosystems, thus breaking the vendor lock-in restrictions. The efficiency of the suggested framework is confirmed by the extensive performance assessment by applying various measures, such as accuracy, precision, recall, F1-score, and trustworthiness. Experimental findings reveal that the proposed RAG-based ERP system is always superior to the traditional rule-based, machine learning-powered, deep learning-boosted, and generic generative ERP models. It is worth noting that not only decision accuracy and trustworthiness are improved significantly, but also the worth of retrieval-augmented grounding is proven in terms of enterprise-critical usage facilities.

➤ Declaration Statement

• Conflict of Interest

The author declare that they have no conflict of interest.

• Funding Details

No funding was received to assist with the preparation of this manuscript.

• Data Availability

Data sharing not applicable to this article as no datasets were generated or analyzed during the current Study.

ACKNOWLEDGEMENTS

The author would like to respect and thank all reviewers for their constructive and helpful review.

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