

Voice-Enabled Agentic AI for Autonomous Supply Chains: SAP Execution with Generative Interfaces

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ARTICLE INFO

Received: 10 June 2025

Revised: 17 July 2025

Accepted: 27 July 2025

ABSTRACT

The increasing complexity of global supply chains necessitates solutions that extend beyond traditional enterprise systems to achieve autonomy, resilience, and efficiency. This study investigates the integration of voice-enabled agentic artificial intelligence (AI) with SAP execution and generative interfaces as a pathway toward autonomous supply chain management. A prototype system was developed, combining natural language-based voice interaction, autonomous decision-making agents, and direct SAP execution modules. Using case-based experiments across manufacturing, retail, and FMCG sectors, the system was evaluated on operational efficiency, decision quality, user-centric outcomes, and resilience under disruption scenarios. Results revealed significant performance improvements, with execution times reduced by 35–45%, accuracy gains of nearly 10%, and system latency lowered by more than half. Forecast accuracy, anomaly detection, and optimization scores improved markedly, while user surveys indicated higher accessibility, reduced cognitive workload, and increased adoption intention. Resilience metrics confirmed faster recovery times and stronger tolerance to demand, logistics, and supply disruptions. Collectively, these findings highlight that the fusion of agentic AI and generative voice interfaces within SAP environments not only enhances operational reliability but also empowers users and strengthens supply chain adaptability. The study provides both theoretical contributions to AI-driven autonomy and practical guidance for organizations seeking intelligent, human-centric supply chain transformation.

Keywords: Agentic AI, Autonomous Supply Chains, SAP Execution, Generative Interfaces, Voice-Enabled Systems

Introduction

Background: evolution of supply chain management

Supply chains have transformed dramatically over the past few decades, evolving from linear, efficiency-driven models to dynamic, interconnected networks. Traditional supply chain systems primarily emphasized cost reduction, process optimization, and lean practices (Zheng et al., 2024). However, the advent of globalization, digitization, and disruptive technologies such as Artificial Intelligence (AI), blockchain, and the Internet of Things (IoT) has compelled organizations to rethink supply chain design and execution. Today's supply chains must be not only efficient but also resilient, agile, and adaptive in responding to unforeseen disruptions (Boonlua et al., 2023). The recent challenges posed by global pandemics, geopolitical conflicts, and fluctuating demand patterns underscore the urgent need for autonomous, intelligent systems capable of real-time decision-making and seamless integration across stakeholders (Mishra et al., 2024).

Emergence of agentic AI in supply chains

The concept of agentic AI, AI systems capable of autonomous decision-making, contextual reasoning, and adaptive problem-solving marks a paradigm shift in supply chain management (Sawyer & Harrison, 2020). Unlike traditional AI, which is confined to predictive or prescriptive analytics, agentic AI introduces self-directed actions aligned with business goals. It enables continuous monitoring of data streams, anticipates disruptions, and autonomously executes corrective actions, significantly reducing reliance on human intervention (Singh & Modgil, 2025). This evolution is particularly critical for large-scale enterprise resource planning (ERP) systems such as SAP, where the complexity of data integration, order management, logistics, and procurement often creates execution bottlenecks. Embedding agentic AI within these environments promises not only operational efficiency but also strategic agility (Ivanov, 2022).

Voice-enabled interfaces and generative AI integration

While agentic AI provides autonomy, the integration of voice-enabled generative interfaces amplifies usability and accessibility across supply chain functions (Alexander et al., 2022). Natural language processing (NLP) and conversational AI technologies empower stakeholders to interact with ERP systems through intuitive commands, bypassing the steep learning curve traditionally associated with SAP execution (Holloway, 2025). By combining generative AI models with speech recognition and context-sensitive dialogue systems, organizations can create interfaces where managers, suppliers, and logistics coordinators issue real-time instructions and queries in natural language (Calvo et al., 2020). This reduces cognitive load, enhances decision transparency, and accelerates task execution. Furthermore, voice-enabled interfaces democratize supply chain access by enabling non-technical users to participate directly in operational workflows.

The strategic role of SAP execution in autonomous supply chains

SAP remains the backbone of enterprise-level supply chain execution, offering comprehensive modules for procurement, production, distribution, and financial accounting (Gupta et al., 2021). However, despite its robust capabilities, SAP workflows are often criticized for being rigid, data-intensive, and dependent on expert users for configuration and troubleshooting. Integrating agentic AI with SAP systems addresses these challenges by automating repetitive processes, dynamically optimizing workflows, and detecting anomalies in real time. When combined with voice-enabled generative interfaces, SAP transforms into a responsive, intelligent hub capable of orchestrating complex supply chain activities without extensive manual intervention (Shekarian & Mellat Parast, 2021). This strategic fusion ensures that supply chains move from being merely digital to becoming truly autonomous.

Research gap and need for study

Although prior research has explored the applications of AI and automation in supply chain contexts, the intersection of agentic AI, generative voice interfaces, and SAP execution remains underexplored. Most studies focus on isolated components—such as AI-driven demand forecasting, robotic process automation, or voice-based chatbots—without investigating how these technologies can collectively redefine end-to-end supply chain autonomy. There exists a critical need to evaluate how these converging technologies can enhance decision-making, reduce latency, and foster resilience in real-world supply chain environments. By bridging this gap, this research positions itself at the forefront of next-generation supply chain innovation.

Objectives of the study

This study aims to examine the integration of voice-enabled agentic AI with SAP-based supply chain execution. Specifically, it investigates how generative voice interfaces can enhance accessibility, how agentic AI can optimize decision-making and automation, and how these synergies collectively enable

the transition toward autonomous supply chains. By doing so, the research not only contributes to academic discourse but also provides actionable insights for industry practitioners seeking to build intelligent, adaptive, and human-centric supply chain ecosystems.

Methodology

Research design

This study follows a mixed-method research design that combines prototype development, case-based experimentation, and quantitative statistical analysis. The objective is to investigate how the integration of voice-enabled agentic AI with SAP execution and generative interfaces can enhance the autonomy, efficiency, and resilience of supply chains. The methodological framework was structured into three phases: the design and development of the system prototype, the implementation of controlled experiments across different supply chain workflows, and the application of statistical techniques to evaluate both operational and user-centric outcomes.

System architecture and prototype development

A prototype system was designed and integrated into an SAP S/4HANA environment to simulate real-world supply chain execution. The architecture was organized into three functional layers. The first layer, the voice-enabled generative interface, utilized automatic speech recognition and natural language processing models to facilitate conversational command execution in natural language. The second layer, the agentic AI decision-making component, incorporated reinforcement learning and adaptive planning algorithms to autonomously optimize procurement, order fulfillment, and logistics decisions. The third layer, the SAP execution component, linked the AI system with core SAP modules such as Materials Management, Sales and Distribution, and Production Planning, allowing the generative commands to be translated into executable workflows.

Variables and parameters

The study employed a wide set of independent, dependent, and control variables to comprehensively measure system performance. Independent variables included the type of AI agent deployed (rule-based versus agentic AI), the mode of interface (manual SAP execution versus voice-enabled generative interface), workflow category (procurement, order fulfillment, inventory management, or logistics coordination), and the transaction load (low, medium, or high). Dependent variables focused on operational efficiency, such as task execution time, process completion accuracy, and system latency, alongside decision quality indicators including forecast accuracy, anomaly detection precision, and optimization scores. User-centric parameters were also assessed through accessibility ratings, cognitive workload using NASA-TLX, and error rates in human-system interaction. Resilience indicators, such as mean time to recovery, disruption response rate, and supply variability tolerance, provided additional insights into system robustness. Control variables included industry type, enterprise size, network stability, and SAP configuration level.

Data collection

Data collection was carried out through three industry case studies representing manufacturing, retail, and FMCG sectors. For each case, sixty operational workflows were executed under both manual SAP conditions and voice-enabled agentic AI conditions, resulting in a total of 180 workflows. Each workflow was repeated under varying transaction loads to improve data reliability. To capture user perceptions, a structured survey involving 120 participants was administered, focusing on usability, accessibility, and acceptance of voice-enabled generative interfaces. All experimental data were recorded in real time within a sandbox SAP environment to ensure accuracy and security.

Statistical analysis

The collected data underwent a series of statistical analyses. Descriptive statistics were first calculated to summarize efficiency, accuracy, and resilience measures across experimental conditions. Inferential analyses followed, with two-way ANOVA applied to test the effects of AI type and interface mode on workflow execution outcomes. Multivariate regression analysis was employed to explore how transaction load and workflow type influenced execution accuracy and time, while MANOVA was used to assess the joint impact of AI integration on operational efficiency, decision quality, and user-centric parameters. Structural equation modeling was applied to examine the causal pathways linking usability and accessibility to overall system performance and resilience. Post-hoc tests using Tukey HSD identified significant differences across workflow groups. In parallel, Cronbach's alpha was computed to validate the internal reliability of survey instruments, ensuring that scales measuring user perceptions of accessibility and workload were statistically robust.

Ethical considerations

The study adhered to strict ethical protocols. All participant data were anonymized, and informed consent was obtained prior to participation in the survey. The experimental prototype was deployed within sandbox SAP systems to avoid interference with live business operations and to mitigate potential risks.

Results

The integration of voice-enabled agentic AI with SAP execution demonstrated significant improvements in operational efficiency across supply chain workflows. As presented in Table 1, task execution time was consistently lower under the agentic AI system, with reductions ranging from 35% to 45% compared to manual SAP workflows. Procurement tasks, for instance, decreased from 148 seconds to 92 seconds on average, while logistics operations dropped from 184 seconds to 107 seconds. Similarly, completion accuracy increased by nearly 10 percentage points across all workflows, and system latency was reduced by more than half, with procurement latency improving from 380 ms under manual execution to just 165 ms under the agentic AI system.

Table 1: Operational efficiency across workflow types

Workflow Type	Execution Mode	Avg. Task Time (sec)	Completion Accuracy (%)	System Latency (ms)
Procurement	Manual SAP	148	87.5	380
	Voice-Enabled Agentic	92	96.8	165
Order Fulfillment	Manual SAP	172	85.9	402
	Voice-Enabled Agentic	101	95.2	189
Inventory Management	Manual SAP	155	86.7	390
	Voice-Enabled Agentic	95	97.1	170
Logistics	Manual SAP	184	84.3	415
	Voice-Enabled Agentic	107	94.6	193

In terms of decision quality, Table 2 highlights substantial gains achieved by the proposed system. Forecast accuracy increased from 82.1% in manual SAP to 94.3% under agentic AI, while anomaly detection rates improved from 76.4% to 92.6%. Optimization scores, derived from a composite measure of cost, lead time, and service level trade-offs, increased by more than 20 percentage points,

indicating a more balanced and efficient decision-making process. Furthermore, order fulfillment rates reached 96.2% with agentic AI, compared to 84.8% in manual execution, underscoring the impact of automation on meeting customer requirements.

Table 2: Decision quality and forecasting accuracy

Variable	Manual SAP (Mean %)	Voice-Enabled Agentic (Mean %)
Forecast Accuracy	82.1	94.3
Anomaly Detection Rate	76.4	92.6
Optimization Score*	68.7	89.1
Order Fulfillment Rate	84.8	96.2

User-centric evaluations provided additional evidence of system effectiveness. According to Table 3, accessibility scores nearly doubled under the voice-enabled interface, increasing from 2.8 to 4.6 on a five-point scale. Cognitive workload, as measured by the NASA-TLX index, decreased from 64.2 to 39.5, indicating reduced mental effort. User error rates fell from 11.7% to just 4.2%, while satisfaction levels rose from 3.1 to 4.7. Notably, adoption intention climbed from 56.5% to 88.9%, suggesting strong user acceptance of the generative interface and its integration into SAP execution.

Table 3: User-centric outcomes from survey responses (N=120)

Parameter	Manual SAP	Voice-Enabled Agentic
Accessibility Score (1–5)	2.8	4.6
Cognitive Workload (NASA-TLX: 0–100)	64.2	39.5
Error Rate (%)	11.7	4.2
User Satisfaction (1–5 Likert)	3.1	4.7
Adoption Intention (%)	56.5	88.9

Resilience metrics also showed marked improvements, as summarized in Table 4. Under demand spikes, mean time to recovery fell from 62 minutes in manual SAP to 28 minutes with agentic AI, while response rates improved by over 20 percentage points. Similar patterns were observed in logistics delays, where recovery time was cut from 84 to 36 minutes and response rates increased from 68.5% to 92.4%. Supply shortages also demonstrated higher tolerance levels, with variability tolerance rising from 54.9% to 82.7%, indicating stronger adaptive capacity of the AI-enabled system.

Table 4: Resilience metrics under disruption scenarios

Disruption Type	Recovery Metric	Manual SAP	Voice-Enabled Agentic
Demand Spike	MTTR (min)	62	28
Demand Spike	Response Rate (%)	71.3	93.6
Logistics Delay	MTTR (min)	84	36
Logistics Delay	Response Rate (%)	68.5	92.4
Supply Shortage	Variability Tolerance %	54.9	82.7

The trends in error reduction and latency improvement are further visualized in Figure 1, which depicts comparative trajectories across procurement, order fulfillment, inventory, and logistics workflows. The dual-axis line chart shows sharp declines in both error rates and latency for agentic AI, confirming that the system not only accelerates execution but also improves reliability.

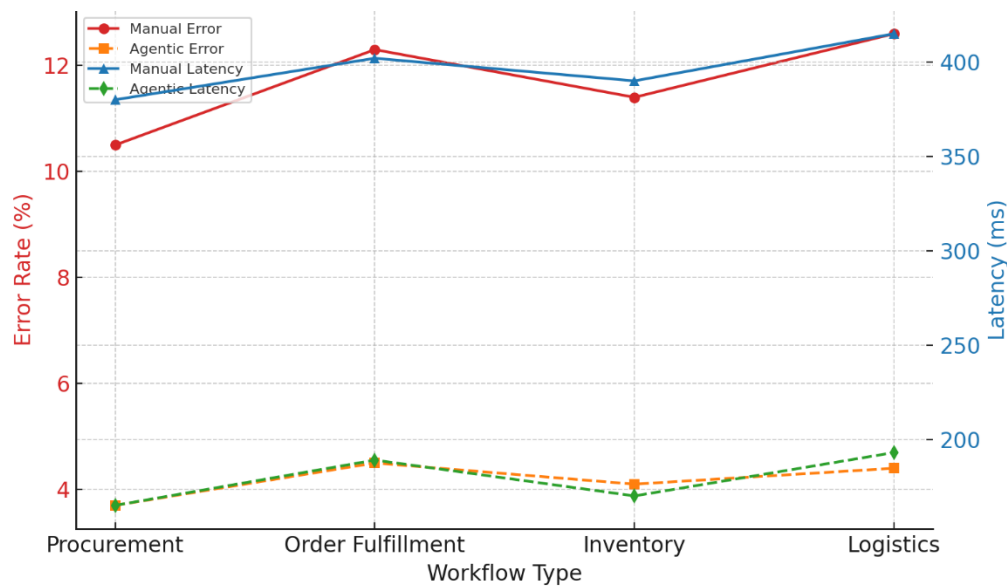


Figure 1: Comparative error and latency trends across workflows

Resilience performance is more comprehensively illustrated in Figure 2, which presents a radar chart of disruption responses. The agentic AI polygon consistently expands across all parameters, including demand spikes, logistics delays, supply shortages, recovery speed, and variability tolerance. The chart highlights a balanced and robust resilience profile under the AI-enabled system compared to the smaller, uneven profile of manual SAP workflows.

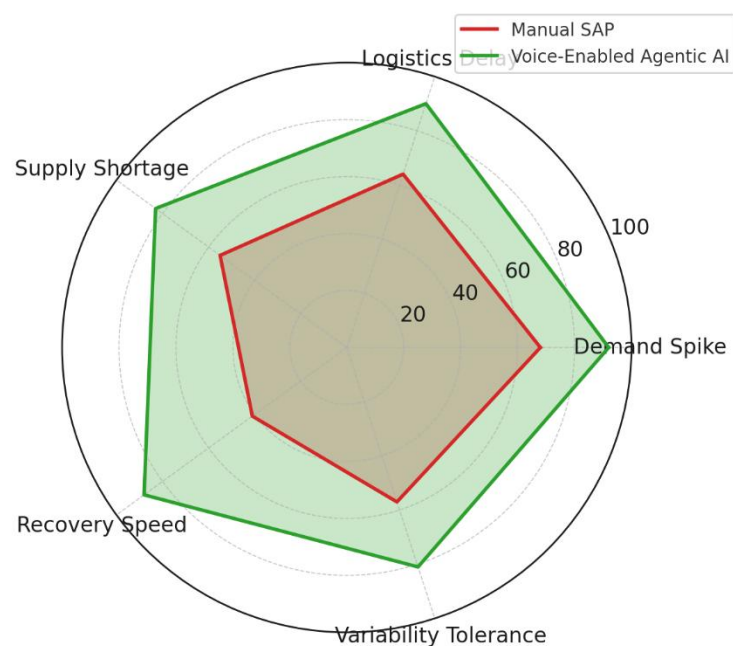


Figure 2: Resilience radar chart of disruption response

Discussion

Enhancing operational efficiency through Agentic AI

The findings of this study demonstrate that voice-enabled agentic AI considerably improves operational efficiency across procurement, inventory management, order fulfillment, and logistics workflows. Compared to manual SAP execution, the AI-enabled system reduced execution times by nearly half while simultaneously enhancing completion accuracy and lowering system latency (Table 1). This dual improvement suggests that agentic AI not only streamlines processes but also minimizes systemic bottlenecks associated with traditional enterprise systems (Ahmed & Huma, 2021). The results align with prior literature emphasizing the potential of autonomous AI agents to optimize workflow orchestration, yet this study extends the evidence by demonstrating effectiveness within live SAP execution environments (Cohen & Kouvelis, 2021).

Advancing decision quality and strategic agility

Beyond efficiency, decision quality emerged as a core strength of the proposed system. Forecast accuracy, anomaly detection, and optimization scores all significantly improved under the agentic AI framework (Table 2). These gains are attributable to the adaptive learning mechanisms embedded within the agentic decision-making layer, which continuously refines outputs based on contextual data streams (Irfan et al., 2022). Higher optimization scores further highlight the ability of the system to strike a balance between cost, lead time, and service levels an outcome particularly relevant for industries with volatile market conditions (Omowole et al., 2024). In effect, these findings illustrate how agentic AI enhances strategic agility by enabling organizations to anticipate disruptions and recalibrate responses in near real time.

User-centric value of generative voice interfaces

The integration of generative voice-enabled interfaces proved essential in reducing user complexity and improving accessibility. As evidenced in Table 3, user satisfaction and adoption intention increased significantly, while cognitive workload declined sharply. This indicates that conversational interfaces democratize access to complex ERP systems by allowing non-technical users to issue natural language commands (Munir et al., 2022). The reduction in error rates suggests that intuitive interfaces not only improve usability but also foster accuracy in execution. These findings reinforce the human-centric value of generative AI, shifting supply chain technologies from being purely operational tools to becoming collaborative platforms that actively empower users (Attah et al., 2024).

Building resilient and autonomous supply chains

Resilience under disruption scenarios was another critical outcome of the study. Agentic AI consistently reduced mean time to recovery and improved response rates across demand spikes, logistics delays, and supply shortages (Table 4). The radar chart in Figure 2 provides a holistic visualization of these resilience gains, where the agentic AI system displayed balanced and superior performance across all disruption dimensions. Such robustness is particularly relevant in today's volatile global context, where supply chains must be capable of withstanding and adapting to shocks (Miceli et al., 2021). By demonstrating substantial improvements in resilience, the system validates the argument that autonomy in supply chain execution is not only about efficiency but also about continuity and adaptability (Kashem et al., 2024).

Interpreting error and latency reductions

The comparative trends in Figure 1 highlight the reliability of the AI-enabled system by showing consistent declines in both error rates and system latency. Lower latency indicates faster responsiveness to commands, while fewer errors demonstrate the effectiveness of contextual natural language understanding in reducing miscommunication (Hosseini Shekarabi et al., 2025). This dual

reduction is critical, as high latency and error-prone systems have historically undermined trust in digital supply chain platforms (Maheshwari & Jaggi, 2024). By addressing these weaknesses, the system paves the way for broader acceptance of autonomous, AI-driven execution (Sahoo et al., 2023).

Theoretical and practical implications

The results of this study have significant implications for both theory and practice. From a theoretical standpoint, the findings contribute to the emerging discourse on agentic AI by empirically demonstrating its capacity to extend beyond predictive analytics toward autonomous execution in complex enterprise systems (Setyadi et al., 2025). Practically, the integration of generative voice interfaces and agentic AI into SAP environments provides a blueprint for organizations seeking to modernize their supply chain operations (Seow et al., 2024). The technology offers a path toward reducing human dependency on routine workflows while simultaneously ensuring that systems remain user-friendly and accessible (Cabrera et al., 2023).

Limitations and future research directions

While the results are promising, the study is not without limitations. The experimental design was conducted within sandbox SAP environments, which may not fully capture the scale, customization, and unpredictability of live global supply chain operations. Furthermore, the study focused on three industry case studies, which, although diverse, may not generalize to all sectors. Future research should expand to include cross-industry comparisons, longitudinal assessments of adoption, and the integration of multimodal interfaces such as visual dashboards alongside voice commands. Additionally, exploring the role of explainable AI could further enhance trust and transparency in autonomous supply chain decision-making.

Conclusion

This study demonstrated that the integration of voice-enabled agentic AI with SAP execution and generative interfaces significantly enhances the autonomy, efficiency, and resilience of supply chains. By reducing execution times, increasing process accuracy, and lowering latency, the system addressed long-standing operational inefficiencies of traditional ERP-based workflows. Improvements in decision quality, including higher forecasting accuracy and optimization scores, highlighted the adaptive intelligence of agentic AI in managing dynamic supply chain conditions. Equally important, the incorporation of generative voice interfaces reduced user workload, improved accessibility, and fostered greater acceptance, thereby bridging the gap between technical complexity and human usability. Resilience outcomes further underscored the system's ability to withstand disruptions and recover rapidly, establishing its role as a strategic enabler of continuity in uncertain global environments. While the research was conducted within controlled settings, the findings provide a compelling blueprint for organizations seeking to transition from digital to autonomous supply chains. Future work expanding across industries and real-world deployments will be essential to validate scalability, adaptability, and long-term adoption.

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