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Article

Intelligent Pricing Architectures for Autonomous Order-to-Cash Transformation

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Abstract: Enterprise SAP pricing is undergoing a structural evolution across three distinct phases: static condition record management, AI-augmented optimization with human-in-the-loop governance, and emerging autonomous pricing where AI commits condition values within pre-approved bounds without per-transaction human approval. No architectural roadmap connects these phases within SAP's clean-core extensibility model. This paper proposes a three-phase SAP pricing evolution framework and an architectural blueprint for autonomous Order-to-Cash pricing using SAP Joule, BAdI-governed AI integration, and BTP event mesh. Design science methodology is applied with feasibility assessment from IBM's Blue Harmony global enterprise program. The architectural components required for Phase 3 autonomous pricing are already present in current S/4HANA environments, the transition is a governance maturity decision, not a technical capability gap. A six-dimension governance framework, covering confidence floors, tolerance ceilings, material risk classification, transaction value limits, customer tier rules, and retraining frequency, defines the conditions under which autonomous condition value commitment is operationally safe. The proposed framework provides enterprise architects a validated pathway from AI-augmented to fully autonomous pricing without architectural rework.

Keywords: SAP S/4HANA, Autonomous Pricing, Order-to-Cash, SAP Joule, Artificial Intelligence, Clean Core, Enterprise Architecture

1. Introduction

Static SAP pricing, condition records set at a prior point, evaluated deterministically at order creation, with no mechanism to learn from outcomes, has been documented as a structural failure mode in enterprise Order-to-Cash operations [1]. Two architectural responses have been validated: a unified architecture eliminating pricing inconsistency across OTC document stages [2], and a hybrid AI-driven architecture connecting an ML optimization engine to SAP's condition evaluation flow through a Business Add-In (BAdI) injection point [3]. Both advances leave one capability gap intact. In the hybrid AI architecture, each recommendation still passes through human governance, confidence thresholds route borderline cases to analyst review, exception workflows hold billing documents until an approver acts. For high-volume global pricing operations, this per-transaction human gate becomes the bottleneck limiting the AI architecture's commercial benefit. What changes when the governance framework defines which decisions the AI engine may commit autonomously, and which require human judgment?

Answering that question is not primarily a technical problem. The BAdI infrastructure, the Business Technology Platform (BTP) API proxy, and the SAP AI Core model hosting required for autonomous pricing are already deployed in Phase 2 architectures. What is missing is a governance framework that defines the conditions under which autonomous commitment is operationally safe, and organizationally defensible when a buyer disputes a price or an auditor requests an explanation [4]. SAP Joule, the generative AI co-pilot embedded within SAP's cloud applications, addresses the organizational defensibility problem: rather than requiring compliance teams to review BAdI configuration tables or AI Core audit logs, Joule's natural language interface allows commercial users to query, govern, and adjust autonomous pricing operations through conversation [5]. Both problems, governance framework design and organizational oversight interface, are solvable with current platform capabilities.

Prior literature on autonomous enterprise pricing addresses the optimization problem without engaging with SAP's transactional architecture, or addresses SAP's architecture without modeling autonomous commitment governance [6]. At Phase 3, governance is the primary unresolved problem rather than the integration mechanism. This paper fills that gap by proposing a governance framework grounded in Phase 2 operational evidence and mapped to controls that are implementable without new SAP extensibility points or new BTP services. The contribution is threefold: a three-phase SAP pricing evolution model; a six-dimension governance framework for autonomous condition value commitment; and a Joule integration architecture mapping five governance interaction types to their feasibility on current S/4HANA infrastructure. Section 2 describes the research method and constructs the framework. Section 3 presents findings and discussion. Section 4 concludes.

2. Research Method

Design science methodology frames this paper's contribution, the three-phase model, the governance framework, and the Joule integration architecture are artifacts constructed to address a well-defined enterprise design problem [7]. Feasibility is assessed against operational evidence from IBM's Blue Harmony program, where the author served as SAP ABAP Technical Lead with direct responsibility for the Phase 2 AI-augmented pricing architecture [8]. Blue Harmony provides a rare evidence base: a production global enterprise environment where Phase 1, Phase 2, and the platform prerequisites for Phase 3 have all been observed, Phase 2 governance controls have been calibrated against real pricing data, and the operational consequences of governance design decisions are documented in the audit log.

Three phases describe the complete trajectory of SAP pricing capability. Phase 1 is the static baseline: pricing governed entirely by condition records, maintained manually, evaluated deterministically at order creation with no feedback from outcomes to future decisions. Phase 2 is AI-augmented pricing: an ML optimization engine provides recommendations through a BAdI injection point, governed by confidence thresholds and tolerance bands, with exception workflows for borderline cases and human approvers for decisions outside governance bounds [9]. Phase 3 is autonomous pricing: within a pre-approved governance framework, the AI engine commits condition values without requiring per-transaction human approval, the governance rules provide the control, and Joule provides the oversight interface for bulk governance actions and escalations. Each phase uses the preceding phase's governance infrastructure as its foundation. Table 1 maps the three phases to their architectural characteristics, governance models, and human involvement requirements.

Table 1. Three-Phase SAP Pricing Evolution Model

Phase	Architecture	Governance Model	Human Involvement
Phase 1, Static	Condition records, VOFM routines, manual VK11 maintenance, deterministic evaluation at order creation	Manual, analyst maintains condition records; no automated governance layer	Required for every pricing decision: condition record maintenance, override approval, reconciliation
Phase 2, AI-Augmented	BAdI injection point (PRCG_DOC_CONDITION_AMOUNT), BTP-hosted AI engine, confidence threshold, tolerance band, exception workflow	Semi-automated, AI recommends, governance rules filter, human approves exceptions and borderline cases	Required for exception cases, below-threshold decisions, and out-of-band recommendations

Phase 3, Autonomous	Phase 2 architecture + autonomous commit configuration, Joule conversational governance interface, BTP Event Mesh for governance triggers	Rule-governed, AI commits within pre-approved bounds; human exercises governance at framework level, not transaction level	Required for governance framework design, bulk exception review, retraining authorization, and flagged high-deviation decisions

Six governance dimensions define when autonomous commitment is operationally safe, derived from governance requirements analysis and validated against enterprise compliance standards [4]. The confidence floor specifies the minimum model confidence required for autonomous commit, recommendations below this floor route to the exception queue. The tolerance ceiling specifies the maximum deviation from the baseline condition record that may be committed autonomously, AI recommendations exceeding this ceiling require human approval regardless of confidence score. Material risk classification assigns each material category a risk tier (standard, elevated, regulated) that determines which governance rules apply. The transaction value ceiling sets a maximum order line value above which all pricing decisions require human sign-off. Customer tier approval specifies which customer classifications, strategic accounts, government contracts, regulated buyers, require human approval unconditionally. Retraining frequency specifies the maximum elapsed time between model retraining cycles; when this threshold is exceeded, autonomous commit suspends pending model refresh [10]. Table 2 maps each dimension to its BAdI-implementable control and the audit record it generates.

Table 2. Six Governance Dimensions, BAdI Controls, and Audit Records

Governance Dimension	**Definition**	**BAdI-Implementable Control**	**Audit Record Generated**
Confidence floor	Minimum AI model confidence score required for autonomous commitment	BAdI pre-check: score >= floor → commit autonomously; score < floor → route to exception queue	Confidence score, threshold applied, routing decision, timestamp
Tolerance ceiling	Maximum deviation from baseline condition record value committable autonomously	BAdI pre-check: recommendation within band → commit; outside band → human approval required regardless of confidence	Recommended value, baseline value, deviation %, band check result
Material risk classification	Risk tier (standard / elevated / regulated) assigned to each material category; regulated tier may prohibit autonomous commit	Extension Layer config table: material type → risk tier → applicable governance rules	Material category, risk tier applied, governance rule invoked
Transaction value ceiling	Maximum order line value above which all pricing decisions require human sign-off	BAdI pre-check: order line value <= ceiling → governance rules apply; > ceiling → mandatory human approval	Order line value, ceiling threshold, routing decision

Customer tier approval	Customer classifications (strategic accounts, government contracts, regulated buyers) requiring unconditional human approval	Extension Layer config table: customer account group → approval requirement flag	Customer tier, approval requirement flag, routing decision
Retraining frequency	Maximum elapsed time between model retraining cycles; exceeding threshold suspends autonomous commit	BAdI pre-execution: compare last retraining timestamp to configured threshold; suspend autonomous commit if exceeded	Last retraining date, threshold, suspension flag, timestamp

Five Joule interaction types connect the autonomous pricing engine to the commercial governance layer. Pricing decision query: users ask Joule to explain recent autonomous decisions for a customer or material group; Joule retrieves governance audit entries and presents them in natural language [5]. Governance parameter adjustment: users instruct Joule to modify confidence floors or tolerance ceilings for specific condition types; Joule translates the instruction to a configuration table update via the BTP API Management gateway. Bulk exception approval: users instruct Joule to clear the exception queue for a specified customer group; Joule processes the entries and releases held billing documents. Autonomous commit review: users ask Joule to surface decisions that deviated significantly from the baseline condition record in a specified period; Joule retrieves and ranks these for human review. Retraining trigger: users instruct Joule to initiate a retraining cycle for a specified material category; Joule publishes the trigger event to the BTP data pipeline [6]. Table 3 maps these five interaction types to their feasibility on current S/4HANA Joule capabilities.

Table 3. SAP Joule Integration: Five Governance Interaction Types and Feasibility Assessment

Joule Interaction Type	Description	Feasibility on Current S/4HANA
Pricing decision query	User asks Joule to explain recent autonomous pricing decisions for a customer or material group; Joule retrieves governance audit log entries and presents in natural language	Immediately feasible, supported by Joule's current NLP and SAP data access capabilities in S/4HANA
Governance parameter adjustment	User instructs Joule to modify confidence floor or tolerance ceiling for a condition type; Joule translates to Extension Layer configuration table update via BTP API Management gateway	Immediately feasible, supported through standard BTP API Management gateway already used by Phase 2 proxy
Bulk exception approval	User instructs Joule to approve all pending pricing exceptions for a specified customer group; Joule processes exception queue and releases held billing documents	Immediately feasible, supported by Joule's workflow triggering capabilities in current S/4HANA
Autonomous commit review	User asks Joule to surface autonomous pricing decisions that deviated significantly from baseline condition record in a specified period; Joule retrieves and ranks for human review	Requires BTP Event Mesh configuration, architecturally viable; deployment task, not development task

Retraining trigger	User instructs Joule to initiate a retraining cycle for a specified material category; Joule publishes trigger event to BTP data pipeline	Requires BTP Event Mesh configuration, architecturally viable; deployment task, not development task

3. Results and Discussion

Blue Harmony's operational record validates the three-phase model at each boundary. Phase 1 accurately describes the legacy pricing architecture before the transformation program, static condition records, manual maintenance, no AI involvement, periodic reconciliation identifying discrepancies. Phase 2 is the current deployed state: AI-augmented pricing through the BAdI integration pattern, confidence thresholds and tolerance bands active in production, exception workflows handling borderline cases [11]. Phase 3 readiness is assessed against what is already deployed: SAP AI Core serving the Phase 2 model, BTP API proxy operational, BAdI implementation carrying forward through a maintenance cycle without modification. What separates Phase 2 from Phase 3 is not a platform capability, it is a governance configuration decision. Table 4 maps the Phase 3 readiness assessment across all technical and governance dimensions.

Table 4. Phase 3 Readiness Assessment, Technical and Governance Dimensions

Readiness Dimension	Current State (Blue Harmony)	Phase 3 Requirement	Gap Assessment
BAdI injection point	PRCG_DOC_CONDITION_AMOUNT in production; carried forward through maintenance cycle without modification	Same BAdI extended with autonomous commit configuration parameter	No gap, configuration change only
BTP API proxy	Operational; routing pricing context payloads to AI engine in production	Same proxy; no changes required for autonomous commit path	No gap, existing deployment sufficient
SAP AI Core model	Phase 2 model deployed and serving recommendations in production	Same model; autonomous commit does not require model changes, only governance configuration change	No gap, existing model sufficient
Confidence floor control	Active as Phase 2 BAdI parameter; governing exception routing	Extended to govern autonomous commit authorization	No gap, parameter extension only
Tolerance ceiling control	Active as Phase 2 BAdI parameter; governing fallback logic	Extended to govern autonomous commit authorization	No gap, parameter extension only
Material risk classification	Not yet configured as governance parameter	New Extension Layer config table entry: material type → risk tier → governance rules	Governance gap, new config required; no new extensibility point needed
Transaction value ceiling	Not yet configured as governance parameter	New Extension Layer config table entry: value	Governance gap, new config required; no new extensibility point needed

		threshold → approval routing	
Customer tier approval	Not yet configured as governance parameter	New Extension Layer config table entry: customer account group → approval flag	Governance gap, new config required; no new extensibility point needed
Retraining frequency check	Not yet implemented	New BAdI pre-execution timestamp comparison against configured threshold	Governance gap, new BAdI logic; no new extensibility point needed
Joule integration (3 of 5)	Joule deployed in S/4HANA environment	Pricing decision query, governance parameter adjustment, bulk exception approval immediately feasible	No gap, current Joule capabilities sufficient for three interaction types
Joule integration (2 of 5)	BTP Event Mesh not yet configured as Joule endpoint	Autonomous commit review and retraining trigger require Event Mesh configuration	Deployment gap only, Event Mesh is available; configuration task estimated at one program increment

The governance framework, evaluated against enterprise audit requirements and SAP platform controls, confirms that all six dimensions map to implementable controls without new architectural components. Confidence floor and tolerance ceiling are already active as Phase 2 BAdI governance parameters, extending them to govern autonomous commitment rather than exception routing is a configuration change, not an architectural one [10]. Material risk classification, transaction value ceiling, and customer tier approval add three parameters to the Extension Layer's governance table; each maps to master data attributes already present in SAP (material type, order header value, customer account group). Retraining frequency adds a timestamp comparison to the BAdI pre-execution check. None of the six dimensions requires a new extensibility point, a new BTP service, or a change to the AI model [12]. The governance framework is entirely constructible from components in the current deployed Phase 2 architecture, reconfigured for autonomous operation.

The Joule feasibility assessment finds that three of the five interaction types work on current platform capabilities, and two require BTP Event Mesh configuration that is available but undeployed. Pricing decision query, governance parameter adjustment, and bulk exception approval are supported by Joule's natural language processing and workflow triggering in current S/4HANA [5]. Autonomous commit review and retraining trigger require Joule to publish events to BTP Event Mesh, architecturally viable, requiring deployment rather than development [6]. The overall readiness assessment is that Phase 3 is deployable within a standard program increment on existing infrastructure, with no platform gaps requiring external resolution.

Organizations that have deployed Phase 2 successfully, where confidence thresholds are calibrated, the audit log is producing clean diagnostic data, and the exception workflow is handling borderline cases reliably, already hold the operational foundation for Phase 3 [13]. The six governance dimensions represent the design decisions that convert that operational foundation into an autonomous commit configuration [4]. Attempting Phase 3 without Phase 2 governance maturity produces the specific failure mode this framework prevents: autonomous commitment of insufficiently calibrated recommendations that are commercially wrong and cannot be defended when challenged [14].

The sequencing principle, Phase 2 maturity before Phase 3 deployment, is not a constraint imposed by the architecture but a design principle embedded in the governance framework itself [15].

4. Conclusion

Autonomous Order-to-Cash pricing is deployable on current S/4HANA infrastructure. The BAdI injection point, the BTP-hosted AI engine, the governance controls, and the Joule conversational interface are all present in environments that have successfully deployed Phase 2 AI-augmented pricing. What the existing literature has not provided, and what this paper contributes, is a formalized governance framework that defines when autonomous commitment is safe, and a Joule integration architecture that makes governance accessible to the commercial users responsible for oversight.

Three artifacts constitute this paper's contribution. The three-phase SAP pricing evolution model provides a staged roadmap connecting static condition records through AI-augmented optimization to fully autonomous pricing, where each phase's governance infrastructure is the foundation for the next. The six-dimension governance framework defines confidence floor, tolerance ceiling, material risk classification, transaction value ceiling, customer tier approval, and retraining frequency as the control dimensions making autonomous commitment operationally safe and auditably defensible. The Joule integration architecture maps five conversational governance interactions to their feasibility on current S/4HANA infrastructure, confirming that three are deployable immediately and two require BTP Event Mesh configuration within a single program increment.

The practical implication is sequencing: Phase 2 governance maturity is the prerequisite for Phase 3. SAP architects should calibrate Phase 2 governance controls and validate audit log quality before configuring autonomous commit parameters, because the quality of Phase 2 governance data is the primary input to Phase 3 framework design decisions. Organizations that skip Phase 2 maturity and attempt direct Phase 3 deployment will produce the exact failure mode the governance framework is designed to prevent.

At Phase 3, SAP S/4HANA becomes what its architecture has been pointing toward, a system where pricing integrity is enforced structurally, optimization is provided by a continuously learning model, and governance is exercised conversationally through Joule with human judgment applied at the level of framework design rather than individual transaction approval. The autonomous enterprise is not a destination requiring new infrastructure. It is a governance configuration decision, made on the infrastructure that Phase 2 already built.

REFERENCES

1. S. Sarferaz, "A model for incorporating AI into ERP software," Discover Artificial Intelligence, vol. 6, no. 1, p. 391, 2026. Available: https://link.springer.com/article/10.1007/s44163-026-01362-5
2. R. Mahankali, "Accelerating S/4HANA migrations through strategic enterprise architecture," International Journal of Scientific Research in Computer Science, Engineering and Information Technology, vol. 11, no. 1, 2025. Available: https://ijsrcseit.com/home/article/view/CSEIT25111250
3. P. R. Devireddy, "Enterprise integration architecture and capabilities of SAP S/4HANA: A technical overview," International Journal of Scientific Research in Computer Science, Engineering and Information Technology, vol. 11, no. 2, pp. 533-543, 2025. Available: https://ijsrcseit.com/home/article/view/CSEIT25112350/CSEIT25112350
4. O. Otunlape, "Governance frameworks for enterprise AI systems operating in regulated environments," International Journal of Computer Applications, vol. 187, no. 74, pp. 13-21, 2026. Available: https://www.ijcaonline.org/archives/volume187/number74/governance-frameworks-for-enterprise-ai-systems-operating-in-regulated-environments/
5. S. Thambireddy, V. R. R. Bussu, and A. Pasumarthi, "Leveraging SAP Joule AI for autonomous business process optimization in 2025," Journal of Artificial Intelligence General Science (JAIGS), vol. 8, no. 1, pp. 241-257, 2025. Available: https://www.researchgate.net/publication/393084630_Leveraging_Sap_Joule_AI_for_Autonomous_Business_Process_Optimization_In_2025
6. S. Anand, "SAP Joule with BTP architecture: Empowering intelligent enterprises," World Journal of Advanced Research and Reviews, vol. 27, no. 1, pp. 620-625, 2025. Available: https://wjarr.com/sites/default/files/fulltext_pdf/WJARR-2025-2502.pdf

7. T. Samara, "AI-driven SAP S4/HANA, advancing firm operational efficiency, decision-making and resource optimization," International Journal of Innovative Research and Scientific Studies, vol. 8, no. 3, pp. 4795-4811, 2025. Available: https://ijirss.com/index.php/ijirss/article/view/7613
8. V. R. R. Bussu, "Unlocking business potential: Artificial intelligence and machine learning capabilities in SAP S/4HANA," International Journal of Innovative Science and Research Technology, vol. 9, no. 3, 2024. Available: https://www.researchgate.net/publication/379061558_Unlocking_Business_Potential_Artificial_Intelligence_and_Machine_Learning_Capabilities_in_SAP_S4HANA
9. S. V. Mhaskey, "Integration of artificial intelligence (AI) in enterprise resource planning (ERP) systems: Opportunities, challenges, and implications," International Journal of Computer Engineering in Research Trends, vol. 11, no. 12, pp. 1-9, 2024. Available: https://www.ijcert.org/index.php/ijcert/article/view/1036
10. R. Mishra, R. K. Singh, and T. Papadopoulos, "Linking digital orientation and data-driven innovations: A SAP-LAP linkage framework and research propositions," IEEE Transactions on Engineering Management, vol. 71, pp. 1346-1358, 2024. Available: https://ieeexplore.ieee.org/document/9745265
11. Zainab Nadhim Jawad and Villányi Balázs, "Machine learning-driven optimization of enterprise resource planning (ERP) systems: A comprehensive review," Beni-Suef University Journal of Basic and Applied Sciences, vol. 13, no. 1, p. 4, 2024. Available: https://link.springer.com/article/10.1186/s43088-023-00460-y
12. S. AlMuhayfith and H. Shaiti, "The impact of enterprise resource planning on business performance: With the discussion on its relationship with open innovation," Journal of Open Innovation: Technology, Market, and Complexity, vol. 6, no. 3, 2020. Available: https://www.mdpi.com/2199-8531/6/3/87
13. S. Nendrambaka, "Leveraging AI and machine learning in SAP S/4HANA Cloud: A research-based approach to supply chain optimization," International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 2024. Available: https://ijsrcseit.com/home/article/view/CSEIT241061232?
14. A. Sharma, "Machine learning and AI in SAP S/4HANA central finance: The future of financial data processing," International Journal of Management, vol. 16, no. 2, pp. 213-230, 2025. Available: https://iaeme.com/MasterAdmin/Journal_uploads/IJM/VOLUME_16_ISSUE_2/IJM_16_02_013.pdf
15. S. V. Mhaskey, "Composable ERP architecture: The future of a scalable and adaptive enterprise systems approach," European Journal of Computer Science and Information Technology, vol. 13, no. 52, pp. 1-12, 2025. Available: https://eajournals.org/ejcsit/vol13-issue52-2025/composable-erp-architecture-the-future-of-a-scalable-and-adaptive-enterprise-systems-approach/