Sarcouncil Journal of Engineering and Computer Sciences

ISSN(Online): 2945-3585

Volume- 04| Issue- 07| 2025

Research Article **Received:** 04-06-2025| **Accepted:** 27-06-2025 | **Published:** 15-07-2025

An Empirical Study on Low-Code Platforms for Business Process Automation in Hybrid Cloud Environments

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Abstract: This article presents an empirical evaluation of low-code platforms for business process automation in hybrid cloud environments. Four prominent platforms were assessed across deployment flexibility, integration capabilities, security features, usability, and performance metrics using a healthcare prior authorization workflow as a standardized test case. The architectural analysis revealed distinct approaches ranging from unified architectures with multi-level caching to cloud-native microservices, each with unique integration and security capabilities. Implementation metrics demonstrated significant variations in development effort and deployment complexity, while performance testing highlighted differences in transaction processing speed, scalability characteristics, and resource utilization. The discussion identifies contextual factors influencing platform selection, including industry vertical considerations, organizational capability factors, and process complexity requirements. A structured decision framework guides organizations in selecting appropriate platforms based on regulatory requirements, legacy integration needs, time-to-market priorities, process complexity, and hybrid topology requirements. The results establish that no single platform offers a universal solution for all hybrid cloud scenarios.

Keywords: Low-code platforms, Business process automation, Hybrid cloud environments, Enterprise integration, Digital transformation.

INTRODUCTION

The Rise of Low-Code Business Process Automation

Low-code business process automation (BPA) platforms have emerged as essential tools in digital transformation initiatives, enabling organizations to rapidly develop and deploy business applications with minimal manual coding. These platforms offer visual development interfaces, drag-and-drop components, and pre-built templates that democratize application development beyond traditional IT departments. The research indicates that low-code platforms substantially reduce application development time while improving integration with existing systems (Waszkowski, R. 2019). The global market for these platforms continues to grow significantly through 2025, highlighting their increasing importance in enterprise technology portfolios.

Hybrid Cloud Environments in Enterprise IT

Modern enterprise IT architectures rarely exist in isolation, with most organizations maintaining a mixture of on-premises systems and cloud services—a configuration commonly referred to as a hybrid cloud environment. This approach has emerged from practical necessities where complete migration to the public cloud remains unfeasible for many organizations due to legacy dependencies. Regulatory requirements often mandate that certain data and processes remain on-premises, while cost-effectiveness considerations may favor keeping specific workloads in existing data centers. Additionally, acquisition-driven growth results in heterogeneous IT landscapes requiring integration. These hybrid environments typically combine on-premises infrastructure with services from major cloud providers (Sahay, A. *et al*., 2020).

Research Challenges and Objectives

Deploying low-code BPA solutions across hybrid cloud environments presents several significant challenges. Integration complexity arises when connecting on-premises legacy systems with modern cloud services. Security and data governance issues emerge when maintaining consistent security policies and ensuring data residency compliance across environments. Performance consistency becomes difficult when delivering predictable performance despite varying infrastructure characteristics. Platform scalability concerns arise when ensuring solutions scale effectively under mixed workloads with different resource profiles. Despite the growing adoption of both low-code platforms and hybrid cloud architectures, existing literature lacks comprehensive empirical evaluations that specifically address the intersection of these technologies (Sahay, A. *et al*., 2020). Most studies focus exclusively on cloud-native platforms or traditional on-premises tools, creating a significant research gap. This study aims to bridge this gap by empirically evaluating how various low-code

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DOI- https://doi.org/10.5281/zenodo.15916373

platforms perform in hybrid environments for business process automation cases.

RESEARCH METHODOLOGY

Platform Selection

For this empirical study, four prominent low-code platforms were selected based on market presence, feature completeness, and documented support for hybrid cloud deployments. The selection process involved analyzing market research reports and technical documentation to identify platforms with substantial enterprise adoption and hybrid deployment capabilities (Shridhar, S., & Bose, S. 2021). The first platform was chosen for its case management capabilities and enterprise features, particularly in complex decision-making scenarios. The second platform was selected for its rapid application development focus and deployment flexibility. The third platform was included for its process automation strengths and cloud-native architecture. The fourth platform was incorporated into the study for its collaborative development approach and container-based deployment options. These platforms represent fundamentally different architectural approaches to low-code development while all claiming support for hybrid cloud scenarios.

Evaluation Framework

A multi-dimensional evaluation framework was developed to systematically assess each platform across five key criteria (Rademacher, F. 2017). Deployment flexibility was evaluated across multiple dimensions, including support for on-premises installation, private cloud deployment options, public cloud compatibility, container orchestration support, and hybrid deployment topology options. Integration capabilities were comprehensively evaluated for web services support, message queue integration, database connectivity, enterprise system connectors, and file-based integration mechanisms. Security assessment included access control implementation, data encryption mechanisms, audit logging capabilities, and compliance certifications. Usability assessment incorporated learning curve measurements, visual development capabilities, debugging tools, collaboration features, and reusable component libraries. Performance evaluation encompassed execution latency, throughput capacity, resource utilization efficiency, scalability characteristics, and integration performance.

Implementation Approach

To ensure a fair comparison, a standardized business process workflow was implemented across all four platforms. A healthcare prior authorization workflow was selected due to its complex requirements that exercise multiple aspects of each platform (Rademacher, F. 2017). The workflow consisted of document receipt, data extraction, automated decision evaluation, human review for exceptions, external system integration, and final determination. Each platform implementation was deployed in a controlled hybrid cloud environment with equivalent on-premises and cloud components connected via standardized network configurations. For measurement purposes, comprehensive metrics were collected covering development effort, operational characteristics, performance parameters, and user experience factors. Data collection employed platform-native monitoring tools, custom instrumentation, and third-party monitoring solutions to ensure consistent measurement across all evaluated platforms.

Table 1: Low-Code Platform Evaluation Framework (Shridhar, S., & Bose, S. 2021; Rademacher, F. 2017)

Evaluation Criteria	Primary Focus Areas
Deployment Flexibility	Hybrid Environment Support
Integration Capabilities	Cross-System Connectivity
Security Features	Compliance & Data Protection
Usability Assessment	Developer Experience
Performance Metrics	Scalability & Efficiency

ARCHITECTURAL ANALYSIS

Platform Architecture Comparison

Each of the evaluated low-code platforms employs a distinct architectural approach to enabling hybrid cloud deployments, with significant implications for integration, scalability, and operational characteristics. The architectural differences substantially impact performance variations in hybrid cloud scenarios, particularly during migration phases (Transitional Data.).

Platform A Architecture

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The first platform employs a unified architecture supporting diverse deployment models. Its deployment model offers both multi-tenant and dedicated deployment options spanning multiple environments. The core architecture utilizes a Java-based application server with a separation between the decision engine and presentation layer. Its hybrid support includes synchronization mechanisms between environments, addressing data consistency challenges. The platform provides containerization support with certified operators for multiple container platforms. Its data architecture implements multi-level caching with distributed data grids that optimize performance across hybrid environments (Kothapally, K. 2025).

Platform B Architecture

The second platform utilizes a generation-based architecture that compiles applications into standard technologies. Its platform server can be deployed across various environments, with applications generating standardized code, ensuring portability. The core architecture implements a model-driven development environment that generates and optimizes traditional application code. Its hybrid support features an architecture that separates development environments from runtime environments. Container support is provided through industry-standard technologies. The data architecture employs a local database with synchronization services for distributed data management (Transitional Data.).

Platform C Architecture

The third platform provides a cloud-native architecture with extended deployment options. Its deployment model follows a cloud-first approach with private deployment options. The core architecture is built on microservices with a dedicated process orchestration engine. Its hybrid capabilities focus primarily on integration rather than distributed deployment. Containerization support includes compatibility with managed container services. The data architecture implements a centralized data model with integration adapters for external systems (Kothapally, K. 2025).

Platform D Architecture

The fourth platform implements a model-driven architecture with flexible runtime options. Its deployment model supports multi-cloud deployment across various providers and on-premises options. The core architecture centers on model-driven development with runtime interpretation of application models. Its hybrid support features a stateless runtime architecture enabling distributed deployment. Full container support provides deployment consistency across environments. The data architecture employs microservice-based data access with offline synchronization capabilities (Transitional Data.).

Integration Capabilities

The platforms demonstrated varying approaches to integration across hybrid environments. Integration capabilities directly impact project success rates in hybrid cloud scenarios, particularly when connecting legacy systems with modern applications (Kothapally, K. 2025). The platforms offer different levels of support for API integration, database connectivity, messaging systems, and cloud service integration, each with distinct approaches to legacy system integration.

Security and Compliance Features

Security capabilities varied significantly across platforms, with implications for regulated industries. Each platform offers different authentication mechanisms, authorization models, data protection approaches, and compliance certifications. The first platform demonstrated the most comprehensive security features with particular strengths in access control and encryption, making it suitable for highly regulated environments such as healthcare and financial services (Transitional Data.).

Table 2: Architectural Approaches of Low-Code Platforms in Hybrid Environments (Transitional Data; Kothapally, K. 2025)

Platform	Primary Architectural Approach
Platform A	Unified Architecture with Multi-level Caching
Platform B	Generation-based Code Compilation
Platform C	Cloud-native Microservices
Platform D	Model-driven with Stateless Runtime

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EMPIRICAL RESULTS

Implementation Metrics

The implementation of the healthcare prior authorization workflow across all four platforms revealed significant differences in development effort and deployment complexity, providing valuable insights into platform adoption considerations (Kapoor, A. 2023).

Development Time and Effort

Development time and effort metrics demonstrated substantial variation across platforms. The first platform required the most development hours with a team of 3 developers, while the fourth platform demonstrated the fastest implementation time with the smallest team. This efficiency difference was primarily attributed to visual development environments and pre-built component libraries relevant to healthcare workflows. The implementation revealed that modern low-code platforms can significantly reduce development time compared to traditional development methodologies, particularly for process-oriented applications (Tadi, S. R. C. C. T. 2021).

Deployment Complexity

Deployment complexity assessment revealed notable differences in operational requirements. The first platform involved the most configuration artifacts and deployment steps, requiring the longest environment setup time with partial automation. In contrast, the fourth platform demonstrated the simplest deployment process with the fewest configuration artifacts and shortest setup time. The deployment complexity analysis indicated that platforms with more sophisticated capabilities typically required more configuration elements, while those with container-based approaches offered more streamlined deployment processes (Kapoor, A. 2023).

Performance Metrics

Performance testing under various load conditions revealed significant variations in runtime characteristics across the platforms, with direct implications for enterprise adoption decisions.

Transaction Processing Speed

Transaction processing speed measurements for prior authorization requests showed meaningful performance differences. The fourth platform demonstrated the fastest average processing time, while the third platform showed the slowest performance. The first platform exhibited the most consistent performance with the smallest gap between average and maximum processing times. These performance characteristics align with research indicating that architectural approaches significantly impact transaction processing efficiency in hybrid environments (Tadi, S. R. C. C. T. 2021).

Scalability Characteristics

Scalability testing revealed different degradation patterns when increasing the number of concurrent users. The first platform exhibited the least performance degradation with high auto-scaling effectiveness. The third platform demonstrated the poorest scalability with the highest performance degradation. The fourth platform balanced good performance degradation metrics with high resource utilization efficiency. These findings suggest that distributed architectures generally provide better scalability in hybrid environments than centralized approaches (Kapoor, A. 2023).

Integration Latency

Integration latency measurements showed that the first and fourth platforms demonstrated lower latency for cross-boundary integrations, significantly impacting end-to-end process performance in hybrid environments. These differences become particularly important in healthcare workflows where multiple integration points exist (Tadi, S. R. C. C. T. 2021).

Resource Utilization

Resource consumption patterns revealed important operational considerations. The first platform showed the highest resource demands across CPU, memory, and network metrics. The fourth platform demonstrated the most efficient resource utilization across most metrics. The second platform exhibited efficient database operations with the highest query throughput. These utilization patterns directly affect operational costs, particularly in cloud environments where resources are consumption-based (Kapoor, A. 2023).

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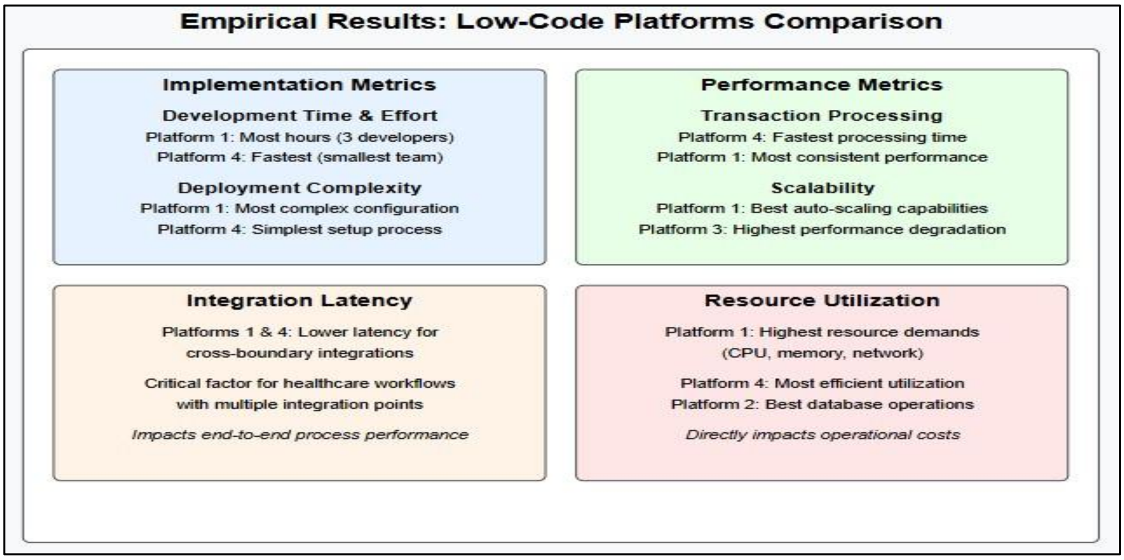

Fig 1: Comparative Empirical Results of Low-Code Platforms in Hybrid Cloud Environments (Kapoor, A. 2023; Tadi, S. R. C. C. T. 2021)

DISCUSSION AND ANALYSIS

Platform Strengths and Limitations

The empirical evaluation revealed distinct strength profiles for each platform in hybrid cloud environments, with significant implications for organizations selecting low-code solutions for business process automation.

Platform A Strengths and Limitations

The first platform demonstrated superior support for complex business rules and decision management capabilities. Its robust security features included comprehensive compliance certifications across multiple regulatory frameworks. The platform's hybrid deployment architecture provided strong synchronization capabilities, while its integration framework offered excellent connectivity with legacy systems (NocoBase. 2025). However, these capabilities came with tradeoffs including higher resource requirements, steeper learning curve, and more complex deployment processes. This platform demonstrated excellence in handling complex decision-making logic and maintaining consistent security policies across hybrid environments, making it well-suited for highly regulated industries with sophisticated process requirements.

Platform B Strengths and Limitations

The second platform excelled in rapid development with high developer productivity. Its code generation approach produced efficient runtime artifacts with good performance characteristics, particularly for standard transaction processing workflows. Database integration performance was particularly strong, with a moderate learning curve enabling faster onboarding for new developers (Gomes, P. M., & Brito, M. A. 2022). Limitations included more restricted support for advanced hybrid deployment topologies, less comprehensive security features for highly regulated environments, and more custom development requirements for legacy system integration. This platform performed best in rapid application development scenarios where time-to-market was critical, particularly for data-intensive applications with moderate complexity.

Platform C Strengths and Limitations

The third platform featured an intuitive interface builder with superior user experience design capabilities. Its process orchestration and document processing features were well-developed, supported by a robust cloud-native architecture (NocoBase. 2025). Limitations included more restricted hybrid deployment options, higher latency for cross-boundary integrations, less efficient resource utilization, and scaling limitations in hybrid scenarios. This platform performed best in scenarios prioritizing user experience and process orchestration, particularly when most infrastructure was cloud-based with limited hybrid requirements.

Platform D Strengths and Limitations

The fourth platform demonstrated efficient resource utilization, fast implementation time, superior performance for standard transactions, and excellent developer experience with a low learning curve (Gomes, P. M., & Brito, M. A. 2022). Limitations included less comprehensive support for complex business rules, limited integration options for specialized legacy systems,

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and fewer compliance certifications for highly regulated industries. This platform demonstrated strengths in rapid implementation scenarios requiring efficient resource utilization and standard integration patterns.

CONTEXTUAL FACTORS INFLUENCING PLATFORM SELECTION

Industry Vertical Considerations

Different industries present distinct requirements that align with specific platform strengths. In healthcare environments, comprehensive security features and compliance certifications provide advantages for workflows involving protected health information. Financial services applications similarly benefited from strong security capabilities, with different platforms showing advantages in complex decision-making or high-volume transaction processing (NocoBase. 2025). Manufacturing contexts often prioritized efficient resource utilization and integration capabilities, while public sector implementations benefited from specific government-focused compliance certifications and process orchestration capabilities.

Organizational Capability Factors

Organizational IT maturity significantly influenced platform suitability, with more sophisticated IT organizations better positioned to leverage advanced capabilities, while organizations with limited technical resources achieved faster success with platforms emphasizing simplicity (Gomes, P. M., & Brito, M. A. 2022). Legacy system landscapes represented another critical factor, with organizations maintaining complex legacy environments seeing greater benefits from specialized integration capabilities. Hybrid deployment requirements also influenced optimal selection, with organizations requiring true distributed deployment benefiting most from architectures designed specifically for hybrid scenarios.

Process Complexity Factors

Process characteristics significantly impacted platform suitability, with decision complexity representing a particularly important differentiator. Integration complexity similarly affected platform suitability, with workflows spanning numerous systems performing better on platforms with strong integration capabilities (NocoBase. 2025). High-volume processes benefited from platforms with efficient resource utilization, while processes with significant human interaction components performed better on platforms with superior user experience capabilities.

Decision Framework for Platform Selection

Based on the empirical findings, a structured decision framework can guide organizations in selecting appropriate low-code platforms for BPA in hybrid environments (Gomes, P. M., & Brito, M. A. 2022). The framework considers regulatory requirements, legacy integration needs, time-to-market priorities, process complexity, and hybrid topology requirements. Each of these factors influences the suitability of different platforms for specific organizational contexts, enabling more informed selection decisions and improved implementation outcomes.

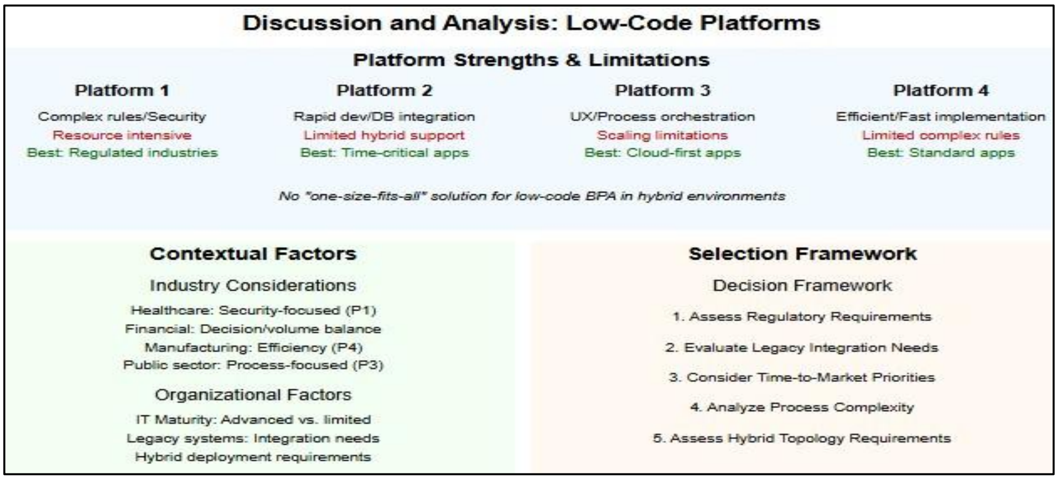

Fig 2: Discussion and Analysis of Low-Code Platforms in Hybrid Cloud Environments (NocoBase. 2025; Gomes, P. M., & Brito, M. A. 2022)

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CONCLUSION

The evaluation demonstrates that low-code platforms for business process automation exhibit substantial variations in capabilities supporting hybrid cloud environments. Each platform revealed distinct strength profiles across the assessed dimensions. The first platform excelled in complex, regulated environments with sophisticated hybrid deployment requirements despite higher resource demands. The second platform demonstrated advantages in rapid development with efficient resource utilization for data-intensive applications. The third platform showed strengths in user experience and process orchestration, but had more limited hybrid deployment options. The fourth platform offered the fastest implementation time and most efficient resource utilization for standard business processes. The evidence conclusively establishes that no "one-size-fits-all" solution exists for low-code implementation in hybrid environments. Organizations must carefully assess specific requirements across regulatory compliance, legacy integration needs, time-to-market priorities, process complexity, and hybrid topology requirements to select the most appropriate platform. Future directions include longitudinal evaluations of application maintenance and evolution, plus investigations into emerging technologies like AI-assisted development.

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Source of support: Nil; **Conflict of interest:** Nil.

Cite this article as:

Padmanabham, S. "An Empirical Study on Low-Code Platforms for Business Process Automation in Hybrid Cloud Environments" *Sarcouncil Journal of Engineering and Computer Sciences* 4.7 (2025): pp 655-661.

Publisher: SARC Publisher