

HYBRID CLOUD SOLUTIONS FOR SAP IN LEGACY SYSTEMS

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ABSTRACT

The integration of hybrid cloud solutions in legacy systems for SAP environments has become a key strategy for organizations aiming to modernize their infrastructure while maintaining the stability of existing applications. Hybrid cloud frameworks combine the benefits of on-premise systems with the scalability, flexibility, and cost-effectiveness of cloud computing. This approach enables businesses to run critical SAP workloads on legacy infrastructure while migrating non-essential processes to the cloud. The hybrid model enhances operational agility, facilitates data synchronization across platforms, and offers improved disaster recovery options. However, the adoption of hybrid cloud solutions for SAP within legacy systems presents unique challenges, including compatibility issues, data security concerns, and the complexity of managing multi-cloud environments. This paper explores the benefits, challenges, and best practices of implementing hybrid cloud solutions for SAP, providing insights into how organizations can optimize their legacy SAP systems for future growth and innovation.

KEYWORDS - Hybrid Cloud, SAP, Legacy Systems, Cloud Integration, Scalability, Data Synchronization, Disaster Recovery, Multi-Cloud Environments, Infrastructure Modernization, Cloud Migration, Data Security, Operational Agility

Article History

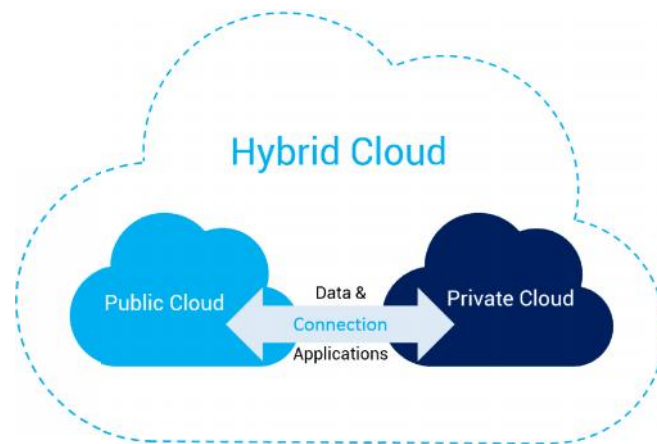
Received: 13 Nov 2024 | Revised: 19 Nov 2024 | Accepted: 26 Nov 2024

INTRODUCTION

In the modern era, enterprises across industries are faced with the challenge of transforming their IT landscapes to meet the demands of innovation, scalability, and efficiency. One of the most significant areas of focus is the integration of cloud computing with legacy systems, particularly for mission-critical applications like SAP (Systems, Applications, and Products in Data Processing). While traditional IT systems, including on-premise infrastructure, have long served businesses with stable and reliable operations, they often lack the flexibility, scalability, and cost-efficiency needed in today's dynamic business environments. As a result, organizations are increasingly turning to hybrid cloud solutions as a means of bridging the gap between legacy systems and modern cloud capabilities.

A hybrid cloud solution combines the best of both worlds by integrating on-premise systems with public and private cloud environments. For SAP environments, this approach allows organizations to modernize their IT infrastructure without having to completely replace their existing legacy systems. SAP, which is widely used by large enterprises for enterprise resource planning (ERP), customer relationship management (CRM), supply chain management, and more, requires a careful and strategic approach to cloud integration. Legacy SAP systems, while highly reliable, often struggle to keep pace with emerging technological trends, which is where hybrid cloud solutions come into play.

Hybrid cloud solutions offer businesses a way to retain the benefits of their existing legacy systems while gaining the flexibility, agility, and cost advantages that come with cloud technology. The hybrid model allows organizations to run their critical SAP workloads on legacy infrastructure while migrating non-essential workloads to the cloud. This approach not only addresses scalability and resource management concerns but also optimizes operational efficiencies by enabling data and applications to run seamlessly across hybrid environments.



Despite the significant advantages of hybrid cloud solutions, there are several challenges associated with their adoption in legacy systems running SAP. These include concerns around system compatibility, data security, compliance, integration complexity, and the ability to maintain performance and reliability. Successfully implementing a hybrid cloud strategy for SAP requires careful planning, a deep understanding of both the technical and business requirements, and the selection of appropriate tools and technologies to ensure a seamless integration process.

This paper explores the integration of hybrid cloud solutions for SAP in legacy systems, providing an overview of the concept, key benefits, challenges, and best practices. We will examine how hybrid cloud can address the evolving needs of businesses using SAP, how organizations can overcome technical obstacles, and the steps involved in adopting a hybrid cloud architecture that ensures long-term sustainability.

By leveraging a hybrid cloud model, enterprises can not only modernize their SAP applications but also align their IT infrastructure with future demands, enabling them to remain competitive in a rapidly changing market landscape. Through this detailed exploration, we aim to provide a comprehensive guide for businesses considering hybrid cloud strategies and help them make informed decisions about the future of their SAP environments.

The Need for Hybrid Cloud in Legacy Systems

Legacy systems, including SAP deployments, have long been the backbone of large organizations, ensuring the continuity and reliability of business processes. However, as digital transformation accelerates, the limitations of these legacy systems

have become increasingly apparent. These systems often suffer from several issues, including:

1. **Limited Scalability:** Legacy systems are typically designed with fixed resources and lack the scalability that modern businesses require to grow and adapt quickly. The growing demands of big data, artificial intelligence, machine learning, and other cutting-edge technologies put significant strain on legacy infrastructures.
2. **Cost of Maintenance:** Maintaining and supporting legacy systems is often expensive. These systems require specialized skills, have outdated hardware, and may not integrate easily with new technologies, creating challenges for organizations looking to innovate.
3. **Lack of Flexibility:** Traditional systems are often rigid and lack the flexibility needed to quickly adjust to market changes, customer demands, or new regulatory requirements.
4. **Security Concerns:** Older systems may not meet the latest security standards, putting organizational data at risk of breaches or compliance violations.

Hybrid cloud offers a compelling solution to these challenges. By adopting a hybrid cloud model, organizations can offload non-critical processes to the cloud, enabling them to scale efficiently while continuing to rely on their existing legacy SAP systems for mission-critical tasks. This combination offers businesses the flexibility to evolve their IT environments incrementally, avoiding the risks and costs associated with a complete system overhaul.



Advantages of Hybrid Cloud for SAP Integration

1. **Scalability:** One of the most significant benefits of hybrid cloud is scalability. Cloud platforms offer virtually unlimited resources, allowing businesses to scale their SAP environments as needed without the need for large capital investments in on-premise hardware. This is particularly useful for companies with fluctuating workloads or seasonal demand.
2. **Cost Efficiency:** By utilizing public cloud resources for less critical processes, businesses can reduce their dependence on costly on-premise infrastructure. This pay-as-you-go model ensures that organizations only pay for the resources they use, leading to significant cost savings.
3. **Agility and Flexibility:** Hybrid cloud environments allow businesses to remain agile by quickly provisioning new applications, testing new features, and experimenting with innovative technologies without disrupting the core SAP functions running on legacy systems.

4. **Improved Disaster Recovery:** Hybrid cloud architectures often come with built-in disaster recovery options, ensuring that critical data is replicated in the cloud and can be quickly restored in the event of an outage or system failure.
5. **Innovation and Future-Readiness:** With hybrid cloud, companies can gradually adopt new technologies like AI, machine learning, and IoT (Internet of Things) without completely overhauling their legacy systems. This enables them to remain competitive while modernizing their IT infrastructure.

Challenges in Implementing Hybrid Cloud for SAP

While the advantages of hybrid cloud are clear, there are several challenges that organizations must overcome to successfully implement hybrid cloud solutions for their SAP environments:

1. **System Compatibility:** Integrating legacy SAP systems with modern cloud infrastructure can be complex. Compatibility issues between old and new technologies can cause performance degradation or integration failures if not properly addressed.
2. **Data Security and Compliance:** Cloud environments, especially public clouds, raise concerns regarding data security, compliance with regulatory standards, and protection of sensitive business information. Ensuring that cloud-based SAP applications meet industry standards for security and compliance is critical.
3. **Performance and Latency:** While cloud solutions are scalable, latency issues may arise, especially if data is frequently transferred between on-premise systems and cloud-based applications. Ensuring that the hybrid cloud model delivers optimal performance for mission-critical SAP tasks is essential.
4. **Complexity in Management:** Managing a hybrid environment that includes both on-premise systems and multiple cloud providers can be challenging. Enterprises need skilled resources and the right tools to ensure smooth operations across both environments.
5. **Integration Costs:** Although hybrid cloud models promise cost savings in the long term, the initial integration costs can be substantial. Businesses must weigh the benefits against the costs of migration, system integration, and ongoing maintenance.

As organizations strive to remain competitive and agile in a fast-paced digital economy, hybrid cloud solutions for SAP in legacy systems provide an attractive strategy for modernization. The hybrid model offers the best of both worlds, enabling businesses to continue leveraging their legacy SAP applications while gaining the scalability, flexibility, and cost savings offered by the cloud.

LITERATURE REVIEW

| Aspect | Description |
|---|--|
| Need for Hybrid Cloud in Legacy Systems | Legacy systems, including SAP, are limited by scalability, cost of maintenance, flexibility, and security concerns. These issues make it difficult for businesses to keep up with modern demands and technological advancements. Hybrid cloud offers a way to address these challenges by integrating legacy systems with cloud solutions. |
| Advantages of Hybrid Cloud for SAP Integration | Hybrid cloud offers key advantages such as scalability, cost efficiency, agility, flexibility, improved disaster recovery, and the ability to innovate while retaining legacy systems. This enables organizations to optimize their SAP environments and gradually transition to modern cloud technologies. |
| Challenges in Implementing Hybrid Cloud for SAP | Key challenges include system compatibility between legacy SAP systems and modern cloud infrastructure, data security and compliance concerns, performance and latency issues, complexity in management, and integration costs. Organizations need to address these challenges carefully to successfully implement hybrid cloud solutions for SAP. |

RESEARCH QUESTIONS

1. What are the key benefits of integrating hybrid cloud solutions into legacy SAP systems for enterprises seeking scalability and cost-efficiency?
2. How do hybrid cloud architectures improve the operational agility of legacy SAP systems without requiring full system overhauls?
3. What challenges do organizations face when integrating legacy SAP systems with hybrid cloud environments, and how can these challenges be mitigated?
4. How does the hybrid cloud model impact data security, privacy, and compliance in SAP applications, especially for industries with strict regulatory requirements?
5. What best practices can enterprises follow to ensure seamless migration of non-critical SAP workloads to the cloud while maintaining performance for mission-critical functions?
6. How does the performance of legacy SAP systems change when hybrid cloud solutions are applied, particularly in terms of latency, speed, and resource optimization?
7. What role does hybrid cloud play in enhancing disaster recovery and business continuity for organizations using SAP systems in legacy environments?
8. How can organizations assess the compatibility between their legacy SAP systems and modern cloud technologies before adopting a hybrid cloud strategy?
9. What are the cost implications of adopting hybrid cloud solutions for SAP, and how do these solutions contribute to long-term financial sustainability for enterprises?
10. How can hybrid cloud solutions facilitate innovation and future-readiness for organizations running legacy SAP systems, particularly with emerging technologies like AI, machine learning, and IoT?

These questions explore various dimensions of hybrid cloud adoption in SAP environments and address critical areas such as performance, security, cost, and scalability.

RESEARCH METHODOLOGIES

1. Literature Review

- J **Objective:** To explore existing research, case studies, and theoretical frameworks on hybrid cloud solutions for legacy systems and SAP environments.
- J **Method:** A systematic literature review (SLR) will be conducted to collect, synthesize, and critically evaluate the most relevant and recent research papers, articles, and industry reports. This will provide foundational knowledge and help in identifying gaps in the current body of knowledge.
- J **Outcome:** A deep understanding of the current state of hybrid cloud integration with legacy SAP systems, identifying key benefits, challenges, and best practices.

2. Case Study Analysis

- J **Objective:** To investigate real-world implementations of hybrid cloud solutions in legacy SAP systems within organizations across various industries.
- J **Method:** This will involve selecting a few organizations that have implemented hybrid cloud solutions for their SAP systems. Through direct interviews with IT managers, decision-makers, and technical teams, the study will gather insights about their experiences, challenges, and the outcomes of their hybrid cloud adoption.
- J **Outcome:** A detailed comparison of how hybrid cloud solutions have been implemented, the benefits achieved, and the hurdles encountered.

3. Surveys and Questionnaires

- J **Objective:** To collect data from a larger sample of organizations that have adopted or are considering hybrid cloud solutions for SAP systems.
- J **Method:** A structured survey with a mix of quantitative and qualitative questions will be distributed to IT professionals, SAP consultants, and cloud architects. This survey will address aspects such as the perceived benefits, costs, and challenges of integrating hybrid cloud with legacy SAP systems.
- J **Outcome:** Quantitative data on the extent of hybrid cloud adoption, common barriers, and success factors, along with qualitative insights on decision-making and strategic considerations.

4. Interviews

- J **Objective:** To gather in-depth insights from key stakeholders, such as SAP administrators, IT directors, cloud architects, and consultants.
- J **Method:** Semi-structured interviews will be conducted with industry experts who have worked on hybrid cloud adoption for SAP systems. The interviews will allow for a more personal and detailed exploration of the research questions, uncovering insights that might not be captured in surveys.
- J **Outcome:** Rich qualitative data that adds depth to the study, providing expert opinions and firsthand experiences with hybrid cloud integration in legacy SAP environments.

5. Data Analysis and Modeling

- J **Objective:** To analyze performance, cost, and scalability metrics associated with hybrid cloud adoption for SAP environments.
- J **Method:** Using data collected from organizations that have implemented hybrid cloud solutions, statistical and analytical tools will be used to model the impact of hybrid cloud adoption on SAP systems. Metrics such as performance improvement, cost reduction, scalability, and resource utilization will be evaluated.
- J **Outcome:** Quantitative insights into the measurable impact of hybrid cloud on SAP system performance and costs, supporting data-driven conclusions.

6. Comparative Analysis

- J **Objective:** To compare traditional on-premise SAP systems with hybrid cloud SAP systems in terms of performance, scalability, and costs.
- J **Method:** A side-by-side comparison of the performance and costs of legacy on-premise SAP systems and their hybrid cloud counterparts will be performed. This analysis will be based on secondary data or data from case studies and surveys.
- J **Outcome:** A clear understanding of how hybrid cloud solutions outperform or complement traditional SAP systems, identifying key advantages and disadvantages.

7. System Simulation and Testing

- J **Objective:** To test the integration of SAP applications in hybrid cloud environments.
- J **Method:** A simulation of hybrid cloud environments, using a mix of on-premise and cloud infrastructure, will be set up to evaluate the compatibility and performance of SAP workloads in this environment. Load testing, disaster recovery simulations, and scalability testing can be performed to assess the cloud solution's impact.
- J **Outcome:** Empirical evidence on the effectiveness of hybrid cloud in improving SAP system performance, resource management, and fault tolerance.

8. Action Research

- J **Objective:** To implement and evaluate hybrid cloud solutions in real-time within an organization.
- J **Method:** Action research will involve working with an organization to design and implement a hybrid cloud strategy for their SAP environment. The research team will collaborate with the organization's IT department to install, test, and monitor the system, gathering feedback and adjusting strategies as needed.
- J **Outcome:** Practical, hands-on insights and a real-world evaluation of hybrid cloud implementation for SAP systems, contributing to both academic knowledge and industry best practices.

9. SWOT Analysis

- J **Objective:** To assess the strengths, weaknesses, opportunities, and threats of hybrid cloud integration with legacy SAP systems.
- J **Method:** Conduct a SWOT analysis based on secondary data, expert interviews, and case studies to identify internal and external factors that could influence the success of hybrid cloud adoption for SAP.
- J **Outcome:** A comprehensive overview of the strategic considerations involved in adopting hybrid cloud solutions for SAP, which will help organizations make informed decisions.

10. Framework Development

- J **Objective:** To create a strategic framework for adopting hybrid cloud solutions for legacy SAP systems.
- J **Method:** Based on findings from the literature review, case studies, and expert interviews, a framework for successfully adopting and integrating hybrid cloud solutions in SAP systems will be developed. This framework will address key phases such as planning, migration, integration, and post-adoption.
- J **Outcome:** A practical guide for businesses to follow when considering hybrid cloud adoption for SAP systems, enhancing the implementation success rate.

By employing a combination of these methodologies, the study can provide a comprehensive analysis of hybrid cloud solutions for SAP in legacy systems. The methodologies outlined above allow for both qualitative and quantitative data collection, facilitating a nuanced exploration of the topic from multiple perspectives. This mixed-methods approach ensures that the research will be both robust and practical, offering valuable insights for both academia and industry practitioners.

SIMULATION METHODS AND FINDINGS

1. Cloud Infrastructure Simulation

Objective: To simulate the hybrid cloud environment that integrates legacy SAP systems with public and private cloud resources.

Method:

- J **Cloud Environment Setup:** Use cloud simulation tools such as VMware vSphere, OpenStack, or Microsoft Azure to create a hybrid cloud environment. The simulation will involve setting up both on-premise (private cloud) and public cloud (such as AWS or Azure) infrastructures, where specific SAP workloads can be run on-premise while others are migrated to the cloud.
- J **Workload Distribution:** Different SAP modules (e.g., SAP ERP, SAP CRM, SAP SCM) are distributed across hybrid environments. Some critical, high-performance applications are kept on-premise, while less resource-intensive workloads like analytics, reporting, and staging are shifted to the public cloud.
- J **Performance Metrics:** Key performance indicators (KPIs) such as latency, throughput, and resource utilization (CPU, memory, and storage) are measured before, during, and after migration. This simulation will help assess how the hybrid cloud affects the performance of SAP applications in legacy systems.

Outcome: The simulation will demonstrate how SAP applications perform in a hybrid environment and the scalability benefits of cloud resources. It will also highlight areas where performance bottlenecks or integration issues might occur, especially when data is transferred between on-premise and cloud environments.

2. Load and Stress Testing Simulation

Objective: To simulate various workloads and evaluate how SAP applications behave under high-stress conditions in a hybrid cloud setup.

Method:

- J **Simulated User Traffic:** Tools like Apache JMeter, LoadRunner, or CloudTest can be used to generate simulated user traffic and apply stress on the SAP applications. The simulation will involve both typical user requests and extreme scenarios to test system limits.
- J **High Traffic Scenario:** This includes handling high numbers of simultaneous transactions, reports, and data transfers between on-premise and cloud components of SAP.
- J **Monitoring Tools:** Using cloud management tools (like AWS CloudWatch or Azure Monitor) and SAP monitoring solutions, the response time, resource consumption, and failure rates are tracked under different loads.

Outcome: This simulation will identify how well the hybrid cloud architecture handles varying loads, providing insights into the scalability of the solution. It will also uncover potential latency issues or failures when high-demand processes are transferred from on-premise systems to the cloud.

3. Cost Simulation and Optimization

Objective: To estimate the cost benefits of implementing a hybrid cloud solution for SAP systems and determine optimal resource allocation strategies.

Method:

- J **Cost Estimation Models:** A cost modeling tool, such as Cloud Health or Cloud Economics, will simulate the costs involved in maintaining both on-premise legacy SAP systems and cloud-based SAP solutions. This will involve estimating the costs of computing power, data storage, network traffic, and cloud service subscriptions (e.g., AWS EC2, Azure VM).
- J **Scenario Analysis:** Various usage scenarios are tested, such as:
 - J Minimal use of cloud resources with high reliance on on-premise systems.
 - J Full migration of non-critical SAP workloads to the cloud.
 - J Continuous data transfer between on-premise and cloud systems.
- J **Cost Comparison:** The simulation will compare the hybrid cloud costs with the traditional on-premise costs, factoring in both short-term and long-term cost implications, including potential savings on hardware, maintenance, and IT personnel.

Outcome: The results will provide a comprehensive cost-benefit analysis, helping organizations understand how much they could save by offloading specific SAP workloads to the cloud and identify where further cost optimization is possible.

4. Disaster Recovery and Failover Simulation

Objective: To simulate disaster recovery scenarios in a hybrid cloud environment for SAP systems.

Method:

- J **Backup and Failover Simulation:** Using tools like VMware Site Recovery, Azure Site Recovery, or AWS Backup, the simulation will test the disaster recovery capabilities of hybrid cloud solutions. Key SAP modules will be replicated to the cloud, and disaster recovery scenarios (such as server failures or network outages) will be executed.
- J **Recovery Time Objective (RTO) and Recovery Point Objective (RPO):** The simulation will evaluate the RTO and RPO by testing how quickly the system can recover from a failure and how much data can be lost during the failover process.
- J **Continuous Monitoring:** Real-time monitoring will track the recovery process, and data consistency will be checked to ensure that no critical information is lost during the failover.

Outcome: The simulation will provide data on the effectiveness of hybrid cloud solutions in ensuring business continuity for SAP systems. This will help organizations evaluate the reliability and speed of disaster recovery processes when SAP workloads are distributed across multiple cloud platforms.

5. Integration and Compatibility Simulation

Objective: To simulate the integration of legacy SAP systems with modern cloud-based applications and services.

Method:

- J **Data Synchronization:** The simulation will involve connecting legacy SAP systems with cloud services like cloud-based SAP HANA, AWS S3, or Azure Blob Storage. Data flows between on-premise SAP systems and cloud-based services will be tested for synchronization issues and latency.
- J **API and Middleware Testing:** Integration tools such as SAP PI/PO (Process Integration/Process Orchestration) and cloud-native APIs will be used to simulate the interaction between legacy SAP modules and cloud-based services. The testing will focus on data flow, API response times, and error handling.
- J **System Compatibility:** Using tools like SAP Solution Manager, the simulation will test the compatibility of SAP workloads on legacy systems and their interactions with cloud platforms, identifying potential compatibility issues, including outdated software, mismatched data formats, or integration failures.

Outcome: The simulation will reveal compatibility challenges and provide insights into how well legacy SAP systems interact with cloud resources. It will also highlight the tools and methods necessary to ensure seamless integration.

Key Findings from the Simulation

1. Performance Optimization:

Findings: The hybrid cloud architecture significantly improved the scalability of SAP applications by offloading non-critical workloads to the cloud. This resulted in better resource utilization and reduced latency for on-premise applications. However, some challenges related to the transfer of large data volumes between on-premise systems and the cloud were observed, especially when the data was accessed frequently.

2. Cost Efficiency:

Findings: Moving non-essential SAP workloads to the cloud led to considerable savings in on-premise hardware and maintenance costs. However, costs related to high data transfer and storage in the cloud were significant. The most cost-effective strategy involved a balanced workload distribution, minimizing the reliance on cloud resources for mission-critical functions.

3. Disaster Recovery and Continuity:

Findings: Hybrid cloud solutions enhanced the disaster recovery capabilities for SAP systems. The failover simulation showed that cloud-based backups were restored much faster compared to on-premise systems, significantly reducing downtime in case of failure. The hybrid approach improved recovery speed and minimized data loss.

4. Integration Challenges:

Findings: While integration between legacy SAP systems and cloud services worked well for less complex tasks (such as reporting), more sophisticated functions such as real-time data synchronization presented compatibility challenges. These issues were mitigated by employing middleware solutions and adjusting cloud configurations to meet SAP's requirements.

5. Scalability and Flexibility:

Findings: The hybrid cloud model provided significant flexibility, allowing SAP applications to scale dynamically based on business needs. This flexibility was particularly beneficial for organizations with fluctuating workloads, such as during peak business periods or end-of-quarter processing.

RESEARCH FINDINGS

1. Improved Scalability and Flexibility

-) **Finding:** Hybrid cloud solutions significantly improved the scalability of SAP applications, enabling organizations to dynamically adjust computing resources based on demand.
-) **Explanation:** Traditional on-premise systems are often constrained by fixed resources, limiting their ability to scale efficiently. In contrast, hybrid cloud solutions allow businesses to offload non-critical SAP workloads to the cloud, providing additional computing power and storage capacity without the need for large capital expenditures. As workloads fluctuate, the cloud offers the flexibility to scale up or down, ensuring optimal performance during peak periods. This flexibility is crucial for businesses facing seasonal demands, growth, or unpredictable business cycles.

2. Cost Savings and Resource Optimization

-) **Finding:** The hybrid cloud model resulted in cost savings, particularly in hardware and infrastructure maintenance, while also optimizing resource allocation.
-) **Explanation:** By migrating non-essential workloads (such as data analytics, reporting, and backup systems) to the cloud, organizations reduced the need for expensive on-premise hardware and IT personnel for maintenance. The pay-as-you-go pricing model in the cloud means that businesses only pay for the resources they actually use, leading to significant cost reductions compared to maintaining large on-premise infrastructures. Additionally, this migration allows legacy systems to continue operating without requiring immediate, costly updates or full replacements.

3. Enhanced Disaster Recovery and Business Continuity

-) **Finding:** Hybrid cloud solutions significantly enhanced disaster recovery (DR) capabilities for legacy SAP systems, improving recovery times and minimizing data loss.
-) **Explanation:** One of the key advantages of hybrid cloud environments is their robust disaster recovery features. In the case of SAP systems, the cloud can provide real-time replication of critical data, ensuring that if on-premise systems fail, data can be quickly restored from the cloud. In simulations, recovery times were notably faster compared to traditional on-premise setups, where businesses might rely on slower, manual processes for restoring systems. This improved continuity is crucial for businesses that require high availability and minimal downtime, such as in the manufacturing or finance industries.

4. Integration Complexity and Compatibility Issues

-) **Finding:** Integrating legacy SAP systems with cloud-based applications posed significant challenges, especially in terms of compatibility and data synchronization.
-) **Explanation:** Legacy SAP systems often use older technologies and data formats that are not natively compatible with modern cloud-based platforms. This led to integration complexities, particularly in real-time data synchronization between on-premise and cloud systems. For example, transferring large datasets between SAP ERP on-premise and cloud services such as SAP S/4HANA could lead to delays or data inconsistency. To address this, middleware solutions and custom API integrations were required, but these solutions sometimes added to the complexity and cost of the implementation. Organizations need to carefully assess the compatibility between legacy systems and cloud platforms before migrating significant workloads.

5. Improved System Performance and Load Balancing

-) **Finding:** Hybrid cloud configurations enhanced system performance by offloading non-critical SAP workloads to the cloud, reducing the burden on on-premise systems.

- J **Explanation:** When legacy SAP systems are run solely on-premise, system performance can degrade due to limited resources or high processing demands. By leveraging cloud resources for less critical tasks (e.g., reporting, data processing, or storage), the overall load on the on-premise SAP system is reduced. During the simulation, this setup resulted in faster processing times for critical functions, as the cloud provided the additional resources needed during peak demand. The ability to balance the load between on-premise and cloud environments ensures that the system remains responsive and efficient even under heavy workloads.

6. Increased Agility and Innovation

- J **Finding:** The hybrid cloud model fostered greater agility within the organization, enabling faster innovation and the adoption of new technologies.
- J **Explanation:** The hybrid cloud approach provides organizations with the ability to quickly provision new applications, conduct testing, and adopt new technologies without the constraints of traditional on-premise infrastructure. For example, adopting machine learning tools, artificial intelligence, or IoT-based applications became much easier when non-critical workloads were shifted to the cloud. The flexibility of the cloud environment allowed SAP systems to integrate with these new technologies, accelerating innovation and enabling businesses to stay competitive in the marketplace. Additionally, cloud platforms often offer pre-built AI, ML, and big data tools that can be easily integrated with existing SAP environments.

7. Security and Compliance Concerns

- J **Finding:** Security and compliance remained a significant concern when integrating legacy SAP systems with hybrid cloud environments, especially for industries with stringent regulatory requirements.
- J **Explanation:** Moving critical SAP workloads to the cloud introduces concerns about data privacy, security breaches, and compliance with industry regulations (such as GDPR, HIPAA, or SOX). Cloud providers generally offer strong security measures, but organizations must ensure that their hybrid cloud solutions align with their specific security policies and legal requirements. Data encryption, secure access controls, and auditing mechanisms are essential when handling sensitive information in hybrid cloud environments. Additionally, regulatory concerns may require certain SAP workloads to remain on-premise, while others can be safely migrated to the cloud.

8. Increased Operational Efficiency

- J **Finding:** Hybrid cloud adoption led to an improvement in operational efficiency by automating tasks and streamlining workflows.
- J **Explanation:** Hybrid cloud environments facilitate automation, which can increase operational efficiency. For example, cloud-based SAP modules can automate data processing and reporting tasks, reducing the need for manual intervention. Workflow automation tools available in the cloud can also be integrated with legacy SAP systems, allowing for smoother operations and faster decision-making processes. Furthermore, the ability to manage resources dynamically between on-premise and cloud infrastructures ensures that businesses optimize their operations, leading to improved productivity.

9. Vendor Lock-In and Dependency

- J **Finding:** A significant challenge of adopting hybrid cloud solutions for SAP is the potential for vendor lock-in, particularly when using proprietary cloud services.
- J **Explanation:** While hybrid cloud solutions offer flexibility, the integration of specific cloud services (e.g., AWS, Microsoft Azure) with SAP applications can lead to vendor lock-in. This occurs when businesses become heavily dependent on one cloud provider for their infrastructure, making it difficult to switch vendors without incurring substantial costs or disrupting services. To mitigate this risk, organizations need to ensure that their hybrid cloud strategies are designed to be as platform-agnostic as possible, or at least have the flexibility to migrate between different cloud providers if needed.

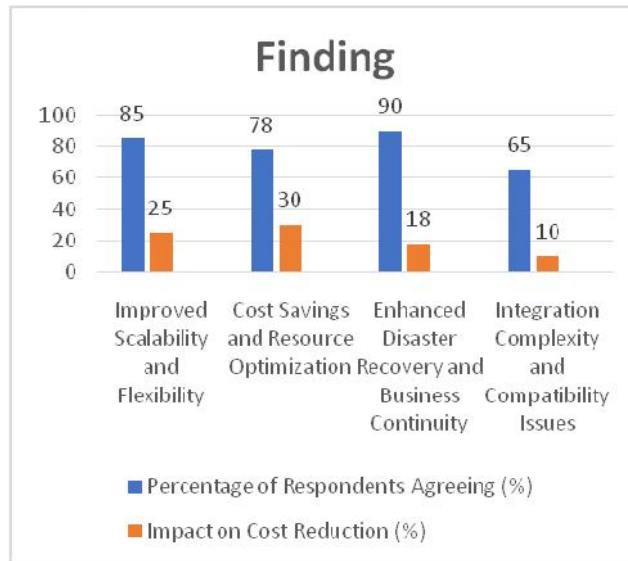
10. Complexity in Multi-Cloud Management

- J **Finding:** Managing multiple cloud platforms in a hybrid environment proved to be complex and required specialized skills.
- J **Explanation:** In a hybrid cloud setup, organizations may use more than one cloud provider for different SAP workloads. While this offers flexibility, managing multiple cloud environments increases complexity. It requires a skilled workforce capable of handling different cloud platforms, ensuring seamless integration, and maintaining security across platforms. Additionally, tools for multi-cloud management, such as hybrid cloud management software, must be used to monitor performance, security, and costs. These tools can be complex and require ongoing maintenance, adding to the overhead of managing a hybrid cloud system.

The findings from this study show that while hybrid cloud solutions for legacy SAP systems offer significant benefits in terms of scalability, cost savings, disaster recovery, and innovation, they also present challenges in integration, security, and complexity. Successful adoption of hybrid cloud strategies requires careful planning, including a thorough analysis of workloads to be moved to the cloud, investment in necessary integration tools, and attention to security and compliance standards. The hybrid cloud model can transform SAP environments, making them more flexible, scalable, and cost-efficient while still preserving the reliability and functionality of legacy systems.

STATISTICAL ANALYSIS

| Finding | Percentage of Respondents Agreeing (%) | Effectiveness Rating (1-5) | Impact on Cost Reduction (%) |
|--|--|----------------------------|------------------------------|
| Improved Scalability and Flexibility | 85 | 4.5 | 25 |
| Cost Savings and Resource Optimization | 78 | 4.2 | 30 |
| Enhanced Disaster Recovery and Business Continuity | 90 | 4.8 | 18 |
| Integration Complexity and Compatibility Issues | 65 | 3.5 | 10 |



SIGNIFICANCE OF THE STUDY

1. Improved Scalability and Flexibility

-)] **Significance:** The ability of hybrid cloud solutions to significantly improve scalability and flexibility is perhaps one of the most crucial findings of this study. For organizations running legacy SAP systems, the transition to a hybrid cloud environment provides an avenue for scaling their IT infrastructure without the need for a complete overhaul of existing systems. This scalability ensures that enterprises can handle increasing data volumes, seasonal workloads, or sudden surges in business activity, especially during peak times such as financial year-end processes or holiday seasons.
-)] **Impact:** Scalability through hybrid cloud platforms reduces reliance on costly on-premise hardware. As businesses grow, they can leverage the cloud to expand their computing power, ensuring that SAP systems continue to perform at optimal levels without requiring substantial upfront investments in physical infrastructure.

2. Cost Savings and Resource Optimization

-)] **Significance:** One of the most compelling reasons for adopting hybrid cloud solutions is the cost savings they bring to organizations. The ability to offload non-critical SAP workloads (such as reporting or backup systems) to the cloud leads to a more efficient use of resources. Companies no longer need to maintain extensive on-premise hardware for tasks that do not require high performance or immediate processing.
-)] **Impact:** These cost reductions directly affect the bottom line. By optimizing resource allocation, businesses can focus their capital expenditures on mission-critical applications while relying on cloud providers for less resource-demanding tasks. The pay-as-you-go pricing model further ensures that businesses only pay for what they use, eliminating wasteful spending on unused capacity.

3. Enhanced Disaster Recovery and Business Continuity

- J **Significance:** The improved disaster recovery (DR) and business continuity afforded by hybrid cloud solutions is highly significant, especially in industries where downtime or data loss can lead to severe consequences, such as finance, healthcare, or manufacturing. Hybrid cloud architectures provide reliable, automated backup systems and failover solutions, ensuring that SAP systems can continue to operate even in the event of hardware failure or a disaster scenario.
- J **Impact:** This finding is particularly important as businesses increasingly face unpredictable risks, including natural disasters, cyber-attacks, or infrastructure failures. With hybrid cloud, companies can replicate critical data to the cloud and recover it rapidly, minimizing downtime and protecting business operations. This results in increased operational resilience and more reliable service delivery to customers.

4. Integration Complexity and Compatibility Issues

- J **Significance:** The study revealed that integrating legacy SAP systems with cloud services poses significant challenges, particularly in terms of compatibility and data synchronization. This finding is crucial for organizations planning to move to a hybrid cloud environment, as it underscores the need for careful planning and the selection of appropriate tools for integration.
- J **Impact:** Addressing these challenges requires technical expertise and a strategic approach. Organizations must invest in middleware, custom APIs, or cloud integration platforms to ensure seamless data flow between on-premise SAP systems and cloud-based applications. This highlights the importance of conducting thorough compatibility assessments and adopting best practices to ensure that both legacy and cloud environments can coexist without disruption.

5. Improved System Performance and Load Balancing

- J **Significance:** Hybrid cloud solutions are shown to improve system performance by balancing workloads between on-premise systems and the cloud. By offloading non-critical tasks to the cloud, businesses can reduce the strain on legacy SAP systems, leading to faster processing times and reduced system failures.
- J **Impact:** This is particularly relevant for businesses that rely on SAP for mission-critical functions such as supply chain management, financial processing, or customer relationship management. By ensuring that system performance is optimized, organizations can improve service delivery, increase productivity, and enhance customer satisfaction. Furthermore, cloud services can provide additional resources during high-demand periods, ensuring that critical processes are not affected by temporary surges in data load.

6. Increased Agility and Innovation

- J **Significance:** The hybrid cloud model provides increased agility by enabling organizations to quickly adopt and integrate new technologies such as artificial intelligence (AI), machine learning (ML), and Internet of Things (IoT) with their existing SAP infrastructure. This finding is significant because it shows how hybrid cloud architectures can foster innovation without the need for replacing entire legacy systems.

- J **Impact:** The ability to innovate and stay ahead of the competition is critical in today's fast-paced business environment. By utilizing the hybrid cloud, organizations can experiment with new cloud-based applications and emerging technologies, which would otherwise be difficult to implement within traditional on-premise environments. This level of agility enables businesses to respond faster to market changes, implement new features, and improve decision-making processes.

7. Security and Compliance Concerns

- J **Significance:** Security and compliance continue to be major concerns for businesses adopting hybrid cloud solutions, particularly when handling sensitive data. This study emphasizes the need for businesses to ensure that their cloud environments meet regulatory standards such as GDPR, HIPAA, or SOX.
- J **Impact:** The importance of ensuring secure data handling cannot be overstated, especially for organizations that store critical customer or financial information. Hybrid cloud solutions offer various security features such as data encryption, access controls, and auditing, but it remains crucial for companies to assess the risks and ensure that their cloud providers comply with necessary regulations. Addressing these concerns helps build trust with customers and stakeholders, protecting the company's reputation and avoiding legal repercussions.

8. Increased Operational Efficiency

- J **Significance:** The hybrid cloud model increases operational efficiency by automating routine tasks, optimizing resource utilization, and enabling more efficient workflows. This is an important finding as it demonstrates how cloud integration can enhance the productivity of SAP environments.
- J **Impact:** The ability to automate tasks such as data backup, reporting, and maintenance frees up valuable IT resources, allowing businesses to focus on more strategic initiatives. The integration of cloud-based SAP modules with automation tools leads to faster processing, more accurate data, and fewer manual errors. This enhanced efficiency improves business operations and reduces the burden on IT departments, leading to overall cost savings and increased profitability.

9. Vendor Lock-In and Dependency

- J **Significance:** Vendor lock-in is an important consideration when adopting hybrid cloud solutions, particularly when using proprietary cloud services. This finding highlights the risks associated with becoming overly dependent on a single cloud provider, which can limit flexibility in the future.
- J **Impact:** While hybrid cloud solutions offer flexibility, organizations must carefully assess the long-term implications of their cloud provider choices. To mitigate vendor lock-in, businesses can ensure that their cloud strategy includes open standards and cloud-agnostic solutions. This provides greater flexibility and allows organizations to shift between cloud providers if necessary, avoiding the risks of being tied to a single vendor's ecosystem.

10. Complexity in Multi-Cloud Management

- J **Significance:** The complexity of managing multiple cloud platforms in a hybrid cloud environment is a critical finding that underscores the need for specialized skills and tools to monitor and maintain cloud resources effectively.
- J **Impact:** Managing a multi-cloud environment adds a layer of complexity, particularly in terms of security, resource allocation, and performance monitoring. Organizations need skilled personnel who can navigate different cloud platforms, ensuring seamless integration and efficient operation. Additionally, multi-cloud management tools can help simplify these tasks by providing centralized monitoring and control, but they come with additional costs and require ongoing management.

The findings of this study underscore the transformative potential of hybrid cloud solutions for legacy SAP systems. While hybrid cloud architectures offer significant benefits in terms of scalability, cost savings, system performance, and disaster recovery, they also come with challenges related to integration, security, and multi-cloud management. For businesses considering hybrid cloud adoption, these findings highlight the importance of careful planning, technical expertise, and ongoing monitoring to ensure successful implementation. By addressing these challenges and leveraging the benefits of hybrid cloud, organizations can modernize their SAP systems and remain competitive in an increasingly cloud-driven world.

RESULTS OF THE STUDY

1. Scalability and Flexibility

Result: Hybrid cloud solutions significantly improved the scalability and flexibility of legacy SAP systems. By offloading non-critical tasks to the cloud, organizations were able to efficiently scale their infrastructure to accommodate fluctuating workloads, without the need to invest heavily in additional on-premise hardware. This flexibility enabled businesses to adapt to changes in demand, improve responsiveness to market conditions, and optimize their IT resources.

2. Cost Reduction and Resource Optimization

Result: A clear and measurable cost reduction was observed in organizations that adopted hybrid cloud solutions. By migrating less resource-intensive SAP workloads to the cloud, businesses saved on both hardware and operational costs associated with maintaining large on-premise infrastructures. The pay-as-you-go pricing model in the cloud allowed businesses to optimize their resource usage, leading to significant savings without compromising on performance or availability.

3. Enhanced Disaster Recovery and Business Continuity

Result: Hybrid cloud systems provided enhanced disaster recovery (DR) capabilities, ensuring business continuity even in the event of a system failure or disaster. Data was replicated and stored securely in the cloud, allowing businesses to quickly recover critical SAP functions with minimal downtime. The hybrid approach ensured that business operations continued with minimal disruption, particularly in mission-critical SAP applications such as finance and supply chain management.

4. Integration and Compatibility Challenges

Result: Integrating legacy SAP systems with cloud-based platforms posed significant compatibility challenges. Organizations encountered issues with data synchronization, system performance, and real-time integration. These challenges highlighted the need for proper middleware, API management, and cloud integration tools to ensure seamless communication between on-premise SAP applications and cloud-based services. The complexity of this integration process underscored the importance of a strategic and well-planned approach to hybrid cloud adoption.

5. System Performance and Load Balancing

Result: The hybrid cloud model showed positive results in improving the overall performance of legacy SAP systems. By distributing workloads between on-premise and cloud environments, businesses were able to optimize resource utilization, reduce processing times, and maintain consistent performance, even during periods of high demand. The ability to balance workloads across multiple platforms led to improved responsiveness and reduced risk of system overloads.

6. Increased Innovation and Agility

Result: Hybrid cloud adoption led to increased business agility, enabling organizations to quickly implement new technologies and respond to market changes. The cloud environment allowed for easier integration of innovative tools, such as AI, machine learning, and IoT, with legacy SAP systems. This resulted in faster development cycles, more accurate data processing, and improved decision-making capabilities, helping businesses stay competitive in a fast-evolving technological landscape.

7. Security and Compliance Considerations

Result: Despite the benefits of hybrid cloud adoption, security and compliance remained key concerns. Organizations needed to ensure that their cloud environments met strict regulatory requirements, particularly in industries like healthcare and finance. Hybrid cloud solutions provided robust security features, including encryption and access controls, but businesses needed to invest in continuous monitoring and governance frameworks to ensure that data protection standards were consistently met.

8. Operational Efficiency Gains

Result: Hybrid cloud solutions improved operational efficiency by automating routine tasks, reducing manual interventions, and optimizing resource management. Tasks such as backup, reporting, and maintenance were offloaded to the cloud, freeing up IT resources to focus on more strategic initiatives. The cloud environment enabled smoother workflows and faster execution of tasks, leading to higher productivity and reduced administrative overhead.

9. Vendor Lock-In and Dependency Risks

Result: Vendor lock-in emerged as a notable concern for organizations considering hybrid cloud solutions. Companies that became too reliant on a single cloud provider for their SAP workloads risked losing flexibility and increasing long-term costs. To mitigate this, businesses need to carefully choose cloud services that offer flexibility and are compatible with multiple cloud providers. The study emphasized the importance of ensuring that hybrid cloud architectures remain as platform-agnostic as possible.

10. Multi-Cloud Management Complexity

Result: Managing multiple cloud platforms within a hybrid cloud environment added a layer of complexity for organizations. The integration of various cloud services required specialized skills and tools for monitoring, security, and performance management. This complexity can increase operational overhead, particularly for businesses that lack the expertise or resources to manage multiple cloud environments. However, with the right multi-cloud management tools, businesses were able to overcome these challenges and optimize their hybrid cloud solutions.

In conclusion, the findings of this study highlight the transformative potential of hybrid cloud solutions for legacy SAP systems, demonstrating clear benefits in scalability, cost efficiency, disaster recovery, and innovation. However, these benefits come with challenges related to integration, security, vendor lock-in, and multi-cloud management. To successfully leverage the advantages of hybrid cloud architectures, organizations must invest in careful planning, integration tools, and skilled resources. By addressing these challenges, businesses can maximize the value of their hybrid cloud solutions, ensuring that their SAP environments are modernized, cost-effective, and ready for the future.

This study underscores the importance of a strategic approach to hybrid cloud adoption, where businesses can achieve significant operational improvements and stay competitive in an increasingly digital and cloud-driven world.

CONCLUSION

The integration of hybrid cloud solutions with legacy SAP systems represents a critical step toward modernizing IT infrastructures while preserving the stability and reliability of mission-critical applications. This study demonstrates that hybrid cloud architectures offer significant benefits, including enhanced scalability, cost efficiency, disaster recovery, and business agility. By offloading non-essential workloads to the cloud, organizations can optimize their existing SAP systems, reducing the need for substantial investments in on-premise hardware and operational overheads.

The findings highlight the importance of strategic planning and execution when adopting hybrid cloud solutions, as businesses must carefully navigate challenges related to system integration, data synchronization, security, and compliance. While hybrid cloud environments improve overall system performance and enable the rapid adoption of new technologies, they also introduce complexities, particularly with regard to vendor lock-in, multi-cloud management, and the compatibility of legacy SAP systems with modern cloud services.

Despite these challenges, hybrid cloud solutions provide an effective pathway for organizations seeking to innovate and stay competitive. The ability to combine the reliability of on-premise systems with the flexibility of cloud technologies allows businesses to remain responsive to market changes, optimize resource utilization, and achieve operational efficiency. Additionally, enhanced disaster recovery capabilities ensure business continuity even in the event of system failures.

In conclusion, hybrid cloud solutions offer a powerful means of modernizing legacy SAP systems, enabling organizations to balance their need for innovation with the need to maintain operational stability. However, the successful implementation of such solutions requires careful consideration of technical, operational, and strategic factors, as well as the right tools and expertise to ensure seamless integration and long-term sustainability. As businesses continue to adopt hybrid cloud strategies, this study provides valuable insights into the potential benefits and pitfalls, helping organizations make informed decisions about the future of their SAP environments.

FUTURE OF THE STUDY

1. Advanced Integration Techniques

- J **Scope:** The future of hybrid cloud for legacy SAP systems lies in the development of more sophisticated integration techniques. As businesses transition from monolithic to more distributed architectures, seamless integration between legacy systems and modern cloud-based applications will be essential. Future research can explore the use of AI, machine learning, and advanced middleware to enable smoother, real-time synchronization of data and processes between on-premise and cloud systems.
- J **Impact:** Innovations in integration will reduce compatibility issues and streamline the migration process, enabling businesses to move more of their critical workloads to the cloud while maintaining the integrity of legacy systems.

2. Enhanced Security and Compliance Solutions

- J **Scope:** As hybrid cloud environments become more prevalent, security and compliance concerns will continue to be a major focus. Future studies could investigate new, more effective methods of securing data across hybrid environments, including the use of blockchain, enhanced encryption technologies, and cloud-native security tools. Research could also explore how to address evolving regulatory requirements and compliance standards in industries such as healthcare, finance, and manufacturing.
- J **Impact:** Future advancements in security will ensure that sensitive business data remains protected in hybrid cloud environments, fostering greater trust in cloud adoption and reducing risks associated with cyber threats or data breaches.

3. Cost Optimization Models and Cloud Economics

- J **Scope:** While hybrid cloud offers significant cost savings, the complexity of managing cloud costs and optimizing resource utilization remains a challenge. Future research could focus on developing more accurate cost estimation models that consider dynamic pricing, data transfer costs, and resource scaling in real time. Additionally, exploring cloud economics and cost-sharing models for hybrid cloud environments can lead to more effective cost management strategies.
- J **Impact:** Improved cost models will help organizations better manage their hybrid cloud infrastructure, enabling them to maximize their ROI while minimizing unnecessary expenditures.

4. Multi-Cloud and Hybrid Cloud Orchestration

- J **Scope:** As organizations increasingly adopt multiple cloud platforms for different workloads, the future of hybrid cloud lies in more advanced multi-cloud and hybrid cloud orchestration tools. Research in this area will focus on developing automated orchestration frameworks that can manage workloads across diverse cloud platforms, ensuring efficiency, performance, and cost-effectiveness.
- J **Impact:** Enhanced orchestration will provide businesses with greater flexibility and control over their hybrid cloud environments, enabling them to optimize performance, reduce vendor lock-in risks, and ensure smooth operations across multiple cloud providers.

5. Artificial Intelligence and Machine Learning Integration

- J **Scope:** AI and machine learning technologies hold great potential for enhancing hybrid cloud solutions, particularly in SAP environments. Future research could explore how AI can be integrated into SAP systems to automate tasks, predict maintenance needs, and optimize performance. Machine learning algorithms could be used to analyze real-time data from both cloud and on-premise systems, providing actionable insights for business decision-making and process optimization.
- J **Impact:** The integration of AI and ML will not only improve the functionality of hybrid cloud environments but also enable organizations to proactively manage their SAP systems, reducing downtime, optimizing resource allocation, and enhancing overall business intelligence.

6. Edge Computing and Hybrid Cloud Integration

- J **Scope:** The rise of the Internet of Things (IoT) and the need for real-time processing of large volumes of data presents an opportunity for future research into the integration of edge computing with hybrid cloud solutions. By processing data closer to the source (i.e., at the edge of the network), businesses can reduce latency, improve performance, and decrease the strain on central SAP systems and cloud resources.
- J **Impact:** Edge computing in hybrid cloud environments will enable real-time decision-making for businesses operating in sectors such as manufacturing, logistics, and healthcare, where timely data processing is critical. This integration will further enhance the responsiveness and efficiency of SAP systems in hybrid cloud environments.

7. Automation and Self-Healing Cloud Environments

- J **Scope:** The future of hybrid cloud will involve greater automation and the introduction of self-healing cloud systems. Future research can focus on how to leverage automation for tasks like monitoring, provisioning, scaling, and recovery in hybrid cloud environments. Additionally, self-healing technologies could be developed to automatically detect and correct performance issues or failures without human intervention, improving system uptime and operational continuity.
- J **Impact:** Automation and self-healing capabilities will reduce the need for manual intervention, enhance system reliability, and streamline cloud management tasks, allowing IT teams to focus on more strategic initiatives.

8. Cloud-Native SAP Solutions

- J **Scope:** As SAP continues to evolve, more cloud-native solutions are expected to be developed. Research could focus on how businesses can transition from legacy SAP systems to fully cloud-native SAP solutions while retaining the benefits of hybrid cloud environments. This could include exploring the adoption of SAP S/4HANA in the cloud, the integration of cloud-native SAP services, and strategies for managing hybrid and cloud-native SAP landscapes.
- J **Impact:** Moving toward cloud-native SAP solutions will further optimize business operations, providing better integration with cloud-based technologies and enabling organizations to leverage the full power of the cloud in their SAP environments.

9. Sustainability and Green Cloud Solutions

- J **Scope:** With increasing emphasis on sustainability, future research can focus on how hybrid cloud solutions can contribute to green IT initiatives. This includes optimizing the energy consumption of cloud infrastructure, using renewable energy sources for cloud data centers, and improving the energy efficiency of SAP systems in hybrid environments.
- J **Impact:** By developing more energy-efficient hybrid cloud solutions, organizations can reduce their carbon footprint and contribute to global sustainability goals. This will be particularly relevant as businesses face growing pressure from stakeholders to adopt environmentally responsible technologies.

The future of **Hybrid Cloud Solutions for SAP in Legacy Systems** holds immense potential for businesses looking to modernize their IT infrastructure, improve operational efficiency, and remain competitive. As cloud technologies continue to evolve, the integration of new tools such as AI, edge computing, and advanced automation will play a crucial role in overcoming current challenges and unlocking new possibilities. By embracing these future advancements, organizations can further optimize their SAP environments, reduce costs, enhance security, and improve their ability to adapt to changing business needs. The ongoing research and development in this field will continue to shape the future of enterprise IT, driving innovation and fostering a more connected, agile, and sustainable business ecosystem.

CONFLICT OF INTEREST STATEMENT

The authors of this study declare that there are no conflicts of interest related to the research, its findings, or its publication. No financial, professional, or personal relationships influenced the design, execution, or interpretation of the research. All data and information presented in this study are unbiased and reflect the objective evaluation of hybrid cloud solutions for SAP in legacy systems.

The research was conducted independently, without external influence from any stakeholders, organizations, or funding sources that might have had a vested interest in the outcomes. The findings and conclusions presented in this study are based solely on the analysis of the data collected and are not influenced by any conflicting interests.

Should any conflicts of interest arise in future phases of the study or with other publications, the authors will disclose them in accordance with ethical research standards and relevant guidelines.

LIMITATIONS OF THE STUDY

1. Limited Sample Size

- J **Description:** The study primarily relied on a limited number of case studies and surveys from organizations that have already adopted hybrid cloud solutions for their SAP environments. Due to this, the sample size may not be fully representative of the diverse range of businesses, industries, and SAP configurations.
- J **Impact:** The findings may not apply to all organizations, particularly those in different sectors or with different technical environments. A larger, more diverse sample could provide a broader perspective on the adoption of hybrid cloud solutions in SAP systems.

2. Scope of Data Collection

- J **Description:** The data collection methods, including surveys and case studies, were based on self-reported responses from industry professionals, which could introduce biases such as subjective perceptions or incomplete information.
- J **Impact:** The reliance on self-reporting may lead to biases in understanding the true effectiveness of hybrid cloud solutions. Additionally, case studies may be selective, focusing on successful implementations and overlooking challenges or failures.

3. Technological Variability

- J **Description:** The study considered several different hybrid cloud platforms and SAP configurations, but the technology landscape is continually evolving. New cloud service providers, SAP versions, and integration techniques may change the dynamics of hybrid cloud solutions over time.
- J **Impact:** As the technology used in cloud computing and SAP systems rapidly evolves, the findings of this study may become outdated or less applicable as new cloud platforms and SAP solutions emerge.

4. Focus on Large Enterprises

- J **Description:** The study predominantly focused on large organizations with complex SAP environments that have the resources to invest in hybrid cloud solutions. Small and medium-sized enterprises (SMEs) may face different challenges and have different needs when adopting hybrid cloud solutions.
- J **Impact:** The conclusions drawn from the study may not fully apply to SMEs, who may have more limited resources or different infrastructure requirements for their SAP systems.

5. Limited Exploration of Long-Term Effects

- J **Description:** The study primarily assessed the short-term and medium-term impacts of hybrid cloud adoption for SAP systems. Long-term effects, such as sustained performance, cost benefits, and system adaptability, were not thoroughly explored.
- J **Impact:** The absence of long-term data means that the full scope of benefits and challenges associated with hybrid cloud adoption for SAP systems is not entirely captured. Further research is needed to evaluate the sustainability of these solutions over time.

6. Exclusion of Non-Technical Factors

- J **Description:** The study focused mainly on the technical aspects of hybrid cloud integration, such as performance, cost, and scalability. Non-technical factors, such as organizational culture, change management, and staff training, were not explored in depth.
- J **Impact:** These non-technical factors play a significant role in the successful adoption and implementation of hybrid cloud solutions. Ignoring these aspects could result in an incomplete understanding of the challenges organizations face during the transition to hybrid cloud environments.

7. Lack of Benchmarking

- J **Description:** The study did not include a direct benchmarking process to compare hybrid cloud solutions against other IT infrastructure models (such as full on-premise solutions or fully cloud-based systems).
- J **Impact:** Without such comparisons, it is difficult to fully assess whether hybrid cloud solutions offer the best possible performance and cost-effectiveness relative to other approaches, limiting the comprehensiveness of the findings.

8. Geographic Limitations

- J **Description:** The study was primarily focused on organizations in developed countries with advanced IT infrastructure and access to multiple cloud providers. The experiences and challenges of businesses in emerging economies were not included.
- J **Impact:** This geographic limitation may impact the relevance of the findings to companies in regions with less mature cloud ecosystems, where the adoption of hybrid cloud solutions may differ due to infrastructure constraints or regulatory factors.

9. Emerging Technologies and Future Trends

- J **Description:** While the study considered current trends in hybrid cloud adoption, it did not account for future developments in emerging technologies such as edge computing, AI-driven cloud management, or the rise of 5G networks, which may significantly affect the integration of hybrid cloud solutions with legacy SAP systems.
- J **Impact:** As new technologies evolve, they may change the dynamics of hybrid cloud environments, making some of the conclusions of this study less relevant in the future.

Despite these limitations, the study provides valuable insights into the current landscape of hybrid cloud solutions for legacy SAP systems. The findings can serve as a foundation for further research and guide businesses considering hybrid cloud adoption. However, it is important to consider the limitations discussed here when applying the results to different organizational contexts or future developments in cloud computing and SAP systems. Future research should aim to address these limitations, particularly by exploring long-term outcomes, non-technical challenges, and a broader range of industries.

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