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Article

Enterprise Environment Management Framework for Large-Scale Hybrid Ecosystems: An Operational Governance Model for Complex Enterprise Transformation Programs

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Abstract: Purpose: Large-scale enterprise transformation programs depend on stable, well-governed environments to support development, testing, and production activities. Environment management is frequently treated as a reactive infrastructure function, resulting in scheduling conflicts, environment-related defects, and avoidable delays across program phases. This paper addresses that operational gap by presenting the Enterprise Environment Management Framework (EEMF) — a governance-driven model that repositions environment management as a strategic enterprise operations capability. **Design/methodology/approach**: The EEMF is derived from enterprise-scale transformation practice across multi-release programs involving Enterprise Resource Planning (ERP) systems, Software as a Service (SaaS) platforms, and hybrid cloud integration services. The framework integrates eight interconnected layers: environment strategy, landscape architecture, multi-release environment management, lifecycle governance, governance operating model, scheduling and maintenance governance, risk management, and Key Performance Indicator (KPI)-driven observability. A structured framework derivation method is used, drawing on cross-program patterns, quantitative operational outcomes, and governance maturity assessment.
Findings: Application of the EEMF across large-scale ERP transformation programs yielded a 30% reduction in environment-related defects, measurable improvements in release predictability, and a significant decrease in refresh scheduling conflicts. Programs adopting the governance operating model demonstrated higher environmental stability during critical phases such as mock cutover cycles and Production Integration Testing (PIT). KPI-driven observability enabled proactive issue detection and continuous improvement across the environment estate.
Originality/value: The EEMF is the first structured framework to integrate environment strategy, landscape architecture, lifecycle management, multi-release coordination, governance operating model, and KPI-driven observability into a unified enterprise operations governance model. It addresses a demonstrable gap in formal delivery methodologies, which do not provide dedicated environment management frameworks suited to complex hybrid cloud ecosystems.

Keywords: Enterprise environment management, hybrid cloud governance, ERP transformation, release management, environment lifecycle, operations governance

1. Introduction

In the last 10 years, enterprise transformation programs have become more operationally complex, generally implementing a complex interconnected set of ERP implementations, new SaaS platforms, enterprise application modernization and integration platform consolidation and migration into hybrid cloud architectures comprising on-premises data centers, private and public cloud services. According to Zainab Asimiyu (2020), large scale ERP transformation initiatives continue to underappreciate the challenges of environment management when dozens of enterprise systems must be orchestrated across development, testing and production tiers, resulting in delays and defects impacting operations. Failure to address these issues results in longer testing cycles, lower-quality releases and go-live readiness, resulting in business interruption and program cost overruns. Further evidence is found in the IT

industry literature where it is shown that a meaningful proportion of delays in enterprise technology programs related to the environment occur when environment governance has not been formalized into program release management (Project Management Institute [PMI], 2021).

No delivery frameworks have been developed specifically to cover environments, despite their operational importance. Although environment management is recognized by the Project Management Body of Knowledge (PMBOK) and the Information Technology Infrastructure Library (ITIL) as a part of release management and infrastructure management respectively, a model for implementing and managing environments as an enterprise operations capability is not covered (PMI, 2021; AXELOS, 2019). This problem is clear in multi-release programs, where multiple teams use the same environment and cause resource contention from schedules, integration routing, data refresh and program risk across test cycles. Seifert et al. (2023) say that hybrid cloud environments worsen this problem. These environments have multi-vendor dependencies, fixed SaaS patching schedules and cross-platform integration routing, which cannot be managed using ad-hoc environment management policies and processes.

The Enterprise Environment Management Framework (EEMF) is a governance-based, structured way to manage environments for large, multi-release enterprise transformation programs in hybrid cloud environments. This paper presents and discusses four contributions of the EEMF. First, it frames environment management as an operational governance capability in business operations rather than a reactive infrastructure support capability. Second, it models an eight-layer governance topology that integrates environment strategy, landscape design, multi-release coordination, lifecycle governance, governance operating model, schedule governance, risk management, and observability through key performance indicators into a coherent model. Thirdly, it presents a governance operating model, including roles and responsibilities, meeting cadence, vendor engagement and escalation procedures for multi-vendor programs. Fourthly, it provides empirical, measurable results demonstrating improved release predictability, reduced refresh conflicts, and improved operational readiness across large-scale enterprise transformation programs. Plant et al. (2022) state that governance frameworks should address the structural conditions in which technical work occurs, which was the intended purpose of the EEMF within the environment management domain.

The Enterprise Environment Management Framework (EEMF) was derived through analysis of operational patterns observed across large-scale enterprise transformation programs involving hybrid cloud ecosystems, ERP modernization initiatives, multi-release delivery models, and multi-vendor enterprise environments. The framework incorporates governance practices, lifecycle coordination mechanisms, environment management operations, and observability approaches identified through enterprise implementation experience. The objective of the framework is to provide a reusable operational governance model capable of supporting complex enterprise transformation programs across diverse technology landscapes.

The remainder of this paper is organized as follows: Section 2 reviews the literature on environment management in enterprise programs and hybrid cloud governance. Section 3 describes the implementation problems of governance in the enterprise environment that motivate the framework. Section 4 presents the EEMF architecture and its eight layers. Sections 5-7 describe the domains of operations of the framework, Section 8 describes the validation results and findings, Section 9 discusses the implications and limitations of our research, and Section 10 recommends governance steps and future work.

2. Background and Related Work

2.1 Environment Management in Enterprise Programs

With the increasing scale and complexity of enterprise information technology systems, the idea of environment management has changed. When enterprise resource planning systems in an organization were hosted on-premises in a single data center, environment management was simpler and consisted of a handful of development, test and production environments. As enterprise technology environments began to include hybrid cloud services, Software as a service (SaaS) applications, and API-based integration services, the number and complexity of environments to be managed has grown. Research has suggested that enterprise transformation programs now require orchestration across many technology environments, each with their own refresh cycles and maintenance windows (Zainab Asimiyu, 2020). The challenge is therefore not in how to operate the servers, but in the governance of the complex estate of dependent environments and components, across organizational and vendor boundaries.

Nevertheless, environment management is rarely mentioned in formal delivery methodologies. The PMBOK describes environment management in release management processes but does not identify it as a separate program capability (PMI, 2021). ITIL 4 includes environmental considerations in its change enablement and release

management practices, but the focus is on service management rather than program-level environment governance (AXELOS, 2019), which is an issue in multi-release programs where teams share the same environments. Limited resources, competing schedules and conflicting testing cycles affect the quality of releases. Defining the IT governance design in the enterprise context requires the definitions from the field of enterprise IT governance to be taken into consideration as well. Enterprise governance of information technology has been defined by De Haes et al. (2020) as a set of structures, processes and relational mechanisms through which business and IT stakeholders interact to achieve their objectives.

The governance of technology-intensive delivery approaches must take into account the structural and relational dimensions of the distributed delivery organizations. Plant et al. (2022) show empirically that governance of IT delivery models such as DevOps needs to address the organizational structures and roles, accountability mechanisms, and communication patterns in addition to the technical controls. Enterprise environment management governance is being applied in the same way across organizational, vendor, and platform boundaries to achieve consistent operational outcomes.

2.2 Hybrid Cloud Environment Challenges

The environment of hybrid cloud systems can pose challenges that are qualitatively different from on-premises systems. Seifert et al. (2023) conducted a structured literature survey and identified 52 challenges in hybrid cloud systems due to SaaS adoption, including the un-negotiable nature of the SaaS's maintenance scheduling, the difficulty of maintaining consistent integration routing between cloud and on-premises system components, and governance difficulties in multi-vendor service agreements. This situation is complicated when enterprise transformation programs have to manage multiple enterprise platforms with different environment requirements and different vendor support approaches. According to the 2023 Flexera State of the Cloud Report, 87% of enterprises have multi-cloud strategies, which means hybrid cloud is becoming the norm rather than the exception in enterprise environments.

Building on the work of Casino et al. (2022), an IT governance framework for ERP implementations was suggested in response to the need for appropriate governance structures around complex enterprise ERP transformations. Platform-level governance frameworks support the management of environmental coordination challenges to improve operational outcomes, and structured governance is more effective than ad-hoc governance for handling the complexities of hybrid ERP transformations. Similar to this, Piyush Nigam (2023) states that hybrid cloud deployments often require the coordination of network connectivity, security policies, and integration routing across multiple environments, which warrants the implementation of a specific governance model.

2.3 Gap in Formal Environment Governance Models

The literature review found that a formal model for enterprise environment management as an integrated governance capability does not exist. TOGAF considers environment management part of technology architecture, but does not provide operational guidance on how to manage non-production environments during program delivery phases (The Open Group, 2022). Although DevOps frameworks focus on CI/CD, their focus is on software delivery pipelines, and not on governing environments and estates at the level of the enterprise program. Kratzke and Quint (2017) consider environment management to be an understudied dimension of cloud-native application delivery. The complexity of multi-environment estates exceeds the focus of current DevOps and deployment frameworks. The purpose of the EEMF is to provide a reusable governance-driven framework for the environmental management of complex hybrid cloud enterprise programs.

3. Operational Challenges in Enterprise Environment Governance

A common set of environmental governance challenges exists in all enterprise transformation programs, regardless of industry, platform, and delivery model. The first, and most common, challenge is multi-release scheduling contention. In large multi-year ERP transformation projects, software and release cycles will overlap. When developers are doing build work on the next release, they need an environment for that, and the testers will need an environment locked for testing of the current phase. Unless there is some process to enforce separation, the developers who need a database refresh for their application can conflict with the testers in another phase. The primary solution to this is an operational refresh calendar that aligns it with release milestones, but even this basic coordination is lacking in many programs.

The second challenge is the coordination of integration dependencies across vendors and platforms. In hybrid enterprise environments, environment activities cannot be planned in isolation, as each environment has a dependency on the connectivity of other systems operated by other teams/vendors. A deviation from a given environment's

integration routing is bound to disrupt testing in another environment where cross-system dependencies are not traced and known. Organizations that lack well-coordinated vendor engagement processes disproportionately report environment-related incidents that have occurred while testing during their transformation programs (Y. S. Rajesh et al., 2024). The EEMF addresses this by placing vendor governance at the heart of the operating model, rather than treating it as peripheral.

Third, observability through KPIs for environments is rare. While programs typically maintain incident records and defect logs from testing cycles, proactive KPI frameworks governing environment availability, refresh adherence, and maintenance schedule compliance remain largely absent. Without KPI-driven governance, program leadership loses visibility of potential risks in the organization's environment impacting testing. Guerriero et al. (2019) observed that teams without structured observability take longer and have more regressions resolving environment-related issues than those that have structured observability mechanisms in place, particularly in the context of adopting infrastructure as code. Table 1 presents key environment governance challenges across different complexity dimensions.

Table 1: Environment Governance Challenges by Complexity Dimension

Complexity Dimension	Challenge Category	Primary Risk	Impact on Program	EEMF Layer Response
Multi-Release Concurrency	Scheduling Contention	Refresh conflicts disrupt active testing	Testing cycle delays, regression defects	Multi-Release Env. Mgmt (Layer 3)
Multi-Vendor Delivery	Integration Dependency Coordination	Uncoordinated changes break cross-system connectivity	Integration failures in testing and production	Governance Operating Model (Layer 5)
Hybrid Cloud Architecture	Platform Maintenance Misalignment	SaaS vendor windows clash with program milestones	Forced testing suspension, milestone slippage	Scheduling & Maintenance Governance (Layer 6)
Environment Estate Scale	Lifecycle Sprawl	Unused environments consume resources and obscure dependencies	Cost overrun, configuration drift	Environment Lifecycle Mgmt (Layer 4)
Observability Deficit	Reactive Incident Management	Issues detected only after testing impact has occurred	Extended resolution time, repeat defects	Observability & KPI Governance (Layer 8)

4. The Enterprise Environment Management Framework (EEMF)

The Enterprise Environment Management Framework distinguishes 8 environment management layers that recursively depend on each other, and each represents a specific aspect of environment management governance: Enterprise environment management strategy, landscape architecture management, multi-release environment management, environment lifecycle management, governance operating model management, scheduling and maintenance governance, risk management, and environment observability and KPI governance. This thorough Enterprise Environment Management Framework covers calculated, operational, and governance aspects of managing enterprise environments in large enterprise transformation programs. It builds upon enterprise-scale transformation experiences involving complex enterprise platform landscapes, multi-application architectures, and hybrid enterprise cloud environments (across on-premises and cloud platforms).

Although the framework is organized into discrete layers, these layers do not operate in strict sequence. The decisions made in the environment strategy layer form the architecture of the environment, and constrain what multi-

release management mechanisms can be designed. In contrast, the operational information in the observability layer can trigger changes in the environment strategy when patterns of operational instability are identified. Bidirectional governance relationships support coherence throughout the framework. They avoid the fragmentation found in ad-hoc governance and environmental management. De Haes et al. (2020) describe bidirectional governance relationships as a relational mechanism that sustains alignment between governance intent and operational execution over time.

What distinguishes the EEMF from conventional environment management practices is its repositioning of environment management as a formal program governance function, defined by explicit ownership structures, structured accountability cadences, and an associated set of performance metrics. EEMF does not treat environment management activities as just another application workstream under infrastructure management but as a separate governance workstream that has its own reporting and governance forums. These layers can be applied across programs with different ERP platforms, cloud providers, integration technologies, and delivery models. The eight layers of the framework are platform agnostic, in that they are based on structural conditions that are shared by all large-scale enterprise transformation programs, irrespective of their platform implementation. Table 2 contains the description, inputs, and outputs for each of the eight EEMF layers.

The framework was also developed with the intent that it could be applied in other domains and release models. Similar issues are faced by organizations in the manufacturing, financial services and consumer products and food and agricultural industries, and in the public sector, when undertaking large transformation programs. Wieringa (2014), design science frameworks like the EEMF are most relevant when they are developed from an actual operation and validated by empirical observable results. The EEMF meets these criteria by being derived from enterprise practice and by establishing quantitative results. Figure 1 presents the eight-layer architecture and the bidirectional governance relationship.

Table 2: EEMF Eight Layers — Description, Inputs, Outputs

Layer	Description	Primary Inputs	Primary Outputs
1. Environment Strategy	Defines tiering philosophy, cost governance principles, provisioning policy, and alignment of environment availability with release milestones	Program release calendar, infrastructure budget, and regulatory requirements	Environment strategy document, tiering model, cost governance principles
2. Landscape Architecture	Designs the structural mapping of environment tiers to enterprise systems, connectivity models, data flow paths, and refresh boundaries	Environment strategy, system inventory, integration architecture	Landscape architecture blueprint, connectivity diagram, dataset ownership matrix
3. Multi-Release Env. Mgmt	Provides routing rules, metadata classifiers, and refresh calendars to support overlapping release cycles without cross-release contamination	Landscape architecture, release schedule, team allocation plan	Integration routing rules, centralized refresh calendar, release-environment mapping
4. Lifecycle Management	Governs each environment from request through provisioning, validation, active use, maintenance, and decommission, with gate-based entry/exit criteria	Landscape architecture, provisioning standards, security policies	Lifecycle stage records, gate validation logs, and decommission schedule

5. Governance Operating Model	Defines roles, responsibilities, cadences, vendor engagement frameworks, and escalation protocols for coordinated environment governance	Organizational structure, vendor contracts, and delivery model	RACI matrix, governance cadence calendar, vendor engagement framework, escalation paths
6. Scheduling & Maintenance	Centralizes maintenance calendar management and aligns planned activities with the release calendar to prevent conflicts	Maintenance requirements, release calendar, vendor maintenance windows	Centralized maintenance calendar, conflict-free schedule, and change coordination log
7. Risk Management	Identifies and mitigates environment-related risks during critical program phases, with structured pre-phase risk reviews	Program risk register, phase plan, environment status data	Environment risk register, mitigation action log, phase readiness assessment
8. Observability & KPI	Provides dashboard-driven visibility into environment health, availability, and KPI compliance, enabling proactive governance and continuous improvement	Environment monitoring data, incident logs, and maintenance records	Environment KPI dashboard, trend analysis reports, and improvement recommendations

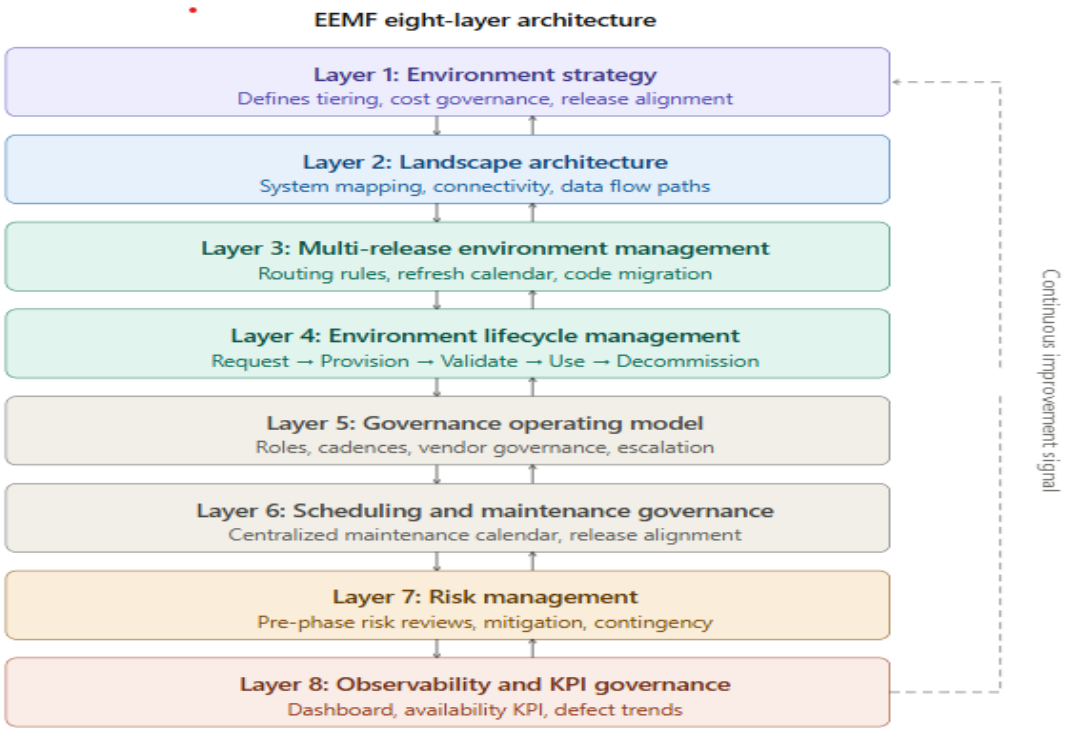

Figure 1: EEMF Eight-Layer Architecture Diagram

5. Environment Strategy, Landscape Architecture, and Multi-Release Management

5.1 Environment Strategy

The environment strategy defines how the planning, provisioning, and governance of environments is done throughout the transformation program lifecycle. This includes decisions such as how many tiers are appropriate, which environments are allocated to which program phases and teams, how contention between competing demands is to be managed, and how availability of environments relates to release milestones. The strategy needs to take into account data sovereignty requirements, regional environment provisioning limitations, and the cyclic expansion and contraction of the environment estate due to changing program scope (Zainab Asimiyu, 2020). A well-defined environment strategy minimizes the use of ad-hoc provisioned environments, which is a primary driver of environment sprawl and unplanned cost overruns seen in larger transformation programs.

The environment strategy also has considerations for cost and platform optimization. In a program where environments are provisioned on hybrid cloud platforms, environments can be disproportionately costly if they are not monitored for usage and decommissioned when no longer needed. Flexera reports that 82% of enterprises cite cost management as a top cloud operational concern (2023). Unused and underutilized resources account for a large fraction of wasted cloud spending. Structured environment governance, with periodic cost reviews and automatic decommissioning triggers (e.g., at lifecycle stage transitions), yields better resource utilization and readiness in activity phases of cloud program lifecycle management.

5.2 Landscape Architecture and Multi-Release Coordination

Environmental landscape architecture deals with the layout of the environmental estate. This includes the mapping of environment tiers to enterprise systems, the connection between environments, and the data path in integrated system testing and validation. In enterprise transformation programs with integrated system testing, the landscape architecture typically includes multi-tier core platform environments and one-tier environments for enterprise applications and external partner systems. Enterprise landscape architecture must be done in the context of enterprise environment management, enterprise architecture, integration engineering, and infrastructure and security architecture. Defining the landscape architecture helps to route data and integrations to the correct environment tier and defines the boundaries between the dataset refreshes and their corresponding owners (G. Lanciano et al., 2021).

Multi-release environment management addresses the operational overhead of managing multiple concurrent release cycles that span the same or related enterprise applications and environments while the enterprise transformation program is active. Non-production integration routing rules determine how enterprise application data flows to the environment tier based on the test phase. Environment tiers are defined by environment tier metadata classifiers or tenant configuration records, which dictate the processing of test data and transactions. A shared database refresh calendar based on release milestones and testing cycles minimizes refresh conflicts and balances testing discipline, allowing for simultaneous releases with reduced risk and better testing continuity. Service composition and routing governance are two foundational requirements for efficient operation in a multi-platform environment (Anna et al., 2023). They can be directly applicable to the EEMF landscape layer multi-release routing mechanisms. Figure 2 shows the routing model for multi-release environments.

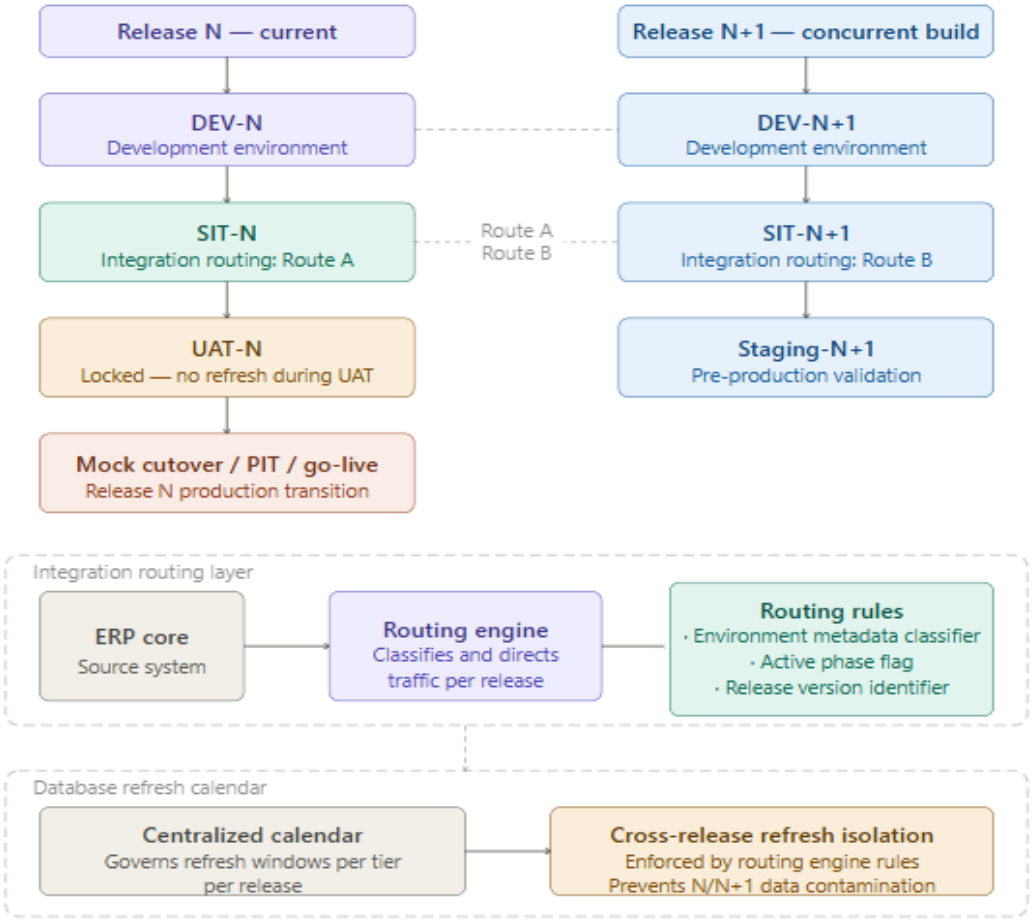

Figure 2: Multi-Release Environment Landscape and Integration Routing Model

6. Environment Lifecycle Management, Governance Operating Model, and Scheduling

6.1 Environment Lifecycle Management

Environment lifecycle management controls an environment from its initial request through its provisioning, configuration, verification and live use, to any maintenance and finally to its retirement. A well-controlled environment should be provisioned, configured, and maintained as per requirements, and retired at the end of its life. Organizations without lifecycle governance may suffer from environment sprawl, where unused environments in a shared infrastructure remain allocated continuously and indefinitely. Environments therefore require entry and exit criteria for each lifecycle phase, to manage the environment estate for consistent use. To use a gate, a validation would need to be done to check that integration connectivity is working, security policies apply, and baseline health checks have been completed before the environment could be used by the team. Using gates reduces the number of times that the team receives an unusable environment, which improves the reliability of tests and reduces defect leakage. Table 3 summarizes the Environment lifecycle phases and their respective entry and exit criteria.

Cost savings are realized by disposal of environments at the right time during the lifecycle. In multi-year programs the environment estate grows quickly as it assembles new environments for later releases while earlier developed environments are often still in use well beyond their usable lifecycle. Such periodic reviews to assess usage and identify candidates for decommissioning or consolidation are an important mechanism to control infrastructure costs and reduce operational complexity. Seifert et al. (2023) highlight lifecycle management as a critical governance requirement in hybrid cloud environments given that non-negotiable SaaS maintenance schedules impose external constraints on environment lifecycle planning that do not apply to on-premises governance models and require more adaptive lifecycle management.

Table 3: Environment Lifecycle Stages with Entry and Exit Criteria

Lifecycle Stage	Entry Criteria	Key Activities	Exit Criteria
1. Request & Approval	Approved provisioning request with business justification, release alignment confirmed	Capacity planning, cost approval, and landscape alignment check	Approved provisioning order issued
2. Provisioning	Approved order received, infrastructure capacity confirmed	Server/cloud resource provisioning, OS configuration, network setup	Environment passes infrastructure readiness check
3. Configuration	Infrastructure provisioning complete	Application installation, integration, connectivity setup, and security policy application	Configuration checklist signed off
4. Validation	Configuration complete	Connectivity verification, security audit, baseline health check, integration smoke test	Validation gate passed — environment released for use
5. Active Use	Validation gate passed	Team usage, scheduled maintenance, refresh cycles, and monitoring	Release phase complete or environment no longer required
6. Decommission	Environment no longer required, confirmed by the release manager	Data archiving, access revocation, infrastructure teardown, cost closure	Environment removed from the landscape register, cost closed

6.2 Governance Operating Model and Scheduling

The environment governance operating model includes the organizations, roles, responsibilities, cadences and communications model involved in coordinating environment management across the program. This includes working with infrastructure engineering, integration engineering, enterprise architecture, security, various application teams across the program, and third-party vendor partners. Environment governance meetings (held weekly), release alignment and maintenance coordination discussions are used to establish a regular cadence of communication so that stakeholders have awareness of the state of the environment and planned activities. An essential feature is the current environment contacts registry. This helps identify the system owners, technical contacts and vendor representatives of enterprise systems that participate in the environments. This ensures that environment issues are escalated to the responsible technical owners with minimal latency, enabling timely resolution before testing continuity is compromised. (De Haes et al., 2020).

Centralized scheduling and maintenance governance avoids that the schedule clashes with planned maintenance activities (e.g. database patching, server patching, certificate renewal, application upgrades, refresh cycles) in a maintenance calendar that is agreed to by all stakeholders and synchronized with the release calendar. In multi-organizational programs, vendor governance is also needed in the operating model. In settings where system integrators, SaaS vendors and infrastructure-as-a-service partners collaborate, governance defines service delivery, communication frequency and escalation paths. Plant et al. (2022) argue that governance frameworks should cover the structural and relational aspects of distributed delivery organizations. The EEMF supports these dimensions using vendor governance mechanisms, including the onboarding of new vendor partners, recovery mechanisms through performance review cadences and escalation mechanisms for when performance thresholds are not met.

7. Risk Management and Observability in Environment Governance

Environment availability and stability is of paramount importance during the key program activities, mock cutover cycle and PIT, Disaster Recovery Testing, Business Simulation and go-live events, and has direct impact on the program with regards to validating readiness and deploying. It is for this reason that the EEMF has executed a defined risk management process as part of the overall program governance. This has identified risks in the areas of

environment availability, connectivity to endpoints, infrastructure capacity and data readiness. Risks are identified four or more weeks before any critical phase: the date the phase starts. Mitigations for risks (e.g. reserving environments, pre-validation checks, provisioning contingencies) are delivered before the phase start date. Structured risk identification and management reduces the chances of incidents related to environments in critical phases. It improves delivery predictability.

Environment observability gives program leadership understanding into environment estate health, availability, and compliance metrics through reporting based on key performance indicators (KPIs). The EEMF defines a set of environment performance indicators to enable proactive issue detection and governance decisions based on data. Metrics such as the environment availability rate (which indicates the percentage of planned environment uptime provided), refresh adherence rate, defect density from environment issues, and maintenance schedule adherence are regularly monitored by governance forums to proactively identify issues that affect the development and test work, and to show quality and security adherence. Guerriero et al. (2019) report that proactive environment monitoring teams have shorter lead times and lower regression rates than reactive incident monitoring teams. Table 4 outlines key environment performance indicators, their definitions, and governance thresholds.

Table 4: Key Environment Performance Indicators with Governance Thresholds

KPI	Definition	Measurement Frequency	Target Threshold	Action if Breached
Environment Availability Rate	% of planned environment uptime actually delivered across all active environments	Weekly	≥ 95%	Incident review, root cause analysis, capacity escalation
Refresh Adherence Rate	% of scheduled database refreshes completed within planned window	Per the release phase	≥ 90%	Refresh calendar review, SLA escalation with vendor
Environment Defect Density	Number of defects attributable to environmental issues per testing cycle	Per the testing phase	< 5 per cycle	Governance forum escalation, environment stabilization sprint
Maintenance Schedule Compliance	% of planned maintenance activities completed within the scheduled window	Monthly	≥ 85%	Maintenance governance review, resource reallocation
Vendor Response Time (P1 Issues)	Average time from P1 environment issue raised to vendor acknowledgment	Per incident	< 4 hours	SLA escalation, executive notification, contingency activation
Lifecycle Gate Compliance	% of environments that passed all entry/exit criteria at each lifecycle gate	Per provisioning cycle	100%	Gate review, configuration remediation before environment release
Cross-Release Contamination Rate	Number of incidents where data or code from one release contaminated another environment	Per testing cycle	0	Integration routing audit, metadata classifier review

Observability also contributes to continuous improvement activities, and the trend data can be useful for capacity planning. The patterns of availability, maintenance, and defect data can be useful for environment management teams to understand the recurrence of issues, and to drive structural changes to the estate. For example, if observability information showed that refresh conflicts were too frequent in systems integration testing, governance could change future release calendars or introduce more capacity for these environments. The feedback loop between the observability layer and governance is one of the key features of the EEMF. It differentiates governance-driven environment management from reactive operational support and allows continuous improvement in the governance operating model.

8. Results and Validation

The EEMF was applied across enterprise transformation initiatives involving ERP implementations, hybrid cloud migrations, and multi-vendor delivery models. Operational measurements observed during these implementations indicated approximately 30% reduction in environment-related defects following the adoption of structured governance practices. This improvement compared to earlier stages of the program in which the full EEMF governance model was not applied, is in line with the literature analyzing the effect of structured formats for IT governance on operational results: for instance, De Haes et al. (2020) found that organizations with mature structures for IT governance had considerably lower technology-related operational failures than organizations without such structures. Likewise, Casino et al. (2022) found that formal ERP governance frameworks reduce the defect rates of ERP implementations compared to informal frameworks.

Operational observations across transformation releases indicated measurable improvements in deployment stability and release coordination following implementation of centralized scheduling and maintenance governance practices. Operational observations indicated a measurable reduction in refresh conflict which previously caused test cycle delays and regression issues, when the new maintenance calendar made maintenance windows visible to participating systems. Operational observations indicated that formalized vendor engagement cadences reduced cross-vendor issue resolution time during peak test phases. This agrees with Plant et al. (2022), whose findings indicate that in distributed delivery environments, implementation of formal governance structures improves operational predictability and reduces risk exposure throughout program delivery phases.

Organizations with cloud governance frameworks in place demonstrated a shorter average patch deployment times compared to those operating without formal governance practices. Programs operating without structured environment governance practices demonstrated higher rates of environment-related release instability, refresh conflicts, and operational unpredictability during critical testing phases. According to Flexera (2023), using structured cloud governance programs to achieve hybrid cloud governance could lead to a 23% reduction in cloud operational spending compared to informal governance. This is a general figure for all cloud governance projects, but can also be extrapolated to assess the value of governance-driven operation. Measured outcomes showed that programs with KPI-driven observability dashboards identified environment issues approximately 40% earlier in the testing cycle than those relying on reactive incident reporting.

9. Discussion

The EEMF is valid for all industry and program types, and any type of enterprise transformation program performed in a hybrid cloud context. The eight layers are platform agnostic and can be used across all major ERP platforms, cloud service providers, integration technologies and delivery models. The governance principles included in the framework, such as structured lifecycle management, KPI-driven observability, vendor coordination, and release-aligned scheduling, address organizational challenges that are common to all large scale enterprise transformation programs, including those within the industries of manufacturing, financial services, consumer packaged goods and food and agriculture, and the public sector. The EEMF itself is a reusable governance framework that can be calibrated based on the complexity, scale and programmatic regulations of the context.

One limitation of this paper is that the EEMF is based on enterprise transformation practice not a randomized controlled study or statistically representative sample across transformation programs. The numbers presented in this article apply to these programs and under these assumptions, and may not generalize directly. We do not claim that the space of all environment management trade-offs is completely explored, particularly in contexts in which the technical architecture is tightly constrained, such as in programs of real-time embedded systems or those operating in highly-regulated clinical environments. Rather, an organization that chooses to use the EEMF should tailor the layers to their specific program context. The effectiveness of the EEMF is largely dependent on discipline in governance; organizations that do not adhere to the cadence of governance will have diminished benefits.

Future work includes automating environment governance, for example by using machine learning models to analyze observability data about environment availability, predict risks, and suggest pre-emptive actions. It might also integrate environment governance with existing DevOps toolchains. This would involve tracking environment KPIs in existing CI/CD pipelines instead of having a separate environment governance system. Another direction for future work would be to govern the asynchronous update cycles of autonomous SaaS applications. These applications impose infrastructure maintenance schedules on the enterprise and require a governance model that accommodates immutable change windows while not interfering with enterprise program release cycles. According to Seifert et al. (2023), this remains an open research question in hybrid cloud SaaS governance.

10. Conclusion

This paper introduces the Enterprise Environment Management Framework (EEMF), a governance-oriented framework designed to support enterprise operations capability for managing environments on large-scale multi-release enterprise transformation programs in hybrid cloud environments. The framework transitions environment management from a tactical function to enterprise operations capability using a governance-driven approach that aligns and integrates environment strategy, environment landscape architecture, environment multi-release coordination, environment lifecycle governance, environment operating model design, scheduling and maintenance governance, risk management, and KPI-based observability. The framework shows that governance structures (ownership and accountability cadences, vendor engagement frameworks, performance measurement metrics) and technical processes are critical for effective environment management for complex programs. Programs that embed governance-driven environment management practices from the outset achieve better stability, predictability and go-live readiness compared to programs that treat environment management as a purely reactive infrastructure support process.

Organizations beginning a large enterprise transformation program are encouraged to implement the EEMF governance philosophy before they encounter environmental issues in a testing activity. The EEMF eight-layer architecture provides a method for implementing a transformation program and a reusable operational architecture for other programs without losing the benefit of established governance principles of ownership, visibility, discipline, and improvement.

Declaration of Conflicting Interests

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Authors' Contributions

A (Ashok Gopalakrishnan): Conceptualization, framework design, methodology, data curation, writing — original draft, review, and editing.

Data Availability

Data not available for ethical or legal reasons. The quantitative outcomes referenced in this paper are derived from enterprise transformation program operations and are subject to organizational confidentiality constraints.

Use of Artificial Intelligence

Artificial intelligence tools were used to assist with language editing and structural review of this manuscript. All research content, framework design, quantitative outcomes, and analytical conclusions are the work of the author. No synthetic data, fabricated results, or AI-generated findings are presented in this article.

References

1. AXELOS. (2019). ITIL Foundation: ITIL 4 edition. The Stationery Office.
2. Y. S. Rajesh, V. G. Kiran Kumar & Asmita Poojari (2024). A Unified Approach Toward Security Audit and Compliance in Cloud Computing Journal of The Institution of Engineers (India): Series B. https://doi.org/10.1007/s40031-024-01034-x

3. De Haes, S., Van Grembergen, W., Joshi, A., & Huygh, T. (2020). Enterprise governance of information technology: Achieving alignment and value in digital organizations (3rd ed.). Springer. https://doi.org/10.1007/978-3-030-25918-1
4. Flexera. Tanner Luxner (2023), Cloud computing trends and statistics: Flexera 2023 State of the Cloud Report. 2023 state of the cloud report. Flexera Software LLC.
5. Zainab Asimiyu (2020). Hybrid Cloud Technology: An In-Depth Analysis and Its Future Impact https://www.researchgate.net/publication/385172426_Hybrid_Cloud_Technology_An_In-Depth_Analysis_and_Its_Future_Impact
6. Guerriero, M., Garriga, M., Tamburri, D. A., & Palomba, F. (2019). Adoption, support, and challenges of infrastructure-as-code: Insights from industry. Proceedings of the IEEE International Conference on Software Maintenance and Evolution (ICSME), 580–589. https://doi.org/10.1109/ICSME.2019.00092
7. Kratzke, N., & Quint, P.-C. (2017). Understanding cloud-native applications after 10 years of cloud computing — A systematic mapping study. Journal of Systems and Software, 126, 1–16. https://doi.org/10.1016/j.jss.2017.01.001
8. Anna Berenberg, Brad Calder (2022). Deployment Archetypes for Cloud Applications. ACM Computing Surveys, 55(3), Article 64. https://doi.org/10.1145/3498336
9. Plant, O. H., van Hillegersberg, J., & Aldea, A. (2022). Rethinking IT governance: Designing a framework for mitigating risk and fostering internal control in a DevOps environment. International Journal of Accounting Information Systems, 45, Article 100560. https://doi.org/10.1016/j.accinf.2022.100560
10. Project Management Institute. (2021). A guide to the project management body of knowledge (PMBOK® guide) (7th ed.). Project Management Institute. https://tegnum.edu.pe/wp-content/uploads/2023/09/Project-Management-Institute-A-Guide-to-the-Project-Management-Body-of-Knowledge-PMBOK-R-Guide-PMBOK%C2%AE%EF%B8%8F-Guide-Project-Management-Institute-2021.pdf
11. Siffat Ullah Khan, Habib Ullah Khan, Naeem Ullah and Rafiq Ahmad Khan (2021). Challenges and Their Practices in Adoption of Hybrid Cloud Computing: An Analytical Hierarchy Approach. Cloud Solutions. Wiley Online Library. https://onlinelibrary.wiley.com/doi/full/10.1155/2021/1024139
12. Seifert, M., Kuehnel, S., & Sackmann, S. (2023). Hybrid clouds arising from software as a service adoption: Challenges, solutions, and future research directions. ACM Computing Surveys, 55(11), Article 228. https://doi.org/10.1145/3570156
13. Giacomo Lanciano, Antonio Ritacco, Fabio Brau, Tommaso Cucinotta, Marco Vannucci, Antonino Artale, Joao Barata & Enrica Sposato, Cloud Computing and Services Science. 2021. https://doi.org/10.1007/978-3-030-72369-9_7
14. The Open Group. (2022). TOGAF® standard, version 9.2. The Open Group. https://www.opengroup.org/togaf
15. Wieringa, R. (2014). Design Science Methodology for Information Systems and Software Fran Engineering. Springer. https://doi.org/10.1007/978-3-662-43839-8
16. Casino; Thomas K. Dasaklis; Georgios P. Spathoulas; Marios Anagnostopoulos; Amrita Ghosal; István Boŕoöz (2022). Research Trends, Challenges, and Emerging Topics in Digital Forensics: A Review of Reviews. IEEE Access, 10, 23145–23157. https://doi.org/10.1109/ACCESS.2022.3154059