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Global ESG Evidence Architecture

A Seven-Layer Governance Model for Trustworthy Sustainability Data

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Institutional Note

The *EMJ.LIFE Institutional Papers* series presents conceptual frameworks and research related to ESG data governance, sustainability evidence systems, and digital institutional infrastructure.

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Abstract

This paper introduces the **Global ESG Evidence Architecture**, a conceptual framework that models sustainability governance as a seven-layer institutional system connecting real-economy sustainability activities with international sustainability standards.

The architecture identifies a structural gap within the current ESG ecosystem: the absence of an evidence infrastructure layer capable of transforming sustainability actions into structured and verifiable ESG data prior to reporting and assurance processes.

To address this gap, the paper introduces the concept of **Evidence Anchoring**, which describes the process through which sustainability activities are captured, structured, and converted into traceable evidence records.

The study further presents the **Participation–Action–Data–Value (PADV) framework** as a conceptual model for structuring behavioral sustainability activities into institutional ESG evidence.

Together, these elements provide a conceptual architecture for understanding how sustainability actions may evolve into verifiable ESG information within global governance systems.

Keywords

ESG governance · sustainability data infrastructure · evidence anchoring · ESG data provenance · ESG digital governance · behavioral sustainability data · PADV framework · sustainability · evidence systems

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Global ESG Evidence Architecture (GEEA) introduces a seven-layer governance model connecting real-economy sustainability activities with international ESG standards through an evidence infrastructure layer.

Series Description

EMJ.LIFE Institutional Papers is a research series dedicated to the conceptual and institutional development of sustainability data governance systems, digital ESG infrastructures, and evidence-based sustainability frameworks.

Executive Summary

The rapid expansion of Environmental, Social, and Governance (ESG) reporting frameworks has significantly increased the volume and complexity of sustainability disclosures produced by corporations and institutions worldwide. Global initiatives such as the IFRS Sustainability Disclosure Standards, the Global Reporting Initiative (GRI), and the Taskforce on Nature-related Financial Disclosures (TNFD) have contributed to the development of standardized reporting practices. At the same time, regulators and financial markets are placing greater emphasis on the credibility, comparability, and verifiability of sustainability information.

Despite these developments, the global ESG ecosystem continues to face a fundamental structural challenge: the **trust gap between real-world sustainability activities and reported ESG data**. Many sustainability disclosures rely on aggregated corporate data, retrospective reporting processes, or narrative explanations that may not fully capture the underlying evidence of sustainability actions. This structural gap increases verification costs and contributes to persistent concerns regarding greenwashing and data reliability.

This paper introduces the concept of a **Global ESG Evidence Architecture**, a governance framework designed to better understand how sustainability data flows across institutional systems. The proposed model conceptualizes ESG governance as a **seven-layer institutional architecture**, connecting real economy activities with international sustainability standards. Within this architecture, the paper identifies the absence of an intermediate infrastructure layer responsible for transforming sustainability activities into structured and traceable evidence before reporting and assurance processes occur.

To address this gap, the paper proposes the concept of **evidence infrastructure**, a digital governance layer that captures sustainability participation and operational activities as structured evidence records. The framework highlights the potential role of evidence anchoring mechanisms in improving the traceability and auditability of ESG data. The paper also introduces a conceptual

data model—the **Participation–Action–Data–Value (PADV) framework**—to illustrate how sustainability participation activities can generate structured evidence that supports ESG reporting and verification systems.

While the architecture presented in this paper is conceptual in nature, it offers a possible institutional lens for understanding how sustainability data systems may evolve in response to growing demands for reliable ESG information. Evidence infrastructures may play an increasingly important role in bridging the gap between sustainability activities and institutional governance processes, thereby strengthening the integrity of global ESG data ecosystems.

Abstract

The expansion of global ESG reporting frameworks has increased the importance of reliable and verifiable sustainability data. However, a structural gap remains between real-world sustainability activities and the ESG information disclosed through reporting systems. This gap contributes to persistent challenges related to data provenance, verification costs, and greenwashing risks.

This paper proposes a conceptual governance framework termed the **Global ESG Evidence Architecture**, which describes ESG governance as a seven-layer institutional system linking real economy activities, digital reporting platforms, verification institutions, capital markets, regulatory bodies, and international sustainability standards. Within this architecture, the paper identifies the absence of a dedicated **evidence infrastructure layer** responsible for transforming sustainability activities into structured evidence prior to reporting and assurance processes.

To address this gap, the study introduces the concept of **evidence anchoring**, a mechanism through which sustainability actions are captured and structured as traceable data records. The paper further presents the **Participation–Action–Data–Value (PADV) framework** as a conceptual model illustrating how sustainability participation can generate structured evidence suitable for integration into ESG governance systems.

By providing an institutional architecture and conceptual data framework, this

paper contributes to the emerging discussion on sustainability data governance and the design of trustworthy ESG information systems.

Key Contributions

This paper makes four primary contributions to the discussion on ESG governance and sustainability data systems.

1. Introducing a Seven-Layer ESG Governance Architecture

The paper proposes the **Global ESG Evidence Architecture**, a conceptual framework that models ESG governance as a seven-layer institutional system connecting real economy activities, digital reporting platforms, verification institutions, capital markets, regulatory bodies, and international sustainability standards.

This architecture provides a structured perspective for understanding how sustainability information flows across global ESG systems.

2. Identifying the Missing Evidence Infrastructure Layer

The paper highlights a structural gap within the current ESG ecosystem: the absence of a dedicated **evidence infrastructure layer** responsible for transforming sustainability activities into structured evidence prior to reporting and assurance processes.

Addressing this gap may help improve data provenance, reduce verification costs, and strengthen the credibility of ESG disclosures.

3. Introducing the Concept of Evidence Anchoring

The study introduces the concept of **evidence anchoring**, which describes the process through which sustainability activities are captured and converted into structured and traceable data records.

Evidence anchoring provides a conceptual mechanism for linking real-world sustainability actions with digital ESG governance systems.

4. Proposing the Participation–Action–Data–Value (PADV) Framework

The paper presents the **PADV framework** as a conceptual model illustrating how sustainability participation activities may generate structured evidence capable of supporting ESG reporting, governance processes, and verification systems.

The framework demonstrates how behavioral sustainability activities can be transformed into structured ESG evidence within digital governance infrastructures.

Chapter 1. Introduction

From ESG Disclosure to ESG Infrastructure

Over the past decade, environmental, social, and governance (ESG) considerations have moved from the periphery of corporate responsibility into the core of global financial and regulatory systems. Investors, regulators, and civil society organizations increasingly expect companies to disclose information related to climate risks, environmental impacts, social responsibility, and governance practices. As a result, sustainability reporting has become a fundamental component of modern corporate transparency.

International initiatives have played a crucial role in shaping this evolution. Organizations such as the **IFRS Foundation**, through the International Sustainability Standards Board (ISSB), have introduced global sustainability disclosure standards designed to enhance comparability and reliability in ESG reporting. Similarly, frameworks developed by the **Global Reporting Initiative (GRI)** and the **Task Force on Nature-related Financial Disclosures (TNFD)** have expanded the scope of sustainability disclosures and strengthened expectations for corporate accountability.

At the same time, regulatory pressure has intensified across major economies. Governments and financial regulators have introduced new rules requiring companies to disclose climate-related risks, environmental impacts, and sustainability performance metrics. These developments reflect a broader

recognition that ESG information plays a critical role in guiding capital allocation, managing systemic risks, and supporting long-term economic resilience.

However, the rapid expansion of ESG disclosure requirements has also exposed a fundamental challenge: **the trustworthiness of ESG data itself**. While reporting standards and verification practices have improved significantly, the processes through which sustainability data is generated and aggregated often remain opaque. ESG metrics may rely on internal estimates, fragmented operational data, or manual reporting processes that vary significantly across organizations.

This structural complexity has contributed to several widely discussed concerns within the global sustainability community. Among these concerns are the increasing costs associated with ESG verification, inconsistencies across reporting frameworks, and growing scrutiny related to potential greenwashing. These issues highlight an important question that extends beyond reporting standards themselves:

How can ESG data become trustworthy at global scale?

Addressing this question requires looking beyond disclosure frameworks and examining the broader architecture of ESG governance systems. Current sustainability reporting frameworks focus primarily on defining *what* organizations should disclose. Assurance frameworks, in turn, focus on verifying *whether* reported information complies with applicable standards.

Yet between real-world sustainability activities and the ESG reports presented to investors lies a complex chain of data collection, transformation, and aggregation. This chain often lacks standardized mechanisms for capturing verifiable evidence of sustainability actions as they occur in the real economy.

In other words, the global ESG ecosystem may be missing a critical structural layer—an infrastructure capable of translating real-world activities into verifiable sustainability evidence before reporting and assurance processes take place.

This paper introduces the concept of **ESG Evidence Architecture**, a governance framework designed to address this structural gap. The framework proposes a

seven-layer model that maps the institutional structure of global ESG systems, ranging from real economy activities to international reporting standards.

Within this architecture, a previously underexplored layer—referred to as the **Evidence Infrastructure Layer**—plays a pivotal role. Positioned between software platforms and real-world economic activities, this layer focuses on structuring sustainability actions into verifiable ESG evidence, thereby improving data provenance, traceability, and audit readiness.

By identifying and conceptualizing this layer, the paper aims to contribute to ongoing discussions about the future of ESG governance. Rather than viewing sustainability reporting solely as a disclosure exercise, the framework encourages a broader perspective in which ESG systems are understood as **institutional infrastructures for trustworthy sustainability data**.

The following sections develop this concept in greater detail. Chapter 2 examines the structural trust gap in current ESG reporting systems. Chapter 3 reviews existing literature on sustainability governance frameworks. Chapter 4 introduces the proposed **Global ESG Evidence Architecture** and outlines its seven-layer governance model.

Together, these discussions provide a conceptual foundation for exploring how digital infrastructures and governance frameworks can evolve to support the next phase of global sustainability data systems.

Chapter 2. The ESG Trust Gap

Structural Challenges in Sustainability Data Governance

As sustainability reporting has expanded across global markets, the importance of reliable ESG data has grown significantly. Investors, regulators, and stakeholders increasingly rely on ESG disclosures to assess corporate risk exposure, sustainability performance, and long-term value creation. However, despite the rapid development of reporting standards and verification practices, concerns regarding the credibility and reliability of ESG data remain widely discussed within both academic literature and policy debates.

These concerns have led to what can be described as the **ESG trust gap**—a

structural disconnect between real-world sustainability activities and the ESG information ultimately presented in corporate disclosures.

Understanding this trust gap requires examining how sustainability data is typically generated and processed within the current ESG ecosystem.

2.1 The Current ESG Data Flow

In most organizations, ESG information flows through a multi-stage process that connects operational activities with corporate reporting systems. Although the exact structure varies across industries and jurisdictions, the general architecture of ESG data generation can be described as follows:

At the base of this structure lie **real-world activities** occurring within companies, supply chains, and communities. These activities may include environmental management practices, energy consumption reductions, employee engagement programs, biodiversity protection initiatives, and other sustainability-related actions.

Operational data related to these activities is typically captured through internal systems such as enterprise resource planning (ERP) platforms, environmental

monitoring systems, or manual reporting processes. The collected data is then aggregated and interpreted by corporate sustainability teams before being incorporated into ESG reporting platforms and sustainability disclosures.

Finally, third-party assurance providers—often accounting firms or specialized verification organizations—review the disclosed information to evaluate whether it aligns with applicable reporting standards.

While this architecture enables companies to produce sustainability reports, it also introduces multiple points where data may be transformed, summarized, or interpreted before reaching external stakeholders.

2.2 Data Provenance and Traceability Challenges

One of the central challenges within the ESG ecosystem concerns **data provenance**—the ability to clearly trace reported information back to its original source.

In traditional financial reporting systems, accounting records are typically supported by structured documentation such as invoices, contracts, and transaction logs. These records create a clear audit trail that enables auditors to verify the origin and validity of financial information.

In contrast, ESG data often emerges from complex operational environments where standardized evidence mechanisms may be less developed. Sustainability metrics can depend on estimations, operational measurements, survey responses, or aggregated internal data sources that may not always provide a consistent or easily verifiable chain of evidence.

As a result, auditors and verification bodies may face difficulties when attempting to trace reported ESG metrics back to specific operational activities. This lack of standardized evidence structures can increase the complexity and cost of assurance processes.

Furthermore, variations in internal data collection methods across organizations may lead to inconsistencies in how sustainability metrics are generated, interpreted, and disclosed.

2.3 Increasing Verification Complexity

As ESG reporting frameworks become more comprehensive, verification requirements have expanded accordingly. Assurance providers are now expected to evaluate a growing range of sustainability indicators, including climate-related risks, environmental impacts, social performance metrics, and governance structures.

This increasing complexity presents significant challenges for both corporations and verification institutions.

For companies, the cost and administrative burden associated with ESG reporting and verification can rise substantially as regulatory requirements expand. Sustainability teams must coordinate data collection across multiple departments, consolidate diverse data sources, and ensure compliance with evolving reporting standards.

For verification institutions, assessing ESG disclosures requires reviewing complex datasets that may originate from heterogeneous operational systems. In many cases, auditors must rely on sampling methodologies or qualitative assessments when direct evidence is difficult to obtain.

These challenges have contributed to growing discussions within policy circles regarding the scalability of ESG verification frameworks.

2.4 Greenwashing and Credibility Risks

Another dimension of the ESG trust gap relates to concerns surrounding **greenwashing**—the practice of overstating or misrepresenting sustainability performance.

Greenwashing concerns arise not only from intentional misrepresentation but also from structural weaknesses in data governance systems. When ESG metrics depend on aggregated or indirect data sources, inconsistencies or ambiguities may emerge in how sustainability outcomes are interpreted.

In recent years, regulators in several jurisdictions have increased scrutiny of sustainability-related claims. Financial authorities and consumer protection

agencies have introduced new guidelines and enforcement mechanisms designed to address misleading environmental or social claims.

These developments reflect a broader recognition that the credibility of sustainability disclosures is essential for maintaining trust in ESG markets and sustainable finance initiatives.

2.5 The Missing Layer in ESG Governance

The challenges described above point toward a structural limitation within the current ESG ecosystem. While existing frameworks provide guidance on **what organizations should disclose** and **how disclosures should be verified**, they often pay less attention to the infrastructure through which sustainability evidence is generated and structured before reporting occurs.

In other words, the ESG system largely focuses on **reporting frameworks and assurance mechanisms**, while the intermediate layer connecting real-world activities to digital reporting systems remains underdeveloped.

This observation suggests the presence of a missing structural component within the global ESG governance architecture.

The ESG ecosystem lacks a dedicated **evidence infrastructure layer** capable of systematically translating real-world sustainability activities into verifiable ESG evidence.

Without such an infrastructure, ESG data must often be reconstructed retrospectively through internal reporting processes, increasing both verification complexity and the risk of data inconsistencies.

2.6 Toward an Evidence-Based ESG Architecture

Addressing the ESG trust gap requires rethinking how sustainability information is captured and structured within governance systems. Rather than focusing exclusively on disclosure requirements or reporting frameworks, future ESG systems may benefit from the development of infrastructures that generate **structured sustainability evidence at the point of activity**.

Such infrastructures could support several important functions:

- improving data provenance by linking reported metrics to verifiable activities
- enhancing audit readiness by providing structured evidence records
- reducing verification costs through standardized data structures
- increasing interoperability across reporting platforms and regulatory systems

This perspective shifts the focus of ESG governance from disclosure alone toward the broader concept of **evidence-based sustainability data systems**.

The following chapter examines how existing sustainability frameworks and governance models approach these challenges and highlights the structural gap that motivates the development of a new architectural framework.

Chapter 4 then introduces the proposed **Global ESG Evidence Architecture**, a seven-layer governance model designed to bridge the gap between real economy activities and trustworthy ESG disclosures.

Chapter 3. Literature Review

Existing Frameworks for ESG Governance and Sustainability Data

The rapid development of environmental, social, and governance (ESG) systems over the past two decades has been supported by a growing body of institutional frameworks and academic research. These frameworks address various dimensions of sustainability governance, including corporate disclosure, sustainability reporting standards, assurance mechanisms, and data governance practices.

While these initiatives have significantly improved transparency and comparability in sustainability reporting, they primarily focus on defining disclosure requirements and verification procedures. Relatively less attention has been given to the underlying infrastructures through which sustainability evidence is generated and structured before reporting takes place.

This chapter reviews three major strands of literature relevant to ESG governance: **sustainability reporting frameworks, ESG assurance mechanisms, and emerging research on digital data governance for**

sustainability systems.

3.1 Sustainability Reporting Frameworks

The first major body of ESG governance literature concerns sustainability reporting frameworks. Over the past two decades, several international initiatives have sought to standardize the disclosure of environmental, social, and governance information.

Among the most widely recognized frameworks is the **Global Reporting Initiative (GRI)**, which provides comprehensive guidelines for corporate sustainability reporting across environmental, social, and economic dimensions. GRI standards have been adopted by thousands of organizations worldwide and have played a central role in establishing voluntary sustainability disclosure practices.

Another influential framework is the **Sustainability Accounting Standards Board (SASB)**, which introduced industry-specific standards designed to help companies disclose financially material sustainability information to investors. SASB standards focus on identifying ESG issues that are most relevant to financial performance within specific industries.

More recently, the **International Sustainability Standards Board (ISSB)**, established by the IFRS Foundation, has introduced global sustainability disclosure standards through **IFRS S1 and IFRS S2**. These standards aim to improve consistency, comparability, and decision-usefulness of sustainability-related financial disclosures, particularly in the context of climate-related risks.

In addition to these frameworks, initiatives such as the **Task Force on Climate-related Financial Disclosures (TCFD)** and the **Task Force on Nature-related Financial Disclosures (TNFD)** have expanded the scope of sustainability governance by encouraging companies to disclose risks and opportunities related to climate change and biodiversity.

Collectively, these frameworks represent a major step forward in standardizing ESG disclosure practices. They provide guidance on **what types of sustainability information organizations should disclose** and how such

information should be structured within corporate reporting systems.

However, these frameworks primarily address **disclosure requirements rather than the underlying infrastructure through which sustainability evidence is generated**.

3.2 ESG Assurance and Verification Systems

A second major strand of ESG governance literature focuses on the assurance and verification of sustainability disclosures. As ESG reporting has expanded, third-party verification has become increasingly important for ensuring the credibility of disclosed information.

Assurance services are typically provided by large accounting firms, specialized sustainability verification bodies, or certification organizations. These institutions evaluate whether corporate sustainability disclosures align with relevant reporting frameworks and whether underlying data appears reliable.

Existing assurance practices often rely on methodologies adapted from financial auditing, including risk assessment procedures, internal control evaluations, and evidence sampling techniques. International standards such as **ISAE 3000** provide general guidelines for assurance engagements related to non-financial information, including sustainability disclosures.

In addition to accounting-based assurance frameworks, environmental verification standards such as **ISO 14064** and **ISO 14065** provide methodologies for verifying greenhouse gas emissions and related environmental data.

While these assurance mechanisms improve confidence in reported sustainability metrics, they also face structural challenges. ESG data may originate from diverse operational systems, supply chains, and measurement processes that differ significantly across organizations. As a result, auditors often need to rely on partial documentation, internal estimates, or sampling methodologies when verifying sustainability information.

These conditions can increase the complexity and cost of ESG verification while also limiting the ability of assurance providers to trace sustainability data back to specific operational activities.

3.3 Digital Data Governance for Sustainability Systems

A third emerging area of research focuses on digital infrastructures for sustainability data governance. As ESG reporting requirements grow, organizations and policymakers have increasingly recognized the need for more robust data management systems capable of supporting large-scale sustainability information flows.

Recent discussions in this area have explored concepts such as **digital monitoring, reporting, and verification (digital MRV)**, which refers to the use of digital technologies to track and validate sustainability-related data. These approaches often incorporate tools such as sensor networks, digital platforms, blockchain systems, and supply chain traceability technologies.

Academic literature on **data lineage** and **digital trust infrastructures** has also emphasized the importance of maintaining clear records of how data is generated, transformed, and transmitted across complex information systems. Such mechanisms can improve transparency and enable more reliable verification of sustainability metrics.

Despite these advancements, many existing digital initiatives focus primarily on improving transparency within specific sectors—such as carbon markets, supply chain traceability, or environmental monitoring—rather than addressing the broader institutional architecture of ESG data systems.

In particular, the integration between real-world sustainability activities and digital reporting infrastructures remains fragmented across many ESG platforms.

3.4 Research Gap: The Missing Evidence Infrastructure

The literature reviewed above demonstrates significant progress in three areas: sustainability reporting standards, assurance frameworks, and digital data governance technologies. Each of these areas contributes important components to the broader ESG governance ecosystem.

However, a structural gap remains.

Current sustainability reporting frameworks define **what organizations should**

disclose, while assurance standards provide guidance on **how disclosures should be verified**. Digital technologies have begun to improve the traceability and management of sustainability data.

Yet relatively little attention has been devoted to the **institutional infrastructure responsible for transforming real-world sustainability activities into structured ESG evidence prior to reporting and verification**.

This missing layer can be described as an **evidence infrastructure**—a governance and technological framework that systematically captures sustainability actions and converts them into verifiable data structures before they enter reporting and assurance systems.

Without such an infrastructure, ESG information often relies on retrospective aggregation and interpretation of operational data, which may contribute to verification complexity and credibility concerns.

Recognizing this structural gap provides the conceptual motivation for the framework proposed in this paper.

The next chapter introduces the **Global ESG Evidence Architecture**, a seven-layer governance model designed to clarify the institutional relationships between real economy activities, evidence generation systems, reporting platforms, and international sustainability standards.

By explicitly identifying the role of **evidence infrastructure** within the ESG ecosystem, the proposed architecture seeks to contribute a conceptual foundation for future research and system design in sustainability data governance.

Chapter 4. The Global ESG Evidence Architecture

A Seven-Layer Governance Model for Sustainability Data

The preceding chapters have highlighted a structural challenge within the global ESG ecosystem: the disconnect between real-world sustainability activities and the ESG data ultimately disclosed in corporate reports. While reporting frameworks and assurance standards have advanced rapidly, the infrastructure

that translates real-world actions into verifiable sustainability evidence remains insufficiently defined.

To address this challenge, this paper introduces the concept of the **Global ESG Evidence Architecture**, a governance framework designed to clarify how sustainability information flows across institutional systems.

The proposed architecture conceptualizes ESG governance as a **multi-layer institutional stack**, linking real economy activities with international sustainability standards through a structured sequence of data infrastructures, software systems, verification institutions, capital markets, and regulatory frameworks.

This model organizes the global ESG ecosystem into **seven interconnected layers**.

4.1 Overview of the Seven-Layer Architecture

The Global ESG Evidence Architecture consists of seven governance layers that collectively form the institutional infrastructure of sustainability data systems.

The architecture is organized from the foundational level of real-world activities to the highest level of international sustainability standards.

Figure 1. Global ESG Evidence Architecture

These layers together form a governance stack through which sustainability information is generated, structured, verified, and ultimately integrated into global financial and regulatory systems.

At the base of this architecture lie **real economy activities**, which represent the practical implementation of sustainability actions across corporations, supply chains, communities, and institutions.

At the top of the architecture sit **international sustainability standards**, which define the reporting frameworks that guide how ESG information is disclosed to capital markets and regulators.

Between these two endpoints lies a complex institutional infrastructure responsible for transforming real-world activities into structured and verifiable sustainability data.

4.2 Layer 7 — Real Economy Activities

The foundational layer of the ESG architecture consists of **real economy activities**, where sustainability actions actually occur.

These activities include a wide range of operational practices such as:

- energy efficiency improvements
- waste reduction initiatives
- biodiversity protection programs
- employee engagement in sustainability programs
- responsible supply chain practices
- community participation initiatives

Real economy activities represent the **primary source of sustainability value creation**. However, these activities often occur in decentralized operational environments where data may not be captured in standardized formats.

Without structured mechanisms for recording and translating these activities into digital evidence, much of the sustainability value generated at this level may remain invisible to reporting and governance systems.

4.3 Layer 6 — Evidence Infrastructure

Directly above real economy activities lies the **Evidence Infrastructure Layer**, which constitutes the central innovation proposed in this paper.

The role of the evidence infrastructure layer is to transform real-world sustainability actions into **structured and verifiable ESG evidence**.

This layer performs three essential functions:

Function	Description
Provenance	Capturing the origin of sustainability actions
Structuring	Converting activities into standardized data formats
Auditability	Preserving verifiable records for assurance processes

By creating structured evidence at the point where sustainability actions occur, the evidence infrastructure layer improves the traceability and reliability of ESG data before it enters reporting and verification systems.

This approach contrasts with traditional ESG reporting processes, where sustainability information is often reconstructed retrospectively through internal aggregation and reporting procedures.

Within the proposed architecture, evidence infrastructures function as **data bridges between real economy activities and digital reporting systems**.

4.4 Layer 5 — Software and Reporting Platforms

The next layer consists of **software platforms that manage ESG data and sustainability reporting processes**.

These platforms are responsible for:

- aggregating sustainability metrics
- organizing ESG indicators
- generating sustainability disclosures
- integrating ESG data with enterprise systems

Examples of such platforms include ESG data management systems, sustainability reporting software, and enterprise analytics tools used to prepare ESG disclosures.

These systems play an important role in operationalizing reporting frameworks, but they typically rely on data inputs that originate from operational systems and internal reporting processes.

Without robust evidence infrastructures, software platforms may face limitations in ensuring the provenance and traceability of underlying sustainability data.

4.5 Layer 4 — Verification and Assurance Institutions

Above the reporting systems lie **verification and assurance institutions**, which evaluate the reliability and credibility of ESG disclosures.

These institutions include:

- accounting firms providing ESG assurance services
- sustainability verification organizations
- certification bodies evaluating environmental and social claims

Verification institutions assess whether reported sustainability information aligns with applicable reporting frameworks and whether underlying evidence appears sufficient to support disclosed metrics.

However, assurance processes can become complex when sustainability data originates from fragmented operational systems lacking standardized evidence structures.

Evidence infrastructures can potentially enhance the efficiency of assurance processes by providing auditors with structured and traceable records of sustainability activities.

4.6 Layer 3 — Capital Allocation Systems

The third layer consists of **capital allocation mechanisms that use ESG information to guide investment decisions**.

Financial institutions, asset managers, banks, and investors increasingly rely on

ESG disclosures to evaluate corporate sustainability performance and long-term risk exposure.

Capital markets use ESG data for various purposes, including:

- sustainable investment strategies
- climate risk assessments
- portfolio allocation decisions
- sustainability-linked financing

The reliability of ESG data is therefore critical for maintaining trust in sustainable finance systems.

Improving the underlying infrastructure of sustainability evidence may enhance the quality and consistency of information used in capital markets.

4.7 Layer 2 — Regulatory Enforcement Systems

The second layer includes **regulatory institutions responsible for overseeing sustainability disclosures and corporate governance practices**.

Financial regulators and public authorities establish rules that define how companies must disclose sustainability information and how such disclosures should be evaluated.

Regulatory frameworks increasingly require companies to report climate-related risks, environmental impacts, and other sustainability indicators.

These regulatory developments aim to improve transparency and accountability within financial markets.

However, effective enforcement depends on the availability of reliable and verifiable ESG data generated across the underlying layers of the governance architecture.

4.8 Layer 1 — International Sustainability Standards

At the top of the architecture sit **international sustainability standards**, which define the frameworks used for corporate ESG disclosures.

Organizations such as the IFRS Foundation, through the International Sustainability Standards Board (ISSB), have introduced global standards designed to improve comparability and consistency in sustainability reporting.

Similarly, initiatives such as GRI, SASB, and TNFD contribute to shaping the global landscape of sustainability disclosure frameworks.

These standards represent the **normative layer of ESG governance**, defining the expectations for how sustainability information should be reported.

However, the effectiveness of these frameworks ultimately depends on the reliability of data generated within the underlying layers of the ESG architecture.

4.9 The Role of Evidence Infrastructure in ESG Governance

The seven-layer architecture highlights the central role of the **evidence infrastructure layer** in bridging the gap between real-world sustainability activities and global ESG governance systems.

By providing structured mechanisms for capturing sustainability actions and translating them into verifiable evidence, evidence infrastructures can strengthen the integrity of ESG data flows across the entire governance stack.

Rather than viewing ESG systems solely as reporting frameworks, the proposed architecture suggests that sustainability governance should increasingly be understood as a **data infrastructure problem**.

In this perspective, ESG reporting standards, assurance mechanisms, regulatory systems, and capital markets all depend on the availability of reliable evidence infrastructures capable of translating real-world sustainability activities into trustworthy data.

This conceptual shift—from disclosure frameworks to **evidence-based sustainability infrastructures**—forms the foundation for the next phase of ESG governance development.

Chapter 5. Evidence Anchoring

The Missing Infrastructure of ESG Governance

The seven-layer architecture introduced in the previous chapter highlights a structural feature of global ESG governance systems: sustainability information flows across multiple institutional layers before reaching investors, regulators, and stakeholders. Within this architecture, the **Evidence Infrastructure Layer** plays a pivotal role in connecting real-world sustainability activities with digital reporting and verification systems.

However, the functionality of this layer requires a clearer conceptual definition. In order to translate sustainability actions into verifiable data structures, ESG systems must incorporate mechanisms capable of capturing, structuring, and preserving evidence of sustainability-related activities.

This paper refers to such mechanisms collectively as **Evidence Anchoring**.

Evidence Anchoring describes the institutional and technological processes through which real-world sustainability activities are recorded and converted into structured ESG evidence prior to reporting and assurance procedures.

By establishing structured evidence at the point where sustainability actions occur, evidence anchoring strengthens the reliability and traceability of sustainability data across the broader ESG governance architecture.

5.1 Defining Evidence Anchoring

Evidence Anchoring can be defined as:

A governance and technological mechanism that records, structures, and preserves sustainability activities as verifiable ESG evidence before such information enters reporting and assurance systems.

This definition highlights three essential characteristics.

First, evidence anchoring focuses on **recording sustainability actions at the moment they occur**, rather than reconstructing information retrospectively through internal reporting processes.

Second, the mechanism transforms sustainability actions into **structured data formats** that can be integrated into digital ESG reporting systems.

Third, anchored evidence remains **traceable and auditable**, enabling verification institutions to examine the underlying activities that support reported ESG metrics.

Together, these characteristics allow evidence anchoring to function as a foundational infrastructure for trustworthy sustainability data.

5.2 The Evidence Generation Process

Within the proposed ESG governance architecture, evidence anchoring operates as an intermediary process between real economy activities and sustainability reporting systems.

The process can be conceptualized as follows:

At the first stage, sustainability actions occur in operational contexts such as corporate programs, supply chain initiatives, or community-based activities.

Evidence anchoring mechanisms then capture these activities through digital recording processes that may include data inputs from operational systems, participation records, environmental monitoring systems, or other forms of

activity documentation.

These records are subsequently transformed into structured sustainability evidence that can be processed by ESG reporting platforms and evaluated by verification institutions.

This structured approach reduces the need for retrospective data reconstruction and enables sustainability evidence to be integrated more efficiently into reporting and assurance systems.

5.3 Core Functions of Evidence Anchoring

The effectiveness of evidence anchoring mechanisms depends on three core functional components.

Provenance

The first function concerns **data provenance**, which refers to the ability to trace sustainability information back to its original activity source.

Evidence anchoring mechanisms capture metadata related to sustainability actions, including information about the actors involved, the timing of activities, and the contextual parameters under which the activity occurred.

Establishing clear provenance enables verification institutions to evaluate whether reported ESG metrics correspond to genuine sustainability activities.

Structuring

The second function involves **data structuring**.

Real-world sustainability activities are often diverse and heterogeneous in nature. Evidence anchoring systems convert these activities into standardized data formats that can be processed by ESG reporting platforms.

Structured data allows sustainability metrics to be aggregated and analyzed without losing the underlying context of the activities that generated them.

This structuring process is critical for enabling interoperability across digital reporting systems and institutional governance frameworks.

Auditability

The third function concerns **auditability**.

Evidence anchoring preserves records of sustainability activities in formats that remain accessible for verification and assurance procedures.

Rather than relying solely on aggregated corporate disclosures, auditors can examine the structured evidence records associated with sustainability actions.

This capability can significantly improve the efficiency and credibility of ESG assurance processes.

5.4 Evidence Anchoring as Institutional Infrastructure

Evidence anchoring mechanisms should not be viewed merely as technical tools. Instead, they represent a broader form of **institutional infrastructure** within ESG governance systems.

Just as financial accounting systems rely on standardized transaction records to ensure the integrity of financial statements, sustainability governance systems increasingly require standardized mechanisms for recording sustainability activities.

Evidence anchoring fulfills this role by creating structured records that support the entire ESG governance stack.

Within the seven-layer architecture, the evidence anchoring mechanism functions as a **structural bridge** between the operational layer of real economy activities and the digital infrastructures used for sustainability reporting.

By strengthening this bridge, ESG systems can improve the reliability, transparency, and scalability of sustainability data.

5.5 Implications for ESG Data Systems

The introduction of evidence anchoring mechanisms has several implications for the future development of ESG governance systems.

First, sustainability data systems may increasingly shift from retrospective reporting toward **activity-based evidence generation**.

Second, digital infrastructures capable of capturing sustainability actions in real time may reduce the administrative burden associated with ESG reporting and verification.

Third, improved evidence structures may enhance interoperability across reporting frameworks, regulatory systems, and capital market institutions.

In this context, evidence anchoring represents a conceptual step toward the development of **evidence-based sustainability governance systems**.

Rather than relying solely on aggregated disclosures, ESG governance systems may increasingly depend on infrastructures capable of generating structured sustainability evidence at the point where sustainability actions occur.

The following chapter examines the broader institutional implications of this shift and explores how evidence infrastructures may reshape the future landscape of global ESG governance.

Chapter 6. Institutional Implications

Impacts of Evidence Infrastructure on ESG Governance Systems

The Global ESG Evidence Architecture proposed in this paper provides a conceptual framework for understanding how sustainability information flows across institutional systems. By identifying the structural role of evidence infrastructures within the ESG governance stack, the framework offers several implications for regulators, capital markets, corporations, and verification institutions.

These implications highlight how the development of evidence-based sustainability infrastructures may influence the evolution of global ESG governance.

6.1 Implications for Regulatory Systems

Regulatory authorities around the world have significantly expanded sustainability disclosure requirements in recent years. Financial regulators increasingly require companies to report climate-related risks, environmental

impacts, and governance practices in order to improve market transparency and protect investors.

However, enforcing ESG disclosure rules presents unique challenges compared with traditional financial regulation. Sustainability information often originates from operational activities that occur across complex supply chains, diverse geographic locations, and decentralized organizational structures.

In such environments, regulators face two major difficulties.

First, it may be difficult to assess the reliability of ESG data when information is generated through fragmented internal reporting processes.

Second, verifying the authenticity of sustainability claims may require extensive documentation and complex assurance procedures.

Evidence infrastructures may help address these challenges by providing **structured records of sustainability activities** that can support regulatory oversight. When sustainability actions are anchored as verifiable evidence at the operational level, regulators may gain greater visibility into the processes that generate reported ESG data.

Such infrastructures could potentially reduce enforcement complexity while improving the overall credibility of sustainability disclosures.

6.2 Implications for Capital Markets

The expansion of sustainable finance has increased the importance of ESG data within global capital markets. Asset managers, banks, and institutional investors increasingly rely on sustainability metrics when evaluating corporate risk exposure and long-term investment opportunities.

However, the usefulness of ESG data for investment decision-making depends heavily on the reliability and comparability of the underlying information.

Inconsistent data generation practices and variations in reporting methodologies may create uncertainty for investors attempting to assess corporate sustainability performance. These uncertainties have contributed to ongoing debates regarding the quality of ESG ratings and the comparability of

sustainability metrics.

Evidence infrastructures may help improve the informational quality of ESG data used in capital markets. By structuring sustainability actions into verifiable evidence records before they enter reporting systems, such infrastructures can strengthen the traceability and transparency of sustainability information.

Improved data provenance may enhance investor confidence in sustainability disclosures and support more informed capital allocation decisions.

6.3 Implications for Corporations

Corporations face growing pressure to collect, manage, and disclose sustainability information across a wide range of operational areas. ESG reporting requirements often involve coordination across multiple departments, including environmental management teams, human resources divisions, supply chain managers, and corporate governance units.

As reporting frameworks expand, many organizations encounter increasing administrative burdens related to sustainability data collection and verification.

Evidence anchoring mechanisms may help corporations address these challenges by shifting ESG data generation closer to the point where sustainability activities occur.

Instead of reconstructing sustainability metrics through retrospective reporting processes, organizations may capture structured evidence of sustainability actions as part of routine operational workflows.

Such an approach could reduce the complexity of ESG reporting while simultaneously improving the reliability of disclosed information.

Furthermore, structured evidence records may provide corporations with more comprehensive documentation of sustainability initiatives, which can be useful for internal governance, stakeholder communication, and regulatory compliance.

6.4 Implications for Verification and Assurance Institutions

Verification and assurance institutions play a critical role in maintaining trust within ESG governance systems. As sustainability disclosures become more widespread, auditors and verification bodies must evaluate increasingly complex datasets originating from diverse operational environments.

Traditional assurance methodologies often rely on sampling techniques, documentation reviews, and internal control assessments. While these approaches can provide reasonable assurance regarding reported information, they may become more challenging as ESG reporting requirements expand.

Evidence infrastructures may offer new opportunities for improving the efficiency and effectiveness of ESG assurance processes.

When sustainability activities are captured through structured evidence records, auditors may gain more direct access to the underlying events that generate reported ESG metrics. This capability could enhance the traceability of sustainability data and reduce the need for extensive retrospective documentation reviews.

In addition, standardized evidence structures may improve interoperability between reporting systems and verification tools, allowing assurance providers to analyze sustainability information more systematically.

These developments suggest that evidence infrastructures may play an increasingly important role in supporting scalable ESG assurance frameworks.

6.5 Toward Evidence-Based Sustainability Governance

Taken together, the institutional implications discussed above point toward a broader transformation in how sustainability governance systems may evolve in the coming years.

Rather than relying exclusively on disclosure frameworks and retrospective reporting mechanisms, future ESG governance systems may increasingly incorporate infrastructures designed to generate structured sustainability evidence at the operational level.

Such infrastructures could strengthen the connections between real economy activities, corporate reporting systems, verification institutions, and global sustainability standards.

In this sense, the development of evidence infrastructures represents not merely a technological innovation but a potential institutional evolution in the architecture of global ESG governance.

The next chapter illustrates how evidence infrastructures may operate in practice through an example of a participation-based sustainability data system.

Chapter 7. Case Illustration

Evidence Infrastructure in Practice

The conceptual framework introduced in the previous chapters proposes that ESG governance systems require an evidence infrastructure capable of translating real-world sustainability activities into structured and verifiable data. While the Global ESG Evidence Architecture is presented as a theoretical model, the concept of evidence anchoring can also be illustrated through emerging digital systems designed to capture sustainability participation at scale.

This chapter provides an illustrative example of how evidence infrastructure principles may operate in practice through a participation-based sustainability data system. The example demonstrates how real-world sustainability activities can be structured into verifiable evidence before entering reporting and assurance processes.

7.1 Participation-Based Sustainability Systems

Many sustainability initiatives rely on participation by individuals, organizations, and communities. Activities such as environmental volunteering, sustainability education, responsible consumption, and community engagement programs represent important contributions to broader sustainability goals.

However, these activities are often difficult to quantify within traditional ESG reporting frameworks. While corporations may report high-level metrics related to sustainability programs, the underlying participation activities that contribute

to these outcomes are rarely captured in structured and verifiable formats.

Participation-based sustainability systems aim to address this limitation by providing digital infrastructures that record sustainability activities as structured evidence.

Within such systems, participation events—such as completing sustainability education programs, engaging in environmental initiatives, or participating in community sustainability programs—are recorded as data events that can be processed by governance systems.

By capturing these activities at the point where they occur, participation-based systems generate structured evidence that may support broader ESG data ecosystems.

7.2 Evidence Anchoring Through Participation Records

Participation-based sustainability systems can serve as practical examples of evidence anchoring mechanisms.

Within such systems, sustainability activities are captured through structured participation records that contain information about the activity event, the actors involved, and the context in which the activity occurred.

These records typically include several forms of metadata, including:

- participant identification
- activity type
- time and location of participation
- verification parameters
- associated sustainability themes

Once recorded, participation events become structured data points that can be aggregated into sustainability datasets while preserving traceability to the original activities.

This approach illustrates how evidence anchoring mechanisms can transform decentralized sustainability actions into structured evidence records suitable for integration into ESG data systems.

7.3 Structured Sustainability Evidence

Evidence generated through participation systems can be structured in ways that support ESG data governance processes.

Rather than representing sustainability engagement solely through narrative descriptions or summary statistics, participation events can be represented as standardized evidence units.

Each unit of evidence may represent a verified sustainability activity and may include attributes that enable aggregation and analysis across broader sustainability programs.

When evidence records are generated consistently across multiple activities and participants, the resulting datasets can support a wide range of sustainability governance functions, including program evaluation, reporting, and verification.

This structured approach to sustainability evidence generation aligns with the broader concept of evidence infrastructure introduced in earlier chapters.

7.4 Participation-Based Commitment Records

In some participation-based sustainability systems, evidence records may also be used to document sustainability commitments.

Commitment records represent structured acknowledgments of participation in sustainability-related activities. Unlike tradable financial instruments or emissions offsets, such records function primarily as documentation of engagement and participation in sustainability initiatives.

When commitment records are generated through structured evidence processes, they may serve as indicators of participation-based sustainability contributions within broader ESG ecosystems.

These commitment records illustrate how evidence infrastructures may capture sustainability participation without relying on traditional carbon credit mechanisms or financialized environmental instruments.

7.5 Integration with ESG Governance Systems

Participation-based evidence infrastructures may interact with broader ESG governance systems in several ways.

First, structured evidence datasets may provide additional inputs for sustainability reporting platforms, allowing organizations to incorporate participation-based metrics into ESG disclosures.

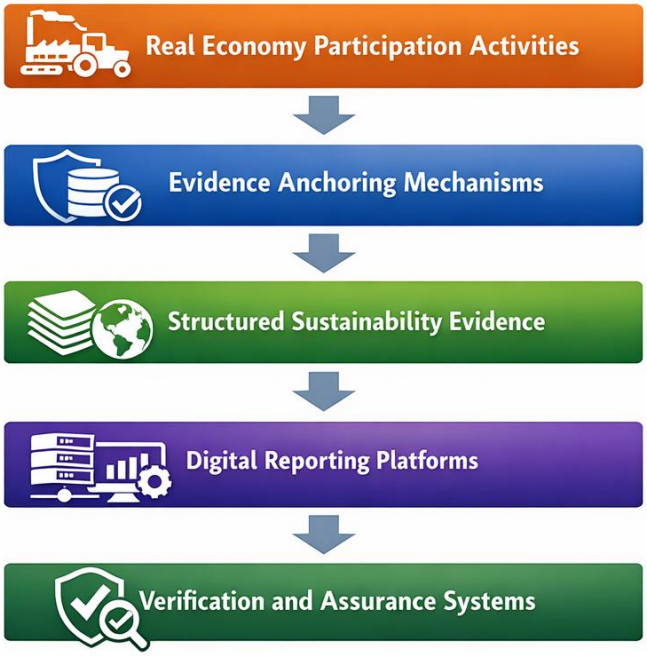
Second, verification institutions may analyze structured evidence records when evaluating the credibility of sustainability programs or engagement initiatives.

Third, evidence infrastructures may support internal governance processes by enabling organizations to monitor sustainability participation across departments, supply chains, or stakeholder networks.

Through these interactions, participation-based evidence infrastructures can contribute to a broader ecosystem in which sustainability data flows across multiple institutional layers.

7.6 Illustrative System Architecture

An illustrative participation-based evidence infrastructure may operate according to the following architecture:



This architecture demonstrates how sustainability participation can be integrated into broader ESG governance frameworks through structured evidence generation.

While specific system implementations may vary, the example illustrates the potential role of evidence infrastructures in strengthening the traceability and reliability of sustainability data.

7.7 Implications of Participation-Based Evidence Systems

Participation-based evidence infrastructures highlight an important dimension of ESG governance that is often overlooked in traditional reporting frameworks: the role of human participation in sustainability systems.

Sustainability outcomes frequently depend not only on technological or operational changes but also on collective behavioral participation across organizations and communities.

By capturing participation activities as structured evidence, evidence infrastructures can help make these contributions visible within broader sustainability governance systems.

Such systems may therefore complement existing ESG reporting frameworks by providing additional layers of traceable sustainability data.

This example demonstrates how the conceptual framework introduced in this paper can be implemented through digital infrastructures designed to anchor sustainability evidence at the level of real-world activities.

Chapter 8. Policy Implications

Evidence Infrastructure and the Future of ESG Governance

The development of global ESG governance systems has accelerated significantly in recent years. Governments, financial regulators, and international organizations have introduced new sustainability disclosure requirements aimed at improving transparency, managing climate-related risks, and supporting the transition toward more sustainable economic systems.

While these initiatives have strengthened sustainability reporting frameworks, they also highlight the growing importance of reliable ESG data infrastructures. As sustainability disclosures become increasingly integrated into financial markets and regulatory oversight mechanisms, policymakers face new challenges related to the credibility, traceability, and scalability of ESG data.

The concept of **evidence infrastructure**, as introduced in this paper, provides a potential framework for addressing these challenges. By focusing on the generation of structured sustainability evidence at the operational level, evidence infrastructures may contribute to the development of more reliable and scalable ESG governance systems.

8.1 Addressing Greenwashing Concerns

One of the most widely discussed issues in contemporary ESG governance is the problem of greenwashing. Regulators and policymakers across multiple jurisdictions have expressed concern that sustainability claims may sometimes lack sufficient evidence or rely on ambiguous reporting practices.

In response, several regulatory authorities have introduced new guidelines designed to strengthen oversight of sustainability disclosures and environmental claims. These initiatives aim to ensure that sustainability information presented to investors and consumers accurately reflects underlying corporate practices.

Evidence infrastructures may contribute to these efforts by improving the traceability of sustainability data. When sustainability activities are captured as structured evidence records at the point where they occur, the resulting data systems may provide clearer links between reported ESG metrics and the underlying actions that generate them.

Such mechanisms may help reduce ambiguity in sustainability disclosures and support regulatory efforts to prevent misleading claims.

8.2 Supporting Regulatory Scalability

As ESG reporting requirements expand, regulators face increasing challenges related to monitoring and enforcement. Sustainability disclosures may involve

large volumes of heterogeneous data originating from diverse operational contexts across multiple industries.

Traditional regulatory oversight mechanisms may encounter limitations when attempting to verify complex sustainability datasets using retrospective documentation and manual review processes.

Evidence infrastructures may offer a complementary approach by enabling sustainability data to be generated through standardized and traceable evidence records.

If sustainability activities are recorded through structured evidence mechanisms at the operational level, regulatory authorities may gain greater visibility into the processes that produce reported ESG metrics. Such infrastructures could potentially improve the scalability of regulatory oversight by supporting more systematic approaches to sustainability data governance.

8.3 Enabling Cross-Border ESG Data Interoperability

Global sustainability governance increasingly requires cooperation across jurisdictions. Multinational corporations operate across multiple regulatory environments, and investors often evaluate sustainability performance across global portfolios.

These conditions create growing demand for **interoperable ESG data systems** capable of supporting consistent sustainability reporting across different regulatory frameworks.

Evidence infrastructures may contribute to this goal by establishing standardized mechanisms for capturing sustainability activities as structured data.

By generating evidence records that maintain clear provenance and standardized data structures, such infrastructures may facilitate interoperability between reporting platforms, regulatory systems, and international sustainability frameworks.

This capability could become increasingly important as global sustainability disclosure requirements continue to evolve.

8.4 Alignment with Emerging Sustainability Policies

Evidence infrastructures may also support the implementation of emerging sustainability policies related to climate change, biodiversity protection, and responsible supply chain management.

For example, regulatory initiatives designed to address climate-related financial risks often require companies to disclose detailed information about emissions, environmental impacts, and sustainability strategies. Similar expectations are emerging in policy frameworks addressing biodiversity conservation and supply chain transparency.

These policy initiatives depend on reliable mechanisms for capturing and verifying sustainability data generated across complex economic systems.

Evidence infrastructures may provide a foundational data layer capable of supporting these policy objectives by ensuring that sustainability information originates from verifiable operational activities.

8.5 Toward Infrastructure-Based ESG Governance

Taken together, these policy considerations suggest that the evolution of ESG governance may increasingly depend on the development of institutional infrastructures capable of supporting trustworthy sustainability data.

Traditional approaches to sustainability governance have largely focused on disclosure frameworks and reporting guidelines. While these frameworks remain essential, they represent only one component of a broader governance architecture.

The framework proposed in this paper suggests that future ESG systems may benefit from integrating **evidence infrastructures** as a foundational component of sustainability governance.

Such infrastructures would complement existing reporting and assurance frameworks by providing structured mechanisms for generating sustainability evidence at the level of real-world activities.

This perspective reflects a broader shift in sustainability governance—from systems centered primarily on disclosure toward governance architectures that emphasize **data integrity, traceability, and evidence-based reporting**.

The next chapter concludes the paper by summarizing the conceptual contributions of the Global ESG Evidence Architecture and outlining potential directions for future research on evidence-based sustainability data systems.

Chapter 9. Future Research Directions

Advancing Evidence-Based Sustainability Data Systems

The Global ESG Evidence Architecture proposed in this paper provides a conceptual framework for understanding how sustainability information flows across institutional systems. By identifying the role of evidence infrastructure in linking real-world sustainability activities with digital reporting and governance frameworks, the architecture highlights a structural dimension of ESG governance that has received relatively limited attention in existing research.

While the framework introduced in this paper establishes a conceptual foundation, several important research questions remain open. Addressing these questions may contribute to the development of more robust sustainability data infrastructures and help advance the next generation of ESG governance systems.

The following sections outline several potential directions for future research.

9.1 Evidence Infrastructure Design

One important area for future research concerns the **design principles of evidence infrastructures** for sustainability data systems.

The conceptual model presented in this paper suggests that evidence infrastructures play a critical role in translating sustainability activities into structured and verifiable data. However, the specific mechanisms through which evidence infrastructures should be designed remain an open research question.

Future studies may explore topics such as:

• data architecture for sustainability evidence generation
• standardized data structures for ESG evidence records
• interoperability between evidence systems and reporting platforms
• governance frameworks for maintaining evidence integrity

Research in this area could contribute to the development of digital infrastructures capable of supporting scalable ESG data systems across multiple sectors and jurisdictions.

9.2 Behavioral Sustainability Data

A second promising research direction concerns the role of **human participation and behavioral activities** in sustainability governance systems.

Traditional ESG reporting frameworks primarily focus on corporate-level metrics related to environmental impacts, governance structures, and social policies. However, sustainability outcomes often depend on collective behavioral participation across organizations, communities, and individuals.

Future research may investigate how participation-based sustainability activities can be captured as structured data within ESG governance systems.

Potential research topics include:

• participation-based sustainability metrics
• behavioral data governance frameworks
• digital systems for tracking sustainability participation
• institutional mechanisms for aggregating participation-based evidence

Exploring these questions may expand the conceptual boundaries of ESG data systems beyond traditional corporate metrics.

9.3 Participation-Based Commitment Systems

Another area for future investigation relates to **commitment-based sustainability accounting mechanisms**.

In many sustainability initiatives, participants engage in activities that reflect commitments to environmental or social goals. These commitments may

include participation in sustainability education programs, environmental initiatives, or community-based activities.

Future research may explore governance models for documenting such commitments through structured evidence records.

Potential topics include:

- frameworks for participation-based sustainability commitments
- governance mechanisms for documenting sustainability engagement
- the role of non-tradable commitment records in sustainability governance
- integration of commitment evidence with broader ESG data systems

These studies may contribute to new approaches for representing sustainability engagement within ESG ecosystems.

9.4 Digital MRV Systems

Digital technologies are increasingly being explored as tools for improving sustainability monitoring and verification processes.

Future research may investigate how **digital monitoring, reporting, and verification (MRV) systems** can be integrated with evidence infrastructures to improve the reliability and efficiency of sustainability data governance.

Areas of potential investigation include:

- digital traceability mechanisms for sustainability data
- integration of sensor-based monitoring with evidence infrastructures
- automated verification tools for sustainability datasets
- interoperability between digital MRV systems and reporting frameworks

Such research may contribute to the development of digital infrastructures capable of supporting large-scale ESG data ecosystems.

9.5 Institutional Governance of ESG Data Systems

Another important research direction concerns the institutional governance structures that oversee ESG data systems.

As sustainability disclosures become more integrated into financial markets and regulatory frameworks, questions related to governance, oversight, and accountability become increasingly important.

Future research may examine:

- governance models for global ESG data infrastructures
- institutional roles within sustainability data ecosystems
- cross-border coordination of sustainability data standards
- public-private governance frameworks for ESG data systems

Understanding these institutional dynamics may help policymakers and regulators design governance systems capable of supporting trustworthy sustainability data at global scale.

9.6 Toward an Evidence-Based ESG Ecosystem

Taken together, the research directions outlined above suggest that the future development of ESG governance systems may increasingly depend on the integration of digital infrastructures, behavioral participation data, and institutional governance frameworks.

Rather than focusing exclusively on disclosure standards, future ESG research may explore how sustainability data ecosystems can be designed to generate structured evidence at the level of real-world activities.

Such approaches may enable ESG governance systems to evolve from **disclosure-centered frameworks toward evidence-based sustainability data infrastructures**.

The conceptual architecture introduced in this paper represents an initial step toward articulating such a framework. Further interdisciplinary research spanning sustainability governance, data systems, institutional economics, and digital infrastructure design may help refine and expand this approach.

Chapter 10. Conclusion

From ESG Reporting to ESG Evidence Infrastructure

Over the past two decades, environmental, social, and governance (ESG) considerations have become a central component of global economic governance. Sustainability disclosures are now widely used by investors, regulators, and policymakers to assess corporate performance, evaluate systemic risks, and guide capital allocation toward more sustainable economic activities.

Despite these advancements, the rapid expansion of ESG reporting frameworks has also revealed structural challenges related to the reliability and traceability of sustainability data. In many cases, the information presented in ESG disclosures is generated through complex internal processes that aggregate operational data from diverse sources. This structure can make it difficult to establish clear links between reported sustainability metrics and the underlying activities that generate them.

This paper has argued that addressing these challenges requires a broader perspective on ESG governance. Rather than viewing sustainability reporting solely as a disclosure exercise, ESG systems should be understood as **institutional infrastructures for sustainability data**.

To support this perspective, the paper introduced the concept of the **Global ESG Evidence Architecture**, a seven-layer governance model that maps the institutional structure through which sustainability information flows across the global ESG ecosystem.

The proposed architecture identifies seven interconnected governance layers:

Layer	**Function**
International Standards	Define sustainability disclosure frameworks
Regulatory Systems	Enforce compliance and oversight
Capital Allocation	Guide sustainable investment decisions
Verification Institutions	Provide assurance of reported data
Software Platforms	Manage ESG reporting processes

Layer	Function
Evidence Infrastructure	Structure sustainability evidence
Real Economy Activities	Generate sustainability actions

Within this framework, the **Evidence Infrastructure Layer** emerges as a critical structural component that has received relatively limited attention in existing ESG governance discussions.

Evidence infrastructures function as institutional mechanisms capable of capturing sustainability activities and converting them into structured and verifiable evidence before reporting and assurance processes occur. By anchoring sustainability actions as traceable evidence records, such infrastructures may strengthen the integrity and reliability of ESG data systems.

The concept of **Evidence Anchoring**, introduced in this paper, describes the process through which sustainability activities are recorded, structured, and preserved as verifiable evidence. This mechanism provides a structural bridge between real-world sustainability actions and the digital systems used for reporting and verification.

By highlighting the role of evidence infrastructures within ESG governance, the proposed architecture suggests a broader conceptual shift in how sustainability data systems may evolve.

Historically, ESG governance has largely focused on the development of disclosure frameworks and reporting standards. While these frameworks remain essential, they represent only one component of a broader institutional architecture.

Future ESG systems may increasingly incorporate infrastructures designed to generate structured sustainability evidence at the point where sustainability activities occur. Such infrastructures could complement existing reporting and assurance mechanisms by strengthening data provenance, improving traceability, and reducing the complexity of sustainability verification processes.

In this sense, the future evolution of ESG governance may involve a transition

from disclosure-centered systems toward evidence-based sustainability infrastructures.

The Global ESG Evidence Architecture presented in this paper represents an initial step toward articulating this broader institutional perspective. By clarifying the structural relationships between real economy activities, evidence generation mechanisms, digital reporting systems, verification institutions, capital markets, and international standards, the framework provides a conceptual foundation for future research and system development in sustainability data governance.

As sustainability governance continues to evolve, interdisciplinary collaboration among policymakers, researchers, technology developers, and institutional stakeholders will play a critical role in shaping the infrastructures that support trustworthy ESG data systems.

Appendix A. Seven-Layer Institutional Mapping of the Global ESG Evidence Architecture

The Global ESG Evidence Architecture introduced in this paper conceptualizes ESG governance as a multi-layer institutional system. Each layer represents a distinct governance function within the sustainability data ecosystem.

This appendix provides an illustrative mapping of these layers to existing institutional actors and governance mechanisms in the global ESG ecosystem.

The mapping is not intended to represent an exhaustive list of organizations but rather to illustrate how the proposed architecture corresponds to the existing landscape of sustainability governance.

A.1 The Seven-Layer Governance Stack

The seven-layer architecture organizes ESG governance from real economy activities at the base of the system to international sustainability standards at the top.

Layer	Governance Function	Illustrative Institutions
Layer 1	International Sustainability Standards	IFRS Foundation (ISSB), GRI, TNFD
Layer 2	Regulatory Enforcement Systems	SEC, European Commission, national financial regulators
Layer 3	Capital Allocation Mechanisms	Asset managers, pension funds, banks
Layer 4	Verification & Assurance	Big Four accounting firms, sustainability assurance bodies
Layer 5	ESG Software & Reporting Platforms	ESG reporting software providers, enterprise data platforms
Layer 6	Evidence Infrastructure	Sustainability evidence systems and participation-based data infrastructures
Layer 7	Real Economy Activities	Corporations, supply chains, communities, and individuals

This layered structure illustrates how sustainability data travels from operational activities through institutional systems before reaching global disclosure frameworks.

A.2 Institutional Roles Across the ESG Architecture

Each layer of the ESG governance stack performs a distinct institutional role within the sustainability data ecosystem.

Layer 7 — Real Economy Activities

The foundation of the ESG architecture consists of sustainability actions taking place within real-world economic environments.

These activities may include:

• corporate sustainability initiatives
• supply chain environmental management
• community-based sustainability programs
• employee engagement in sustainability initiatives

Real economy activities represent the primary source of sustainability data generation.

Layer 6 — Evidence Infrastructure

The evidence infrastructure layer captures sustainability actions and converts them into structured evidence records.

Within the ESG ecosystem, this layer may include:

• digital systems for recording sustainability activities
• participation-based sustainability data systems
• activity verification mechanisms
• sustainability evidence registries

Evidence infrastructures function as a bridge between operational activities and digital ESG reporting systems.

Layer 5 — ESG Software and Reporting Platforms

Software platforms play an operational role in managing ESG data within corporate systems.

These platforms typically support:

• sustainability reporting workflows
• ESG data aggregation and analytics
• integration with enterprise management systems
• generation of sustainability disclosures

Such systems provide the technical infrastructure for compiling ESG information.

Layer 4 — Verification and Assurance Institutions

Verification institutions evaluate the credibility of ESG disclosures and sustainability claims.

Examples include:

- accounting firms providing ESG assurance
- environmental verification bodies
- sustainability certification organizations

These institutions assess whether disclosed sustainability information aligns with reporting standards and available evidence.

Layer 3 — Capital Allocation Systems

Capital markets increasingly rely on ESG information to guide investment decisions.

Institutional actors within this layer include:

- asset management firms
- institutional investors
- banks and financial institutions
- sustainable finance platforms

These actors incorporate ESG data into risk assessments, investment strategies, and financing decisions.

Layer 2 — Regulatory Governance Systems

Regulatory institutions oversee sustainability disclosures and enforce compliance with reporting requirements.

These authorities may include:

- financial regulators
- environmental regulatory agencies
- securities commissions
- governmental policy institutions

Regulatory systems play a critical role in shaping corporate ESG disclosure practices.

Layer 1 — International Sustainability Standards

At the top of the governance architecture sit international organizations responsible for establishing sustainability disclosure frameworks.

Examples include:

• International Sustainability Standards Board (ISSB)
• Global Reporting Initiative (GRI)
• Task Force on Nature-related Financial Disclosures (TNFD)

These institutions define the normative expectations for sustainability reporting within global financial systems.

A.3 ESG Data Flow Across Institutional Layers

Within the seven-layer governance architecture, sustainability information flows upward from real-world activities toward international reporting frameworks.

The process can be conceptualized as follows:

Each layer transforms sustainability information as it moves through the system.

At the operational level, sustainability actions generate primary data. Evidence

infrastructures convert these activities into structured evidence records. Software systems aggregate the evidence into reporting metrics, which are then evaluated by verification institutions and interpreted by capital markets.

Regulatory authorities oversee compliance with disclosure requirements, while international standards provide the frameworks that guide sustainability reporting practices.

A.4 Implications of the Institutional Mapping

Mapping the ESG ecosystem into a layered governance architecture highlights several important observations.

First, sustainability data flows through a complex network of institutional actors before reaching investors and regulators.

Second, existing ESG frameworks concentrate primarily on the upper layers of the architecture—particularly reporting standards, regulatory oversight, and capital market applications.

Third, the evidence infrastructure layer, which links real-world sustainability activities to digital reporting systems, remains relatively underdeveloped in many ESG governance frameworks.

Recognizing this structural gap provides the conceptual foundation for the **Global ESG Evidence Architecture** proposed in this paper.

By clarifying the institutional relationships between these layers, the architecture offers a framework for future research and system design aimed at strengthening the integrity of sustainability data systems.

Appendix B. Evidence Infrastructure Data Model

A Participation–Action–Data–Value Framework for Sustainability Evidence

The Global ESG Evidence Architecture introduced in this paper highlights the importance of evidence infrastructures in transforming sustainability activities into structured and verifiable data.

While the main chapters of the paper present a conceptual governance

framework, this appendix outlines an illustrative **data model** that demonstrates how sustainability activities may be translated into structured ESG evidence.

The model presented here is referred to as the **Participation–Action–Data–Value (PADV) framework**.

The PADV framework describes a structured process through which sustainability participation activities can generate verifiable evidence records suitable for integration into broader ESG governance systems.

B.1 Overview of the PADV Framework

The PADV framework organizes sustainability evidence generation into four sequential stages:

Stage	Description
Participation	Engagement of individuals or organizations in sustainability initiatives
Action	Execution of sustainability-related activities
Data	Structured recording of sustainability evidence
Value	Aggregation of evidence into sustainability metrics

This structure illustrates how sustainability participation can evolve from real-world activities into data structures that may contribute to ESG reporting systems.

The PADV model can be represented as follows:

Each stage represents a transformation in the governance lifecycle of sustainability information.

B.2 Participation Layer

The first stage of the PADV model concerns **participation**.

Participation represents the involvement of individuals, organizations, or communities in sustainability-related initiatives.

Examples of participation activities may include:

- sustainability education programs
- environmental volunteering
- responsible consumption initiatives
- community sustainability events
- corporate sustainability engagement programs

Participation is an important dimension of sustainability governance because many environmental and social outcomes depend on collective behavioral engagement.

However, participation activities are often difficult to represent within traditional ESG reporting frameworks.

The PADV model treats participation as the initial stage of sustainability evidence generation.

B.3 Action Layer

The second stage of the PADV model involves **sustainability actions**.

Actions represent concrete activities carried out by participants within sustainability initiatives.

Examples of sustainability actions may include:

- completing sustainability education modules
- participating in environmental restoration activities
- engaging in waste reduction programs
- supporting community sustainability initiatives

At this stage, participation transitions into measurable sustainability actions.

These actions form the operational basis for evidence generation within the PADV framework.

B.4 Data Layer

The third stage involves the generation of **structured sustainability data**.

Evidence anchoring mechanisms capture sustainability actions as structured records containing relevant metadata.

These records may include:

- participant identification or anonymized identifiers
- activity type
- timestamp of the action
- contextual information about the sustainability activity
- verification parameters

Structured data records allow sustainability actions to be stored in formats that support traceability and verification.

This stage represents the core function of evidence infrastructure systems.

B.5 Value Layer

The final stage of the PADV framework concerns the generation of **sustainability value metrics**.

Structured evidence records generated in the data layer can be aggregated and analyzed to produce sustainability indicators.

These indicators may represent various forms of sustainability value, including:

- participation-based sustainability engagement metrics
- aggregated sustainability activity indicators
- commitment-based sustainability records
- participation contributions to sustainability initiatives

The value layer does not necessarily imply financial valuation or tradable instruments. Instead, it reflects the aggregation of sustainability evidence into

metrics that can inform governance processes, reporting systems, and program evaluations.

B.6 Evidence Anchoring in the PADV Model

The PADV framework operates in conjunction with the **evidence anchoring mechanism** introduced in Chapter 5.

Evidence anchoring occurs primarily during the transition between the **action layer and the data layer**.

At this stage, sustainability actions are captured and transformed into structured evidence records.

The process can be represented as follows:

Figure 2. PADV Sustainability Evidence Data Model

This mechanism ensures that sustainability actions are documented in ways that preserve traceability and support verification processes.

B.7 Integration with ESG Data Systems

The PADV framework illustrates how participation-based sustainability evidence

can be integrated into broader ESG governance systems.

Evidence records generated through the PADV process may support several institutional functions:

- sustainability reporting
- program evaluation
- stakeholder engagement monitoring
- verification and assurance processes

When integrated with digital reporting systems, structured sustainability evidence can complement traditional ESG metrics derived from operational or environmental measurements.

B.8 Conceptual Role of the PADV Framework

The PADV model represents an example of how evidence infrastructures can generate sustainability data from real-world participation activities.

Rather than replacing existing ESG reporting systems, such frameworks may function as complementary data generation mechanisms that strengthen the traceability and reliability of sustainability information.

By structuring sustainability participation into verifiable evidence records, the PADV framework illustrates how behavioral activities can contribute to the broader ecosystem of sustainability governance.

Appendix C. Sustainability Evidence Lifecycle

Governance Processes for Evidence-Based ESG Data Systems

The Global ESG Evidence Architecture introduced in this paper emphasizes the role of evidence infrastructures in generating trustworthy sustainability data. While the main chapters describe the institutional architecture and conceptual data model underlying evidence-based ESG governance, it is also necessary to consider the **lifecycle of sustainability evidence**.

Sustainability evidence does not exist as a static dataset. Instead, it emerges through a series of governance processes that capture, structure, store, and

utilize information related to sustainability activities.

This appendix outlines an illustrative **Evidence Lifecycle Framework** describing how sustainability evidence may evolve within evidence-based ESG data systems.

C.1 Overview of the Evidence Lifecycle

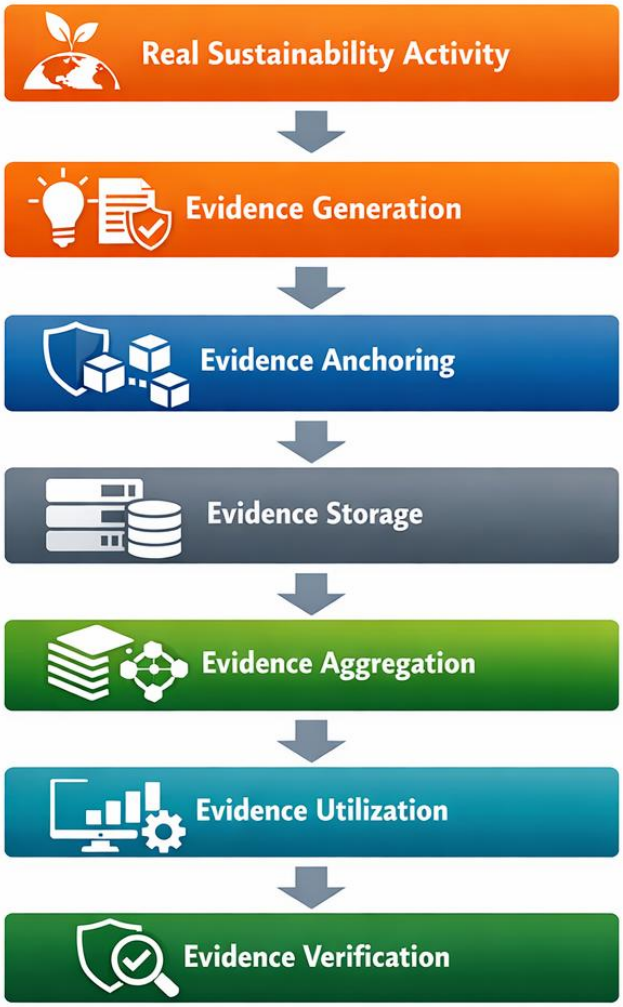
Within evidence-based sustainability governance systems, sustainability evidence may pass through several stages.

These stages can be conceptualized as the **Sustainability Evidence Lifecycle**.

Stage	**Function**
Evidence Generation	Sustainability activities produce primary evidence
Evidence Anchoring	Activities are recorded and structured
Evidence Storage	Structured evidence is preserved in digital systems
Evidence Aggregation	Evidence records are aggregated into datasets
Evidence Utilization	Evidence supports reporting and governance
Evidence Verification	Verification institutions evaluate evidence

The lifecycle illustrates how sustainability actions are transformed into structured data capable of supporting ESG governance processes.

The lifecycle can be represented as follows:



C.2 Evidence Generation

The first stage of the lifecycle involves the generation of sustainability evidence through real-world activities.

Evidence generation occurs whenever sustainability-related actions take place within operational environments. These actions may include environmental initiatives, participation in sustainability programs, supply chain activities, or community-based projects.

At this stage, evidence exists primarily as **primary activity information**, which may include:

- participation records
- operational measurements
- event documentation

• activity logs

Capturing such information at the moment when sustainability actions occur is critical for preserving data integrity.

C.3 Evidence Anchoring

The second stage involves **evidence anchoring**, a key mechanism introduced in Chapter 5.

Evidence anchoring converts primary activity information into structured records suitable for digital governance systems.

This process typically involves:

• recording activity metadata
• assigning identifiers to participation events
• structuring activity information into standardized data formats
• preserving contextual information about the activity

Evidence anchoring ensures that sustainability actions become traceable data records rather than unstructured documentation.

C.4 Evidence Storage

Once anchored, sustainability evidence must be preserved within **digital storage infrastructures**.

Evidence storage systems may include databases, digital registries, or distributed information systems designed to maintain the integrity of sustainability records.

Key objectives of evidence storage include:

• ensuring long-term accessibility of evidence records
• preserving data integrity and preventing unauthorized modification
• enabling efficient retrieval of sustainability evidence

Effective storage infrastructures are essential for supporting the traceability and reliability of sustainability data systems.

C.5 Evidence Aggregation

Individual evidence records may subsequently be aggregated into broader sustainability datasets.

Evidence aggregation involves combining multiple evidence records to produce indicators or metrics that reflect patterns of sustainability participation or operational performance.

Aggregation processes may support various governance functions, including:

- sustainability program evaluation
- participation analysis
- ESG reporting metrics
- policy impact assessments

Aggregation should preserve the ability to trace metrics back to underlying evidence records.

C.6 Evidence Utilization

Aggregated sustainability evidence may then be utilized across various institutional systems.

Potential uses of sustainability evidence include:

- sustainability reporting
- internal governance and management systems
- stakeholder communication
- sustainability program monitoring
- policy evaluation

At this stage, sustainability evidence becomes part of broader ESG data ecosystems that support decision-making processes within corporations, financial institutions, and regulatory bodies.

C.7 Evidence Verification

The final stage of the lifecycle involves **verification and assurance processes**.

Verification institutions may review sustainability evidence to evaluate the credibility of reported information.

Verification processes may involve:

- examining evidence records associated with sustainability metrics
- evaluating data provenance
- assessing consistency between reported information and underlying evidence

Evidence-based data systems may enhance the efficiency of verification processes by providing structured and traceable records of sustainability activities.

C.8 Implications of the Evidence Lifecycle

The Sustainability Evidence Lifecycle highlights an important feature of evidence-based ESG governance systems: sustainability data emerges through structured governance processes rather than simple reporting mechanisms.

Understanding this lifecycle is essential for designing ESG data systems capable of supporting trustworthy sustainability information.

By capturing sustainability activities as structured evidence and preserving traceable records throughout the data lifecycle, evidence infrastructures can strengthen the integrity of sustainability data ecosystems.

Such systems may complement existing reporting frameworks and verification mechanisms by providing a foundational layer of trustworthy sustainability evidence.

Appendix D. Terminology and Conceptual Definitions

Key Concepts in Evidence-Based ESG Governance

The Global ESG Evidence Architecture introduced in this paper incorporates several conceptual terms that describe the mechanisms and institutional components of evidence-based sustainability governance systems.

This appendix provides standardized definitions for key terminology used throughout the paper. The purpose of these definitions is to ensure conceptual clarity and facilitate consistent interpretation across research, policy discussions, and system implementations.

D.1 ESG Evidence

ESG Evidence refers to structured information that documents sustainability-related activities and can be used to support environmental, social, and governance reporting or evaluation processes.

Unlike aggregated sustainability metrics, ESG evidence represents the **underlying records of sustainability actions** that provide the basis for reporting indicators.

Examples of ESG evidence may include:

- documentation of sustainability participation activities
- operational records related to environmental practices
- structured data generated from sustainability programs
- verifiable records of sustainability commitments

ESG evidence serves as the foundational data layer from which sustainability metrics and disclosures are derived.

D.2 Evidence Infrastructure

Evidence Infrastructure refers to the institutional and technological systems responsible for generating, structuring, storing, and managing sustainability evidence.

Within the Global ESG Evidence Architecture, evidence infrastructures operate as a distinct governance layer that connects real economy activities with digital reporting and verification systems.

Evidence infrastructures typically perform several core functions:

- capturing sustainability activities as data events
- structuring activity records into standardized formats

• preserving traceable records of sustainability actions
• enabling interoperability with ESG reporting systems

In this sense, evidence infrastructures function as the **data foundation of ESG governance systems**.

D.3 Evidence Anchoring

Evidence Anchoring describes the process through which sustainability activities are recorded and converted into structured evidence records.

Evidence anchoring typically occurs at the interface between real-world activities and digital governance systems.

The process involves:

• capturing sustainability participation or operational activities
• recording metadata associated with those activities
• transforming activity information into structured data records

Through evidence anchoring, sustainability actions become traceable data objects capable of supporting reporting, governance, and verification processes.

D.4 Behavioral ESG Data

Behavioral ESG Data refers to sustainability information generated from human participation in sustainability-related activities.

While traditional ESG reporting frameworks often focus on corporate-level metrics such as emissions, governance policies, or financial disclosures, behavioral ESG data captures **participation-based sustainability activities**.

Examples may include:

• participation in sustainability education programs
• engagement in environmental initiatives
• community-based sustainability activities
• employee participation in corporate sustainability programs

Behavioral ESG data expands the scope of sustainability governance by

recognizing the role of human participation in sustainability systems.

D.5 Participation Evidence

Participation Evidence refers to structured records documenting participation in sustainability-related activities.

Participation evidence represents one form of ESG evidence generated through evidence anchoring mechanisms.

These records typically include metadata such as:

- participant identifiers or anonymized participation IDs
- activity type and sustainability theme
- timestamp and contextual information
- verification parameters associated with the activity

Participation evidence enables sustainability participation to be incorporated into broader ESG data ecosystems.

D.6 Commitment Credits

Commitment Credits represent structured records of sustainability commitments generated through participation-based activities.

Commitment credits are not designed as tradable financial instruments or emissions offset units. Instead, they function as documentation of sustainability engagement and commitment within evidence-based ESG governance systems.

Commitment credits typically represent:

- participation in sustainability initiatives
- engagement with sustainability programs
- contributions to sustainability-related activities

Within participation-based sustainability systems, commitment credits may serve as indicators of sustainability engagement while remaining distinct from tradable carbon credit mechanisms.

D.7 Evidence-Based ESG Governance

Evidence-Based ESG Governance refers to governance systems that rely on structured sustainability evidence as the foundation for reporting, verification, and decision-making processes.

In evidence-based ESG governance systems, sustainability data flows from real-world activities through evidence infrastructures before entering reporting frameworks and regulatory systems.

This approach differs from traditional ESG reporting models that rely primarily on retrospective data aggregation and narrative disclosures.

Evidence-based governance emphasizes:

- traceable sustainability evidence
- structured data generation
- improved auditability of sustainability information

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