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Exploring the Role of Leadership Style in Enabling TOGAF as a Driver for Green Software in Logistics

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ABSTRACT

This study aims to investigate the role of leadership style in enabling The Open Group Architecture Framework (TOGAF) to drive sustainability within the logistics sector. The analysis focuses on how transformational, strategic, participative, and adaptive leadership styles influence the adoption and institutionalization of Enterprise Architecture (EA) initiatives. Particular attention is given to the role of leadership in strengthening governance policies and organizational processes through mechanisms such as the Architecture Review Board (ARB), which ensures compliance, oversight, and alignment of EA practices with long-term sustainability objectives. By emphasizing that Environmental, Social, and Governance (ESG)-related strategies were incorporated or considered in the application design through the ARB during the governance and change management phases, the study highlights how different leadership styles promote accountability, transparency, and cross-functional collaboration in logistics organizations. This integration not only strengthens decision-making but also embeds sustainability principles systematically into core operations. The researcher distributed a custom questionnaire to the study sample at a rate of 78% valid practitioners. The study used an analytical approach, comparing the results with secondary platforms such as ESG databases to validate them. The study concluded that adaptive and participative leadership styles, along with efficient EA practices and governance, are highly effective, as evidenced by KPIs measured through S&P ESG and CSA scores.

***Keywords**: Sustainability Management, Software Project Management, Green Software, Enterprise Architecture, Leadership Styles, TOGAF, Architecture Review Board, ESG.*

Introduction

Over the past few years, the logistics industry has undergone a significant digital transformation, with sustainability as one of its primary objectives. As software becomes increasingly essential to organizational operations, it is not only a technical component but a strategic management issue. Decisions about how software is designed, deployed, and maintained directly influence not only focusing solely on business outcomes but also the long-term environmental, economic, and social sustainability of the enterprise.

Incorporating sustainability into Enterprise Architecture (EA) requires a management-oriented perspective that treats software systems as sustainability enablers rather than as isolated IT components. This means that sustainability management must become a guiding principle in architectural governance, investment decisions, and lifecycle planning, ensuring that technology strategies align with broader organizational sustainability objectives.

The rapid rise of Cloud adoption, Artificial Intelligence (AI), and Machine Learning (ML) in the market introduces powerful capabilities but also demands high computational resources, leading to

increased energy consumption and environmental concerns. Companies are shifting to cloud-based infrastructures, which, while scalable and operationally efficient, also contribute to sustainability challenges due to their reliance on energy-intensive data centers and complex supply chains. This dual reality necessitates organizations to adopt sustainability management practices that balance innovation with responsible resource use.

Leadership contributes to the adoption and institutionalization of EA practices for any organization. Studies highlight that transformational, strategic, participative, and adaptive leadership styles are particularly relevant for guiding change, fostering collaboration, and embedding sustainability within organizations (Bass & Riggio, 2006; Yukl, 2013; Eisenbach, Watson,& Pillai, 1999). In logistics organizations, effective leadership ensures that EA initiatives are not merely technical interventions but integral to governance and sustainability strategies. Mechanisms such as the Architecture Review Board (ARB) extend this leadership role by providing oversight, ensuring compliance, and reinforcing sustainability goals through cross-functional alignment (Niemi & Pekkola, 2019).

Furthermore, Recent studies argue that EA governance mechanisms are responsible and should be integrated with sustainability practices. The logistics sector, with its significant environmental footprint, offers a valuable opportunity to explore these dynamics.

This study focuses on the role of leadership in enabling EA to be a leading driver for sustainability in logistics organizations. It examines how leadership influences the institutionalization of EA through governance mechanisms such as the ARB, and how EA practices alignwith sustainability goals. By combining survey data with Environmental, Social, and Governance (ESG) data, the study aims to demonstrate how leadership-driven EA governance can enhance accountability, transparency, and long-term sustainable value creation.

These developments contribute to sustainability as architectural decisions directly influence long-term costs, risks, and resource utilization. However, sustainability is often viewed as an optional architectural characteristic rather than a governing principle. This sub-representation is evident in existing EA frameworks and research, where sustainability dimensions such as energy efficiency, lifecycle impacts, carbon accounting, and circular IT practices are addressed solely. Furthermore, the lack of mechanisms to monitor, measure, and evolve sustainability in software systems over time leaves a significant management gap.

Source: Researcher provided diagram

Related Literature

Bhuvan Unhelkar (2011)described Green Enterprise Architecture (GEA) as an extension and application of Enterprise Architecture in the environmental domain. A GEA strategically utilizes green IT systems, also known as CEMS (Carbon Emission Management Software), resulting in an all-encompassing approach to the greening effort that incorporates carbon data, information, processes, and knowledge into the organization's decision-making.

Marc Lankhorst (2005) provides a detailed overview of these frameworks, noting that while they offer structural rigor, they offer limited guidance on integrating sustainability objectives, a limitation that is gaining attention amid digital and ecological transformation.

San Murugesan (2008) and Simon Mingay (2007) highlighted energy-efficient hardware, virtualization, and lifecycle management. These principles have periodically been adopted in enterprise-wide architecture strategies.

Harmon and Auseklis (2009) suggested that Enterprise Architecture could help make an organization more sustainable. Winter and Fischer (2007) saw EA as a tool for making IT sustainable. Bhuvan Unhelkar (2011) created a layered model for GEA that highlights environmental measurements.

Berkhout (2009) termed the Sustainable EA Model, which integrates environmental objectives directly into EA design. The Green Layered Architecture (GLA) provides a dedicated layer within EA for monitoring sustainability metrics.

Mokhobo (2020) examines leadership styles within enterprise architecture in a South African telecommunications organization. The study highlights how transformational, strategic, and participative leadership approaches influence EA adoption, governance, and effectiveness.

Naumann (2011) asserts that quantifying sustainability in GEA remains challenging. Researchers have developed methods to incorporate environmental performance indicators (EPIs) into architectural assessments. Common indicators include carbon emissions, energy consumption, and IT utilization rates.

Beese, J. (2023)analyzes the impact of enterprise architecture management on organizational performance.

Methodology

Study Strategy

The study employed a descriptive, field-based approach, with data gathered from relevant sources and literature on the subject and the study's dimensions. To collect primary data, the researcher developed a questionnaire. This questionnaire was distributed to several professionals involved in the Architecture Review Board (ARB) process, including Overall Solution architects (OSAs), Domain architects, Enterprise architects, the ESG team, and operations managers. The objective of the questionnaire was to assess the level of understanding and enforcement of sustainability practices in the design process at a logistics company. The researcher used the field method to gather data from primary sources. The study attempted to analyze the influence of leadership roles in the TOGAF process, bringing an actionable measure of sustainability achievement.

Study Population and Sample Size Selection

The study population comprises over 250 architects spread across 43 Global Capability Centers (GCCs) and Service-based companies in India, where the logistics company’s business is primarily in the US and Europe. The researcher provided questionnaires to the architects of these companies in the selected sample. The following formula was used to discover finite populations to ensure adequate coverage of the target population of architects. For the study, this equation assumes a confidence level of 95%, a margin of error of 5% (Sharma et al., 2020)

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p)}{E^2 \cdot (N-1) + Z^2 \cdot p \cdot (1-p)}$$

Where, n = sample size, N = population, p = proportion of the population, E = Margin of Error Z=Confidence Level

With the following values: N = 250, p = 0.78, E = 0.05, Z = 1.96 (95% confidence), the derived sample size was **129**.

$$n = \frac{250 \cdot 1.96^2 \cdot 0.78 \cdot 0.22}{0.05^2 \cdot 249 + 1.96^2 \cdot 0.78 \cdot 0.22}$$

Accordingly, the number of distributed questionnaires reached 250 questionnaires and **195** valid questionnaires were retrieved for analysis, with a retrieval rate of 78%.

Results and Discussions

Study Stability

The collected TOGAF Adoption score is used as a key mediating variable to evaluate the influence of leadership on ESG performance, reflecting the extent to which organizations utilize EA principles to support sustainability objectives. However, assessing this needs inputs from Enterprise architects to Associate solution architects, whose interpretations and self-assessments may vary over time, particularly depending on maturity, awareness, and internal organizational dynamics.

For example, if the answers reflect areas of implementation, the scoring is as follows.

Criterion	Score (1–5)
TOGAF Awareness and Training	4
EA Governance Structure	3
ADM Usage	3
Integration with ESG Goals	4
Green Software Practices via TOGAF	3
Tooling and Automation	2
Continuous Improvement & Compliance	3
Total Raw Score	**22**
Max Possible (5 x 7)	**35**
TOGAF Adoption Level (1–10)=(22/35)×10=6.3	

Source: Researcher provided table

Hypothesis Testing

HI: Leadership positively influences ESG performance in logistics companies, both directly and indirectly, through the adoption of TOGAF as a driver for green software practices.

To examine the primary hypothesis, analysis was performed to identify the effect of ESG leadership style based on who takes the responsibility or chair the ESG initiatives for the company which makes it as qualitative and Categorical Independent variable, a Leadership score is derived based on Likert scale questions on how effectively the leader or leadership team demonstrates certain behavior, traits, and acumen that are related to effective leadership especially in the context of your study (e.g., promoting ESG performance and green practices) acts as Independent variable, Company's TOGAF adoption level is a mediating variable involves assessing how deeply and effectively the organization implements TOGAF particularly as it relates to driving green software practices and supporting ESG performance. It reflects both the extent and maturity of TOGAF implementation in a logistics company, especially in areas that support Enterprise Architecture (EA) governance, Sustainable IT practices, Process alignment for ESG goals, and green software development. The scoring model is built on key criteria, each scored on a Likert scale, and then scaled to a 10-point scale.

In this study, the Corporate Sustainability Assessment (CSA) is integrated as a mediating variable, reflecting the extent to which companies have implemented green software practices aligned with the TOGAF Enterprise Architecture Framework. The CSA, originally developed by Robeco SAM and currently maintained by **S&P Global**, offers a structured and industry-recognized approach to measuring corporate sustainability performance. It evaluates companies across a range of ESG criteria,

incorporating both qualitative and quantitative indicators related to sustainability strategy, innovation management, environmental policy, and resource efficiency.

The CSA data serves as a proxy for green software maturity relative to the adoption of TOGAF and sustainability-oriented IT practices. By leveraging CSA scores, the study provides a standardized, externally validated measure of sustainability-related capabilities within firms, particularly aspects relevant to IT and enterprise architecture, such as emissions reduction from digital operations and sustainable IT infrastructure.

The ESG performance score, used as the dependent variable, represents each company's overall sustainability outcome and is derived from publicly available ESG databases, with S&P Global' s ESG Scores as the primary data source. These scores offer a comprehensive assessment of a company's environmental, social, and governance performance and are widely used in both academic research and industry benchmarking. The ESG score reflects how well a company manages material ESG risks and opportunities and is considered an appropriate outcome variable for assessing the broader organizational impact of leadership, strategic TOGAF framework, and sustainability practices.

By using standardized, publicly available ESG and CSA data for the company, the study ensures transparency, comparability, and methodological rigor in measuring the mediating and outcome variables. This approach aligns with best practices in sustainability research, enabling meaningful insights into the impact of leadership and enterprise architecture on ESG outcomes in logistics companies.

Company	ESG Leadership Style	Leadership Score (1–10)	Company's TOGAF Adoption Level (1–10)	CSA Score (Corporate Sustainability Assessment)	ESG Score (Environment, Social and Governance)
C1	Adaptive	8	8	55-60	60-65
C2	Adaptive	9	8	50-55	50-55
C3	Adaptive	6	4	40-45	40-45
C4	Participative	6	5	30-35	35-40
C5	Participative	10	9	30-35	35-40
C6	Strategic	8	7	25-30	30-35
C7	Strategic	7	6	30-35	30-35
C8	Transformational	6	8	25-30	30-35
C9	Strategic	9	8	15-20	0-5
C10	Transformational	5	3	20-25	15-20
C11	Participative	7	5	15-20	15-20
C12	Participative	7	5	0-5	0-5

Source: Researcher compilation from questionnaire responses.

The results of this study have been reported in aggregate form to preserve the confidentiality and anonymity of the participating companies. Specifically, company identifiers and the precise Corporate Sustainability Assessment (CSA) and Environmental, Social, and Governance (ESG) scores have been omitted from the published data. This approach ensures that individual organizations cannot be directly identified or linked to their sustainability performance metrics, thereby upholding ethical standards and maintaining the trust of all stakeholders involved in the research.

Result Discussion

Through testing the hypotheses and analyzing the data collected in the study, the results exhibited that the logistic company following TOGAF has good scope of making different leadership styles to take individual phases of decisions in ADM cycle, Companies with strong adaptive leadership (Dedicated ESG team) and Participating leadership (Enterprise Architects) with stringent governance policies provides ability to enhance their ESG position in the global market and capable of increasing their reusability and environmental leadership.

In contrast, organizations primarily adopting strategic or transformational leadership for sustainability initiatives often experience limited impact. The Architecture Review Board's participation in these initiatives is inconsistent and fails to deliver sustained ESG improvements. This underscores the need for a comprehensive leadership approach that combines strategic vision and operational governance to achieve meaningful sustainability outcomes.

A score of 70 is considered good, while companies adhering to strict ESG regulations are heading in the right direction, whereas other companies are in the red.

The findings support recent literature highlighting the pivotal role of Enterprise Architecture (EA) in embedding sustainability within organizational structures. Frameworks like TOGAF's Green ADM enable architects to assess environmental impacts alongside traditional performance metrics, fostering a holistic approach to sustainability. Furthermore, considering ESG data in EA governance structures ensures that sustainability objectives are systematically included and aligned with business strategies.

The results indicate that logistics companies seeking to enhance their ESG performance should adopt a leadership model that incorporates adaptive and participative approaches, supported by a strong governance framework. Such a model not only drives the effective implementation of TOGAF but also ensures that sustainability becomes a vital part of the organizational culture, leading to long-term environmental stewardship.

Conclusion

Logistics companies seeking to enhance their green software initiatives must prioritize developing effective management and governance policies grounded in adaptive and participative leadership. Companies that actively implement such leadership approaches demonstrate stronger alignment with ESG outcomes, suggesting that dedicated, focused leadership not only drives TOGAF adoption but also contributes to sustainable, environmentally responsible operations.

It should be noted that leadership, change management, and governance play complementary and interconnected roles in enabling green software practices. A comprehensive and unified approach that syndicates these factors within corporate strategies can amplify their positive impact, fostering both operational efficiency and sustainability.

The results also indicate that leadership-driven policies vary according to the company’s existing governance structures, market conditions, and stakeholder engagement. This underscores the need for logistics companies to invest in continuous monitoring, adaptive leadership training, and stakeholder collaboration. As KPIs related to sustainability continue to evolve, governance policies should be revisited periodically to incorporate industry-level upgrades. Such collaboration can provide technical, financial, and organizational assistance, while also providing environmental and social benefits.

The researcher recommends that logistics companies leverage adaptive leadership to reinforce their change management processes and governance frameworks in TOGAF, ensuring that ESG objectives are embedded in regular operations, thereby improving their ESG performance and securing a competitive advantage, positioning themselves as leaders in sustainable logistics and green software innovation.

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