

Green Public Administration: A Mixed-Method Conceptual and Comparative Framework for Sustainability-Oriented States

Altantuya Dashnyam¹, Ariungerel Tseden-Ish¹, Burmaa Natsag¹, Sana Hassan², Zahid Ali³, Abdul Salam Shah⁴, Muhammad Adnan Kaim Khani²

¹National University of Mongolia, Ulaanbaatar, Mongolia

²Universiti Tunku Abdul Rahman, UTAR, Malaysia

³Faculty of Science and Technology, Ilma University, Karachi, Pakistan

⁴School of Computer Science, Taylor's University, Subang Jaya, Malaysia

DOI: <https://doi.org/10.47772/IJRISS.2026.100700503>

Received: 24 July 2026; Accepted: 30 July 2026; Published: 05 August 2026

ABSTRACT

The strong global trend towards sustainable governance, using sustainable public administration, has created a demand for integrated governance that enables institutional systems to connect with the aims of sustainability. This study explores the Sustainable Leadership's influence on Sustainable Outcomes via the mediation of the governance mechanisms of Sustainable Public Engagement, Cross-Sectional Coordination, Green Budgeting, and Institutional Capacity in the context of Green Public Administration. Based on Ecological Modernization Theory and New Public Governance, the paper suggests a governance structure to provide an explanation of the relationship between institutional transformation and participatory governance in the promotion of environmental and administrative governance. The research design used a quantitative approach, a cross-sectional analysis technique, which was followed by Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis. The framework was tested for reliability, convergent validity, discriminant validity, model fit, and mediation analyses. The findings reveal that Sustainable Leadership significantly influences Public Engagement ($\beta = 0.725$, $p = 0.000$), Cross-Sectional Coordination ($\beta = 0.845$, $p = 0.000$), Green Budgeting ($\beta = 0.811$, $p = 0.000$), and Institutional Capacity ($\beta = 0.820$, $p = 0.000$). In addition, there are significant direct effects of Public Engagement ($\beta = 0.448$, $p = 0.000$) and Institutional Capacity ($\beta = 0.377$, $p = 0.000$) on Sustainable Outcomes and insignificant direct effects of Cross-Sectional Coordination and Green Budgeting. Theoretically, the study contributes by building on Green Public Administration literature with three dimensions of governance: leadership, institutional effectiveness, and participative governance. From a practical perspective, the results have relevance for policymakers who are interested in pushing for administrative reforms and/or changes in institutional mechanisms that can assist them in achieving sustainable environmental governance in the long term.

Keywords: Green Public Administration, Sustainable Leadership, Public Engagement, Institutional Capacity, Green Budgeting, Sustainable Outcomes, PLS-SEM.

INTRODUCTION

GPA is one of the most important paradigms of government today, focusing on environmental sustainability and embedding it within the systems and processes of the government. Climate change, ecological degradation, resource scarcity, and other crises are increasingly challenging government decision-making and choice of administrative systems beyond the traditional, document-heavy, bureaucratic approaches, toward adaptive, coordinated, and sustainable approaches to government systems. In this context, GPA is in keeping with the principles of the United Nations Sustainable Development Goals (SDGs), specifically SDG 16, whereby

sustainable outcomes are targeted in the context of effective, accountable, and inclusive institutions. Cultural dimensions and institutional coordination also play an important role in improving sustainability and environmental governance outcomes in both developed and emerging economies (Hofstede Insights Compare Countries, 2021; International Institute for Sustainable Development, 2021; Mukherji & Bhatnagar, 2022; Piwovar-Sulej, 2022). Moreover, the growing prevalence of green human resource management and circular economy initiatives has enhanced governments' capacity to turn intent into action, manifested in tangible sustainability outcomes and evidence of environmental responsibility (Sulich & Sołoducho-Pelc, 2022; U.S. International Trade Administration, 2022). Previous research has also found that sustainable leadership, institutional consistency, and socially responsible governance are pivotal for long-term environmental outcomes and sustainable development pathways (Murillo-Ramos et al., 2023; Piwovar-Sulej & Iqbal, 2023). The sustainability literature has also expanded across organizational contexts, including small and medium-sized enterprises, reinforcing the need to connect institutional arrangements with sustainable-development implementation (Prashar & Sunder, 2020). Hence, GPA offers a holistic approach to understanding how leadership can create administrative transformation that brings sustainability to governance systems and leads to sustainable results.

Enormous changes have taken place within the public administration role as the principal system by which governments develop, operate, and assess policies against the backdrop of growing sustainability issues. The industry, typically governed in hierarchical matrices and sectoral silos, is moving away from those structures and towards integrated governance frameworks based on networks focused on ecological sustainability and fiscal accountability, and working collaboratively with communities and multi-stakeholder groups. During recent years, more public sector institutions in present-day advanced and emerging economies have taken to institutionalizing practices to synchronize administrative systems with the goals of sustainability, including practices such as green budgeting, cross-sectoral coordination, and digital governance. Empirical studies show that countries integrating sustainability into institutional and human resource frameworks are more successful in improving environmental performance and governance effectiveness (Mukherji & Bhatnagar, 2022; Piwovar-Sulej, 2022; Murillo-Ramos et al., 2023; Sulich & Sołoducho-Pelc, 2022; Piwovar-Sulej & Iqbal, 2023). Furthermore, the importance of good governance, institutional development, and stakeholder participation in sustainable development is highlighted by various international organizations and comparative country analyses (Hofstede Insights Compare Countries, 2021; International Institute for Sustainable Development, 2021). Consequently, the public administration industry is becoming increasingly dynamic, with sustainability issues integrated into planning and governance mechanisms.

LITERATURE REVIEW

This study conceptualizes this through the Green Public Administration (GPA) paradigm, which has grown out of the unity of theory and practice, focusing on institutional change within governance systems and the role of leaders in achieving this change, following the principles of sustainability. Sustainable leadership is at the heart of this framework, representing strategic (government) commitment to ensure environmental goals in policy and administrative frameworks. Based on insights from more recent literature, especially from the community of political sustainability transitions, it is argued that leadership in sustainability transitions is indeed a determining factor in aligning governance mechanisms, mobilizing institutional resources, and enabling integration across sectors (Murillo-Ramos et al., 2023; Piwovar-Sulej & Iqbal, 2023; Piwovar-Sulej et al., 2023). This is where the importance of cross-sectoral coordination has emerged as a key construct, helping governments to surmount the barriers of policy silos and ensure coherence between sectors like the energy sector, the finance sector, and the environmental management sector. Likewise, green budgeting has become one of the important instruments of fiscal policy because of green budget components that have been integrated in the decision-making process of public expenditure programs, to carry out sustainable development (International Institute for Sustainable Development, 2021; Polish Ministry of Foreign Affairs, 2023). Governance quality and institutional alignment are other early studies that argue that they are the core factors of environmental and long-term performance (Hofstede Insights Compare Countries, 2021; Piwovar-Sulej, 2022). Therefore, sustainability is now increasingly a part of people's current knowledge, moving beyond the policy dimension, to the action of integrated administrative systems with strategic governance.

THEORETICAL FRAMEWORK

Ecological Modernization Theory (EMT)

Ecological Modernization Theory (EMT) offers an extended framework to help understand how environmental sustainability can be mainstreamed into economic and administrative systems by implementing institutional change and innovation. Recognizing that protecting the environment does not inevitably clash with economics, EMT believes the process can be promoted through the development of new institutions, new technologies, and new regulations. In recent years, research in the EMT framework has brought to the fore the importance of inter-sector coordination, fiscal alignment, and governance structures to facilitate sustainability transition processes in public administration (Piwowar-Sulej & Bąk-Grabowska, 2024; Bertelsmann Stiftung, 2022; Habib et al., 2020). At this level, it is like the United Nations Sustainable Development Goals (SDGs) as they relate to SDG 16, focusing on the importance of effective institutions for the achievement of sustainability outcomes. Previous theoretical work also confirms that institutional change, policy integration, and administrative innovation play a key role in processes of ecological modernization (Mikalef et al., 2020; Miroshnychenko et al., 2021). For this reason, EMT offers a comprehensive body of theory to study the possibilities for governance transformation along sustainability paths. Consequently, EMT offers a strong framework for discussing the possibilities of governance transformation for sustainability-oriented states.

Sustainable Development and Institutional Quality

Sustainable development is now recognized as a governance-based process, and institutional quality has a critical role in determining social and environmental outcomes. Effective and democratically controlled institutions are also a condition for sustainability, as highlighted in the United Nations Sustainable Development Goals (SDGs), especially SDG16. Using effective, accountable, and transparent institutions is a prerequisite for achieving sustainability, as emphasized in the United Nations Sustainable Development Goals (SDGs), especially SDG16. Countries with comprehensive institutional structures are shown to be more efficient in their policies and regulations, as well as their institutional capacities, which results in better environmental performance and the successful execution of sustainability efforts (Bertelsmann Stiftung, 2022; Piwowar-Sulej & Bąk-Grabowska, 2024; Habib et al., 2020). Through institutional quality, governance mechanisms, fiscal policies, and cross-sectoral coordination can be aligned, allowing governments to tackle complex sustainability issues in an integrated way (Mikalef et al., 2020). Other previous research also demonstrates that fragility of institutions fosters poor policy implementation and poor environmental results, while robust institutional structures improve long-term environmental sustainability (Meirun et al., 2020; Miroshnychenko et al., 2021). So, the quality of institutions becomes a preliminary tool to translate sustainability goals into effective institutions and measurable environmental effects.

New Public Governance

New Public Governance (NPG) is a move from the traditional, hierarchical structure of public administration to a more network-based and collaborative approach to governance that relies on the involvement of stakeholders, the need for coordination between different organizations, and the growing significance of participative decision-making when tackling complex policy problems. Sustainability-driven NPG emphasizes the value of bringing together all three (government, private sector, civil society) in creating solutions that are adaptive, inclusive, and environmentally and socially responsive. Recent research indicates that NPG governance systems change the NHDR results towards more effective policy making and increased sustainability outcomes achieved through better coordination and collective problem-solving (Piwowar-Sulej & Bąk-Grabowska, 2024; Bertelsmann Stiftung, 2022; Habib et al., 2020). In addition, participatory governance tools, like public consultation and digital platforms for citizens' engagement, etc., increase transparency and institutional legitimacy, supporting policy implementation and sustainability outcomes (Mikalef et al., 2020).

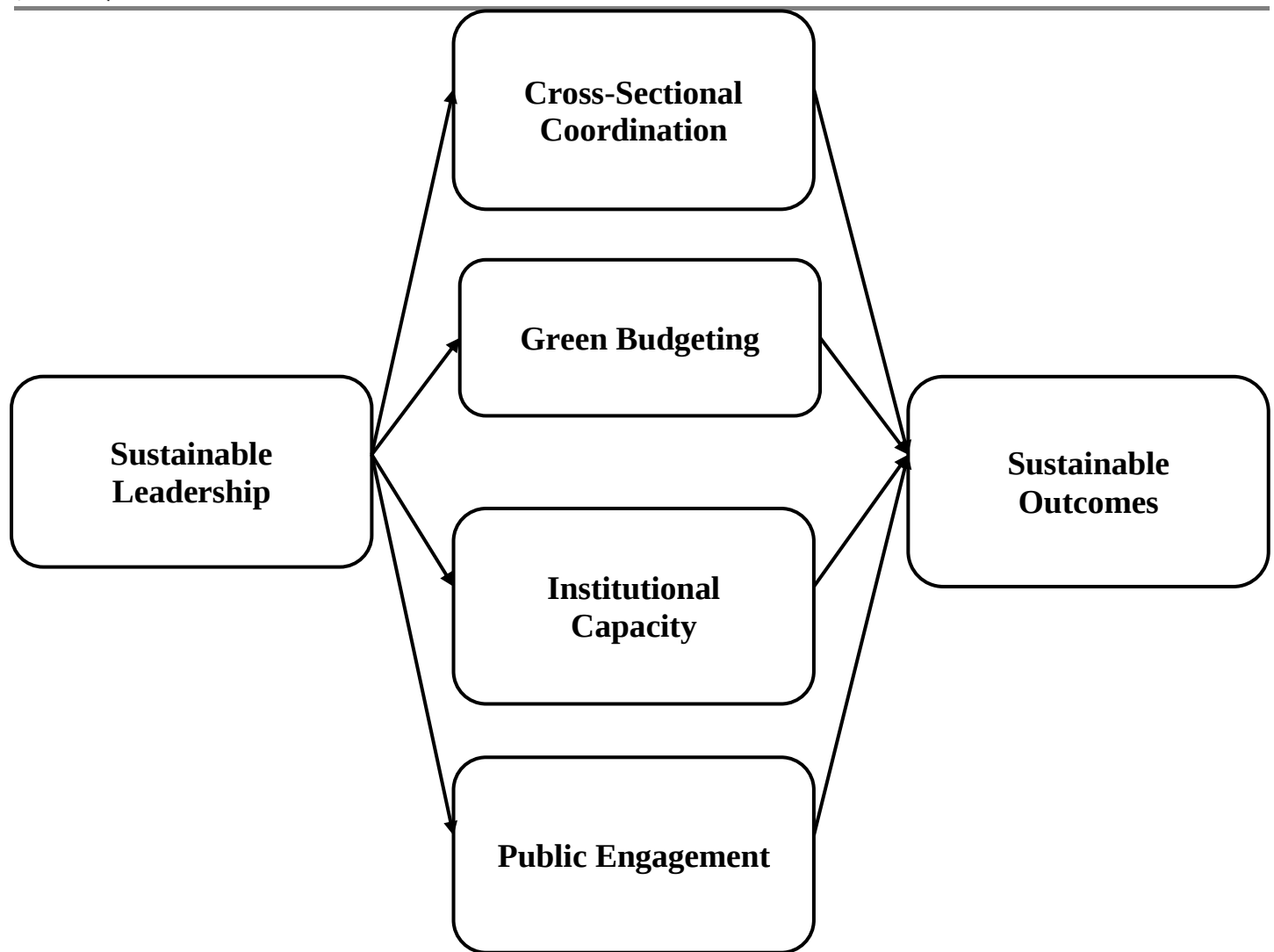


Figure 1. Conceptual Framework: The Five Pillars of Green Public Administration

The conceptual framework for this study focuses on the five dimensions of “Green Public Administration (GPA)” that, taken together, offer a way of understanding the implementation of green public administration in public sector systems in Figure 1. The centerpieces of the framework are sustainable leadership, which gives guidance and integrates nature at the heart of government through several important administrative processes such as cross-sectoral coordination, green budgeting, institutional capacities, and public awareness. The pillars are key elements that enable sustainability targets to be implemented as governance practices. Integrated coordination, fiscal alignment, and participatory governance are shown to markedly improve environmental performance and the effectiveness of environmental policy in sustainable states (Piwowar-Sulej & Iqbal, 2023; Piwowar-Sulej et al., 2023; Piwowar-Sulej & Bąk-Grabowska, 2024).

Sustainability Leadership

At the institutional level, Sustainability leadership is one of the most important factors as a driver of Green Public Administration, expressing how high-level political commitment incorporates environmental aspects within the national governance structures and policy design. This includes the development of countries' strategies on sustainability, the enactment of climate legislation, and putting in place cabinet-level coordination mechanisms to ensure inter-sectoral and inter-ministerial coordination. Recent research emphasizes that a robust commitment from leadership can greatly increase policy coherence, promote sustainability transitions, and drive better environmental outcomes by integrating long-term ecological objectives into governance frameworks (Piwowar-Sulej & Iqbal, 2023; Murillo-Ramos et al., 2023; Piwowar-Sulej et al., 2023). Efficient sustainability leadership also helps get leaders from different sectors working together and the sector's institutions involved in solving complex environmental problems together (Polish Ministry of Foreign Affairs, 2023). What was found previously also demonstrates that a governance system reform anchored in leadership is crucial in institutionalizing

sustainability and implementing environmental policies successfully (Piwowar-Sulej, 2022; Mukherji & Bhatnagar, 2022).

Cross-Sector Coordination

One of the core concepts of Green Public Administration concerns cross-sector coordination, which champions the unity of the seemingly disparate parts of government and policy areas towards sustainability. It includes the creation of inter-ministerial councils, whole-of-government planning processes, and policy coherence audits for the coordination and strengthening of the links between environmental policy, economic policy, and social policy. Sometimes the issue of sustainability does not fall along single sector boundaries, but touches various issues (e.g., energy, transport, agriculture, and finance), which makes coordinated decision-making key for the implementation of the policy. Governments with a (new) approach to building the necessary policy coherence and a sustainable development framework on the basis of integrated coordination, thereby prompting a better match of actions and policies at sub-governmental levels, have reportedly improved institutional integration and policy coherence, resulting in better policy outcomes on policy measures for low-carbon developments (Piwowar-Sulej & Iqbal, 2023; Piwowar-Sulej et al., 2023; Piwowar-Sulej & Bąk-Grabowska, 2024).

Green Budgeting

Green budgeting is an important part of Green Public Administration, which integrates environmental priorities into the fiscal policy and public financial management systems, and public expenditure and resource allocation accord with environmental public policies. It includes climate expenditure tagging, integration of carbon pricing into the budget, and sustainability impact assessments, among other mechanisms, that allow governments to systematically consider and account for the environmental dimension of the budgetary process. They provide public administration with a way of monitoring investments made in the face of the climate crisis, incorporating environmental costs, as well as understanding the ecological impact of fiscal policies in climate-related areas. Recent research underscores the link between green budgeting frameworks and environmental improvement, as well as better political results stemming from better fiscal transparency and accountability at the national level (Qi et al., 2021; Rehman et al., 2021; Feng et al., 2022, Zaman et al., 2025). In addition, sustainability-based budgeting enables long-term climate mitigation measures by synchronizing financial planning and the SDG commitments with environmental goals.

Institutional Capacity

Institutional capacity is one of the main components of Green Public Administration, which is the capacity of public sector institutions to prepare, enact, and operate public sector policies oriented towards sustainability. It covers aspects including technical competencies, data systems, monitoring and enforcement systems, as well as regulatory capabilities, that are crucial to achieving measurable results from policy commitments. Building institutional capacity will allow governments to have access to evidence-based decision-making, monitor environmental performance, and enforce sustainability legislation. The results of recent studies highlight that increasing institutional capacity has significant positive effects on policy effectiveness, environmental performance, and the success of sustainability policies, especially those implemented in complex policy-making settings (Khan et al., 2023; Makhloufi et al., 2024; Williams et al., 2024). Further, sophisticated data processes and supervisory mechanisms enable transparency, which facilitates accountability and enables responses in an anticipatory manner to environmental problems (Kytömäki, 2020).

Public Engagement

Participatory governance as a component of public engagement is an essential element of the concept of Green Public Administration, and helps to improve the transparency, legitimacy, and effectiveness of sustainability policies. It has mechanisms for involving citizens, civil society, and private actors in the design and execution of policies – public consultations, digital governance platforms, and stakeholder advisory councils. These participatory techniques allow governments to make use of diverse perspectives for a better sense of accountability, and behavioural change is required if sustainability objectives are to be achieved. Empowering collaborative governance has been found to be strongly associated with better outcomes for institutional trust, policy acceptance, and in the longer-term sustainability (Qi et al., 2021; Rehman et al., 2021; Feng et al., 2022).

Furthermore, digital governance platforms have also opened new avenues for citizens to be engaged, accounting for inclusive and responsive governance in contemporary administrative contexts (Kytömäki, 2020).

METHODOLOGY

Mixed-Method Comparative Design

The study follows the mixed-method comparative research design because it provides a complete picture of using both qualitative and quantitative research methods to understand the phenomenon of Green Public Administration and its outcomes on sustainable development. Using multiple methods in research has become a common approach in governance and sustainability studies because of the need to have the benefits of in-depth qualitative analysis alongside those of broader quantitative analysis. This recent literature suggests that mixed-method designs offer unique benefits for studying complex institutional phenomena, offering both a means of capturing the structural dynamics and measurable performance indicators that otherwise remain unaccounted for (Talib et al., 2021; Fauzi et al., 2021; Khoso et al., 2025). The qualitative part of this study includes analysis of policies and policy documents, review of institutional structure, policy, legal, and administrative dimensions, and administrative reforms, and will allow an in-depth study of governance and administrative capacities in various countries. This will give context to the practice of sustainable management of public administration systems. Qualitative methods have also been used in the field of governance studies, as reported in previous research, where they can be used as an analytical tool for governmental institutional arrangements and processes (Baas et al., 2020; Mas-Tur et al., 2021).

Complementing the qualitative analysis, the study also consists of a quantitative component, which uses valid and commonly used metrics and indicators like World Governance Indicators (WGI), SDG 16 institutional indicators, and Environmental Performance Index (EPI) to measure climate policy integration and sustainability outcomes. These indicators will enable cross-country comparison and ensure the findings are reliable and valid. Recently, research has highlighted the need to integrate quantitative indicators with qualitative institutional analysis to get a more comprehensive and multi-faceted assessment of sustainability performance, especially when used in comparative governance studies (Leong et al., 2021; Rivera et al., 2021; Lu et al., 2020). In addition, by comparing the design, it is possible to determine best practices and identify institutional gaps in various governance settings, especially relevant in the analysis of developed and transitioning economies. Previous studies, too, have shown the need for a comparative use of mixed method approaches to draw conclusions on the linkage between governance quality and the environmental performance in different institutional settings (Mas-Tur et al., 2021; Baas et al., 2020). As a result, this research design contains a systematic and comprehensive approach to the study of the contribution of Green Public Administration/Sustainability-oriented state transformation.

Case Selection Rationale

The method used in this study is the comparative case study method, which is characterized as a method for comparative analysis. In this study technique, the technique that has been applied is the comparative case study method, which is understood as a method of case study analysis to compare and analyze the application of the concept of Green Public Administration in achieving sustainable outcomes in various institutional contexts. The countries chosen (Germany, New Zealand, the European Union, and Mongolia) are each strategically advanced and transitioning countries with a wide range of governance, fiscal, and integration to sustainability structures. Germany is well-known for its innovative federal sustainability integration and robust laws; New Zealand is exemplifying the approach of embedding a wellbeing concept into fiscal governance in a unique way. The European Union is a supranational governance structure that coordinates sustainability policies in several member states, and Mongolia is a good example of a resource-dependent economy in transition that suffers from institutional and capacity constraints. Recent research has made it very clear that comparative analysis of different governance configurations can help the understanding of sustainability transitions and institutional inefficiencies, as it is through comparison that both best practices and situations of shortcomings can be identified, as per Table 1 below (Fauzi et al., 2021; Opoku & Lee, 2022; Rashid et al., 2025). All selected showed diversity of administrative models, allowing for a thorough assessment of the impact of organizational governance systems

on the performance of sustainability. Comparative case studies are also widely used in governance and environmental policy analysis research in earlier studies, where they prove to be useful in examining institutional variations and different policy results in various socio-economic contexts (Rivera et al., 2021; Mas-Tur et al., 2021).

Table 1. Analytical Framework

Pillar	Qualitative Indicator	Quantitative Proxy
Sustainability Leadership	National sustainability strategies, climate legislation, and cabinet-level coordination	Climate Governance Index / SDG 16 Index
Cross-Sector Coordination	Inter-ministerial councils, whole-of-government frameworks, policy coherence audits	Policy Coherence Score / Government Effectiveness (WGI)
Green Budgeting	Climate expenditure tagging, carbon pricing mechanisms, and sustainability impact assessments	Climate Expenditure Ratio / Green Budget Index
Institutional Capacity	Environmental agency strength, technical expertise, monitoring, and enforcement systems	Regulatory Quality Index (WGI)
Public Engagement	Public consultations, digital participation platforms, stakeholder advisory councils	Voice & Accountability Score (WGI)

Following the "academic approach" to Green Public Administration, this study operationalizes these five pillars of green PA, using qualitative indicators of the institutions and quantitative indicators of the performance of governments regarding sustainability issues across selected countries. There are qualitative dimensions of each pillar, including the policy frameworks, administration, and governance, as well as quantitative dimensions, such as climate expenditure indicators, climate governance index, and World Governance Indicators (WGI). This holistic approach allows for a full profile of the contribution of sustainability leadership, coordination, budgeting, institutional capacity, and public engagement to sustainability outcomes. Recent research has highlighted the importance of incorporating qualitative governance analysis alongside quantitative indicators to increase the robustness and comparability of sustainability research, particularly when it comes to institutional context (Daradkeh et al., 2022; Pinti et al., 2022; Nazeer et al., 2022). Furthermore, standardized global indices enable cross-country comparisons and enhance the empirical robustness of results (Opoku & Lee, 2022). Previous research similarly favors the adoption of hybrid analytical approaches for governance studies, where they are demonstrated to be effective tools to combine understanding of institutional processes and sustainability outcomes (Rivera et al., 2021; Mas-Tur et al., 2021). The framework therefore covers this way an integrated and comprehensive analysis of sustainability outcomes and relates to Green Public Administration.

RESULTS AND DISCUSSIONS

The present study revealed significant evidence from the empirical side that supports the development of the Green Public Administration framework proposed by the researcher as it is concluded that the main leadership dimensions towards sustainable governance can be significantly influenced by the dimension of sustainable leadership in public administration. The findings show that sustainable governance leadership does significantly affect public engagement, cross-sectional coordination, green budgeting, and institutional capacity, thus highlighting the importance of leadership-induced governance reforms for enacting sustainability within the public sector systems. Additionally, the very good model exogenous variable (XEN), if it is used to explain the results of the model, can be used to understand environmental and developmental goals, which are very important, in part due to administrative transformation. The findings resonate with the latest studies (A. K. Khan et al., 2024; Khoso et al., 2024; Khoso et al., 2025), which have highlighted the importance of sustainable leadership to deliver effective governance, coherent policies, and synchronicity within the pillars of the institutions of sustainable governance. The argument is also supported by earlier research that institutional modernization and institutional reforms play a crucial role in fostering environmental sustainability and shaping long-term governance performance (Rivera et al., 2021; Opoku & Lee, 2022).

Table 2. Path Coefficients

Path coefficients					
Mean, STDEV, T values, p values					
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Cross_Sectional_Coordination -> Sustainable_Outcomes	0.073	0.068	0.078	0.936	0.349
Green_Budgeting -> Sustainable_Outcomes	0.023	0.030	0.077	0.299	0.765
Institutional_Capacity -> Sustainable_Outcomes	0.377	0.374	0.076	4.980	0.000
Public_Engagement -> Sustainable_Outcomes	0.448	0.449	0.074	6.036	0.000
Sustainable_Leadership -> Cross_Sectional_Coordination	0.845	0.845	0.022	38.249	0.000
Sustainable_Leadership -> Green_Budgeting	0.811	0.811	0.033	24.906	0.000
Sustainable_Leadership -> Institutional_Capacity	0.820	0.820	0.025	33.234	0.000
Sustainable_Leadership -> Public_Engagement	0.725	0.725	0.036	20.345	0.000

Table 2 defines the statistics of path coefficients, showing that Sustainable Leadership is fundamental in improving the Green Public Administration governance mechanisms. The findings reveal that Sustainable Leadership has significant positive effects on Cross-Sectional Coordination ($\beta = 0.845$, $T = 38.249$, $p = 0.000$), Green Budgeting ($\beta = 0.811$, $T = 24.906$, $p = 0.000$), Institutional Capacity ($\beta = 0.820$, $T = 33.234$, $p = 0.000$), and Public Engagement ($\beta = 0.725$, $T = 20.345$, $p = 0.000$). These pivotal relationships show that leadership focused on sustainability significantly improves interdepartmental relations, fiscal sustainability, institutional governance capacity, and participation of stakeholders. The strong T-statistics and the significant p-values support the conclusion that Sustainable Leadership constitutes the main governance lever that encourages public sector governance bodies to transform and integrate sustainability.

Table 3. Construct Reliability and Validity

Construct reliability and validity				
Overview				
	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Cross_Sectional_Coordination	0.832	0.843	0.898	0.747
Green_Budgeting	0.908	0.909	0.942	0.844
Institutional_Capacity	0.862	0.865	0.916	0.784
Public_Engagement	0.856	0.857	0.912	0.776
Sustainable_Leadership	0.887	0.887	0.930	0.815
Sustainable_Outcomes	0.853	0.857	0.911	0.773

In Table 3, the results of collecting construct reliability and validity show that the construct of this study has internal consistency reliability and convergent validity at a high level. The reliability and consistency of the measures in all constructs are above the recommended range of 0.70, ranging from the alpha of 0.832 to 0.908. Likewise, all constructs have composite reliability values higher than 0.70 (rho_a and rho_c), which means that all constructs are measured reliably and stably. In particular, Green Budgeting has the highest Composite reliability (rho_c = 0.942), indicating good measurement consistency. The AVEs of the constructs obtained also showed values that were above 0.50 (acceptable, ranging from 0.747 to 0.844), verifying convergent validity and

indicating that the indicators of each construct explain the variation of the construct well. Based on these results, in general, the measurement model can be concluded to be statistically reliable and valid to be suitable for further analysis using structural equation modeling.

Table 4. Discriminant Validity

Discriminant validity						
Heterotrait-Monotrait ratio (HTMT) - Matrix						
	Cross_Sectional_Coordination	Green_Budgeting	Institutional_Capacity	Public_Engagement	Sustainable_Leadership	Sustainable_Outcomes
Cross_Sectional_Coordination						
Green_Budgeting	0.946					
Institutional_Capacity	0.962	0.864				
Public_Engagement	0.865	0.813	0.958			
Sustainable_Leadership	0.974	0.903	0.936	0.832		
Sustainable_Outcomes	0.859	0.786	0.956	0.969	0.823	

In Table 4, the discriminant validity of the constructs in the measurement had been evaluated using the HTMT (Heterotrait-Monotrait Ratio) results. In general, the answer to this question will be 'yes' if the HTMT values are less than 0.90, which shows the constructs are empirically different from each other, demonstrating discriminant validity. The results also reveal that most of the constructs, Green Budgeting–Institutional Capacity (0.864), Green Budgeting–Public Engagement (0.813), Green Budgeting–Sustainable Outcomes (0.786), and Sustainable Leadership–Sustainable Outcomes (0.823), have an acceptable discriminant validity level within the 0.70–0.90 range. Some HTMT values are higher than recommended (0.90): Cross-Sectional Coordination–Institutional Capacity (0.962), Sustainable Leadership–Cross-Sectional Coordination (0.974), Institutional Capacity–Sustainable Outcomes (0.956), and Public Engagement–Sustainable Outcomes (0.969). The high HTMT values indicate some overlap or conceptual similarity in some of the constructs, meaning that the respondents might view some of the constructs in the Green Public Administration framework as related. Overall, however, the measurement model shows good validity for the measures, although some require more refinement or further specification of conceptual distinctions in future research.

Table 5. Model Fit

Model Summary	Fit	
	Saturated model	Estimated model
SRMR	0.051	0.089
d_ ULS	0.451	1.365
d_ G	0.416	0.572
Chi-square	922.519	1095.605
NFI	0.852	0.825

In Table 5, the results of the model fit showed an acceptable but moderate overall goodness of fit with the proposed model. Model fit is good according to Standardized Root Mean Square Residual (SRMR), with a value of 0.051 for the saturated model and 0.089 for the estimated model, both below the advised value of 0.08. The values d_ ULS and d_ G are relatively low, which is typical for a reasonably acceptable discrepancy between the

empirical and model-implied correlation matrix. In addition, the Chi-square value of the saturated model (922.519) and the estimated model (1095.605) indicates the overall difference level. However, generally, the Chi-square tends to be more sensitive to the sample size in SEM analysis. NI, 0.852 and 0.825, are moderately below the recommended value of 0.90 (0.9=very good fit; >0.8=moderate fit), indicating the model has moderate adequacy in explaining and predicting. The overall results suggest good model fit and adequate predictive power for the testing of the relations between the constructs within the frame of "Green Public Administration." However, there is room for model improvements by optimizing the fit of the overall model.

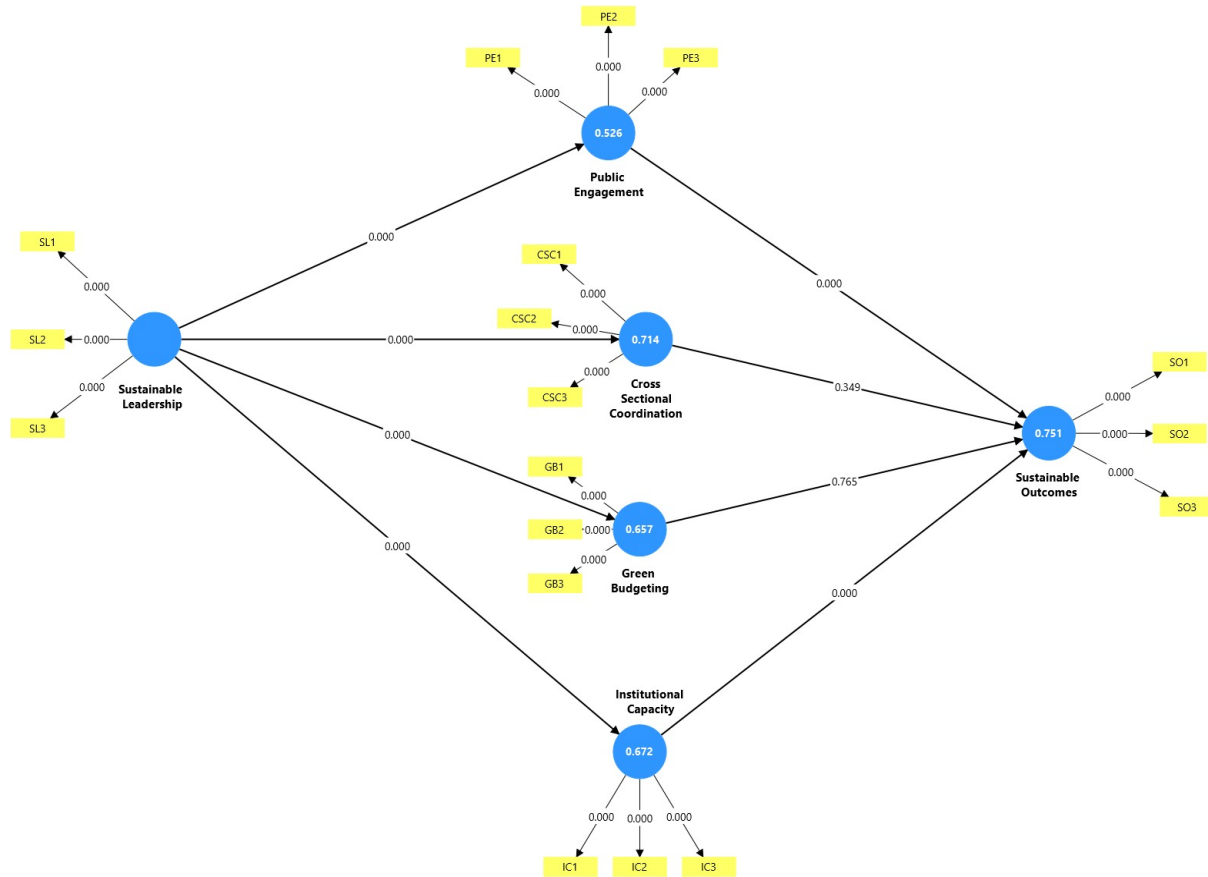


Figure 2. PLS SEM Bootstrapping

In Figure 2, the structural model depicts the relationships between Sustainable Leadership, the various governance dimensions, and Sustainable Outcomes in the suggested framework of Green Public Administration. The results show that Sustainable Leadership significantly affects all four governance mechanisms, such as Public Engagement, Cross-Sectional Coordination, Green Budgeting, and Institutional Capacity, as seen by the p-value, which is significant, namely 0.000. The R² values also further reinforce the model's strong explanatory power, with R² values of respectively 52.6%, 71.4%, 65.7% and 67.2% respectively for Public Engagement, Cross-Sectional Coordination, Green Budgeting, and Institutional Capacity. The results indicate that sustainable leadership significantly enhances institutional effectiveness, institutional arrangements for participatory governance, fiscal sustainability mechanisms, and administrative coordination in public administration systems.

Table 6. Mediation & Moderation Analysis

Specific indirect effects					
Mean, STDEV, T values, p values					
	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Sustainable _Leadership -> Public _Engagement -> Sustainable _Outcomes	0.325	0.326	0.058	5.621	0.000
Sustainable _Leadership -> Institutional	0.309	0.306	0.063	4.930	0.000

_Capacity -> Sustainable _Outcomes					
Sustainable _Leadership -> Green _Budgeting -> Sustainable _Outcomes	0.019	0.025	0.063	0.296	0.767
Sustainable _Leadership -> Cross_Sectional_Coordination -> Sustainable _Outcomes	0.062	0.057	0.066	0.936	0.349

In Table 6 the results of the specific indirect effects, it has been tested that Public Engagement and Institutional Capacity mediate between Sustainable Leadership, and Sustainable Outcomes in the proposed Green Public Administration framework for the proposed framework. The indirect path (Public Engagement) is positive and significant ($\beta = 0.325$, $T = 5.621$, $p = 0.000$) – So, sustainable leadership increases sustainability outcomes moderated by promoting stakeholder involvement, transparency, and public engagement in governance processes. Further, Sustainable Leadership has a significant coefficient indirect effect on Sustainable Outcomes, through the mediation of Institutional Capacity ($\beta = 0.309$, $T = 4.930$, $p = 0.000$), meaning that the increase in institutional systems, technical area-specific skills, and governance ability is a key driver to improve sustainability performance. Both indirect effects, however, come out as statistically insignificant since the p-values of these two are higher than 0.05 and the T values are lower than 1.96 for both the estimates of Green Budgeting ($\beta = 0.019$, $T = 0.296$, $p = 0.767$) and Cross-Sectional Coordination ($\beta = 0.062$, $T = 0.936$, $p = 0.349$). These findings suggest that sustainable leadership, in its positive effect on green budgeting and coordination of governance, does not translate into sustainability outcomes unless sustainable leadership is accompanied by more robust implementation of governance and participation. Overall, the mediation test results support that Public Engagement and Institutional Capacity are the most important indirect factors between Sustainable Leadership and Sustainable Outcomes.

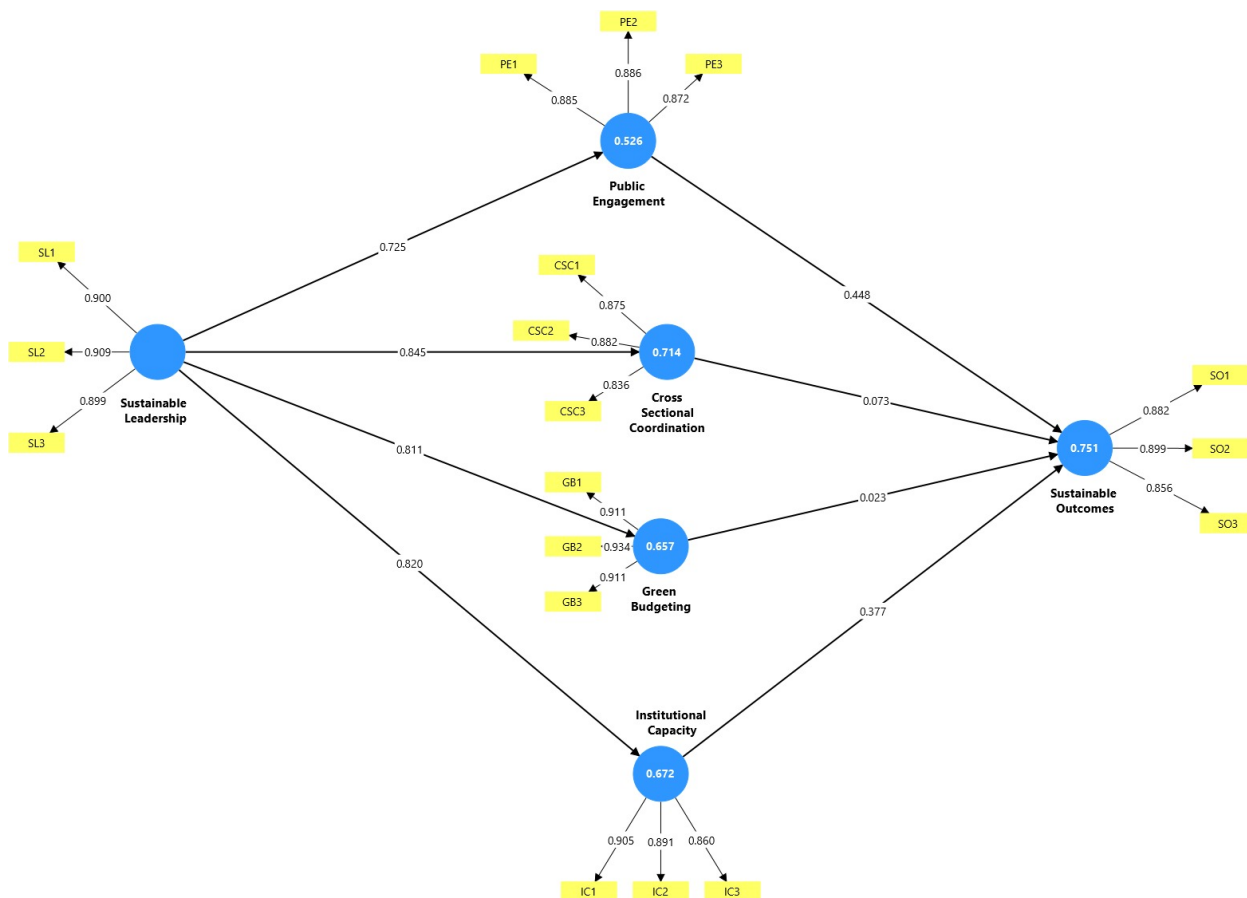


Figure 3 PLS SEM

Figure 3 displays the complete PLS-SEM structural and measurement model of the proposed Green Public Administration framework straightforwardly. Indicator reliability is good, with outer loadings of all the variables being above the recommended threshold of 0.70, as shown in the measurement model. The Sustainable

Leadership indicators (GPSA0899 to GPSA0909) exhibit well-defined convergent validity and measurement reliability, as do the Public Engagement indicators (GPSA0872 to GPSA0886), Cross-Sectional Coordination (GPSA0836 to GPSA0882), Green Budgeting (GPSA0911 to GPSA0934), Institutional Capacity (GPSA0860 to GPSA0905), and Sustainable Outcomes (GPSA0856 to GPSA0899). This R^2 is generally very high, with Sustainable Leadership providing all of the following 52.6% of the variance in Public Engagement, 71.4% of the variance in Cross-Sectional Coordination, 65.7% of the variance in Green Budgeting, and 67.2% of the variance in Institutional Capacity. Moreover, the constructs of the governance model together account for 75.1% of the variance in Sustainable Outcomes, which indicates the model has good explanatory power and predictive ability concerning sustainable-governance systems.

The results of the structural model demonstrated that Sustainable Leadership in relation to other factors of the governance model are quite meaningful, with all dimensions of the governance model, including Public Engagement ($\beta = 0.725$), Cross-Sectional Coordination ($\beta = 0.845$), Green Budgeting ($\beta = 0.811$), and Institutional Capacity ($\beta = 0.820$). This shows that the relationship between Sustainable Leadership and the other governance factors is significant for the promotion of sustaining oriented government system. The analysis reveals that Public Engagement ($\beta = 0.448$) and Institutional Capacity ($\beta = 0.377$) significantly positively influence Sustainable Outcomes, evidencing that participation of relevant stakeholders and transparency, institutional efficiency, and administrative capacities are essential enablers for sustainability performance. Yet at a lower level than the two, particularly weak and non-significant relationships with Sustainable Outcomes are observed for two policy areas of development—Cross-Sectional Coordination ($\beta = 0.073$) and Green Budgeting ($\beta = 0.023$), implying that they need a stronger institutional implementation and citizen participation to produce more noticeable effects on sustainability. Finally, it is concluded that Sustainable Leadership is the main factor driving governance, while Public Engagement and Institutional Capacity are the most crucial enablers for a sustainable governance outcome.

DISCUSSION

The results of this study make a relevant theoretical contribution to the still fledgling field of Green Public Administration by filling in the gaps of the debates on Ecological Modernization Theory (EMT) and New Public Governance (NPG) in the context of sustainability-oriented governance systems. Results show that Sustainable Leadership is an effective governance mechanism that has a significant impact on Public Engagement, Cross-Sectional Coordination, Green Budgeting, and Institutional Capacity. This confirms the use of the assumptions of Ecological Modernization Theory – the need for institutional change, administrative change, and governance change to bring about environmental sustainability and sustainable development results. Findings indicated a strong relationship between the dimensions of Sustainable Leadership and governance, thereby establishing that transformation towards sustainability needs to be led and institutionalized through coherence of policies. Researchers have also recently found that leadership for sustainability plays a positive role in improving governance systems through better coordination, institutional integration and the effectiveness of environmental policy implementation (Piwowar-Sulej & Iqbal, 2023; Piwowar-Sulej et al., 2023; Piwowar-Sulej & Bąk-Grabowska, 2024). The results also align with New Public Governance principles, which highlight the importance of a collaborative approach to governance and participation of stakeholders as key elements in contemporary sustainability-driven governance structures. The small direct influence of Cross-Sectional Coordination and Green Budgeting on Sustainable Outcomes contradicts the governance integration theories, which assume that this would lead to Sustainable Outcomes directly. Hence, the idea of achieving Sustainable Outcomes through Cross-Sectional Coordination and Green Budgeting alone, without other institutional interventions and participatory governance, is questioned. Based on the existing literature on ecological modernization, Rivera et al. (2021) and Mas-Tur et al. (2021) have pointed to integrated governance in the form of support systems for sustainability reforms being required for the ecological modernization to be enacted entirely.

The findings of this study from a literature contribution angle extend previous studies on governance and sustainability, by providing empirical evidence for the role of Public Engagement and Institutional Capacity as the most influential dimensions of governance that are related to Sustainable Outcomes. The robust positive association between Public Engagement and Sustainable Outcomes aligns with recent research that highlights how citizen involvement in governance, transparency, and the engagement of stakeholders enhances governance's legitimacy and effectiveness in the implementation of environmental policies (Wang et al., 2022; Daradkeh et

al., 2022). Likewise, the findings of this study regarding the importance of Institutional Capacity and Sustainable Outcomes support the previous arguments that the quality of governance in terms of sustainability is closely related to the strength of regulatory systems, monitoring and control mechanisms and technical competence (A. K. Khan et al., 2024; Mukherji & Bhatnagar, 2022). The results add to the body of literature in confirming through statistical significance that while policy development is important for sustainability success, so is institutional capability and governance involvement. Losing the insignificant findings on Green Budgeting and Cross-Sectional Coordination at the same time would be an important addition to the already existing literature. In several studies, it has been claimed that green fiscal reforms and integrated coordination mechanisms can directly increase sustainability outcomes (Opoku & Lee, 2022; Wang et al., 2022), though in the current study, the impact of the green fiscal reforms and coordination mechanisms on sustainability is either indirect or depends on other governance capacities. The revelation of this new understanding of quasi-public goods, fiscal renovation, and coordination measures can still result in non-measured environmental performance when implementation is not effective, and there is no societal involvement.

CONCLUSION

The findings of this study point to the strategic position of Green Public Administration for achieving environmental performance outcomes, which is oriented to sustainability. The results validate that within public administration systems, Sustainable Leadership is the most important governance determinant that affects Public Engagement, Cross-Sectional Coordination, Green Budgeting, and Institutional Capacity. The broad compatibility of the proposed framework with the experiences and insights gathered indicates that the governance of sustainability demands more than just environmental policies but a set of measures that extends to transforming the administration into an integrated arrangement. In particular, the study confirms that Public Engagement and Institutional Capacity make significant contributions to Sustainable Outcomes, suggesting that participatory governance and institutional effectiveness or capacity and administration is necessary to successfully implement Sustainable Outcomes. These findings align with current governance and sustainability research, which underscores the importance of institutional modernization and leadership-led reforms to help ensure governance institutions are more effective and capable of meeting sustainability goals (Qi et al., 2021; Rehman et al., 2021; Feng et al., 2022). Earlier studies also made similar claims regarding the need for a robust institutional framework and governance restructuring processes for sustainability-oriented public administration (Habib et al., 2020; Meirun et al., 2020).

Theoretically, the study expands the conceptual frameworks of Ecological Modernization Theory and New Public Governance in the context of sustainability-oriented public administration, making important contributions to them. The findings highlight that sustainability governance has a multi-dimensional nature and requires an interplay between leadership, institutional systems, participative governance, and administrative integration. Public Engagement and Institutional Capacity are other important mediators, suggesting that governance effectiveness lies in collaborative and institutionalized sustainability mechanisms. By statistically substantiating the significance of transformation towards sustainability that would be led by the leadership and participatory governance systems, these findings add to the body of governance literature. Recent research has also focused on the role of institutional quality and governance involvement in the attainment of sustainable development outcomes (Khan et al., 2023; Makhoulfi et al., 2024). Other recent papers have also confirmed that collaborative governance and the participation of stakeholders enhance sustainability-focused public administrations (Williams et al., 2024; Alsharif et al., 2020).

Future Research Direction

The proposed Green Public Administration framework should be extended through the inclusion of further variables related to governance and sustainability within public sector institutions, which would contribute to explaining the link between governance and sustainable outcomes in institutions. Further research can include dimensions like digital governance, environmental innovation, policy measures and enforcers, political stability, institutional culture, etc., as additional constructs to the current topics of Sustainable Leadership, Public Engagement, Cross-Sectional Coordination, Green Budgeting, and Institutional Capacity, to complement the analysis of a comprehensive governance system oriented towards sustainability. Related digital-technology studies demonstrate how computer vision and AI-enabled analytics are being applied to monitoring, assessment,

and decision-support tasks (Khani et al., 2024; Malik et al., 2023; Shah, Akbar, et al., 2025; Ali et al., 2025). Other work illustrates the institutional relevance of SaaS platforms, real-time communication and service-quality infrastructures, IoT-enabled safety and emergency-response systems, and predictive planning (Mughal et al., 2022; Sarwar & Humair Nawaz, 2021; Bamboat et al., 2024; S. A. Khan et al., 2024; Shah et al., 2024; Aziz et al., 2026; Kamal et al., 2024). Research on major digital policy frameworks and blockchain-based voting further demonstrates that technological adoption in public administration raises policy, participation, accountability, and implementation questions that future GPA models should explicitly address (Shah, Khani, et al., 2025; Dashnyam et al., 2025). Moreover, there is ample potential for further investigation of moderation and mediation factors affecting sustainability governance relationships, especially in the context of complex government relationships. The studies of recent years highlight the multi-dimensional and dynamic nature of sustainability governance influenced by technological change, climate change pressures, and institutional change (A. K. Khan et al., 2024; Khoso et al., 2024). Thus, the conceptual model can be extended to give a stronger explanation and a better theoretical understanding of sustainability-oriented public administration systems.

REFERENCES

1. Hofstede Insights Compare Countries. (2021). *Compare countries*. Available from: <https://www.hofstede-insights.com/product/compare-countries/>
2. International Institute for Sustainable Development. (2021). *Visegrad countries discuss ways to ramp up SDG progress*. Available from: <https://sdg.iisd.org/news/visegrad-countries-discuss-ways-to-ramp-up-sdg-progress/>
3. Mukherji, A., & Bhatnagar, J. (2022). Conceptualizing and theorizing green human resource management: A narrative review. *International Journal of Manpower*, 43(3), 862–888. <https://doi.org/10.1108/IJM-06-2021-0376>
4. Khani, M. A. K., Usama, M., Shah, A. S., Shah, A., Abbas, S. H., Maqsood, A., & Laghari, A. A. (2024). Intelligent vehicle number plate recognition system using yolo for enhanced security in smart buildings. *Journal of ICT, Design, Engineering and Technological Science*, 8(2), 11-17.
5. Piwovar-Sulej, K. (2022). Environmental strategies and human resource development consistency: Research in the manufacturing industry. *Journal of Cleaner Production*, 330, 129538. <https://doi.org/10.1016/j.jclepro.2021.129538>
6. Sulich, A., & Sołoducho-Pelc, L. (2022). The circular economy and the Green Jobs creation. *Environmental Science and Pollution Research*, 29(10), 14231–14247. <https://doi.org/10.1007/s11356-021-16562-y>
7. Khan, S. A., Samoo, S., Shah, A. S., Maqsood, A., Khani, A. K., & Shah, A. (2024). Enhancing Residential Safety and Comfort Through Smart Home Security and Automation Technologies. *Journal of ICT, Design, Engineering and Technological Science*, 8(2).
8. U.S. International Trade Administration. (2022). *Energy sector: Poland country commercial guide*. Available from: <https://www.trade.gov/country-commercial-guides/poland-energy-sector>
9. Malik, N., KaimKhani, M. A., Shaikh, A. A., Brohi, A. B., & Luhrani, A. (2023). MCQ's Evaluation using Python OCR: An Algorithmic Implementation and Design Approach. *International Journal of Artificial Intelligence & Mathematical Sciences*, 2(1), 37-52.
10. Murillo-Ramos, L., Huertas-Valdivia, I., & García-Muiña, F. E. (2023). Exploring the cornerstones of green, sustainable and socially responsible human resource management. *International Journal of Manpower*, 44(3), 524–542. <https://doi.org/10.1108/IJM-12-2021-0696>
11. Piwovar-Sulej, K., & Iqbal, Q. (2023). Leadership styles and sustainable performance: A systematic literature review. *Journal of Cleaner Production*, 382, 134600. <https://doi.org/10.1016/j.jclepro.2022.134600>
12. Mughal, Z. A., Kaim, A., Ahmed, S. S., & Qazi, S. (2022). Key factors and features analysis of popular SaaS ERP Systems for Adoptability. *Journal of Software Engineering*, 1(1), 11-21.
13. Piwovar-Sulej, K., Malik, S., Shobande, O. A., Singh, S., & Dagar, V. (2023). A contribution to sustainable human resource development in the era of the COVID-19 pandemic. *Journal of Business Ethics*, 191(2), 337–355. <https://doi.org/10.1007/s10551-023-05456-3>
14. Polish Ministry of Foreign Affairs. (2023). *Visegrad group*. Available from: <https://www.gov.pl/web/diplomacy/visegrad-group>
15. Piwovar-Sulej, K., & Bąk-Grabowska, D. (2024). Developing future competencies of people employed

- in non-standard forms of employment: Employers' and employees' perspective. *Personnel Review*, 53(3), 721–742. <https://doi.org/10.1108/PR-10-2023-0841>
16. Bertelsmann Stiftung. (2022). *Sustainable governance indicators*. Available from: <https://www.sgi-network.org/2022/About>
 17. Habib, M. A., Bao, Y., & Ilmudeen, A. (2020). The impact of green entrepreneurial orientation, market orientation and green supply chain management practices on sustainable firm performance. *Cogent Business & Management*, 7(1), 1743616. <https://doi.org/10.1080/23311975.2020.1743616>
 18. Sarwar, A. L., & Humair Nawaz, Z. A. (2021). Analysis Of Session Initiation Protocol With VoIP In Multimedia Conferencing System. *International Journal*, 10(3).
 19. Mikalef, P., Krogstie, J., Pappas, I. O., & Pavlou, P. (2020). Exploring the relationship between big data analytics capability and competitive performance: The mediating roles of dynamic and operational capabilities. *Information and Management*, 57(2), 103169. <https://doi.org/10.1016/j.im.2019.05.004>
 20. Meirun, T., Makhoulfi, L., & Ghazali Hassan, M. (2020). Environmental outcomes of green entrepreneurship harmonization. *Sustainability*, 12(24), 10615. <https://doi.org/10.3390/su122410615>
 21. Bamboat, M. A., Laghari, A. A., Li, H., Khan, A. A., & Qaimkhani, M. A. (2024, August). Quality of Experience Assessment of Over the Top Services. In *2024 4th International Conference on Blockchain Technology and Information Security (ICBCTIS)* (pp. 145-149). IEEE.
 22. Miroshnychenko, I., Strobl, A., Matzler, K., & De Massis, A. (2021). Absorptive capacity, strategic flexibility, and business model innovation: Empirical evidence from Italian SMEs. *Journal of Business Research*, 130, 670–682. <https://doi.org/10.1016/j.jbusres.2020.02.015>
 23. Qi, G., Jia, Y., & Zou, H. (2021). Is institutional pressure the mother of green innovation? Examining the moderating effect of absorptive capacity. *Journal of Cleaner Production*, 278, 123957. <https://doi.org/10.1016/j.jclepro.2020.123957>
 24. Rehman, S. U., Kraus, S., Shah, S. A., Khanin, D., & Mahto, R. V. (2021). Analyzing the relationship between green innovation and environmental performance in large manufacturing firms. *Technological Forecasting and Social Change*, 163, 120481. <https://doi.org/10.1016/j.techfore.2020.120481>
 25. Shah, A. S., Akbar, F., Khani, M. A. K., Maqsood, A., & Bukhari, F. S. (2025). Utilizing a Hybrid Deep Learning Architecture For Salat Posture Detection. *J. ICT des. eng. technol. sci*, 9(1), 16-22.
 26. Feng, T., Li, Z., Shi, H., & Jiang, W. (2022). Translating leader sustainability orientation into green supply chain integration: A missing link of green entrepreneurial orientation. *Journal of Business & Industrial Marketing*, 37(12), 2515–2532. <https://doi.org/10.1108/JBIM-05-2021-0241>
 27. Shah, A. S., Dinesh, A., Shah, A., Farooq, M., Maqsood, A., & Khani, M. A. K. (2024). Smart Gas Leak Detection And Emergency Response System Using Iot For Homes. *Journal of ICT, Design, Engineering and Technological Science*, 8(1), 18-23.
 28. Khan, N. R., Ameer, F., Bouncken, R. B., & Covin, J. G. (2023). Corporate sustainability entrepreneurship: The role of green entrepreneurial orientation and organizational resilience capacity for green innovation. *Journal of Business Research*, 169, 114296. <https://doi.org/10.1016/j.jbusres.2023.114296>
 29. Makhoulfi, L., Djermani, F., & Meirun, T. (2024). Mediation-moderation model of green absorptive capacity and green entrepreneurship orientation for corporate environmental performance. *Management of Environmental Quality: An International Journal*, 35(1), 139–157. <https://doi.org/10.1108/MEQ-05-2023-0164>
 30. Williams, C., You, J. J., & Spielmann, N. (2024). The effect of breadth of external pressure on leaders in small and medium-sized enterprises: Does the firm become more entrepreneurial? *International Journal of Entrepreneurial Behavior and Research*, 30(5), 1270–1289. <https://doi.org/10.1108/IJEBR-08-2022-0712>
 31. Ali, H., Khani, M. A. K., Shah, A. S., Laghari, A. A., & Minam, M. (2025). Smart Class Analytics for Assessing Group Understanding via Facial Expressions. *Journal of Information Communication Technologies and Robotic Applications*, 16(1).
 32. Alsharif, M. A., Peters, M. D., & Dixon, T. J. (2020). Designing and implementing effective campus sustainability in Saudi Arabian universities: An assessment of drivers and barriers in a rational choice theoretical context. *Sustainability*, 12, 5096. <https://doi.org/10.3390/su12125096>
 33. Kytömäki, O. (2020). *Digitalization and Innovation in the Real Estate and Facility Management Sectors—An Ecosystem Perspective*. Royal Institute of Technology Kungliga Tekniska Högskolan,

Stockholm, Sweden.

34. Prashar, A., & Sunder, M. V. (2020). A bibliometric and content analysis of sustainable development in small and medium-sized enterprises. *Journal of Cleaner Production*, 245, 118665. <https://doi.org/10.1016/j.jclepro.2019.118665>
35. Baas, J., Schotten, M., Plume, A., Cote, G., & Karimi, R. (2020). Scopus as a curate, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, 1, 377–386.
36. Shah, A. S., Khani, M. A. K., Nasir, H., Lajis, A., Shah, A., & Laghari, A. A. (2025). Major global digital policy frameworks. In *Cyber Security, Forensics and National Security* (pp. 359-377). CRC Press.
37. Lu, Q., Parlikad, A. K., Woodall, P., Don Ranasinghe, G., Xie, X., Liang, Z., Konstantinou, E., Heaton, J., & Schooling, J. (2020). Developing a digital twin at building and city levels: Case study of West Cambridge Campus. *Journal of Management in Engineering*, 36, 05020004. [https://doi.org/10.1061/\(ASCE\)ME.1943-5479.0000765](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000765)
38. Talib, A. A. A., Ariff, N. R. M., Hasim, M. S., & Hanafiah, M. H. (2021). Sustainable facilities management (SFM) initiatives in Malaysia hotel industry: Reliability and validity analysis using Smart-PLS. *Earth and Environmental Science*, 1067, 012079.
39. Aziz, S., Khan, S. A., Shah, A. S., Khani, M. A. K., Maqsood, A., & Shah, A. (2026). Intelligent Survivor Detection System for Post-Earthquake Rescue Operations Using IoT and Sensor-Based Monitoring.
40. Fauzi, N. S., Johari, N., Zainuddin, A., & Chuweni, N. N. (2021). The importance of sustainability implementation for business corporations. *Planning Malaysia*, 19, 237–248.
41. Rivera, F. M., Mora-Serrano, J., & Oñate, E. (2021). Factors influencing safety on construction projects (fSCPs): Types and categories. *International Journal of Environmental Research and Public Health*, 18, 10884.
42. Mas-Tur, A., Roig-Tierno, N., Sarin, S., Haon, C., Sego, T., Belkhouja, M., Porter, A., & Merigó, J. M. (2021). Co-citation, bibliographic coupling and leading authors, institutions and countries in the 50 years of *Technological Forecasting and Social Change*. *Technological Forecasting and Social Change*, 165, 120487.
43. Leong, Y. R., Tajudeen, F. P., & Yeong, W. C. (2021). Bibliometric and content analysis of the internet of things research: A social science perspective. *Online Information Review*, 45, 1148–1166.
44. Opoku, A., & Lee, J. Y. (2022). The future of facilities management: Managing facilities for sustainable development. *Sustainability*, 14, 1705.
45. Wang, K., Almasy, R., Wei, H., & Shohet, I. M. (2022). Integrated building maintenance and safety framework: Educational and public facilities case study. *Buildings*, 12, 770.
46. Pinti, L., Codinhoto, R., & Bonelli, S. (2022). A review of building information modelling (BIM) for facility management (FM): Implementation in public organisations. *Applied Sciences*, 12, 1540.
47. Daradkeh, M., Abualigah, L., Atalla, S. S., & Mansoor, W. (2022). Scientometric analysis and classification of research using convolutional neural networks: A case study in data science and analytics. *Electronics*, 11, 2066.
48. Kamal, M. H., Zaman, S. U., Alam, S. H., Iqbal, M., & Dashnyam, A. (2024). Sustaining Pakistan's Economy through Strategic Gas Planning and Predictive Analytics. *ILMA JOURNAL OF SOCIAL SCIENCES & ECONOMICS*, 5(2).
49. Nazeer, F. S., Ramachandra, T., & Gunatilake, S. (2022). Sustainable facilities management practice and its perception in health care organisations: A Delphi survey. In *Proceedings of the World Construction Symposium* (pp. 806–820).
50. Dashnyam, A., Peljid, A., Natsag, B., Tseden-Ish, A., Ali, Z., Khani, M. A. K., & Hassan, S. (2025). Evaluating Block Chain Based Voting Systems: An Empirical Study on Public Administration Adoption and Challenges. *Pakistan Journal of Life & Social Sciences*, 23(2).
51. Zaman, S. U., Yousfi, F. A., & Alam, S. H. (2025). Consumer Behavior in Choosing Shopping Malls versus Local Traditional Markets. *ACADEMIA International Journal for Social Sciences*, 4(1), 461-483. <https://doi.org/10.63056/ACAD.004.01.0090>
52. Khan, A. K., Zaman, S. U., & Alam, S. H. (2024). Impact of Big Data Analytics on Organizational Performance: The Role of Business Analytics, Decision-Making Quality and Sustainability. *The Regional Tribune*, 3(1), 389-406. <https://doi.org/10.63062/trt/V24.069>
53. Khoso, R. H., Manzoor, A., Alam, S. H., & Faheem, M. (2024). Voice AI and Conversational Marketing:

-
- Redefining the Digital Customer Journey. *The Critical Review of Social Sciences Studies*, 2(2), 1800-1819. <https://doi.org/10.59075/cntmea74>
54. Khoso, R. H., Alejandra, C., Khurram, S., & A., Alam, S. H., (2025). AI and Neuromarketing: A New Frontier in Understanding Consumer. *Research Journal of Psychology*, 3(1), 822–837. <https://doi.org/10.59075/rjs.v3i1.257>
55. Rashid , S.A., Zaman, S.U., & Alam, S.H. (2025).Impact of Retailer Identity and Website Design on Purchase Intent in Cross Border E Commerce. *Research Journal for Social Affairs*, 3(3), 23-32. <https://doi.org/10.71317/RJSA.003.02.018>