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Green Project Leadership and Sustainable Project Outcomes at Universities of Balochistan: The Mediating Role of Green Knowledge Sharing and the Moderating Role of Organizational Environmental Culture

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ABSTRACT

Pressure on higher education institutions to align their operations and development projects with international sustainability goals is growing. This research is an in-depth study of the relationship between Green Project Leadership (GPL) and Sustainable Project Outcomes (SPO) in Universities in Balochistan. This study reviewed environmental leadership and knowledge management literature and tested a moderated mediation model using a quantitative, cross-sectional design. Data were collected from 208 academic, administrative, and technical staff engaged in university projects. Ordinary least squares (OLS) regression and bootstrapping analyses ($n=5000$) indicate that Green Knowledge Sharing (GKS) partially mediates the relationship between GPL and SPO (Indirect Effect = 0.3617). The interaction of University Environmental Culture (UEC) and GPL in predicting GKS was marginally significant, but a bootstrapped index of moderated mediation revealed that this conditional pattern falls just below conventional levels of significance (Index = -0.0302, 95% CI [-0.0710, 0.0022]). This suggests that the substitutive effect of institutional culture on leadership-driven knowledge sharing represents a trend that requires further investigation, but it is not an established fact. Supplementary analyses found no effects of gender or project role and no multicollinearity (all of the VIFs were < 3.3). These results, although constrained by the cross-sectional variance (Harman's single factor = 68.49%), bring policy implications for institutionalising sustainability in higher education sectors in the developing economy.

Introduction

However, sustainability initiatives have gone beyond being a mere administrative priority in higher education institutions (HEIs) and are now firmly established as a strategic goal (Zhong et al., 2025; Serfani et al., 2022). Beyond academic dialogue, universities also conduct large-scale projects involving infrastructure development, community outreach, and capacity-building, with significant environmental and social impacts (Amaral et al., 2020; Bravo et al., 2025). However, these projects face specific challenges in developing areas of Pakistan, such as Balochistan, including limited resources and underdeveloped regulatory bodies, and therefore depend heavily on effective project leadership to achieve sustainable goals (Irfan et al., 2021). The significance of Sustainable Project Outcomes (SPO) is well established, but the leadership behaviours and mindsets needed to achieve SPO have not been sufficiently explored in the project management literature (Zada et al., 2024).

Over the last few years, scholarship has identified the leadership behaviours that clearly articulate and proactively champion the environmental responsibility agenda as a driver for sustainable operational performance (Zacher et al., 2024; Zhong et al., 2025), namely those defined as Green Project Leadership (GPL). But leadership isn't what gets projects done; it's what influences the teams' thinking. Based on this, this study proposes that Green Knowledge Sharing (GKS) is the critical link between green leadership and sustainable outcomes (Huo et al., 2022; Rubel et al., 2021), which is the sharing of tacit and explicit knowledge among team members. In addition, building on the 'Substitutes for Leadership' theory (Kerr & Jermier, 1978), we suggest that the effect of GPL is not isolated from contexts. We examine University Environmental Culture (UEC) as a boundary condition and determine whether the individual green project leader and the system's cultural context (institutional) have a multiplicative or replacement effect.

Literature Review and Hypotheses

Green Project Leadership and Sustainable Outcomes

Students will examine how to apply leadership theories to achieve outcomes, focusing on sustainability in the context of green projects. Green Project Leadership is a leader's ability to deliver an environmental vision and inspire team members to weave environmental concerns into everyday project work (Zacher et al., 2024). Sustainability-focused leadership enables project teams to identify resource efficiencies, reduce waste, and promote social inclusiveness (Zhong et al., 2025). Thus, we hypothesize that:

H1: Sustainable Project Outcomes are positively linked to Green Project Leadership.

The Mediating Role of Green Knowledge Sharing.

Knowledge sharing forms the bedrock of projects, helping to minimise duplication of effort and drive innovation. Green Knowledge Sharing for sustainability means project members share knowledge about waste reduction, energy efficiency, and solving environmental problems (Rubel et al., 2021). Leaders who establish a green vision (GPL) create conditions that motivate team members to share environmentally responsible practices, as evidence shows that responsible and green-oriented leadership styles use knowledge-sharing and shared-vision mechanisms to influence downstream green behaviours (Huo et al., 2022; Younas et al., 2023). This shared learning directly contributes to the project's environmental, social and economic impacts.

H2: Green Knowledge Sharing mediates the relationship between Green Project Leadership and Sustainable Project Outcomes.

The role of the University Environmental Culture in moderation.

Organizational culture is the informal regulation system of an organization. A robust University Environmental Culture should incorporate sustainability into institutional planning and reflect the commitment of institutional management and staff to sustainability expectations (Bravo et al., 2025). According to institutional theory, strong organisational cultures can replace certain leadership behaviours (Kerr & Jermier, 1978). If a university already has a comprehensive environmental culture, the role of a Green Project Leader might not be as significant, as project members might be intrinsically motivated to share the green knowledge, which is similar to the results of Wang et al. (2018) that value congruence and shared green vision can carry a large part of the influence that leadership behaviour would otherwise need to provide directly. On the other hand, without an environmental culture in a university, the leader may be one of the more central forces driving the development of GKS.

H3: University Environmental Culture (UEC) will moderate the relationship between GPL and GKS, whereby the relationship between GPL and GKS will be less positive if UEC is high (substitutive effect).

Boundary Conditions and Individual Differences

We also explored differences by demographic and role-based factors because these factors may influence sustainability engagement, which in turn may influence Sustainable Project Outcomes. We did not formally hypothesise these comparisons as relationships, but used them as exploratory checks on the generalizability of the core model, as there was no strong theoretical basis to expect these differences in this sample.

Methodology

Research Design, Sample, and Procedure

This study used a quantitative, cross-sectional approach to assess the hypothesised moderated mediation model. The target population consisted of academic, administrative, and technical staff participating in university projects in higher education institutions (HEIs) in Balochistan, Pakistan. The study obtained 208 valid responses. The projects assessed were mostly research, capacity building and institutional development projects from the past 3–5 years.

Measures and Reliability

The survey instrument used a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree" for all constructs (Zairbani et al., 2024; Mubarak et al., 2024).

Green Project Leadership (GPL): Measured the leader's communication of environmental visions (e.g., "The project leader communicated a clear vision regarding environmental responsibility") using four items.

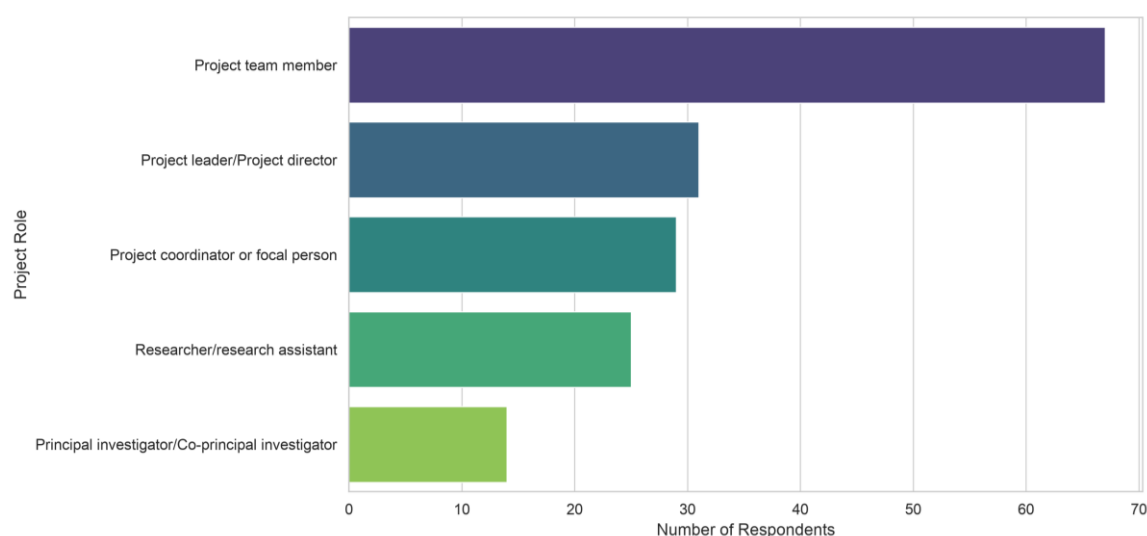
Green Knowledge Sharing (GKS): Assessed using 4 items related to the sharing of good practices, which are environmentally friendly, among project members.

University Environmental Culture (UEC): Evaluated using 4 items related to institutional commitment to environmental sustainability.

Sustainable Project Outcomes (SPO): Measured comprehensively across three sub-dimensions: Environmental (4 items), Social (4 items), Economic/Institutional (4 items). These were combined, and a composite SPO score was created.

Internal consistency was assessed using Cronbach's Alpha. All constructs demonstrated excellent reliability: GPL ($\alpha = 0.942$), GKS ($\alpha = 0.939$), UEC ($\alpha = 0.942$), SPO Environmental ($\alpha = 0.929$), SPO Social ($\alpha = 0.946$), and SPO Economic/Institutional ($\alpha = 0.942$).

Figure 1: Demographic Breakdown of Project Roles



Data Analysis Strategy

We used Python (pandas, statsmodels, pingouin, scikit-learn) to analyse the data. We assessed common method bias (CMB) using Principal Component Analysis (PCA) with Harman's single-factor test. We tested the hypothesised structural relationships with Ordinary Least Squares (OLS) regression. To assess the mediation effect, we re-sampled the data 5,000 times to estimate the 95% confidence interval of the indirect effect. To reduce multicollinearity, we mean-centred the independent variable and moderator before creating the interaction term for the moderation analysis.

Results

Common Method Bias and Descriptive Statistics

To ensure the data were collected from a single source across sections, we performed Harman's Single Factor test, as recommended in the literature for detecting common method variance (Podsakoff et al., 2003). Common method bias (CMB) was observed in the first unrotated factor, which explained 68.49% of the variance and should be considered when interpreting the effect sizes. The mean scores of the constructs were similar (3.42-3.56). Pearson correlation analysis showed that all primary variables were significantly and positively correlated ($r > 0.71$; $p < 0.01$), supporting the structural model (see Table 1).

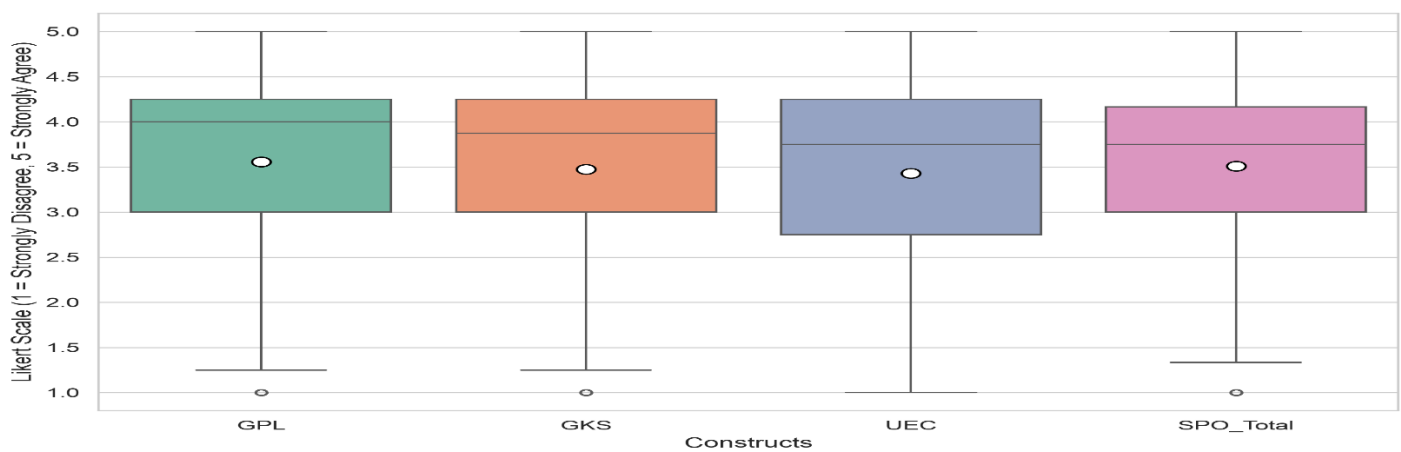


Figure 2: Distribution of construct scores

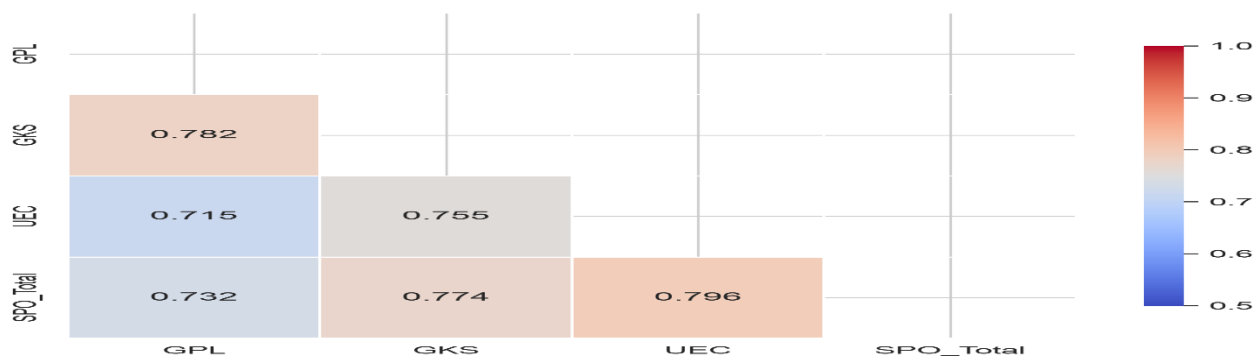


Figure 3: Correlation Heatmap of Main Constructs

Table 1: Descriptive Statistics and Correlations

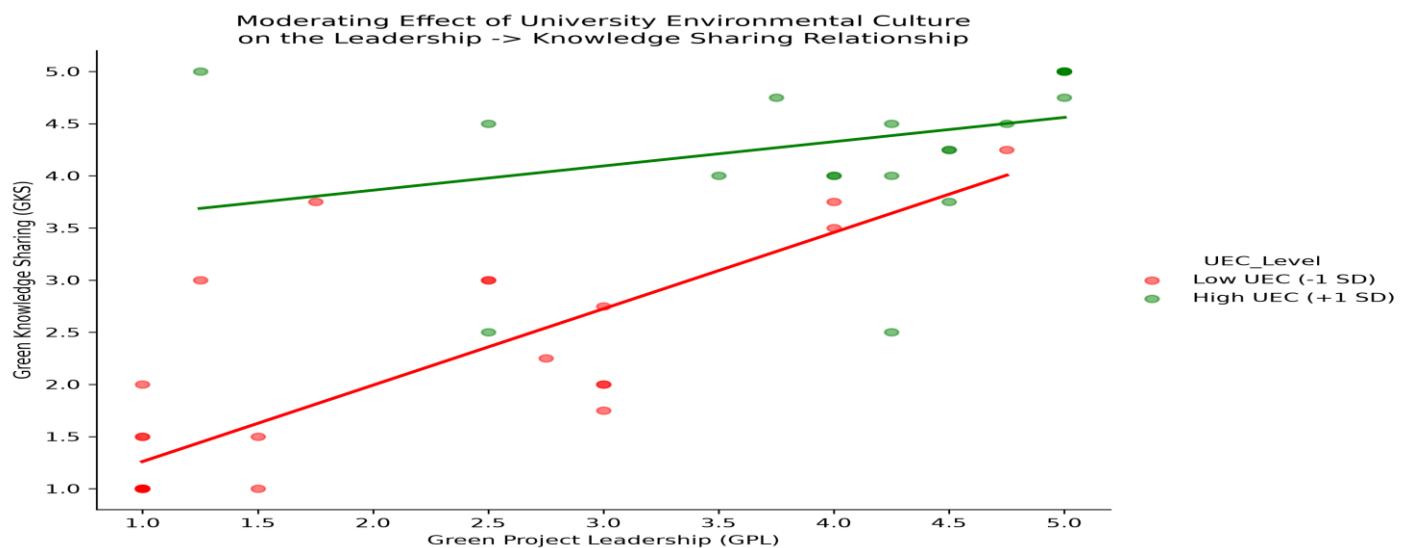
Variables	Mean	SD	1. GPL	2. GKS	3. UEC
1. GPL	3.56	1.16	(0.94)		
2. GKS	3.47	1.10	0.782**	(0.93)	
3. UEC	3.42	1.17	0.714**	0.761**	(0.94)
4. SPO	3.51	0.99	0.732**	0.775**	0.799**

Note: ** $p < 0.01$. Diagonal values in parentheses represent Cronbach's Alpha.

Hypothesis Testing: Moderated Mediation

We tested hypotheses using OLS regression and bootstrapping ($n = 5,000$ resamples). A regression model predicting SPO indicated that GPL significantly predicted SPO ($\beta = 0.2776$, $p < 0.001$), as did GKS ($\beta = 0.4730$, $p < 0.001$). The indirect effect of GPL on SPO through GKS mediation was significant (Indirect Effect = 0.3617, 95% CI [0.2072, 0.5176]). The confidence interval did not cross zero, so the alternative hypothesis (H1 and H2) is strongly supported, and there is partial mediation.

To test H3, I mean- centered the variables to reduce multicollinearity. The interaction term (GPL x UEC) had a significant and negative effect on GKS ($\beta = -0.0666$, $p = 0.029$, 95% CI [-0.126, -0.007]). The descriptive pattern of the GPL-GKS relationship was steeper when UEC was low than when UEC was high, consistent with a substitutive moderation pattern.

**Figure 4: Simple Slopes for the Moderating Effect of UEC**

We also calculated the bootstrapped index of moderated mediation (5,000 resamples; Preacher, Rucker, & Hayes, 2007) and the conditional indirect effects of GPL on SPO at low (-1 SD), mean, and high (+1 SD) levels of UEC.

Table 2: Bootstrapped Conditional Indirect Effects (GPL -> GKS -> SPO)

Level of UEC	Effect	95% CI Lower	95% CI Upper
Low UEC (-1 SD)	0.230	0.143	0.323

Mean UEC	0.195	0.117	0.287
High UEC (+1 SD)	0.159	0.068	0.269
Index of Moderated Mediation	-0.030	-0.071	0.002

Note: Bootstrapped with 5,000 resamples. Conditional indirect effects are significant when the CI excludes zero. The Index of Moderated Mediation CI marginally includes zero, indicating non-significance at the conventional 95% threshold.

The conditional indirect effect of GPL on SPO through GKS was significant across all three levels of UEC (all 95% CIs excluded zero), suggesting that GKS mediates the GPL-SPO relationship across all three institutional culture strengths. The index of moderated mediation (Index = -0.0302, 95% CI [-0.0710, 0.0022]) was not statistically significant, with a margin slightly above zero. Overall, these results suggest that H3 is marginally supported by the raw interaction coefficient ($p < .05$) and the simple slopes analysis (steeper slopes under low UEC), but does not meet the standard for conventional significance regarding whether moderation of the indirect effect on Sustainable Project Outcomes is meaningful. We take this as suggestive, but not conclusive, evidence for the substitutive moderation hypothesis; a larger sample would be needed to make a more definitive decision.

Supplementary Diagnostics and Group Comparisons

We examined common threats to the inferences in the moderated mediation model by checking for multicollinearity, distributional normality, and demographic confounds. The variance inflation factors (VIFs) were 2.82, 3.29, and 2.60 for GPL, GKS, and UEC, respectively, which are below 5, indicating that multicollinearity is not a concern in the regression models. Skewness and kurtosis values for all four constructs were within acceptable limits for OLS estimation, although all constructs exhibited a small left skew typical of Likert agreement scales (range in skewness: -1.02 to -0.68) that would tend to cluster responses toward the agreement end of the scale.

Independent-samples comparisons found no statistically significant difference in Sustainable Project Outcomes between male ($M = 3.51$, $SD = 1.02$, $n = 164$) and female respondents ($M = 3.52$, $SD = 0.84$, $n = 43$), Welch's $t = -0.11$, $p = .913$, Cohen's $d = -0.02$. Likewise, a one-way ANOVA found no statistically significant difference in Sustainable Project Outcomes among the five most common project roles (team member, project leader/director, coordinator, researcher, and principal investigator), $F = 1.72$, $p = .149$. The null results support confidence that the core moderated mediation results are not due to sample composition across gender and role subgroups.

Discussion

This study presents empirical evidence that Green Project Leadership is a crucial precursor to Sustainable Project Outcomes in higher education settings, primarily through the mobilization of Green Knowledge Sharing. The project leaders set an ecological vision, which makes the individuals in the team more willing to share resource-saving and socially inclusive practices, consistent with the overall literature showing that mechanisms that foster knowledge transfer and green behaviours rely on green-oriented leadership (Younas et al., 2023; Huo et al., 2022).

This research also explores the moderating effect of University Environmental Culture. The interaction term and simple-slopes pattern suggest a substitutive relationship as described by Substitutive Leadership theory (Kerr & Jermier, 1978) – when a university has a strong, systemic culture of sustainability, then the specific actions of the project leader seem descriptively less important for knowledge sharing, with the institution's culture taking on more of the burden. The bootstrapped index of moderated mediation (the more conservative test of whether this pattern significantly affects the downstream indirect effect on Sustainable Project Outcomes) was not quite significant (95% CI [-0.071, 0.002]). Therefore, the substitutive interpretation is treated as plausible and theoretically motivated rather than as a confirmed one. If this trend continues in the future, as it has in the past, more significance attaches to the practical implication in a university where environmental culture is either weak or non-existent, a situation that is common in the developing regions of the world, such as Balochistan, where Green Project Leadership is a more potent lever to drive sustainability – particularly when it is the project leader who carries the greater burden.

The supplementary analyses also support the core model. The GPL-GKS-SPO pathway did not appear to be affected by multicollinearity (all VIFs were below 3.3) or by significant differences between the associations of Sustainable Project Outcomes with respondents' gender and project role (no significant differences were found).

Limitation and future directions

A few caveats should be noted. The main drawback of the survey was its cross-sectional, single-source design which led to a high Harman's single-factor variance (68.49%) and therefore implies a potential Common Method Bias (Podsakoff et al., 2003). Second, the moderated mediation hypothesis (H3) was partially supported: although the raw interaction term remained conventionally significant, the more stringent bootstrapped moderated mediation term was not significant (-0.071, 0.002, 95% CI). This may be partially due to low statistical power ($n = 203$) to detect a second-stage moderated effect. Future research could be strengthened by using longitudinal designs, multi-source assessments (e.g., leader self-assessment versus subordinate assessment), and larger sample sizes to better establish the boundary conditions of Green Project Leadership and provide more definitive conclusions. Moreover, further research on specific sub-categories of university projects (such as infrastructure vs research projects) should be conducted to see whether project context affects these relationships.

The results indicate a two-pronged approach for policymakers and university leaders. Universities should proactively cultivate and deploy project leaders with green management knowledge in the short term. Over time, however, institutions must build systemic environmental cultures that embed sustainability issues in purchasing decisions, performance measures, and values, reducing reliance on individual leaders and promoting sustainable outcomes systematically (Bravo et al., 2025).

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