

Green Human Resource Management and Employee Green Behavior in Indonesian State-Owned Construction Enterprises: The Mediating Role of Green Organizational Culture and the Moderating Role of Environmental Knowledge

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Abstract

Background: Indonesian state-owned construction enterprises face the challenge of converting national decarbonization commitments and formal sustainability policies into consistent employee behavior across dispersed head-office and project-site operations. **Purpose:** This study examines whether Green Human Resource Management (GHRM) promotes Employee Green Behavior (EGB) among employees of Indonesian state-owned construction enterprises, while testing Green Organizational Culture (GOC) as a mediating mechanism and Environmental Knowledge (EK) as a moderating condition. **Methods:** An explanatory, cross-sectional online survey was administered to permanent employees working at head offices and project sites in six state-owned construction enterprises. Purposive sampling produced 238 valid responses. The model was evaluated using Partial Least Squares Structural Equation Modeling (PLS-SEM), including reflective measurement assessment, structural model evaluation, mediation, moderation, and out-of-sample predictive assessment. **Results:** GHRM positively affected EGB ($\beta = .390, p < .001$) and GOC ($\beta = .741, p < .001$), while GOC positively affected EGB ($\beta = .386, p < .001$). GOC partially mediated the relationship between GHRM and EGB (indirect $\beta = .286, p < .001$; $VAF = 42.31\%$). EK strengthened the GHRM-EGB relationship (interaction $\beta = .198, p < .001$). The model explained 58.0% of the adjusted variance in EGB and showed adequate predictive relevance. **Implications:** The findings extend the Ability-Motivation-Opportunity framework by positioning GHRM as a source of motivation and formal opportunity, GOC as contextual opportunity, and EK as ability. State-owned construction enterprises should integrate environmental objectives into training, performance appraisal, rewards, and promotion, while institutionalizing environmental values and strengthening context-specific environmental knowledge.

INTRODUCTION

Indonesia's decarbonization agenda reveals a persistent implementation gap between national commitments and operational outcomes. The National Energy General Plan established through Presidential Regulation No. 22/2017 provides a policy framework for cross-sector emission reduction and the transition toward net-zero emissions. Nevertheless, national statistics for 2018-2022 show that industrial greenhouse-gas emission intensity increased from 75.9 to 79.2 tons of CO₂e per billion Indonesian rupiah, an increase of approximately 4.3% (Badan Pusat Statistik, 2018-2022). The trend suggests that macro-level targets do not automatically alter organizational routines. Their effectiveness depends on whether firms translate regulatory expectations into resource-use decisions, work procedures, and employee behavior at the operational level.

The construction industry is particularly important in this transition because its environmental consequences are produced through dispersed, project-based activities involving materials, energy, water, equipment, transportation, and waste. The Indonesian energy-sector inventory reported that construction and manufacturing jointly represented 17.75% of national greenhouse-gas emissions, following energy production and transportation (Pusat Data dan Teknologi Informasi Energi dan Sumber Daya Mineral, 2019). The Ministry of Public Works and Housing has further warned that construction-sector emissions could rise substantially toward 2060 without stronger mitigation (Kementerian PUPR, 2023). These conditions make employee decisions consequential: environmental policies are ultimately enacted through choices about material handling, equipment use, housekeeping, waste segregation, energy conservation, and compliance with project environmental procedures.

Evidence from Indonesian construction projects indicates that behavioral and managerial weaknesses remain substantial. Fitriani et al. (2022) reported that approximately 30% of materials at construction sites may become waste and identified non-value-adding activities, inadequate skills, late design changes, poor site management, limited experience, and weak planning as major causes. A dynamic model developed by Suciati et al. (2018) similarly demonstrated that interventions directed at construction-worker waste behavior could reduce material waste by 34.58%. These findings do not imply that workers are the sole source of environmental inefficiency; project scale, technology, design, procurement, and client decisions also matter. They do, however, establish Employee Green Behavior (EGB) as an operational mechanism through which environmental objectives can be supported or undermined.

The practical challenge is visible among Indonesian state-owned construction enterprises, commonly referred to as BUMN Karya. A review of 2023-2024 sustainability reports from six enterprises found that only five disclosed selected indicators in sufficiently comparable forms. Electricity consumption per employee, domestic waste per employee, business-travel emissions, and indoor-air-quality reporting varied markedly, while several indicators were not disclosed. Such company-level data cannot be treated as direct measurements of individual EGB because they are affected by project volume, reporting boundaries, equipment intensity, and the number and location of projects. However, the variation indicates that formal sustainability commitments have not yet been translated into fully standardized operational practices across the enterprises.

Green Human Resource Management (GHRM) offers an organizational route for addressing this gap. GHRM integrates environmental objectives into human resource policies and systems, including environmental goal setting, training, performance appraisal, reward and compensation, and promotion (Ahmad, 2015; Ahmad et al., 2021; Renwick et al., 2013). In the Indonesian state-owned enterprise context, the Ministry of State-Owned Enterprises Regulation No. PER-1/MBU/03/2023 provides a formal basis for special assignments and social and environmental responsibility programs (Kementerian BUMN, 2023). Yet the existence of formal programs does not establish their behavioral effectiveness. Employees must understand the policies, recognize that environmental behavior is valued, and have sufficient opportunities and knowledge to enact the expected practices.

Empirical research generally associates GHRM with employee pro-environmental outcomes, but the relationship is not uniform across settings. Positive direct effects have been reported in public utilities, manufacturing, hospitality, universities, and other organizations (Chandra & Pendrian, 2024; Hameed et al., 2020; Ogiemwonyi et al., 2023; Raza & Khan, 2022; Saeed et al., 2019). By contrast, Fawehinmi et al. (2020) and Kim et al. (2019) indicate that formal GHRM practices may not always generate a significant direct behavioral response. The inconsistency implies that GHRM may require social and cognitive mechanisms that explain how organizational systems become daily behavior.

Two mechanisms are central to the present study. First, Green Organizational Culture (GOC) represents the shared values, norms, and assumptions through which environmental responsibility becomes an accepted way of working (Abbas & Dogan, 2022; Liu & Lin, 2020; Mirahsani et al.,

2024). GHRM may shape this culture by repeatedly signaling which environmental behaviors are trained, assessed, rewarded, and promoted. GOC may then provide social expectations and contextual support that encourage employees to act consistently with environmental goals. Second, Environmental Knowledge (EK) represents employees' understanding of environmental problems and appropriate protective actions (Ahmad et al., 2021; Safari et al., 2018). Employees with greater knowledge should be more capable of interpreting environmental policies and converting general HR practices into context-appropriate actions.

The study addresses three interrelated gaps. The first is contextual: research on EGB has concentrated on manufacturing, hospitality, education, and other service settings, while evidence from project-based Indonesian state-owned construction enterprises remains limited. The second is explanatory: prior studies often examine a direct GHRM-EGB relationship or a single mediating mechanism, leaving the cultural process through which formal HR systems become shared expectations insufficiently developed. The third is conditional: although EK has been examined as a predictor or moderator in other industries, its role in strengthening the behavioral effectiveness of GHRM in construction enterprises has received limited empirical attention. Integrating GOC and EK in one model allows the study to explain both *how* GHRM influences EGB and *when* the influence becomes stronger.

Literature Review, Theoretical Foundation, and Hypothesis Development

The Ability-Motivation-Opportunity (AMO) perspective provides the principal theoretical foundation for the model. AMO explains employee behavior as the joint product of employees' ability to perform, their motivation to perform, and the organizational opportunities that support performance (Jackson et al., 2014). Applied to environmental management, the theory predicts that pro-environmental behavior is most likely when employees understand environmental problems and suitable responses, receive incentives and clear expectations, and operate within systems and social conditions that permit green action (Iftikar et al., 2022). Accordingly, the model assigns EK primarily to ability, GHRM to motivation and formal opportunity, and GOC to contextual opportunity. These assignments identify each construct's dominant theoretical role without assuming that a construct can contribute to only one AMO dimension.

The theoretical sequence begins with GHRM because environmental goal setting, training, appraisal, rewards, compensation, and promotion communicate expected conduct and create formal channels for action. Repeated implementation of these practices can shape GOC by turning formal signals into shared norms about legitimate environmental conduct. GOC then provides contextual opportunity through managerial and coworker support, while EK supplies the cognitive ability needed to recognize environmental consequences and select task-appropriate responses. AMO therefore supports the direct GHRM-EGB relationship, the indirect GHRM-GOC-EGB pathway, and the expectation that EK strengthens employees' behavioral response to GHRM (Ahmad et al., 2021; Hooi et al., 2022).

Green Human Resource Management and Employee Green Behavior

EGB includes both task-related and discretionary actions intended to reduce negative environmental impacts in the workplace. Task-related behavior involves completing assigned duties in environmentally responsible ways, whereas extra-role behavior includes voluntary initiatives that exceed formal job expectations (Bissing-Olson et al., 2013; Dumont et al., 2017). In construction enterprises, these behaviors can include reducing unnecessary material consumption, following waste-separation procedures, conserving energy and water, preventing pollution, and proposing improved environmental practices.

GHRM clarifies environmental expectations and links them to systems that employees routinely experience. Environmental training develops procedural understanding; appraisal communicates standards; rewards and compensation provide motivational reinforcement; and promotion criteria signal that environmental responsibility has career relevance. When these practices are coherent, employees are more likely to perceive green conduct as part of their job rather than as an optional

corporate campaign. Prior studies support this pathway by showing that GHRM improves employee environmental performance and green behavior through motivational and capability-building processes (Hameed et al., 2020; Raza & Khan, 2022; Sabokro et al., 2021).

The effect may be especially relevant in state-owned construction enterprises because hierarchical structures and project controls make formal targets, procedures, and performance indicators salient. Environmental requirements embedded in HR systems reduce ambiguity about individual responsibilities and create formal opportunities to participate in sustainability programs. Accordingly, the study proposes the following hypothesis:

H1: Green Human Resource Management has a positive effect on Employee Green Behavior.

Green Human Resource Management and Green Organizational Culture

Organizational culture develops through repeated messages about which values are endorsed and which behaviors are recognized. GHRM contributes to this process by embedding environmental criteria in recruitment, training, evaluation, reward, and advancement. Employees receive consistent signals when environmental commitments are not merely stated in sustainability reports but are reflected in decisions that affect their work experience and career outcomes (Aggarwal & Agarwala, 2022; Roscoe et al., 2019).

In highly formalized organizations, HR systems can institutionalize environmental values by converting broad sustainability commitments into routines. Training creates shared language, appraisal defines acceptable conduct, and rewards communicate what the organization regards as valuable. Over time, repeated alignment among these practices can produce a common belief that environmental protection is a legitimate organizational priority. Studies in manufacturing and service organizations have found that GHRM strengthens green culture and related enabling conditions (Muisyo et al., 2022; Rizvi & Garg, 2021; Roscoe et al., 2019). Therefore:

H2: Green Human Resource Management has a positive effect on Green Organizational Culture.

Green Organizational Culture and Employee Green Behavior

GOC provides contextual guidance by defining the environmental values and norms that employees encounter in everyday interactions. A culture that emphasizes environmental responsibility reduces uncertainty about appropriate conduct, legitimizes the allocation of time and attention to green practices, and creates social reinforcement from supervisors and coworkers. This contextual support can be particularly important for discretionary behavior, which often depends on whether employees believe that voluntary initiatives will be accepted rather than ignored or penalized (Abbas & Dogan, 2022; Mirahsani et al., 2024).

Empirical evidence associates green culture with pro-environmental behavior, environmental citizenship behavior, and responsible organizational conduct (Al-Swidi et al., 2021; Hooi et al., 2022; Yeşiltaş et al., 2022). In construction projects, shared norms can influence whether environmental procedures are treated as meaningful operating requirements or merely administrative documentation. When employees perceive that the organization genuinely cares about environmental protection, changes management practices for environmental reasons, complies with environmental principles, and maintains a clear environmental vision, they should be more willing to enact green behavior. Thus:

H3: Green Organizational Culture has a positive effect on Employee Green Behavior.

The Mediating Role of Green Organizational Culture

A direct GHRM-EGB relationship explains whether HR systems are associated with behavior, but it does not fully explain the internalization process. GHRM initially operates as a formal organizational system. Employees may comply with training requirements or appraisal criteria without interpreting environmental responsibility as a shared organizational value. GOC captures the stage at which repeated HR practices become collective expectations and socially supported routines. It therefore provides a mechanism linking formal policies with more stable behavior.

Prior research shows that green culture can mediate the effects of GHRM on environmental performance and citizenship behavior (Aggarwal & Agarwala, 2022; Hooi et al., 2022; Roscoe et al., 2019). In AMO terms, GHRM supplies motivation and formal opportunity, while GOC supplies contextual opportunity. The combination should make behavior more durable because employees receive both institutional direction and social confirmation. The study accordingly proposes:

H4: Green Organizational Culture mediates the positive effect of Green Human Resource Management on Employee Green Behavior.

The Moderating Role of Environmental Knowledge

Environmental policies can be difficult to translate into action when employees lack knowledge of environmental impacts or appropriate responses. The same HR practice may therefore produce different behavioral effects across employees. Training, appraisal, and rewards can motivate action, but employees still need sufficient cognitive ability to identify which actions conserve resources, prevent pollution, or reduce waste in a specific task. EK increases the likelihood that employees will understand the purpose of GHRM practices and apply them accurately (Safari et al., 2018). Studies have reported that environmental knowledge strengthens the influence of organizational practices and leadership on employee green behavior (Ahmad et al., 2021; Farrukh et al., 2022; Karmoker et al., 2021). In construction, the moderating role should be meaningful because environmental risks differ across project phases, materials, equipment, and locations. Employees with stronger knowledge can interpret general policy signals within these changing technical conditions. Consequently:

H5: Environmental Knowledge positively moderates the effect of Green Human Resource Management on Employee Green Behavior, such that the relationship is stronger at higher levels of Environmental Knowledge.

Based on the five hypotheses, the study examines a moderated mediation-oriented framework in which GHRM has direct and culture-mediated effects on EGB, while EK strengthens the direct GHRM-EGB pathway. The novelty lies in integrating a collective contextual mechanism and an individual cognitive boundary condition within a single AMO-based model and testing it among employees of six Indonesian state-owned construction enterprises.

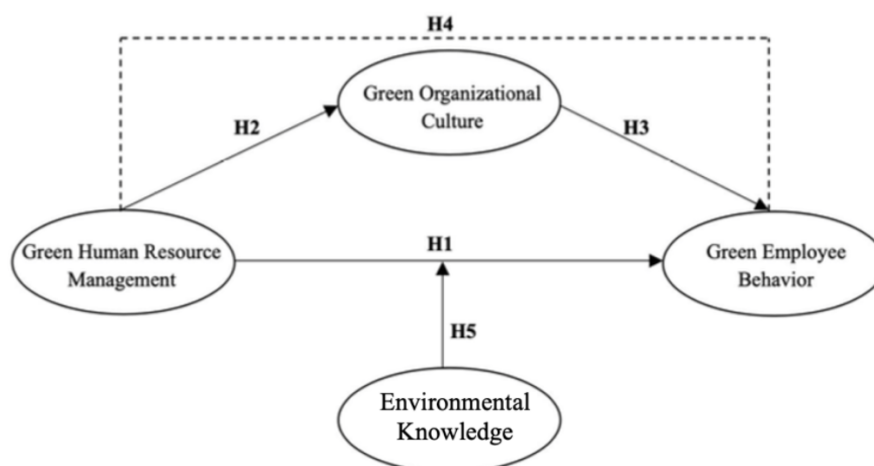


Figure 1. Research Conceptual Model

METHODS

The study used a positivist, explanatory, quantitative design to test the proposed relationships. Data were collected through a non-contrived, cross-sectional online survey, enabling the model to capture employee perceptions within their normal organizational and project environments without experimental manipulation (Sekaran & Bougie, 2016). The individual employee was the unit of analysis because all constructs were measured as individual perceptions or self-reported behaviors. GOC was therefore interpreted as employees' perception of organizational culture rather than an aggregated organization-level construct.

The research setting comprised six Indonesian state-owned construction enterprises: PT Wijaya Karya (Persero) Tbk., PT Pembangunan Perumahan (Persero) Tbk., PT Adhi Karya (Persero) Tbk., PT Hutama Karya (Persero), PT Brantas Abipraya (Persero), and PT Waskita Karya (Persero) Tbk. The companies were selected because of their strategic role in national infrastructure development and their exposure to environmental requirements across engineering, procurement, construction, property, energy, and infrastructure activities. Employees worked either at head offices or project sites, allowing the study to include both administrative and operational perspectives.

Purposive sampling was applied because the target population could not be enumerated precisely and the model required respondents with direct exposure to organizational sustainability practices. Eligible respondents were permanent employees, held Project Manager positions or positions below that level, worked at a head office or project site, and had participated in at least one sustainability-related program such as social and environmental responsibility activities, sustainability training, environmental certification, or another green initiative. Screening questions embedded in the online questionnaire excluded respondents who did not meet these criteria.

The minimum sample size was determined by multiplying the 22 measurement indicators by ten, producing a target of 220 responses, consistent with the PLS-SEM sampling guideline used in the thesis (Hair et al., 2019). A pilot test was conducted with 50 eligible respondents who were not included in the final sample. The main data collection generated 258 responses. After screening, 20 responses were excluded because they did not satisfy the eligibility criteria, resulting in 238 valid cases for analysis. Participation was voluntary, identities were kept confidential, and responses were used solely for academic purposes.

All constructs were modeled reflectively and measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). EGB was measured with six items adapted from Ahmad et al. (2021), covering environmentally responsible task completion, fulfillment of work responsibilities, expected green conduct, active environmental protection, personal initiative, and behavior exceeding organizational expectations. GHRM used six items from Ahmad et al. (2021), measuring environmental goal setting, value-oriented training, knowledge- and skill-oriented training, environmental performance appraisal, environmental rewards and compensation, and environmental promotion criteria.

GOC was measured with six items adapted from Mirahsani et al. (2024), assessing organizational concern for the environment, active protection, compliance with environmental principles, management-practice changes for environmental reasons, environmental responsibility, and an environmental protection vision. EK used four items adapted from Safari et al. (2018), covering knowledge of pollution caused by construction, general understanding of environmental issues, awareness of environmental deterioration, and knowledge of environmental protection. The measurement sources and operational coverage are summarized in Table 1.

Data analysis was performed using SmartPLS 4. Descriptive analysis summarized respondent characteristics and construct response patterns using frequency, mean, and standard deviation. The reflective measurement model was evaluated through outer loadings ($\geq .708$), Cronbach's alpha and composite reliability ($\geq .70$), average variance extracted (AVE $\geq .50$), and the heterotrait-monotrait ratio (HTMT $< .85$) (Hair et al., 2021, 2022). The structural model was assessed using inner VIF (< 3), adjusted R^2 , effect size (f^2), and PLSpredict. Hypotheses were tested with

bootstrapping using one-tailed tests because all relationships were directional. Statistical support required a positive coefficient in the hypothesized direction, $t > 1.645$, and $p < .05$. Mediation was evaluated using the specific indirect effect and Variance Accounted For (VAF), while moderation was evaluated through the $GHRM \times EK$ interaction term.

Table 1. Construct Measurement and Sources

Construct	Items	Operational coverage	Source
Employee Green Behavior (EGB)	6	Green task completion, responsible performance, active protection, initiative, and extra-role environmental action	Ahmad et al. (2021)
Green Human Resource Management (GHRM)	6	Green goals, value and technical training, appraisal, rewards/compensation, and promotion	Ahmad et al. (2021)
Green Organizational Culture (GOC)	6	Environmental concern, protection, compliance, management adaptation, responsibility, and vision	Mirahsani et al. (2024)
Environmental Knowledge (EK)	4	Construction pollution, environmental issues, deterioration awareness, and environmental protection knowledge	Safari et al. (2018)

Note. All items were measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree).

RESULTS AND DISCUSSION

Results

The 238 valid respondents were distributed relatively evenly across the six enterprises; each company contributed between 15.97% and 17.65% of the sample. Staff at project sites or head offices represented the largest position group (33.19%), followed by Site Administration Managers (21.85%). The sample was predominantly male (92.86%), reflecting the gender composition commonly found in construction work. Most respondents were aged 28-40 years (60.08%), and 97.06% held at least a bachelor's degree. All respondents had participated in a sustainability-related program, most frequently sustainability training (37.39%) or social and environmental responsibility/CSR programs (34.03%). Table 2 presents the detailed profile.

Table 2. Respondent Profile (N = 238)

Category	Group	n	%
Company	PT Wijaya Karya Tbk.	39	16.39
	PT Pembangunan Perumahan Tbk.	41	17.23
	PT Adhi Karya Tbk.	39	16.39
	PT Hutama Karya	42	17.65
	PT Brantas Abipraya	39	16.39
	PT Waskita Karya Tbk.	38	15.97
Position	Project Manager	37	15.55
	Site Operation Manager	35	14.71

Category	Group	n	%
	Site Engineering Manager	35	14.71
	Site Administration Manager	52	21.85
	Project/head-office staff	79	33.19
Gender	Male	221	92.86
	Female	17	7.14
Education	Diploma	6	2.52
	Bachelor's degree	108	45.38
	Master's degree	123	51.68
	Doctoral degree	1	.42
Age	21-24 years	1	.42
	25-27 years	33	13.87
	28-40 years	143	60.08
	40-43 years	59	24.79
	> 43 years	2	.84
Sustainability program	TJSL/CSR	81	34.03
	Sustainability training	89	37.39
	Environmental certification	52	21.85
	Other sustainability initiative	16	6.72

Source: Authors' analysis of survey data (2026).

The construct means ranged from 4.150 to 4.225, indicating generally positive perceptions and self-reported behavior. EGB recorded the highest mean (4.225) and the lowest standard deviation (.970), while GHRM recorded the lowest mean (4.150) and the highest standard deviation (1.141). The result suggests that respondents were relatively consistent in reporting green behavior but differed more strongly in their experience of HR practices. This difference is substantively plausible because environmental HR systems may vary across companies, divisions, projects, and positions. The high EGB mean should nevertheless be interpreted cautiously because self-reported socially desirable behavior may be vulnerable to response inflation. Company-level resource and waste indicators cannot validate individual behavior directly, but their variability underscores the importance of future multi-source measurement.

Table 3. Descriptive Statistics of the Constructs

Construct	n	Min.	Max.	Mean	SD
EGB	238	1.000	5.000	4.225	.970
GHRM	238	1.000	5.000	4.150	1.141
GOC	238	1.000	5.000	4.179	1.051
EK	238	1.000	5.000	4.221	1.043

Note. EGB = Employee Green Behavior; GHRM = Green Human Resource Management; GOC = Green Organizational Culture; EK = Environmental Knowledge. Source: Authors' analysis of survey data (2026).

The reflective measurement model met all recommended reliability and convergent-validity criteria. Outer loadings ranged from .807 to .918 and therefore exceeded the .708 threshold. Cronbach's alpha ranged from .908 to .952, while composite reliability (ρ_C) ranged from .929 to .947. AVE values ranged from .686 to .817. These results indicate that the indicators consistently represented their respective constructs and that each construct explained more than 50% of its indicators' variance (Hair et al., 2022). Table 4 summarizes the measurement quality.

Table 4. Reflective Measurement Model Assessment

Construct	Loading range	Cronbach's α	ρ_A	ρ_C	AVE
EGB	.807-.842	.908	.909	.929	.686
GHRM	.878-.909	.952	.953	.961	.805
GOC	.831-.901	.931	.932	.946	.745
EK	.882-.918	.925	.930	.947	.817

Note. EGB = Employee Green Behavior; GHRM = Green Human Resource Management; GOC = Green Organizational Culture; EK = Environmental Knowledge.

Discriminant validity was evaluated with HTMT. All ratios were below .85. The highest ratio was between GHRM and GOC (.786), followed by EGB and GOC (.752) and EGB and GHRM (.715). EK was more clearly differentiated from the other substantive constructs, with ratios between .282 and .374. The interaction construct also remained distinct. The results therefore supported the empirical separation of the four constructs despite their theoretically related environmental orientation.

Table 5. Heterotrait-Monotrait Ratio (HTMT)

Construct	EGB	EK	GHRM	GOC	GHRM $\times$ EK
EGB	-				
EK	.374	-			
GHRM	.715	.282	-		
GOC	.752	.359	.786	-	
GHRM $\times$ EK	.055	.266	.252	.182	-

Note. All HTMT values were below the .85 threshold.

The structural model showed no critical collinearity. Inner VIF values ranged from 1.000 to 2.328, below the threshold of 3. The adjusted R^2 for EGB was .580, indicating that GHRM, GOC, EK, and the interaction term jointly explained 58.0% of its variance. The adjusted R^2 for GOC was .547, meaning that GHRM explained 54.7% of the perceived culture variance. The effect of GHRM on GOC was large ($f^2 = 1.216$), while the direct GHRM-EGB effect ($f^2 = .161$) and GOC-EGB effect ($f^2 = .155$) were moderate. The interaction effect was statistically significant but small ($f^2 = .099$), which means that EK changed the strength of the relationship without becoming the model's dominant determinant.

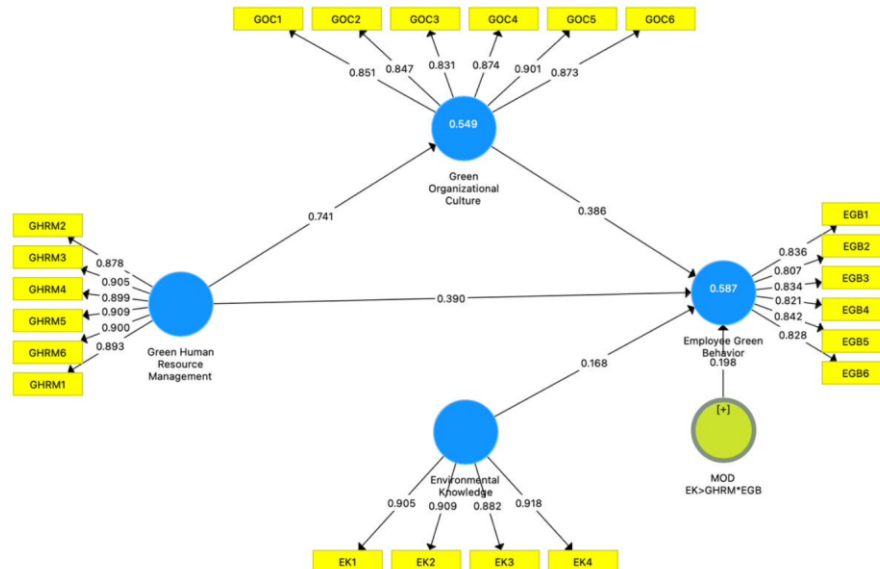


Figure 2. PLS-SEM Structural Model Results

Bootstrapping supported all five hypotheses. GHRM had a positive direct effect on EGB ($\beta = .390$, $t = 4.647$, $p < .001$), supporting H1. GHRM had a strong positive effect on GOC ($\beta = .741$, $t = 21.456$, $p < .001$), supporting H2. GOC positively affected EGB ($\beta = .386$, $t = 4.852$, $p < .001$), supporting H3. The specific indirect effect of GHRM on EGB through GOC was positive and significant ($\beta = .286$, $t = 4.617$, $p < .001$), supporting H4. Because the direct and indirect effects were both significant, the mediation was partial. The VAF of 42.31% indicates that a substantial portion of the total GHRM effect operated through culture. Finally, the $GHRM \times EK$ interaction positively affected EGB ($\beta = .198$, $t = 3.906$, $p < .001$), supporting H5.

Table 6. Hypothesis Testing

Hyp.	Path	β	SE	t	p	Result
H1	GHRM $\rightarrow$ EGB	.390	.084	4.647	< .001	Yes
H2	GHRM $\rightarrow$ GOC	.741	.035	21.456	< .001	Yes
H3	GOC $\rightarrow$ EGB	.386	.080	4.852	< .001	Yes
H4	GHRM $\rightarrow$ GOC $\rightarrow$ EGB	.286	.062	4.617	< .001	Yes
H5	GHRM $\times$ EK $\rightarrow$ EGB	.198	.051	3.906	< .001	Yes

Note. One-tailed bootstrapping. Yes = hypothesis supported. H4 represents the specific indirect effect; VAF = 42.31%.

The model also demonstrated predictive relevance. Q^2_{predict} was .501 for EGB and .542 for GOC, both above zero. At the indicator level, PLS-SEM produced lower root mean square error

than the linear-model benchmark for most indicators, although EGB2 and EGB6 were exceptions. The latent-variable RMSE values were .713 for EGB and .684 for GOC. The results indicate adequate, but not uniformly superior, out-of-sample predictive performance and justify cautious use of the model for prediction beyond the analyzed sample.

Table 7. Predictive Assessment

Endogenous construct	Adjusted R ²	RMSE	MAE	Q ² predict
Employee Green Behavior	.580	.713	.540	.501
Green Organizational Culture	.547	.684	.542	.542

Note. Positive Q²predict values indicate predictive relevance.

Discussion

The positive GHRM-EGB effect supports the AMO proposition that behavior improves when organizational systems simultaneously provide motivational direction and opportunities for action. Employees who perceive that the company sets environmental goals, provides relevant training, evaluates green conduct, and links that conduct to rewards and promotion are more likely to report completing tasks responsibly and undertaking voluntary environmental initiatives. Within the AMO framework, appraisal and rewards strengthen motivation, while training and participation create formal opportunities to enact environmental expectations. The result is consistent with Hameed et al. (2020), Raza and Khan (2022), Sabokro et al. (2021), and Saeed et al. (2019), and extends their findings to a project-based state-owned construction setting.

The construction setting helps explain why formal HR practices matter. Environmental consequences emerge from thousands of routine decisions that are geographically dispersed and difficult for a central sustainability unit to supervise continuously. GHRM distributes responsibility by incorporating environmental expectations into systems that reach employees across projects and functions. Training explains how to act, appraisal establishes accountability, and rewards or career criteria communicate organizational seriousness. This configuration can transform environmental responsibility from a specialist function into an employee-level work requirement. At the same time, the result should not be interpreted as evidence that any formal green policy will automatically produce behavior. GHRM had the lowest construct mean and the highest response dispersion. Employees therefore did not experience the HR system uniformly. The finding helps reconcile the present result with the non-significant relationships reported by Fawehinmi et al. (2020) and Kim et al. (2019). GHRM is likely to be more influential when practices are coherent, visible, and connected to actual work conditions. Fragmented training or symbolic rewards may create compliance language without changing resource-use decisions.

The very strong effect of GHRM on GOC demonstrates that culture is not merely an independent background characteristic but can be shaped through consistent management systems. This finding supports the AMO interpretation of GOC as contextual opportunity: formal HR practices repeatedly signal which environmental actions are legitimate, supported, and expected in everyday work. In hierarchical state-owned enterprises, employees infer organizational priorities from administrative decisions. When environmental behavior is included in training, appraisal, compensation, and promotion, employees receive a common message about what the organization values. The result supports Aggarwal and Agarwala (2022), Muisyo et al. (2022), Rizvi and Garg (2021), and Roscoe et al. (2019), who identify green HR practices as antecedents of green culture or related cultural enablers.

The magnitude of the coefficient ($\beta = .741$) and effect size ($f^2 = 1.216$) suggests that formal HR systems were the model's primary explanation for perceived GOC. This result is theoretically meaningful in organizations undergoing sustainability transition. Where environmental values have not yet become deeply institutionalized, employees may depend heavily on formal systems to judge whether sustainability is a genuine priority. However, the large effect also indicates conceptual

proximity between perceived GHRM and perceived culture. The acceptable HTMT value (.786) supports empirical distinction, but future studies should use temporal separation, multiple data sources, or organizational-level culture indicators to test the sequence more rigorously.

GOC positively affected EGB, confirming the AMO expectation that employees require contextual opportunity in addition to written policies. A culture characterized by environmental concern, active protection, compliance, adaptive management practices, responsibility, and a clear environmental vision supplies social legitimacy for green action. In project environments, such legitimacy matters because employees often face competing pressures related to time, cost, quality, and safety. A strong GOC reduces the risk that environmental action will be viewed as peripheral to core performance and increases the likelihood that formal opportunities supplied by GHRM will be used in practice.

The result aligns with Abbas and Dogan (2022), Al-Swidi et al. (2021), Mirahsani et al. (2024), and Yeşiltaş et al. (2022). It also clarifies the AMO mechanism: culture functions as contextual opportunity. Formal access to training or programs does not guarantee that employees will use their knowledge when local norms discourage additional effort. Conversely, when managers and coworkers treat environmental responsibility as normal, employees have social permission to conserve resources, question wasteful practices, and propose improvements. The moderate effect size ($F^2 = .155$) indicates that this contextual mechanism contributes substantively alongside the direct GHRM pathway.

The mediation result provides a more complete explanation of how GHRM influences behavior. The indirect coefficient of .286 and VAF of 42.31% show that nearly half of the total effect was transmitted through employees' perception of green culture. GHRM therefore operates partly by changing individual incentives and opportunities directly and partly by institutionalizing environmental values. The partial, rather than full, mediation is theoretically appropriate: employees can respond to appraisal, training, or rewards even before those practices have become shared cultural assumptions, while culture adds stability and social reinforcement.

This finding strengthens prior evidence that green culture and climate-related constructs connect HR practices with environmental outcomes (Hooi et al., 2022; Roscoe et al., 2019; Shah et al., 2021). It also has practical implications for implementation sequencing. Organizations should not treat culture-building as a communication campaign separate from HRM. Culture is more likely to develop when environmental messages are supported by consequential systems. Conversely, an HR policy that is inconsistent with managerial behavior, resource allocation, or project routines is unlikely to create genuine cultural internalization.

EK strengthened the GHRM-EGB relationship, supporting the AMO proposition that ability conditions whether motivation and opportunity can become performance. Employees with stronger environmental understanding can interpret the purpose of HR practices and select actions that fit the technical setting. A general instruction to reduce environmental impact may be too abstract for employees who cannot identify relevant sources of pollution, waste, or energy use. Knowledge therefore makes formal policy signals actionable. The result is consistent with Ahmad et al. (2021), Farrukh et al. (2022), and Karmoker et al. (2021), which show that environmental knowledge improves the conversion of organizational signals into pro-environmental behavior.

The moderation effect was statistically reliable but small ($F^2 = .099$). This qualification is important. EK is not a substitute for coherent HR systems, supportive culture, suitable technology, or project resources. Knowledge can strengthen the response to GHRM, but knowledgeable employees may still be unable to act when procedures, budgets, equipment, or managerial priorities constrain them. The result should therefore be interpreted as evidence that knowledge improves policy effectiveness at the margin, not as evidence that training alone will resolve construction-sector environmental problems.

The study contributes to AMO research by specifying different forms of opportunity. GHRM supplies formal opportunity through programs and procedures, while GOC supplies contextual opportunity through norms and shared expectations. This distinction helps explain why access to

training or participation can coexist with inconsistent behavior: employees may formally be allowed to act but lack social reinforcement. Integrating these dimensions offers a more precise account of environmental behavior than treating opportunity as a single undifferentiated component.

The study also integrates organizational and individual explanations without conflating levels of analysis. GHRM and GOC were measured as individual perceptions, while EGB and EK were assessed at the employee level. The findings therefore explain how employees' perceptions of systems and culture relate to their own reported behavior. They do not establish organization-level cultural effects or objective differences among the six enterprises. This level-specific interpretation is important for avoiding ecological claims that the survey design cannot support.

A further contribution is the simultaneous examination of mediation and moderation in a construction setting. The model shows that GHRM effectiveness involves both a transmission mechanism and a boundary condition. GOC explains part of the process through which policies become behavior, whereas EK explains variation in the strength of the direct response. The combined model therefore moves beyond the question of whether GHRM works and provides a more nuanced account of the social and cognitive conditions under which it works.

For managers, the first priority is to improve the consistency of GHRM across companies, projects, and positions. The relatively low mean for value-oriented environmental training suggests that existing programs may emphasize technical compliance and certification more strongly than the internalization of environmental values. Training should therefore combine technical content with project-based cases, simulations, and reflection on how daily decisions affect waste, energy, water, pollution, and surrounding communities. Learning outcomes should be assessed through demonstrations or problem-solving tasks rather than attendance alone.

Second, appraisal, reward, and promotion systems should use observable environmental behaviors and role-specific indicators. Generic statements such as 'support sustainability' are difficult to evaluate and may invite symbolic compliance. Project managers might be assessed on waste prevention and environmental corrective actions; engineering managers on design and method alternatives; site administrators on data quality and resource monitoring; and staff on compliance and improvement initiatives. Indicators should be adjusted for project scale and activity so that employees are not rewarded or penalized for factors outside their control.

Third, companies should institutionalize culture through managerial consistency. Leaders must reinforce environmental standards when cost, schedule, and environmental objectives conflict, because employees learn cultural priorities from trade-off decisions. Environmental achievements should be discussed in project meetings, successful initiatives should be shared across sites, and employees should have safe channels to identify wasteful or polluting practices. These routines convert formal HR policies into social expectations and help prevent sustainability from being perceived as a reporting exercise.

Fourth, EK development should be differentiated by task and exposure. Office-based employees, project-site staff, managers, and technical specialists encounter different environmental risks. Training should therefore address the environmental consequences of each role and connect national regulations with local project procedures. Because the moderation effect was small, knowledge development should be accompanied by equipment, information systems, authority, and budget that allow employees to use what they know. Multi-source monitoring can then compare self-reported EGB with supervisor evaluations, project audits, waste records, energy data, and documented improvement initiatives.

CONCLUSION

This study examined the effect of GHRM on EGB among 238 permanent employees of six Indonesian state-owned construction enterprises. All proposed relationships were supported. GHRM directly increased EGB and strongly shaped GOC; GOC increased EGB and partially mediated the GHRM-EGB relationship; and EK strengthened the direct relationship. The model

explained 58.0% of the adjusted variance in EGB and displayed adequate predictive relevance. The findings indicate that employee green behavior is more likely when formal HR systems, shared environmental values, and individual environmental understanding operate together.

The study advances the AMO perspective by distinguishing formal and contextual opportunity. GHRM supplies motivation and formal opportunity through environmental goals, training, appraisal, rewards, and promotion. GOC supplies contextual opportunity through shared norms and social support. EK provides the ability to interpret environmental consequences and select appropriate action. This integrated explanation is particularly relevant in construction enterprises where environmental outcomes depend on dispersed, project-level decisions and where formal sustainability commitments may not yet be consistently internalized.

The results should be interpreted within several limitations. The purposive sample was limited to six state-owned construction enterprises and was dominated by male, highly educated respondents. All constructs were measured through a cross-sectional self-report questionnaire, which restricts causal inference and may be affected by common method and social desirability biases. GOC was measured as an individual perception rather than an aggregated organizational property. The moderation effect of EK, although significant, was small. Company-level environmental indicators were used only as contextual evidence and cannot validate individual behavior.

Future research should use longitudinal or time-lagged designs, supervisor and coworker ratings, behavioral observations, and project-level environmental records. Comparative studies could examine private construction companies, other infrastructure sectors, or different national settings. Multi-group analysis may test whether relationships vary by company, position, age, gender, education, or work location. Additional mechanisms such as green transformational leadership, green psychological climate, perceived organizational support, green empowerment, and knowledge sharing may explain the remaining variance in EGB. These extensions would clarify how environmental HR systems become verifiable operational improvements rather than solely positive employee perceptions.

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