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# HUMAN RESOURCE DEVELOPMENT AND GREEN GROWTH IN THE COAL MINING INDUSTRY: EVIDENCE FROM VIETNAM

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***Abstract***

In the context of the coal mining industry in Vietnam facing pressure to transform towards sustainable development, this paper studies the relationship between green human resource management and green growth in mining enterprises. Based on modern theoretical frameworks RBV, TPB and PLS-SEM method, survey data from 220 officers and engineers at coal enterprises are analyzed to test a theoretical model consisting of 6 hypotheses. The results show that green human resource management practices such as recruitment, training, and environmental assessment and compensation all have a positive impact on the green growth of enterprises. In particular, green innovation culture plays an important mediating role, helping to amplify the impact of green human resource management on environmental performance. The research model has good explanatory and predictive capacity, and clearly reflects the transformation characteristics of the coal mining industry in the context of implementing the National Green Growth Strategy. From the research results, the article proposes policy implications towards integrating green human resource management in business development strategies, building a green innovation culture, and perfecting the institutional support system from the state to promote an effective and equitable energy transition in the resource exploitation sector.

**Keywords:** Green human resource development; green innovation culture; green growth; coal mining industry; Vietnam

## 1. INTRODUCTION

In the context of the global move towards sustainable development, traditional industries, especially the coal mining industry, are facing an urgent need to transform their growth model towards green and inclusiveness. The concept of green growth does not simply refer to reducing carbon emissions, but also a long-term strategy to maintain economic growth while protecting natural resources and improving the quality of life (OECD, 2013; UNEP, 2011). For developing economies like Vietnam, where coal still plays an important role in the national energy structure, realizing the goal of green growth poses a huge challenge but also opens up many strategic opportunities.

One of the key factors to achieving green growth in the extractive industries is the development of green human resources, that is, building a workforce with knowledge, skills and a strong commitment to sustainable values. Many studies have confirmed that human resources are the central driving force that helps organizations adapt to technological changes, operate cleaner production systems and maintain innovation efficiency in an environment with increasing pressure from environmental policies (Jabbour & Santos, 2008; Renwick et al., 2013).

In the context of energy transition, green human resource management (GHRM) is identified as one of the strategic management tools capable of promoting organizational behavioral change towards environmental friendliness (Jackson et al., 2011; Dumont et al., 2017). GHRM practices such as green recruitment, environmental skills training, green performance appraisal or building a culture of sustainable innovation have been shown to have a positive impact on environmental performance and corporate competitiveness (Teixeira et al., 2016; Yong et al., 2020).

In particular, in the coal mining industry - a sector that is considered to have a high negative environmental impact, implementing green training programs, investing in energy-saving technology and developing green skills are mandatory if businesses want to maintain operations in a rapidly changing legal and market environment (International Energy Agency - IEA, 2022). In Vietnam, in the National Strategy on Green Growth for the period 2021 - 2030, with a vision to 2050, the Government has emphasized the role of high-quality human resources in innovating production technology, improving productivity and reducing greenhouse gas emissions in the fossil fuel mining and use industry (Ministry of Planning and Investment, 2021).

However, the realization of the goal of developing green human resources in coal mining enterprises still faces many obstacles, including the shortage of highly skilled human resources, limited investment in training, and delays in transforming the management model. In that context, this paper aims to: (i) clarify the role of human resource development in promoting green growth in the coal mining industry in Vietnam; (ii) analyze factors affecting the effectiveness of GHRM in business practices; and (iii) propose policy implications to improve the effectiveness of human resource management for green transformation.

## 2. THEORETICAL BASIS

### Green growth in the context of industrial transformation

The concept of green growth was developed by international organizations such as OECD (2011) and UNEP (2011), aiming to propose a model of long-term sustainable economic development, in which environmental factors are not considered as "external costs" but become a central part of the development strategy. This model is especially important for industries with high resource consumption and large emissions such as coal mining, where the urgent requirement is to ensure energy security, reduce emissions and restore the environment. According to Zhang & Liu (2015), green growth in the mining sector includes three main pillars: (i) applying environmentally friendly mining technology; (ii) using natural resources efficiently; and (iii) investing in organizational capacity for sustainable transformation. The IEA (2022) warns that without comprehensive energy and technology reforms, the coal sector will not be able to achieve net zero emissions targets by mid-century.

### Green human resource development is the driving force of sustainable transformation

Green human resources are defined as a workforce with knowledge, skills, and attitudes that are consistent with sustainable development goals, including the ability to perform green jobs and green skills (ILO, 2011; OECD, 2013). These skills include systems analysis, environmental risk management, clean technology application, and innovation in a green context. Renwick et al (2013) point out that, to develop green human resources effectively, businesses need to build a comprehensive human resource strategy - from recruiting people with environmental commitments, to designing green skills training programs and evaluating performance based on sustainability criteria. Especially in the coal mining industry, where safe operations, resource

management, and environmental compliance are highly demanded, developing green human resources is a strategic requirement.

**Green Human Resource Management (GHRM)**

GHRM is a system of human resource management policies and practices that integrate environmental goals throughout the entire human resource cycle: from recruitment, training, assessment, reward to organizational development (Jackson et al., 2011). Dumont et al. (2017) found that organizations that effectively apply GHRM often create a working environment that encourages green behavior among employees, thereby contributing to improved environmental outcomes and enhanced brand reputation. In the study of Yong et al. (2020), GHRM not only directly impacts environmental performance but also promotes innovation through increased organizational commitment and intrinsic motivation. Especially in the mining industry, where the risk of environmental incidents is high, GHRM policies such as "reskilling" and "periodic environmental risk assessment" are essential for the transition to a green operating model.

**The impact of GHRM on green growth is a mediating mechanism and a moderating factor.**

Recent studies (Teixeira et al., 2016; Pham et al., 2023; Tang et al., 2018) show that GHRM impacts green growth through a series of mediating mechanisms and moderating factors. Specifically, GHRM promotes positive environmental awareness and behavior within organizations, thereby increasing energy efficiency, reducing emissions and waste treatment costs. At the same time, GHRM can create a green organizational culture - where sustainable values are integrated into the operating system, encouraging initiatives to minimize negative impacts on the environment. Green innovation culture plays an important mediating role when it exists, it helps increase the positive impact of GHRM on green growth outcomes (Zhang & Zhu, 2017). However, the effectiveness of GHRM also depends on moderating factors such as senior management commitment, employee autonomy, and technological adaptability within the firm (Jabbour et al., 2010).

**Theoretical basis of research orientation**

This paper is built on the foundation of two main theories.

First, Barney's (1991) Resource-Based View ( RBV) asserts that human resources – when developed in a specialized and difficult-to-copy manner-can become a sustainable competitive advantage. In the context of green growth, GHRM is seen as a form of organizational capability that can enhance operational efficiency and strategic adaptation to environmental requirements. Second, Ajzen's (1991) Theory of Planned Behavior (TPB) explains that employees' environmental behavior depends on three factors: attitudes, social norms, and perceived behavioral control. In this model, GHRM plays an indirect role in influencing employees' green behavior through adjusting organizational culture, providing training, and facilitating sustainable actions.

## 3. RESEARCH METHODS

**Research design**

The study applied a mixed-methods approach to combine the advantages of qualitative and quantitative methods. This method is suitable for both exploring the nature of GHRM practices and green innovation culture in coal enterprises and testing the causal relationship between variables through the proposed theoretical model. The research structure includes two phases:

Phase 1: Qualitative research aims to explore the specific characteristics of the coal mining industry in Vietnam, identify appropriate measurement variables and calibrate the scale before the official survey.

Phase 2: Quantitative research to test the theoretical model through empirical survey and analysis using PLS-SEM structural model.

This approach is proposed by Creswell & Plano Clark (2018) to achieve both depth of content and high generalizability in applied social research.

**Theoretical models and hypothetical systems**

The theoretical model is built on the synthesis of the fundamental theories Resource-Based View (RBV, and Theory of Planned Behavior (TPB), together with empirical evidence from international studies. The model proposes that GHRM practices affect green growth through the mediating mechanism of green innovation culture.

The theoretical model includes three main groups of variables:

Independent Variable: Components of GHRM (green recruitment, green training and development, green compensation assessment)

Mediating Variable: Green Innovation Culture

Dependent Variable: Green growth outcomes of enterprises

**Hypothesis system**

H1: Green recruitment has a positive impact on green growth outcomes.

H2: Green training and development has a positive impact on green growth outcomes.

H3: Evaluation and reward systems linked to environmental criteria have a positive impact on green growth.

H4: GHRM has a positive influence on the formation of green innovation culture in enterprises.

H5: Green innovation culture has a positive influence on green growth outcomes.

H6: Green innovation culture plays a mediating role in the relationship between GHRM and green growth.

**Scale of research variables**

The scales in the study are inherited and calibrated from studies that have been verified in international works. The scale structure is presented in Table 1 below.

**Table 1. Summary of measurement scales of research variables**

| Research variables | Scale source | Number of indicators | Main content description |
|---|---|---|---|
| Green Recruitment | Renwick et al. (2013); Yong et al. (2020) | 3 | Recruiting candidates with environmental commitment, green criteria in JD |
| Green training and development | Teixeira et al. (2016); Jabbour et al. (2010) | 4 | Green skills training, retraining, environmental awareness raising |
| Green assessment and treatment | Dumont et al. (2017) | 3 | Assessment results linked to environmental goals, green initiative rewards |
| Green innovation culture | Jabbour et al. (2010); Pham et al. (2023) | 4 | Environmentally friendly innovation, leadership encourages innovation |

| | | | |
|---|---|---|---|
| Green growth results | Zhang & Zhu (2017); Tang et al. (2018) | 5 | Energy efficiency, emission reduction, clean technology, reputation |

The scale used a 5-point Likert scale (1: completely disagree - 5: completely agree). Before the official survey, the questionnaire was preliminarily tested through expert interviews and a pilot test with 30 people to correct the semantics and structure.

**Objects and methods of data collection**

Survey subjects: Middle-level managers and technical engineers at large coal mining enterprises, including: Vietnam National Coal - Mineral Industries Group (TKV), Dong Bac Corporation, and some private enterprises in Quang Ninh, Thai Nguyen and Lang Son.

Sampling method: Controlled convenience sampling, ensuring coverage by geographic area and job role.

Sample size: 250 questionnaires were distributed, 232 valid questionnaires were collected; after removing missing data, 220 questionnaires were included in the analysis.

In-depth interviews: 12 semi-structured interviews with business leaders, GHRM experts and policy officials to supplement quantitative data, identify practical challenges and opportunities in implementing green GHRM.

**Data processing and analysis methods (quantitative)**

Survey data were processed using SmartPLS 4.0 software using the PLS-SEM method, suitable for exploratory research, models with mediating factors and non-standard data.

The analysis is performed in two steps:

*Evaluation of measurement models includes:*

Scale reliability: Cronbach's Alpha and Composite Reliability > 0.7.

Convergence value: AVE > 0.5.

Discriminant value: using Fornell-Larcker and HTMT criteria (< 0.85).

*Structural model evaluation includes:*

Path coefficient (β) to test hypotheses.

$R^2$, $f^2$ and $Q^2$ values are used to evaluate the model's goodness of fit and predictive ability.

Intermediate validation: using bootstrapping (5,000 samples) to determine the role of green innovation culture.

The analysis results are the basis for testing the hypothesis and providing interpretations in the next section.

## 4. RESEARCH RESULTS AND DISCUSSION

**Survey sample characteristics**

A total of 220 valid questionnaires were collected from technical staff, managers and environmental specialists at coal mining enterprises operating in Quang Ninh, Thai Nguyen and Lang Son. The survey sample was designed to ensure diversity in terms of job position, business type and professional level, thereby reflecting the implementation of green human resource management practices in the entire industry.

**Table 1. Survey sample description information**

| No | Criteria | Classify | Frequency | Rate (%) |
|---|---|---|---|---|
| **1** | **Business type** | State-owned enterprise (TKV) | 143 | 65.0% |

| | | | | |
|---|---|---|---|---|
| | | Joint stock company | 44 | 20.0% |
| | | Private enterprise | 33 | 15.0% |
| **2** | **Job title** | Middle management | 99 | 45.0% |
| | | Technical Engineer | 88 | 40.0% |
| | | Environmental/safety officer | 33 | 15.0% |
| **3** | Gender | Male | 172 | 78.2% |
| | | Female | 48 | 21.8% |
| **4** | **Professional qualifications** | University | 157 | 71.4% |
| | | Postgraduate (MSc, PhD) | 36 | 16.4% |
| | | College/high school | 27 | 12.3% |
| **5** | **Years of service** | Under 5 years | 39 | 17.7% |
| | | From 5 to under 10 years | 106 | 48.2% |
| | | Over 10 years | 75 | 34.1% |

Regarding enterprise type: The largest proportion comes from state-owned enterprises (65%), reflecting the leading role of TKV in the Vietnamese coal industry. However, the proportion of non-state enterprises (35%) is still large enough to compare and evaluate differences in GHRM implementation.

Regarding job title: 85% of respondents are managers or technical engineers, who are directly involved in building and operating production - human resources - environmental programs at the enterprise, ensuring reliability of the responses.

Regarding professional qualifications: More than 87% of respondents have a university degree or higher, showing that the survey subjects have solid professional knowledge of environmental management and engineering activities.

In terms of seniority: Nearly 82.3% have 5 years or more of experience, ensuring the ability to correctly assess the status of green transformation within the unit.

**Evaluation of measurement model**

Before testing the relationship between latent variables in the structural model, the study conducted a measurement model assessment to check the reliability and validity of the scales. The three main criteria used include:

**1. Testing reliability and convergent validity**

**Table 2. Reliability and convergence of the scales**

| Latent variable | Indicator number | Cronbach's Alpha | Composite Reliability (CR) | AVE |
|---|---|---|---|---|
| GHRM | 5 | 0.792 | 0.859 | 0.553 |
| Green innovation culture | 4 | 0.810 | 0.876 | 0.639 |
| Green growth | 5 | 0.833 | 0.887 | 0.613 |

All scales meet:

Cronbach's Alpha > 0.7: ensures internal reliability;

CR > 0.8: represents the overall consistency of the scale;

AVE > 0.5: meets the requirement of convergent validity (Hair et al., 2019).

This confirms that the measurement indicators are capable of reflecting the corresponding theoretical concepts well.

**2. Test of discriminant value by p-test using Fornell-Larcker method**

**Table 3. Discriminant validity test according to Fornell-Larcker criterion**

| | GHRM | Green innovation culture | Green growth |
|---|---|---|---|
| **GHRM** | 0.744 | | |
| **Green innovation culture** | 0.673 | 0.799 | |
| **Green growth** | 0.641 | 0.685 | 0.783 |

The square root value of AVE (diagonal) is greater than the correlation coefficient between pairs of variables, indicating that discriminant validity is guaranteed between variables in the model. This shows that the research concepts are independent in terms of measurement.

**3. Test of discriminant value by p HTMT method**

**Table 4. HTMT ratio between latent variables**

| | GHRM | Green innovation culture | Green growth |
|---|---|---|---|
| **GHRM** | 0.721 | | |
| **Green innovation culture** | | 0.654 | |
| **Green growth** | | | 0.688 |

All HTMT indices are less than 0.85, the threshold recommended by Henseler et al. (2015). This further confirms that the latent variables in the model do not overlap concepts, ensuring strong discriminant validity.

**Assessing the predictive ability of the model**

To test the model's goodness of fit and predictive ability, the study used two indices:

$R^2$ (R-squared): Reflects the extent to which the variance of the dependent variable is explained by the independent variable.

$Q^2$ (Predictive Relevance): Calculated using blindfolding technique, evaluates the predictive ability of the model with new data.

**Table 5. $R^2$ and $Q^2$ indices of dependent variables**

| Dependent variable | $R^2$ | $Q^2$ | Level of explanation and prediction |
|---|---|---|---|
| Green innovation culture | 0.231 | 0.192 | Medium |
| Green growth | 0.412 | 0.297 | Pretty good |

$R^2 = 0.231$ for green innovation culture shows that GHRM explains 23.1% of the variation in this variable - medium level.

$R^2 = 0.412$ for green growth is a relatively high result in social research, showing that the model has good explanatory power.

$Q^2 > 0$ for both variables, especially with $Q^2 = 0.297$ for green growth, indicating that the model has high predictive power for the core dependent variable.

**Structural model testing**

After evaluating the measurement model as satisfactory, the next step is to test the structural model to determine the impact level of latent variables, i.e. the relationship between the components of green human resource management (GHRM), green innovation culture and green growth outcomes. The structural model testing process is carried out using the PLS-SEM method with the indicators presented in Table 6 :

**Table 6. Results of structural model testing**

| Relationship | β coefficient | t-value | p-value | $f^2$ | Level of influence |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| GHRM and Green Growth | 0.273 | 4.12 | 0.000 | 0.128 | Medium |
| GHRM and Green Innovation Culture | 0.481 | 6.75 | 0.000 | 0.227 | Big |
| Green Innovation Culture and Green Growth | 0.369 | 5.43 | 0.000 | 0.183 | Medium |

The coefficient $\beta = 0.273$ from GHRM to green growth is statistically significant ($p < 0.001$), showing that GHRM has a significant direct impact on green growth in enterprises.

The impact of GHRM on green innovation culture is $\beta = 0.481$ with $f^2 = 0.227$, indicating a strong relationship, reflecting the decisive role of GHRM in forming a sustainable innovation environment.

The relationship from green innovation culture to green growth ($\beta = 0.369$) is also very clear, showing that organizations that encourage environmental innovation will have a higher probability of achieving green growth performance.

The $f^2$ indices show medium to large effect sizes, according to Cohen's (1988) classification, confirming that GHRM and green innovation are not only statistically significant but also have clear practical significance.

**Testing the hypothesis system**

The proposed research model consists of 6 hypotheses on the relationship between green human resource management practices (GHRM), green innovation culture (GIC), and green growth outcomes (GG). The testing process is carried out using PLS-SEM method with bootstrap technique (5,000 replicate samples), to determine the level of influence and statistical significance of each relationship.

**Table 7. Results of testing the hypothesis system**

| Hypothesis | Relationship | Coefficient (β) | t-value | p-value | Conclude |
|---|---|---|---|---|---|
| H1 | Green Recruitment and Green Growth | 0.181 | 2.97 | 0.003 | Accepted |
| H2 | Green Training & Development and Green Growth | 0.205 | 3.42 | 0.001 | Accepted |
| H3 | Assessment, Compensation and Green Growth | 0.157 | 2.64 | 0.009 | Accepted |
| H4 | Integrated GHRM and Green Innovation Culture | 0.481 | 6.75 | 0.000 | Accepted |
| H5 | Green Innovation Culture and Green Growth | 0.369 | 5.43 | 0.000 | Accepted |
| H6 | GHRM and Green Innovation Culture<br>Green growth (intermediate) | 0.178 | 4.21 | 0.000 | Accepted |

Hypothesis H1: *Green recruitment has a positive impact on green growth.*

Coefficient $\beta = 0.181$, $p = 0.003$

This result shows that policies to recruit candidates with environmentally friendly awareness and behavior significantly contribute to the overall performance of the organization in terms of

saving resources, improving processes, and enhancing green reputation. This is empirical evidence that reinforces the studies of Renwick et al. (2013) and Yong et al. (2020).

Hypothesis H2: *Green training and development has a positive impact on green growth.*

Coefficient β = 0.205, p = 0.001

Investing in green training programs helps employees improve their clean technology operations, reduce environmental errors, and promote technical innovation. This result is consistent with studies by Jabbour et al. (2010) and Teixeira et al. (2016), which emphasize the pivotal role of training in green transformation.

Hypothesis H3: Green *valuation and compensation have a positive impact on green growth.*

Coefficient β = 0.157, p = 0.009

This relationship suggests that when companies incorporate environmental criteria into their evaluation and reward systems, employees tend to adjust their behavior in a more sustainable direction. This confirms that internal incentive mechanisms are the driving force behind green behavior.

Hypothesis H4: *Green human resource management (GHRM) has a positive influence on green innovation culture.*

Coefficient β = 0.481, p = 0.000

This is the relationship with the strongest impact coefficient in the model. GHRM practices such as training, recruitment, and compensation, when implemented in a coordinated manner, will create an organizational culture that encourages environmental innovation, paving the way for innovation in production processes and techniques.

Hypothesis H5: *Green innovation culture has a positive influence on green growth.*

Coefficient β = 0.369, p = 0.000

These results show that organizations with an innovative spirit and environmental commitment are more effective in optimizing resources, improving energy and waste management, which is an important link between organizational capabilities and sustainable outcomes.

Hypothesis H6: *Green innovation culture plays a mediating role in the relationship between GHRM and green growth.*

Indirect coefficient = 0.178, p = 0.000

The intermediate validation confirms that a green innovation culture is not only an outcome of GHRM but also a spillover mechanism that impacts human capital on organizational outcomes. GHRM is more effective when it operates in an environment that encourages initiative, supports leadership, and empowers innovation.

All six hypotheses were proven to be statistically and empirically significant, thereby confirming:

- GHRM not only directly affects the green performance of enterprises, but also shapes the organizational cultural environment;
- Green innovation culture is an essential mediating variable, amplifying the impact of human resource policies on green growth;
- GHRM practices need to be implemented in a coordinated manner, with green training and organizational innovation playing pivotal roles.

## 5. CONCLUSION AND POLICY IMPLICATIONS

This study analyzed the relationship between green human resource development and green growth in the coal mining industry in Vietnam. Through the PLS-SEM model and survey data

from 220 technical and managerial staff at coal enterprises, the results showed that green human resource management (GHRM) practices including green recruitment, green training and development, and environmental criteria-based assessment and compensation all have positive and statistically significant effects on the green growth outcomes of enterprises. This confirms that human resources are one of the decisive factors in promoting environmental performance, saving resources and improving corporate image in the energy transition period.

Notably, the study also shows that green innovation culture plays a significant mediating role in the relationship between GHRM and green growth. When enterprises build an environment that encourages creativity, supports leadership, and spreads the spirit of innovation associated with environmental responsibility, the effectiveness of human resource policies will be significantly amplified. The research model has high explanatory and predictive value, contributing to affirming the practical value and applicability of GHRM policies in traditional resource industries such as coal mining.

Based on the above findings, the study proposes some practical policy implications. For enterprises in the coal mining industry, GHRM should be integrated as a strategic component in the transition to sustainable development. GHRM is not only a human resource operation, but must be understood as a tool for long-term value creation, through selective recruitment, green operational skills training, and building a reward system linked to environmental performance. In addition, enterprises should also focus on building a green innovation culture by creating mechanisms to encourage employees to propose environmental protection initiatives, enhancing the exemplary role of leaders, and selectively investing in technology and people to adapt to the energy transition.

On the part of state management agencies, it is necessary to develop and perfect a policy framework to promote the development of green human resources for the mining industry. In particular, the role of ministries such as the Ministry of Industry and Trade, the Ministry of Natural Resources and Environment, and the Ministry of Labor, Invalids and Social Affairs is particularly important in developing green vocational training programs, occupational competency standards associated with green transformation skills, and financial support mechanisms for businesses investing in sustainable human resource training. In addition, there should be policies to encourage technological innovation, environmental tax exemptions for businesses that effectively apply GHRM, and a green ranking mechanism to create healthy competition in the industry.

Overall, this study not only provides empirical evidence on the role of human resources in promoting green growth in Vietnam, but also suggests a new approach for the extractive industry - where organizational, human and cultural factors need to be simultaneously transformed to meet the requirements of sustainable development in the post-carbon era.

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