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THE IMPACT OF HUMAN CAPITAL ON GREEN JOB GROWTH IN VIETNAM

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ABSTRACT

Developing human resources and green jobs is one of the key solutions to materialize the National Green Growth Strategy for 2021-2030, vision towards 2050 in Vietnam. However, the intension and method of measuring green jobs in Vietnam are not unified, so the development of research models is still limited. Therefore, the article proposes a method to specifically identify the number of green jobs in Vietnam based on the approach of The Occupational Information Network in the USA (O*NET). Besides, the study analyzes the impact of human capital on green job growth in Vietnam in the period of 2018-2022 by using the “Generalized Least Squares” method with the data of Labor Force Survey (LFS) and Statistical Yearbook. The results indicate that human capital has a positive influence on green job growth in Vietnam. According to the findings, the article proposes some recommendations to promote green jobs in the future, contributing to the National Green Growth Strategy.

Keywords: Green jobs, human capital, Vietnam.

1. Introduction

The transition to green jobs is a key to sustainable development, in the purpose of promoting the quality and quantity of jobs with higher levels of satisfaction (Sulich et al., 2021). Most foreign studies are based on the definition of the International Labor Organization (ILO) to estimate the number of green jobs in the research country (Nguyen, 2020). Previous studies about green jobs only analyze the relationship of green jobs with other factors such as the economic complexity

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

index (ECI) (Dordmond et al., 2020); unemployment and education (Yi, 2013); renewable energy (Lee, 2017);... As Vietnam has not had a unified definition nor a systematic analysis of green jobs (Le, 2023), research on green jobs and their related relationships is still limited, nor is the awareness of green jobs of Vietnam. Today, when green jobs are one of the important strategic solutions in the National Green Growth Strategy, researching on factors affecting green jobs is extremely urgent to contribute to the sustainable growth in Vietnam. Besides, human capital is the key to job creation (World Bank, 2023). Therefore, research on the relationship between human capital and green jobs is necessary to promote not only green jobs but also sustainable development in the future in Vietnam. Hence, this study focuses on solving two major goals: (1) Researching methods to identify green jobs in Vietnam and (2) Analyzing the impact of human capital on the growth of green jobs in Vietnam.

The results are the basis for making appropriate recommendations to promote green jobs towards a sustainable economy. The article consists of 5 sections. After the introduction, section 2 presents the overview and theoretical basis. Section 3 focuses on presenting the research methodology. Section 4 analyzes and discusses the research results. Finally, section 5 draws conclusions and proposes some recommendations.

2. Overview and theoretical basis

2.1. Green jobs

First appearing in 1999, the OECD defines jobs as "green" if they produce goods and services for measuring, preventing, limiting, and minimizing damage to the environment, water, air, and soil. In 2008, the definition of green jobs is officially mentioned for the first time in the Report *"Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World"* by UNEP (2008), according to which green jobs are jobs in agriculture, manufacturing, research and development, administrative activities and services that contribute to the conservation or rehabilitation of environmental quality, including jobs that help protect ecosystem and biodiversity, reducing energy, raw materials and water consumption through the effectively applying strategies such as promoting a low carbon economy. Additionally, in 2016, the International Labor Organization (ILO) (2016) defines green jobs more broadly, in which, "green jobs are decent jobs that contribute to preserve or restore the environment in traditional sectors such as manufacturing and construction, or in new, emerging green sectors such as renewable energy and energy efficiency."

However, when applied in Vietnam, the above green job approaches still have some limitations. The ILO's method, when researching in Vietnam, can only be applied in certain industries or cannot calculate a specific number or identify a completed list of green jobs with the

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

characteristics of a decent job because Vietnam doesn't completely approach the data proposed by the ILO (Nguyen Quynh Hoa, 2020). Besides, the definitions of green jobs by OECD (1999) and UNEP (2008) are built based on the output and process aspects, thereby, when identifying green jobs according to these approaches, jobs can be misclassified because they include all jobs with "green" output regardless of whether they are related to green tasks or vice versa (World Bank, 2023; Esposito et al., 2017).

Therefore, to overcome the above limitations, the article identifies green jobs based on the approach of The Occupational Information Network in the USA (O*NET), in which, based on the definition of green economy and greenness of tasks, green jobs are jobs that include all tasks related to economic activities in terms of reducing fossil fuel, CO_2 emissions, increasing energy efficiency, developing renewable energy (Martin & Monahan, 2022). Specifically, green jobs are classified into three groups, depending on the extent to which green economy activities and technologies can create distinct job and work requirements: (1) Green Increased Demand (Green ID), (2) Green Enhanced Skills (Green ES), (3) Green New and Emerging (Green NE) (Dierdorff et al., 2009). The O*NET approach can overcome the above limitations for the following reasons: Firstly, it is possible to build full of job codes' conversion tables to determine green job codes in Vietnam according to this approach, and then specifically calculate the number of green jobs instead of just estimating green jobs as the ILO. Secondly, O*NET applies a relatively broad approach to green jobs, so green jobs include most jobs affected by the greening process of the economy (Dell'Anna, 2021). This approach is also chosen by some scholars to calculate green jobs in the EU, UK, and Argentina (Bowen & Hancké, 2019; Valero et al., 2021; Porto et al., 2022)

2.3. The influence of human capital on green jobs

When the term "human capital" are more widely used in the 1960s, there are some different definitions of human capital. According to Becker & Murphy (2009), human capital is the skill and knowledge that individuals acquire through investing in schooling. In addition, human capital is also expressed in the attitudes and professional qualifications that workers have accumulated, which represents the worker's ability to work at a certain level (Rastogi, 2002). More broadly, the Organization for Economic Cooperation and Development (OECD) believes that human capital is the knowledge, skills, abilities, and characteristics belonging to individuals that can facilitate the creation of personal, social, and economic well-being. Because the definition according to the OECD approach is suitable for the human capital measurement of the study, the percentage of trained employed workers aged 15 years and older, therefore, the authors use the OECD definition of human capital.

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

More green jobs created means more green skills required, which are accumulated through human capital, especially through education or training programs (Hofmann & Strietska-Ilin, 2014), hence, we can see the close relationship between human capital and green jobs. Additionally, green jobs require higher standards of human capital such as formal education, work experience, and on-the-job training (Consoli, 2016). Besides, Aceleanu (2015) argues that the current vocational education and training system must be able to fully equip essential human capital and competence for the workforce to take advantage of new green technologies that help promote green jobs.

Vietnam, with the participation of many industries, is aiming at green growth, creating a great demand for green jobs in the labor market, but most of the current resources in our country don't have enough technical skills (Luu, 2023). Therefore, improving human capital to push green job creation is necessary, however, research on this relationship in Vietnam is still limited. Most previous studies focus on the impact of human capital on employment. Typically, Pham et al. (2021) believe that workers with low human capital would negatively affect income and working time. Besides, research by Pham (2015) finds that experience and skills, two aspects of human capital, are considered to have a profound effect on individual's ability to develop their career in the labor market. Therefore, the authors focus on analyzing the impact of human capital on green jobs in Vietnam in this article with the hypothesis: *Human capital has a positive influence on the growth of green jobs.*

3. Research methods

3.1. Method to identify green jobs

Thanks to the green job classification developed by O*NET in the USA in 2010, the article identifies and analyzes green jobs in Vietnam at the occupational level. The above database classifies green occupations based on the greenness of the task and takes a relatively broad approach to green jobs, in which any jobs affected by the greening process of the economy are considered to be green jobs. Specifically, green jobs are divided into 2 groups: Direct green jobs (New and Emerging green jobs (Green NE), Green Enhanced Skills (Green ES)) and Indirect Green Jobs (Green Increased Demand (Green ID)). In particular, indirect green jobs are jobs which do not contain "green tasks" but created due to the greening process (Valero et al., 2021). Therefore, the authors eliminate the occupation code "Green ID" when identifying green job codes in Vietnam at the occupational level.

To determine green job codes in Vietnam, it is necessary to create a crosswalk which convert the occupation codes of O*NET SOC 2010 Occupational Listing to the codes of Vietnam Standard Classification of Occupations (VSCO). This method is also used by the International Labour

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

Organization (World Bank, 2019). However, due to not having access to a direct crosswalk between O*NET's green occupation code classification and VSCO, the authors use the United States Standard Occupational Classification (US SOC) and the International Standard Classification of Occupations (ISCO-08) as intermediaries based on three reasons: *Firstly*, the O*NET SOC Occupational Listing is built based on the US Standard Occupational Classification (US SOC). *Secondly*, VSCO is built based on the International Standard Classification of Occupations (ISCO) (General Statistics Office, 2008). *Thirdly*, the crosswalk between US SOC and ISCO is released by the US Bureau of Labor Statistics. Besides, the study applies the VSCO's 4-digit codes, because the crosswalk between US SOC and ISCO uses ISCO's 4-digit codes. Specifically as follows:

(1) Creating a crosswalk mapping O*NET SOC 2010 codes to VSCO codes:

Step 1: Building a crosswalk between O*NET occupation classifications (O*NET SOC 2010 - O*NET SOC 2019)

Step 2: Building a crosswalk between O*NET SOC 2019 and US SOC 2018

Step 3: Building a crosswalk between US SOC 2018 and ISCO-08

Step 4: Building a crosswalk between ISCO-08 and VSCO 2020

Step 5: Building a crosswalk between VSCO (VSCO 2020 - VSCO 2008)

(2) Identifying green job codes in Vietnam: After creating a crosswalk between O*NET SOC 2010 and VSCO, we compare and determine green job codes in Vietnam according to the maximum green approach. Accordingly, a VSCO occupation code equivalent to one of O*NET's two green occupation codes (Green NE or Green ES) is considered to be a green job. This method is also applied in EU countries and the UK (Bowen & Hancké, 2019; Valero et al., 2021).

3.2 Method to analyze the impact of human capital on green job growth in Vietnam

To research the impact of human capital on green job growth in Vietnam, the authors use 3 datasets: (1) The list of green job codes identified in section 3.1; (2) Vietnam Statistical Yearbook and Statistical Yearbook of 63 provinces in the 5 years of 2018 - 2022 to calculate human capital, urbanization rate, per capita income, trade openness rate and population density; (3) Labor Force Survey (LFS) to calculate the proportion of green jobs per province (dividing the number of green jobs by the total number of jobs per province). Because VSCO changes in 2020 and takes effect on January 15th, 2021, for 2018 - 2020 data, the LFS uses the 2008 VSCO, for 2021 - 2022 data, the LFS uses the 2020 VSCO.

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

To evaluate the impact of human capital on green job growth in Vietnam, the research uses standard estimation methods for balanced panel data including 302 observations from 61 provinces in Vietnam (Lai Chau and Dien Bien are removed due to lack of data) in the period of 2018 - 2022 through a linear model (1) with equation:

$$GJS_{jt} = \beta_0 + \beta_1 * HUMAN_{jt} + \beta_2 X_{jt} + u_{jt} \qquad (1)$$

Where:

GJS_{jt} is the green job rate of province j in year t

$HUMAN_{jt}$ the percentage of trained employed workers at 15 years of age and above of province j in year t

X_{jt} are control variables

The Pooled OLS or constant coefficients model ignores the dual nature of panel data (Gujarati, 2012), so it often suffers from problems such as multicollinearity, heteroskedasticity, and autocorrelation, which decreases the accuracy of the tests in the model (Gujarati, 2011). Therefore, many researchers use fixed-effects model (FEM) and random-effects model (REM) to overcome the above problems (Gujarati, 2012). According to the proposal of Gujarati & Porter (1999), the study uses the F Test to test the compatibility between the OLS model and the FEM model. Besides, the Hausman test is used to choose the appropriate method between FEM and REM as suggested by Hausman (1978). Table 1 shows that the FEM model is more suitable than the OLS model because the F Test has a level of statistical significance of P-value<0.05. In addition, the Hausman test shows the coefficient Chi2 = 25.15 and P-value<0.05, which means that the model doesn't have a correlation between u_j and independent variables. This result indicates that the FEM model is more suitable.

Table 1: Model testing results

F Test	
F (60.236)	= 6.09
Pro > F	= 0.0000

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

Hausman Test			
Chi2 (5)		= (b-B)'[(V_b-V_B)^(-1)](b-B)	
		= 25.15	
Prob > chi2		= 0.0001	
Wooldridge and Wald Test			
Wooldridge Test		Wald Test	
F(1.60) = 38.890	Prob > F = 0.0000	chi2 (61) = 9995.51	Prob > chi2 = 0.0000

Source: Authors' calculation

Suggested by Wooldridge (1991), the authors use the Wooldridge Test to check the autocorrelation in the model. Also, heteroscedasticity is checked by the Wald Test proposed by Breusch & Pagan (1980). From table 1, the Wooldridge test shows Prob>F=0.0000 (<0.05), so the model has first-order autocorrelation. According to the Wald Test's result, Prob>chibar2=0.0000 (<0.05) means that the model has heteroscedasticity. Therefore, the study solves the above phenomena by using the "Generalized Least Squares"method to achieve the most efficiency for the model (Results in table 5).

4. Research results and discussion

4.1. Overview of the rate of green jobs in Vietnam in the period of 2018 – 2022

Table 2 shows that the proportion of green jobs in Vietnam tends to increase but not continuously in the period of 2018 - 2022. Specifically, in 2018, green jobs consist of 15.70% but decrease by 0.88% in 2019 and increase in 2022 (19.06%). Besides, during this period, the green job growth rate reaches 21.4% and the average green job rate in the country is 16.67%.

Specifically, the average percentage of green jobs in each region over the years and during the entire research period increase in the following order: Central Highlands; Northern midlands and mountain areas; Mekong River Delta; North Central and Central coastal areas; South East and Red River Delta. Although the Central Highlands has the lowest percentage of green jobs in the country, it has the 4th highest growth rate in Vietnam at 22.21%. Meanwhile, the Red River Delta always has the highest green job proportion in the country for 5 years but has the slowest green job growth rate at 17.21%. In contrast to the Red River Delta, the Northern midlands and

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

mountain areas has the fastest growth rate in the country, reaching 37.64% in the 5-year research period.

Table 2: The percentage of green jobs in Vietnam in the period of 2018 - 2022 by whole country and economic regions (%)

	2018	2019	2020	2021	2022	Average 5 years	Growth rate
Whole country	15.70	14.82	15.40	18.35	19.06	16.67	21.40
Central Highlands	6.53	6.87	7.46	7.97	7.98	7.36	22.21
Northern midlands and mountain areas	11.40	10.54	10.85	16.25	15.80	12.97	37.64
Mekong River Delta	14.85	13.52	15.42	17.11	18.56	15.89	25.02
North Central and Central coastal areas	16.50	14.81	15.80	19.27	19.81	17.24	20.10
South East	17.69	18.49	18.30	21.08	22.30	19.57	26.08
Red River Delta	21.55	19.85	20.67	24.67	25.26	22.40	17.21

Source: Authors' calculation

4.2. How do green jobs require higher skills than non-green jobs?

Table 3 shows that in the period of 2018 - 2022, both green jobs and non-green jobs with no qualification account for the highest proportion and the proportion of workers with a university degree or higher always maintains the second place. This can be explained by the similarity in labor structure by technical qualification in the country nowadays. Besides, the results show that green jobs tend to require higher qualifications than non-green jobs because the proportion of the pre-intermediate, intermediate and university or higher group of green jobs are higher than those of non-green jobs in the whole period. In particular, the percentage of workers with a university degree or higher has the largest gap between green jobs and non-green jobs (5% - 12%). The reason may be that green jobs often apply modern technology and tend to be more concentrated in areas specializing in green technology (Vona et al., 2019), so they require more highly

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

qualified workers with higher-level technical skills to adapt to new technologies (Consoli, 2016). In addition, the proportion of green jobs at university level or higher tends to decrease but not continuously during the research period. Specifically, in the period of 2018 - 2020, this rate gradually increases by 0.2% and 0.05% respectively. However, in 2021, it decreases by 4.54% compared to 2020 and increases again in 2022, reaching 16.46% (an increase of 1.59% compared to 2021). This can be explained by the negative impact of the COVID-19 pandemic in 2021, leading to a reduction in the job demand as well as the number of workers participating in the economy in general and the green economy in particular. In addition, when not yet greatly affected by the pandemic, the proportion of green jobs at university level or higher tends to gradually increase (2018 - 2020), as well as when the pandemic is under control in 2022, in which the above indicators have been gradually improved, leading to an increase in the proportion of green jobs with a university degree or higher.

Table 3. The percentage of green jobs and non-green jobs by professional level (Unit: %)

Year	Technical qualification	Non-green jobs	Green jobs
2018	No qualification	80.82	65.55
	Pre-intermediate	3.04	6.02
	Intermediate	5.03	5.28
	College	3.47	3.89
	University or higher	7.64	19.26
	Total	100	100
2019	No qualification	79.94	64.60
	Pre-intermediate	3.06	6.96
	Intermediate	4.62	4.94
	College	3.69	4.04
	University or higher	8.69	19.46

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

	Total	100	100
2020	No qualification	78.87	64.52
	Pre-intermediate	4.13	7.56
	Intermediate	4.29	4.57
	College	3.65	3.84
	University or higher	9.09	19.51
	Total	100	100
2021	No qualification	74.90	69.62
	Pre-intermediate	6.56	8.07
	Intermediate	4.12	4.14
	College	3.59	3.20
	University or higher	10.83	14.97
	Total	100	100
2022	No qualification	75.30	67.39
	Pre-intermediate	6.81	8.61
	Intermediate	3.63	4.07
	College	3.72	3.47
	University or higher	10.54	16.46
	Total	100	100

Source: Authors' calculation

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

Similar to the statistical results about the proportion of workers by professional level, the proportion of green jobs with high skills is always higher than that of non-green jobs with high skills. Specifically, in the period of 2018 - 2022, the rate difference is: 15.05%; 16.35%; 16.08%; 7.15% and 10.05%. On the other hand, the proportion of green jobs requiring average skills is smaller than that of non-green jobs during the research period (Table 4). The results are similar to the research about green jobs in the United States with similar methodology, which researchers show that green jobs require significantly higher skills than non-green jobs, specifically, 60.6% of green jobs are high-skill occupations during 2006 - 2014 (Consoli, 2016). Therefore, green jobs having higher skills are more likely to sign long-term contracts (Valero et al., 2021).

Table 4. The proportion of green jobs and non-green jobs by skill (Unit: %)

	High skill	Average skill	Low skill
2018			
Non-green jobs	9.31	54.14	36.54
Green jobs	24.36	44.76	30.88
2019			
Non-green jobs	8.48	50.43	41.10
Green jobs	24.83	45.76	29.41
2020			
Non-green jobs	8.52	51.88	39.60
Green jobs	24.60	44.82	30.58
2021			
Non-green jobs	9.68	63.07	27.25

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

Green jobs	16.83	50.83	32.34
2022			
Non-green jobs	9.03	65.99	24.98
Green jobs	19.08	50.17	30.75

Source: Authors' calculation

4.2. The influence of human capital on green jobs

Table 5 shows the positive influence of human capital on green jobs. Specifically, when human capital increases by 1%, the rate of green jobs will increase by 0.148%. This can be explained as follows: Firstly, green jobs require a higher level and intensity of human capital than non-green jobs (Consoli et al., 2016). Therefore, when human capital is improved or the training rate of workers over 15 years old is increased, it will help workers develop working skills, improve technical expertise, and create favorable conditions for employment. Join green jobs as well as increase the rate of green jobs. Secondly, training programs not only help workers improve professional skills but also raise their awareness and consciousness, including environmental awareness. According to Duong & Nguyen (2016), it is necessary to provide workers with training courses to raise workers' awareness of corporate social responsibility (CSR), including environmental protection and development. Therefore, workers are motivated to self-study and develop themselves to participate in green jobs.

Table 5: The results of estimating the impact of human capital on green jobs

Variables	Symbols	Green job percentage
Human capital	HUMAN	0.148***
Urbanization rate	URBAN	0.0313**
Per capita income	LnINC	6.623***
Trade openness	LnOPEN	0.324***
Population density	POP	-0.000332

ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

-cons	-42,96***
Pro>chi2	0.0000
Number of observations	302
Statistical significance level: * p < 0.1, ** p < 0.05, *** p < 0.01	

Source: Authors' calculation

Besides, to further analyze green jobs in Vietnam, the authors research more about the changes in green jobs based on different characteristics of each province, including: Urbanization rate, per capita income, trade openness and population density.

In terms of the urbanization rate, table 5 shows that the urbanization rate has a positive impact on the green job rate in Vietnam. Specifically, when the urbanization rate increases by 1%, the green job rate will increase by 0.0313%. This can be explained by two reasons: (1) The number of workers in urban areas has increased due to urbanization, thereby increasing the number of workers with access to green technology and promoting green jobs; (2) Rural areas are becoming more developed, which increases the speed of urbanization and then increase the proportion of green jobs due to the impact of industrialization and modernization. Besides, the requirements of sustainable economic development also contribute to increasing the rate of green jobs.

In terms of per capita income, at the 1% significance level, per capita income and the proportion of green jobs in Vietnam have a positive relationship during the research period. Specifically, if per capita income increases by 1%, the percentage of green jobs will increase by 0.06623%. The higher the income is, the more opportunities workers have to access to professional training programs, higher levels of education and more modern technology. Therefore, it creates more favorable conditions for workers to participate in green jobs because the technical qualification requirements of green jobs are more complex.

In terms of trade openness, table 5 shows that trade openness has a positive impact on the percentage of green jobs in Vietnam. Specifically, when trade openness increases by 1%, the proportion of green jobs will increase by 0.00324%. The reason may be the high correlation between trade openness and economic growth (Nguyen et al., 2021). Also, as the economy develops, more new jobs will be created, including green jobs (Kaspos, 2005).

In terms of population density, during the research period, the impact of population density on the ability to create green jobs in Vietnam has not been proven. The reason may be that population density indicators do not accurately reflect the living standards, qualifications of workers and the level of development in the area but only a basis for urban classification,

ISSN: 2455-8834
Volume:09, Issue:03 "March 2024"

especially in developing countries like Vietnam, where population density in rural areas is still high.

5. Conclusion and policy implications

The study is based on the green job approach of the O*NET Career Information Network and occupation classification tables to convert green job codes from the O*NET-SOC of the United States to the VSCO of Vietnam, thereby identifying and calculating the percentage of green jobs in Vietnam in terms of the whole country and the economic regions, besides, pointing out the distinction of the professional qualifications and skills between green jobs and non-green jobs. Also, the research shows that human capital has a positive influence on the potential to promote green jobs. Additionally, the proportion of green jobs is also controlled by urbanization rate, trade openness and per capita income, in which per capita income has the biggest impact on the growth of green jobs. According to the findings, the results show a number of theoretical and practical implications.

In theory, firstly, the research has pioneered the method to specifically calculate the number of green jobs in Vietnam through the Labor Force Survey dataset and the green job codes obtained by converting between occupational classification tables. Secondly, the authors develop and analyze a research model of the relationship between human capital and green job growth in the period of 2018-2022. The study is expected to be a theoretical reference for future research to further develop the definition and measurement method of green jobs. Also, we hope the analysis on the impact of human capital on green job growth will contribute to providing policy implications for the Government to improve sustainable development strategies, focusing on development and reasonable utilization of current resources as well as paying attention to environmental protection and improving quality of life.

In practice, so far, Vietnam has not had a unified definition of green jobs although this term has been used commonly. Besides, “Developing human resources and green jobs” is one of the important solutions in implementing the National Green Growth Strategy in the period 2021-2030, so the Government needs to develop specific indicators to identify and measure green jobs as well as raise community awareness about green jobs. In addition, it is necessary to analyze comprehensively and conformably with the country's context on green job growth to propose policies and tasks timely to directly contribute to materializing the National Green Growth Strategy in Vietnam.

The research results show that human capital has an impact on promoting green job growth, which means that in the transition to a green economy, the Government needs to consider the labor market quality as an important solution of the transition. Firstly, the Government needs to propose reasonable methods to identify the skills and knowledge necessary to meet the green job demands in the future. Secondly, the Government can formulate policies focused on developing and forecasting human resource supply and demand in the context that Vietnam is transforming towards greening economic sectors, applying the circular economy model.

The research results also show that trade openness, urbanization rate and per capita income all have a positive impact on green job creation. As a result, in terms of foreign affairs, the Government needs to actively expand foreign trade and develop policies aimed at international cooperation. In terms of domestic affairs, the Government continues to maintain the country's urbanization rate; reduce human vulnerability to climate change through human-centered design; encourage responsible lifestyle of each individual towards the community and society in which income improvement is a direct motivation.

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ISSN: 2455-8834

Volume:09, Issue:03 "March 2024"

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