JOURNAL OF ECONOMIC DEVELOPMENT
Volume 50, Number 4, December 2025 

# SUSTAINABLE DEVELOPMENT STATUS IN CLMV COUNTRIES FOLLOWING ECONOMIC REFORM AND OPENNESS*

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This study examines the status and trends of sustainable development in the Kingdom of Cambodia, the Lao People`s Democratic Republic, the Republic of the Union of Myanmar, and the Socialist Republic of Viet Nam (CLMV) from 1990 to 2020. Using country-level panel data, it applies the Principal Common Factor (PCF) method to determine the weight of each Sustainable Development Goal (SDGs) and construct a Sustainable Development Index (SDI). Key findings include: First, Most SDGs, except Goals 5 and 15, display common patterns across CLMV countries, with significant improvements in people (Goals 1, 2, 3, 4), planet (Goals 6, 14), prosperity (Goals 7, 8, 9), and partnerships (Goal 17). Second, The SDI of CLMV countries shows a steady upward trajectory despite temporary shocks. Finally, the SDI trend closely aligns with per capita GDP, indicating economic reform and openness have enhanced sustainable development outcomes in these countries

*Keywords*: Sustainable Development; CLMV Countries; Principal Common Factor; Economic Reform and Openness
*JEL Classification*: C43; O53; P20

## 1. INTRODUCTION

In recent years, the growing severity of global challenges such as inequality and climate change has intensified discussion on development, shifting the focus beyond economic growth to include social and environmental dimensions. Within this context, the concept of sustainable development has gained more prominence. In the report *Our Common Future* (1987) by the World Commission on Environment and Development (WCED), sustainable development is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own

* This research was supported by the Korea University Grant (K2211681) of Korea.

needs."

In 2000, the United Nations (UN) proposed the Millennium Development Goals (MDGs) in response to the increasing demand for sustainable development, setting specific targets to be achieved by 2015. While the MDGs achieved significant progress in various areas, they also highlighted certain limitations, such as their abstract nature and predominant focus on low-income and middle-income economies (Fehling et al., 2013). To address these shortcomings, the UN introduced the Sustainable Development Goals (SDGs) in 2015, expanding and refining the framework established by the MDGs. The SDGs encompass 17 goals and 247 indicators, with the ambitious aim of achieving them by 2030 (UN SDGs).

As the world continues its efforts to achieve the SDGs, the Southeast Asian nations of the Kingdom of Cambodia (Cambodia), the Lao People`s Democratic Republic (Lao PDR), the Republic of the Union of Myanmar (Myanmar), and the Socialist Republic of Viet Nam (Vietnam) are actively pursuing these objectives. In addition to sharing the common aim of achieving the SDGs, these countries are distinguished by their experience as economies undergoing reform and openness. Kang and Jung (2019) describe this process, referred to as economic transition, as a shift from a centrally planned economy to a market-based system while retaining a single-party political framework.

Socialist countries predominantly embarked on reform and openness initiatives after the 1990s. These can be categorized into three distinct models: Germany, the former Soviet Union, and East Asia. First, Germany achieved reform and openness through the unification of East and West Germany, involving simultaneous changes in both the economic and political systems. Second, the Commonwealth of Independent States (CIS) countries, formerly part of the Soviet Union, adopted economic and political reforms, through their systems significantly influenced by Russia. Third, the CLMV countries retained their single-party political systems while reforming only their economic systems (Kang and Jung, 2019).

Several factors drove the reform and openness of socialist countries. Internally, the rejection of market mechanisms and private property within centrally planned economies resulted in diminished motivation and lower productivity. Externally, these systems faced the weakening of solidarity among socialist countries, compounded by economic recessions and the eventual dissolution of the Soviet Union (Kang et al., 2021). In response to these pressures, the CLMV countries adopted measures of economic reform and openness. Similarly, countries like Germany and the former Soviet states restructured their economies following the collapse of socialism. However, their transitions were marked by significant political and social upheaval. In contrast, the CLMV countries retained their single-party political systems while reforming their economic systems, a strategy that is credited with minimizing the disruptions faced by other transitioning nations (Kang and Jung, 2017).

The CLMV countries share a historical commonality of colonization: Cambodia, Lao PDR, and Vietnam were under the French colony, while Myanmar was a British colony.

Many countries that endured colonization during the era of imperialism continue to face persistent poverty, but the CLMV countries are gradually overcoming poverty-related challenges and making significant progress toward economic development.

This study examines the trends and status of sustainable development in the CLMV countries by deriving a Sustainable Development Index (SDI) following their economic reform and openness. Previous studies on the sustainable development of the CLMV countries include the Voluntary National Review (VNR) and Sachs et al. (2024). The VNRs published by Cambodia, Lao PDR, and Vietnam highlight their progress in implementing the SDGs. However, their significant limitation is their reliance on National Development Goals (NDGs), which makes it challenging to align with international standards. Furthermore, while the VNRs do not calculate an SDI, Sachs et al. (2024) calculate the SDIs to assess sustainable development more comprehensively.

Various methods have been employed in previous studies on the SDI, including Ranking (Qizilbash, 2001), Min-Max (Yu et al., 2010; Strezov et al., 2017), and Standardization (Lee and Huang, 2007). However, these studies do not incorporate all the goals and variables outlined in the SDGs, as VNRs attempt to do. This discrepancy makes it difficult to align these assessments fully with the overarching intentions and framework of the SDGs.

Unlike VNRs and other studies deriving the SDI, Sachs et al. (2024) standardized cross-sectional data across the 17 SDGs and calculated a simple average to derive SDI for CLMV countries. While this approach is valuable for comparing SDI between countries, it has limitations in evaluating sustainable development trends within a single country over time and in identifying the individual contributions of each goal to overall sustainable development. To address these limitations, this study aims to determine the contributions of each goal to sustainable development and incorporate these weights to a time-based calculation of the SDI (Kang et al., 2022; Kang et al., 2024). Specifically, SDG variables for the CLMV countries from 1990 to 2020 are identified, and the Principal Common Factor (PCF) method is employed to derive the SDI, offering a comprehensive and dynamic assessment of sustainable development.

The main findings are as follows: First, the CLMV countries exhibit similar trends for most SDGs. Notably, many goals (Goals 1, 2, 3, 4, 6, 7, 8, 9, 14, and 17) show consistent improvement following economic reforms and openness. However, some goals present unique patterns: Goal 10 fluctuates, Goal 12 follows a U-shaped trend, and Goal 13 experiences a decline. Second, differences are observed across the CLMV countries. For Goal 5, Cambodia and Myanmar show an improving trend, while Lao PDR and Vietnam do not. Similarly, varying patterns are evident in Goals 11, 15, and 16 across the four countries. Third, with many goals exhibiting upward trends, the overall SDI for the CLMV countries reflects steady improvement. Although temporary shocks, such as natural disasters, have occurred, these have not significantly disrupted the upward trajectory. Furthermore, a similar trend is observed when comparing SDI with GDP per capita, indicating that the CLMV countries have made significant progress in both sustainable development and economic growth since adopting economic reform and openness.

This paper is organized as follows: Section 2 reviews previous studies on economic reform, openness, and sustainable development in the CLMV countries. Section 3 details the methodology and data used to construct the SDI for the CLMV countries. Section 4 presents the estimation results of the SDI, and Section 5 concludes with key findings and implications.

## 2. LITERATURE REVIEW

The CLMV countries initiated economic reforms and openness during the 1980s and 1990s, implementing a range of policies to facilitate this transition.[1] Table 1 summarizes the key policies enacted by the CLMV countries for economic reform and openness. These policies can be categorized into four areas: privatization of land and enterprises, price liberalization, macroeconomic and financial stabilization, and opening to external relations. Although the timing of these policy implementations differed among the countries, a notable commonality was their adoption of a gradual approach to ensure stability during the reform and opening process.

Although economic outcomes varied by country following the reforms and openness, the CLMV countries commonly experienced significant improvements in economic performance, particularly in terms of GDP, GDP per capita, and foreign direct investment (FDI). Since the onset of reforms, GDP increased remarkably in each country: 399% in Cambodia, 1,085% in Lao PDR, 923% in Myanma, and 884% in Vietnam. Similarly, GDP per capita and FDI also showed overall growth across the CLMV countries, reflecting the positive economic impacts of their reform and openness policies.

While the CLMV countries have achieved significant economic growth following reforms and openness, these changes have brought both positive and negative impacts on society and the environment. On the positive side, there have been improvements in education and healthcare services. However, negative consequences have also emerged, including increasing inequality between urban and rural areas, deforestation, and a decline in biodiversity. As the CLMV countries continue to evolve post-reform, assessing their progress in sustainable development through objective SDG indicators has become a critical task.

As related research, three CLMV countries-Cambodia, Lao PDR, and Vietnam- have published VNRs on their implementation of the SDGs, while Myanmar has not. The Cambodia VNR (2023) highlights progress in poverty reduction, hunger alleviation, and national health improvements. However, challenges remain in education and

[1] The starting years of economic openness and reform are 1993 (Cambodia), 1986 (Lao PDR), 1988 (Myanmar) and 1986 (Vietnam).

environmental management. The report also emphasizes the critical role of financing in advancing future sustainable development. The Lao PDR VNR (2024) documents improvements in poverty alleviation and health but identifies a pressing need to enhance the collection and analysis of environmental data to support effective SDG monitoring. The Vietnam VNR (2023) describes achievements in poverty reduction and health improvements. Nonetheless, the report outlines challenges for sustainable development, particularly addressing social inequality and expanding renewable energy supplies to meet environmental sustainability goals.

**Table 1**. Reform and Openness Policy in the CLMV Countries

| Category | Cambodia | Lao PDR | Myanmar | Vietnam |
|---|---|---|---|---|
| Privatization | - Initiation of State-Owned Enterprises Reform (1989)<br>- Enactment of Land Law (1992)<br>- Enactment of Enterprise Law (2005) | - Enactment of Land Law (1997)<br>- Enactment of Enterprise Law (2005) | - Enactment of Private Industrial Enterprise Law (1990) | - Enactment of Legislation related to the reform of State-Owned Enterprises (1987)<br>- Promulgation of Land Law (1988) |
| Liberalization | Abolition of Price Controls (1994) | Implementation of Price liberalization (1987) | Price liberalization of essentials (1988) | Implementation of Price liberalization (1987-1989) |
| Stabilization | Enactment of Bank Law (1999) | Establishment of Stock Exchange (2010) | Enactment of Financial Institutions Law and Central Bank Law (1990) | Enactment of the State Bank Law, Financial Institutions Law (1990) |
| Openness | - Enactment of Foreign Investment Law (1989)<br>- WTO membership (2004) | - Enactment of Foreign Investment Promotion Law (1988)<br>- ASEAN membership (1997) | - Enactment of Foreign Investment Law (1988)<br>- Promulgation of Special Economic Zones Law (2011) | - Promulgation of Foreign Investment Law (1987)<br>- WTO membership (2007) |

*Notes*: () is enactment year

*Sources*: Adapted and modified by the author based on Montes et al. (1995), Leung and Vo (1996), Han (2002), Gunawardana and Sisombat (2008), Union of Myanmar (2011), Choi et al. (2020), and Kang et al. (2021).

A key commonality across the VNRs of the CLMV countries is the documented progress in implementing the SDGs, particularly in areas like poverty reduction and health improvement, which directly impact individual well-being. At the same time, the VNRs emphasize the need for further societal and environmental improvements, including addressing climate change and reducing inequality. However, there are notable limitations in using the VNRs to assess each country's sustainable development comprehensively. First, the indicators in the SDGs are not fully aligned with those in the VNRs, as countries often adapt goals and indicators to fit their specific context. Second, the VNRs provide valuable insights into the status of individual indicators, they lack aggregated figures or indices that reflect overall sustainable development progress.

**Table 2**. Economic Performance of the CLMV Countries

| Cambodia | 1993 | 2020 | Myanmar | 1988 | 2020 |
|---|---|---|---|---|---|
| GDP | 5,775 | 23,024 | GDP | 6,377 | 69,198 |
| GDP per capita | 564 | 1,404 | GDP per capita | 164 | 1,295 |
| FDI | 54 | 3,625 | FDI | 0 | 1,907 |
| Lao PDR | 1986 | 2020 | Vietnam | 1986 | 2020 |
| GDP | 2,325 | 18,584 | GDP | 36,666 | 323,972 |
| GDP per capita | 604 | 2,539 | GDP per capita | 599 | 3,352 |
| FDI | 0 | 968 | FDI | 0 | 15,800 |

*Notes*: GDP and FDI are in millions of US dollars, and Real GDP and GDP per capita are in 2015 US dollars.
*Sources*: World Bank, WDI (2024).

To comprehensively assess the status of the SDGs, there are useful studies deriving SDI for countries or cities outside the CLMV countries. These studies often utilize methodologies outlined by the OECD (2008). For example, Qizilbash (2001) calculated the SDI by ranking six sustainable development-related variables across 59 countries. Yu et al. (2010) and Strezov et al. (2017) employed the Min-Max method to derive the SDI for Yantai and 114 countries, respectively. Lee and Huang (2007) used the standardization to calculate the SDI for Taipei, incorporating 51 variables. Despite their contributions, these studies share a limitation with the VNRs-they only utilize a subset of the indicators specified in the SDGs, making it challenging to fully capture the comprehensive nature of sustainable development.

Second, Sachs et al. (2024) calculated the SDI for each country using the 98 SDGs indicators. Their methodology involves several steps. First, the values of variables for each country, corresponding to each goal, are standardized. Next, the average value of standardized variables for each goal is computed, resulting in an index value for each goal. Finally, the SDI for each country is determined by averaging the index values of all 17 SDGs. This approach produces an SDI based on cross-sectional analysis, enabling a comparative assessment of each country's relative position among nations for a given year.

The 2024 SDI results for the CLMV countries are as follows: Cambodia achieved an SDI score 64.9, ranking 104th out of 167 countries; Lap PDR scored 63.0, placing 119th; Myanmar followed closely with a score of 62.8. ranked 120th; and Vietnam performed significantly better, ranking 54th with a score of 73.3. All four countries displayed strong performance in Goal 12 (responsible consumption and production) and Goal 13 (climate action). However, they faced challenges in Goal 15 (life on land). Additionally, Cambodia, Lao PDR, and Myanmar, excluding Vietnam, showed weakness in Goal 9 (industry, innovation and infrastructure).

Unlike the VNRs, the study of Sachs et al. (2024) provides valuable insights by enabling a global comparison of sustainable development levels across individual countries. However, it has considerable limitations, particularly in its inability to track the progress of sustainable development within individual countries over time. Monitoring trends over time is essential for assessing each country's advancement toward achieving the SDGs. Additionally, the SDI in Sachs et al. (2024) is derived from a simple average of the individual goals indices, which fails to capture the relative contribution of each goal to overall sustainable development.

Third, Kang et al. (2022) and Kang et al. (2024) conducted analyses on the sustainable development of the Democratic People's Republic of Korea (North Korea) and the People`s Republic of China (China) respectively. Both studies employed an advanced methodology for calculating the SDI by using factor analysis to determine the impact of each goal on the SDGs. This approach enabled the derivation of a time-series SDI, illustrating trends in sustainable development over time. Building on these methodologies, this study examines the extent to which each goal contributes to sustainable development. However, unlike the previous studies, it identifies factors according to the categories established by the UN (2015). Furthermore, this study evaluates the sustainable development of the CLMV countries by calculating their SDIs over time.

## 3. DATA DESCRIPTION AND ANALYSIS METHOD

The sustainable development of the CLMV countries is analyzed based on the available variables among the 247 indicators (or variables) listed by the UN SDGs.[2] These variables differ across countries and are summarized in Table 3. The observation period spans from 1990 to 2020, utilizing statistical data from various international organizations, including the UN SDGs, World Bank, WHO, IHME, UNICEF, and UNESCO. Following the UN (2015) framework, the 17 SDGs are categorized into five thematic areas; People, Planet, Prosperity, Peace, and Partnership. Table 3 outlines these categories as defined by the goals.[3]

[2] Among the 247 variables, there are duplicate variables for each goal. This means that a change in that variable can affect several goals. (1)8.4.1/12.2.1 (2)8.4.2/12.2.2 (3)10.3.1/16.b.1 (4)10.6.1/16.8.1 (5) 15.7.1/15.c.1 (6) 15.a.1/15.b.1 (7) 1.5.1/11.5.1/13.1.1 (8)1.5.3/11.b.1/13.1.2 (9)1.5.4/11.b.2/13.1.3 (10)4.7.1/12.8.1/13.3.1 (11)7.b.1/12.a.1 (12)13.2.1/13.b.

[3] Some studies categorized the 17 SDGs into three categories: Economy, Social, and Environment. According to the UN (2015), People, Planet, and Prosperity can correspond to the categories Social, Environment, and Economy, respectively. Achieving goals in these three categories requires Peace and Partnership. Therefore, this study utilizes the UN's 5P categories to comprehensively analyze SDGs, as it can effectively capture the essence of the SDGs' objectives.

Using the time-series data for the SDGs, this study examines the impact of each goal on sustainable development, and calculates the SDI based on these impacts. The methodology follows these steps. First, instead of using the raw available variables directly, they are treated as observed variables corresponding to each goal. Missing data during the observation period is imputed through linear interpolation. If the actual observation period for a variable is shorter than the study's observation period, the most recent available data value is used as a proxy. To ensure across variables with different measurement units, each variable is standardized. Variables that indicate negative outcomes are reversed to ensure a consistent interpretation of direction across all metrics. The standardized variables (*N*) related to each goal are aggregated, and the average value ($z_{t,p}$) for goal *p* at *t* time is calculated as shown in Equation (1).

$$z_{t,p} = \frac{z_{t,1} + z_{t,2} + \cdots + z_{t,N}}{N}. \quad (1)$$

**Table 3**. Observed Variables by SDGs of the CLMV Countries

| Category | Goal | | UN SDGs | Cambodia | Lao PDR | Myanmar | Vietnam |
|---|---|---|---|---|---|---|---|
| People | 1 | No Poverty | 13 | 7 | 7 | 7 | 8 |
| | 2 | Zero Hunger | 14 | 8 | 6 | 8 | 10 |
| | 3 | Good Health and Well-being | 28 | 25 | 25 | 25 | 25 |
| | 4 | Quality Education | 12 | 7 | 7 | 7 | 7 |
| | 5 | Gender Equality | 14 | 6 | 6 | 5 | 5 |
| Planet | 6 | Clean Water and Sanitation | 11 | 7 | 6 | 6 | 6 |
| Prosperity | 7 | Affordable and Clean Energy | 6 | 6 | 6 | 6 | 6 |
| | 8 | Decent Work and Economic Growth | 16 | 12 | 12 | 13 | 14 |
| | 9 | Industry, Innovation and Infrastructure | 12 | 10 | 9 | 10 | 10 |
| | 10 | Reduced Inequality | 14 | 5 | 6 | 6 | 7 |
| | 11 | Sustainable Cities and Communities | 14 | 4 | 4 | 3 | 4 |
| Planet | 12 | Responsible Consumption and Production | 13 | 4 | 3 | 5 | 5 |
| | 13 | Climate Action | 8 | 2 | 2 | 2 | 2 |
| | 14 | Life below Water | 10 | 4 | 0 | 4 | 4 |
| | 15 | Life on Land | 14 | 7 | 7 | 7 | 7 |
| Peace | 16 | Peace, Justice and Strong Institutions | 24 | 9 | 7 | 8 | 8 |
| Partnership | 17 | Partnership for the Goals | 24 | 11 | 9 | 11 | 9 |
| | | Total | 247 | 134 | 122 | 133 | 137 |

*Notes*: Since Lao PDR does not have an ocean, there are no variables for Goal 14.

Second, the Principal Common Factor (PCF) method is applied to identify latent factors and describe their relationship with the observed data, following methodologies outlined by Lattin et al. (2003) and Kim (2016). The PCF method estimates the correlations between unobserved (latent) factors and the 17 SDGs, allowing for a deeper understanding of how these goals contribute to sustainable development. Using the factor loadings as weights, the SDI for each country is calculated, resulting in the derivation of the following Equation (2). This equation encapsulated the weighted contributions of the goals, based on the latent factor correlations, to the overall SDI.

$$z_{t,p} = \lambda_{p,1}\xi_{t,1} + \lambda_{p,2}\xi_{t,2} + +\lambda_{p,k}\xi_{t,k} + \delta_{t,p}. \tag{2}$$

In equation (2), $z_{t,p}$ is the observed variable at *t* time of goal $p$, $\lambda_{p,k}$ is the factor loading between goal $p$ and factor $k$, $\xi_{t,k}$ is the latent factor at *t* time of factor *k*, and $\delta_{t,p}$ is the error term at *t* time of goal $p$. In equation (2), the observed variable ($z_{t,p}$) at *t* time of goal $p$ is influenced by latent factors ($\xi_{t,k}$) through their corresponding factor loadings ($\lambda_{p,k}$), with any residual variation not explained by the latent factors captured by the error term ($\delta_{t,p}$). Equation (2) can be extended to include all 17 goals and represented in matrix form, as shown in Equation (3).

$$Z = \Xi\Lambda' + \Delta, \tag{3}$$

$$[Z_1 \quad \cdots \quad Z_{17}] = [\Xi_1 \quad \cdots \quad \Xi_K][\Lambda_1 \quad \cdots \quad \Lambda_K]' + [\Delta_1 \quad \cdots \quad \Delta_{17}]$$

$$Z_p = \begin{bmatrix} z_{1990,p} \\ \vdots \\ z_{2020,p} \end{bmatrix}, \ \Xi_k = \begin{bmatrix} \xi_{1990,k} \\ \vdots \\ \xi_{2020,k} \end{bmatrix}, \ \Lambda_k = \begin{bmatrix} \lambda_{p,k} \\ \vdots \\ \lambda_{p,k} \end{bmatrix}, \ \Delta_p = \begin{bmatrix} \delta_{1990,p} \\ \vdots \\ \delta_{2020,p} \end{bmatrix}.$$

In Equation (3), *Z* is the observed variable matrix, *Ξ* is the latent factor matrix, *Λ* is the factor loading matrix, and *Δ* is the error term matrix. There are three assumptions to estimate the factor loading based on equation (3).

$$\frac{1}{T-1}\Xi'\Xi = I, \tag{4}$$

$$\Theta = \frac{1}{T-1}\Delta\Delta' = \begin{bmatrix} \theta_{11}^2 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \theta_{PP}^2 \end{bmatrix}, \tag{5}$$

$$\Xi'\Delta = 0. \tag{6}$$

By applying the assumptions outlined in Equations (4), (5), and (6), Equation (3) can be transformed into Equation (7). Specifically, the latent variable matrix (*Ξ'Ξ*) satisfies the identity (*I*) property, the error term matrix (*ΔΔ*') reflects the individual error variances ($\theta_{pp}^2$), and the product of the latent variable and error term matrices ($\Xi'\Delta$) is zero.

In Equation (7), $\hat{R}$ represents the covariance matrix, $\Lambda\Lambda'$ is the common variance matrix, and $\Theta$ is the error variance matrix. The covariance matrix reflects the correlations among the observed variables and is decomposed into two components: the common variance ($\Lambda\Lambda'$), which captures the relationship between the latent factors and the observed variables, and the error variance($\Theta$). The common variance matrix can be further decomposed into eigenvalues ($D$) and eigenvectors ($U$), as shown in equation (8). The eigenvalues and eigenvectors are calculated for each of the $P$ observed variables, and based on the Kaiser-Guttman criterion, a subset of $K$ out of $P$ is selected. Using the property that the common variance can be decomposed, the factor loadings are estimated as shown in Equation (9).

$$\hat{R} = \Lambda\Lambda' + \Theta, \tag{7}$$

$$\Lambda\Lambda' = UDU', \tag{8}$$

$$\Lambda = UD^{\frac{1}{2}}. \tag{9}$$

Factor rotation is applied to the estimated factor loadings ($\Lambda$) to enhance interpretability, and this study employs Varimax factor rotation. Varimax rotation is an orthogonal method that maximizes the sum of the squared factor loadings, ensuring that each observed variable is strongly associated with a single factor, thereby simplifying the structure of the factor loadings.

$$w_p = \frac{[max(factor\ loading\ of\ Z_p)]^2}{\sum_{p=1}^{17}[max(factor\ loading\ of\ Z_p)]^2}. \tag{10}$$

$$SD\ Index_t = \sum_{p=1}^{17} w_p z_{t,p}. \tag{11}$$

After estimating the rotated factor loadings, the maximum factor loading for each goal is identified, and these maximum values are used as weights for each goal ($w_p$), as shown in Equation (10). Finally, the SDI for year $t$, as expressed in Equation (11), is calculated by multiplying the standardized values of each goal at year $t$ ($z_{t,p}$) by their respective weights $w_p$ and summing them.

## 4. DERIVATION OF SUSTAINABLE DEVELOPMENT INDEX

Figures 1 to 4 illustrate the trends of each category for the CLMV countries. Figure 1 focuses on the trends for the People category. overall, Goals 1, 2, 3, and 4 exhibit an upward trend across the CLMV countries. However, for Goal 1, Cambodia, Lao PDR, and Myanmar experienced a negative shock, primarily due to an increase in the death rate from exposure to the forces of nature.

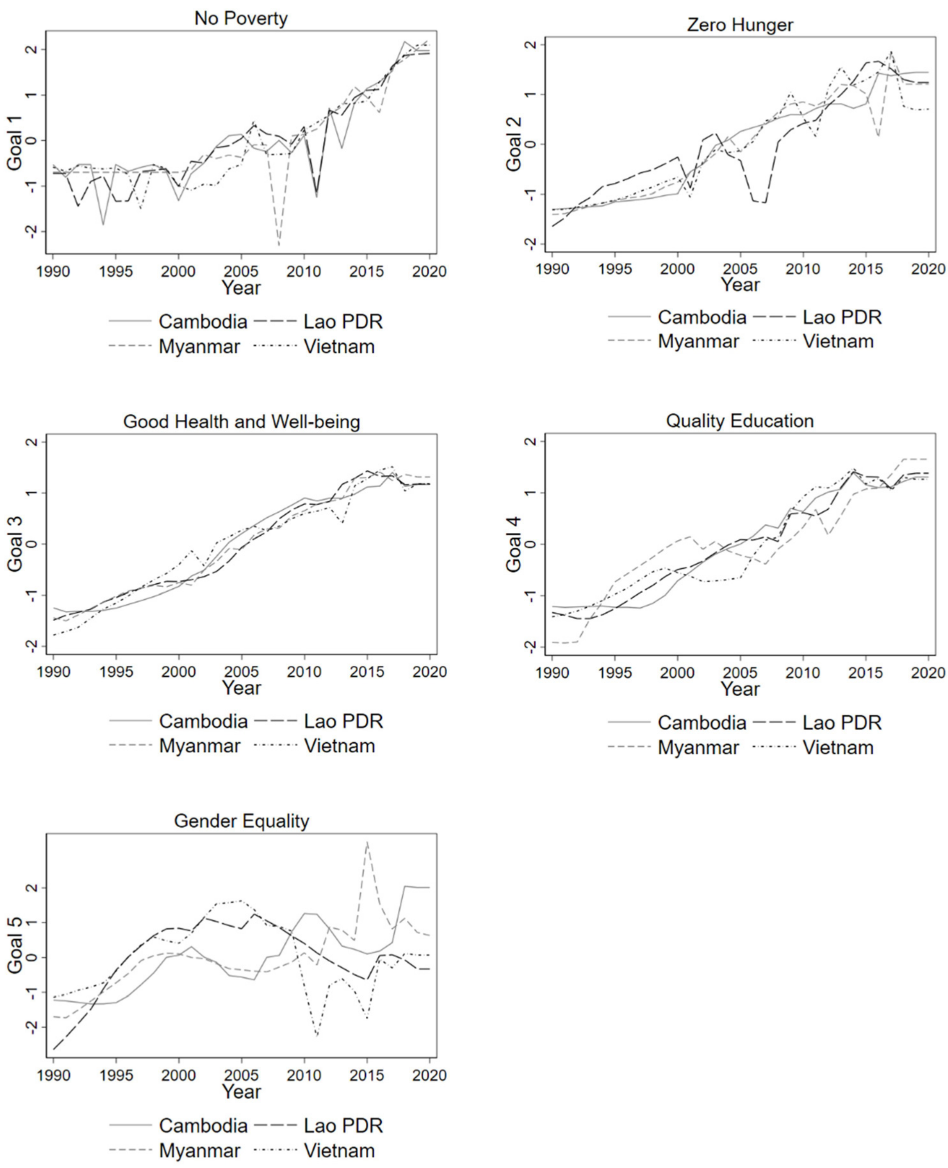


**Figure 1**. Trends of People (Goals 1,2,3,4,5) of the CLMV Countries

Goal 2 shows a negative shock in Lao PDR, where the proportion of local breeds classified as being at risk increased significantly, from 25% in 2005 to 50% in 2006. Fortunately, this shock proved to be temporary. However, for Goal 5, the CLMV countries exhibit differing trends. Cambodia and Myanmar demonstrate an overall upward trend, albeit with fluctuations, while Lao PDR and Vietnam display an inverted U-shaped trend. For example, Vietnam experienced a temporary decline in the contraceptive prevalence of modern methods ratio in 2011 and 2015.

Figure 2 presents the trends of the Planet category, reflecting the environmental status of the CLMV countries. Goals 6 and 14 show positive progress, with improvement in water supply and sanitation supported by increased official development assistance (ODA) contributing to Goal 6. Goal 12 exhibits a U-shaped trend, initially declining during the 2000s due to factors such as material footprint and fossil-fuel subsidies but recovering in the 2010s as environmental initiatives gained momentum. In contrast, Goal 13 shows a worsening trend, driven by rising carbon emissions and the impacts of natural disasters. For instance, the increase in per capita carbon dioxide emissions across the CLMV countries contributes to the decline in Goal 13. Additionally, several shocks are evident in Goal 13, including a sharp rise in the death rate due to exposure to forces of nature. Two different trends emerge in Goal 15, while Myanmar and Vietnam are improving, Cambodia and Lao PDR experience a decline.

Figure 3 presents the trends for goals within the Prosperity category. Several goals, including Goals 7,8, and 9, display an upward trend across the CLMV countries. In contrast, Goal 10 shows fluctuating trends, with Lao PDR experiencing a temporary shock caused by an increase in the number of deaths and disappearances recorded during migration. Regarding differences among the countries, Goal 11 demonstrates a recent upward trend for Cambodia, Lao PDR, and Vietnam. Myanmar shows a slightly downward trend and a temporary shock in 2008, when the death rate from exposure to forces of nature surged dramatically from 0 in 2007 to 279 in 2008.[4]

Figure 4 shows trends of the Peace and Partnership category. For Goal 16, Lao PDR and Myanmar exhibit an upward trend, while Cambodia and Vietnam show fluctuating trends. Myanmar’s improvement is reflected in most variables, except for the Corruption Perception Index, which remains a challenge. Conversely, Cambodia faced a shock in the 2010s due to an increase in the age-standardized prevalence of physical violence and sexual violence. Vietnam encountered a significant shock in 2016, driven by an increase in conflict-related deaths. Unlike Goal 16, Goal 17 exhibits an upward trend across the CLMV countries. For instance, net FDI inflows have increased, and other indicators, such as tariff rates, also demonstrate improving trends.

Using data for the 17 goals (observed variables), the weight of each goal is calculated, and the SDI for the CLMV countries is derived based on these weights. The process involves several steps, starting with the estimation of eigenvalues for each latent factor. As shown in Table 4, eigenvalues for the latent factors are estimated using the

[4] In 2008, Myanmar experienced a cyclone that resulted in 140,000 deaths.

PCF method, which determines 17 latent factors-one for each goal, as the method sets the number of latent factors equal to the number of goals.

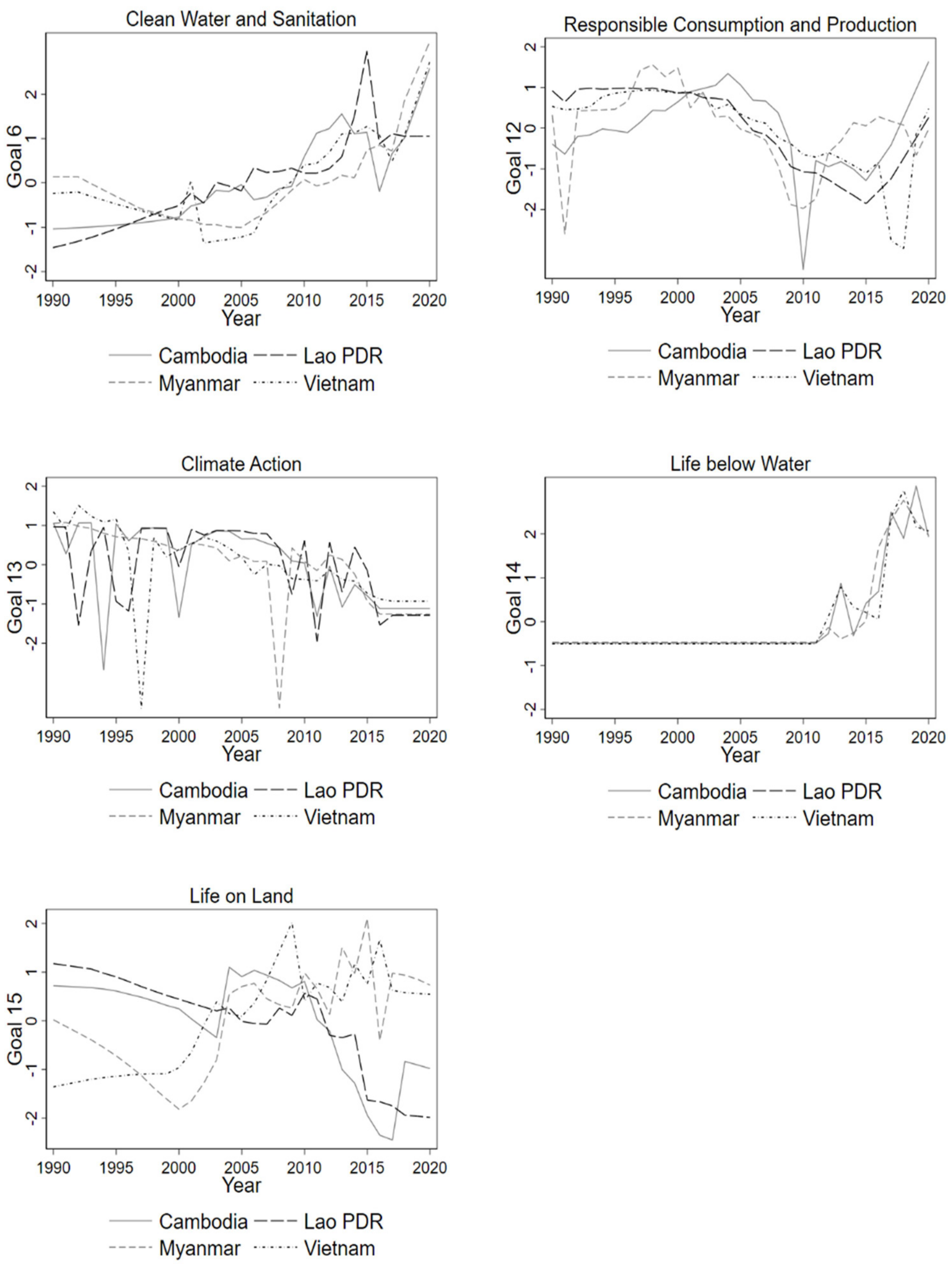


**Figure 2**. Trends of Planet (Goals 6,12,13,14,15) of the CLMV Countries

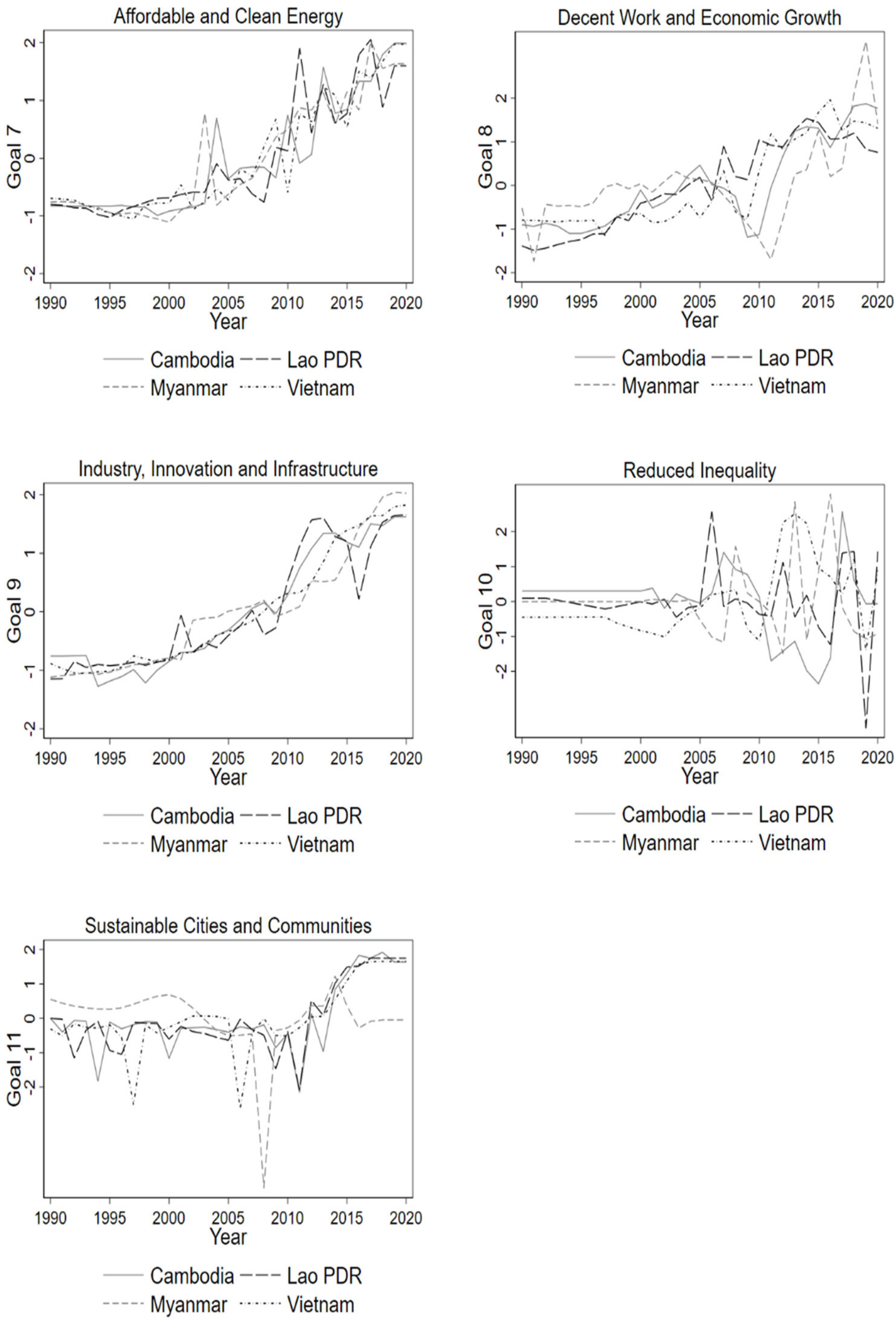


**Figure 3**. Trends of Prosperity (Goals 7,8,9,10,11) of the CLMV Countries

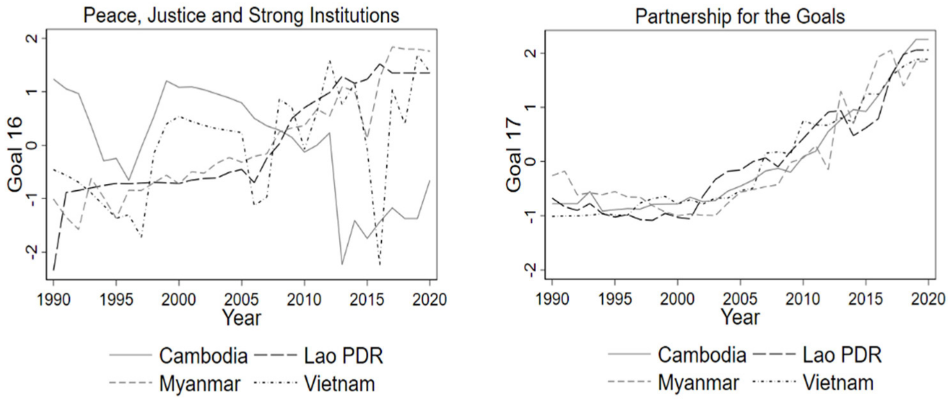


**Figure 4**. Trends of Peace and Partnership (Goals 16,17) of the CLMV Countries

**Table 4**. Eigenvalues of Each Latent Factor of the CLMV Countries

| Factor | Cambodia | | Lao PDR | | Myanmar | | Vietnam | |
|---|---|---|---|---|---|---|---|---|
| | Eigenvalue | Cumulative | Eigenvalue | Cumulative | Eigenvalue | Cumulative | Eigenvalue | Cumulative |
| 1 | 11.304 | 0.665 | 11.103 | 0.694 | 10.196 | 0.600 | 11.212 | 0.660 |
| 2 | 1.753 | 0.768 | 1.393 | 0.781 | 2.138 | 0.726 | 1.617 | 0.755 |
| 3 | 1.122 | 0.834 | 1.155 | 0.853 | 1.532 | 0.816 | 1.191 | 0.825 |
| 4 | 0.886 | 0.886 | 0.908 | 0.910 | 1.010 | 0.875 | 0.879 | 0.876 |
| 5 | 0.780 | 0.932 | 0.624 | 0.949 | 0.924 | 0.929 | 0.620 | 0.913 |
| 6 | 0.329 | 0.951 | 0.256 | 0.965 | 0.454 | 0.956 | 0.502 | 0.942 |
| 7 | 0.316 | 0.970 | 0.160 | 0.975 | 0.227 | 0.969 | 0.415 | 0.967 |
| 8 | 0.166 | 0.980 | 0.125 | 0.983 | 0.173 | 0.980 | 0.211 | 0.979 |
| 9 | 0.140 | 0.988 | 0.100 | 0.989 | 0.106 | 0.986 | 0.153 | 0.988 |
| 10 | 0.066 | 0.992 | 0.068 | 0.993 | 0.096 | 0.992 | 0.060 | 0.992 |
| 11 | 0.050 | 0.995 | 0.045 | 0.996 | 0.047 | 0.994 | 0.049 | 0.995 |
| 12 | 0.043 | 0.997 | 0.024 | 0.998 | 0.030 | 0.996 | 0.032 | 0.997 |
| 13 | 0.028 | 0.999 | 0.018 | 0.999 | 0.026 | 0.998 | 0.024 | 0.998 |
| 14 | 0.008 | 0.999 | - | - | 0.021 | 0.999 | 0.015 | 0.999 |
| 15 | 0.006 | 1.000 | 0.012 | 1.000 | 0.013 | 0.999 | 0.012 | 1.000 |
| 16 | 0.002 | 1.000 | 0.005 | 1.000 | 0.009 | 1.000 | 0.008 | 1.000 |
| 17 | 0.002 | 1.000 | 0.004 | 1.000 | 0.001 | 1.000 | 0.001 | 1.000 |
| Total | 17.000 | 1.000 | 17.000 | 1.000 | 17.000 | 1.000 | 17.000 | 1.000 |

*Notes*: The number of SDGs goals in Lao PDR is 16, and the number of factors is the same.

Since the standardized data for each goal is used in this study, the sum of the eigenvalues of the latent factors equals 17, matching the total number of goals. Based on the Kaiser criterion, only latent factors with eigenvalues greater than 1 are included in the analysis. For Cambodia, Lao PDR, and Vietnam, latent Factors 1, 2, and 3 have eigenvalues greater than 1, while in Myanmar, the latent factors 1, 2, 3, and 4 meet this criterion. As a result, Cambodia, Lao PDR, and Vietnam select latent factors 1, 2, 3, whereas Myanmar includes latent Factors 1, 2, 3, 4. The selected factors explain 83.4%, 85.3%, 87.5%, and 82.5% for Cambodia, Lao PDR, Myanmar, and Vietnam, respectively.

**Table 5**. Rotated latent Factors and Variances

| Factor | Cambodia | | Lao PDR | | Myanmar | | Vietnam | |
|---|---|---|---|---|---|---|---|---|
| | Variance | Cumulative | Variance | Cumulative | Variance | Cumulative | Variance | Cumulative |
| 1 | 7.477 | 0.440 | 11.067 | 0.692 | 9.675 | 0.569 | 7.613 | 0.448 |
| 2 | 4.714 | 0.717 | 1.347 | 0.776 | 1.988 | 0.686 | 4.449 | 0.710 |
| 3 | 1.988 | 0.834 | 1.237 | 0.853 | 1.808 | 0.792 | 1.957 | 0.825 |
| 4 | - | - | - | - | 1.405 | 0.875 | - | - |

**Table 6**. Selected Factor Loading of the CLMV Countries

| | Cambodia | Lao PDR | Myanmar | Vietnam |
|---|---|---|---|---|
| Goal 1 | 0.751 | 0.919 | 0.873 | 0.645 |
| Goal 2 | 0.896 | 0.924 | 0.902 | 0.896 |
| Goal 3 | 0.904 | 0.975 | 0.944 | 0.886 |
| Goal 4 | 0.908 | 0.979 | 0.895 | 0.861 |
| Goal 5 | 0.885 | 0.893 | 0.747 | -0.917 |
| Goal 6 | 0.877 | 0.924 | 0.771 | 0.597 |
| Goal 7 | 0.737 | 0.894 | 0.939 | 0.711 |
| Goal 8 | 0.694 | 0.933 | 0.653 | 0.720 |
| Goal 9 | 0.819 | 0.928 | 0.981 | 0.767 |
| Goal 10 | 0.715 | 0.670 | 0.515 | 0.590 |
| Goal 11 | 0.906 | 0.706 | 0.823 | 0.871 |
| Goal 12 | 0.794 | -0.845 | 0.654 | -0.669 |
| Goal 13 | -0.496 | 0.588 | -0.720 | -0.761 |
| Goal 14 | 0.778 | - | 0.821 | 0.741 |
| Goal 15 | -0.728 | -0.922 | 0.690 | 0.863 |
| Goal 16 | -0.593 | 0.946 | 0.958 | 0.662 |
| Goal 17 | 0.735 | 0.933 | 0.912 | 0.768 |

In the second step, factor rotation is applied to the selected latent factors to improve interpretability. Table 5 presents the variance of the latent factors after factor rotations. In Cambodia, the rotated factors collectively explained 83.4% of the total variance, consistent with the variance before rotation. However, the variance attributed to Factor 1 decreased, while the variances of Factors 2 and 3 increased. Similarly, in Lao PDR, Myanmar, and Vietnam, the total variance remained unchanged after rotation, with only the variance contribution of each factor being adjusted.

In the third step, the highest factor loading for each goal is identified to determine its contribution to the SDI. For instance, in Cambodia, the factor loadings for Goal 1 across Factors 1, 2, and 3 are 0.579, 0.751, and 0.062, respectively Since the factor loading in Factor 2 is the highest, the value 0.751 from Factor 2 is selected as the factor loading for Goal 1.[5] This process is repeated for all goals, and the selected factor loading values are summarized in Table 6.

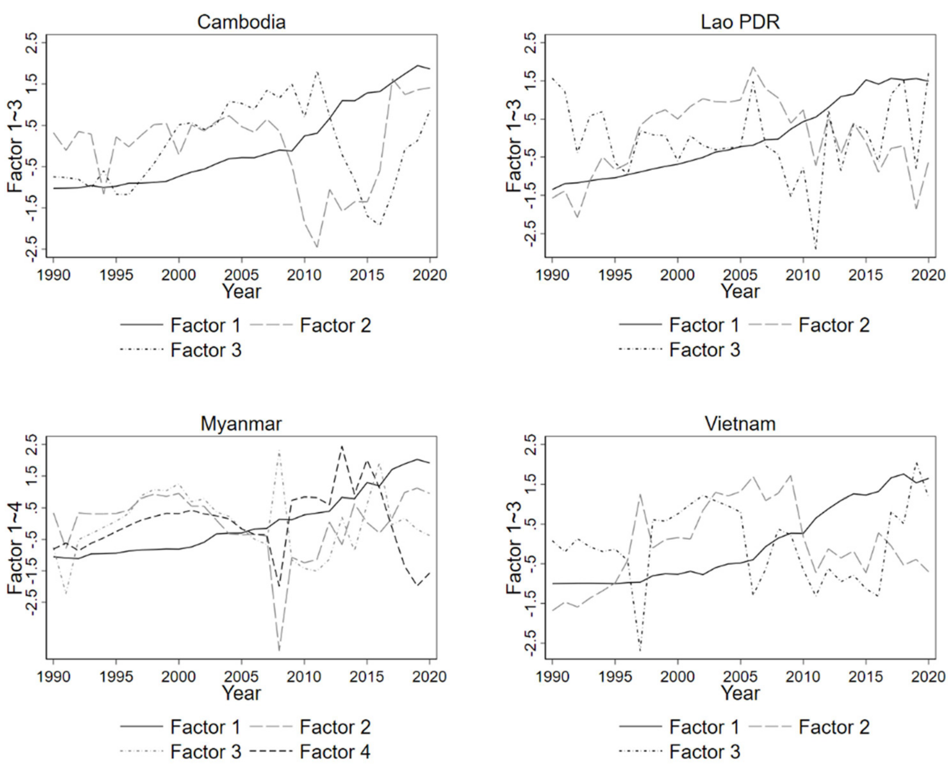


**Figure 5**. Trends of Selected Factors

5 Tables showing the factors and their loadings for the CLMV are presented in the appendix.

Figure 5 presents the trends of the selected factors over time for each CLMV country. Factor 1 shows an increasing trend across all four countries. Among the five goals with the highest factor loadings in Factor 1, Goals 2, 3, and 4 are consistently selected across the CLMV countries, indicating that Factor 1 is strongly associated with indicators in the People category. The remaining factors display more variable trends. For Factor 2, no goals are commonly selected across all four counties; however, Goals 8, 11, 13, and 14 are frequently identified, suggesting that Factor 2 may reflect indicators from both the Planet and Prosperity categories. In Factor 3, Goal 10 emerges as highly relevant across all four countries. Additionally, in Myanmar's Factor 4, Goal 5 is identified as particularly significant.

In the fourth step, the weight of each goal is calculated using the selected factor loadings. Table 7 presents the weights of each goal across the CLMV countries. In Cambodia, Goal 4 is estimated to have the highest weight at 7.9%. Analyzing the top five goals with the highest weights reveals that Cambodia and Vietnam prioritize goals predominantly in the People category, and Myanmar and Lao PDR focus more on goals in the Peace and Partnership category. This reflects variations in development priorities among the CLMV countries.

**Table 7**. Weight of Each Goal

| | Cambodia | Lao PDR | Myanmar | Vietnam |
|---|---|---|---|---|
| Goal 1 | 0.054 | 0.068 | 0.067 | 0.042 |
| Goal 2 | 0.077 | 0.069 | 0.071 | 0.080 |
| Goal 3 | 0.078 | 0.077 | 0.078 | 0.078 |
| Goal 4 | 0.079 | 0.077 | 0.070 | 0.074 |
| Goal 5 | 0.075 | 0.064 | 0.049 | 0.084 |
| Goal 6 | 0.073 | 0.069 | 0.052 | 0.036 |
| Goal 7 | 0.052 | 0.064 | 0.077 | 0.051 |
| Goal 8 | 0.046 | 0.070 | 0.037 | 0.052 |
| Goal 9 | 0.064 | 0.069 | 0.084 | 0.059 |
| Goal 10 | 0.049 | 0.036 | 0.023 | 0.035 |
| Goal 11 | 0.078 | 0.040 | 0.059 | 0.076 |
| Goal 12 | 0.060 | 0.058 | 0.037 | 0.045 |
| Goal 13 | 0.024 | 0.028 | 0.045 | 0.058 |
| Goal 14 | 0.058 | - | 0.059 | 0.055 |
| Goal 15 | 0.051 | 0.069 | 0.042 | 0.075 |
| Goal 16 | 0.034 | 0.072 | 0.080 | 0.044 |
| Goal 17 | 0.052 | 0.070 | 0.073 | 0.059 |
| Total | 1.000 | 1.000 | 1.000 | 1.000 |

In the final step, the SDI is derived using the weights and data for each goal. Figure 6 illustrates the SDI alongside GDP per capita for the CLMV countries from 1990 to

2020. The SDI in all four countries demonstrates an overall upward trend, although temporary shocks are evident, primarily due to natural disasters such as Cyclone Nargis in Myanmar in 2008 and Typhoon Linda in Vietnam in 1997. While the CLMV countries exhibit varying trends for certain goals, such as Goal 5 and Goal 15, most goals show a consistent increase over time, contributing to the overall upward trajectory of the SDI. Notably, despite Goal 5 and Goal 15 holding significant weights in Vietnam, their influence does not substantially affect the overall upward trend of the SDI. This indicates that progress in other goals largely drives the observed growth in sustainable development.

The trends of the SDI and GDP per capita are similar in the CLMV countries. Both indicators show an increasing trend. Although GDP per capita varies across the CLMV countries, it highlights that the CLMV countries have maintained consistent economic growth since the period of reform and openness. The increasing trend of SDI also indicates that the CLMV countries have made progress not only in economic growth but also in sustainable development since reform and openness.

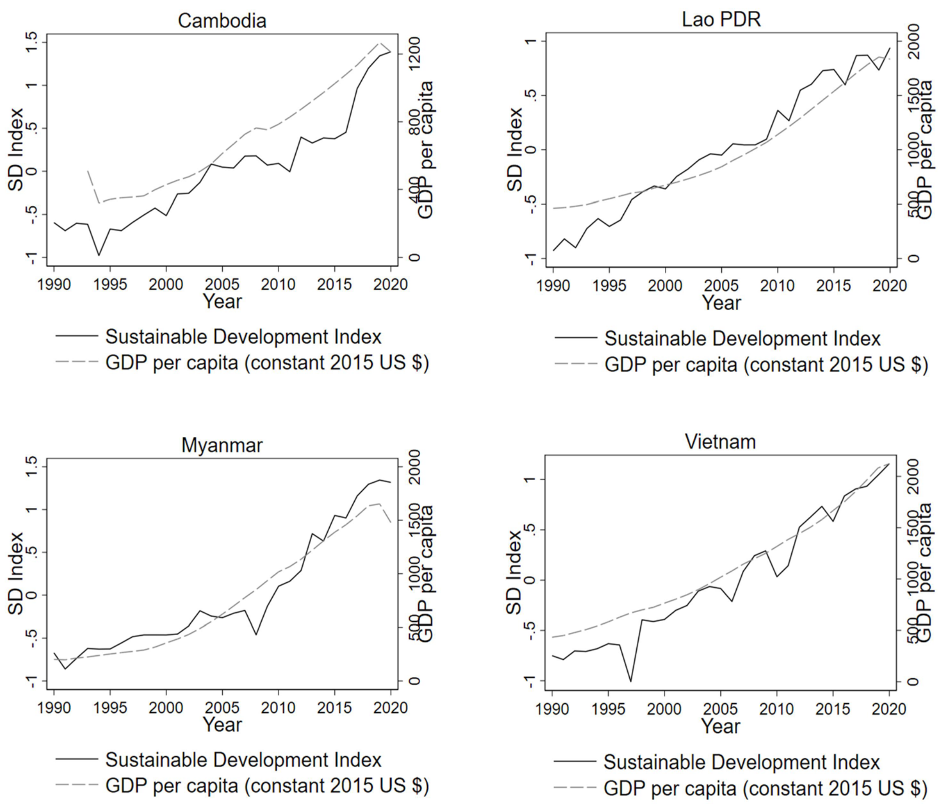


**Figure 6**. Trends of SD Index and GDP per capita in the CLMV Countries

Based on these results, reforms and openness, economic growth, and sustainable development of the CLMV countries are closely interconnected. By adopting a market economy system, the CLMV countries have achieved economic growth through increased production and productivity, as well as expanded foreign trade. Due to economic growth, the CLMV countries have gradually begun to pay more attention to society and the environment. As a result, an upward trend has been observed in several goals within the 'people' and 'planet' categories. However, some goals still show fluctuating or regressive trends. It means that continuous efforts from the CLMV countries towards sustainable development are still required.

The SDI for the CLMV countries has shown a generally upward trend over time. However, when assessed against global standards, the current state of sustainable development in these countries remains less than favorable. According to Sach et al. (2024), the global rankings for Cambodia, Lao PDR, Myanmar, and Vietnam are ranked 104th, 119th, 120th, and 54th, respectively, out of 167 countries. With the exception of Vietnam, none of these nations are among the top 100. These rankings indicate that, despite progress, substantial efforts are still needed to elevate sustainable development levels across the CLMV countries.

## 5. CONCLUSION

This study examined the status and trends of sustainable development in the CLMV countries since their economic reform and openness. Unlike previous studies that primarily utilized cross-sectional data, this study employed time series data spanning from 1990 to 2020. Additionally, it utilized the PCF method to determine individual goal weights, offering a more nuanced approach compared to the conventional practice of assigning equal weights.

Key findings of the study are as follows. First, several SDGs in the CLMV countries have shown remarkable improvement. Specifically, progress was observed in Goals 1, 2, 3, 4, 6, 7, 8, 9, 14, and 17, which fall under the categories of People, Prosperity, and Partnership. This reflects advancement in societal and economic aspects within the region. However, the study also highlights areas requiring significant improvement. These include social aspects such as gender equality and reduced inequalities, as well as environmental concerns like climate action, which remain pressing challenges for the CLMV countries.

Second, both the SDI and GDP per capita in the CLMV countries have exhibited similar upward trends. Despite challenges such as natural disasters, the SDI has continued to rise, indicating that both economic growth and sustainable development have improved following the period of reform and openness.

This study utilized the SDI to examine the trends and status of sustainable development in the CLMV countries following their reforms and economic opening. Although the study aimed to incorporate all 247 variables outlined by the UN SDGs, it was limited to the available data. Future research could conduct more precise analyses on sustainable development in the CLMV as additional variables and data become available.

# APPENDIX

**Table A1**. Rotated Factor Loading and Unique Variances of Cambodia

| Variable | Factor1 | Factor2 | Factor3 | Uniqueness |
|---|---|---|---|---|
| Goal 1 | 0.579 | 0.751 | 0.062 | 0.097 |
| Goal 2 | 0.896 | 0.353 | -0.090 | 0.065 |
| Goal 3 | 0.904 | 0.277 | -0.159 | 0.081 |
| Goal 4 | 0.908 | 0.297 | -0.212 | 0.042 |
| Goal 5 | 0.885 | 0.194 | 0.040 | 0.178 |
| Goal 6 | 0.877 | 0.305 | -0.184 | 0.104 |
| Goal 7 | 0.737 | 0.582 | -0.158 | 0.094 |
| Goal 8 | 0.694 | 0.613 | -0.054 | 0.141 |
| Goal 9 | 0.819 | 0.479 | -0.251 | 0.038 |
| Goal 10 | -0.249 | 0.055 | 0.715 | 0.424 |
| Goal 11 | 0.218 | 0.906 | 0.090 | 0.124 |
| Goal 12 | -0.032 | 0.078 | 0.794 | 0.363 |
| Goal 13 | -0.496 | -0.233 | 0.418 | 0.525 |
| Goal 14 | 0.498 | 0.778 | 0.089 | 0.139 |
| Goal 15 | -0.368 | -0.728 | 0.379 | 0.190 |
| Goal 16 | -0.415 | -0.593 | 0.537 | 0.187 |
| Goal 17 | 0.735 | 0.645 | -0.126 | 0.028 |

**Table A2**. Rotated Factor Loading and Unique Variances of Lao PDR

| Variable | Factor1 | Factor2 | Factor3 | Uniqueness |
|---|---|---|---|---|
| Goal 1 | 0.919 | -0.125 | 0.277 | 0.063 |
| Goal 2 | 0.924 | 0.020 | -0.153 | 0.122 |
| Goal 3 | 0.975 | 0.135 | -0.087 | 0.024 |
| Goal 4 | 0.979 | 0.147 | -0.038 | 0.019 |
| Goal 5 | 0.180 | 0.893 | 0.093 | 0.162 |
| Goal 6 | 0.924 | 0.151 | 0.037 | 0.123 |
| Goal 7 | 0.894 | -0.160 | -0.250 | 0.113 |
| Goal 8 | 0.933 | 0.252 | -0.075 | 0.061 |
| Goal 9 | 0.928 | -0.073 | -0.070 | 0.130 |
| Goal 10 | -0.021 | 0.058 | 0.670 | 0.548 |
| Goal 11 | 0.706 | -0.424 | 0.416 | 0.149 |
| Goal 12 | -0.845 | -0.106 | 0.163 | 0.247 |
| Goal 13 | -0.466 | 0.361 | 0.588 | 0.307 |
| Goal 15 | -0.922 | 0.136 | -0.103 | 0.121 |
| Goal 16 | 0.946 | -0.007 | -0.201 | 0.064 |
| Goal 17 | 0.933 | -0.184 | -0.019 | 0.096 |

**Table A3**. Rotated Factor Loading and Unique Variances of Myanmar

| Variable | Factor1 | Factor2 | Factor3 | Factor4 | Uniqueness |
|---|---|---|---|---|---|
| Goal 1 | 0.873 | 0.389 | -0.268 | 0.076 | 0.009 |
| Goal 2 | 0.902 | -0.226 | -0.107 | 0.154 | 0.101 |
| Goal 3 | 0.944 | -0.147 | -0.016 | 0.191 | 0.051 |
| Goal 4 | 0.895 | 0.103 | 0.205 | 0.158 | 0.122 |
| Goal 5 | 0.747 | 0.110 | 0.332 | 0.438 | 0.128 |
| Goal 6 | 0.771 | 0.225 | -0.157 | -0.336 | 0.218 |
| Goal 7 | 0.939 | -0.072 | -0.149 | 0.068 | 0.087 |
| Goal 8 | 0.653 | 0.470 | 0.326 | -0.260 | 0.179 |
| Goal 9 | 0.981 | 0.012 | 0.046 | -0.076 | 0.030 |
| Goal 10 | 0.013 | -0.392 | 0.515 | 0.422 | 0.402 |
| Goal 11 | -0.141 | 0.823 | -0.342 | 0.400 | 0.025 |
| Goal 12 | -0.265 | 0.622 | 0.654 | 0.016 | 0.115 |
| Goal 13 | -0.720 | 0.453 | -0.405 | 0.273 | 0.038 |
| Goal 14 | 0.821 | 0.283 | 0.098 | -0.336 | 0.123 |
| Goal 15 | 0.690 | -0.326 | -0.391 | 0.096 | 0.255 |
| Goal 16 | 0.958 | -0.038 | -0.001 | 0.015 | 0.082 |
| Goal 17 | 0.912 | 0.050 | -0.071 | 0.036 | 0.159 |

**Table A4**. Rotated Factor Loading and Unique Variances of Vietnam

| Variable | Factor1 | Factor2 | Factor3 | Uniqueness |
|---|---|---|---|---|
| Goal 1 | 0.628 | 0.645 | 0.305 | 0.098 |
| Goal 2 | 0.896 | 0.334 | 0.022 | 0.085 |
| Goal 3 | 0.886 | 0.386 | -0.104 | 0.056 |
| Goal 4 | 0.861 | 0.402 | 0.203 | 0.055 |
| Goal 5 | 0.050 | -0.131 | -0.917 | 0.140 |
| Goal 6 | 0.480 | 0.597 | 0.513 | 0.150 |
| Goal 7 | 0.711 | 0.611 | 0.218 | 0.074 |
| Goal 8 | 0.720 | 0.496 | 0.400 | 0.076 |
| Goal 9 | 0.790 | 0.565 | 0.192 | 0.021 |
| Goal 10 | 0.590 | 0.086 | 0.446 | 0.446 |
| Goal 11 | 0.228 | 0.871 | 0.120 | 0.175 |
| Goal 12 | -0.669 | -0.394 | -0.275 | 0.321 |
| Goal 13 | -0.761 | 0.141 | -0.060 | 0.398 |
| Goal 14 | 0.431 | 0.741 | 0.164 | 0.239 |
| Goal 15 | 0.863 | 0.200 | -0.186 | 0.180 |
| Goal 16 | 0.253 | 0.662 | -0.254 | 0.434 |
| Goal 17 | 0.768 | 0.576 | 0.214 | 0.033 |

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*Received July 06, 2025, Accepted December 19, 2025.*