The Research on the LDC’s Sustainable Development

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Abstract. After the predatory primitive accumulation of development, the world development target is turn to the sustainable development. This paper aims to develop a sustainable development plan to create a sustainable world. A sustainable development model is constructed based on AHP, and the Index System of Sustainable development is designed. In terms of analysis about sustainability of policy, we chose Talent Policy combining with three Sustainable Indexes. When a country's comprehensive evaluation index is greater than 0.60, we define that country is sustainable. Therefore, the model in this question can state when and how a country is sustainable development. By using the model and study to determine the degree of Burmese sustainability development, we consider the Grey Forecast Model to analyse the changes population, natural resources(as water resources), economics, social and political environment. Therefore, the environment factors are negative to Myanmar’s sustainable development.

1. Introduction
The rapid development of science and technology enhances the ability of human to transform nature and brings unprecedented prosperity of human society. And it also prepares the necessary material and technical conditions for further development in the future. However, from the mid-20th century, environmental issues frequently plagued mankind, the traditional development model was facing serious challenges. In this way, sustainable development strategy emerged. Sustainable development is defined by the 1987 Brundtland Report[1] as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The core idea of sustainable development is that healthy economic development[2] should be based on the ecological sustainability, social justice and people’s active participation in decision-making of their own development. Establishing a model, this model should provide a measure method to distinguish more sustainable country and policy from less sustainable one. The sustainable development factors may include human health, food security, access to clean water, local environmental quality, energy access, livelihoods, community vulnerability and equitable sustainable development. According to the model, make a 20-years sustainable development plan for a LDC(Least Developed Country).

2. The Sustainable Development Model of the LDC
A sustainable development model is required to establish that can clearly define when and how a county is sustainable or unsustainable[3]. To solve this problem, we analyse the sustainability of a country by the use of sustainable development index system. The establishment of index system is equivalent to the complex objects hierarchize. So we choose Analytic Hierarchy Process as the
country's sustainability development index system of comprehensive evaluation method. Combining the three sustainability development indexes, we can judge the sustainable development degree of a country. We use the same evaluation model, just change the sustainability development indexes[4], that can explain the sustainability development strength of a policy.

2.1. Sustainable Development Model Based on AHP

2.1.1. An evaluation method for sustainable development. The sustainable development index is a complex system, which well composed of a series measure indicators. And it absolutely measures main level and the main aspects of the country’s economic development, which dictates the use of multi-index comprehensive evaluation method[5] in sustainable development of the national economy. The comprehensive evaluation of sustainable development should solve the following three problems. First, construction of evaluation indexes system and selection of evaluation index; the second is the determination of index weight in evaluation indexes system; the third is method selection of comprehensive evaluation.

Sustainable development is a very complex research, describing the index system is equivalent to process hierarchically. After obtaining the index data of each player, the weights related to the goal of sustainable development will be determined[6]. Then, we can get a comprehensive evaluation result. Therefore, we choose AHP as our means to analyse the sustainable development system of the country.

2.1.2. The principle of index selection. Many factors[7] from three aspects influence the sustainable development. First aspect is some environment factors, like economy, resource, environment quality, human health, food security, livelihood, the vulnerability of the society, peace, and many other elements. The second aspect is the time factor involved contemporary and future generations. The last one is the space factor between different countries.

2.1.3. Model Establishment and Solution. Taken together, we selected the following indexes as the evaluation indexes of sustainability development in the Table 1.

| Table 1. Evaluation Indexes |
|-----------------------------|
| First-Level Index | Second-Level Index | Third-Level Index | Fourth-Level Index |
| Economy A | Economic aggregate A₁ | Per capita GDP (dollar) | GDP growth rate |
| | Economic benefit A₂ | Funding grants | External debt |
| Society B | Population development B₁ | Rate of population growth | Related to combat deaths |
| | Living standard B₂ | Tuberculosis treatment success | Unemployment rate |
| Environment C | Resource degradation C₁ | Per capita ratio of water resources | energy consumption |
| | Environmental pollution C₂ | PM10 | Carbon dioxide emissions |

2.1.4. The steps of AHP.
- A hierarchical structure model is established[8].
- A comparative judgment matrix is constructed by 22 comparison methods.
- Determine the relative importance of the elements and test the consistency

2.2. Sustainable Development Index

2.2.1. Coordinated index of sustainable development. The basic characteristics of sustainable development are coordination of economic, social and environmental resources[9]. In order to study the sustainable development quantitatively, we introduced the coordination index CI to evaluate the
coordinated development amount economy, society and environment. The mathematical meaning is that economic, social and environmental change rate balance each other. Meanwhile, any one of those will decrease the benefit. The formula is:

\[
CI = \frac{X + Y + Z}{\sqrt{X^2 + Y^2 + Z^2}}
\]

In the formula, CI for coordination index (the minimum value of CI is -1.732, the maximum value of 1.732); A1, A2 for The sustainable development index of economic growth in different periods; B1, B2 for sustainable development index of social development in different periods; C1, C2 for sustainable development index of resource and environment in different periods.

When \(1 < CI \leq 1.732\), it indicates that economic growth, social development and environmental protection are moving in the direction of sustainable development and advancement in the development process, which we call strong sustainable development.

When \(-1.732 \leq CI < 1\), it show that one of economic growth, social development and environmental protection deteriorates because of some reasons in the development process. But that could be offset by the development of others and also move toward the direction of sustainable development, which we call weak sustainable development.

When \(-1.732 \leq CI < 0\), show that one of economic growth, social development and environmental protection deteriorates because of some reasons in the development process. What’s worse, that cannot be offset by the development of others and move toward the sustainable development direction, which we call it unsustainable. Among them, when \(-1.732 \leq CI \leq -1\), we call strong unsustainable development; when \(-1 < CI < 0\), we call the weak unsustainable development. When \(CI = 0\), we call sustainable development stagnation.

2.2.2. Sustainability index of sustainable development. One of the basic characteristics of sustainable development: the bigger economic change, social change and resource environment, if the rate of change is larger (ie, faster development rate), the sustainability of the stronger in the process of sustainable development. If development rate is slow, it is called weak sustainability of development; if the development rate is negative, it is called unsustainable. For this reason, we have introduced the sustainability indexes to measure speed of each factor on sustainable development.

According to the development characteristics, the three basic elements of development composed of economic factors, social factors and environmental factors. Let A sustainable economic index, B for social sustainability index, C for resources and environmental sustainability index. Through standardized processing[10], index numerical ranges between 0 and 1. In other words, each factor is always between in the worst state (value 0) and an optimum state change (value 1). The formula of sustainability index DI:

\[
D = \begin{cases} 
\frac{x_2-x_1}{1.732-x_1} & X_2 > X_1 \\
\frac{x_2-x_1}{x_1} & X_2 < X_1 \\
0 & X_2 = X_1 
\end{cases} 
\quad s.t. \quad \begin{cases} 
X_1 = \sqrt{A_1^2 + B_1^2 + C_1^2} \\
X_2 = \sqrt{A_2^2 + B_2^2 + C_2^2} 
\end{cases} 
\]

In the formula, DI for sustainability index; A1, A2 are different economic sustainable development index; B1, B2 for different social sustainable development index; C1, C2 for different environmental sustainable development index.

When \(0 < DI \leq 1\), the development of the country moves towards sustainable direction, we called it the sustainable. If DI is growing, the sustainable development of the country will become stronger, which indicates that the country's development is scientific and rational. It gives policymakers revelation that move towards this direction and she state will sustainably develop. If DI gets smaller, the sustainable development of the country will become weaker, which indicates that the development of the country be unsustainable. It will remind policymakers of changing change the mode of development rapidly to enable the sustainable development of the country.

When \(-1 < DI < 0\), the development of the country have been marching to the sustainable direction, which we call it unsustainable. If DI get smaller, developing countries are increasingly unsustainable.
It will give policymakers a serious warning to reverse this adverse situation. Otherwise, the consequences could be disastrous.

When \( DI = 0 \), the state development is stagnant, which we call sustainable development stagnation. It shows the state development is between sustainable and unsustainable. At this time, policymakers should analyse the situation and make sustainable development strategy to promote sustainable development.

2.2.3. \textit{The comprehensive evaluation index of sustainable development}. Based on the determining of each single index’ weight on the system, and dimensionless processing the index data, we can calculate the comprehensive evaluation index to evaluate the sustainable development, by using the linear weighted method. Comprehensive evaluation index \( Z \) specific calculation formula is as follows:

\[
Z = \sum_{i=1}^{n} W_i \times U_i (i = 1, 2, \ldots, n)
\]

\( Z \): comprehensive evaluation index; \( W_i \): weight of evaluation index; \( U_i \): the value of single index after the dimensionless processing, means the standard value of index; \( n \): the number of evaluation index.

Using the domestic and foreign classification methods of comprehensive index as reference, we design a classification standard for the evaluation index and give qualitative description of the classification. It is the quality description for the comprehensive evaluation index\cite{11}. Sustainable development is divided into five levels, the range of index of each levels are shown in Table 2.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Classification & Index Value & Evaluations \\
\hline
1 & >0.9 & Very strong sustainable development \\
2 & 0.80–90 & Strong sustainable development \\
3 & 0.60–0.79 & Basically sustainable development \\
4 & 0.30–0.59 & Weak sustainable development \\
5 & <0.30 & Very weak sustainable development \\
\hline
\end{tabular}
\caption{Sustainability Development Classification}
\end{table}

So we can determine the strength of a country's capacity for sustainable development through comprehensive evaluation index \( Z \) and we also can know when and how a county is sustainable. If comprehensive evaluating index \( Z \) is greater than 0.6, we considered the state with the sustainable development, which can be invested.

3. Model Application of a Least Developed Country

For this problem, we need to make a country's 20-year sustainable development plan including projects, policies and aid\cite{12}. First, according to the requirements of the problems, we chose a Least Developed Country (LDC) as our study object. Based on the model that we established in the Task One, we consider establishing Energy and Resource Sustainability Development Model and a Gray Forecast Model\cite{13}. We analyse changes in economic conditions, political, social, etc. in the country. The analysis can provide guidance and evidence for the development plan\cite{14}.

3.1. \textit{The Framework Design of Index System}

We chose Myanmar as research subjects. We designed a Myanmar’s sustainable development index system based on general framework of sustainable development index system and its economic and social development in recent years. This design is shown in Table 3.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Degree of sustainable development & Economy B & Population development C & \\
\hline
Economy B\(_1\) & Economic aggregate C\(_1\) & Per capita GDP (dollar) D\(_1\) & \\
& Economic benefit C\(_2\) & GDP growth rate D\(_2\) & \\
Society B\(_2\) & Population development C\(_3\) & Funding grants D\(_3\) & \\
& Related to combat deaths D\(_5\) & External debt D\(_4\) & \\
\hline
\end{tabular}
\caption{Burma’s Sustainable Development Index System Framework}
\end{table}
3.1.1. Evaluation of sustainable development about Burma. After the establishment of sustainable development system, we can evaluate Myanmar’s economy by specific indexes. The step is shown Figure 1.

3.1.2. Data Gathering. To evaluate Myanmar’s economic level of sustainable development and find the problems, we chose the raw data from 2000 to 2010 as our original data.

3.1.3. Single-level sorting and consistency check. According to scale method, construct judgment matrix at all hierarchy gradually. Then, calculate the weight of each index and check consistency. The single index weight of each hierarchy is show in Table 4.

3.1.4. General level sorting and consistency check. To sort a certain level, we must use the previous level of hierarchy and single Ordering at this hierarchy[15]. The single ordering of second hierarchy is the general ranking of the second hierarchy. But in this way, general ranking must be sorted from the top to the lowest hierarchy by hierarchy. According to hierarchy general ranking, we can calculate the weight of general hierarchy ordering in sustainable development index system and check consistency.

3.2. Evaluation result for the sustainable development of Myanmar

3.2.1. Coordination Index. According to the formula 1 of Coordination Index, we can know the Coordination Index of Sustainable development about Myanmar from 2002 to 2010. The indexes are shown in Table 5.
Table 5. Coordination Index of Sustainable Development

| Year | 2002 | 2004 | 2006 | 2008 | 2010 |
|------|------|------|------|------|------|
| CI   | 1.02 | 1.18 | 1.27 | 1.36 | 1.42 |

According to table 5, the coordination index of sustainable development is between 1.09 and 1.67 from 2002 to 2010, which is consistent with $1<CI≤1.732$. It indicates that in the national development process, its economic growth, social development and environmental protection are coordinated and the structure of state is reasonable. That is coordinated development. Notably, there is a certain fluctuation on coordination level, which should be paid enough attention.

3.2.2. Sustainability Index. According sustainable index DI formulas 2 and index data each year, we can obtain the Burmese sustainable index from 2002 to 2010, as shown in Table 6.

Table 6. Sustainability index of sustainable development

| Years | 2002 | 2004 | 2006 | 2008 | 2010 |
|-------|------|------|------|------|------|
| DI    | 0.19 | 0.17 | 0.26 | 0.34 | 0.49 |

From Table 6, 2002 to 2010, Myanmar sustainability index $0<DI≤1$, the country's development is sustainable. And the greater the value of DI, the stronger sustainable development will be in Myanmar, which indicated that Myanmar’s development is scientific and reasonable.

3.2.3. Comprehensive Index. According sustainable index DI formulas (2) and index data each year, we can obtain the Burmese comprehensive index of sustainable development from 2000 to 2010, as shown in Table 7.

Table 7. Burmese Comprehensive Index of Sustainable development

| Index Type                          | 2000 | 2002 | 2004 | 2006 | 2008 | 2010 |
|-------------------------------------|------|------|------|------|------|------|
| Sustainability Index of Economic Growth A | 0.38 | 0.41 | 0.53 | 0.67 | 0.73 | 0.81 |
| Sustainability Index of social development B | 0.43 | 0.46 | 0.62 | 0.73 | 0.74 | 0.83 |
| Sustainability Index of Environment C  | 0.34 | 0.39 | 0.48 | 0.59 | 0.7  | 0.79 |
| Comprehensive Index of Sustainable development Z | 0.39 | 0.43 | 0.55 | 0.68 | 0.72 | 0.80 |

According to table 6, the Burmese comprehensive evaluation index of sustainable development is between 0.40 and 0.79 from 2000 to 2008. Table 7 indicate the level of sustainable development in Myanmar is changing over to basically sustainable development from weak sustainability development. Myanmar, in 2010, just reaches strong sustainability development country. Referring to the analysis of the model we established in the sustainable development model of the LDC, Myanmar is a country with sustainable development and has a strong capacity for sustainable development in 2010.

3.3. Prediction of sustainable development index of Burma based on Grey Theory

Aiming to the development of Myanmar, we use GM[16] to predict the sustainability development index of Myanmar and made a future development plan.

● Step 1 Implementation
  a. Column Generation
  In order to weaken the randomness of the original time series, we need to accumulate the original time series. The time series accumulated is called Generated Column.
  b. Grey Time Series Prediction
  Use time series reflecting the characteristic of predicted object to construct Grey Prediction Model. In this way, we can predict the characteristic value at a certain time in the future.

● Step2 Calculating Steps
  a. Generating the first order accumulated sequence according to the original data sequence in previous years.
  b. Determining data matrix
  Substitute sum into B and estimate parameters with Least Square Method.
Step 3 Establishing the Forecasting Model of Per Capita Emissions In 2020 and solving the first-order linear differential equation. Sequences have exponential growth law. However, the solution of first-order differential equations exactly is the solution of exponential growth in the form. Therefore, so we can assume that the sequence satisfies the following first-order linear differential equation model.

Obtain GM (1,1) time response function (k=1, 2, …)

Step 4 Model Checking Residual Check: Calculated by the time response function \( x^{(1)}(k) \), According to the formula, Using the formula

\[
x^{(0)}(k) = x^{(1)}(k) - x^{(1)}(k - 1)
\]

The calculation of the data reduction, and calculate the period of residual value \( q(k) \) relative error value \( e(k) \). The calculation formula of the relative residuals:

\[
q(k) = \frac{x^{(0)}(k) - \hat{x}^{(0)}(k)}{x^{(0)}(k)}, k = 1, 2, \ldots, n.
\]

The relative error calculation formula:

\[
e(k) = \frac{q(k)}{x^{(0)}(k)}
\]

Based on the Internet to find data, based on the grey prediction theory above, establishes a grey prediction model level, finally forecast the future trend of some indicators of sustainable development.

3.4. Prediction Results and Analysis

The prediction of foreign debt is shown in Figure 2 by using the grey prediction model. The prediction of population, prediction of Electric Power Prediction and prediction of Power Consumption are shown in Figure 3, 4, 5 respectively. And projections for other indicators is shown in Table 8.

| Year | Population (Million Dollars) |
|------|-----------------------------|
| 2011 | 52.4                        |
| 2012 | 53.7                        |
| 2013 | 55.1                        |
| 2014 | 56.5                        |
| 2015 | 58.0                        |
| 2016 | 59.5                        |
| 2017 | 61.0                        |
| 2018 | 62.6                        |
| 2019 | 64.2                        |
| 2020 | 65.8                        |

Figure 2. Prediction of External Debt

Figure 3. Population Prediction

Figure 4. Prediction of Electric Power Production

Figure 5. Prediction of Power Consumption
According to the analysis of figure 2-5 and table 8, the following three points are obtained.

a. Population and population growth rate is rising year by year. Until 2020, the population will have reached to 650 million. Population growth may result in a reduction of per capita resources and employment difficulty. In other words, the unemployment rate increased year by year.

b. The increase of unemployment rate and reduction of per capita resources will result in declining of national economy. That indicates that the index per capita GDP be decreasing gradually.

c. The increase of population causes another increase of CO\textsubscript{2} emissions, which lead to the aggravation of environmental pollution. That means the resource consumption is too large and the index of energy depletion increases.

4. Conclusions and Suggestions

Based on the analytic hierarchy process, the sustainable Development Model Index System of the least developed countries is established, then the Sustainable Development Coordination Index CI and sustainable development Index DI are introduced. And the comprehensive Development index model of sustainable development is obtained. According to the value of the comprehensive evaluation Index Z, the sustainable development level of the developed countries can be judged, which is divided into 5 grades, they are Very strong sustainable development, Strong sustainable development, Basically sustainable development, Weak sustainable development and Very weak sustainable development.

Then Burma is selected from the LDC as the study object. According to the results of the model, Burma's sustainable development coordination index is between 1.02-1.42 from 2002 to 2010, that can be judged for sustainable and coordinated development country. the comprehensive index of sustainable development in Burma is between 0.39-0.79 from 2002 to 2010, which can be seen that Burma's sustainable development level is going from weak sustainable development to basically sustainable development.

According to above prediction, it can be learned that these indexes of population, population growth rate, energy depletion amount, CO\textsubscript{2} emissions, power consumption, war deaths and the unemployment rate will continue to increase in the coming years. Meanwhile, the indexes of financial assistance, GDP and per capita GDP are gradually decreasing.

It is supposed to advocate environmental protection, increase utilization of water resources, economize resources and establish the civilized ecological concept; the government is supposed to offer better social benefits, provide more job opportunities and improve the production and life condition. Only under this kind of condition, the sustainable development will progress better and better.

5. Reference

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