Team Control Number

38727

Problem Chosen

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The objective of this model is to establish a comprehensive index that can identify more and less sustainable countries of the world, and to identify target sectors for improvement in sustainability. Identifying the most urgent sustainability issues for a country allows for the formulation of a development plan and can aid in the allocation of resources to reduce instability and increase sustainability. The projected impact of the sustainable development goals are used to forecast the future sustainability of the country.

The model assumes that:

- Subindex parameter properties are uniform across the data set
- Subindices are representative indicators of a network of interconnected factors
- Subindex parameters are accurate and unbiased

Countries are scored across indices of sustainability: Economic, Institutional, Political, Environmental, Social, and Disaster Susceptibility. Within each category, a variety of subindices are used, taking advantage of big data availability to evaluate the stability of each nation with regard to that category. Explicit documentation of the model and parameters used as well as how they were aggregated can be found in the methodology.

The model uses datasets that were chosen because of their completeness making it a robust model for comparing underdeveloped nations. The model is not sensitive to small changes in data values and indicators were chosen to make the model resistant to manipulation. The model penalizes countries for foreign influence on subindices such as air pollution that cannot be contained within the country of origin. There is no alternate subindex evaluation in the rare cases where data is unavailable for a country of interest.

Bhutan was selected for the assistance of the International Conglomeration of Money because of its rapidly growing economy and its high scores across the Sustainability Index relative to other underdeveloped nations. A sustainable development plan was created for Bhutan and model parameters were projected 20 years into the future to determine the effect on Bhutan' sustainability. The result was that Bhutan was predicted to maintain or even increase their overall sustainability in the face of rapid development which could let Bhutan serve as the gold standard in sustainably developing the worlds least developed nations.
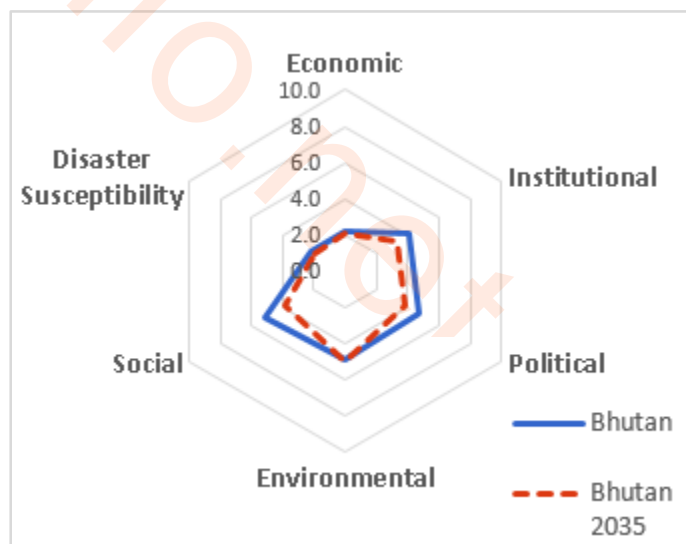
Current and projected levels of sustainability of Bhutan

Introduction

Sustainable development attempts to balance the material and social needs of present populations with the needs of the planet as a system and the future generations of the population to come. In planning for sustainable development, some prioritization of current needs must be attempted. An analysis of the trajectory of needs and problems must also be performed to try to balance the complicated and uncertain factors for an uncertain future. Resources available for developing nations are limited, so a method of prioritizing the needs and goals for development is needed to aid in the planning process.

What does sustainability look like?

The essence of sustainability is stability. It is the ability to maintain a process or activity for an extended period of time. On a national scale, it is the ability to indefinitely maintain a country's institutions, ecosystems and communities for future generations. The basis of the sustainability of nations is stability. Without stability, there is uncertainty in a nation's future ability to meet the needs of its people. Development can bring great prosperity to a nation, but this progress often comes at the expense of sustainability. A balance between these forces should be the goal of sustainable development. The primary requirement for national sustainability is stability in the factors most significantly affecting human welfare:

- Political Stability
- Social Stability
- Economic Stability
- Resilience to risk
- Institutional Stability
- Environmental Stability

Objective

The objective of this model is to create a comprehensive index to describe the sustainability of a nation in the context of various forms of stability. This index is intended to be used to identify more and less sustainable countries of the world and to identify target sectors for improvement in sustainability, set sustainable development goals, identify the most urgent sustainability issues for a country, and to allocate resources to reduce instability and increase sustainability. The index can also be used to describe the anticipated benefits of various policy changes and sustainability programs. Thus the index is a tool to match up policy measures and unmet needs with their effects on a given sustainability measure.

Methodology

The Sustainability Index

The Sustainability Index consists of a visual map of 6 factors (the subindices) describing various kinds of instability a country could experience that would cause it to be considered unsustainable. It is designed such that the user can easily determine which sector or sectors of the country of interest are most in need of improvement to improve the overall sustainability of the country. It also allows the user to determine which factors may be the greatest hindrance to sustainable development. The Sustainability Indices of different countries can be plotted together to compare side by side the nature and severity of the sustainability issues effecting each country. The sustainability index can also be used to track changes in a country's sustainability over time, and as a tool to assess the efficacy of a development intervention by comparing the Indices before and after the introduction of a development initiative.

A set of 6 indices were defined for six categories that were determined to be most important for determining the sustainability of a country. Indices incorporate factors generally thought to influence or correlate with the sustainability and stability of a nation.
The indices were defined such that:
- They could be calculated from readily available current datasets.
- Each index was on a scale of 0 to 10.
- Higher numbers indicate greater instability and less sustainability.
- Values were obtained from the same data set for each country (In all but a few cases in which there was missing data).
- Values input into the composite indices come from the most recent data available.
- All factors included in a given index were initially weighted equally.
- To be considered "Unsustainable" a country would need to obtain a score of at least 5.0 for any subindex.
- Scores lower than 5.0 do not automatically imply sustainability, but a lack of severe and urgent sustainability issues.

Subindices

Institutional Stability:
Institutional Stability quantifies the integrity of the infrastructure systems and the development of the institutions. The degree of development and lack of corruption signifies a country's investment into its future.

$$Institutional\ Stability\ Index = \frac{(\frac{C}{100} + \frac{S}{100} + \frac{W}{100} + \frac{Sa}{100} + In + Ex)}{5}$$

Where:

$C = 1 - the\ Corruption\ Perceptions\ Index$ (Transparency International, 2015)

$S = 1 - \%\ of\ paved\ roads\ as\ a\ percentage\ of\ total\ roads.$ (The World bank, 2014)

W = % of the population without access to improved water sources (The World Bank, 2015)

$Sa = $
% of the population without access to sanitation infrastructure
 (The World Bank, 2015)

$In = \dfrac{the\ infant\ mortality\ rate/\ 1000\ live\ births}{by\ the\ maximum\ infant\ mortality\ rate}$ (The World Bank, 2015)

$Ex = 5, if\ Expected\ years\ of\ education\ is\ \leq 9.0\ years$

$= 4, if\ 9 < Expected\ years\ of\ education < 11.7$

$= 3, if\ 11.7\ < Expected\ years\ of\ education\ is\ < 13.4$

$= 2, if\ 13.4 < Expected\ years\ of\ education\ is\ < 16.3$

$= 1, if\ Expected\ years\ of\ education\ is\ > 16.3$

 This scale was based on the World Bank calculated limits for expected years of education corresponding to Low, Medium, High and Very High human development (The World Bank, 2015).

Environmental Stability

Environmental Stability is a measure of how degraded various spheres of the environment are for the country in question. This categories incorporates indicators of terrestrial, aquatic, atmospheric, and environmental health to assess and describe the sustainability of the countries environmental systems.

$$Environmnetal\ Index = \dfrac{\left(\dfrac{Cl}{100} + (2 \cdot \dfrac{PM}{100}) + \dfrac{F}{100} + \dfrac{\gamma}{100} + \dfrac{Ha}{100} + RN\right)}{6}$$

$Cl = the\ evaluation\ of\ the\ Climate\ and\ Energy\ sustainability$ (Yale University, 2014)
$PM = average\ exceedance\ of\ PM$ (Yale University, 2014)
$F = the\ evaluation\ of\ forest\ health$ (Yale University, 2014)
$\gamma = evaluation\ of\ fisheries\ health$ (Yale University, 2014)
$H = the\ evaluation\ of\ habitat\ and\ biodiversity\ health$ (Yale University, 2014)
$RN = \dfrac{energy\ consumed\ per\ capita \cdot \%\ energy\ from\ alternatives}{maximum\ total\ energy\ consumption\ per\ capita\ (Qatar)}$ (kg oil equivalent) (The World Bank, 2015)

Political Stability

The Political Stability index quantifies political instability in terms of violence, and the likelihood of political unrest or failure. It is designed to both indicate the need for political reforms and intervention and identify potential political obstacles to sustainable development programs.

$$Political\ Instability\ Index = \dfrac{PII \cdot CPVI \cdot PYBI}{3}$$

Where:

PII = Political Instability Index (The Economist, 2015)
$CPVI$ = Conflict and Political Violence Index (Relifweb, 2015)
$$PYBI = 0.5 \cdot \left(\left(1 - \frac{Ma - 15}{31}\right) + \left(1 - \frac{EPR - 12}{53}\right)\right)$$

Where:

Ma = Median Age of Population (CIA, n.d.)

EPR =
Rate of Male unemployment fro men ages 15 to 24 (The World Bank, 2015)

Social Stability

The social Stability index measures a few factors correlated with social unrest. Social instability may indicate areas that should be coupled with sustainable development for maximum humanitarian benefits, or populations with special development needs. The Social stability index may also help identify social factors that can cause resistance to sustainable development initiatives.

$$\text{Social Index} = \frac{\left(V + \frac{Re}{4} + Ge + \frac{H}{10}\right)}{4}$$

Where:

Ge = Gender Inequality Index (U. N. Development Programme)

H = estimate of happiness (Helliwell, Layard, and Sachs, 2013)

Re = estimate of the refugee population by country of origin (Nations, Human Development Reports Data, 2014)

Where:

Re = 5, if $2 \geq Log(\mu)$

$\quad$ = 4, if $1 \leq Log(\mu) < 2$

$\quad$ = 3, if $0 \leq Log(\mu) < 1$

$\quad$ = 2, if $-1 \leq Log(\mu) < 0$

$\quad$ = 1, if $-2 \leq Log(\mu) < -1$

$\quad$ = 0, if $Log(\mu) < -2$

Where $\mu = \dfrac{\frac{\text{refugees}}{\text{population}}}{\text{Maximum value of } \frac{\text{refugees}}{\text{population}}}$ (World Databank)

$$V = 5, \quad if \ Log(\vartheta) > 2$$
$$= 4, \quad if \ 2 \geq Log(\vartheta) > 1$$
$$= 3, \quad if \ 1 \geq Log(\vartheta) > 0$$
$$= 2, \quad if \ 0 \geq Log(\vartheta) > -1$$
$$= 1, \quad if \ -1 \geq Log(\vartheta) > -2$$
$$= 0, \quad if \ Log(\vartheta) < -2$$

Where $\vartheta = \dfrac{\text{deaths due to} \frac{\text{violence}}{100,000 \text{ People}} / \text{Population}}{\text{Maximum value of deaths due to violence/100,000 people}}$ (World Life Expectancy)

Economic Stability

The Economic Stability Index indicate the magnitude of poverty, economic inequality, economic dependency and economic participation of a country. As the primary goal of sustainable development is eradicating poverty, the Economic Instability Index is particularly important for identifying the magnitude and urgency of the need for the development programs.

$$\text{Economic Index} = \frac{(I + \frac{G}{100} + \frac{P}{100} + \frac{R}{100} + \frac{U}{100})}{5}$$

Where:

$I = 1 -$ the U. N. development Programme Income index (The United Nations, 2015)
$G =$ World Bank estimate of GINI coefficient a measure of Income inequality (The World bank, 2014)
$P =$ The World Bank estimate of the % of population that lives on less than \$1.25 a day (The World Bank, 2015)
$R = \dfrac{\text{monetary remittances as a \% of countries GDP}}{\text{the maximum value of remittances as a \% of GDP}}$ (The World bank, 2014)
$U =$ percentage of unemployed individuals seeking work

Risk Stability

The Risk Stability Index is an indication of a country's vulnerability to and capacity to deal with disasters, emergencies, epidemics and other calamities. Emergency aid is one of the largest shares of international aid. Disasters can unexpectedly hinder development projects and severely impact all other sectors of a country's well-being. Therefore the risk a country faces from large scale risk is an important factor when assessing both the need for development and the potential for failure of a development program.

$$\text{Risk Index} = \text{WWRA Index} \ (\text{Development, 2014})$$

Results

The Subindices for 8 different countries were calculated using the procedure described. The countries were chosen based on their diverse cultures, environmental problems, political systems and regions of the world. This was done to ensure that the Sustainability Index

was robust and universally applicable. The Sustainability Index for each country was graphed as a radar graph on the same axis to determine the efficacy of the Sustainability Index as a tool of comparison. The resulting graph (Figure 1) shows that the model effectively shows differences in sustainability in each country. The primary areas of concern for each country. The Sustainability Index uses the entire scale, to effectively show the comparative magnitude of the sustainability metrics across countries. Representative countries were chosen to show approximate ranges of nations on the sustainability index for each category.
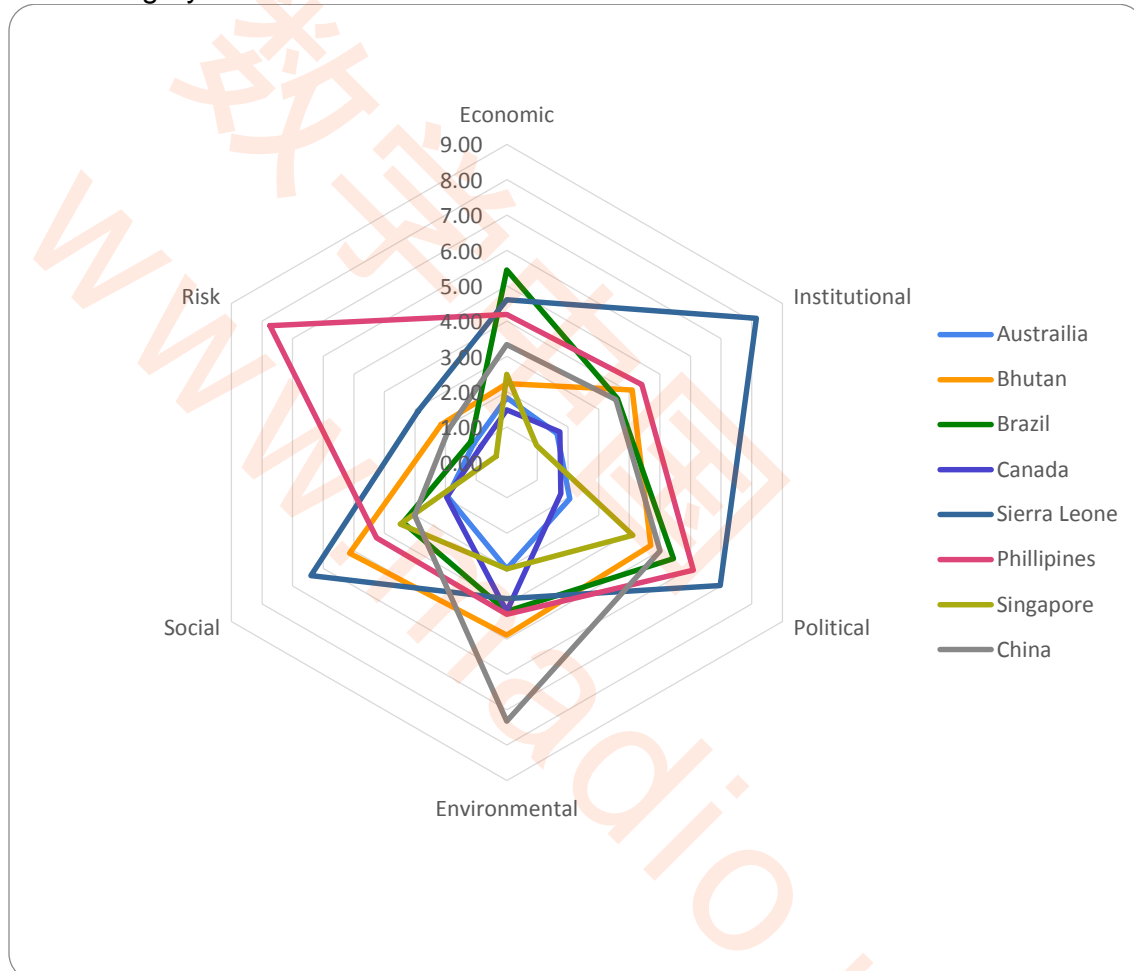

Figure 1: The Sustainability Index is a visual indicator to compare the various forms of instability of different countries.

Case Study: Bhutan

To investigate the utility of the sustainability index as a metric for setting sustainable development goals. The Kingdom of Bhutan was chosen as a case study.
Bhutan was chosen as the subject of the sustainable Development Plan for a few reasons. Bhutan listed as among the 48 Least Developed Countries according to the United Nations (UN, 2015). A complete data set was available for the Kingdom of Bhutan allowing for an accurate calculation of the Sustainability Index. Furthermore, Bhutan is not currently embroiled in war and is not perceived to have excessive political or institutional corruption. It

was felt that the last two factors would significantly hinder the efficacy of development programs in any country and therefore should be avoided as complicating factors.

Bhutan has expressed as a nation, significant interest in developing sustainably, and has a rapidly growing economy. The growing economy has caused a traditionally rural society to shift towards urbanization. This trend will increase populations in cities such as Thimphu, where a lack of infrastructure may lead to environmental problems associated with rapid urbanization. To promote the growth of the nation in the most sustainable way the following primary goals are proposed:

        Improved Sanitation
        Improved Transportation
        Improved Educational Opportunities
        Improved Health Care
        Building Code Regulations

The primary goals are intended to ensure sustainable growth, and have been developed in response to Bhutan's performance on the Sustainability Index and the declared national priorities as stated in "Bhutan 2020: A Vision for Peace, Prosperity and Happiness", the 20 year plan for the Kingdom of Bhutan. (Planning Commission, Royal Government of Bhutan. , May, 2, 1999)

Bhutanese Sustainability Index

Due to a strong national interest in sustainable development, Bhutan scores reasonably well on the Sustainability Index, with individual subindex scores in the medium low range. Iceland has been included alongside Bhutan as a benchmark of high sustainability. Poor fisheries management is the single factor significantly increasing Iceland's Environmental Sustainability index. Nigeria is included for comparison of a developing nation with very poor sustainability (Figure 2).
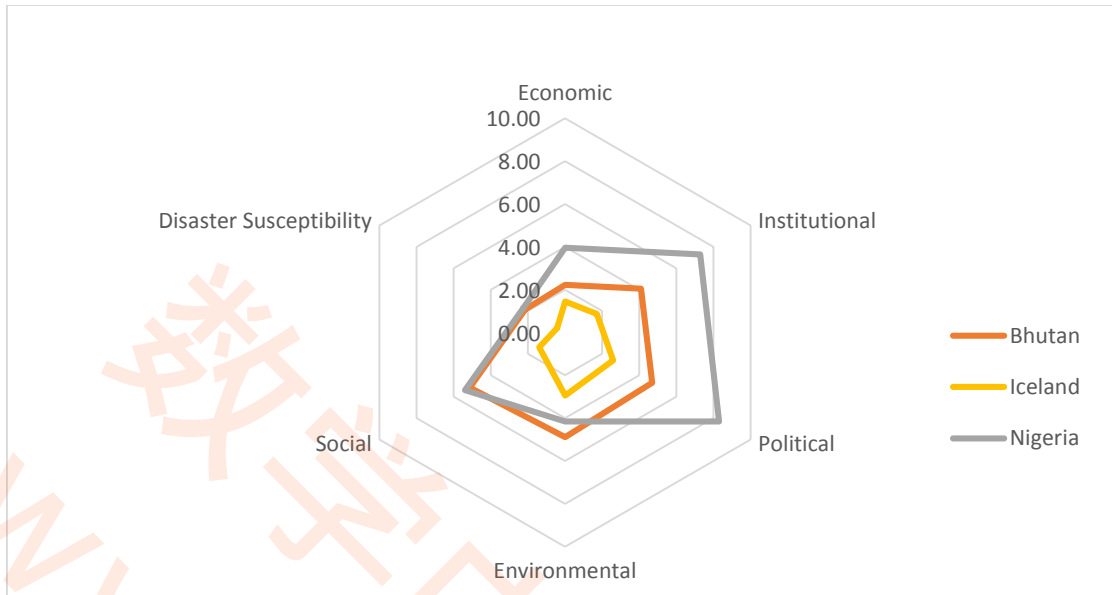
Figure 2: The Sustainability index For Bhutan, Nigeria and Iceland clearly shows the differences and main problem areas of the three countries.

Economic

Bhutan which has traditionally been dominated by subsistence farming, is one of the fastest growing economies in the world. For these reasons Bhutan has very low rates of unemployment and scores reasonably well on the index. The economic Index is increased slightly by the current level of income inequality. As the population modernizes and becomes more urban, one of the challenges faced by Bhutan will be to prevent further disparity in wealth inequality.

Institutional

Bhutan scores much better in the political and institutional categories as compared to Nigeria. A long history of peace and less corruption, combined with Bhutan's progressive policies have resulted in a happier populace with better infrastructure development than can be seen in Nigeria.

Unplanned urban development has lead recurring public health and environmental problems associated with lack of sanitation practices (IRC, SNV, 2013). Assuming that the population centers of Bhutan will continue to grow the future need for a sanitation system is imperative for the major cities of Thimphu and Phuentsholing. The current Institutional Index for Bhutan is 4.1. This score is primarily due to penalties due to a low percentage of paved roads, some corruption and somewhat low expected education indicators.

Social

Bhutan scores somewhat poorly in the social sector (5.1) because of a high number of departing refugees leaving the country and a moderate state of gender inequality. The refugees are primarily made up from conflict with the ethnically Nepali group, the Lhotshampa. Ethnic tensions have continued and talks with Nepal over the repatriation of

refugees have recently degraded (Savada, 2011). Barring action on these issues Bhutan is unlike to improve on the Social Instability index.

Political

Bhutan's Political Sustainability index falls near the middle of the scale (4.7) because of ethnic tensions with the Lhotshampa. A porous border with India has led to several Indian terrorist groups setting up training camps in Southern Bhutan. While many of these camps were forcibly removed by the Bhutanese military, some remain, and the military action may have redirected the attention of terrorist groups to the Bhutanese government (Savada, 23 June 2011). This has elevated the risk of political violence indicator and thus the Political Instability Index.

Environmental

Bhutan in many ways is actually a model nation with regard to environmental considerations the nation has maintained a focus on development that will not compromise the long term health of the environment. Bhutan scores fairly poorly on the environmental index because of poor air quality. This problem is primarily due to the fact that the country borders India and China, two nations with very poor air quality resulting, from heavy industry. There is room for improvement within Bhutan however, in the areas of indoor air quality resulting from their traditional cultural cooking practices and forest and habitat conservation.

Risk

Bhutan is a landlocked country and thus does not suffer many of the risks typically associated sea level rise. The country is not particularly susceptible to extreme like forest fires, hurricanes, tornadoes, drought, and other disasters. Its location in the South-Eastern region of the Himalayas puts Bhutan largely above zones at risk of significant flooding. For these reasons and others, Bhutan has a very Low Risk Index. There is room for improvement through adopting stricter building codes and retrofit requirements for earthquake mitigation as Bhutan does lie in a seismically active region (Geohazards Intl., 2013). The lack of good transportation infrastructure also limits the ability for the Bhutanese government to respond to a natural disasters with evacuation measures and could hinder the effective distribution of emergency aid.

The Bhutanese 20 year Sustainable Development plan

To address some of the problems identified in the Sustainability Index a 20 year development program for Bhutan is proposed. The Sustainable Development program consists of three primary Development Initiatives, comprehensive long term planning and development aid to help fund the initiatives. These initiatives were designed to improve the overall development, sustainability and well-being of Bhutan and to reflect the national priorities set forth in *Bhutan 2020: A vision for peace Prosperity and happiness*.

Educational Initiative
The Educational Initiative consists of:

The construction and endowment of a Private Non-profit Woman's University. The college will consist of four major courses of study to address the major occupational needs of Bhutan. The colleges include:

- College of Nursing and Midwifery
- College of Agricultural Technology
- College of Computer Science and Technology
- College of Education.

The Educational Initiative also includes a system to help Bhutanese women to cover the costs of attendance. This would be done through a policy of free tuition to the College of Midwifery or College of Education to women who agree to work in these fields for a period of at least five years in Bhutan upon graduation. Tuition to the College of Agricultural Technology and College of computer science and technology would be funded through low interest microloans to students.
Additionally the initiative includes a move to make primary and secondary education, which is already free, compulsory.

This Initiative is intended to:

Improve educational outcomes
Improve gender equality
Improve access to healthcare
Decrease infant mortality rates
Slow population growth
Diversify the Bhutanese economy
Foster economic growth in the tech sector
Improve nutrition
Improve agricultural output
Improve sustainable farming practices

The four majors to be included in the woman's University were chosen to address the need for trained professionals in Bhutan's educational and medical sector, and to encourage growth in the areas of greatest economic potential in Bhutan. The College would be a Private, Non-profit University. This is consistent with the educational objectives set forth in Bhutan's *Vision for Peace Prosperity*. It is thought that if Bhutan is trying to move towards a private educational system any new institutions should conform to that goal. This condition is intended to prevent "brain drain" of educated individuals from Bhutan, to allow a greater number of Bhutanese woman to have access to higher education, and to create an educated workforce for Bhutan to serve as professional teachers and Healthcare workers to serve in underserved or remote areas of Bhutan in the most need of skilled professionals in these fields.

The Colleges of Agriculture and Technology are intended to ensure women are included in the economic sectors with the greatest potential for economic growth. Agriculture in Bhutan is the largest industry. However most farmers are subsistence farmers. Crop yields in Bhutan are relatively poor and may benefit from modern agricultural techniques.

The Transportation Initiative

The Transportation Initiative consists of a long term program of improving the transportation infrastructure of Bhutan. The highly mountainous country has one main road, The Lateral Road, traversing the country and connecting the main population centers. The road is currently in very poor condition and only one lane in many locations. It is subject to landslides and winter closure severely restricting the movement of goods and people through Bhutan (J.A., 2013).

The central program of the Transportation Initiative is the repaving and improvement of the Lateral Road. This will include the construction of bypasses of particularly dangerous sections of the road where possible and the improvement of bridges with the worst performance and safety records. The program also includes aid for the purchase and maintenance of multiple snow plows to allow the clearing of the Lateral Road during winter storm events in an effort to maintain mobility of goods and people year round. Additionally a program of funds matching will be instituted to encourage smaller communities to raise money to connect their communities to the Lateral Road.

This Initiative is intended to:

> Improve transportation
> Improve the movement of people and goods
> Improve access to education and health care
> Increase community investment in infrastructure
> Reduce youth unemployment
> Develop the pool of skilled laborers
> Improve crisis response capabilities
> Increase national unity
> Facilitate the growth of industries reliant on transportation

The Infrastructure Initiative

The infrastructure initiative consists of a set of smaller programs and policies designed to introduce the expectation of modern infrastructure to Bhutanese Society. Because of the relatively small size and populations (all under 100,000) of the urban centers of Bhutan, infrastructure projects enacted in the large population centers can provide benefits to large percentages of the Bhutanese population.

The infrastructure initiative consists of:

- The institution of a national fund to provide loans for cities and towns to build waste water treatment facilities, and modern sewer systems. Priority for loans shall go to towns based on their population density, and level of need.
- A public health education campaign to encourage hand washing and the use of existing latrines, which are currently pervasive, but under used for a variety of

reasons (WASH, 2013). This program shall be administered in conjunction with the national education system and community health workers and midwives.

- A requirement that new buildings include modern latrines or sewer access, cook stove ventilation and meet basic earthquake safety standards.

The Infrastructure Initiative is intended to:
     Improve access to sanitation
     Build modern infrastructure
     Improve community health
     Improve water quality
     Increase employment opportunities
     Improve earthquake safety

Economic Development Initiatives

The following list of low cost initiatives have been included as measure to encourage and direct the growth of Bhutan's critical industries towards sustainable growth.

- A pilot program to make the entire city of an Thimphu into an internet Hot Spot to encourage growth in the technological sector and the tourism sector
- The development of a long term mining and mineral extraction plan to ensure the sustainability of the extractive industries without threatening Bhutan's long term environmental health
- The institution of a public agency to encourage organic farming practices, small scale beekeeping and organic certification to increase the sustainability and economic potential of the agricultural sector.

20-year changes to sustainability sub-index parameters

The following parameters were updated to reflect the change in the Sustainability Sub-Indices of Bhutan after the sustainable development plan is implemented. All values not mentioned are considered to remain constant over the 20 year period.

Economic

Parameter	Current Value	Predicted Value 2035	Rationale
I (Income Index)	0.363	0.243	Economic growth should improve indicator of general economic health
G (Income Inequality)	38.7	45	Rapid growth and urbanization will likely increase income inequality between the rural subsistence farmers and city dwellers
P (% Living in Poverty)	12	8	As more of the population will be found in cities, their income is likely to be higher and overall % of people living in poverty could drop as much as a third

Institutional

Parameter	Current Value	Predicted Value 2035	Rationale
S (% of Unpaved Roads)	0.658	0.5	While the percentage of roads paved will increase, improvement is likely to be slow because of the very mountainous terrain
Sa (% Without Access to Sanitation)	0.53	0.15	Increasing proportions of the population living in cities combined with new wastewater treatment plants and building codes will increase access to sanitation
In (Infant Mortality)	0.28	0.14	Improved healthcare and a focused program to increase numbers of rural midwives and improve prenatal care should at least halve the current infant mortality rate
E (Expected Years of Schooling Category)	3	2	Focused education policies should maintain current trends toward increased schooling

Political

Parameter	Current Value	Predicted Value 2035	Rationale
PYBI - (Problematic Youth Bulge Index)	0.55	0.40	Population projections predict an aging population and lowering unemployment
Pi (Political Instability Index)	5.3	4	Changing demographics, increased prosperity and the easing of ethnic tensions should decrease the level of political instability

Environmental

Parameter	Current Value	Predicted Value 2035	Rationale
PM (Frequency of PM-2.5 Exceedance)	75.9	77.89	China's current public sentiment and ambitious plan to reduce PM-2.5 emissions counteracted with increased energy needs and population in asian nations will probably result in a slight increase in PM-2.5 overall

Social

Parameter	Current Value	Predicted Value 2035	Rationale
Re (# of refugees originating from Bhutan score)	4	2	Easing of ethnic tensions and increased education and cultural awareness may significantly decrease refugees leaving Bhutan by 2035
Ge (Gender Equality Index)	0.495	0.395	Focused women's education programs should help women enter the economy in the healthcare and tech fields

Risk

Parameter	Current Value	Predicted Value 2035	Rationale
Risk Index	7.8	6.8	Improved building codes, roads and retrofit requirements should reduce Bhutan's susceptibility to seismic events

20-year changes to the Sustainability Index

After updating the parameters of the sustainability measure to account for the effects of the sustainable development plan for Bhutan, the model shows significant improvement to the overall sustainability for Bhutan (Figure 3). The only sector not improved was the environmental sustainability score for Bhutan. The country is likely to suffer from the continued degradation to their air quality resulting from the neighboring countries China and India. On the whole, Bhutan is on track to remain a model nation for sustainable development among the UN's least developed nations.
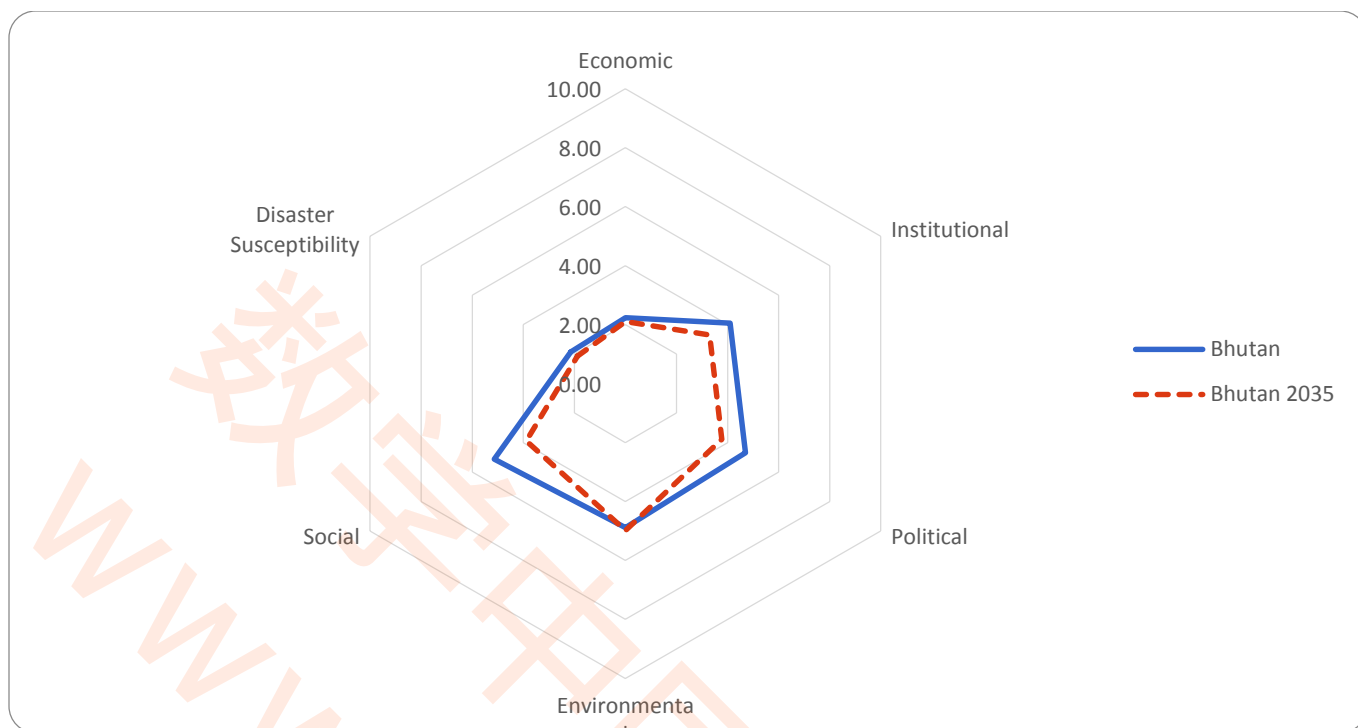
Figure 3: The current and projected Sustainability Index for Bhutan reflects the potential benefits of the 20 year Sustainable development plan.

Strengths and Weaknesses of the Sustainability Index

The Sustainability Index Model was developed to aid policy makers in decision when considering aid for developing nations. The variation of index values provide insight into sustainability strengths and weakness. The model is highly robust with regard to the limited uniformity of available data in underdeveloped nations, which can be a major hurdle when attempting to compare sustainability indices. Many data sets for the most important indicators lack information on at least a few developing nations. The model is only as accurate as the available data used to calculate the indices. However, the model is not sensitive to small changes in data values assuming that the variation in values is uniform across a given data set.

The use of a few specific indicators does not make the model sensitive to manipulation. Should a country desire to be more sustainable, they only need to improve on the specific indicators used in the model.

Furthermore, certain sustainability issues like food security or climate refugees have multiple causes and cannot be accurately described by just one index. Inclusion in one subindex or another may magnify or obscure a factor's impact on a certain form of instability.

The environmental index score was not found to be below 3.0 for any nation evaluated. This does not necessarily reflect a lack of sustainable practices within a nation. It is because the environmental index is sensitive to the effects of neighboring countries polluting the environment, over-harvesting fisheries, or endangering animal species that

happen to share habitat with the nation of interest. The Environmental index could also be improved by accounting for the risk of environmental collapse should any one subindex encroach upon a threshold value. For example, the point at which PM2.5 exceedance is so high that environment becomes uninhabitable for humans, such as the situation in Beijing. (Kaiman, 2015)

The environmental, and in some cases, the political and economic index does not take into account a country's inability to control certain subindex categories. For example, Bhutan's score (75.9 of 100) for exceedance of PM2.5 emissions in the Environmental subindex is largely because of the country's proximity to India and China, heavy industrial air polluters. (Pannozzo, "Brown Cloud" penetrates Bhutan, 2011). Distortion of indices/subindices of sustainability due to the influence of other countries can be used as indicators of international environmental issues that are best addressed with a more regional approach to Sustainability.

Continued development of the model should incorporate the addition of methods to accurately estimate missing parameters, an evaluation of how the individual indicators should be weighted in the subindex calculations to reflect their importance, and an evaluation of the Unsustainable threshold for each category.

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