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Short Communication

A proposed local sustainable development index: An application to cities of Davao Region, Philippines

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ABSTRACT

Aim: A proposed local sustainable development index (LSDI) is developed using 16 indicators which are locally available, internationally accepted, and coherent with national development goals. **Methods:** Indicator values were normalized using the Min-Max technique. Equal weighting and linear additive aggregation method was also done for the computation. The LSDI was then pilot tested to compare 6 cities in Davao Region, Philippines. The study was conducted in June, 2012. **Results:** The index revealed that Mati City has the highest LSDI score due to its high scores especially in terms of ecological indicators. On the other hand, the Island Garden City of Samal has the lowest LSDI score which is mainly attributed to its high poverty incidence as well as low scores in health and nutrition. **Conclusions:** Though the LSDI does not absolutely reflect the sustainability of cities, it can be helpful in identifying future development programs as it identifies weak and strong points of a city in comparison with other areas.

KEY WORDS: Composite index, indicators, Philippines, sustainable development

INTRODUCTION

Sustainable development (SD) is a combination of three global problems: Ecological, economic, and social. However, several initiatives have short changed all these three problems because these efforts fail to combine all three in all these actions [1]. Thus, there is a need to develop a model that encompasses all these three disciplines into a comprehensive and holistic understanding of what SD really is in order to facilitate a more effective approach in achieving it.

According to Mega and Pedersen [2] "SD is equity and harmony extended into the future, a careful journey without an endpoint, a continuous striving for the harmonious co-evolution of environmental, economic, and socio-cultural goals." Essential to the evolutionary development of the concept of SD is its integrative concept. The present concept of SD we know of today consists not only the ecological dimension but also the economic and social dimensions. This came about through the realization that SD is not just a conservation or antipollution (environmental) issue but rather an integration with the economic (business and income) and social (human development) issues.

Indeed, SD is a multidimensional issue. It has been realized that our present development practices are unsustainable and needs to be redirected toward a sustainable one through the values of human partnership with nature. This includes the evaluation of each of our practices in terms of its ecological, economic, and social impacts [3]. Furthermore, we must not only look at development in terms of profit, but also on its results in terms of ecological and social performance [4,5].

One of the main features that SD should have is that environmental principles should be integrated in economic and social development initiatives as stated in the Rio Declaration [6]. Furthermore, sustainability principles should also be incorporated in the formulation of government policies as exemplified in the targeting of the Millennium Development Goals [7]. Ultimately such endeavors should be in partnership with a larger spectrum of society especially in the implementation of SD initiatives as proposed by the World Summit on SD [8].

The above claims necessitate a certain measure of SD in order for us to define it and eventually achieve it [9]. Furthermore, Bell and Morse [10] stated that "given that SD, […] is a practical goal to be reached by intervention of some sort, one clearly needs to be aware of whether the system is still unsustainable or whether the goal of sustainability has been reached." Thus, there is a need to further the concept of SD to transcend from being an abstract concept used by politicians to market their platforms of government or by development practitioners to solicit funding for their projects into something which can be measured in which we can have a more realistic grasp of a local government unit's effort to achieve SD.

Multidimensional concepts were found to be measurable using composite indicators - which are increasingly recognized as a useful tool in policy analysis and public communication [11]. Examples of such composite indicators are: Human development index, environmental performance index, global competitiveness index, etc. With the idea that the mentioned composite indicators are country performance indices which are related to SD, there is a need to localize such endeavor in order to benefit local governments in the direction of SD goals.

Thus, in the context of the study, a proposed composite indicator called local SD index (LSDI) will be developed based on the methodology employed by the previously mentioned composite indices. Some similar studies have been undergone in Europe [12] and in South America [13] but none have been done in the Philippines so far. However, previous works tried to develop indices for good governance in the country [14,15] which cannot really be considered as wholly related to SD. In this context, the study was done in order to test the following hypotheses that: (a) Cities in the Davao region differ in terms of their performance in achieving SD based on several indicators, and (b) Better performers in terms of SD can offer an insight on what the lesser performers should do in order to achieve SD goals.

METHODS

Procedure of the Study

The main procedure used in the construction of the proposed composite index is based upon the methods advocated by the Organization for Economic Cooperation and Development [11]. The first procedure is the selection of indicators, followed by normalization and aggregation. The last part of the procedure is the pilot testing of the said index on a group of cities for the purpose of ranking them in terms of their achievement of SD goals.

Selection of Indicators

Indicators used in the index are the 16 indicators of SD previously selected using the LIANA Framework (Local availability, International Acceptance, and National Agenda). The said indicators and their corresponding categories in the SD framework are shown in Table 1. A discussion of how these indicators were selected using the LIANA Framework is discussed in a previous study [16].

Table 1: List of 16 SD indicators used in the calculation of LSDI

SD dimensions	Sub dimensions	Indicators (units)
Economic	Poverty reduction	1) Unemployment rate (%) 2) Poverty incidence (%)
	Infrastructure services	3) Proportion of households with access to electricity (%) 4) Percentage of paved road length
Social	Health and nutrition	5) Prevalence rate of underweight children under 5 years old (%) 6) Under-5 mortality rate (per 1,000 live births) 7) Contraceptive prevalence rate (%) 8) Percent of population with access to sanitary toilet facility (%) 9) Proportion of households with access to safe drinking water (%) 10) Maternal mortality rate (per 100,000 live births)
	Quality education	11) Completion rate (%) 12) Literacy rate (%) 13) Cohort survival rate (%)
	Public safety	14) Crime solution efficiency (%)
Ecological	Forest protection	15) Percentage of forest cover (%)
	Solid waste management	16) Solid waste generation rate (kg/capita/day)

SD: Sustainable development, LSDI: Local sustainable development index

Normalization Procedure

After the identification of appropriate indicators, the next step in the construction of the composite index is the normalization of data. The gathered values for the indicator primarily are composed of different units of measurement. Although majority of the indicators uses percentage (%) as a unit of measure, the mortality rates use different units (e.g., per 100,000 live births). This makes it difficult to proceed to the aggregation of data for a composite index because we cannot directly calculate indices for data with different units.

For this purpose, the Min-Max method was utilized. This technique normalizes the indicators to have an identical range (0, 1) by subtracting the indicator value with the minimum value and dividing the difference by the range of the indicator values [11].

The formula for the Min-Max normalization method is shown as Equation 1 below:

$$X = \frac{V - Min}{Max - Min} \quad (1)$$

Where:
X = normalized value of the indicator (0, 1)
V = value of the indicator
Min = the minimum (lowest) value of the indicator
Max = the maximum (highest) value of the indicator

However, Equation 1 only refers to values with positive directions (the larger, the better). Thus, indicators such as cohort survival rate, percent forest cover, or contraceptive prevalence rate applies to this equation. On the other hand, in case of indicators with negative directions (the smaller, the better), the above equation does not apply.

Another purpose of normalization is to create a uniform set of values for the indicators in which, in this case, all shall have a positive direction (a higher value means a positive SD achievement). Thus, in this case a further normalization technique should be employed for indicators with negative direction. For this purpose, computing for the inverse (1 - X) is done to normalize the value of a negative indicator.

Weighting and Aggregation

Equal weights were given to each indicator with regards to its values in the composite index. While other methods exist for the determination of weights for each indicator, equal weighting is a viable alternative due to the fact that all the indicators involved are priority policy concerns. Thus in the light of this measurement objectives, all the indicators are equally considered (none is greater than the others).

In terms of the aggregation method, the linear additive technique was adapted. This involves adding all the normalized values arithmetically. Thus, the final equation for the LSDI is:

$$LSDI = \frac{1}{n}\sum_{i=1}^{3} X_i \qquad (2)$$

Where:
X = value of the subindices (economic, social, ecological)
n = number of subindices

Furthermore, shown in Table 2 are the computation details of the subindices for SD dimensions. Subindices are essential in the sense that it summarizes achievement in the specific dimensions (economic, social, and ecological).

Pilot Testing of the Index

The index was tested on the 6 city governments of Region XI (Davao Region) namely: Mati, Tagum, Panabo, Island Garden City of Samal (IGaCoS), Davao, and Digos. Data sets on the selected indicators for SD were collected from these study areas and subjected to data processing as previously mentioned in this section.

Economic data were taken from the National Economic Development Authority (unemployment rate), Department of Public Works and Highways (percent paved road length), National Electrification Administration (electrification rate), and the National Statistical Coordinating Board (poverty incidence). Social data were taken from the Department of Education (education indicators), Department of Health (health and nutrition indicators), and Philippine National Police (crime solution efficiency). Ecological data were taken from the Department of Environment and Natural Resources (forest cover and solid waste). These offices are all located in Davao City.

Table 2: Formula for computing the subindices of LSDI

Subindices	Indicator/s	Formula
Economic LSDI ($LSDI_E$)	X_1=Unemployment rate X_2=Poverty incidence X_3=Electrification rate X_4=% of paved road length	$LSDI_E = \frac{1}{n}\sum_{i=1}^{4} X_i$
Social LSDI ($LSDI_S$)	X_1=% of underweight children X_2=Under-5 mortality rate X_3=Contraceptive prevalence rate X_4=Access to sanitary toilet X_5=Access to safe drinking water X_6=Maternal Mortality Rate X_7=Completion rate X_8=Literacy rate X_9=Cohort survival rate X_{10}=Crime solution efficiency	$LSDI_S = \frac{1}{n}\sum_{i=1}^{2} X_i$
Ecological LSDI ($LSDI_{Ec}$)	X_1=Percentage of forest cover X_2=Solid waste generation	$LSDI_{Ec} = \frac{1}{n}\sum_{i=1}^{2} X_i$

LSDI: Local sustainable development index

The data gathered were also validated and supplemented by data from local development plans, government websites, as well as brochures from the local tourism offices of the cities involved. The resulting values of LSDI for each city were used in order to rank each city based on the said index. The gathering of data was done on June, 2012.

Interpreting the Index Results

The index results are within the values of 0-1. The index values were used to rank cities in terms of SD performance. Thus, cities with higher index values are better than those with lower index values. However, this does not necessarily mean that the highest value (1) means it has achieved SD in general but only means it achieved the highest performance in all indicators compared to other cities. In this context, the interpretation lies in the ability of the index to determine which city is better and in which component such city is better than the others (as in the case of the subindices).

RESULTS

Table 3 shows the LSDI of the six cities as well as its subindices in terms of economic, social, and ecological indices. In terms of the economic subindex ($LSDI_E$), Davao City and Panabo City leads the other cities in the region. Following close to these two cities is Mati City. Trailing behind Mati are the cities of Tagum and Digos. Farther away is IGaCoS in terms of economic achievement.

In terms of the social subindex ($LSDI_S$), Tagum City leads among the six cities (0.76). This is followed by Davao (0.54) then Mati (0.50) and Panabo (0.50) and Digos (0.47). Trailing behind is IGaCos (0.42).

In the ecological subindex ($LDSI_{Ec}$), Mati City leads (0.73) followed by Digos (0.71), then IGaCoS (0.54). Davao follows (0.50) then Panabo City (0.48). Far behind is Tagum (0.25).

Table 3: LSDI of 6 cities including scores in the 3 subindices

City	Economic	Social	Ecological	LSDI	Rank
Mati	0.56	0.50	0.73	0.60	1
Digos	0.52	0.47	0.71	0.57	2
Davao	0.58	0.54	0.50	0.54	3
Panabo	0.58	0.50	0.48	0.52	4
Tagum	0.52	0.76	0.25	0.51	5
IGaCoS	0.34	0.42	0.54	0.43	6

Dimensionless units (1.0 is the highest and 0.0 is the lowest possible value), LSDI: Local sustainable development index

The above results showed that Mati City leads all the other cities in terms of the overall LSDI with 0.60. Mati City ranked first in the ecological subindex ($LDSI_{Ec}$) and ranked third in both economic ($LSDI_E$) and social ($LSDI_S$) subindices. The city with the lowest performance in achieving SD is the Island Garden City of Samal (IGaCoS) with 0.43 LSDI value.

DISCUSSIONS

In terms of an economic subindex ($LSDI_E$), IGaCoS lags behind due mainly to its high poverty incidence. Although it doesn't come last in terms of infrastructure services (electrification rate and paved roads), its extreme poverty incidence contributed to its low economic performance among the other cities in the region.

Tagum attributes its favorable social subindex ($LSDI_S$) to its performance in health and nutrition indicators as well as quality education indicators in which it fared best among the other cities in the region. Consequently, IGaCoS owes its low score from the same indicators (health and nutrition) in which Tagum excelled. It is thus essential that IGaCoS improve its performance in both subdimensions specifically on health and nutrition and more importantly in terms of reproductive health.

Clearly the reason for the low scores of both IGaCoS and Tagum on ecological subindex ($LDSI_{Ec}$) is on their low indices in forest protection (percent forest cover). This implies that several initiatives regarding the greening of both cities should be done in order to improve its ecological viability.

In general, Mati City's overall LSDI could be attributed to its high achievement with regards to the goals of health and nutrition as well as its high percentage of forest cover and low waste generation rate compared to other cities in the region.

Furthermore, although IGaCoS is not considered to have the lowest score in the ecological subindex, it's extremely low score in the economic and social subindices affected its overall LSDI value. This is attributed to its very high poverty incidence and low scores in several health and nutrition indicators compared to the other cities in the region.

CONCLUSIONS

It should be noticed that LSDI does not reflect SD achievement per se but rather achievements in the identified SD indicators in comparison with other cities in the region. Although, the values does not absolutely mean that a city is sustainable or not, it can help assess a city's performance and how it fared in comparison with the achievement of other cities. This helps in identifying programs or projects to be considered by looking at what other cities have done. Furthermore, the subindices help identify the weak and strong points of the city which provide insights on where to improve on their performance. Finally, because the LSDI is based on annual data, calculation of LSDI annually will provide information on the trend of a city's progress toward achieving SD.

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