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Title of Paper: **Environmental Sustainability based Budget Allocation System**

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Abstract:

In the past, environmental sustainability indicators (ESIs) and budget allocation were two independent systems. As a result, the budget allocated by a local government might not be adequate for effectively improving regional environmental sustainability (RES). A special budget allocation system was therefore developed to assist the local authority with making appropriate budget allocations for improving RES. This system includes the establishment of visions and goals, managing ESI and key indicators, classifying ESIs, analyzing the linkages between indicators and budget items, and evaluating the budget allocated.

Each region has its own specific characteristics and may differ significantly from other regions. The Strength-Weakness-Opportunity-Threat (SWOT) framework is thus adopted for promoting environmental sustainability based on regional characteristics that are hard to evaluate with the Driving force-State-Response framework. The previous system was applicable for the water sector only and was not adequate to cover all aspects of environmental sustainability. Therefore, the proposed system includes other main sectors such as air pollution control, waste management, and toxic substances management. To demonstrate the applicability of the proposed system, a case study for a local environmental protection bureau was implemented and discussed.

Introduction

An environmental sustainability indicator (ESI) system is generally independent of the budget allocation system, making it difficult for a local government to assess the effectiveness of the budget they allocated for improving ESIs. To alleviate this problem an environmental sustainability based budget allocation system is proposed. With the proposed system, a manager can evaluate the budget allocated for improving associated ESIs and make necessary adjustments according to past achievements for enhancing regional environmental sustainability (RES).

The proposed system includes five major functions for setting visions and goals, managing ESIs and key indicators (KIs), classifying ESIs, analyzing the linkages between budget allocation and indicators, and evaluating the budget allocated. Visions and goals reflect the value of a region and guide them toward sustainable development (Hardi and Zdan, 1997). Proper ESIs can show the progress with respect to the sustainability goals (Bossel, 1999). Several classification methods are provided to facilitate ESI analysis, management, and presentation and to reflect local characteristics. Linking ESIs and budget items can improve the effectiveness in allocating the available budget. However, linking all indicators to all budget items is too complicated and makes the evaluation of the allocation too complicated. Therefore, a set of KIs from ESIs is selected, and the budget items are only allowed to be linked to the KIs. It is expected that the proposed system will assist the manager in allocating the budget for raising RES.

Appropriate ESI classification is essential for ESI management and for reflecting local characteristics. Several classification frameworks are adopted. The Driving force-State-Response (DSR) is a popular framework (UNCSD, 2001) that can present the cause and effect relations among ESIs. However, the DSR framework does not vary for different regions and therefore can not reflect regional characteristics. For example, the indicators for air quality are regarded as the state indicators of DSR, but these state indicators are unable to reflect local characteristics. The DSR framework is unable to provide information as to which indicators are hard to improve or which ones will deteriorate in the future because of regional characteristics. Therefore, the Strength-Weak-Opportunity-Threat (SWOT) (Karppi et al., 2001; Webley, 2001) framework is adopted. The SWOT framework can show the strength, weakness, opportunity, and threat of a local region when it comes to improving its environmental sustainability. In the SWOT framework, the indicators are classified based on three region-specific factors of geographical features, pollution source characteristics, and trend. These three factors can reflect the regional characteristics, and the SWOT classification is expected to help the manager with adjusting the budget.

A web-based system was developed to implement the proposed system, and a case study for the Bureau of Environmental Protection in Hsinchu City is used to evaluate its applicability. This web-based system had been developed previously for the water sector. However, environmental sustainability must consider other aspects as well, including atmosphere, waste management, and others. Therefore, three additional divisions of air pollution control, waste management, and toxic substances management were taken into consideration in this study.

The remainder of this paper is organized as follows. In the following sections, the conceptual configuration of the system is explained. Next, the SWOT classification framework is described. Finally, the budget allocation analysis for the case study is demonstrated and discussed for the applicability of the proposed system.

System Configuration

To assist the manager in allocating the budget for improving the environmental sustainability, in the developed system, five functions, as shown in Fig. 1, are provided and are explained as follows.

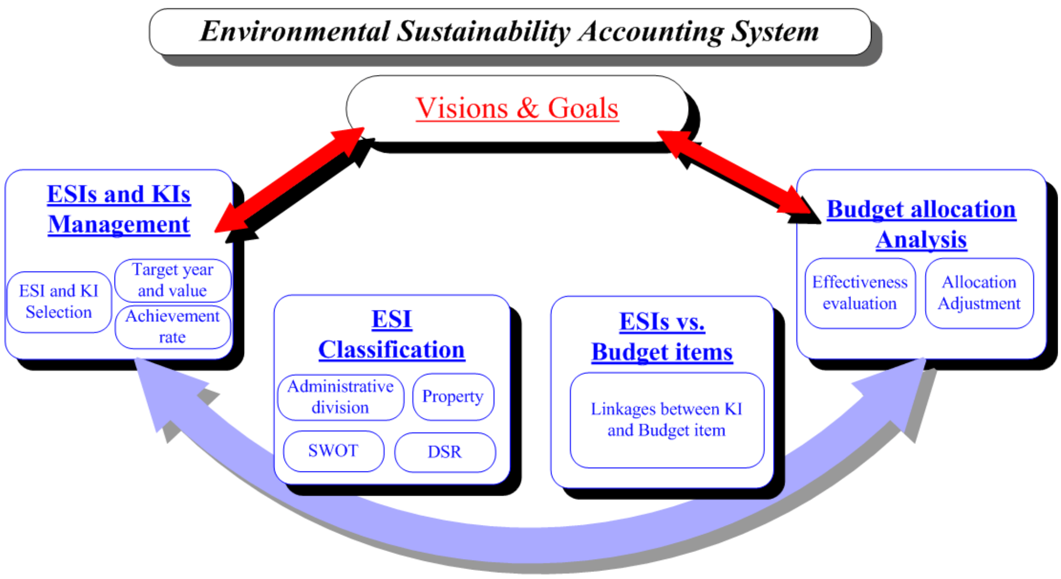


Figure 1. The configuration of the environmental sustainability based budget allocation system

(1) Vision and Goals: this function stores visions and goals that describe the desired environment the local residents expect to live with. ESIs in this local area should be improved toward these visions and goals.

(2) ESI and KI management: various ESIs are collected. A region generally has specific environmental characteristics and thus a careful selection of an appropriate set of indicators is required. ESIs can be selected based on various criteria. The definition of

an indicator should be clear, understandable, and related to stakeholder care (ICLEI, 1996; Best et al., 1998; Bossel, 1999). Each ESI can be assigned a desired target value based on the visions and goals. An achievement rate, indicating the progress of improving an indicator towards the desired target value, can be calculated using the ESI and the target values.

(3) ESI Classification: classifying the ESIs can provide a manager with the information regarding the relationships among the ESIs. The proposed system provides four different classification frameworks: property, administrative division, DSR, and SWOT. For the property framework, ESIs are classified according to their environmental properties, such as water, air, and waste sectors. This classification can let the authority and residents know the quality in different environmental areas. Since the ESI properties generally do not match with the administrative divisions to which the budget is allocated, the administrative division classification framework is thus provided. This framework helps a manager or policymaker with evaluating the performance or applicability of a budget allocation plan for a specific department or division. However, these two frameworks are not applicable for analyzing the interaction among ESIs and local characteristics, and so the DSR and SWOT frameworks are included as well. The DSR framework (UNCSD, 2001) is adopted to represent the causal relationships among indicators. However, the DSR framework does not consider local characteristics, and thus the SWOT framework is adopted. The SWOT framework is described in detail in the next section.

(4) Relationships among ESIs and budget items: it is impractical to link all indicators to budget items because some indicators are directly or indirectly related to more than one budget item, and some indicators are related to each other. In order to reduce the complexity associated with linking ESIs to budget items, a set of KIs were selected. KIs make it possible to establish direct linkages to budget items and to show any improvement in RES.

(5) Budget allocation analysis: the budget allocation analysis involves the following two main steps. First, a set of tasks (or projects) with required budgets are chosen based on visions, goals and associated indicators. Next, the system displays the tasks along with their expected environmental outcomes and associated expenditures. Then the system allows the user to change the chosen tasks, display the new result, and generate the new budget plan. Four major principles, as listed below, are proposed for allocating the budget.

   i. Ensure that high priority KIs and KIs with low achievement rates have a sufficient amount allocated from the budget.

ii. Any KI with poor performance or small improvement, but with significant investment in the previous years, should be examined in terms of efficiency or suitability for the implementation of related tasks.

iii. The budget item relating to a KI that has exceeded its desired target or is expected not to improve significantly in the coming year should be reviewed to see if it is possible to reduce its allocated budget .

iv. If the target year is close and the achievement of an indicator is still far away from its desired target, effective actions should be taken to improve the indicator and increase the rate of achievement.

SWOT

Since the DSR framework can not reflect the regional characteristics, this study adopted the SWOT framework. The SWOT framework can show the strength, weakness, opportunity, and threat of a local region for improving its environmental sustainability. The classification criteria of the SWOT framework are as follows.

(1) Strength: based on the achieved level of the indicator and the local characteristics, the strength indicator is an indicator with good value, its temporal change is on a positive trend, the associated target can be achieved. However, some indicators with good values may increase the difficulty to improve them further. For example, since the climate in Hsinchu city is windy, the air pollutants are readily diffused. The number of days with Pollution Standard Index (PSI) exceeding 100 is thus only 1 day in 2002 for Hsinchu city, and the achievement rate of this indicator is good. This indicator is thus classified as a strength indicator. However, only one day with PSI exceeding 100 is not easy to improve upon in the next year.

(2) Weakness: a weakness indicator is an indicator with a decreasing trend, or the indicator value is influenced by local characteristics and is hard to improve. For improving a weakness indicator, the authority needs to invest resources or implement effective strategies. For example, the amount of toxic chemicals being used is a weakness indicator for Hsinchu city because there is a high-tech industrial district located in the city. These toxic chemicals are used to produce the high-tech products. The trend of the amount of toxic chemical substances being used keeps increasing, making it impossible to reduce that number in the following year if no regulatory action is implemented to enforce a reduction.

(3) Opportunity: an opportunity indicator is an indicator with a low quality value, and its temporal change is on a negative trend. However, it is likely to improve the indicator by integrating available resources or increasing the allocated budget. For example, the ratio of waste composting is low in Hsinchu city. In recent years, the environmental consciousness of the citizens has increased, and as a result the ratio of recycled waste

is also increasing. If the authorities can establish a proper collection system to collect kitchen waste, the ratio of waste composting can be increased significantly.

(4) Threat: a threat indicator is an indicator with a good value, but its value has started to decline with a gradual and obviously negative trend. For example, although the ozone concentration in Hsinchu City is still acceptable, its annual average is gradually increasing. The ozone concentration in the atmosphere is affected by several factors, such as volatile organic contaminants, nitrogen oxides, sunshine, and temperature. If no action is taken, the indicator will continue to deteriorate.

Case Study

To demonstrate the applicability of the proposed system, a case study for Hsinchu City Environmental Protection Bureau (HCEPB) was implemented. Hsinchu city is located in northern Taiwan. The city has an area of about 103 km^2 and a population of about 390,000 people. The financial budget information was provided by the accounting office of the HCEPB. In a previous study (Kao et al., 2008), a system was established for the water sector. In order to assist the manager with improving the environmental sustainability, this earlier system has been enhanced further in the present study. Three additional sectors of air pollution control, waste management, and toxic substance control have been included in the system.

The procedure for applying the proposed system is as follows.

(1) Specify RES visions and goals. Using this system, RES visions and goals can be set, as shown in Figure 2. Different indicator classification frameworks, including property, administrative division, DSR, and SWOT, are provided for analyzing the relationships among the indicators.

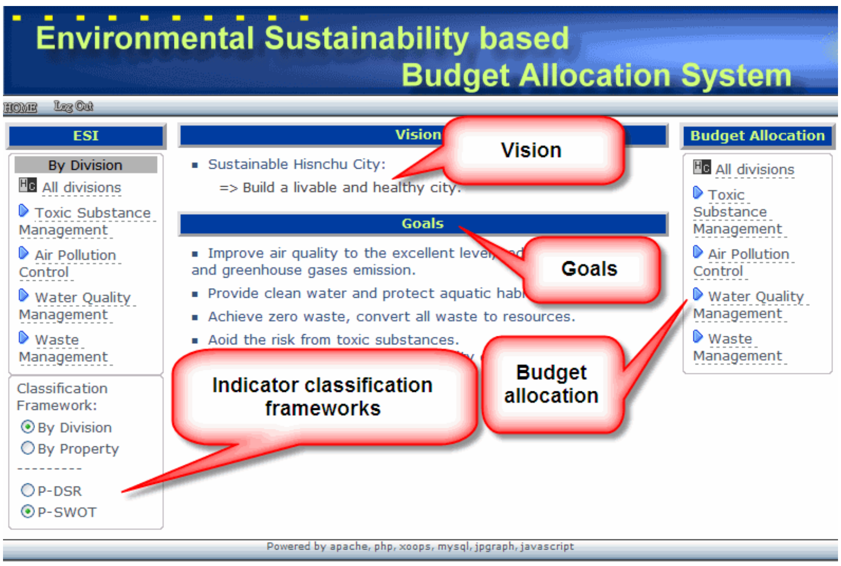


Figure 2. Homepage of the prototypical system.

(2) Select or establish ESIs for assessing regional environmental sustainability and set the target year with target value for each indicator. In this step, as shown in Figure 3, the user can select the indicators from a provided list of indicators or establish new ones. All selected indicators can be grouped according to the framework selected. The achievement rate, displayed by a radar chart, of each indicator is also calculated based on its indicator value and specified target. For example, as shown in Figure 3, the ESIs of the waste management sector are classified into four groups of strength, weakness, opportunity, and threat, as described below.

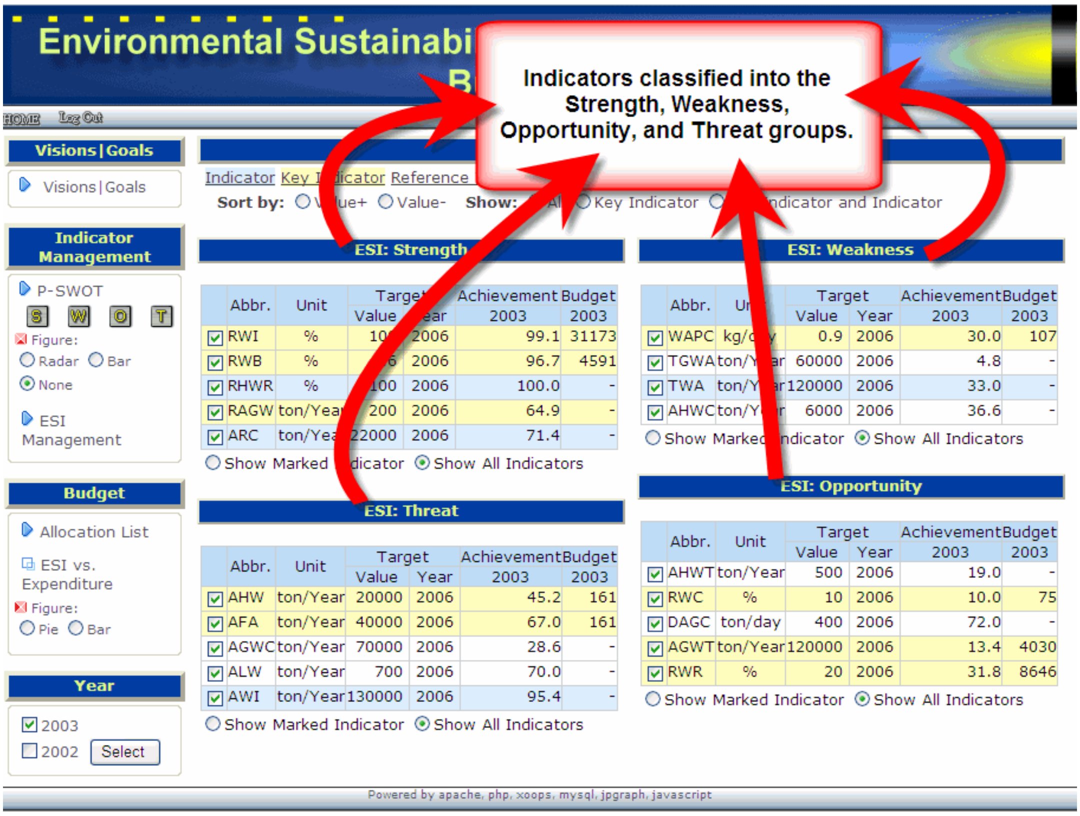
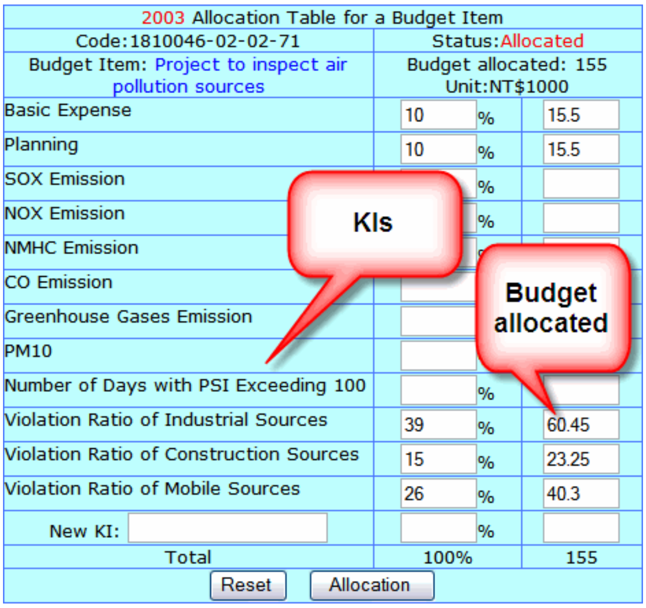


Figure 3. Achievement rates of ESIs, classified by the SWOT framework.

- Strength: flammable and corrosive solvents from the high tech industrial district are major hazardous wastes in Hsinchu city. Since the concentrations of those waste solvents are usually high, most companies recycle them. Therefore, the ratio of hazardous waste recycle is good and regarded as a strength indicator.
- Weakness: the achievement rates for both the total waste amount and the waste amount per capita are low. However, for the former indicator, it keeps increasing because the number of residents in the city is increasing. As for the latter indicator, in order to reduce the waste generated per capita, the lifestyle of the citizens must be altered significantly. As it stands now, these two indicators will not be easy to change in the short term. Therefore, both indicators are regarded as weakness indicators.

- Opportunity: although the achievement rate of the recycled waste ratio is at present not good in Hsinchu city, the improving trend of the indicator is positive. This indicator is expected to increase significantly once the frequency of waste collection is being increased. Therefore, the indicator is treated as an opportunity indicator.
- Threat: the amount of hazardous waste and the amount of fly ash generated from the city incinerator are both regarded as threat indicators. Because of the growing development of the high tech industrial park in the city, the amount of hazardous waste continues to increase and poses a potential health risk to the public. The increasing amount of fly ash and associated air pollution generated by the incinerator has attracted public attention due to its potential threat to public health.



2003 Allocation Table for a Budget Item			
Code:1810046-02-02-71	Status:Allocated		
Budget Item: Project to inspect air pollution sources	Budget allocated: 155 Unit:NT$1000		
Basic Expense	10	%	15.5
Planning	10	%	15.5
SOX Emission		%	
NOX Emission		%	
NMHC Emission			
CO Emission			
Greenhouse Gases Emission			
PM10			
Number of Days with PSI Exceeding 100		%	
Violation Ratio of Industrial Sources	39	%	60.45
Violation Ratio of Construction Sources	15	%	23.25
Violation Ratio of Mobile Sources	26	%	40.3
New KI:		%	
Total	100%		155
Reset Allocation			

Figure 4. Budget allocation interface.

(3) Select KIs and determine which KIs are related to which budget item or planned task. Figure 4 shows a typical interface for implementing this budget-indicator linkage establishment step. A budget item is allowed to link to different KIs, but the budget allocated for each KI must be specified. The manager can allocate the budget, using the table shown in Figure 4, based on the performance of associated indicators and the expected performance to improve the environmental sustainability of a task, financially supported by a specific budget item. Budget items such as general administration, miscellaneous, and planning expenditures that can not be directly assigned to any specific KI can be linked to basic or planning budgets. If the manager can not find any proper KI in the left column, a new KI can be added, one at a time, by entering it into the box provided in the table.

(4) Analyze the appropriateness of the entire budget allocation plan and make the necessary adjustments. After linking all budget items to related indicators, an allocation result table is generated, as shown in Figure 5. The table shows the KIs and the amounts allocated from all related budget items. Based on this table, the manager can verify whether each budget item is linked to proper KIs or not, and assess whether enough funds are allocated for implementing related tasks or actions for improving the associated KIs. For example, Figure 5 shows the budget allocated to the KI of the concentration of toxic chemicals in the atmosphere. Most of the budget is allocated for atmospheric monitoring. Monitoring, although essential for knowing the status in atmosphere, itself does not directly reduce the concentration. Therefore, increasing the allocated budget for assisting factories to substitute or to stop using toxic chemical substances should be considered.

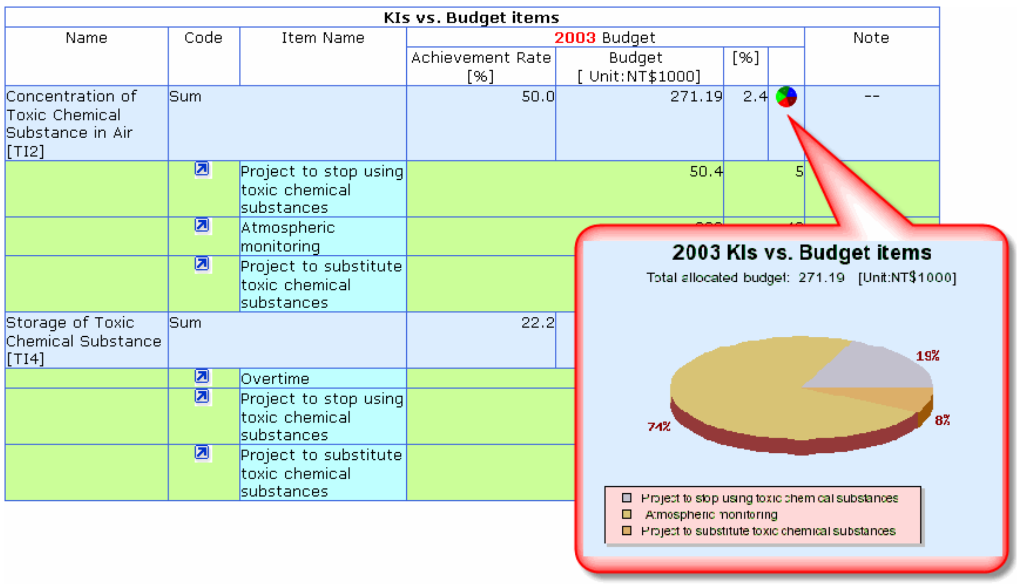


Figure 5. Key indicators (KIs) vs. Budget items.

Conclusion

Existing ESI systems are generally independent of a budget allocation system. A local government will thus be unable to estimate the budget to be allocated to each ESI. Therefore, this study proposed a system to integrate the ESI and the budgetary allocation systems. The proposed system includes five major functions for establishing RES visions and goals, managing ESIs and KIs, classifying ESIs, analyzing the linkages between budget allocation and indicators, and evaluating the budget allocated to each KI. With the proposed system, the local authority can evaluate the budget allocated to each KI and make the necessary adjustments to improve regional environmental sustainability.

For assessing the appropriateness of the budget based on regional characteristics, this study adopted the SWOT framework for classifying selected indicators, in addition to the DSR framework. The SWOT classification framework shows the strengths, weaknesses, opportunities, and threats for improving the environmental sustainability of a local region. Although the complete system is still under development and its configuration is not finalized, a prototypical web-based system has been successfully developed. A case study covering the multiple sectors of air pollution control, waste management, and toxic substance management were implemented, and the applicability of the proposed system was demonstrated.

Acknowledgement

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