Enhanced Balanced Scorecard: A Proposed Sustainability Planning Platform

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***Abstract*— This work developed and evaluated a sustainability planning platform composed of a methodology and a tool suite called Enhanced Balanced Scorecard (EBSC). The platform was built on the synergy of widely used production systems design and evaluation methodologies and tools namely Quality Function Deployment (QFD), Theory of Inventive Problem Solving (TRIZ), and Abridged Life Cycle Assessment (ALCA). EBSC was designed to (1) address the deficiencies of existing frameworks and (2) exhibit the desired characteristics of a sustainability planning framework, which are: (a) allows possibility of certification; (b) integrates the social; (c) environmental, and economic dimensions of the organization; (d) involves continual improvement; (e) exhibits structural clarity; (f) involves participative decision making among internal and external stakeholders; (g) allows ease of information handling; and (h) considers individual characteristics of companies.**

***Index Terms*—QFD, TRIZ, ALCA, sustainability planning**

I. Introduction

Sustainability management systems (SMS) were developed as a response to the call for sustainable development. They serve as holistic management systems in which environmental efficiency, social equity and justice, and economic development are integrated and balanced. The establishment of SMS lead to many important benefits such as revenue growth; cost efficiencies due to operational efficiency, reduced resource and energy use, and reduced waste; improved risk management; and increased access to capital [1].

Sustainability planning is the foundation of a successful SMS. It is during this phase of the SMS where crucial activities such as (1) identification of sustainability aspects and impacts; (2) identification and prioritization of performance measures; and (3) setting and prioritization of targets, objectives, and action plans are conducted.

Although sustainability planning frameworks exist, several deficiencies need to be addressed in order to facilitate the implementation of this task and improve the quality of its output. Primary of which are the lack of (1) a systematic methodology for identifying and prioritizing sustainability aspects, impacts, objectives, actions, and tasks; (2) a methodology for life cycle thinking; and (3) a tool suite to facilitate task implementation.

II. A Review of Existing SMS and Sustainability Planning Frameworks

A. SMS: A Vehicle to Sustainable Development

The publication of *Our Common Future*, more commonly known as the *Brundtland Report* [2], contributed significantly in the recognition of the value of sustainable development all over the world. The *Brundtland Report* states that sustainable development is about "development that meets the needs of the present without compromising the ability of future generation to meet their own needs." The Brundtland Commission listed seven critical objectives for environment and development policies [2]:

- Reviving growth;
- Changing the quality of growth;
- Meeting essential needs for jobs, food, energy, water, and sanitation;
- Ensuring a sustainable level of population;
- Conserving and enhancing the resource base;
- Re-orienting technology and managing risk; and
- Merging environment and economics into decision making.

However, it has been noted that this concept proved to be very challenging to practice [3]. One of the reasons is that its specific meaning varies [4] according to "one's training, one's working experience and one's political and economic setting" [5]. Esquer-Peralta, et al. [4] agreed with Prugh and Assadourian [6] and Frankel [7] in saying that sustainable development is a combination of conceptual (subjective) and practical (objective) dimensions, wherein the latter, which refer to specific actions to solve current problems of industrialization, should be driven by the former (i.e. principles and values). For instance, the specific definition of sustainable development in a manufacturing company woud be different from that in a university setting.

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Esquer-Peralta [8] proposed that sustainability or sustainable development is "the general idea of a sense of stability for environmental, social and economic dimensions."

This research adopted the sustainability definition offered by Esquer-Peralta [8] taken in the context of the Brundtlund Report's definition. That is, in order to meet the needs of the present without compromising the need of the future, stability should be achieved in the economic, social and environmental dimensions. Thus, the different dimensions should be taken from two time perspectives – present and future.

Consequently, SMS were developed to serve as holistic management systems in which environmental efficiency, social equity and justice, and economic development are integrated and balanced. Experts perceive this kind of systems to be "a promising and potentially useful tool in helping companies in their sustainability performance once it has been fully understood by senior leaders and properly implemented [4]."

In their study, Equer-Peralta, et al. [4] surveyed 14 experts from different parts of the world regarding their perceptions of core elements for SMS. Ten of these experts believe that management systems are useful for sustainable development, or at least potentially useful. In general, the experts highlighted four important points and these are (1) the integration of management system elements to encompass the different aspects of sustainable development; (2) the mounting of the management system on a more strategic perspective; (3) the participation of stakeholders; and (4) the use of life cycle thinking. In addition to this, the experts also noted the importance of measuring and demonstrating continuous improvement.

B. A Review of Existing SMS and the Role of Sustainability Planning

Literature on SMS is limited. It was observed that there is a lack of available guides or standards for establishing an SMS. This was also expressed in Stewart [9]. Because sustainability planning is a component of SMS, the same conclusion can be made about it. However, it was also observed that despite the differences in the various SMS frameworks encountered, there are also noticeable and important similarities. The following discussions provide the primary findings from the review of existing SMS and sustainability planning frameworks.

The different SMS encountered were compared with respect to three aspects namely: context, process and categories/components. These aspects were adapted from the work of Esquer-Peralta [8] as it was observed that all the other SMS frameworks can be characterized using the said aspects.

It was observed that in terms of context, the existing SMS frameworks are actually Integrated Management Systems (IMS). Although the compositions of these IMS are varied among the different SMS frameworks, it was observed that the incorporation of EMS, predominantly in the form of ISO 14001, is widespread. The companies that have adopted the ISO 14001 did so primarily because ISO 14001 is perceived to be a proven and widely used management system ([9], [10], [11], [12]). In fact, by the end of December 2007, there were at least 154, 572 ISO 14001 certificates issued in 148 countries and economies all over the world [13].

The second most popular reason for the adoption of ISO 14001 is the provision for possible ISO certification ([9]; [10]; [11], [12]). Based on current global market trend, ISO certification will soon become a business necessity. Thus, although certification is not the initial motivation for the establishment of SMS in the works encountered, it is an opportunity that is made provision for.

A third reason is the similarity of ISO 14001 to quite popular management system standards such as the ISO 9000, EMAS, EFQM, and Malcolm Baldridge Award. Thus, it was much easier for the companies which had one of the said standards in their system to integrate ISO 14001.

On the other hand, the most important characteristics of an SMS were identified from the literature review (see Table 1). These characteristics were grouped according to the aspects adapted from Esquer-Peralta [8].

Table 1. Desired SMS Characteristics

Group	Desired Characteristics
Context	• Involves integration of economic, environmental, and social dimensions • Uses the synergies of proven MS during integration • Allows possibility of certification
Process	• Involves continual improvement (embodied by the PDCA cycle) • Structural clarity
Components/ Categories	• Involves participative decision making among internal and external stakeholders • Involves strategic perspective • Deploys strategic sustainability solutions to process level (Strategic-to-tactical decisions bridging) • Invokes strong sustainability leadership • Involves performance assessment with identified and ranked performance measures • Involves life cycle thinking • Involves easy handling of the systems, even by untrained employees • Allows better handling of information • Considers individual characteristics of companies

Meanwhile, it was seen that the sustainability planning component of an SMS is the most crucial. Its output forms the skeleton of the entire SMS. Thus, it has to be implemented in such a way that the desired SMS characteristics are considered. The expected outputs of sustainability planning are listed in Table 2.

Table 2. Expected Sustainability Planning Outputs

Desired Output	Present In
List of sustainability aspects and impacts	[9], [10], [11], [14], and [15]
Ranking of sustainability aspects	[9], [10], [11],

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according to significance	[14], and [15]
List of legal and other requirements	[9], [10], [11], [14], and [15]
List of sustainability objectives and targets	[9], [10], [11], [14], and [15]
Ranking of sustainability objectives and targets	[10]
Program for achieving objectives and targets - Management structure, responsibilities, organization, and authority - Resources (People and their skills, financial resources, tools) - Detailed Tasks - Measurement System and auditing	[9], [10], [14], and [15]

Lastly, the research gaps identified are summarized as follows:

- Need for easy information handling;
- Method for life cycle thinking;
- Need for tool suite to facilitate task implementation (Only [11] attempted to provide a tool suite. However, the said tool suite is not yet fully developed and particularly lacks an environmental assessment tool.);
- Need for an explicit definition of and method for determining sustainability aspects and sustainability impacts (Only [9] provided a definition of sustainability aspects and impacts as well as a methodology for identifying these.);
- Objective method for identifying and prioritizing performance measure, objectives, and targets (Only [10] explicitly required the prioritization of objectives and targets. However, no method for doing so was proposed).

As such, the necessity for a sustainability planning methodology and tool suite (i.e.: sustainability planning platform) which can address the above deficiencies was established.

III. EBSC Methodology Formulation

To build the sustainability planning platform, first, an appropriate sustainability planning methodology was formulated. This was based primarily on the review of existing SMS and sustainability planning platforms as well as the ISO 14001 environmental planning methodology. After the methodology was formulated, the appropriate tool suite configuration was established.

Furthermore, based on the review of related literature, the EBSC objectives taken into consideration in the design of the methodology and configuration of the tool suite, are summarized in Table 3.

Table 3. EBSC Objectives

Objectives	
O_1	Provide a systematic and more objective methodology for identifying and prioritizing performance measures, objectives and targets, actions, and tasks/ Deploy strategic sustainability solutions to process level (Strategic-to-tactical decisions bridging)
O_2	Provide a methodology for life cycle thinking
O_3	Conform to ISO 14001 environmental planning requirements
O_4	Provide a set of integrated tools to facilitate task implementation
O_5	Involve integration of economic, environmental, and social dimensions
O_6	Allow possibility of certification
O_7	Involve continual improvement
O_8	Exhibit structural clarity
O_9	Involve participative decision making among internal and external stakeholders
O_{10}	Allow better handling of information
O_{11}	Consider individual characteristics of companies

The methodology tasks were identified based on the expected outputs of sustainability planning as shown in Table 2. The sequence of tasks was based primarily on the requirements of ISO 14001. This was done because provision for certification is one desired characteristic of the framework and ISO 14001 has been found to be most promising.

The generated sustainability planning methodology and its relation to the ISO 14001 environmental planning components are illustrated in Fig. 1. The steps were grouped into two modules namely, the *Reality/Achievement Module* and the *Ideality Module*. The *Reality Module* simply consists of steps pertaining to the characterization and assessment of the current condition of the system under study. Since continual improvement is desired, the situation being characterized or assessed maybe an improvement of previous efforts, thus the term *Achievement*. After the characterization and assessment of the system, the next activities pertain to the identification of directions of improvement, objectives, targets and specific tasks. These activities were grouped under the *Ideality Module*. Moreover, since ISO 14001 requires a specific methodology for the identification of sustainability aspects and impacts, a methodology for this purpose is provided in EBSC (see Fig. 2). The definition for sustainability aspects and impacts are as follows:

Sustainability Aspect - Elements of a system's activities, products or services that can interact with the community (both internal and external) and the environment *[adapted from [14] and [15]]*

Sustainability Impact - Any change to the community (both internal and external) and the environment, whether adverse or beneficial, wholly or partly resulting from an organization's activities, products or services *[adapted from [14] and [15]]*.

IV. EBSC Tool Suite Configuration

QFD, TRIZ, and ALCA, were included as the primary tools in the EBSC tool suite. The following subsections discuss the primary roles of each of these tools with respect to the achievement of the EBSC objectives as a sustainability planning platform.

A. The role of QFD

The conformance to ISO 14001 has already been incorporated in the formulated sustainability planning methodology discussed in the previous section. The following are the most important contributions of QFD in the EBSC tool suite:

- Enables participatory and cross-functional decision making;
- Enables linkage of strategic to tactical decisions;
- Enables systematic identification of performance measures (i.e. Sustainability Aspects), objectives, targets, action plans, and tasks;
- Enables more objective identification of the interrelationships among the dimensions of environment, profit, and society;
- Enables more objective ranking of Sustainability Aspects, objectives and actions;
- Enables a structured and systematic decision making process;
- Enables the documentation of the thinking process of the decision makers and serves a convenient repository of information;
- Facilitates midcourse changes; and
- Promotes accountability among decision makers.

B. The role of ALCA

As seen from the above discussion, QFD addresses all the desired characteristics of an SMS except for providing a method for life cycle thinking and a tool for generating solutions (i.e.: sustainability actions and tasks). To answer the first deficiency, ALCA was incorporated in the tool suite. The Environmentally Responsible Process Matrix was adapted to serve as the EBSC's Environmentally Responsible System Matrix. Meanwhile, the scoring guideline corresponding to the Environmentally Responsible Process Matrix developed by Graedel [16] was also adopted as scoring guideline in EBSC's Environmentally Responsible System Matrix.

Aside from this, ALCA also aims to aid in the identification of sustainability impacts and aspects, especially those related to the environment. Moreover, ALCA can show the organization's activities that put the highest burden on the environment and in what manner (e.g.: choice of materials, energy requirement, residues). Thus, it aids in identifying the impacts with the highest risks and the aspects that lead to these impacts. This information also helps in generating solutions that would address the most significant impacts of the organization.

C. The role of TRIZ

Lastly, although QFD and ALCA already address the primary requirements for the sustainability planning platform, it was seen that to further aid this task, a way to facilitate the generation of solutions should be provided. The objective is to lead the planner to the most promising solutions. The most promising solution is the one that leads to ideality and TRIZ is a proven tool for this purpose. Thus, TRIZ was included primarily to aid in formulating sustainability action plans and tasks.

V. EBSC Sustainability Planning Platform

This section explains how the EBSC methodology and EBSC tool suite function together to fulfill the expectations from a sustainability planning platform. It is reiterated at this point that the EBSC methodology and EBSC tool suite together, form the EBSC sustainability planning platform. Table 4 serves as a step-by-step guide in implementing the EBSC Platform. Note that the tasks in the first column of Table 4. The configuration of the House of Quality (HOQ) rooms with respect to these tasks is shown in Fig. 3. Moreover, the second column of Table 4 lists the specific tools used in accomplishing each task. It can be observed that the three primary tools used – QFD, TRIZ, and ALCA – are actually interdependent.

VI. EBSC Case Study on a Philippine Gold Jewelry Manufacturing Company

A case study on a small Philippine gold jewelry manufacturing company was conducted to validate the proposed model. The results and analysis of the said study are found in [17] and [18]. The results of the case study application prove the feasibility of the EBSC as a sustainability planning platform. With the use of EBSC, all the expected sustainability planning outputs were derived. It is believed that a systematic and more objective methodology for the identification of sustainability aspects, impacts, objectives, targets, actions and tasks was exemplified. Prioritization of the said objectives and actions was shown to have an objective basis. Moreover, the relationship between the elements from different dimensions of sustainability (i.e.: environmental, social, and economic) was clearly established. Insights from a life cycle point of view were also used throughout the sustainability planning process. Other desired properties of a sustainability planning platform are also believed to have been exemplified by EBSC in the case study application as shown in the results.

VII. Recommendation for Further Study

To further establish the applicability of EBSC in various types of organizations, it is highly suggested that more case studies be conducted regarding the feasibility of EBSC in other types of organizations.

Moreover, although the integration of QFD, TRIZ, and ALCA as a tool suite for sustainability planning was established to be feasible, there is a need to explore ways of making the tool suite easier to use. Obvious areas to consider are:

- Improving the presentation of the set of rules and instructions for using EBSC; and
- Establish the necessary level of QFD, TRIZ, and ALCA familiarity or expertise.

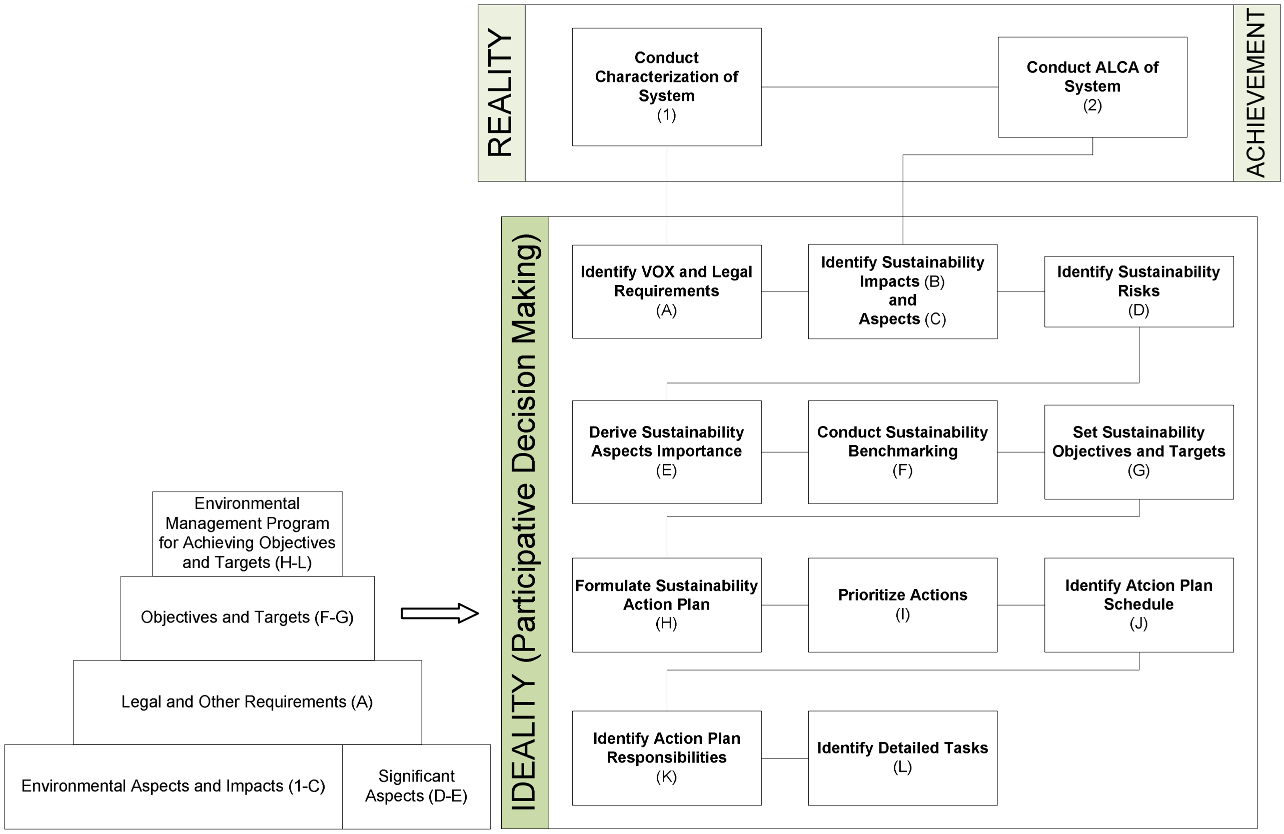

Fig. 1. EBSC Methodology with Corresponding ISO 14001 Planning Components

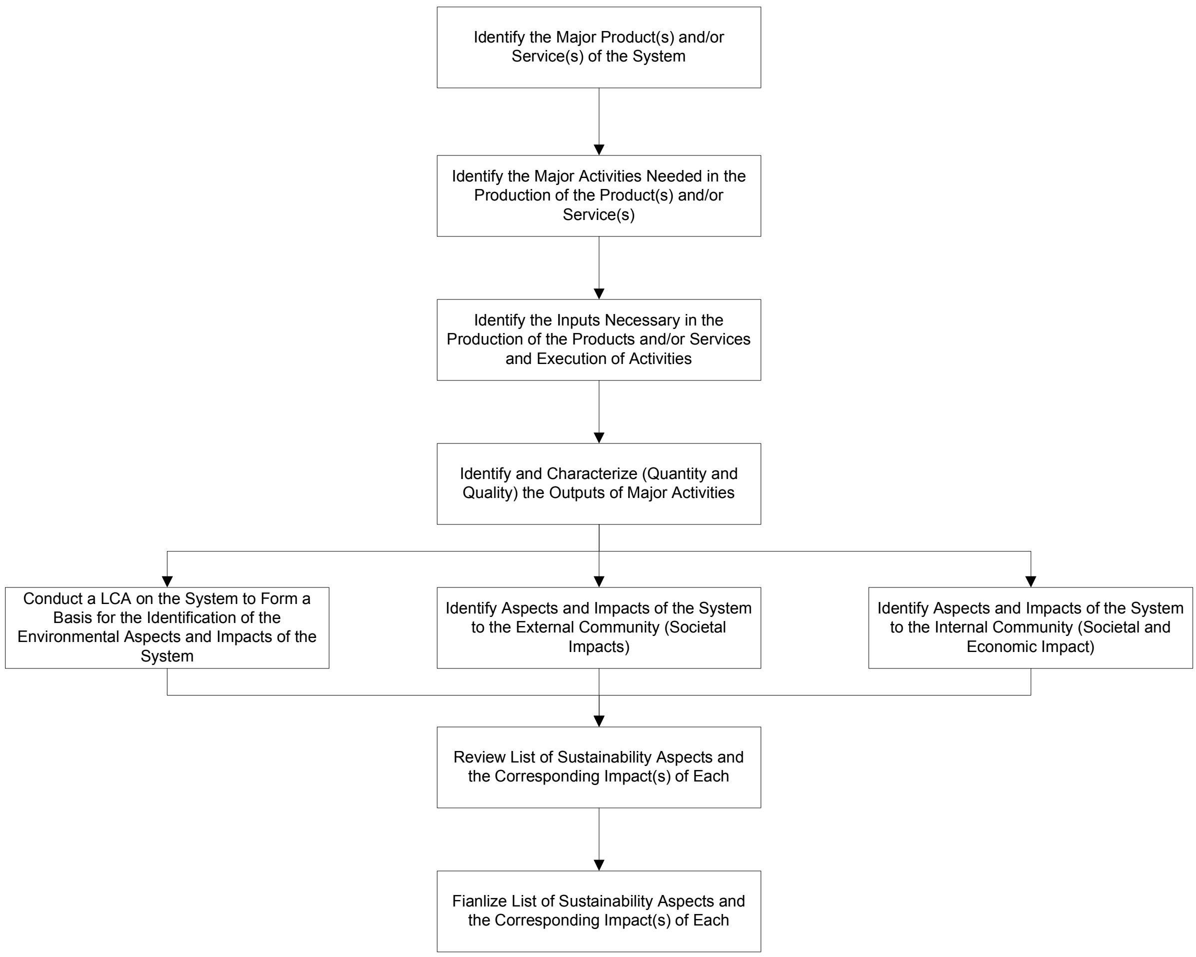

Fig. 2. Methodology for Identifying Sustainability Aspects and Impacts

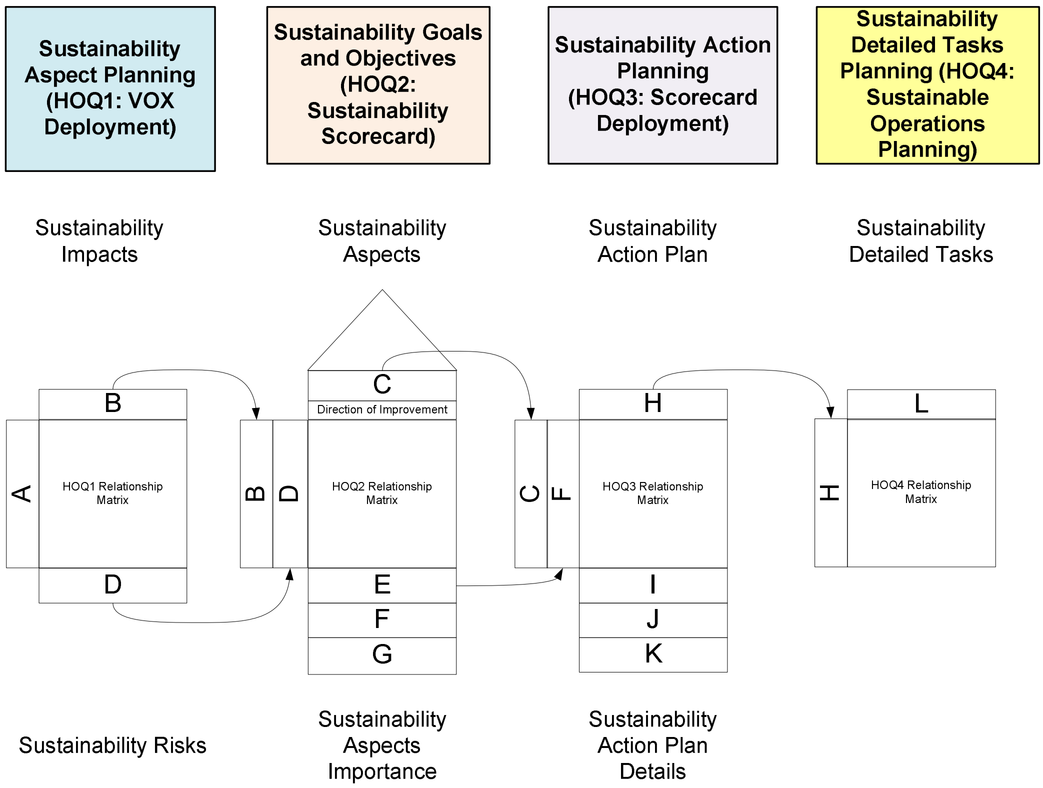

Fig. 3. EBSC HOQ Configuration

ESIPOC DIAGRAM TEMPLATE						
SUPPLIER	**INPUT**	**REQ'T**	**PROCESS**	**OUTPUT**	**REQ'T**	**CUSTOMER**
From whom or from where do the inputs come?	1) Direct Materials	Quantity, Quality	What is the process involved in coverting the input to the output?	1) Product	Quantity, Quality	To whom or to where do the outputs go?
	2) Process Materials			2) Residues		
	2.a) Liquid	Quantity, Quality		2.a) Liquid	Quantity, Quality	
	2.b) Solid	Quantity, Quality		2.b) Solid	Quantity, Quality	
	2.c) Gased	Quantity, Quality		2.c) Gased	Quantity, Quality	
	3) Energy	Quantity, Quality		3) Energy	Quantity	
	4) Labor	Quanity, Quality				
	5) Machine/ Equipment/Tools	Quanity, Quality				
	6) Information	Quality				
	7) Time	Quantity				

Fig. 4. ESIPOC Diagram

Table 4. EBSC Platform Guide

Task	Tool	Task Details
1	<u>QFD</u> ESIPOC (refer to Fig. 4)	1. Identify the major processes. 2. Identify the Inputs (Direct and Process Materials, Energy, Labor, Machine/Equipment/Tools, Information, and Time) and Outputs (Product, Residues, and Energy) of each process. 3. Quantify and/or qualify each input and output. 4. Identify the Suppliers of each Input. 5. Identify the Customers of each Output.
2	<u>ALCA</u> ERSM; Scoring Guideline (Graedel, 1998)	1. Basing on characterization made, rate each process using the Scoring Guideline for Environmentally Responsible Process Matrix developed by Graedel (1998). 2. Determine the column, row, and Environmentally Responsible System Rating (ERSR). 3. Identify the Hotspots (i.e.: lowest ratings).

A	QFD Affinity Diagram, HOQ1	1. Basing on the ESIPOC, establish list of stakeholders. 2. Survey, interview or conduct focus group discussions to identify the stakeholder needs and wants from the system (i.e.: VOX). 3. Identify the importance of each VOX. The It is suggested that AHP be used in this step. 4. Research policies and laws relevant to the system under study. 5. Input final list of VOS in *HOQ1: Room A*.
B	ESIPOC, ALCA	Please refer to Fig. 2.
C	QFD: HOQ1	1. Input Sustainability Impacts in *HOQ1: Room B*. 2. Rate the relationship between each VOX/Legal Requirement and each Sustainability Impact. In rating, a 3-6-9 scale may be used with the following meanings: 9 – strong interrelationship; 6 – medium interrelationship; and 3 – weak interrelationship. Put the rating in the corresponding cell of the *HOQ1 relationship matrix*. 3. Compute the sustainability risks for each sustainability impact using the following formula. Let: SR_j = sustainability risk for impact j VR_i= VOX i importance rating r_{ij} = interrelationship rating between VOX i and Sustainability impact j $$SR_j = \sum_{i=1}^{I} VR_i r_{ij}$$ Input the SRs in *HOQ1: Room D*.
D	QFD: HOQ2	1. Input Sustainability Impacts in *HOQ2: Room B* and SRs in *HOQ2: Room D*. 2. Put Sustainability Aspects in HOQ2: Room C. 4. Rate the relationship between each Sustainability Impact and each Sustainability Aspect. In rating, the 3-6-9 scale may be used. Put the rating in the corresponding cell of the *HOQ2 relationship matrix*. 5. Compute the importance of each sustainability aspect (Sustainability Aspect Importance) using the following formula. Let: SAI_k = importance for sustainability aspect *k* SR_j = sustainability risk for impact *j* *Note: The sustainability risk matrix was transposed.* s_{jk} = interrelationship rating between Sustainability Aspect *k* and Sustainability Impact *j* $$SAI_k = \sum_{j=1}^{J} SR_j s_{jk}$$ Input the SAI_ks in *HOQ2: Room E*.
E	QFD: HOQ2	1. Research regarding the performance of competitors pertaining to the identified sustainability aspects. Put findings in *HOQ2: Room F*.
F	QFD: HOQ2	1. Identify the desired direction of improvement for each sustainability aspect. Put this in the *HOQ2: Direction of Improvement Room*. 2. Establish targets for each sustainability aspect. Input this in *HOQ2: Room G*.
G	QFD: HOQ2 HOQ3 TRIZ TRIZ Tools ALCA: ERSR QFD: HOQ3	1. Input Sustainability Aspects in *HOQ3: Room C* and the SAIs in *HOQ3: Room E*. 2. Establish correlation of sustainability impacts in the *HOQ2 roof*. 3. Generate Sustainability Action Plans corresponding to the Sustainability Aspects. -Identify TRIZ problems. -Use TRIZ tools and ALCA findings to generate solutions. Input Sustainability Actions in *HOQ3: Room H*.
H	QFD: HOQ3	1. Rate the relationship between each Sustainability Aspect and each Sustainability Action Plan. In rating, the 3-6-9 scale may be used. Put the rating in the corresponding cell of the *HOQ3 relationship matrix*.

I		2. Compute the importance of each sustainability action using the following formula. Let: $SAcI_l$ = importance for sustainability action l SAI_k = importance for sustainability aspect k *Note: The sustainability aspect matrix was transposed.* t_{kl} = interrelationship rating between Sustainability Action l and Sustainability Aspect k $$SAcI_l = \sum_{k=1}^{K} SAI_k t_{kl}$$ Input the SAcIs in *HOQ3: Room I*.
J	QFD: HOQ3	1. For each action, identify the target time frame for implementation. Input this in *HOQ3: Room J*.
K	QFD: HOQ3	1. For each action, identify the person(s) responsible for implementation. Input this in *HOQ3: Room K*.
L	QFD: HOQ4 TRIZ: TRIZ Tools ALCA: ERSR and HOQ3	1. Input the Sustainability Actions in *HOQ4: Room H*. 2. Identify the detailed tasks corresponding to each Sustainability Action. -Identify TRIZ problems. -Use TRIZ tools and ALCA findings to generate solutions. Input the generated tasks in *HOQ4: Room L*. 3. Identify the relationship between action plans and detailed tasks. Input this in *HOQ4 relationship matrix*.

REFERENCES

[1] UNEP Finance Initiative, "Sustainability Management and Reporting: Benefits for Financial Institutions in Developing and Emerging Economies," *UNEP Finance Initiative*, December 2006.

[2] World Commission on Environment and Development (WCED), "Our Common Future," Oxford: Oxford University Press, 1987.

[3] A. Bagheri and P. Hjorth, "Planning for Sustainable Development: A Paradigm Shift Toward Process-baseed Approach," *Sustainable Development*, vol. 15, 2007, pp. 83-96.

[4] J. Esquer-Peralta, L. Velasquez and N. Munguia, "Perceptions of Core Elements for Sustainability Management Systems (SMS)," *Management Decision*, vol. 46(7), 2008, pp. 1027-1038.

[5] W.L. Filho, "Dealing with Misconceptions on the Concept of sustainability," *International Journal of Sustainability in Higher Education*, vol. 1(1), 2000, pp. 9-19.

[6] T. Prugh and E. Assadouria, "What is Sustainability Anyway?," *World Watch Magazine*, 2003, p. 11.

[7] C. Frankel, "In Earth's Company: Business, Environment and the Challenge of Sustainability," Gabriola Island: New Society Publishers, 1998.

[8] J. Esquer-Peralta, "Sustainaility Management Systems: Sustainable Development in Relation to Different Kinds of Management Systems," *10th Canadian Pollution Prevention Round Table*, Halifax, Canada, 2006.

[9] J. Stewart, "City of South Perth: Developing a Sustainability Management System," South Perth, Australia, 2006.

[10] Fort Carson, "Sustainability Management System Five-Year Plan," unpublished, 2002.

[11] J. Grosskopf, "The Metro Sustainability Management System Pilot Project," *The Los Angeles County Sustainability Summit*, Los Angeles, 28 May 2008.

[12] Association for Professional Engineers and Geoscientists of B.C. (APEGBC), "Towards a Sustainability Management System for APEGBC: A Blueprint for SMS with an Action Plan," 14 September 2000.

[13] ISO Central Secretariat, "The ISO Survey of Certifications," [Online]. Available: http://www.iso.org.

[14] G. Woodside, P. Aurrichio and J. Yturri, "ISO 14001 Implementation Manual," New York: McGraw-Hill, 1998.

[15] J. Casciao, G. Woodside and P. Mitchell, "ISO 14000 Guide: The New International Environmental Management Standards," New York: McGraw-Hill, 1996.

[16] T.E. Graedel, "Streamlined Life-Cycle Assessment," New Jersey: Prentice-Hall Inc., 1998.

[17] M.M. Tamayao, "A Sustainability Planning Platform Using Enhanced Balanced Scorecard," MS Thesis, University of the Philippines, Quezon City, Philippines, May 2009, pp. 73-93.

[18] M.M. Tamayao, "A Case Study Application of the Enhanced Balanced Scorecard (EBSC)," *ERDT Conference Proceedings*, submitted for publication.