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Enhancement of Roundtable on Sustainable Palm Oil (RSPO): Quantitative Assessment Tool

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Sustainability assessment is an appraisal process which takes a pluralistic and iterative approach. It is conducted for supporting decision-making and policy in broad scenario (environmental, economic and social perspective) and viewed as a vital instrument to aid in the shift towards sustainability. Sustainability assessment transcends a technical or scientific evaluation. The growth of indicators in numerous fields has influenced sustainability assessment methodologies to a great extent. In general, two broad approaches for sustainability can be distinguished, top-down and bottom-up. Despite the abundance and diversified procedures for evaluating sustainability, indicators based assessment is one of the most widely used platform. Existing sustainability assessments schemes typically provide various interpretations involving various quantification methods, hence difficult to be integrated. Subsequently, this paper provides an integrative analysis of existing sustainability assessment approaches. It not only offers a very valuable insight on the features of existing sustainability assessment schemes, but also highlighting gaps to a certain extent.

1. Introduction

This study examined existing assessment schemes that help in tracking and benchmarking environmental performance. It is not intended to evaluate the best or point out the weaknesses of these schemes, but rather to compare the main features of each of the schemes. The scope is limited to the integration in manufacturing processes even though the evaluation of the existing indicators sets is very relatable to other businesses as well. Emphasis is put on the environmental pillar of sustainability. The sustainable production proposition has increasingly gained attention and is now a key component of business strategies. Therefore, meaningful data on production system and current performance is needed to drive this notion. The demand for a metrics or index is grounded on the notion that “what you don’t measure, you can’t manage”.
The administration of a multi-faceted issue such as environmental sustainability calls for a systematic management and representation in a simple manner that enables objective driven decision making. This condensed data is regarded as indicators. Indicators provide the flexibility to set target and subsequently track their progress. Indicators are capable to go beyond the role as simple information and represent trends and cause-effect interaction between various situations. Indicators are also capable to raise alertness and appreciativeness by setting baseline and current performance of an entity. Many organisations integrate a number of parameters and indicators and apply these as a set for ease of execution. The following categories were identified on the basis of multitude sets of indicators which encompasses all kinds of metrics application, known as Sustainability Assessment Schemes Categorisation: (1) Individual / Set of Indicators; (2) Composite Indices; (3) Material and Energy Flow Analysis; (4) Environmental Accounting; (5) Life Cycle Analysis; (6) Socially Responsible Investment Indices; and (7) Sustainability Reporting Indicators. The categorisation of these schemes lies in the ways organisation choose to consolidate data which indirectly distinguishes them from one another solely on their features.

2. Environmental sustainability index

One important point to note is that the proposed index is based upon the operational definition of environmental sustainability which outlines that the triple bottom line idea of sustainability shall not be

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weighted in a similar manner as destruction to the environment is a permanent condition to a certain extent unlike the consequences to the other two factors – social and economy, which are somewhat reversible. Environmental element shall never be compromised for the other two or rather for any other factors. A feasible environmental condition will contribute to economic and social advancements (ADB, 2006), but this does not necessarily apply the other way around. Therefore, the proposed index will only focus on the environment pillar of sustainability. One prominent tool that is worthwhile for managing these types of complicated decisions is a sustainability index. A sustainability index is intended to simplify the multifaceted decision-making process. Boiling this data down to a manageable set of decision criteria and indicators can significantly alleviate this complexity. The underlying idea behind a sustainability index is to aggregate the relative information pertaining to sustainability aspects of various decisions, strategies and approaches and ultimately designing an easy-to-understand "scoring" scheme to quickly determine the most sustainable options (Garbarino and Holland, 2009).

The environmental sustainability index was initiated from the notion that is very crucial to have a tool which functions as a platform in inhibiting environmental destruction and advocate towards a sustainable society. Its main underlying goal is to promote environmental protection in an orderly manner by launching technique for quantification and subsequently integrating the assessment results in decision-making process. The framework not only helps to identify and understand the positive and adverse effects of the palm oil manufacturing process, it also enables exploration of various options for minimising the impact the environment. Above all, it provides an on-going basis for monitoring the potential impacts of the activity. A tailored sustainability index will help to offer a platform for evaluating decisions that will increase the sustainable value of any organisation. The three main references among others used for the development of the framework are:

- Roundtable on Sustainable Palm Oil (RSPO): RSPO was founded in 2004 with the objective of encouraging the growth and use of sustainable oil palm products through reliable global standards and engagement of various stakeholders. RSPO was initiated to drive the development and implementation of global standards for sustainable palm oil.
- Higg Index (Radhakrishnan, 2015): The Higg Index is a very good and close example of a suite of assessment tools that empower industry players to measure their environmental, social and labour effects at every stage of the product lifecycle. The Higg Materials Sustainability Index (MSI) is a cradle-to-gate material scoring tool incorporating the fundamentals of life cycle assessment (LCA) data and methodology to involve the entire value chain in environmental sustainability.
- Environmental Sustainability Index (ESI) (Yale University and Columbia University, 2005): The ESI is a measure of overall progress towards environmental sustainability. The index offers a composite profile of national environmental stewardship based upon a compilation of indicators extracted from underlying datasets. The ESI benchmarks the capacity of nations to safeguard the environment over the next several decades.

3. Construction of palm oil environmental sustainability

The construction process of the index can be summarised in 7 high level stages.

3.1 Step 1: Scoping

Scoping is merely the stage of the process of narrowing the areas of interest for investigation. This study was segregated into two main parts - abiotic and biotic components. Abiotic components encompass the three most critical aspect of environment – air, water, soil (Levy, 2016). On the other hand, biotic components comprise of all biological aspects within the abiotic component. Noting the fact that the proposed framework lies upon the fundamental concepts of physical systems which can be described by measurable variables and well-defined boundaries (Jamaludin et al., 2017), the abiotic components is not the main area to be address at this stage.

3.2 Step 2: System boundary

Firstly, the proposed enhancement to the environmental pillar of the RSPO will accommodate for Malaysian context for a start as the limits and standards adopted for the quantification procedure will adopt Malaysian policies and guideline. Secondly, this study will concentration only on the upstream and midstream portion of palm oil business, namely the crude palm oil (CPO) production. The CPO production process flow is analysed to identify the sources of waste generated. The process flow in Figure 1 outlines the main stages of a typical palm oil upstream process along with the points of waste generation (Thani et al., 1999). The sources of waste can be categories into 3 main classes. First, liquid effluent as extraction of CPO consumes a considerably large amount of water. Approximately half of the water ends up as palm oil mill effluent (POME) while the balance 50 % is lost as steam (Thani et al., 1999). Total POME generated (breakdown) is a combination of various wastewaters discharged from several processes along the CPO processing (Table 1). Second, gaseous emission in which there are two primary sources of air pollution in CPO processing as described in Table 2 (Thani et. al., 1999). Third, solid waste and by-products which are produced in the CPO processing plant in terms of FFB input are itemised in Table 3 (Thani et al., 1999).

Table 1: Breakdown of liquid effluent (Thani et al., 1999)

Process	Source	Volumetric percentage
Sterilisation of FFB	Steriliser condensate	36 %
Clarification of CPO	Clarification wastewater	60 %
Hydrocyclone separation	Hydrocyclone wastewater	4 %

Table 2: Breakdown of gaseous emission

Source	Material
Boiler	Waste fibre and shell materials
Incinerator (Potash Ash Recovery)	Empty fruit bunch (EFB)

Table 3: Breakdown of solid waste and by-products

Material	Mass percentage (of FFB)
Empty Fruit Bunches (EFB)	23 %
Potash ash	0.5 %
Palm kernel	6 %
Fibre	13.5 %
Shell	5.5 %
Total	48.5 %

3.3 Step 3: Screening

At this stage, the main reference source – RSPO, is screened for criteria and indicators that fall under the pre-determined components of the earlier step. The criteria and indicators are re-categorised into the 3 abiotic components. The RSPO is being extensively filtered to assess criteria that would eventually help to comprehend the impact on the environment of a wide range of man-made influences (Jamaludin et al., 2017).

3.4 Step 4: Baseline

During this stage, existing conditions or standards are established and regarded to as the baseline against which the scoring computation is benchmarked (Lim and Biswas, 2015). This step can be a crucial stage as it is highly relevant to select the appropriate baseline conditions. This is done by extracting threshold values from existing policies (Environmental Quality Regulations, 1977), target conditions or industry best practices.

3.5 Step 5: Data collection

There are various means for data collection such as actual data from CPO manufacturing plant, published data or material balance based on typical CPO manufacturing process. Data which are unable to be calculated based on the process flow are taken from existing literature for similar CPO processing plant in terms of capacity and technology.

3.6 Step 6: Normalisation

Collected data require to be normalised by transforming the raw data to standardised values since they are in various different units. The main purpose of data normalisation is to contextualise the scores. The proximity-to-target (PTT) method (Hashim et al., 2014) is used in doing so which assist in gauging assesses how close a particular data is to the identified target. Data normalisation converts the raw data to a scale of 0 to 100 by simple arithmetic calculation whereby 0 is the farthest from the target while 100 is closest to the target. There are 2 types of PTT formula.

Type A data (high values equate to good performance) → $$\text{PTT} = \frac{[(\text{target - min}) - (\text{target - raw data})]}{(\text{target - min})} \times 100 \quad (1)$$

Type B data (high values equate to bad performance) → $$\text{PTT} = \frac{[(\text{max - min}) - (\text{raw data - target})]}{(\text{max - target})} \times 100 \quad (2)$$

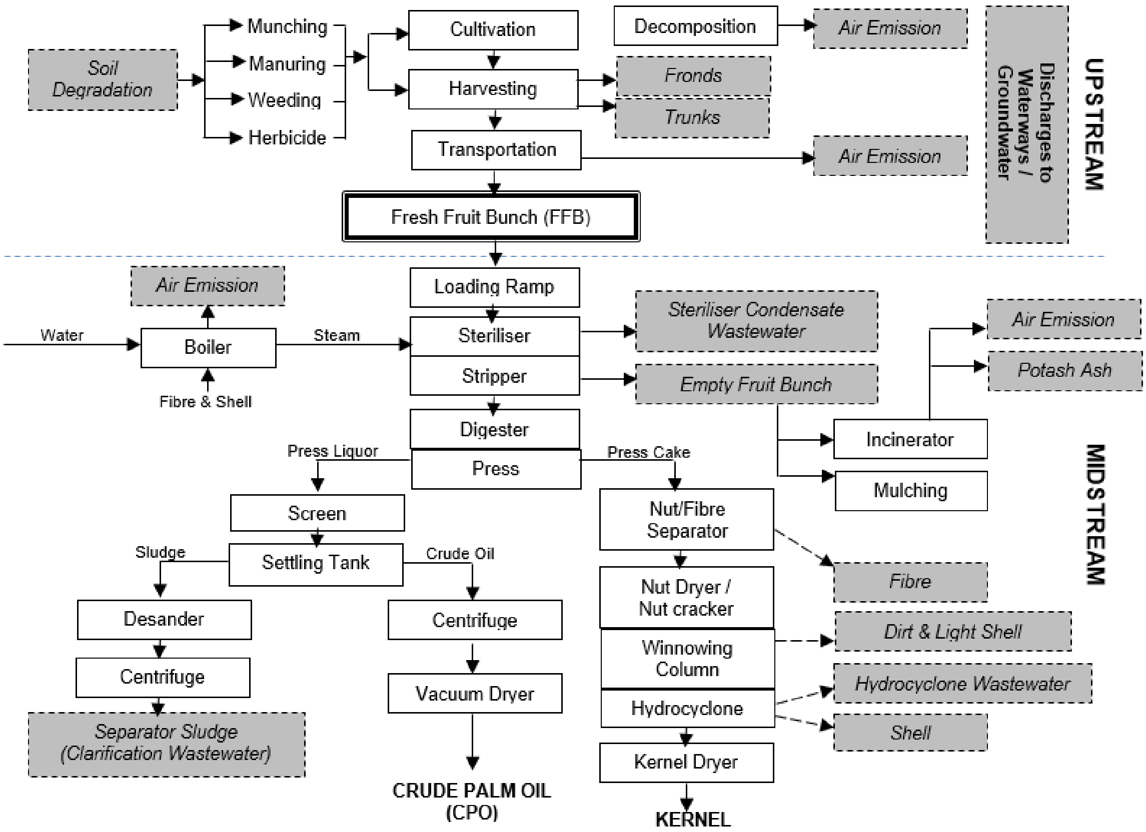


Figure 1: Standard upstream CPO production process flow

3.7 Step 7: Index analysis

Once the scores have been assigned to each indicator using the methodologies mentioned above, the modified indicators are then aggregated into a synthetic index (Jamaludin et al., 2016). Each of the individual normalised scores is summed up to produce a single score that can be used for quick comparison. Alternatively, the normalised data can be represented in graphical form for ease of interpretation as a whole or by pillar (averaged). The data is best represented in a radar chart by section where the radius indicates the performance of the particular indicator (Hashim et al., 2014). The further away an indicator is from the centre, the better its performance. As the radar chart approaches a regular pentagon, it illustrates that all the indicator has equal weightage contribution to the overall index. The final step would be to identify the weak performance indicators (hotspot). Recommendations can be proposed for the identified weak performance indicators. Recommendations include improvising the existing environmental sustainability indicators to make it more comprehensive or suggesting alternative practical environmental sustainability indicators.

4. Data collection and analysis

For baseline setting the following policy and regulations were referred to for data on regulatory control of wastes generation. Effluent Discharge employs Environmental Quality Act, 1974: (Prescribed Premises) (Crude Palm Oil) Regulations 1977, whereas Gaseous Emissions use the Environmental Quality (Clean Air) Regulations, 1978 and Malaysia Ambient Air Quality Standard. Solid Wastes and By Products adopt the Environmental Quality (Scheduled Wastes) Order, 1989 and Environmental Quality (Scheduled Wastes) Regulations, 1989.

For the index computation demonstration purposes, waste generation data are obtained only from published data. On the other hand, for data which are not available, material balance is calculated using standard CPO production processes. Table 4 was also used to estimate the emission quantity. At the same time, the CH_4 and N_2O emissions from solid biomass boilers were assumed to be negligible. The overall index structure coupled with the scores is presented in Table 5.

Table 4: Equivalent mass of chemical fertiliser and CO_2 emission from production

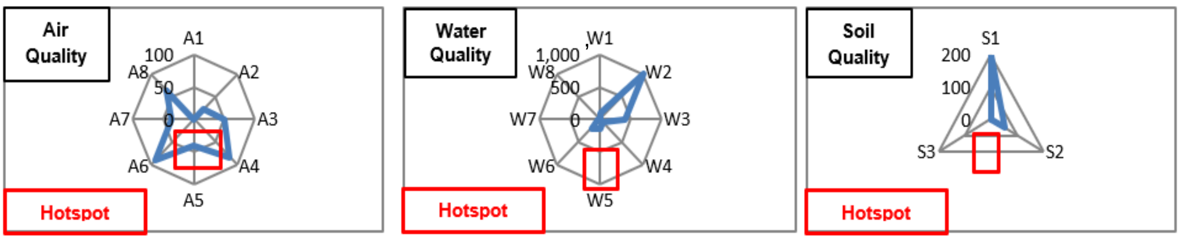
	Equivalent chemical fertilisers	CO_2 emission factors
N content 3.2 kg N/t EFB	30 % Urea : 0.84 kg N/t EFB 70 % Ammonium Sulphate : 2.36 kg N/t EFB	3.29 kg CO_2-eq/kg N 2.68 kg CO_2-eq/kg N
P content 0.38 kg P/t EFB	0.89 kg P_2O_5/t EFB	2.46 kg CO_2-eq/kg P_2O_5
K content 9.6 kg K/t EFB	11.6 kg K_2O/t EFB	0.50 kg CO_2-eq/kg K_2O

Table 5: Proposed environmental sustainability index indicators and scoring

Indicator		Unit	Target	PTT
	Air Quality			
Nitrogen Dioxide	A1	µg/m³	300	0
Sulphur Dioxide	A2	µg/m³	300	22.3
CO	A3	µg/m³	200	50.8
Ground Level Ozone (O_3)	A4	mg/m³	35	82.2
NO_x	A5	mg/m³	350	40.5
GHG	A6	t CO_2-eq/t CPO	0.7	88.8
Particulate Matter (size < 10 micron)	A7	µg/m³	45	37.8
Particulate Matter (size < 2.5 micron)	A8	µg/m³	25	64.3
		(Weightage (%) = 40.7)	Total	48.3
	Water Quality			
Biological Oxygen Demand	W1	mg/L	100	89
Chemical Oxygen Demand	W2	mg/L	1000	45.6
Suspended Solids	W3	mg/L	400	73.2
Oil and Grease	W4	mg/L	50	50.3
Ammonical Nitrogen	W5	mg/L	150	48.3
Total Nitrogen	W6	mg/L	200	37.7
Temperature	W7	°C	45	15.7
pH	W8	NA	7	56.8
		(Weightage (%) = 43.9)	Total	52.1
	Soil Quality			
Soil Nitrate Level (Total Nitrogen)	S1	mg/L	200	43.2
Waste Generation (% Biomass Recovery / Recycling)	S2	%	50	3
Fossil Fuel Consumption Intensity (Output/Input Energy Ratio)	S3	NA	0	8.6
		(Weightage (%) = 15.4)	Total	18.3

5. Preliminary results and discussion

The data computed from the previous section is illustrated in Figure 2a, 2b and 2c. Radar charts are best to display multivariate observations in the form of a two-dimensional chart.



(a) Air Pillar *(b) Water Pillar* *(c) Soil Pillar*

Figure 2: Radar diagram with hotspots for the 3 environmental pillars (a) air pillar; (b) water pillar; and (c) soil pillar

Each radar chart represents the data for each of the environmental pillar selected. Each of the indicators listed in Table 5 form individual axes which are radially arranged around a point. The value of each indicator is depicted by the length of each spoke (axis). The length of the spoke is directly proportional to the magnitude of the indicators. Data from every single observation are plotted along each axis and connected to form a polygon. Radar chart not only helps in comparing individual indicators, but also assists in providing insight on the overall differences of the polygons. A regular-shaped polygon indicates that the indicators have equal performance. Small sized polygon means the overall performance is at the lower bound while large sized polygon simply means overall performance is at the higher bound. A significant feature of the radar chart is it helps locate outliers very easily. Outliers in this case would either mean extremely good performing indicators or bad performing indicators. The bad performing indicators are the hotspots that are identified as the peak closest to the centre (0 value as the worst performance) and vice versa for good performing indicators.

6. Conclusion

This framework measures the overall progress towards environmental sustainability. The index delivers a composite profile of national environmental stewardship constructed based on a compilation of indicators derived from underlying datasets. The important feature about environmental assessments is the emphasis on carrying out a systematic, unbiased and holistic process. The index assists in quantifying the sustainability impacts of upstream manufacturing activities and eliminates redundancy in measuring sustainability in the palm oil sector as a whole.

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