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Development of Systematic Sustainability Assessment (SSA) for the Malaysian Industry

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Abstract. Sustainability assessment is recognized as a powerful and important tool to measure the performance of sustainability in a company or industry. There are various initiatives exists on tools for sustainable development. However, most of the sustainability measurement tools emphasize on environmental, economy and governance aspects. Some of the companies also implement different of sustainability indicators to evaluate the performance of economy, social and environmental separately. In this research, a new methodology for assessing sustainability in the context of Malaysian industry has been developed using integration of Green Project Management (GPM) P5 Integration Matrix, new scale of "Weighting criteria" and Rough-Grey Analysis. This systematic assessment will help the engineers or project managers measure the critical element of sustainability compliance.

1. Introduction

The idea of sustainability or sustainability development has grown rapidly into many levels of society over the last decade. Brundtland Commission specifies sustainability development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED,1987) [1]. In Malaysia, a sustainability idea has always been encouraged by Bursa Malaysia as a key to their business success today. The investors in the auspices of Bursa Malaysia are also required to embed the sustainability concept at the forefront of their business. It is crucial for investors to determine the sustainability performance level and to recognize any unsteady condition in aspects regard to environmental, social and economy in order to ensure their business continuity [2]. Other than that, each company has to prepare the sustainability report or sustainability statement as required under the listing requirements of Bursa Malaysia Securities Berhad.

Therefore, sustainability assessment (SA) is highly acknowledged as a significant tool to assist towards a sustainability reporting production in addition to aid in the transformation towards sustainability. It is an action where the parameters of an effort towards sustainability are measured. SA assists decision-makers to decide the best option they have to create a more sustainable society. The goal of SA is to ensure that a plan, system or activity contributes towards sustainable development [3]. In fact, the SA thinking has been derived by environmental impact assessment (EIA) and strategic environmental assessment (SEA). Thus, SA is generally considered to be the continuation of environmental assessment. SA also stands with similar definition which assigns to the EIA-driven that used to specify a model of integrated assessment considers economic, environmental and social impacts [4]. Therefore, SA is a vital aspect to be considered to make secure a long term value creation for company and society.

Finkbeiner et al. [5] explores the current status of Life Cycle Sustainability Assessment (LCSA) for products and processes and they found the life cycle perspective is inevitable for all sustainability dimensions in order to achieve reliable and robust results. In addition, Ghadimi et al. [6] proposed a validated methodology in order to be used as a road map for manufacturers to move toward manufacturing more sustainable products. (for product sustainability assessment). Latest research by Chong et al. [7] is framework development of sustainability indicators that can serve as a reference for future research in waste-to-energy systems. They developed a metric of sustainability (MOS) which can provide more objective reference that is useful for decision-makers in strategically allocating resources to critical aspects, in improving the overall sustainability of a system. In the same context, Streimikiene and Siksnelyte [8] introduced sustainability assessment of electricity market models to identify what electricity market organization models are the best ones based on the established sustainability criteria in selected developed world countries, while Scandelius and Cohen [9] developed sustainability program brands to improve the knowledge on how organisations can manage diverse stakeholders to improve value chain collaboration towards more sustainable practices.

Amid the resurgence of interest in such researches, literature review indicates that Much of the research relating to sustainability practices focuses on triple bottom line: people, planet, profit [7, 9], product sustainability perspective [6], and environmental sustainability perspective. Furthermore, attention was often concentrated on Life-Cycle Assessment (LCA) method [7]. Research mostly conducted in the western countries, it is still minimal in developing countries including Malaysia and limited attempts at bringing Green Project Management (GPM) P5 method to use in sustainability practices. According to Bursa Malaysia, there is only 2 companies (in Malaysia) who attempted/registered to use this method.

Nowadays, every single company that under the auspices of BURSA Malaysia is required to yield the sustainability reporting. Thus, Systematic Sustainability Assessment (SSA) is designed in the advancing of sustainability reporting for promoting sustainability practices. Most of the companies in Malaysia have implemented green practice in their organization management. However, the green practice only emphasizes the environmental aspect, and that causes other important aspects within the company seem to have overlooked. Hence, GPM P5 standard is introduced as one of the sustainability assessment tool to measure the sustainability practices performance comprehensively by taking into account the aspects of planet, people, profit, process and product.

The general objective of this research is to evaluate the level of sustainability compliance in the context of Malaysian business. This study of SSA will provide the guidelines to the industry to assess their level of sustainability compliance.

2. Methodology

The general framework of the approach is as portrayed in Figure 1.

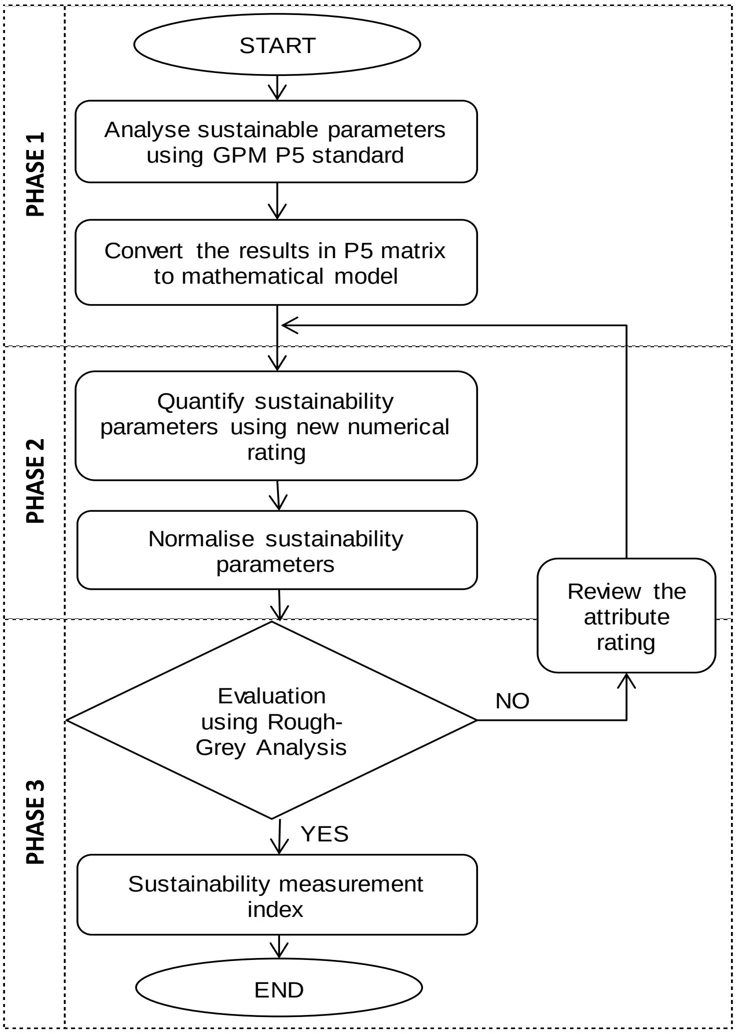

Figure 1. General framework of proposed approach

2.1. GPM P5 Concept Integration Matrix
The P5 concept integration matrix is describes in the following paragraph [10]:

a) Product impacts – objectives and efforts, lifespan and servicing
b) Process impacts – maturity and efficiency
c) Society (People) – labor practices and decent work, society and customers, human rights, ethical behavior
d) Environment (Planet) – transport, energy, water, waste
e) Financial (Profit) – return on investment, business agility, economic simulation

2.2. Scale of "Weighting criteria"
The scale between 0 – 10 was developed to ease the respondents' group for rating the evaluation criteria, which initially selected by the design engineers based on technical documents and the results of a prior survey. The rating value obtained from the survey then will be used to quantify the attribute ratings ⊗v at later stage. Table 1 describes the scale of "Weighting criteria" in more detail.

Table 1. Scale of "Weighting criteria"

Numerical rating	Description
0 – 0.4	Absolutely useless
0.5 – 1.4	Very inadequate

1.5 – 2.4	Weak
2.5 – 3.4	Tolerable
3.5 – 4.4	Adequate
4.5 – 5.4	Satisfactory
5.5 – 6.4	Good with few drawbacks
6.5 – 7.4	Good
7.5 – 8.4	Very good
8.5 – 9.4	Exceeding the requirement
9.5 – 10	Ideal

2.3. Method of quantifying the attribute ratings

The new method of quantifying the attribute ratings value, ⊗v as described in the following paragraph:

a) Develop the dummy attribute ratings chart for all criteria as shown Table 2.

Table 2. Dummy attribute ratings chart [11]

a_j	S_i	**DM *1***			**…**	**…**	**DM *K***		
		$v_{ij\ Typ.}$	$v_{ij\ Min}$	$v_{ij\ Max}$	…	…	$v_{ij\ Typ.}$	$v_{ij\ Min}$	$v_{ij\ Max}$
a_1	S_1	V_{11}	V_{11}-0.5	V_{11}+0.5	…	..	V_{1K}	V_{1K}-0.5	V_{1K}+0.5
	S_2	V_{21}	V_{21}-0.5	V_{21}+0.5	…	…	V_{2K}	V_{2K}-0.5	V_{2K}+0.5
	...	…	…	...	…	…	…	…	...
	S_n	V_{n1}	V_{n1}-0.5	V_{n1}+0.5	…	…	V_{nK}	V_{nK}-0.5	V_{nK}+0.5
…		…	…	…	…	…	…	…	…
…		...	…	…	…	…	...	…	…
a_7	S_1	V_{11}	V_{11}-0.5	V_{11}+0.5	…	..	V_{1K}	V_{1K}-0.5	V_{1K}+0.5
	S_2	V_{21}	V_{21}-0.5	V_{21}+0.5	…	…	V_{2K}	V_{2K}-0.5	V_{2K}+0.5
	...	…	…	...	…	…	…	…	...
	S_n	V_{n1}	V_{n1}-0.5	V_{n1}+0.5	…	…	V_{nK}	V_{nK}-0.5	V_{nK}+0.5

where Vi refers to the rating value of evaluation criteria from respondents' survey results, K is the number of group of respondents and DM is abbreviation of decision maker.

b) Determine the $\underline{v}_{ij}$ and $\bar{v}_{ij}$ using the following formula:

$$\underline{v}_{ij} = \frac{1}{K}\left[v_{ij}^{1}{}_{Min} + v_{ij}^{2}{}_{Min} + \ldots + v_{ij}^{K}{}_{Min}\right] \quad (1)$$

$$\bar{v}_{ij} = \frac{1}{K}\left[v_{ij}^{1}{}_{Max} + v_{ij}^{2}{}_{Max} + \ldots + v_{ij}^{K}{}_{Max}\right] \quad (2)$$

2.4. Procedure of the rough–grey analysis

The Rough-Grey Analysis approach is very suitable for solving the group decision-making problem in an environment of uncertainty. The attribute ratings ⊗v for benefit attributes are shown in Table 3.

Table 3. The scale of attribute ratings ⊗v for benefit attributes

Scale	**⊗v**
Very poor (VP)	[0,1]
Poor (P)	[1,3]
Medium poor (MP)	[3,4]
Fair (F)	[4,5]

Medium good (MG)	[5,6]
Good (G)	[6,9]
Very good (VG)	[9,10]

The selection procedures are summarised as follows [12-14]:

a) Establishment of grey decision table.
Form a committee of DMs and determine attribute values of alternatives. Assume that a decision group has K persons and then the grey number value of attribute $\otimes v_{ij}$ can be calculated as:

$$\otimes v_{ij} = \frac{1}{K}\left[\otimes v_{ij}^{1} + \otimes v_{ij}^{2} + \cdots + \otimes v_{ij}^{K}\right] = \left[\underline{v}_{ij}, \bar{v}_{ij}\right] \quad (3)$$

where i refers to alternatives, while j refers to different attributes; $\otimes v_{ij}^{K} = \left[\underline{v}_{ij}^{K}, \bar{v}_{ij}^{K}\right]$, $(i = 1,2,\cdots,m;\ j = 1,2,\cdots,n)$ is the attribute rating value of the Kth DM that is expressed by a grey number.

b) Normalisation of grey decision table.
Form a committee of DMs and determine attribute values of:

$$\otimes v_{ij}^{*} = \left[\frac{\underline{v}_{ij}}{v_j^{\max}}, \frac{\bar{v}_{ij}}{v_j^{\max}}\right] \quad (4)$$

where $v_j^{\max} = \max_{1\le i\le m}\{\bar{v}_{ij}\}$.

For cost attributes, its normalised grey number value $\otimes v_{ij}^{*}$ is expressed as:

$$\otimes v_{ij}^{*} = \left[\frac{v_j^{\min}}{\bar{v}_{ij}}, \frac{v_j^{\min}}{\underline{v}_{ij}}\right] \quad (5)$$

where $v_j^{\min} = \min_{1\le i\le m}\{\underline{v}_{ij}\}$.

The normalisation method mentioned above is to preserve the attribute that the ranges of normalised grey numbers belong to [0, 1].

c) Determination of the suitable alternatives.
In order to reduce unnecessary information and maintain the determining rules, we determine the suitable alternatives by a grey-based rough set with lower approximation. The lower approximation of suitable alternatives S* are determined by:

$$\underline{R}S^{*} = \{S_i \in U \mid [S_i]_R \subseteq S^{*}\} \quad (6)$$

where $S^{*} = \{S_i \mid d_i = yes\}$.

d) Making the ideal alternative for reference.
According to $\underline{R}S^{*}$ obtained from equation (6), we determinate the ideal alternative $S^{\max}$ for reference by:

$$S^{\max} = S_0 = \left\{ \begin{array}{l} \left[\max\limits_{\forall i} \underline{v}^*_{i1}, \max\limits_{\forall i} \overline{v}^*_{i1}\right], \\ \left[\max\limits_{\forall i} \underline{v}^*_{i2}, \max\limits_{\forall i} \overline{v}^*_{i2}\right], \\ \cdots, \left[\max\limits_{\forall i} \underline{v}^*_{im}, \max\limits_{\forall i} \overline{v}^*_{im}\right] \end{array} \right\} \quad (7)$$

e) Selection the most suitable alternative.
The grey relational coefficient (GRC) of $\otimes x_i$ with respect to $\otimes x_0$ at the kth attribute, is calculated as [15]:

$$\gamma(\otimes x_0(k), \otimes x_i(k)) = \frac{\Delta \min + \rho \Delta \max}{\Delta_{0i}(k) + \rho \Delta \max} \quad (8)$$

where

$$\Delta \max = \max \max_{\forall i, \forall k} L(\otimes x_0(k), \otimes x_i(k)) \quad (9)$$

$$\Delta \min = \min \min_{\forall i, \forall k} L(\otimes x_0(k), \otimes x_i(k)) \quad (10)$$

$$\Delta_{0i}(k) = L(\otimes x_0(k), \otimes x_i(k)) \quad (11)$$

$L(\otimes x_0(k), \otimes x_i(k))$ is the Euclidean space distance of $\otimes x_0(k)$ and $\otimes x_i(k)$ which is calculated by equation below:

$$L(\otimes x_1, \otimes x_2) = \sqrt{(\underline{x}_1 - \underline{x}_2)^2 + (\overline{x}_1 - \overline{x}_2)^2} \quad (12)$$

ρ is the distinguishing coefficient, ρ=[0, 1]. The grey relational grade (GRG) between each comparative sequence $\otimes x_i$ and the reference sequence $\otimes x_0$ can be derived from the average of GRC, which is denoted as:

$$\Gamma_{0i} = \sum_{k-1}^{n} \frac{1}{n} \gamma(\otimes x_0(k), \otimes x_i(k)) \quad (13)$$

where Γ_{0i} represents the degree of relation between each comparative sequence and the reference sequence. Through the calculation of GRG between comparative sequences $\underline{R}S*$ with reference sequence $S^{\max}$, the alternative corresponding to the maximum value of GRG can be considered as the most suitable alternative.

2.5. Proposed ranking of sustainability compliance

Result of sustainability compliance ratio of each sustainability parameters are proposed to be ranked as shown in Table 4 below:

Table 4. Proposed ranking of sustainability compliance of each sustainability parameters

Ranking	Description
80 – 100%	Complied (Accepted)
50 – 79%	Partially complied (Conditionally accepted)
0 – 49%	Not complied (Not accepted)

According to above ranking, engineer and project manager can do their self-assessment on the critical element of sustainability compliance and take necessary actions to improve the practice.

3. Conclusion

Although the validation of SSA model is has not been implemented in the real field, this model is expected to aid engineers or project managers in producing sustainability reporting, strengthening brand equity, progressing vision and strategy, reducing compliance costs and advantage in competition.

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References

[1] R. K. Singh, Murty, H. R., Gupta, S. K., & Dikshit, A. K., "An overview of sustainability assessment methodologies," *Ecological indicators,* vol. 9, pp. 189-212, 2009.

[2] B. Malaysia. (2015). *Sustainability Reporting Guide*. Available: http://www.bursamalaysia.com/

[3] S. Sala, Ciuffo, B., & Nijkamp, P., "A systemic framework for sustainability assessment," *Ecological Economics,* vol. 119, pp. 314-325, 2015.

[4] A. J. Bond, & Morrison-Saunders, A., "Re-evaluating sustainability assessment: Aligning the vision and the practice," *Environmental Impact Assessment Review,* vol. 31, pp. 1-7, 2011.

[5] M. Finkbeiner, Schau, E. M., Lehmann, A., & Traverso, M., "Towards life cycle sustainability assessment," *Sustainability,* vol. 2, pp. 3309-3322, 2010.

[6] P. Ghadimi, Azadnia, A. H., Yusof, N. M., & Saman, M. Z. M., "A weighted fuzzy approach for product sustainability assessment: a case study in automotive industry," *Journal of Cleaner Production,* vol. 33, pp. 10-21, 2012.

[7] Y. T. Chong, Teo, K. M., Tang, L. C., "A lifecycle-based sustainability indicator framework for waste-to-energy systems and a proposed metric of sustainability," *Renewable and Sustainable Energy Reviews,* vol. 56, pp. 797-809, 2013.

[8] D. Streimikiene, Siksnelyte, I., "Sustainability assessment of electricity market models in selected developed world countries," *Renewable and Sustainable Energy Reviews,* vol. 57, pp. 72-82, 2016.

[9] C. Scandelius, Cohen, G., "Sustainability program brands: Platforms for collaboration and co-creation," *Industrial Marketing Management,* vol. 57, pp. 166-176, 2016.

[10] G. Global. (2015). *The GPM® P5™ Standard for Sustainability in Project Management*. Available: http://www.greenprojectmanagement.org/the-p5-standard

[11] F. M. Turan, Omar, B., "Design Evaluation Method for Design Engineer in Manufacturing Industries using Integrated Rough-Grey Analysis Approach," *Applied Mechanics and Materials Journal,* vol. 660, pp. 1052-1056, 2014.

[12] G. D. Li, Yamaguchi, D., Nagai, M., "A grey-based rough decision-making approach to supplier selection," *International Journal of Advanced Manufacturing Technology,* vol. 36, pp. 1032-1040, 2008.

[13] C. Bai, Sarkis, J., "Integrating sustainability into supplier selection with grey system and rough set methodologies," *Int. J.ProductionEconomics,* vol. 124, pp. 252-264, 2010.

[14] C. Bai, Sarkis, J., "Evaluating supplier development programs with a grey based rough set methodology," *Expert Systems with Applications,* vol. 38, pp. 13505-13517, 2011.

[15] Y. G. Dang, Liu, S. Y., Liu, B., "On the multiple-attribute incidence decision model for interval numbers," in *Proceedings on Networking, Sensing and Control IEEE*, 2005, pp. 711-715.