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SUSTAINABILITY MEASUREMENT OF SYSTEM'S ORGANIZATION UNDER GREY-KNOWLEDGE BASED EWZ MODEL USING GREY-FMF APPROACH

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Abstract-*The utilization of grey sets theory in multi metrics modeling to benchmark sustainability of system's organizations under integrated approach helps for decision making. EWZ (Environmental, Minimization of the Waste and Zero Defect) measurement of each production unit simultaneously is considered complex problem. In the presented research work, the authors have proposed a DSS, consist of implementation Grey-FMF FMF (Full Multification Form) upon EWZ 'Environmental, Minimization of the Waste and Zero Defect' system sustainability model to evaluate the performance's score of system's organization under partial information of team of professionals (Ps) against vague practices.*

Keywords: EWZ system sustainability model, Grey set, Benchmarking, Lean Manufacturing, Sustainability, FMF (Full Multification Form).

I. EWZ SYSTEM SUSTAINABILITY

Sustainability is an important goal, it transfer the memorandum for promoting economic production via decreasing waste and improving quality of goods in concerning with environmental chains. Sustainability mainly focuses to protection environment by minimizing waste and improving quality of goods which is obtained by zero defect planning.

The problems of measuring the sustainability of system's organizations consist of a number of alternatives experiments /options, explicitly known at the starting of the solution process. Each alternative is represented by its performance in multiple-criterions. The problem may be defined as finding the best sustainability of system's organizations, by the professionals (Ps), or finding a set of suitable alternatives.

One may also be interested in 'sorting' or 'classifying' alternatives. Sorting refers to placing the alternatives in a set of preference-ordered classes (such as assigning credit-ratings to countries), and classifying refers to assigning alternatives to non-ordered sets (such as diagnosing patients based on their symptoms Stanujkic et al., (2012); Samantra, et al.,(2013); Sahu et al., (2012); Vinodh et al., (2011); Liu et al., (2015); Naim and Gosling 2011); Matawale et al., (2012).
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II. OBJECTIVE

The EWZ system sustainability appraisement model built by recognizing and considering 3 pertinent measures and 9 measures' interrelated practices. EWZ based sustainability measurement model is valid towards assessing the sustainability of system's organization. Fig. 1 has shown the EWZ based sustainability measurement model.

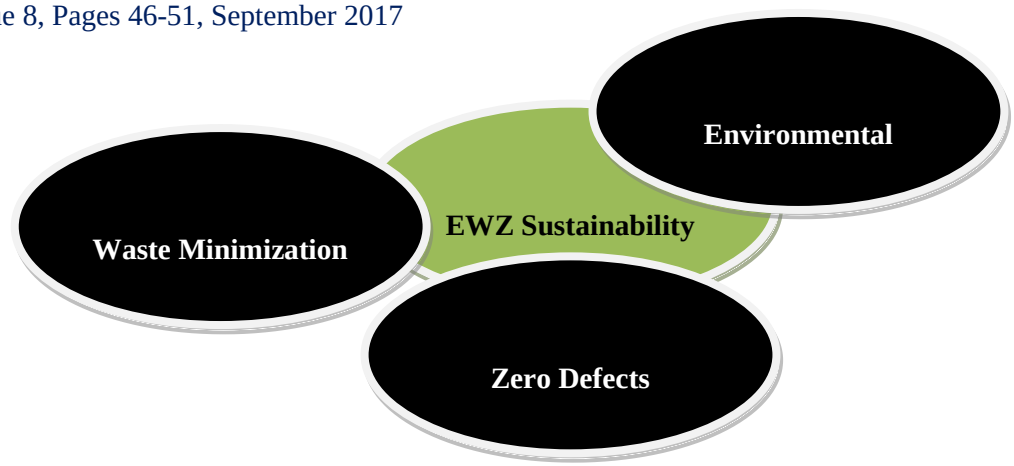


Fig. 1 The EWZ based sustainability model.

III. GREY SET THEORY

In the present research work, the authors have prolifically implemented grey theory (discrete information system), deals with (partial information) utterly known cum unknown information, where utterly known information is being enveloped passing through white number, while unknown information is enveloped passing through black number. In grey theory, discrete information aligns the amputation of both information that cope the range of the grey system itself. Grey theory has now been applied to various areas such as forecasting, system control, and decision-making and computer graphics. grey set and grey number in grey theory Deng, the concept of a grey system is shown in fig. 2.

IV. NOVELTY OF RESEARCH WORK

The authors has proposed a crisp AHP (Analytic Hierarchy Process) weight evaluation technique with the novel idea of global weight evaluation coupled with Grey-FMF (***Full Multification Form***) to tackle the partial information of Professionals against practices.

V. SYSTEM SUSTAINABILITY MEASUREMENT APPROACH

The Grey-Multi-objective optimization by ratio analysis:

For the normalization of responses of alternatives expressed in the form of interval numbers, suggested the use of the following formula (Stanujkic et al., (2012); Samantra, et al.,(2013); Sahu et al., (2012); Vinodh et al., (2011); Liu et al., (2015); Naim and Gosling 2011); Matawale et al., (2012):

$$\otimes x_{ij}^{*} = \frac{\otimes x_{ij}}{\sqrt{\sum_{j=1}^{m} (\underline{x}_{ij}^{2} + \overline{x}_{ij}^{2})}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The Grey-FMF (*Full Multification Form*):

Determining overall ranking index based on Multi-objective optimization on the *Full Multification Form* decision making evaluation technique (Stanujkic et al., (2012); Samantra, et al.,(2013); Sahu et al., (2012); Vinodh et al., (2011); Liu et al., (2015); Naim and Gosling 2011); Matawale et al., (2012).

$$y_j^{+} = \frac{\prod_{i \in \Omega_G^{+}} s_i x_{ij}^{*}}{\prod_{i \in \Omega_G^{-}} s_i x_{ij}^{*}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

i. When objectives have the same significance ($\lambda = 0$):

$$y_j^{+} = (1-\lambda)\left(\prod_{i \in \Omega_G^{+}} \underline{s_i x_{ij}^{*}} \Big/ \prod_{i \in \Omega_G^{-}} \underline{s_i x_{ij}^{*}}, \right) + \lambda\left(\prod_{i \in \Omega_G^{+}} \overline{s_i x_{ij}^{*}} \Big/ \prod_{i \in \Omega_G^{-}} \overline{s_i x_{ij}^{*}}, \right)$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

ii. When the decision maker has no preferences ($\lambda = 0.5$)

$$y_j^+ = \frac{1}{2}\left(\prod_{i \in \Omega_G^+} s_i \underline{x}_{ij}^* / \prod_{i \in \Omega_G^-} s_i \underline{x}_{ij}^* \right) + \frac{1}{2}\left(\prod_{i \in \Omega_G^+} s_i \overline{x}_{ij}^* / \prod_{i \in \Omega_G^-} s_i \overline{x}_{ij}^* \right) \quad \text{.....(4)}$$

iii. When the decision maker has no preference and objectives have the same significance ($\lambda = 1$) :

$$y_j^+ = \lambda\left(\prod_{i \in \Omega_G^+} \overline{s_i x}_{ij}^* / \prod_{i \in \Omega_G^-} \overline{s_i x}_{ij}^* \right) + (1-\lambda)\left(\prod_{i \in \Omega_G^+} \underline{s_i x}_{ij}^* / \prod_{i \in \Omega_G^-} \underline{s_i x}_{ij}^* \right) \quad \text{.....(5)}$$

During problem solution, i.e. ranking of alternatives, the attitude of the professionals can lie between pessimistic and optimistic, and the whitening coefficient λ , allows expression of professionals degree of optimism or pessimism.

In the cases of particularly expressed optimism, the whitening coefficient λ , in accordance with the formula (2), takes higher values ($\lambda \to 1$) and ranking order of alternatives is mainly based on the upper bounds of intervals with which overall response of each alternative is expressed, $y_{j(\lambda=1)} = y_j^+$. On the other hand, in the cases of particularly expressed pessimistic, the whitening coefficient λ takes lower values ($\lambda \to 0$) and ranking order of alternatives is mainly based on lower bounds of the intervals, $y_{j(\lambda=0)} = y_j^+$. On the other hand, in the cases of particularly expressed moderate, the whitening coefficient λ takes half of lower and upper values ($\lambda \to 0.5$) is taken and ranking order of alternatives is mainly based on lower bounds of the intervals, $y_{j(\lambda=0.5)} = y_j^+$.

VI EMPIRICAL CASE RESEARCH

Step 1: Constructed a Grey-knowledge based EWZ sustainability appraisement hierarchical structural evaluation model for assessing the sustainability of system's organization, shown in Table 1.

Step 2: Evaluation of suitable linguistic grey scale in terms of appropriateness ratings, shown in Table 2.

Step 3: Evaluation of performance ratings. Weights is given by Ps in crisp values are given here i.e. *[0.019,0.023,0.039,0.051,0.072,0.105,0.153,0.223,0.314] against metrics.* From the 2nd level metrics, the global weight of 1st level is computed. The computed global weights for first level are i.e. 0.081,0.228 and 0.691, shown in fig 3.

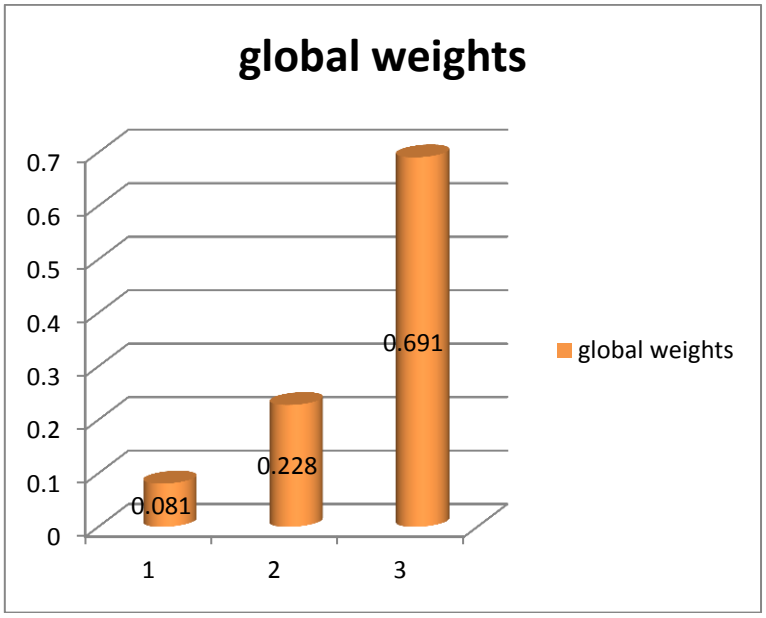


Fig: 3 Global weights

Step4: Transform the linguistic variables into grey set and then assigned by Ps in linguistic terms, shown in Table 3-5. Then converted into single responses against first level measures.

Step 5: Applied equation 1 to normalize rating data and multiplied by measure's global weights.

Step6: Estimation of overall performance of material supplier firm by using equation 2,3,4,5

with respect to $\lambda = 0, 0.5, 1$. The result shown in Table.6

Table: 5.1. Grey-knowledge based EWZ sustainability appraisement hierarchical structural evaluation model

Goal, (C)	Measures, (C_i)	Metrics, (C_{ij})	Attitudes
Sustainability Measurement	Environmental, (C_1)	Renewable Energy, ($C_{1,1}$)	**(+)**
		Recycling of Waste Material, Hazard Material, ($C_{1,2}$)	**(+)**
		Recycling of Water, ($C_{1,3}$)	**(+)**
	Waste Minimization, (C_2)	Over Processing, ($C_{2,1}$)	**(-)**
		Unwanted Production, ($C_{2,2}$)	**(-)**
		Unnecessary Movement, ($C_{2,3}$)	**(-)**
	Zero Defect, (C_3)	Defective Product, ($C_{3,1}$)	**(-)**
		Rejection, ($C_{3,2}$)	**(-)**
		Rework, ($C_{3,3}$)	**(-)**

Table 2: The scale of attribute ratings $\otimes G$

Scale	$\otimes r$
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]

Table.3 Appropriateness grey rating against indices for A_1

Metrics, (C_{ij})	P1	P2	P3	P4	P5
Renewable Energy, ($C_{1,1}$)	VG	G	G	G	VG
Recycling of Waste Material, Hazard Material, ($C_{1,2}$)	VG	VG	VG	VG	MP
Recycling of Water, ($C_{1,3}$)	MG	F	F	MP	MP
Over Processing, ($C_{2,1}$)	G	F	F	MP	VG
Unwanted Production, ($C_{2,2}$)	VG	F	F	MP	F
Unnecessary Movement, ($C_{2,3}$)	MG	F	P	MP	F
Defective Product, ($C_{3,1}$)	MG	MP	VG	VG	F
Rejection, ($C_{3,2}$)	MG	MP	F	MG	G
Rework, ($C_{3,3}$)	F	MP	F	MG	G

Table.4 Appropriateness grey rating against indices for A_2

Metrics, (C_{ij})	P1	P2	P3	P4	P5
Renewable Energy, ($C_{1,1}$)	F	G	MG	MG	G
Recycling of Waste Material, Hazard Material, ($C_{1,2}$)	G	MG	MG	G	G
Recycling of Water, ($C_{1,3}$)	MG	MP	MG	G	G
Over Processing, ($C_{2,1}$)	MG	MP	F	G	G
Unwanted Production, ($C_{2,2}$)	MG	F	F	G	MG
Unnecessary Movement, ($C_{2,3}$)	VG	F	VG	MG	MG
Defective Product, ($C_{3,1}$)	F	VG	F	MG	MG
Rejection, ($C_{3,2}$)	MG	MP	F	G	F
Rework, ($C_{3,3}$)	MG	MP	VG	G	MG

Table.5 Appropriateness grey rating against indices for A_3

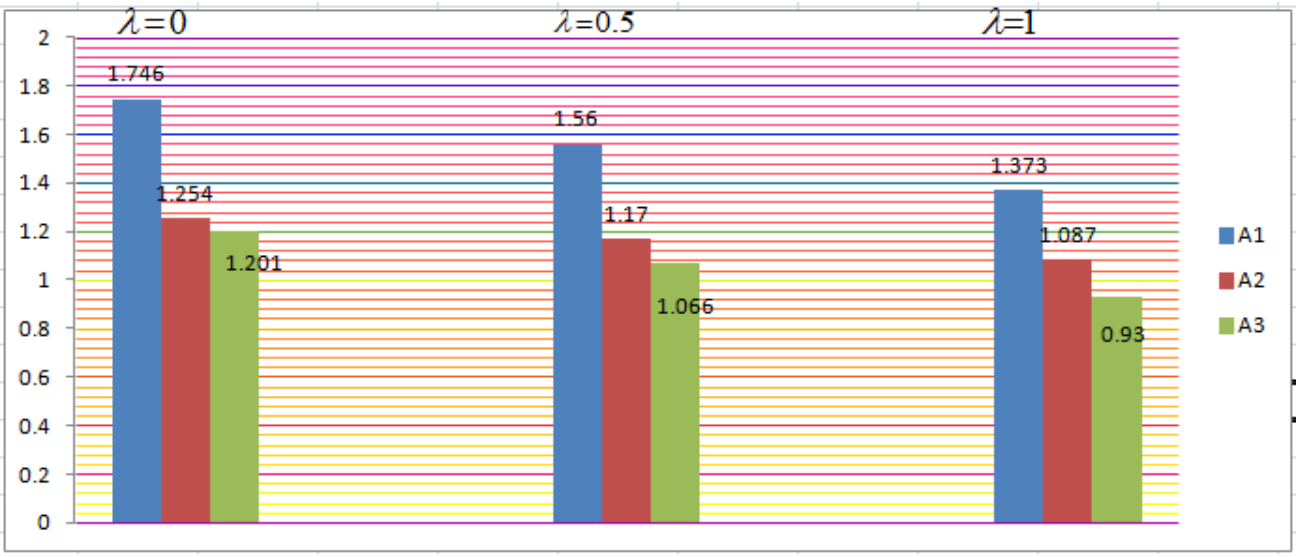
Metrics, (C_{ij})	**P1**	**P2**	**P3**	**P4**	**P5**
Renewable Energy, ($C_{1,1}$)	MG	MP	F	G	MG
Recycling of Waste Material, Hazard Material, ($C_{1,2}$)	VG	MP	F	G	MG
Recycling of Water, ($C_{1,3}$)	F	VG	F	G	MG
Over Processing, ($C_{2,1}$)	F	F	G	VG	MG
Unwanted Production, ($C_{2,2}$)	MG	F	P	VG	VG
Unnecessary Movement, ($C_{2,3}$)	F	F	VP	MG	G
Defective Product, ($C_{3,1}$)	F	VG	VP	MG	G
Rejection, ($C_{3,2}$)	G	F	G	MG	G
Rework, ($C_{3,3}$)	MG	VG	G	MG	VG

Table.6 Ranking results obtained using Full Multification Form technique for $\lambda=0,\ 0.5,\ 1$

λ	$\lambda=0$		$\lambda=0.5$		$\lambda=1$	
Alternatives	y_j^*	Ranking	y_j^*	Ranking	y_j^*	Ranking
A1	1.746	1.000	1.560	1.000	1.373	1.000
A2	1.254	2.000	1.170	2.000	1.087	2.000
A3	1.201	3.000	1.066	3.000	0.930	3.000

VII. RESULTS

A Grey-knowledge based EWZ sustainability appraisement hierarchical structural evaluation model with AHP combined with Grey- Grey-FMF (Full Multification Form) decision making evaluation techniques is called Decision Support System (DSS) is proposed. The sustainability of 1st candidate system's organization is found the best than rests. It must be elected. Ranking results obtained using Grey-FMF (Full Multification Form) technique for $\lambda=0,\ 0.5,\ 1$ is shown in Fig.4.



VIII. CONCLUSION

In the presented work, the Grey-knowledge based EWZ sustainability appraisement hierarchical structural evaluation model (constituted by mixing the segregated environmental, minimization of the waste and zero defect 'three pillar' and their corresponding interrelated practices. AHP combined with Grey-FMF (Full Multification Form) evaluation techniques is applied on model to tackle the incomplete information of

decision makers against vague practices. The sustainability of 1st candidate system's organization is found the best.

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