Volume 1, Issue 8, Pages 38-45, September 2017

BENCHMARKING OF STUFF PROVIDER'S ORGANIZATIONS UNDER LEAN BASED TWMCCR PRACTICE-METRICS BY USING AHP WITH MOOSRA APPROACH

Rohit Kumar Mishra[1], Neha Verma[2]

M-Tech Scholar, Production Engg (Specialization)[1], Faculty[2],
Department of Mechanical Engg, Shri Shankaracharya Institute of Professional Management and Technology Mujgahan, Raipur.
Email: siddharthdwivedi1992@gmail.com[1], nv5678@gmail.com[2]
Communicating author: siddharthdwivedi1992@gmail.com[1]

Abstract- *An 2nd layer lean based TWMCCRR practice-metrics hierarchical appraisement model is proposed. The proposed model dealt with identified six measures and twenty seven interrelated metrics for measuring the performance of stuff provider firms under lean performance measurement strategy. The lean based TWMCCRR hierarchical appraisement model undertook fuzzy information of DMs. In order to compute the performance scores of vendor firms, fuzzy-AHP (Analytic Hierarchy Process) is utilized to compute weight against six momentous measures, while MOOSRA (Multi-Objective Optimization by Basic Ratio Analysis) is implemented on said model to robustly evaluate score and making potential decision.*

Keywords: Lean Supply chain, Model, Subjective Information (SI), Multi-Criteria Group Decision Making Process (MCGDMP), Benchmarking, MOOSRA.

I. MCDM DECISION MAKING

MCDM (Multi Criteria Decision Making) has aim to find optimal choice under several (conflicting) criterion, which are to be achieved simultaneously. The characteristics of MCDM are a set of (conflicting) objectives, having non constraints. Therefore, it is naturally associated with the technique of mathematical programming for dealing with optimization problems. However, it can be seen that two main difficulties involving the trade-off and the scale problems complicate the MCDM situations through the mathematical programming model. Lean manufacturing executive thinking, which derived typically from the Toyota Production System (TPS) and recognized as 'lean' only in the 1990s. TPS is well known for its heart on reduction of the original Toyota seven wastes to get better overall purchaser worth. Lean Manufacturing (LM) is fundamentally a production practice that believes on the expenditure of resources for any goal other than the making of worth for the end users to be wasteful and thus an aim for removal.

II. BENCHMARKING MODEL

The benchmarking process is significance as it has observed as potential tool for analyzing complex real problems due to its ability to judge different alternatives (Choice, strategy, policy, and scenario) under various criteria. These alternatives may be further explored in-depth for their final implementation. The benchmarking processes deals with a set of (contradictory) criterions, which lay down of well-defined limitations. Garvin (1993) discovered rough set hypothesis to examine the relations among managerial attributes, dealer development program involvement features, and performance outcomes. The performance outcomes focused on green and business dimensions. Greeen et al., (1998) sustainable supply chains manage the firm for environmental issues and too influence the alliance among supply chain management and the normal environment. It is also referred in form of modernism in Supply Chain Management (SCM).

III. MOOSRA METHOD

The Multi-Objective Optimization by Basic Ratio Analysis (MOOSRA) method was introduced by Brauers and Zavadakas (2006); Brauers and Zavadakas (2010) extended the method to make it more robust as MOOSRA. Let $E=\{e_1, e_2, ..., e_q\}$ be the set of decision-makers in the group decision making process. $A=\{A_1, A_2, ..., A_m\}$ be the set of alternatives, and $C=\{C_1, C_2, ..., C_n\}$ be the set of criteria-attributes. Suppose that $\tilde{\tilde{a}}_{ijk}=(a_{ijk1}, a_{ijk2}, a_{ijk3})$ is the attribute value given by decision maker e_k, where $\tilde{\tilde{a}}_{ijk}$ is a trapezoidal fuzzy number for the alternative A_i with respect to the attribute C_j.

Evaluation of rating from 2nd to 1st level:

$$\mathbf{R}=(r_{ij})_{m\times n}=\frac{r_{i1}+r_{i2}+r_{i3}+r_{i4}+r_{i5}+r_{i6}..........r_{in}}{C_n} \quad ....(1)$$

$$\mathbf{R}=(r_{ij})_{m\times n}=\begin{array}{c} \\ f_1 \\ f_2 \\ \vdots \\ f_m \end{array}\begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \ldots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \ldots & r_{mn} \end{bmatrix} \end{array}$$

Normalize the decision matrix $X=(x_{ij})_{mn}$ using the following equation:

$$r_{ij}=\frac{x_{ij}}{\sqrt{\sum_{j=1}^{n} x^2_{ij}}}, \quad i=1,2,3,.......m,, \quad j=1,2,3,.......n \quad ....(2)$$

Here r_{ij} is the normalized criterion rating. The normalization method mentioned above is to preserve the property that the range of a normalized trapezoidal fuzzy number $\tilde{r}_{ij}$ belongs to the closed interval $[0,1]$.

$$\tilde{\mathbf{R}}=(\tilde{r}_{ij})_{m\times n}=\begin{array}{c} \\ f_1 \\ f_2 \\ \vdots \\ f_m \end{array}\begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} x'_{11} & x'_{12} & \cdots & x'_{1n} \\ x'_{21} & x'_{22} & \ldots & x'_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x'_{m1} & x'_{m2} & \ldots & x'_{mn} \end{bmatrix} \end{array}$$

Let $W=(w_{1,}\ w_{2,..........}, w_n)$ be the relative weight vector about the criteria, evaluated by fuzzy AHP satisfying $\sum_{j=1}^{n} w_j = 1$.

Calculate the weighted normalized decision matrix $v=(v_{ij})_{mn}$ ....(3)

$$\mathbf{R}=(r_{ij})_{m\times n}=\begin{array}{c} \\ f_1 \\ f_2 \\ \vdots \\ f_m \end{array}\begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \ldots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \ldots & r_{mn} \end{bmatrix} \end{array}$$

$$\times \begin{array}{c} \\ f_1 \\ f_2 \\ \vdots \\ f_m \end{array}\begin{array}{c} \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{bmatrix} x'_{11} & x'_{12} & \cdots & x'_{1n} \\ x'_{21} & x'_{22} & \ldots & x'_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x'_{m1} & x'_{m2} & \ldots & x'_{mn} \end{bmatrix} \end{array}$$

$$\tilde{\mathbf{V}}=(\tilde{v}_{ij})_{m\times n}=\begin{array}{c} \\ f_1 \\ f_2 \\ \vdots \\ f_m \end{array}\begin{array}{c} \begin{array}{cccc} x_1 & x_2 & \cdots & x_n \end{array} \\ \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \ldots & \tilde{v}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{v}_{m1} & \tilde{v}_{m2} & \ldots & \tilde{v}_{mn} \end{bmatrix} \end{array}$$

Then, the decision matrix $v = (v_{ij})_{mn}$ can be transformed into the normalized fuzzy decision matrix:

$$y_i^* = \frac{\sum_{j=1}^{g} x_{ij}^*}{\sum_{j=g+1}^{n} x_{ij}^*}$$

$$y_i^* = \frac{\sum_{j=1}^{g} w_i * x_{ij}^*}{\sum_{j=g+1}^{n} w_i * x_{ij}^*}$$

……………………………………(4)

Here $g = 1,...,n$ denotes number of objectives to be maximized. Then every ratio is given the rank: the higher the index, the higher the ranking. In the (Equa. 4) w_i represented the attribute/criterion weights.

IV. EMPIRICAL RESEARCH

The lean based TWMCCR hierarchical structural evaluation model has aim to evaluate the best vendor amongst feasible alternatives in accordance with comparative analysis is shown in Table. 1. To evaluate result, a committee of five highly experience decision makers, has been formed from units of manufacturing industry. Fuzzy APH is applied, which revealed the results: [0.084171, 0.14683, 0.137025, 0.240021, 0.203531, 0.188566]. Calculated λ_{max}=7.21 by using Equa. 18 (considered M=6). Then, the consistency (for CI =1.24) has been checked by using Equation 19, depicted 0.1025. Later, using the concept of trapezoidal fuzzy numbers in fuzzy set theory, the linguistic variables, shown in Table. 2, used by team of same decision makers to assign ratings against for stuff provider firms firm A_1, A_2 and A_3 have aggregated by fuzzy rules, and then, defuzzification is carried out on aggregated ratings, shown in Tables 3-5 for 2nd level. Addition is carried out by Equation 1 to get 1st level rating is shown in Tables 3-5, for stuff provider firms firm A_1, A_2 and A_3.. Then, normalization is carried out by using Equ. 2 for bring value in the interval of 0 to 1 excluding transforming non-beneficial criterion into beneficial criterion and constructed the weighted normalized matrix by using Eq. 3, shown in Table. 6.

In case of MOOSRA, Equ.4 has applied on data available of Table 3-5 to compute ranking orders of stuff provider firms firm A_1, A_2 and A_3, shown in Table.7. Results, obtained by MOOSRA have been shown in Table. 7.

;;

Table: 1. Fuzzy based TWMCCR hierarchical structural model

	Technological involvement, (C_1)	Systematic process control, ($C_{1,1}$)
		Utility of TQM tools, ($C_{1,2}$)
		Maintenance of machine tools, ($C_{1,3}$)
		Reduction of unwanted cost via approaches, ($C_{1,4}$)
		Recognition and prioritization of significant machine tools, ($C_{1,5}$)
	Work force leanness,(C_2)	Flexible labor force for adaptation of new advanced technologies, ($C_{2,1}$)
		Multi-skilled workers, ($C_{2,2}$)
		Strong employee courage and cooperation, ($C_{2,3}$)
		Employee empowerment, ($C_{2,4}$)
		Group efforts of employees, ($C_{2,5}$)
	Manufacturing	Enhancement in working culture, ($C_{3,1}$)

Fuzzy based TWMCCR hierarchical structural model	management, (C_3)	JIT delivery to clients, ($C_{3,2}$)
		Optimization of processing sequence and flow in shop floor, ($C_{3,3}$)
		Overall production waste reduction, ($C_{3,4}$)
	Collaborative planning, (C_4)	Stuff planning, ($C_{4,1}$)
		Collaborative manufacturing planning, ($C_{4,2}$)
		Vendor planning, ($C_{4,3}$)
		Supply planning, ($C_{4,4}$)
	Customer service performance,, (C_5)	Purchaser satisfaction, ($C_{5,1}$)
		Delivery reliability, ($C_{5,2}$)
		Responsiveness, ($C_{5,3}$)
		Orders fill capacity, ($C_{5,4}$)
		Agility, ($C_{5,5}$)
	Resource utilization, (C_6)	Planning of capital, ($C_{6,1}$)
		Optimized deployment of tools,(C_{62})
		Retrofitting of machine tools, (C_{63})
		Scheduled actions on production assets, (C_{64})

Table: 2. Aggregated fuzzy appropriateness rating

Linguistic Term (Appropriateness Rating)	Corresponding Fuzzy Numbers
Absolutely Poor (AP)	(0, 0, 0, 0; 1.00)
Very Poor (VP)	(0, 0, 0.2, 0.7; 1.00)
Poor (P)	(0.4, 0.1, 0.8, 0.23; 1.00)
Medium Poor (MP)	(1.7, 2.2, 3.6, 4.2; 1.00)
Fair (F)	(3.2, 4.1, 5.8, 6.5; 1.00)
Medium Good (MG)	(5.8, 6.3, 8.0, 8.6; 1.00)
Good (G)	(7.2, 7.8, 9.2, 9.7; 1.00)
Very Good (VG)	(9.3, 9.8, 10.0, 10.0; 1.00)
Absolutely Good (AG)	(10.0, 10.0, 10.0, 10.0; 1.00)

Table.3 Appropriateness rating against subjective Lean assessment metrics for A_1

Lean assessment metrics	Appropriateness rating against individual 2nd level evaluation metrics					AFR	Crisp value
	DM1	DM2	DM3	DM4	DM5		
($C_{1,1}$)	G	MP	F	F	MP	(3.800,4.800,5.400,6.400)	5.1
($C_{1,2}$)	G	G	VG	G	VG	(7.800,8.800,9.400,10.00)	8.98
($C_{1,3}$)	VG	VG	VG	G	G	(8.200,9.200,9.600,10.00)	9.22
($C_{1,4}$)	VG	G	VG	VG	VG	(8.600,9.600,9.800,10.00)	9.45
($C_{1,5}$)	VG	MG	G	G	G	(7.000,8.000,8.800,9.600)	8.34
($C_{2,1}$)	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
($C_{2,2}$)	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
($C_{2,3}$)	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
($C_{2,4}$)	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8

$(C_{2,5})$	G	MG	F	VG	MG	(6.000,7.000,7.600,8.400)	7.24
$(C_{3,1})$	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
$(C_{3,2})$	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
$(C_{3,3})$	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
$(C_{3,4})$	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8
$(C_{4,1})$	G	MG	F	VG	MG	(6.000,7.000,7.600,8.400)	7.24
$(C_{4,2})$	VG	VG	G	G	G	(7.800,8.800,9.400,10.00)	8.98
$(C_{4,3})$	MG	VG	G	F	G	(6.400,7.400,8.000,8.800)	7.64
$(C_{4,4})$	G	VG	MG	VG	VG	(7.800,8.800,9.200,9.600)	8.82
$(C_{5,1})$	MG	G	MG	G	VG	(6.600,7.600,8.400,9.200)	7.94
$(C_{5,2})$	F	VG	F	MP	VG	(5.600,6.600,6.800,7.400)	6.57
$(C_{5,3})$	VG	VG	G	G	G	(7.800,8.800,9.400,10.00)	8.98
$(C_{5,4})$	MG	VG	G	F	G	(6.400,7.400,8.000,8.800)	7.64
$(C_{5,5})$	G	VG	MG	VG	VG	(7.800,8.800,9.200,9.600)	8.82
$(C_{6,1})$	MG	G	MG	G	VG	(6.600,7.600,8.400,9.200)	7.94
(C_{62})	F	VG	F	MP	VG	(5.600,6.600,6.800,7.400)	6.57
(C_{63})	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
(C_{64})	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7

Table.4 Appropriateness rating against subjective Lean assessment metrics for A_2

Lean assessment metrics	Appropriateness rating against individual 2^{nd} level evaluation metrics					AFR	Crisp value
	DM1	DM2	DM3	DM4	DM5		
$(C_{1,1})$	G	MG	MG	MG	G	(5.800,6.800,7.800,8.800)	7.3
$(C_{1,2})$	VG	MG	MG	MG	MG	(5.800,6.800,7.600,8.400)	7.14
$(C_{1,3})$	G	MP	MG	MP	G	(4.600,5.600,6.600,7.600)	6.1
$(C_{1,4})$	VG	G	MG	VG	VG	(7.800,8.800,9.200,9.600)	8.82
$(C_{1,5})$	F	G	G	MP	MP	(4.400,5.400,6.200,7.200)	5.8
$(C_{2,1})$	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
$(C_{2,2})$	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
$(C_{2,3})$	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
$(C_{2,4})$	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8
$(C_{2,5})$	G	MG	F	VG	MG	(6.000,7.000,7.600,8.400)	7.24
$(C_{3,1})$	G	MP	F	F	MP	(3.800,4.800,5.400,6.400)	5.1
$(C_{3,2})$	G	G	VG	G	VG	(7.800,8.800,9.400,10.00)	8.98
$(C_{3,3})$	VG	VG	VG	G	G	(8.200,9.200,9.600,10.00)	9.22
$(C_{3,4})$	VG	G	VG	VG	VG	(8.600,9.600,9.800,10.00)	9.45
$(C_{4,1})$	VG	MG	G	G	G	(7.000,8.000,8.800,9.600)	8.34
$(C_{4,2})$	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
$(C_{4,3})$	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
$(C_{4,4})$	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
$(C_{5,1})$	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8
$(C_{5,2})$	G	MG	F	VG	MG	(6.000,7.000,7.600,8.400)	7.24
$(C_{5,3})$	VG	G	MG	VG	VG	(7.800,8.800,9.200,9.600)	8.82
$(C_{5,4})$	F	G	G	MP	MP	(4.400,5.400,6.200,7.200)	5.8

($C_{5,5}$)	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
($C_{6,1}$)	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
(C_{62})	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
(C_{63})	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8
(C_{64})	G	MG	F	VG	MG	(6.000,7.000,7.600,8.400)	7.24

Table.5 Appropriateness rating against subjective Lean assessment metrics for A_3

Lean assessment metrics	Appropriateness rating against individual 2^{nd} level evaluation metrics					AFR	Crisp value
	DM1	DM2	DM3	DM4	DM5		
($C_{1,1}$)	G	G	VG	VG	G	(7.800,8.800,9.400,10.00)	8.98
($C_{1,2}$)	MG	VG	MG	VG	MG	(6.600,7.600,8.200,8.800)	7.78
($C_{1,3}$)	MG	VG	MG	G	VG	(7.000,8.000,8.600,9.200)	8.18
($C_{1,4}$)	G	G	F	MG	MG	(5.600,6.600,7.400,8.400)	7
($C_{1,5}$)	G	G	MG	VG	MG	(6.600,7.600,8.400,9.200)	7.94
($C_{2,1}$)	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
($C_{2,2}$)	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
($C_{2,3}$)	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
($C_{2,4}$)	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8
($C_{2,5}$)	G	MG	F	VG	MG	(6.000,7.000,7.600,8.400)	7.24
($C_{3,1}$)	G	MP	F	F	MP	(3.800,4.800,5.400,6.400)	5.1
($C_{3,2}$)	G	G	VG	G	VG	(7.800,8.800,9.400,10.00)	8.98
($C_{3,3}$)	VG	VG	VG	G	G	(8.200,9.200,9.600,10.00)	9.22
($C_{3,4}$)	VG	G	VG	VG	VG	(8.600,9.600,9.800,10.00)	9.45
($C_{4,1}$)	VG	MG	G	G	G	(7.000,8.000,8.800,9.600)	8.34
($C_{4,2}$)	MG	F	G	MG	VG	(6.000,7.000,7.600,8.400)	7.24
($C_{4,3}$)	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
($C_{4,4}$)	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
($C_{5,1}$)	F	G	G	G	G	(6.400,7.400,8.200,9.200)	7.8
($C_{5,2}$)	G	G	VG	VG	G	(7.800,8.800,9.400,10.00)	8.98
($C_{5,3}$)	MG	VG	MG	VG	MG	(6.600,7.600,8.200,8.800)	7.78
($C_{5,4}$)	MG	VG	MG	G	VG	(7.000,8.000,8.600,9.200)	8.18
($C_{5,5}$)	G	G	F	MG	MG	(5.600,6.600,7.400,8.400)	7
($C_{6,1}$)	F	G	MG	F	G	(5.400,6.400,7.000,8.000)	6.7
(C_{62})	F	G	G	G	F	(5.800,6.800,7.400,8.400)	7.1
(C_{63})	G	G	VG	VG	G	(7.800,8.800,9.400,10.00)	8.98
(C_{64})	MG	VG	MG	VG	MG	(6.600,7.600,8.200,8.800)	7.78

Table.6. Weighted normalized matrix

C_j	A_1	A_2	A_3
Technological involvement, (C_1)	0.0368	0.0326	0.0355
Work force leanness,(C_2)	0.0564	0.0584	0.0560
Manufacturing management,(C_3)	0.0526	0.0619	0.0593
Collaborative planning, (C_4)	0.1044	0.0972	0.0931

Customer service performance,(C_5)	0.0866	0.0828	0.0855
Resource utilization, (C_6)	0.0714	0.0750	0.0761

Table.7 Preferences of stuff providers firm under lean performance evaluation strategy by MOOSRA

A_i	A_1	A_2	A_3
MOOSRA			
A_i	A_1	A_2	A_3
Performance evaluation score	0.408200000000	0.407900000000	0.405500000000
Preference orders	***3***	***2***	***1***

V. CONCLUSIONS

An lean performance measurement problem under inherently information has been found as sizzle problem. Recently, the globalization market has brought new defies to the business owners. Market is continuously fragmenting, customers' demands, which also required fast service from manufacturing firm. Delay in scheduled production does not make the reputation of companies ill well, but beak the relationship of manufacturing firm quite long time. The result, evaluated by MOOSRA, shown in fig. 1 that A_3 alternative is best.

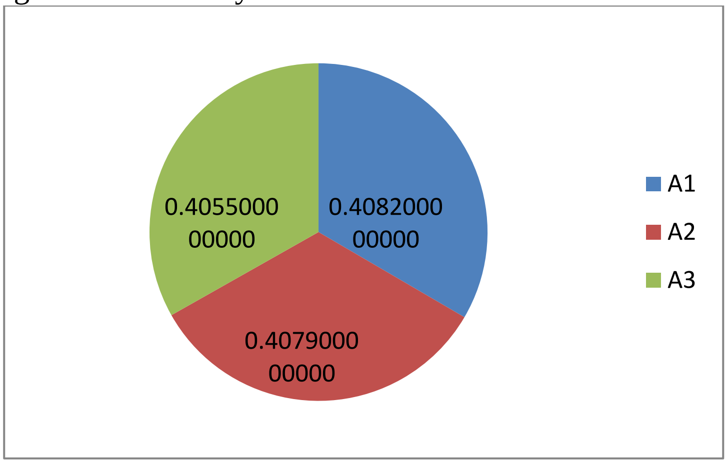

Fig: 1 The results shown by MOOSRA

REFERENCES

Arbos, L.C. (2002). Design of a rapid response and high efficiency service by lean production principles: Methodology and evaluation of variability of performance, International Journal of Production Economics, Vol. 80, No. 2, pp. 169-183.

Brauers, W.K.M. and Zavadskas, E. K. (2006) "The MOORA method and its application to privatization in a transition economy'', Control and Cybernetics, Vol. 35, No. 2, pp. 445-469.

Brauers, W.K.M. and Ginevicius, R., (2010) "The economy of the Belgian regions tested with MULTIMOOSRA '', Journal of Business Economics and Management, Vol. 11, No. 2, pp. 173-209.

Garvin, A.O. (1993). The 12 commandments of environmental compliance,' Industrial Engineering, Vol. 25, No. 9, pp. 18-22.

Greeen, K., Morton, B., and New, S. (1998). Green purchasing and supply policies: Do they improve companies' environmental performance. Supply Chain Management, Vol.3, No. 2, pp. 89-95.