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Investigation on Green Human Resource Management Practices using Interval Type-2 Fuzzy Logic for Sustainable Industrial Development with Reference to Public and Private Steel Industry

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Abstract

The purpose of this study is to explore the status and challenges of green human resource management practices in India, an under-researched area. Further, it proposes a theoretical framework to fill the identified gaps and build a sustainable organization.

The findings suggest that there is further scope to utilize the full potential of GHRM practices for encouraging pro-environmental behavior in the organizations. Analyses of data also reveal that top-management support and mutual learning among departments are crucial to facilitate green behaviors among employees.

This study fulfills the need to explore green human resource management in emerging economies like India. Studies like these are more important in developing countries, which have alarming environmental concerns and poorly implemented government regulations.

Green performance evaluations require and often involve disparate types of information that are vague, incomplete, objective and subjective. This paper proposes a green performance evaluation system of employees considering various performance evaluation criteria using interval type-2 fuzzy logic.The main task in the proposed approach involves determining the performance indices of employees considering their respective performance in various qualitative and quantitative evaluation criteria and then selecting the best employee who holds highest performance index comparing all the indices.

A model is developed for any kind of organization where performance evaluation is significantly important for staff motivation, attitude and behavior development, communicating and aligning individual and organizational aims and fostering positive relationships between management and staff. Interval type-2 fuzzy logic is used to determine the overall performance index by combining results of the performance in selected criteria and provided it in numerical

values which will undoubtedly ensure convenience of the concerned human resource personnel during performance rating calculation.

A green performance evaluation model is developed using interval type-2 fuzzy logic approach for any kind of organization where performance evaluation is significantly important for staff motivation attitude and behavior development, communicating and aligning individual and organizational aims, and fostering positive relationships between management and staff. The Interval Type-2 Fuzzy Logic System Toolbox (IT2FLS), is an environment for interval type-2 fuzzy logic inference system development. The Toolbox's best qualities are the capacity todevelop complex systems and the flexibility that enables the userto extend the availability of functions for working with the use of type-2 fuzzy operators, linguistic variables, interval type-2 membership functions, defuzzification methods and the evaluation of Interval Type-2 Fuzzy Inference Systems.

Keywords

Green human resource management, Green organizations, Green Performance evaluation, interval type-2 fuzzy logic, interval type-2 fuzzy set, Performance index, Performance appraisal

1. Introduction

Human resources with knowledge and competencies are the key assets in assisting organizations to sustain their competitive advantage. Globally competitive organizations depend on the uniqueness of their human resources and the systems for managing human resources effectively to gain competitive advantages. Performance evaluationof the human resources is a vital issue in this regard. In creating and implementingan appraisal system, management must determine what the performance appraisal (PA) system will be used for and then decide on the process to implement the system. For many organizations, the primary goal of an evaluation system is to improve individual and organizational performance. So it is needless to say, a properly designed systemcan help achieve organizational objectives and enhance employee performance. It is utilized to track individual contribution and performance against organizational goals and to identify individual strengths and opportunities for future improvements and assess whether organizational goals are achieved or serves as basis for the company's future planning and development. It has been proved by many research works that effective appraisal system is directly related to employee motivation and productivity. It is really difficult to consider many factors at a time to evaluate performance of employees in an organization. Interval type-2 Fuzzy logic can consider multiple input parameters with uncertainty of each factor. This paper proposes a case study of performance evaluation system of employees working in an organization based on 20 specific performance evaluation criteria using interval type-2 fuzzy logic. This research calls attention to an alternative method of the performance evaluation system as opposed to the traditional quantitative methods.

The interval type-2 fuzzy sets were presented to process / manipulate data and information affected by unprobabilistic uncertainty / imprecision. These were designed to mathematically represent the vagueness and uncertainty of linguistic problems; there by obtaining formal tools to work with intrinsic imprecision in different type of problems; it is considered a generalization of the classic set theory.

Intelligent Systems based on interval type-2 fuzzy logic are fundamental tools for nonlinear complex system modeling. Interval type-2 Fuzzy sets and interval type-2 fuzzy logic are the basis for interval type-2 fuzzy systems, where their objective has been to model how the brain manipulates in exact information. Interval type-2 fuzzy sets are used for modeling uncertainty and imprecision in a better way.

The new concepts were introduced by Mendel and Liang allowing the characterization of an interval type-2 fuzzy set with a superior membership function and an inferior membership function; these two functions can be represented each one by a type-1 fuzzy set membership function. The interval between these two functions represents the footprint of uncertainty (FOU), which is used to characterize an interval type-2 fuzzy set. Recently, there have been a lot of applications of interval type-2 fuzzy systems and for this reason we considered the need of building a software tool that could ease the development of type-2 fuzzy systems for real-world problems like green human resource management.

Only a few organizations explore the internal factors, such as the role of human behavior in protecting the environment (Davis and Challenger, 2013; Ones and Dilchert,2012), as most of them undertake environmental development initiatives outside their boundaries (Uzzell and Moser, 2009). Studies on green human resource management (GHRM) are significant as it is a branch of green management philosophy which explores the role of human behavior in environmental management (Jackson and Seo, 2010) and sustainable development (O'Donohue and Torugsa, 2016). Opatha and Arulrajah (2014) have explained GHRM as the policies, practices and systems of an organization green that make its employees green for the benefit of the individuals, society, natural environment and business. In GHRM various human resource practices, such as recruitment and selection, performance appraisal, compensation and benefits and training, are designed in a manner to create a work force that understands and promotes green behavior in the organization (Mathapati, 2013).

Further, Industrial organizational strategies for environmental management and sustainable development will succeed when they are well-aligned with its human resource practices (Ichniowski et al., 1997; Mendelson and Pillai, 1999; Collins and Clark, 2003). The effectiveness of any strategic measure is dependent on the availability and capability of its people (Boselie et al., 2001;

Paauwe and Boselie, 2003; Jiang et al., 2012). Thus, efficient workforce and human resource systems are critical for an impactful environmental growth strategy. As GHRM links people with environmental sustainability, it helps in bridging the gap between available vs required technically and managerially skilled workforce for successful implementation of environmental management systems (Daily and Huang, 2001; Renwick et al., 2013). Research on GHRM can suggest strategic measures for building the capability of employees and creating a supportive culture which facilitates in adopting pro-environmental behavior.

In India, GHRM is an under-researched area, although green organizations are the need of the hour. Hence, it has become importantto explore GHRM in India. The objective of this study is to identify gaps by exploring thestatus of GHRM practices in India. It suggests measures to address the gaps and identify key motivating factors for the employees to exhibit environmental-friendly behaviors and practices within the organization. Finally, it suggests an interdisciplinary framework to build a green organization.

The study is divided into two phases. In the first phase, literature is reviewed tounderstand various green human resource practices across the world to extract the themes for collecting data, as there is limited information available in the Indian context, and this study being one of the few empirical studies conducted on GHRM in the Indian context. In the second phase, using the extracted themes, data are collected for reviewing the GHRM status in the Indian organizations.

2. Literature review

One of the key responsibilities of a human resource professional is getting the support of the employees to implement environment-friendly initiatives (Priya et al., 2014). Jabbour et al. (2010) highlighted the importance of human resource management in different stages of environmental management system. Ahmad (2015) emphasized on the role of human resource in engaging employees and promoting practices such as car pooling, recycling and conservation of energy. Renwick et al. (2013) developed a theoretical model where distinguished policies in the field of recruitment, performance and appraisal management, training and personnel development, employee relations and reward systems are considered powerful tools for aligning employees with a company’s environmental strategy.Green recruitment and selection process has two parts:

(1) Employing eco-friendly ways for hiring such as online tools, limited paper usage at the time of recruitment and selection process; and

(2) Measuring green attitudes at the time of selection, considering people who value green practices and follow basic environment-friendly activities such as recycling, less printing and conservation of energy.

Individual's personality factors should be incorporated in green recruitment (Dilchert andOnes, 2011). They have also developed a scale to measure employee's preferences toward green behavior. Individual's green competencies are crucial for pro-environmental performance (Subramanian et al., 2016). On the other hand, even candidates are likely to be attracted toward organizations that are environment-friendly and branded as "green". An effective way to attract new talent is by gaining a reputation of "green employer" (Phillips,2007; Stringer, 2009; Guerci et al., 2016). The study by Brekke and Nyborg (2008) took a theoretical approach and built a model to explain how environment-friendly organizations can attract responsible employees. They advocated that for all other conditions being the same, people are more likely to join socially responsible organizations. It was found that environmental commitment of the company has a positive impact on its brand image, and candidates gave value to the environment-friendly strategies adopted by the organization (Grolleau et al., 2012).

The performance management system helps in analyzing the current efficiency of an employee, finding gaps, exploring measures for improvisation and in setting future targets. Performance management is considered as one of the key human resource practices for promoting environmental behavior and sustainable development, thus advocating green performance management (Gholami et al. (2016). Green performance appraisal may be significant because when a behavior is measured to judge an individual, its perceived valuerises and efforts to comply with the same are increased. Thus, including green behaviors in the performance appraisal system will facilitate their adoption among employees.Compensation and reward system is a significant human resource process through which employees are rewarded for their performance. This system attunes individual's and organization's goal. It motivates the employees to put extra efforts, which is required to meet the deliverables. By green compensation and reward system, it means to align the system with green behaviors and activities adopted within the organization. While performance management system ensures evaluation of green behaviors, a green compensation system ensures that the result of the assessment is linked with rewards and benefits. A study conducted on 469 US firms operating in high-polluting context reported that the CEO of the firms with high environment-friendly performance were paid more than those of non-environment-friendly firms. Further, long-term company results were linked with greater pollution prevention success in accordance to pay (Berrone and Gomez-Mejia, 2009).

Green training and development aim to improve employee's awareness and knowledge on environmental issues, build positive attitude, take a proactive approach toward environmental concerns and develop competencies to conserve energy and reduce waste (Zoogah, 2011). Environmental-training is reported as one of the most crucial aspects of human resource practices

(Jabbour et al., 2013). In a study conducted in Brazil, it was reported, “environmental-training for mitigating climate change” is relevant for the systematic development of low-carbon products (SaturninoNeto et al., 2014). Further, both direct and moderating effects of employee training were found on the organizations sustainable development (Ji et al., 2011). Employee training is crucial for successful implementation of the environmental management system and creation of an environment friendly culture in the organization (Teixeira et al., 2012). Environmental-training leads to better performance of environmental management system (Sarkis et al., 2010).

Many organizations do not use the systematic way to evaluate the performance of their employees that often makes their evaluation method vague and inefficient. Soit is very necessary to develop a systematic approach for regular use to perform the performance evaluation process at planning stage. Again organizations use several criteria for evaluating an employee which makes the whole process very complex as there are different rules for each criterion with different priority. So obtaining a total performance index for an employee considering all criteria is a tire some process. Interval type-2 Fuzzy rule-based decision making could solve this problem easily as Interval type-2 fuzzy logic takes into account various criteria and provides an easier way to perform the aggregated calculation based on given rules which is complex to do in usual traditional method. So formulating a model where employees performances are rated in some defined factors according to judgment scale and using this rated performance as input, interval type-2 fuzzy logic could be applied to determine the overall performance index of an employee. Interval type2 Fuzzy logic helps to find the performance index of an individual if the company’s performance data and rating based on judgment are available. In this model, the judgment of the performance on a scale decided by evaluator and establishment of rules in interval type-2 fuzzy logic according to which the calculation works are the most important tasks. In the fuzzy environment numerous studies have been conducted in different areas and applications.

A leader usually has defective and incomplete information at his disposal and, besides, is subjective. To solve the aforesaid problem, interval type-2 fuzzy approach and interval type-2 fuzzy logic are used. Interval type-2 Fuzzy evaluation system has been designed to reduce evaluation subjectivity. Beheshtiand Lollar (2008) developed a fuzzy logic model approach to decision making and its value for managers by illustrating its application to employee performance appraisals. Pakdamar and Guler (2008) developed a fuzzy logic approach in the performance evaluation of reinforced concrete structures. They showed that the performance level can be defined to be flexible by using certain weighted values depending on number and deformation level of elements. Paladini (2009) used fuzzy logic to structure an evaluation process of the performance levels of human resources who operate in both industrial and service providing organizations. A model has been

developed to each sector. The performance standards reflect an ideal profile of decision-making agents in industrial and service providing organizations. Wua et al. (2009) proposed a Fuzzy Multiple Criteria Decision Making approach for banking performance evaluation.

Fuzzy due dates, cost over time and profit rate result the job priority andto determine the machine priority processing time of each machine is considered. MATLAB Fuzzy Toolbox is used to calculate the priorities of jobs and machines at different stages. Finally, jobs are assigned into machines based on a grouping and sequencing algorithm that minimizes the total work in process inventory. Sun (2010) developed a performance evaluation model based on the FAHP and the technique for order performance by similarity to ideal solution, fuzzy TOPSIS wherethe vagueness and subjectivity are handled with linguistic values parameterized by triangular fuzzy numbers. Zemkova´ (2011) used fuzzy sets in performance evaluation of employees in a company where multiple criteria evaluation is utilized. Cheng et al. (2011) developed an evolutionary fuzzy hybrid neural network toenhance the effectiveness of assessing subcontractor performance in the construction industry. Yadav and Singh (2011) proposed a fuzzy expert system for student academic performance evaluation based on fuzzy logic techniques. Manoharan et al. (2011) demonstrated how an integrated tool like fuzzy multi-attribute decision making, with FAHP, fuzzy quality function deployment is applied as a fair evaluating and sorting tool to support the PA system. Several approaches using fuzzy logic techniques have been proposed for evaluating student academic performance and compare the results with existing statistical method. Sahu et al. (2012) proposed an efficient supplier appraisement system by considering green performance criteria, in fuzzy environment. A fuzzy evaluation index has been estimated toward assessing suppliers' green performance extent. Meenakshi (2012) proposed a multisource feedback-based PA system using fuzzy logic decision support system. Yarahmadi and Sadoughi (2012) presented a comprehensive approach for decision makers to evaluate and prioritize environmental indices using a TOPSIS.

3. Methodology-Interval Type-2 Fuzzy Logic

The model proposed in this research utilizes interval type-2 fuzzy inference system (FIS) which is an optimization technique that considers different inputs and relates those inputs with output with some rules. Rules indicate the relationship between inputs and outputs. The output is optimized based on relationship between variables. The final output is obtained from the aggregated optimized result of individual rule. Interval type-2 Fuzzy inference is the process of formulating the mapping from a given input to an output using interval type-2 fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned. FISs are associated with a number of names, such as fuzzy-rule-based systems, fuzzy expert systems, fuzzy modeling, fuzzy associative memory, fuzzy logic controllers, and simply (and ambiguously) fuzzy systems.

Mamdani's fuzzy inference method is the most commonly seen fuzzy methodology. Mamdani's method was among the first control systems built using fuzzy set theory.

A. Fuzzy Set Operations

We can apply operators to the interval type-2 fuzzy sets or we can make some operations between them. When we apply an operator to one interval type-2 fuzzy set we obtain another interval type-2 fuzzy set; by the same manner when we combine an operation with two or more sets we obtain another interval type-2 fuzzy set.

B. Fuzzy Inference System

The human knowledge is expressed in fuzzy rules with the following form:

IF <*fuzzy proposition*>**THEN** <*fuzzy proposition*>

The fuzzy propositions are divided in two types, the first one is called **atomic:** for example **x is A**, where x is a linguistic variable and A is a linguistic value; the second one is called **compounded:** for example **x is A AND y is B OR z is NOT C**, this is a compounded atomic fuzzy proposition with the "AND", "OR" and "NOT" connectors, representing fuzzy intersection, union and complement respectively. The compounded fuzzy propositions are fuzzy relationships. The membership function of the rule IF-THEN is a fuzzy relation determined by a fuzzy implication operator. The fuzzy rules combine one or more fuzzy sets of entry, called antecedent, and are associated with one output fuzzy set, called consequents.

The interval type-2 Fuzzy Sets of the antecedent are associated by fuzzy operators AND, OR, NOT and linguistic modifiers. The fuzzy rules permit expressing the available knowledge about the relationship between antecedent and consequents. To express this knowledge completely we normally have several rules, grouped to form what it is known a rule base, that is, a set of rules that express the known relationships between antecedent and consequents. The fuzzy rules are basically IF <Antecedent> THEN <Consequent> and expresses a fuzzy relationship or proposition.

In fuzzy logic the reasoning is imprecise or approximated, which means that we can infer from one rule a conclusion even if the antecedent doesn't comply completely. The inference method is known as direct reasoning and is summarized as:

Rule *IF x is A THEN y is B*

Fact *x is A'***Conclusion** *yes B'*

Where A, A', B and B' are interval type-2 fuzzy sets of any kind. This relationship is expressed as $B' = A' \circ (A \rightarrow B)$. Figure 1 shows an example of Interval Type-2 direct reasoning with Interval Type-2 Fuzzy Inputs An Inference Fuzzy System is a rule base system that uses fuzzy logic, instead of Boolean logic utilized in data analysis [4, 10, 20]. Its basic structure includes 4 components (Fig. 2):

• ***Fuzzifier.*** Translates inputs (real values) to fuzzy values.

• ***Inference System.*** Applies a fuzzy reasoning mechanism to obtain a fuzzy output.

• ***Type Defuzzifier/Reducer.*** The defuzzifier translates one output to precise values; the type reducer transforms a Interval Type-2 Fuzzy Set into a Type-1 Fuzzy Set.

• ***Knowledge Base.*** Contains a set of fuzzy rules and a membership functions set known as the database.

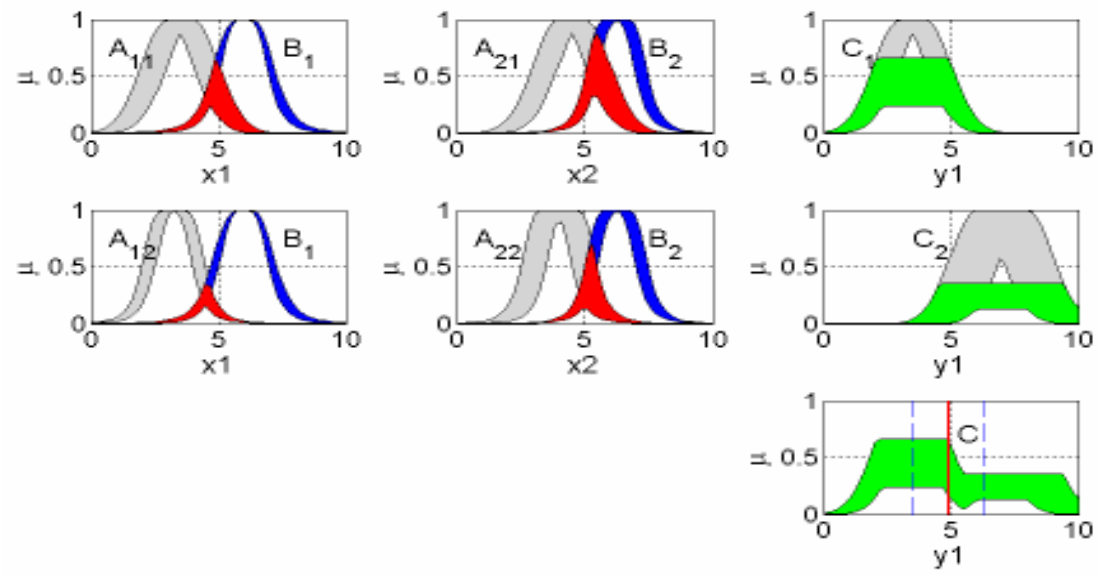

Fig.1 Interval Type-2 Fuzzy Reasoning

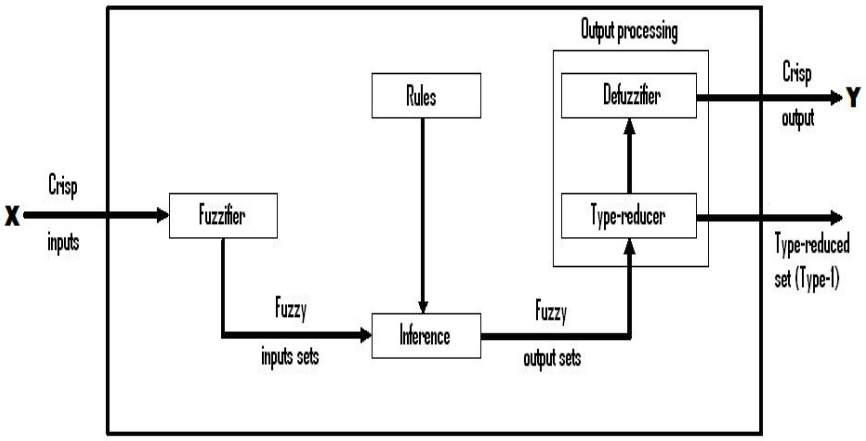

Fig.2 Structure of the Type-2 Fuzzy Inference System

The decision process is a task that identifies parameters by the inference system using the rules of the rule base data. These interval type-2 fuzzy rules define the connection between the input and output interval type-2 fuzzy variables. A interval type-2 fuzzy rule has the form: IF <Antecedent>THEN <Consequent>, where antecedent is a compound interval type-2 fuzzy logic

expression of one or more simple fuzzy expressions connected with fuzzy operators; and the consequent is an expression that assigns interval type-2 fuzzy values to output variables.

4. Modeling of performance evaluation system

During the generation of the interval type-2 fuzzy model's linguistic variables, 20 GHRM practices are considered. These selected performance criteria reflects the results of scholars findings during their visit to human resource department of five renowned companies of different fields. Though in practice some companies may have some customized criteria of their own for evaluation but these are the most important and commonly used criteria for performance evaluation and hence considered for model formulation. Moreover the appraisal rule for each of the considered criteria is also obtained from the information gathered during scholars' visit. For each ofthese criteria three linguistic variables are developed which are used for evaluating performance. For all of these inputs in the model the linguistic variables used are "low," "medium," and "high". For the output termed as "performance index" five linguistic variables are considered which are termed as "very low," "low," "medium," "high," and "very high". The range and boundary values considered for linguistic variables could be unique to specific company. Here these values are taken to relate the model to a specific steel industry and it is not at all tough to formulate similar model for another company.

After examining the linguistic variables, membership functions are determined and entered into MATLAB Fuzzy Toolbox. The FIS for input and output variables in general is shown in Figure 3. In this figure, inputs variables are shown in the left side and output variable is shown in the right side. The membership function and the linguistic variables of input and output variables are entered in MATLAB Fuzzy Toolbox Membership Function Editor. Triangular membership function is used for each linguistic variable. Tables 1 and 2 show, respectively, the linguistic variables for input and output. After the membership functions and linguistic variables for both input and output are entered, the rules are designated and written in MATLAB Fuzzy Toolbox for evaluation. When all the needed data are entered, inputs are solved according to changing input positions for solving of fuzzified systems. With 20 inputs variables each having three levels, total 82 rules are developed with the help of MATLAB Fuzzy Toolbox Rule Editor. Here an example of one rule is given. If (employee's knowledge of the job is low) and (quality of work is low) and (quantity of work is low) and (problem solving and decision-making skill is low) and (teamwork and cooperation skill is low) and (leadership skill is low) and (rate of absenteeism is high) and (late attendance is high) and (communication skill is low) and (time management skill is low) and (adaptability and flexibility is low) and (appearance and grooming is low) and (professional attitude is low) and (initiative and innovation skill is low) and (dependability is high) and (confidence level is low) and (steadiness under pressure is low) and (ethics and integrity is low) and (planning capability is low) and

(versatility is low) then (performance index is very low). Like this 82 rules are developed and entered in the Fuzzy Toolbox Rule Editor.

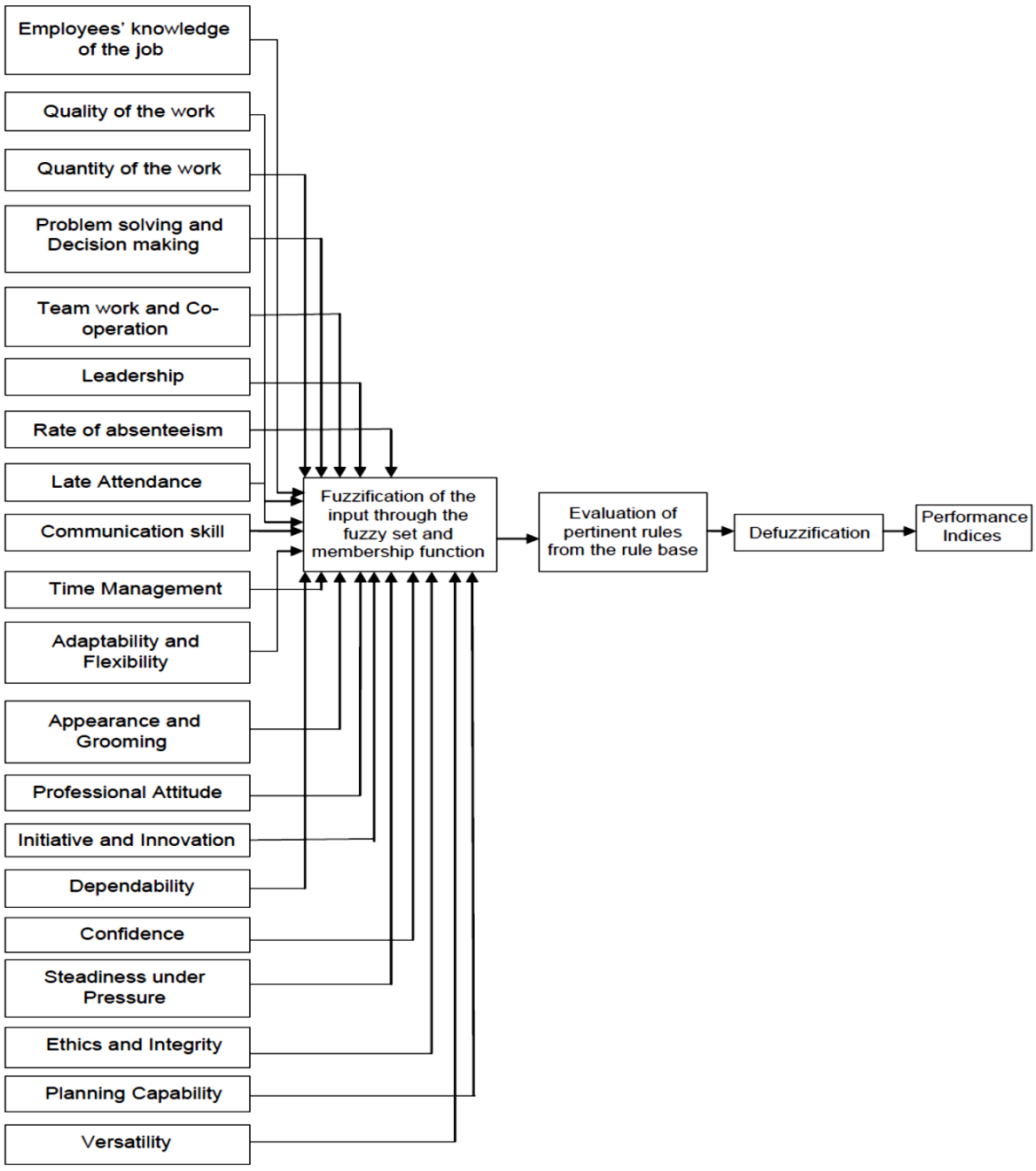

Fig.3 Interval Type2 Fuzzy model ofproposed system

Table 1

Variation of linguistic variables for input parameters

Input variable	Notation	Low	Medium	High
Employees' knowledge of the job	A	0-4	4-7	7-10
Quality of the work	B	0-4	4-7	7-10
Quantity of the work	C	300-400	400-500	500-600
Problem solving and decision making	D	0-4	4-7	7-10
Team work and co-operation	E	0-4	4-7	7-10
Leadership	F	0-4	4-7	7-10
Rate of absenteeism (per month)	G	0-1	1-3	3-5
Late attendance (per month)	H	0-4	4-8	9-12
Communication skill	I	0-4	4-7	7-10
Time management	J	0-0.4	0.4-0.7	0.7-1
Adaptability and flexibility	K	0-0.4	0.4-0.7	0.7-1
Appearance and grooming	L	0-4	4-7	7-10
Professional attitude	M	0-4	4-7	7-10
Initiative and innovation	N	0-4	4-7	7-10
Dependability	O	0-0.4	0.4-0.7	0.7-1
Confidence	P	0-0.4	0.4-0.7	0.7-1
Steadiness under pressure	Q	0-4	4-7	7-10
Ethics and integrity	R	0-4	4-7	7-10
Planning capability	S	0-0.4	0.4-0.7	0.7-1
Versatility	T	0-0.4	0.4-0.7	0.7-1

Table 2 Variation of output linguistic variables

Output variable	Notation	Very low	Low	Medium	High	Very high
Performance index	U	0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1

5. Simulation Model

The Interval Type-2 Fuzzy Inference Models and the design of Interval Type-2 membership functions and operators are implemented in the IT2FLS Toolbox (Interval Type-2 Fuzzy Logic Systems) reused from the Matlab® commercial Fuzzy Logic Toolbox. The IT2FLS Toolbox includes a series of folders called dit2mf, it2fis, it2mf and it2op (Fig.4). This folders contain the functions to create Mamdani and TSK Interval Type-2 Fuzzy Inference Systems (new fis type2.m), functions to add input-output variables and their ranges (addvartype2.m), it has functions to add 22 types of Interval Type-2 Membership functions for input-outputs (addmftype2.m), functions to add the rule matrix (addruletype2.m), it can evaluate the Interval Type-2 Fuzzy Inference Systems (evalifistype2.m), evaluate Interval Type-2 Membership functions (evalimftype2.m), it can generate the initial parameters of the Interval Type-2 Membership functions (igenparamtype2.m), it can generate the solution surface of the Fuzzy Inference System (gensurftype2.m), it plots the Interval type-2 membership functions (plot2dtype2.m, plot2dctype2.m), a folder to evaluate the derivatives of the Interval type-2 Membership Functions (dit2mf) and a folder with different and generalized Type-2 Fuzzy operators (it2op, t2op).

The Interval Type-2 Fuzzy Inference Systems (IT2FIS) structure is the MATLAB object that contains all the interval type-2 fuzzy inference system information. This structure is stored inside each GUI tool. Access functions such as getifis type-2 and setifistype-2 make it easy to

examine this structure. All the information for a given fuzzy inference system is contained in the IT2FIS structure, including variable names, membership function definitions, and so on. This structure can itself be thought of as a hierarchy of structures, as shown in the following diagram (Fig.5).

Fig.4 Toolbox Folder

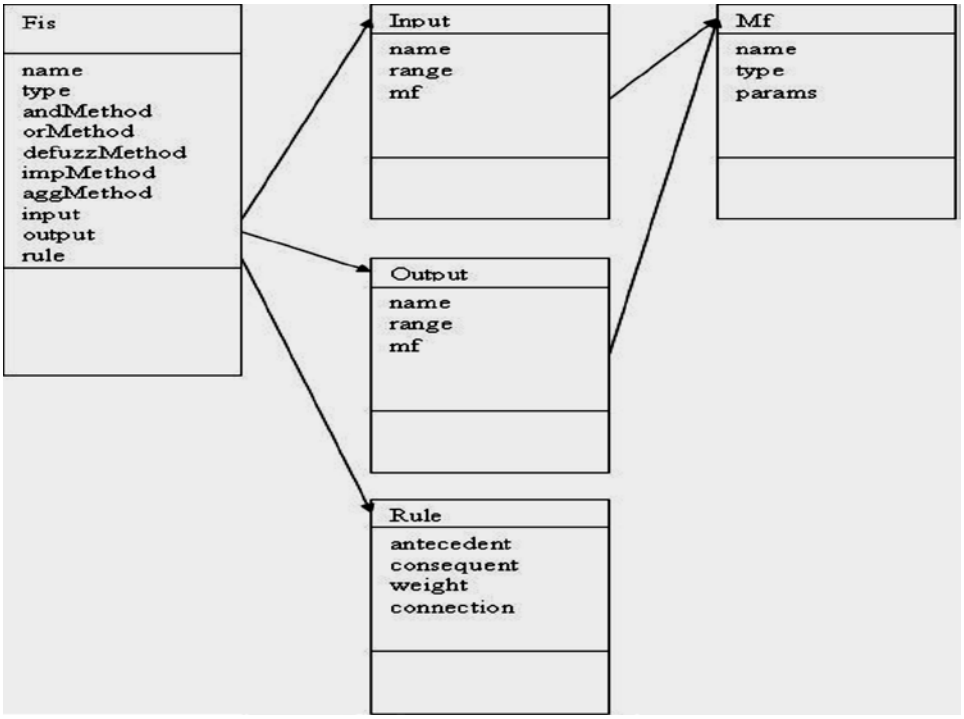

Fig.5 Hierarchy of IT2FIS structures diagram

The implementation of the IT2FLS GUI is analogous to the GUI used for Type-1 FLS in the Matlab® Fuzzy Logic Toolbox, thus permitting the experienced user to adapt easily to the use of

IT2FLS GUI. Figures 6 and 7 show the main view of the Interval Type-2 Fuzzy Systems Structure Editor called IT2FIS (Interval Type-2 Fuzzy Inference Systems).

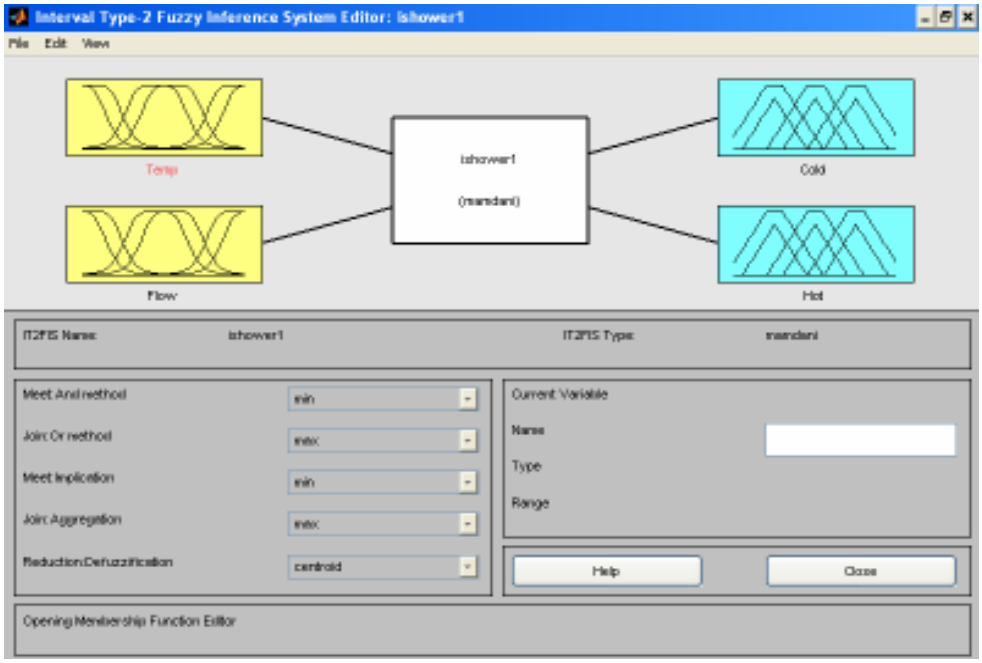

Fig.6 IT2FIS Editor

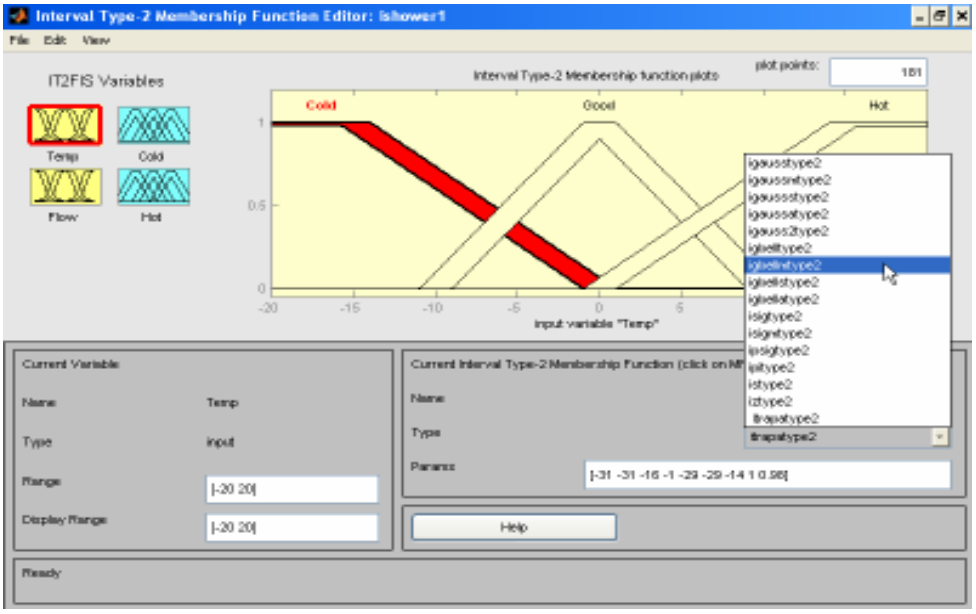

Fig.7 Interval Type-2 MF's Editor

6. Result analysis and findings

To judge the model just formulated data of five employees termed as "E_1," "E_2," "E_3," "E_4," and "E_5," collected from the human resource department of a steel industry, has been considered and the result is then analyzed on the basis of the data. The input data for these five

employees are shown in Table 3 and results obtained from the fuzzy model is shown is Table 4. Employee obtained highest performance indices is ranked 1 in performance ranking. In rule viewer inputs are given for employee E_5 and performance index is automatically generated by using data of input variables and developed rules. Here inputs used are E_5 employee's

Table 3 Data of five employees of an organization

Input parameters	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Employee																				
E_1	2	4	500	6	7	8	4	8	9	0.6	0.8	9	8	2	0.8	0.6	7	2	0.5	0.4
E_2	9	9	400	5	4	6	2	4	6	0.4	0.5	6	8	5	0.4	0.7	5	7	0.5	0.7
E_3	5	7	500	5	7	8	1	3	8	0.8	0.9	8	7	2	0.5	0.6	8	3	0.4	0.8
E_4	6	5	900	7	9	6	1	0	6	0.7	0.8	9	8	5	0.4	0.5	7	5	0.6	0.9
E_5	6	8	700	5	7	3	1	2	6	0.3	0.4	4	6	8	0.7	0.3	4	2	0.3	0.1

"A" knowledge of the job(recruitment and selection) (6), "B" quality of work (8), "C" quantity of work (700), "D" problem solvingand decision-making skill(performance appraisal system) (5), "E" green teamwork and cooperation skill (7), "F" leadership skill is (3), "G" rate of absenteeism (1), "H" late attendance (2), "I" communication skill (6), "J" time management skill (0.3), "K" adaptability and flexibility (0.4), "L" appearance and grooming(environmental learning and awareness) (4), "M" professional attitude (6), "N" initiative and innovation skill (8), "O" dependability (0.7), "P" confidence level (compensation/reward system) (0.3), "Q" steadiness under pressure (4), "R" ethics and integrity(green corporate social responsibility (CSR)), (2), "S" planning capability (0.3),"T" versatility (0.1). The output performance index (U) for E_5 is obtained 0.5. So according to the linguisticvariables defined earlier, performance of the employee E_5 is medium.

Table 4 Results obtained from the fuzzy model

Employee	Fuzzy results (performance indices)	Performance ranking
E_1	0.492	5
E_2	0.594	2
E_3	0.519	3
E_4	0.606	1
E_5	0.5	4

7. Conclusions

To maintain Green Human Resource Management or appraisal on continual basis is to be performed by human resource management of a steel industry. In this research, an interval type2 fuzzy model for green human resource management or appraisal evaluation is proposed and using historical data of a steel industry the performance index is obtained by which the best employee is

selected. Here, 20 input variables for five employees are considered to determine the result. For each input and output variable triangular membership functions of interval type-2 fuzzy sets are considered to design the model. As based on the performance index obtained by the model, selecting people for promotion, environmental training, green performance bonus, and green performance-based pay awards could be accomplished through a transparent process; naturally it could become a great supportive tool for the managers. It is a user friendly process. The complex middle calculation of interval type-2 fuzzy logic is done entirely by MATLAB software. Input, output values will be provided and found from the interval type-2 fuzzy toolbox in MATLAB which could be operated very easily by concerned human resource personnel (i.e. performance officer, HR specialist) who usually handle the green performance evaluation system and determine the performance index of the employees.

The proposed approach is very convenient to perform comparing to other available approaches like analytical hierarchy process, weighted average method that require substantial calculation if at a time a good number of performance criteria is considered as the basis of evaluation. It is also extremely flexible compared to other methods as it allows the decision maker to introduce vagueness, uncertainty, and subjectivity into the evaluation system. Again it allows the decision maker to use a broad range of linguistic variables and modifiers for finer discrimination or to make changes to membership values and/or performance categories which clearly turns it into a superior method. Very apparently the more the rule is considered the result becomes the more appropriate but developing the rule in various combinations is some while troublesome and tiresome too. But the good thing is once the rules are set, it could be used onward. Again it is to be mentioned too that the result found considering a good number of rules that are quite easy to set is also handy and more appropriate compared to other traditional quantitative methods.

The design and implementation done in the IT2FLS Toolbox is potentially important for research in the interval type-2 fuzzy logic area, thus solving complex problems on the different applied areas.

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