IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 8 Issue 11, November 2021
ISSN (Online) 2348 – 7968 | Impact Factor (2020) – 6.72
www.ijiset.com

Fuzzy Logic Based Data Analysis on Usefulness of Reverse Performance Appraisal in 21st Century

[1]Neha Agrawal, [2]Dr. Archana Agrawal

[1]Research Scholar, Dept. of Management Studies, Dr. C.V. Raman University, Kota, Bilaspur (C.G.), India

[2]Faculty of Commerce & Management, Dr. C.V. Raman University, Kota, Bilaspur (C.G.), India

Abstract

The present competitive environment, organizations have to ensure peak performance of their employees continuously in order to complete the market place, effectively. "Giving Effective Feedback" is definite lien important management tool and considered as an art, which managers master over a period of time. The process of giving feedback down the corporate hierarchy is common and pervasive but the concept of giving reverse feedback is getting popular nowadays. It is the only medium where subordinates can provide feedback and performance review of their seniors. In reverse appraisal, employees can evaluate the effectiveness of their managers. In this study the usefulness of reverse performance appraisal technique analyzed with the current requirement of organizations.

This study was aimed at evaluating the usefulness of the reverse performance appraisal process in selected private organizations of Chhattisgarh. Fuzzy logic was applied in assessing the usefulness of the reverse performance process using a case study of private industry. Linguistic variables were used to represent the performance of the metrics, and the variables were converted into fuzzy numbers. Fuzzy operators were applied to these numbers to obtain the performance of the measures and the entire process. From the results obtained, it was found that the approach adopted is applicable in evaluating the usefulness of reverse performance appraisal of the private industry. Based on this study, subordinates (workers/staffs) can provide feedback and performance review of their seniors (managers) with ease and identify areas which are deficient, thus improving the overall performance of their seniors. In essence, this paper contributes to knowledge in reverse performance measurement at large, thus putting forth a measurement approach for reverse performance appraisal in the private industry in Chhattisgarh. It also gives guidelines for future research in reverse performance management.

Key words:

Reverse performance appraisal (RPA), feedback, Reverse Performance Evaluation

1. Introduction

Reverse Performance appraisal

The evaluation of the behavior of management and the superior's effectiveness is known as reverse performance appraisal. Evaluation of a management's behavior and effectiveness by the employees used typically in participatory management practices and employee empowerment programs in known as reverse performance evaluation. In the endeavor to create true openness and transparency within the culture, it is important that bilateral feedback is encouraged irrespective of the hierarchy and power distance.

For supervisors to build leadership capabilities and inculcate superior management traits there is no better opportunity than to improvise on the feedback inputs that they receive from the reporters. Not only will this feedback extremely pertinent, but will also be linked to the immediate work settings which will help the manager relate easily. This will also address the habit of bad mouthing and cribbing which some employees do against their managers within their peer group. The reverse performance appraisal helps a company to Fix the system, Reveal pattern- the data will reveal patterns of dysfunction and systematic issues that need to be addressed, Measure the success, Everyone benefit, Establish priorities, Improved employer branding. A format for feedback from subordinates of their superiors is provided here.

System of reverse performance evaluation feedback for supervisors by staff (Staff to Supervisor):-

Data analysis system

After the comments and expertise statement reverse performance appraisal system is useful to the following

For the Appraise

- Better understanding of his role in the organization-what is expected and what needs to be done to meet those expectations.
- Clear understanding of his strength and weaknesses so as to develop himself into a better performer in future
- Increased motivation, job satisfaction and self esteem
- Opportunity to discuss work problems and how they can be overcome.
- Opportunities to discuss aspirations and any guidance, support or training needed to fulfill these aspirations
- Improved working relationship with the subordinates

For the Management

- Identification of performers and non performers and their development towards better performance
- Opportunity to prepare employees for assuming higher responsibilities
- Opportunity to improve communication between the employee and the management
- Identification of training and development needs Generation of ideas for improvement
- Better identification of potential and formulation of career plans

For the Organization

- Improved performance throughout the organization
- Creation of a culture of continuous improvement and success
- Conveyance of message that people are valued

Department:	Evaluation Date:
Evaluation Period:	
1. Immediate Supervisor Name:	
2. Supervisor's Supervisor Name:	
3. Dean/Department Head Name:	
4. Name and Signature of Evaluator (optional):	

Departments are encouraged to establish a system of performance evaluation feedback for supervisors by staff that reflects an impartial input to each supervisor regarding his/her performance. Formal feedback can be a positive means to assist the supervisor in improving job performance. Feedback affords staff members the opportunity to clarify what they expect of the supervisor in fostering a work climate that helps to attain the goals of the department. Supervisor performance feedback should be conducted on a periodic basis (at least annually) and should not reflect personal prejudice, bias, or favoritism on the part of the staff member for the rating or review. It is important to provide constructive feedback in all evaluations. Remember performance is being measured, not the supervisor's value as a person. To preserve the anonymity of the staff member providing the feedback, this form does not require any signatures. If the feedback is a factor that contributes to an overall unsatisfactory rating by the person's supervisor, signatures will be required.

Form Instructions

1. Use one of the following ratings to describe the performance of the supervisor in each of the categories.

(3) Performs Very Well (PVW)	Performance often exceeds expectationsfor the job
(2) Performs Well(PW)	Performance consistently meets expectationsfor the job
(1) Needs Improvement(NI)	Performance sometimes meets expectationsfor the job
(0) Unable to Evaluate(UE)	Knowledge of performance is unknown

2. This form shall first be sent to the next higher supervisor in which a feedback summary will be provided to the employee.
3. Procedures for using this evaluation within departments shall be decided at the department level.
4. Copies of all Supervisor Feedback Forms will be incorporated with the individuals overall performance evaluation and submitted to HR/EO.

Feedback Factor Ratings

3 = Performs very well; 2 = Performs well; 1 = Needs improvement; 0 = Unable to Evaluate

I. LEADERSHIP	**3**	**2**	**1**	**0**
a) Demonstrates the ability to direct others in accomplishing work				
b) Demonstrates professional, administrative, supervisory and/or specialized knowledge required to perform the job				
c) Creates a culture supportive of staff, which fosters individual motivation, high levels of individual and team performance, and quality of service				
d) Provides opportunities for others to develop skills				
e) Functions effectively under pressure				
f) Represents self and situations honestly				
g) Responds appropriately to criticism and to suggestions for work improvement				
h) Manages assets including technology, equipment, budget and space, where applicable				
i) Generates a favorable climate for change				
j) Encourages career growth and training opportunities for staff				
Comments				

II. PROGRAM / PROJECT MANAGEMENT	3	2	1	0
a) Defines expectations and tasks clearly				
b) Plans and organizes work, coordinates with others, establishes appropriate priorities to ensure work completion				
c) Delegates work effectively and allows sufficient time for completion of assignments				
d) Delegates authority when appropriate				
e) Determines appropriate action and follows through in a timely and decisive manner				
f) Implements solutions on a timely basis, monitors effectiveness of solutions and makes changes as needed				
g) Ensures that work products and services consistently meet needs of customers				

III. JOB KNOWLEDGE	3	2	1	0
a) Remains up-to-date on current trends in the profession				
b) Demonstrates knowledge of theoretical, practical and routine aspects of the position				
c) Applies knowledge effectively to job duties				
d) Applies University and departmental policies, procedures and regulations appropriately				
e) Brings innovative ideas to the attention of others				
Comments				

IV. PERSONNEL MANAGEMENT	3	2	1	0
a) Fosters an enthusiastic and optimistic attitude in the unit				
b) Rewards and recognizes individual and team successes				
c) Evaluates employees objectively, provides timely information on performance and frequent feedback				
d) Demonstrates tact and diplomacy when resolving conflicts and seeks win/win outcomes				
e) Acts forthrightly in response to unacceptable behavior or performance and focuses on the situation, issue or behavior rather than on the person				
f) Manages personnel issues; enforces policies, safety procedures and work rules				
g) Handles pressure and crisis situations with control and composure				
h) Maintains high ethical standards for self and employees; is professional				
i) Demonstrates proper judgment with sensitive information and issues				
j) Overall communication style is respectful and professional to staff, colleagues, etc.				

A sound reverse performance appraisal system is necessary; in order to achieve a successful human resource management. The only means of revealing the performance of the superiors is through the evaluation of its key performance measures. Till date, no study has used a set of measures and metrics to conduct the performance evaluation of superiors by staff. Since such a process is characterized by vague information, uncertainties and imprecise data, fuzzy logic becomes the most appropriate tool for its performance evaluation. The rest of the paper is organized

as follows, a brief review of some previous studies related to a description of the fuzzy set concept. Subsequently, the research methodology as well as the fuzzy logic measurement approach is explained. The study culminates with a case study conducted to illustrate and assess the use of the fuzzy logic approach in measuring the usefulness of reverse performance appraisal process. The results obtained are discussed and finally, the paper ends with conclusions and directions for future studies.

Advantages of Reverse Performance Appraisal

Reverse Performance Appraisal provide document of employee performance over a specific period of time. It not only provides a platform for employees to give feedback about their supervisors and manager's performance but also allows the employee to provide a fair review about the problems they face with their seniors. It also provides a structured process for an employee to clarify expectations with their supervisors/manager. A timely and regularly done appraisal provide a structure for thinking through and planning the upcoming year and developing goals for the effective working of all. It also helps the Human resource manager to decide the merit increase and change in compensation system and growth avenues.

This is a win-win situation and by being able to freely give feedback to his supervisor, the employee not only feels empowered, but also realizes that he is playing an important developmental role.

Review of literature

Ankur Poddar (2013) describes that for supervisors to build leadership capabilities and inculcate superior management traits there is no better opportunity than to improvise on the feedback inputs that they receive from there portees. Not only will this feedback be extremely pertinent, but will also be linked to the immediate work settings which will help the manager relate easily. This will also address the habit of bad mouthing and cribbing which some employees do against their managers within their peer group. This is a win-win situation and by being able to freely give feedback to his supervisor, the employee not only feels empowered, but also realizes that he is playing an important developmental role.

Lisa Mc. Querrey (2017) explained in her study that employee evaluations are common place in most small business environments, giving supervisors the chance to provide feedback to staffers about performance issues. Reverse evaluations turn the tables and let employees rate their managers. This can be a useful way to gather data about how well your supervisors are doing their jobs. Supervisors should be evaluated on criteria that relates to how they interact with their supervisees.

To date, there has not been a focused study which applied measures and metrics directly related to the reverse performance appraisal in measuring the usefulness of the reverse performance appraisal process in the private industry. It is an established fact that, scoring techniques as well as simulations techniques have some shortcomings such as inability to incorporate ambiguity and multi-possibility that goes with mapping people's decisions to numbers, and subjectivity in judgments and individual preferences of evaluators.

Research Methodology

Thus, experts' perceptions which are characterized by subjectivity require fuzzy logic for assessment. On this ground, linguistics approximation and fuzzy arithmetic have been applied to achieve this purpose.

Fuzzy set concept

Fuzzy set theory which was first presented by Zadeh (1978) is applied in the representation of human reasoning. Fuzzy logic is a superset of conventional logic that has been extended to represent the concept of partial truth (Ordoobadi, 2008). It is described as a problem solving methodology which provides definite conclusions from imprecise, vague and uncertain information (Dweiri and Kablan, 2006; Alex, 2007). This fuzzy concept is anchored on the fact that, human reasoning is based on knowledge and concepts which do not conform to well-defined boundaries (Kumar and Ravi, 2007). Thus, fuzzy logic uses its ability to generate precise solutions from certain approximate information for solving problems in engineering and operations management which could not be solved using purely mathematical and logic-based approaches in system design.

Fuzzy logic is basically a multi-value logic which permits intermediate values to be defined between conventional ones like true/false, low/high, good/bad, etc. It is an established fact that, as the complexities surrounding a system increase, making a precise statement about the state of the system becomes very difficult. This complexity can only be best handled by applying the fuzzy logic method inherent in human beings. This is supported by Zadeh's (1978) assertion that, as the complexities of a system increase, precision of our knowledge about the system decreases, until a stage is attained at which the precision and significance become mutually exclusive. Thus, fuzzy decision making involves a process of selecting one or more alternatives or solutions from a finite set of alternatives which suits a set of constraints (Ganesh, 2006; Lin et al., 2006). Fuzzy logic provides Olugu and Wong 1641 mathematical strengths to capture the uncertainties associated with human cognitive and judgmental processes, such as thinking and reasoning (Zadeh, 1978). Therefore, it provides an inference mechanism that enables approximate human reasoning capabilities to be applied to knowledge-based systems (Alex, 2007; Ordoobadi,2008).

Fuzzy numbers

The concept of fuzzy set is an extension of the concept of crisp set. A fuzzy set is used to express a collection of elements in a universe of data in which the boundary of the set within the universe is vague, imprecise and ambiguous (Ganesh, 2006; Lin et al., 2006). Every fuzzy set is specified by a membership function of each of its elements in the universe of discourse with values ranging within the unit interval of [0,1]. The value 0 is used to represent non-membership, while the value 1 implies complete membership and those between 0 and 1 are the intermediate degrees of membership. Thus, a fuzzy set is defined by its membership function. Let *X* be a set of items, known as the universe, and its elements are denoted by *x*.

Therefore, a fuzzy subset *A* in *X* is characterized by a membership function *fA(x)* which is associated with each element *x* in *A* and a real number in the interval [0,1]. The membership function *fA(x)* maps each element *x* to a membership value between 0 and 1, and this value represents the level of membership of *x* in *A*. A fuzzy subset *A* is called a fuzzy real number. There are various fuzzy number categories that can be applied in representing imprecise information. Some of them are triangular, trapezoidal, etc (Cox, 1994; Ganesh, 2006). In this study, the triangular fuzzy is applied as it is the most suitable and convenient (Zadeh, 1978; Lin et al., 2006).Let $x, a, b, c \in R$, where R is a real number. Based on his definition, a triangular fuzzy is represented as a fuzzy number *A* in *R*, if its membership function $f_A: R \rightarrow [0,1]$ is

$$f_A(x) = \begin{cases} \frac{x-a}{b-a}, & a \le x \le b, \\ \frac{c-x}{c-b}, & b \le x \le c \\ 0, & otherwise \end{cases} \qquad (1)$$

Hence, the triangular fuzzy number is represented as *A* = (*a*,*b*,*c*) , where the lower and upper limits of the area for data evaluation are represented by *a* and *c* respectively. The peak grade is represented by *b*, which is the full membership value. Thus, $f_A(b) = 1$, Triangular fuzzy numbers have been the most applied mainly because they are easily specified by experts.

Table 1 Fuzzy numbers for estimating the linguistic variable values

Importance wright		Performance Factor Rating	
Linguistic Variable	Fuzzy Numbers	Linguistic Variable	Fuzzy Numbers
Low	**(0.0,0.2,0.4)**	**Unable to Evaluate**	**(0,2,4)**
Moderate	**(0.3,0.5,0.7)**	**Needs Improvement**	**(3,5,7)**
High	**(0.5,0.7,0.9)**	**Performs Well**	**(5,7,9)**
Highest	**(0.6,0.8,1.0)**	**Performs Very well**	**(6,8,10)**

Fuzzy arithmetic operators

The arithmetic operators applied in fuzzy sets are synonymous to those used in regular statistical operations (Ordoobadi, 2008; Ganesh, 2006; Lin et al.,2006). Assuming that two triangular fuzzy numbers are represented by X and Y, such that$X = (a_1,b_1,c_1)$ and$Y = (a_2,b_2,c_2)$. The triangular fuzzy number arithmetic operations for X and Y using the extension principle are presented in Equations 2 and 3. According to the extension principle, the classical results of Boolean logic are recovered from fuzzy logic operations, when all fuzzy membership grades are restricted to the conventional set {0,1}. Thus, fuzzy sets and logic are true generalization of classical set theory and logic

$$X \oplus Y = (a_1, b_1, c_1) \oplus (a_2, b_2, c_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2) \quad (2)$$

$$X \otimes Y = (a_1, b_1, c_1) \otimes (a_2, b_2, c_2) = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2) \quad (3)$$

Linguistic variables

Since fuzzy sets are usually aimed at modeling cognitive states of human beings, their determinations are based on certain prescriptions rather than precise numbers. This is because a direct determination of vague scores indicators is virtually impractical for experts. The truth of a statement in fuzzy logic is considered to be a matter of degree, which can be viewed as a generalization of the Boolean logic (Ganesh, 2006; Alex, 2007).Therefore, it offers tools to operate with vaguely defined parameters or concepts. In order to achieve these prescriptions, natural languages are used to convey the degree of imprecision and these are the linguistic variables (Ganesh, 2006; Efendigil et al., 2008). Such variables are in the form of very low, low, medium, high, very high etc. According to Lin et al. (2006), it is suggested that linguistic levels should be limited to nine levels, as this is the limit of human absolute discrimination.

Fuzzy membership functions are defined for the assessment of the importance of weight and performance factor rating. The former is represented by 4 membership functions for the possible data domain which are low, moderate, high and highest while the latter is also represented by 4 membership functions which are Unable to Evaluate, Needs improvement, Performs well and Performs very well as shown in Figures 1 and 2.

Fuzzy logic based evaluation for reverse performance appraisal

The measures and their corresponding metrics for the reverse performance evaluation in the private industry are adopted from Olugu et al. (2010b). These measures are Performs very well (PVW); Performs well (PW); Needs Improvement (NI); Unable to Evaluate (UE).

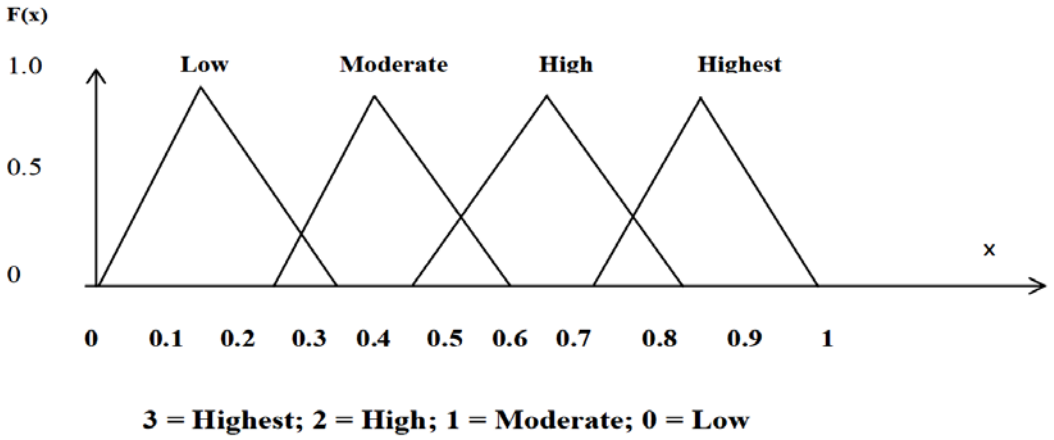

Figure 1.Linguistic importance scale.

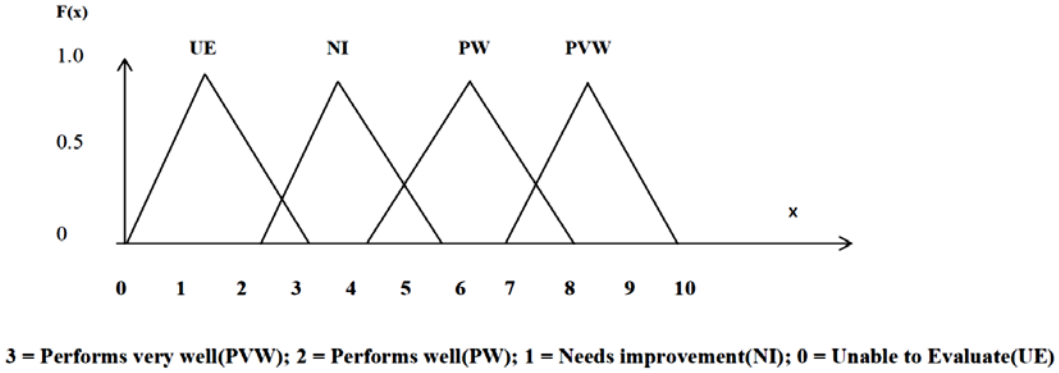

Fig.2 Linguistic performance scale

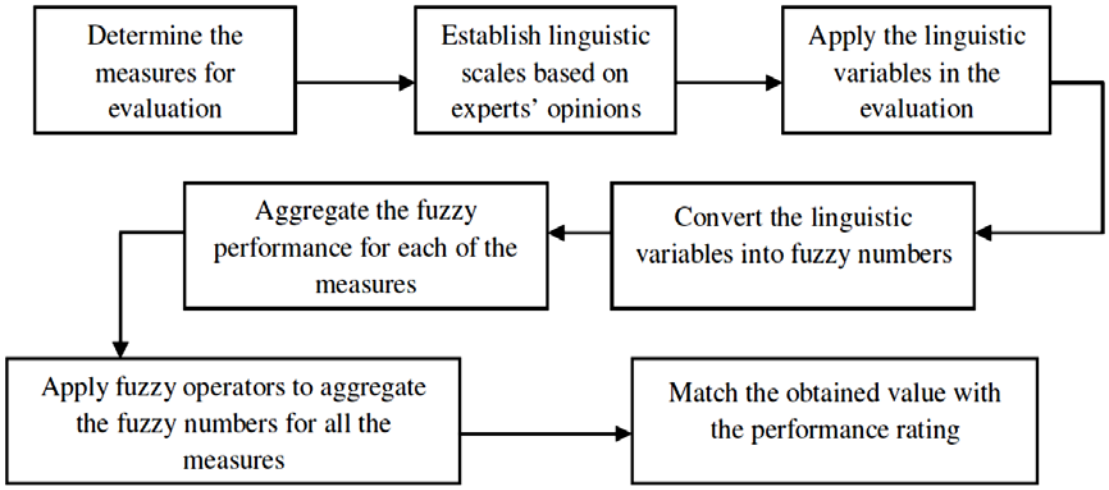

Fig.3 Methodology for the performance evaluation

All the measures are assessed based on their individual metrics which are used in quantifying them. The importance weights of each of the measures and their performance factor

ratings will be synthesized to obtain the overall performance. The measurement methodology (as shown in Figure 3) is described in the ensuing steps:

1. Determine the measures for performance evaluation.
2. Establish the suitable linguistic scales upon which the importance weight and performance rating will be based on, using industrial experts' opinions.
3. Apply the linguistic variables in evaluating the importance weight and performance rating of the metrics for each of the measures.
4. Convert the linguistic variables into fuzzy numbers for the importance weight and performance factor rating respectively (as presented in Table 1) based on the outcome for each metric.
5. Aggregate the fuzzy performance for each of the measures by multiplying the fuzzy performance numbers with the fuzzy importance numbers for each of the metrics and dividing by their cumulative fuzzy importance numbers.
6. Repeat step (5) for each of the measures and apply fuzzy operators to aggregate all the obtained fuzzy numbers for all the measures.
7. Match the obtained value with the performance rating to determine the overall performance level.

Table 2 Measures and their metrics for reverse logistics performance evaluation

Metrics / Measures	**1**	**2**	**3**
Performs very well(PVW)	**Took bold decisions**	**Guides properly**	**Approves all claim**
Performs well(PW)	**Took decisions occasionally**	**Guidance is delayed**	**Delay claim clearance**
Needs improvement(NI)	**Poor in decision making**	**Poor guidance**	**Stops claim for no reason**
Unable to Evaluate(UE)	**Vague Decision**	**Unclear guidance**	**Poor understanding of claims**

A case study

Here, a case study is used to illustrate the application of the proposed fuzzy logic approach in measuring the usefulness of the reverse performance appraisal process of an private company

Chhattisgarh. Data were collected from the company using a score sheet. The score sheet used linguistic variables which were Performs very well; Performs well; needs improvement and Unable to Evaluate as the measurement scales for the reverse performance.

The first stage of assessment involved the determination of the measures for evaluation. Based on the measures adopted in this study, the company was assessed according to its reverse performance on each of the measures which were Performs very well; Performs well; needs improvement and Unable to evaluate. These measures and their corresponding metrics as adopted are described subsequently and presented in Table 2.

Results

In the second stage, the subordinates were consulted to give their perceptions on the performance of the metrics based on the actual achievement of the seniors/superiors of company, using linguistic variables (Performs very well; Performs well; needs improvement and Unable to evaluate). The importance weights and performance factor ratings are summarized in Table 3. In the next stage, the linguistic variables were converted into fuzzy numbers based on the linguistic scales presented in Table 1, for both the importance weight and performance rating respectively. Subsequently, the aggregation of the fuzzy importance numbers and fuzzy performance numbers of the metrics to achieve the performance for a particular measure was carried out. This was done such that,

$$P_M = \sum_{k=1}^{n}(W_m \otimes R_m) \,/\, \sum_{k=1}^{n}(W_m) \qquad (4)$$

Where, P_M is the performance of a measure, W_m and R_m are the fuzzy importance number and fuzzy performance number of the metrics respectively, and n is the number of metrics. The next stage involved the application of fuzzy operators on the performance of each measure to determine the performance of the reverse logistics process. Therefore,

$$P_{RL} = \sum_{k=1}^{n}(W \otimes P_m) \,/\, \sum_{k=1}^{n}(W) \qquad (5)$$

Where, P_{RL} is the usefulness of reverse performance appraisal process, W and P_M are the fuzzy importance number and performance of each of the measures respectively, and n is the number of measures. The final stage involved matching the P_{RL} value with the appropriate performance level using the Euclidean distance method. Based on the information presented in Table 3, each of the measures was evaluated as a product of the fuzzy importance numbers and performance numbers of their metrics. Thus:

$$P_{M(PVW)} = \frac{(0.5,0.7,0.9)(3,5,7)*(0.5,0.7,0.9)(0,2,4)*(0.3,0.5,0.7)(0,2,4)}{(0.5,0.7,0.9)*(0.5,0.7,0.9)*(0.3,0.5,0.7)} \qquad (6)$$

Therefore,

$$P_{M(PVW)} = \frac{(1.2,3.4,6)*(0.5,1.7,0.9)*(0.3,2,7)}{(1.1,2.2,3.1)} = \frac{(1.9,7.1,13.6)}{(1.1,2.2,3.1)} = (1.7,3.2,5.12) \qquad (7)$$

Similarly,

$P_{M(PVW)}^{=}$ **(1.7,3.2,5.12),** $P_{M(PW)}^{=}$ **(.78,3.1,4.92),** $P_{M(NI)}^{=}$ **(.2,2.3,4.24),** $P_{M(UE)}^{=}$ **(3,5,7,)**

Since the performance values for each of the measures have been obtained, the next step involved aggregating these values with their fuzzy importance numbers to obtain the performance of the reverse logistics operation. Thus,

$P_{RL}^{=}$ (1.82, 3.86, 5.99)

Table 3 The obtained measurement grades for the company.

Measures	Metrics	Importance(measures)	Importance(metrics)	Performance factor Rating
PVW	PVW1	High	High	Needs improvement
	PVW2		High	Unable to Evaluate
	PVW3		Moderate	Unable to Evaluate
PW	PW1	Moderate	High	Unable to Evaluate
	PW2		Moderate	Unable to Evaluate
	PW3		Moderate	Needs improvement
NI	NI1	Low	Low	Performs well
	NI2		Moderate	Needs improvement
	NI3		High	Needs improvement
UE	UE1	Highest	Highest	Performs very well
	UE2		Moderate	Performs well
	UI3		High	Needs improvement

Finally, the P_{RL} value was matched with the appropriate performance level in order to deduce the suitable linguistic variable. The Euclidean distance method was adopted, since it is known to be the best approximation of human reasoning (Lin et al., 2006). Figure 4 represents the mapping using Euclidean distance. Mathematically, this distance was evaluated from a given fuzzy number to each of the fuzzy numbers representing the performance level (Lin et al., 2006). If the fuzzy performance is expressed as P_{RL}, and the performance linguistic variable is expressed as *LV(linguistic variable)*, then UP_{RL} and *ULV* represent their respective fuzzy numbers. The Euclidean distance between P_{RL} and *LV* was thus calculated using Equation 8.

$$D(P_{RL}, LV_{NI}) = \sqrt{\{\sum_{rep}(U_{RL}(x) - U_{LV}(x))^2} \quad (8)$$

Where,

$$p = \{x_0, x_1, \ldots . x_n\} \subset [1,10]$$

The distance from P_{RL} to each *LV* was evaluated and the lowest *LV* value having the smallest distance was identified.

$$For\ LV_{NI} = (0.2,4)$$

$$D(P_{RL}, LV_{NI}) = \sqrt{(1.82 - 0)^2 + (3.86 - 2)^2 + (5.99 - 4)^2}$$

$$= \sqrt{3.3124 + 3.4596 + 3.9601}$$

$$= \sqrt{10.7321}$$

$$= 3.2760$$

Similarly,

$$For, \qquad LV_{pw} = (5,7,9) = 6.9875$$

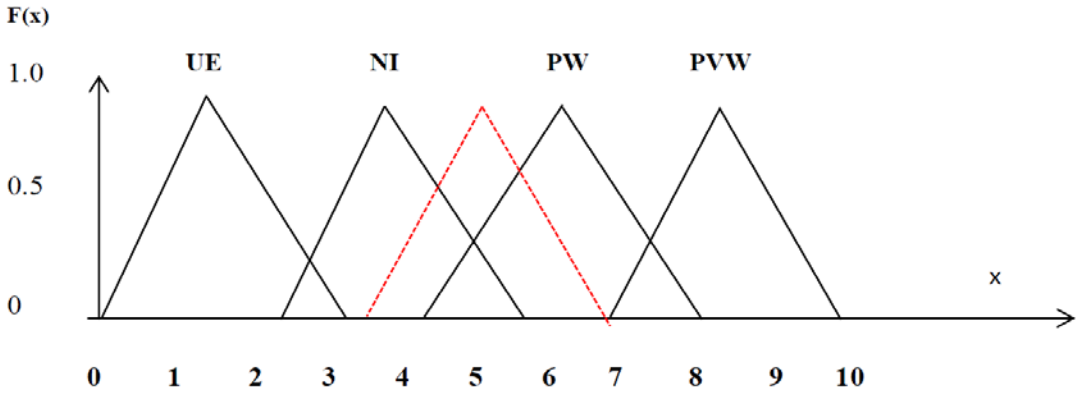

Fig.4 Mapping of the result

Discussion

This study has demonstrated how to evaluate the usefulness of the reverse performance appraisal process of the private industry. Due to the fact that conventional performance evaluation methods will not be appropriate for this kind of evaluation which is characterized by vagueness and complexities (Lin et al., 2006; Alex, 2007), fuzzy logic method has been adopted. The fuzzy methodology employed linguistic approximation and fuzzy arithmetic. Hence, it can be seen from the result that, the reverse performance of the company is somewhat "Needs Improvement (NI)". This is because LV_{NI} has the least distance from the fuzzy performance, P_{RL}. This implies that the company should put more effort in this area. This goes to support the assertion that, the success of a reverse performance appraisal requires the joint effort of the company's top management, subordinates and workers. Motivation could be in the form of incentives. To improve management performance, the company could arrange training programs.

Conclusions

The reverse performance appraisal process presents the possibility of disgruntled subordinates giving vengeful appraisals. For this reason, executives should be careful not to assign too much weight to one or more appraisals. However when several subordinates point out similar concerns it should cue the executive to take corrective actions. It is also seen that reverse performance appraisal process is very time consuming and can be taken negatively by managers and supervisors. But as the scenario of business houses is changing so the performance appraisal system

also needed to be changed. Traditionally the performance appraisal was done by superiors to evaluate the performance of their subordinates but nowadays the concept of performance appraisal has been changed totally. Today subordinates also want to give feedback about the performance of their supervisors/ managers. As it will help the employees to create a better understanding of each other to work as a team.

The reverse performance evaluation methodology involves defining the criteria for evaluation, selecting the suitable linguistic variables based on experts' opinions, applying the linguistic variables in the evaluation, converting them into fuzzy numbers, aggregating the fuzzy performance, and subsequently matching the obtained value with the performance level. Future research could be directed towards implementing this methodology into a computer based program which allows the evaluation of the reverse performance appraisal of an organization with less time and enhanced accuracy. This program can be built with 'if then rules" which shall be based on experts' opinions. In this manner, their opinions will represent the industry standards.

References

1. https://smallbusiness.chron.com/reverse-performance-evaluation
2. https://www.mediabistro.com/employer/blog/best-practices/develop-better-talent-reverse-performance-reviews
3. Mark lerner(may 2017), Develop better talent with Reverse Performance Reviews, https://www.mediabistro.com/employer/blog/best-practices/develop-better-talent-reverse-performance-reviews.
4. Ankur Poddar (2013), the power of reverse feedback- a tool or an art, https://www.peoplematters.in/blog/employee-engagement/the-power-of-reverse-feedback-a-tool-and-an-art
5. Human Resource Management by Biswajeet Patnayak, 3rd edition, 2005
6. Decision support system for the intelligent identification of Alzheimer using neuro Fuzzy Logic International Journal for Soft Computing(IJSC) -Vol.2 NO.2 May-2011
7. Fuzzy Approach to Critical Bus Ranking under Normal and Line outage contingencies (IJSC) International Journal for Soft Computing(IJSC) -Vol.2 NO.1 ,Feb 2011
8. Evolving Rules using Genetic fuzzy Approach to an educational case-study International Journal for Soft Computing(IJSC) -Vol.2 NO.2 ,Feb 2011
9. Fuzzy decision based soft multi-agent controller for speed controller for three phase induction motor International Journal for Soft Computing(IJSC) -Vol.2 NO.3 ,AUG 2011

10. Moon, C., Lee, J., Jeong, C., Lee, J., Park, S. and Lim, S. (2007), "An Implementation Case for the Performance Appraisal and Promotion Ranking", in IEEE International Conference on System, Man and Cybernetics, 2007.
11. Adnan, S. and Minwir, A. (1998), "Fuzzy Logic Modeling for Performance Appraisal Systems – A Framework for Empirical Evaluation", Expert Systems with Applications, Vol. 14, No. 3, p. 323-328.
12. Khairul, A. R and Qiang, S. (2006), "Data-Driven Fuzzy Rule Generation and Its Application for Student Academic Performance Evaluation", Applied Intelligence, Vol. 25, Issue. 3. p. 305-319.
13. Ab. Aziz Yusof.(2003), Performance Appraisal Issues, Challenges & Prospects, Pearson.
14. Dessler, G. (2000), Human Resource Management (8th Edition), New Jersey, Pearson Education, Inc.
15. Terrence, H. M. and Joyce, M. (2004), Performance Appraisals, ABA Labor and Employment Law Section, Equal Employment Opportunity Committee.
16. Vicky, G. (2002), Performance Appraisals, Loss Control Services, Texas Association of Counties.
17. Jing, R.C, Cheng, C. H. and Chen, L. S. (2007), "A Fuzzy-Based Military Officer Performance Appraisal System", Applied Soft Computing, Vol. 7, Issue. 3, p. 936-945.
18. Autry CW (2005). Formalization of reverse logistics programs: a strategy for managing liberalized returns. Ind. Market. Manage, 34(7): 749-757.
19. Alex R (2007). Fuzzy point estimation and its application on fuzzy supply chain analysis. Fuzzy Set Syst., 158(14): 1571-1587.
20. Biehl M, Prater E, Realff MJ (2007). Assessing performance and uncertainty in developing carpet reverse logistics systems. Comput. Oper. Res., 34(2): 443-463.
21. Cox E (1994). The Fuzzy Systems Handbook: A Practitioner's Guide to Building, Using and Maintaining Fuzzy Systems. USA AP Professional, pp. 436-447.
22. Cruz-Rivera R, Ertel J (2009). Reverse logistics network design for the collection of end-of-life vehicles in Mexico. Eur. J. Oper. Res., 196(3): 930-939.
23. Dweiri FT, Kablan MM (2006). Using fuzzy decision making for the evaluation of the project management internal efficiency. Decis. Support Syst., 42(1): 712-726.
24. Dyckhoff H, Souren R, Keilen J (2004). The expansion of supply chains to close loop systems: a conceptual framework and the automotive industry's point of view. In Dyckhoff et al (eds) Supply chain management and reverse logistics, Springer Verlag, Berlin, pp. 13-34.

25. Efendigil T, Onut S, Kongar E (2008). A holistic approach for selecting a third-party reverse logistics provider in the presence of vagueness. Comput. Ind. Eng., 54(2): 269-287.
26. El-Sayed M, Afi N, El-Khabotly AA (2008).A stochastic model for forward–reverse logistics network design under risk, Comput. Ind. Eng., 58(3): 423-431.
27. Ganesh M (2006). Introduction to Fuzzy Sets and Fuzzy Logic, India Prentice-Hall, pp. 85-166.
28. Gonza´lez-Torre PL, Adenso-Dı´az B (2006). Reverse logistics practices in the glass sector in Spain and Belgium. Int. Bus. Rev., 15(1): 527-546.
29. Hamner B (2006). Effects of green purchasing strategies on supplier behavior. In Sarkis J (ed) Greening the supply chain, Springer Verlag, London, pp. 25-37.
30. Helms MM, Hervani AA (2006). Reverse logistics for recycling: challenges facing the carpet industry. In Sarkis (ed) Greening the supply chain, Springer Verlag, London, pp. 117-135.
31. Hernández CT, Marins FAS, da Rocha PM (2009). Using AHP and ANP to evaluate the relation between reverse logistics and corporate performance in Brazilian automotive industry. Proceeding of Proceedings of the 10th International Symposium on the Analytic Hierarchy/Network Process Multi-criteria Decision Making held at Pennsylvania, USA, July 29 - August 1 2009.
32. Ilgin MA, Gupta SM (2010). Environmentally conscious manufacturing and product recovery (ECMPRO): a review of the state of the art. J. Environ. Manage., 91(3): 563-591.
33. Johnson PF (1998). Managing value in reverse logistics systems, Transp. Res. Part E: Logist. Transp. Rev., 34(3): 217-227.
34. Kara S, Rugrungruang F, Kaebernick H (2007). Simulation modeling of reverse logistics networks. Int. J. Prod. Econ., 106(1): 61-69.
35. Kumar PR, Ravi V (2007). Bankruptcy prediction in banks and firms via statistical and intelligent techniques: a review. Eur. J. Oper. Res., 180(1): 1-28.
36. Kumar S, Putnam V (2009). Cradle to cradle: reverse logistics strategies and opportunities across three industry sectors. Int. J. Prod. Econ., 115(2): 305-315.
37. Lee D, Dong M (2009).Dynamic network design for reverse logistics operations under uncertainty. Transp. Res. Part E: Logist. Transp. Rev., 45(3): 61-71.
38. Lee JE, Gen M, Rhee KG (2009). Network model and optimization of reverse logistics by hybrid genetic algorithm.Comput. Ind. Eng., 56(3): 951-964.
39. Lin CT, Chiu H, Tseng YH (2006). Agility evaluation using fuzzy logic.Int. J. Prod. Econ., 101(2): 353-368.

40. Lin CT, Chiu H, Chu P. (2006).Agility index in the supply chain. Int. J. Prod. Econ., 100 (2): 285-299.
41. Mezher T, Ajam M (2006). Integrating quality, environmental and supply chain management systems into the learning organization. In: SarkisJ (ed) Greening the supply chain, Springer Verlag, London, pp.67- 86.
42. Nunes KRA, Mahler CF, Valle RA (2009). Reverse logistics in the Brazilian construction industry. J. Environ Manage., 90(1): 3717- 3720.
43. Olugu EU, Wong KY, Shaharoun AM (2010a). A comprehensive approach in assessing the performance of an automobile closed-loop supply chain. Sustainability, 2: 871-889.
44. Olugu EU, Wong KY, Shaharoun, MA (2010b). Development of key performance measures for the automobile green supply chain. Resour. Conserv. Recy. doi:10.1016/j.resconrec.2010.06.003.
45. Ordoobadi SM (2008). Fuzzy logic and evaluation of advanced technologies. Ind. Manage. Data Syst., 108(7): 928-946.
46. Pokharel S, Mutha A (2009). Perspectives in reverse logistics: a review. *Resourc, Conserv.* Recy., 53(4): 175-182.
47. Ravi V, Shankar R (2005).Analysis of interactions among the barriers of reverse logistics. Techn. Forecast Soc. Change, 72(1): 1011-1029.
48. Ravi V, Shankara R, Tiwarib MK (2005). Analyzing alternatives in reverse logistics for end-of-life computers: ANP and balanced scorecard approach. Comput. Ind. Eng., 48(1): 327-356.
49. Sheu J (2008). Green supply chain management, reverse logistics and nuclear power generation, Transport. Res Part E: Logist Transport Rev., 44(1): 19-46.
50. Mehmed, K. (2003), Data Mining Concepts, Models, Methods, and Algorithms, Wiley-Interscience.
51. Tutmez, B., Kahraman, S. and Gunaydin, O. (2006), “Multifactorial Fuzzy Approach to the Sawability Classification of Building Stones”,Construction and Building Materials, Vol.21, Issue 8, p. 1672-1679.
52. Emma, B. and Bryman, A. (2003), Business Research Methods. US:Oxford University Press.
53. World Academy of Science, Engineering and Technology 53 2009 C. C. Yee, and Y.Y.Chen
54. Brett, J. (2006) "360 Degree Feedback to Leaders." Group and Organization Management 31 578-600.

55. Doolittle, P. (1994). Teacher Portfolio Assessment. Washington, DC, ERIC/AEDigest, The Catholic University of America, Department of Education.
56. Fuzzy Logic with Engineering Applications By Timothy J. Ross
57. C. H. Chiu, W. J. Wang, A simple computation of MIN and MAX operations for fuzzy numbers, Fuzzy Sets and Systems 126 (2002) 273-276.
58. Fuzzy Logic - Lotfi A. Zadeh, Berkeley
59. Data Mining: Concepts, Models, Methods, and Algorithms (Mehmed Kantardzic)
60. Novack, Kenneth, M. 360 degree feedback: The whole Story. Training and development, January 1993, pg. 69-72
61. Rao, T. V. Making 360 degree feedback work, Human Capital, August 1999
62. Sharma, Radha. 360 Degree feedback, Competency Mapping and Assessment Centers, New Delhi: Tata McGraw Hill, 2002.