CONTINUOUS PERFORMANCE EVALUATION OF EMPLOYEES USING AHP AND MODIFIED PUGH MATRIX METHOD: CONTRASTING WITH TOPSIS, PROMETHEE AND VIKOR

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ABSTRACT

Applications of the AHP for employee performance evaluation in organizations are widely discussed in the literature. Contemporary organizations are increasingly discarding the traditional periodic appraisal systems and moving towards a real-time continuous process of evaluation. The existing multi-criteria decision making method (MCDM)-based employee performance evaluations are not suitable for such continuous evaluations, due to the complexity of the MCDM method. The current appraisal system is notoriously difficult to administer which prevents organizations from using it as an ongoing evaluation. There is a need for a simple yet robust multi-criteria decision making method for continuous performance evaluation of employees (CPEE). In this article, a modified version of the Pugh Matrix Method (MPMM) is proposed as a robust outranking method. The MPMM in combination with the AHP can function as an effective tool for CPEE. The MPMM is compared with other established and popular methods including TOPISIS, PROMETHEE and VIKOR. A statistical comparison using correlation validates the evaluation by the MPMM. There appears to be no significant difference in the evaluation of the MPMM with the other MCDM methods. Owing to its robustness and ease of use, the MPMM can easily be adopted by organizations for CPEE. The managerial implications and agenda for future research are also discussed.

Keywords: continuous performance evaluation of employees; Modified Pugh Matrix Method; multi-criteria decision making; AHP; TOPSIS; PROMETHEE; VIKOR

1. Introduction

Many organizations use a formal Performance Appraisal System (PAS) to conduct periodic performance evaluations of their employees. The PAS is a comprehensive and confidential process where managers evaluate the performance of team members periodically (usually once a year). Unlike other organizational resources (such as machinery or finance) which undergo annual maintenance or audit, human resources need a continuous and ongoing process of performance evaluation. This continuous evaluation is needed because human resources (i.e., employees) are capable of being motivated and

Acknowledgements: The suggestions and comments offered by the anonymous reviewers helped to improve the quality of this paper. Their contributions are acknowledged.

have the potential to perform better with timely information related to their current performance (Boice & Kleiner, 1997; Jawahar, 2006). Therefore, there is a demand for a mechanism that facilitates continuous performance evaluation of employees (CPEE).

The existing performance appraisal using PAS has been criticized as being subjective. While subjectivity in the performance evaluation of employees cannot be completely avoided, it can be reduced by associating the performance ratings based on a series of subjective evaluations conducted at shorter intervals rather than a once a year evaluation. CPEE contributes a quantitative (objective) score and rank for each employee in a team and inputs this information into the existing PAS process. By performing CPEE, the annual evaluation can be broken down into smaller portions, each with its own objective output that provides a cumulative score for the performance of employee over the year.

There are various criteria that are used to comprehensively evaluate the performance of employees. A robust CPEE process should encapsulate all such criteria. Practitioners and academic researchers are encouraged to utilize a multi-criteria decision making (MCDM) method when evaluating employee performance. However, a gap exists in the research for MCDM methods specifically used for CPEE. In this article, a moderately used MCDM method, the Pugh Matrix Method (PMM), is proposed and demonstrated to be an effective tool for CPEE. The proposed method is compared with other popular methods including TOPSIS, PROMETHEE and VIKOR as a proof of concept to substantiate its robustness.

2. Background

One of the most active areas of management research for the past few decades is the performance evaluation of employees (Heidemeier & Moser, 2009; Pichler, 2012; Cerasoli et al., 2014; DeNisi & Murphy, 2017; Alves & Lourenco, 2023). The literature highlights issues related to the practice of annual performance appraisal, and a few of them can be effectively eliminated or reduced by decreasing the frequency of appraisal (Fisher, 1994; Ferratt et al., 1999; Pichler et al., 2020), making it a near continuous activity. Researchers have highlighted the compulsion and requirement of practicing a CPEE process rather than annual performance appraisal (Schraeder et al., 2007; Palaiologos et al., 2011; Rivera et al., 2021).

Despite researchers arguing for CPEE, there is not enough evidence of its practice in organizations. There are two possible reasons for this. First, performance evaluation of employees is considered an additional responsibility of a manager. Since the CPEE is not their primary responsibility, managers cannot be expected to spend a considerable amount of time and effort on it. Managers might consider CPEE as another PAS exercise, and since the annual PAS takes considerable time to execute and administrate (Aguinis et al., 2011), managers may avoid and/or put off the task of CPEE.

Second, although there are theoretical recommendations for CPEE, there is a lack of an operational framework for a formal CPEE. Managers conduct several informal methods of performance evaluation (Shekshina, 1998) with varying frequency (Hearty & Morley, 2000). However, such informal evaluations are highly subjective in nature, and also arbitrary and vague so that no useful information can be drawn from their implementation. The intent of this article is to present a CPEE process that is a formal,

periodic, cyclical, transparent and ongoing process with a certain amount of objectivity. The CPEE process should be simple enough so that the manager does not have to spend a lot of time and effort in its administration.

Various methods for the performance evaluation of employees have been practiced in industries, particularly since World War II (Wiese & Buckley, 1998). More recently, various MCDM methods have been increasingly practiced in industries for the purpose of performance evaluation of employees (Sreejith & Mathirajan, 2022).

The Analytical Hierarchy Process (AHP) and its variations have been extensively used for performance evaluation of employees (Agarwal & Raghav, 2023). During the last decade, other MCDM methods in combination with the AHP have been increasingly used (Giotopoulos et al., 2023). Outranking methods such as TOPSIS and PROMETHEE are almost always used in combination with the AHP. There is a dearth of literature on the application of MCDM methods for the process of CPEE. In this article, we attempt to develop a Modified Pugh Matrix Method (MPMM) for CPEE. For comparative understanding, three outranking methods (TOPSIS, PROMETHEE and VIKOR) are also investigated.

2.1 TOPSIS

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a popular MCDM method (Lai et al., 1994) that has been widely used in a plethora of decision making scenarios. TOPSIS and its variants (such as Fuzzy TOPSIS) are also used in employee performance evaluation (Derebew et al., 2021). This method ranks a set of alternatives against a given set of criteria. The top ranked alternative is the one closest to the positive ideal solution and farthest from the negative ideal solution. For a step by step explanation of TOPSIS, refer to Yoon and Kim (2017).

2.2 PROMETHEE

Preference Ranking Organization METHod for Enrichment of Evaluations (PROMETHEE) is another popular outranking method (Brans & Vincke, 1985). PROMETHEE conducts a pairwise comparison and builds positive and negative preference flows, from which a net preference flow is determined (Singh et al., 2021). PROMETHEE II offers a full ranking as opposed to PROMETHEE I. This method has found wide applications, including employee performance evaluation (Ishizaka & Pereira, 2016). Refer to Singh et al. (2021) for a comprehensive understanding of the PROMETHEE II method.

2.3 VIKOR

Vlsekriterijumsko KOmpromisno Rangiranje (VIKOR) is another outranking MCDM method used for multi-criteria optimization and the determination of a compromise solution (Opricovic & Tzeng, 2007). In VIKOR, the final solution (ranking) is determined based on relative performance or compromise from amongst the alternatives based on a given set of criteria. VIKOR has also been implemented in employee performance evaluation, along with other management decision scenarios (Krishnakumar et al., 2020). A detailed working of VIKOR is explained in Jahan et al. (2011).

2.4 Pugh Matrix Method (PMM)

The Pugh Matrix Method (PMM) is a decision matrix method developed by Stuart Pugh in the early 1980s (Pugh, 1981). The PMM was originally developed to facilitate concept selection in the design of mechanical equipment (Pugh, 1991). It is known for its ease of use and simple arithmetic methods to decide the best possible alternative, satisfying a given set of evaluation criteria (Burge, 2009). The PMM works on the principle of pairwise comparison, similar to many MCDM ranking methods. It generates a set of quantitative scores for all the alternatives being compared and the one with the highest arithmetic score outranks all other alternatives (Burge, 2009). Given the similarity in objective and its working principle, the PMM can be considered an outranking method.

3. Modified Pugh Matrix Method (MPMM) for CPEE

In all the MCDM methods used for performance evaluation of employees, the weights for the evaluation criteria are determined using the AHP or its variations (such as Fuzzy AHP). Similarly, in the proposed MPMM for CPEE, the weights for the criteria are determined using the AHP. Step-by-step details of the proposed MPMM for CPEE are detailed in Sreejith & Mathirajan (2022)

3.1 Numerical example to demonstrate the proposed MPMM for CPEE

Consider a hypothetical team of seven employees who are being evaluated under six evaluation criteria identified for the CPEE process (Sreejith & Mathirajan, 2020). The six criteria identified for the CPEE process are Proactive, Prompt, Responsible, Resourceful, Diagnostic and Dynamic. These criteria were obtained by conducting exploratory factor analysis among 26 latent variables that were identified from a study of 443 employees at Indian IT organizations. The latent variables under each of these criteria are listed in Table 1.

Table 1
Performance evaluation criteria and the corresponding variables

Proactive	**Prompt**	**Resourceful**	**Responsible**	**Diagnostic**	**Dynamic**
Updating professional knowledge	Timeline adherence	Understanding big picture	Additional responsibilities	Quality of the job	Customer Interaction
Initiative	Timely reporting	Ideas and suggestions	Knowledge sharing	Documentation	Communication
Self-learning	Process adherence	Creativity	Commitment	Analytical ability	Negotiation
Leadership	Punctuality	Cost saving	Teamwork	Reviewing	---
---	---	---	Mentoring	Presentation	---
---	---	---	Improving morale	---	---

Using the MPMM, the performance of the seven employees is calculated as follows:

Step 1.1: Determine the importance of indicators under each criteria using the AHP
The weights for each of the indicators (variables) listed under each criteria (refer to Table 1) are determined using the AHP. An example of the first criteria is shown in Table 2.

Table 2

Calculating the indicator weights for the criteria 'Proactive' using the AHP

	Updating professional knowledge	Initiative	Self-learning	Leadership	Normalized Weights
Updating professional knowledge	1	0.25	0.17	0.17	0.059
Initiative	4	1	2	1	0.342
Self-learning	6	0.5	1	0.5	0.229
Leadership	6	1	2	1	0.370

The pairwise comparison in Table 2 results in a consistency ratio of 0.043. This is below the maximum permissible limit of 0.1 (Donegan et al., 1992) and is therefore acceptable. Similarly, the indicator weights of all the other five criteria can also be determined using the AHP.

Step 1.2: Determine the importance of each of the evaluation criteria using the AHP
The weights for the evaluation criteria are determined using the AHP. The normalized weights are shown in Table 3.

Table 3
Calculating the criteria weights using the AHP

	Proactive	Prompt	Responsible	Resource-ful	Diagnostic	Dynamic	Normalized Weights
Proactive	1	0.33	0.5	1	4	2	0.1334
Prompt	3	1	2	3	7	7	0.3896
Responsible	2	0.50	1	2	3	5	0.2266
Resourceful	1	0.33	0.50	1	5	3	0.1501
Diagnostic	0.25	0.14	0.33	0.20	1	1	0.0479
Dynamic	0.50	0.14	0.20	0.33	1	1	0.0517

The principal eigen value is 6.141. For a random index of 1.24, the consistency ratio for the pairwise comparison in Table 3 is 0.023.

Step 2: Evaluate the employees based on the evaluation criteria using the MPMM
After the criteria weights are calculated, the seven employees are compared using the MPMM with one employee as the baseline on a scale of -2 (much worse than) to +2

(much better than) for each criterion. For the purpose of demonstration, the first employee, Lisa, is considered as the baseline. The performance of Lisa for all six criteria is considered as zero. The performance of all other six employees is compared with that of Lisa against each criterion. For example, the next employee, Felica, is as good as Lisa for the Proactive criterion, and hence obtains a score of zero. Similarly, Felica is slightly more prompt than Lisa and scores +1 for that criterion; however, Felica is much worse in the Responsible criterion than Lisa and scores -2, and so on. A similar pairwise evaluation is conducted for all six employees using Lisa as the baseline. Table 4 shows the first stage of the evaluation using Lisa as the baseline.

Table 4
Performance evaluation of employees using MPMM with one employee as baseline

	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic
Weight	0.1334	0.3896	0.2266	0.1501	0.0479	0.0517
Lisa*	0	0	0	0	0	0
Felica	0	1	-2	2	-1	0
Eliana	-2	-1	1	0	1	-1
Brad	2	1	-1	1	1	0
Sherill	-1	-1	0	-1	0	2
Shena	2	0	-1	2	1	1
Gerard	2	0	2	-1	-2	0

* baseline

Step 3: Determine the performance score for each employee

Once the pairwise evaluation using the extended evaluation scale is completed with one employee as the baseline, the performance score for all employees needs to be calculated. The performance score for each employee is obtained by determining the sum of the product of the criteria weights with the score for the respective criteria, for each employee. The normalized performance score for all seven employees is shown in Table 5.

Table 5
Performance evaluation of employees using the MPMM with one employee as baseline*

	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic	Score	Normalized score
Weight	0.1334	0.3896	0.2266	0.1501	0.0479	0.0517		
Lisa*	0	0	0	0	0	0	0	0
Felica	0	1	-2	2	-1	0	0.189	0.259
Eliana	-2	-1	1	0	1	-1	-0.434	-0.596
Brad	2	1	-1	1	1	0	0.628	0.863
Sherill	-1	-1	0	-1	0	2	-0.570	-0.783
Shena	2	0	-1	2	1	1	0.440	0.605
Gerard	2	0	2	-1	-2	0	0.474	0.652

Step 4: Determine the mean performance score for each employee

As observed in Table 5, the baseline employee (Lisa) has a normalized performance score of zero. In the proposed MPMM, all employees are selected as baseline one at a time and scores are calculated for each employee during each rotation. In this example, seven tables, similar to Table 5, would be created each with a resultant column vector indicating the normalized performance score. After the last employee (Gerard in this case) is considered as the baseline, there would be seven column vectors representing the normalized performance score.

The normalized performance of baseline employees in each of these seven column vectors will be zero. These vectors are combined to form a 7x7 matrix, with diagonal elements as zero. This 7x7 matrix is shown in Table 6. From this matrix, the mean performance score for each employee is calculated. The matrix with the performance score for all seven employees and their corresponding mean score is shown in Table 6.

Table 6
Normalized performance score matrix for all employees and the final rank

	Lisa	Felica	Eliana	Brad	Sherill	Shena	Gerard	Mean (Global Weight)	Rank
Lisa	0.000	-0.189	0.434	-0.628	0.570	-0.440	-0.474	-0.104	4
Felica	0.189	0.000	-0.561	-1.248	0.438	0.169	-0.306	-0.188	6
Eliana	-0.434	0.561	0.000	-0.937	0.597	-0.121	-0.756	-0.156	5
Brad	0.628	1.248	0.937	0.000	1.312	0.330	0.237	0.670	1
Sherill	-0.570	-0.438	-0.597	-1.312	0.000	-0.310	-0.946	-0.596	7
Shena	0.440	-0.169	0.121	-0.330	0.310	0.000	-0.254	0.017	3
Gerard	0.474	0.306	0.756	-0.237	0.946	0.254	0.000	0.357	2

The mean score shown in Table 6 is the final performance score for all seven employees obtained using the MPMM for one cycle of CPEE. It can be noted from Table 6 that Brad has the highest mean score while Sherill has the lowest mean score. This score indicates the relative level of performance of the employees in the team considering the six evaluation criteria. The top scorer(s) based on the MPMM evaluation could be shown appreciation such as an appropriate reward or recognition as motivation for the employee as well to encourage others in the team to perform better.

The MPMM evaluation results in the following rank order:
Brad> Gerard> Shena> Lisa> Eliana> Felica> Sherill

4. Evaluation using TOPSIS, PROMOTHEE and VIKOR

There is an abundance of literature that demonstrates employee performance evaluation using popular outranking methods such as TOPSIS, PROMETHEE and VIKOR. The proposed MCDM method can be compared against other outranking methods to examine its validity. This is demonstrated in the numerical example by utilizing the MPMM for ranking employees and then comparing the results with other methods. For a comparative analysis, we use the same evaluation with TOPSIS, PROMETHEE and VIKOR. The criteria weights are from Table 3 and the evaluations are based on Table 4. While the MPMM method uses an interval scale, the other MCDM methods discussed here use a ratio scale for the same data. A ratio scale contains an absolute starting point (zero in this case). Table 3 is repeated with an equivalent ratio scale and shown in Table 7.

Table 7
Performance ratings of employees on an absolute scale (rescaled from Table 4)

	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic
Weight	0.1334	0.3896	0.2266	0.1501	0.0479	0.0517
Lisa	3	3	3	3	3	3
Felica	3	4	1	5	2	3
Eliana	1	2	4	3	4	2
Brad	5	4	2	4	4	3
Sherill	2	2	3	2	3	5
Shena	5	3	2	5	4	4
Gerard	5	3	5	2	1	3

4.1 Evaluation using TOPSIS

Based on the normalized and weighted performance of employees in each criteria, the highest value in each column vector is identified as the positive ideal (PI) and negative ideal (NI) as shown in Table 8.

Table 8
Positive ideal and negative ideas for each criterion

	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic
PI (X_j^+)	0.14	0.34	0.25	0.15	0.04	0.05
NI (X_j^-)	0.03	0.17	0.05	0.06	0.01	0.02

The corresponding positive (S+) and negative (S-) values are identified as the global weights (S*) and are determined using the following formula:

The preference (global weight):

$$S^* = \frac{S_i^-}{S_i^+ + S_i^-}$$

where,

$$S_i^+ = \left[\sum_{j=1}^{m} \left(X_{ij} - X_j^+\right)^2\right]^{1/2}$$

$$S_i^- = \left[\sum_{j=1}^{m} \left(X_{ij} - X_j^-\right)^2\right]^{1/2}$$

For this, the employees are ranked in descending order as shown in Table 9.

Table 9
Global weights and ranks of employees based on TOPSIS

Employee Name	Positive Ideal [$S^{+]}$	Negative Ideal [S^-]	Global weight S*	Rank
Lisa	0.155	0.148	0.489	5
Felica	0.209	0.202	0.491	4
Eliana	0.219	0.159	0.421	6
Brad	0.152	0.219	0.590	2
Sherill	0.232	0.112	0.326	7
Shena	0.171	0.177	0.508	3
Gerard	0.128	0.245	0.658	1

The TOPSIS evaluation resulted in the following rank order:
Gerard> Brad> Shena> Felica> Lisa> Eliana> Sherill

4.2 Evaluation using PROMETHEE

From Table 7, the cell values are normalized (see Table 10) based on the following equation:

$$R_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}$$

Table 10
Normalized employee ratings using PROMETHEE

	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic
Weight	0.1334	0.3896	0.2266	0.1501	0.0479	0.0517
Lisa	0.50	0.50	0.50	0.33	0.67	0.33
Felica	0.50	1.00	0.00	1.00	0.33	0.33
Eliana	0.00	0.00	0.75	0.33	1.00	0.00
Brad	1.00	1.00	0.25	0.67	1.00	0.33
Sherill	0.25	0.00	0.50	0.00	0.67	1.00
Shena	1.00	0.50	0.25	1.00	1.00	0.67
Gerard	1.00	0.50	1.00	0.00	0.00	0.33

Further, the pairwise comparisons (preference function) are carried out such that:

$$P_j(a,b) = 0, if\ R_{aj} \leq R_{bj}$$
$$P_j(a,b) > 0, D(a,b) = W_j * D(a,b)$$

i.e, D(Lisa-Felica) = $X_{Lisa} - X_{Felica}$ = 0.5-0.5=0

This is shown in Table 11.

Table 11
Pairwise comparison of all employees using PROMETHEE

Pairwise preference	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic
D(Lisa-Felica)	0	-0.5	0.5	-0.67	0.34	0.00
D(Lisa-Eliana)	0.5	0.5	-0.25	0.00	-0.33	0.33
…	…	…	…	…	…	…
D(Brad-Sherill)	0.75	1.00	-0.25	0.67	0.33	-0.67
…	…	…	…	…	…	…
D(Gerard-Sherill)	0.75	0.50	0.50	0.00	-0.67	-0.67
D(Gerard-Shena)	0.00	0.00	0.75	-1.00	-1.00	-0.34

The aggregate preference function is further calculated as:

$$\pi(a.b) = \frac{\left[\sum_{j=1}^{n} W_j * P_j(a.b)\right]}{\sum_{j=1}^{n} W_j}$$

Here $\sum_{j=1}^{n} W_j = 1$

Table 12 indicates the aggregated preference for employees across the criteria.

Table 12
Aggregated preference of all employee pairs for all criteria using PROMETHEE

Preference	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic	π
	0.1334	0.3896	0.2266	0.1501	0.0479	0.0517	
D(Lisa-Felica)	0	0	0.1133	0	0.016126	0	0.1294
D(Lisa-Eliana)	0.0667	0.1948	0	0	0	0.017061	0.2785
…	…	…	…	…	…	…	…
D(Eliana-Gerard)	0	0	0	0.049533	0.0479	0	0.0974
…	…	…	…	…	…	…	…
D(Gerard-Sherill)	0.10005	0.1948	0.1133	0	0	0	0.4081
D(Gerard-Shena)	0	0	0.16995	0	0	0	0.1699

Leaving flow for the a[th] alternative is the positive preference flow, calculated as:

$$\varphi^{+} = \frac{1}{m-1}\sum_{b=1}^{m} \pi(a.b)$$

Entering flow for the a[th] alternative is the negative preference flow, calculated as:

$$\varphi^{-} = \frac{1}{m-1}\sum_{b=1}^{m} \pi(b.a)$$

Table 13 indicates the leaving and entering flow values for each employee.

Table 13
Consolidated preference flow of employees in comparison with other employees

	Lisa	Felica	Elaina	Brad	Sherill	Shena	Gerard	SUM	ϕ+
Lisa	-	0.129	0.279	0.057	0.278	0.057	0.082	0.881	0.147
Felica	0.295	-	0.573	0.050	0.573	0.195	0.361	2.047	0.341
Eliana	0.073	0.202	-	0.113	0.122	0.113	0.097	0.721	0.120
Brad	0.328	0.155	0.591	-	0.606	0.195	0.343	2.218	0.370
Sherill	0.035	0.164	0.085	0.091	-	0.074	0.067	0.515	0.086
Shena	0.200	0.173	0.463	0.067	0.461	-	0.215	1.579	0.263
Gerard	0.180	0.293	0.402	0.170	0.408	0.170	-	1.623	0.271
SUM	1.110	1.116	2.392	0.548	2.448	0.803	1.165		
ϕ^-	0.185	0.186	0.399	0.091	0.408	0.134	0.194		

The net outranking flow is then identified as:

$$\varphi^*(a) = \varphi^+(a) + \varphi^-(a)$$

The global weight using PROMETHEE and the ranks of employee is shown in Table 14.

Table 14
Net outranking flow indicating the global weights and ranks for all employees using PROMETHEE

Employee Name	Leaving Preference	Entering Preference	Global Weight, $\varphi*$	Rank
Lisa	0.147	0.185	-0.038	5
Felica	0.341	0.186	0.155	2
Eliana	0.120	0.399	-0.279	6
Brad	0.370	0.091	0.278	1
Sherill	0.086	0.408	-0.322	7
Shena	0.263	0.134	0.129	3
Gerard	0.271	0.194	0.076	4

The PROMTHEE evaluation resulted in the following rank order:
Brad> Felica> Shena> Gerard> Lisa> Eliana> Sherill

4.3 Evaluation using VIKOR

The first step in VIKOR is to normalize the columns based on maximum and minimum column values, as shown in Table 15.

Table 15
Normalized employee ratings for VIKOR

	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic
Employee	0.1334	0.3896	0.2266	0.1501	0.0479	0.0517
Lisa	0.5	0.5	0.5	0.666667	0.333333	0.666667
Felica	0.5	0	1	0	0.666667	0.666667
Eliana	1	1	0.25	0.666667	0	1
Brad	0	0	0.75	0.333333	0	0.666667
Sherill	0.75	1	0.5	1	0.333333	0
Shena	0	0.5	0.75	0	0	0.333333
Gerard	0	0.5	0	1	1	0.666667

The utility measure (S_i) and the regret measure (R_i) are determined using the following equations:

$$S_i = \sum_{j=1}^{m} \left(Wj * \frac{Xi^+ - X_{ij}}{Xi^+ - Xi^-} \right)$$

$$R_i = max \left(Wj * \frac{Xi^+ - X_{ij}}{Xi^+ - Xi^-} \right)$$

Table 16 indicates the utility measure and regret measure for each employee.

Table 16
Utility (S_i) and regret (R_i) values for VIKOR

Employee	Proactive	Prompt	Responsible	Resourceful	Diagnostic	Dynamic	Si	Ri
	0.067	0.195	0.113	0.100	0.016	0.034	0.525	0.195
Lisa	0.067	0.000	0.227	0.000	0.032	0.034	0.360	0.227
Felica	0.133	0.390	0.057	0.100	0.000	0.052	0.731	0.390
Eliana	0.000	0.000	0.170	0.050	0.000	0.034	0.254	0.170
Brad	0.100	0.390	0.113	0.150	0.016	0.000	0.769	0.390
Sherill	0.000	0.195	0.170	0.000	0.000	0.017	0.382	0.195
Shena	0.000	0.195	0.000	0.150	0.048	0.034	0.427	0.195
Gerard	0.067	0.195	0.113	0.100	0.016	0.034	0.525	0.195
						S*, R*	0.25445	0.16995
						S-, R-	0.769017	0.3896

The compromise solution is calculated using the formula (with the weight of decision making strategy, ν set to 0.5)

$$Q_i = \vartheta * \frac{S_i - S^*}{S^- - S^*} + (1 - \vartheta) * \frac{R_i - R^*}{R^- - R^*}$$

The ranks and the global weights are indicated in Table 17.

Table 17
Global weights and rank of all employees using VIKOR

Employee	Global Weight, Q	Rank
Lisa	0.320	5
Felica	0.231	4
Eliana	0.963	6
Brad	0.000	1
Sherill	1.000	7
Shena	0.180	2
Gerard	0.224	3

The VIKOR evaluation resulted in the following rank order:
Brad> Shena> Gerard> Felica> Lisa> Eliana> Sherill

5. Comparison of MPMM, TOPSIS, PROMETHEE and VIKOR

A comparison of all four methods used is presented in Table 18, indicating their global weights (GW) and ranks.

Table 18
Global weights and ranks of MPMM, TOPSIS, PROMETHEE and VIKOR

Employee	MPMM GW	Rank	TOPSIS GW	Rank	PROMETHEE GW	Rank	VIKOR GW	Rank
Lisa	-0.1039	4	0.48927	5	-0.03825	5	0.320	5
Felica	-0.18849	6	0.490514	4	0.155068	2	0.231	4
Eliana	-0.15577	5	0.421034	6	-0.27863	6	0.963	6
Brad	0.6704	1	0.589957	2	0.278273	1	0.000	1
Sherill	-0.59603	7	0.32647	7	-0.32219	7	1.000	7
Shena	0.016786	3	0.50837	3	0.129352	3	0.180	2
Gerard	0.357	2	0.657657	1	0.076377	4	0.224	3

The employee Brad ranked first with the MPMM, PROMETHEE and VIKOR and ranked second in TOPSIS. All four methods ranked Sherill last. A correlation of both global weights and rankings indicated the level of uniformity in the rankings.

5.1 Correlation

The global weights are compared using Pearson's correlation (see Table 19) and the ranks are compared using Spearman's correlation method (see Table 20) (Vafaei et al., 2016). The correlation results indicate that at a 95% significance level, the MPMM GW has a statistically significant positive relation with the global weights of TOPSIS, PROMETHEE and VIKOR. Also the MPMM ranks have a statistically significant positive relation with the ranks of TOPSIS and VIKOR, and a positive relation with the PROMETHEE rank.

Table 19
Comparing the global weights of MPMM, TOPSIS, PROMETHEE and VIKOR using Pearson's correlation

		TOPSIS GW	PROMETHEE GW	VIKOR GW
MPMM GW	Pearson's r	—		
	p-value	—		
TOPSIS GW	Pearson's r	0.891 **	—	
	p-value	0.007	—	
PROMETHEE GW	Pearson's r	0.768 *	0.787 *	—
	p-value	0.044	0.036	—
VIKOR GW	Pearson's r	0.758 *	0.823 *	0.975 *** —
	p-value	0.048	0.023	< .001 —

Table 20
Comparing the ranks of MPMM, TOPSIS, PROMETHEE and VIKOR using Spearman's correlation

		MPMM Rank	TOPSIS Rank	PROMETHEE Rank	VIKOR Rank
MPMM	Spearman's rho	—			
Rank	p-value	—			
TOPSIS	Spearman's rho	0.857 *	—		
Rank	p-value	0.024	—		
PROMETHEE	Spearman's rho	0.607	0.750	—	
Rank	p-value	0.167	0.066	—	
VIKOR	Spearman's rho	0.857 *	0.893 *	0.893 *	—
Rank	p-value	0.024	0.012	0.012	—

Note. * p < .05, ** p < .01, *** p < .001

6. Discussion

In an organization, every employee's performance counts. Strategically, the cumulative performance of employees should lead to the successful performance of an organization and therefore, every position should have a predetermined set of objectives that leads to positive overall organizational performance. In an ideal scenario, employees would be evaluated against these criteria in an absolute sense. However, in reality, the performance

of a homogenous set of employees happens in a relative manner. Even if there is a well-defined PAS in an organization, it may not be suitable for comparing relative performance. Therefore, a method for relative comparison is necessary and any pairwise comparison method can be used for this purpose. The importance of having a CPEE is underlined in the paper. The MCDM pairwise comparison methods are often used for a discrete process; however, they have not been used for CPEE. A simple but robust method for CPEE based on pairwise comparison is needed. The MPMM proposed in this article can be used for a CPEE on a relative comparison method.

As with all pairwise comparison methods used for employee performance evaluation, the MPMM is also suited for a small team size. Studies suggest that teams that are smaller, more manageably sized exhibit better performance than larger ones (Bernet et al., 2023). Although highly contextual, the often cited magic number (7 plus or minus 2) is an ideal team size (Powell & Lorenz, 2019). Extant literature supports the idea of having a smaller sized team to ensure better productivity and effective performance monitoring (Smeets, 2017; Bagautdinova & Validova, 2014; Jacobsen et al., 2023). For common evaluation processes, the job description and the key result areas of the team members should be homogenous in nature. For this reason, we considered a team of 7 for the purposes of illustration in this article.

Other popular MCDM methods like TOPSIS and VIKOR offer a method for evaluating absolute performance. Although TOPSIS is a relatively easy to use MCDM method, it may not serve the purpose of relative performance comparison. PROMETHEE can be used for a pairwise comparison, but it is complex and takes more effort and time to comprehend. The MPMM method proposed and illustrated here is an ideal method for a relative performance comparison.

Comparatively, no difference was found in the evaluation and ranking of the same set of employees with other MCDM methods. The MPMM showed high positive correlation with TOPSIS on global weights (Table 19) and high positive correlation with TOPSIS and VIKOR in ranking (Table 20). This can be considered as validation for the MPMM.

7. Conclusion

Every contemporary organization needs to have an agile process to continuously evaluate the performance of its employees. An ongoing process of performance evaluation of employees not only reduces the subjectivity of evaluation but also informs the employees about their performance in real time. This article attempted to develop a MCDM-based procedural framework for CPEE. In this study, the original PMM was extended by addressing its limitations and customized to suit the process of CPEE along with the AHP.

This article makes four main contributions to the field. First, due to its simplicity, PMM has been used for many purposes. However, PMM has not been used for performance evaluation of employees, which is addressed in this article. Second, the limitations of the original PMM are addressed by proposing a Modified PMM (MPMM). Third, although the literature supports the necessity and importance of CPEE, there is no known process to operationalize CPEE. This is addressed in this article by developing a MCDM-based procedural framework for CPEE. Finally, this article proposes that the cumulative score

obtained by using the MPMM for CPEE can act as an objective and transparent input to the existing PAS. The validity of the proposed MPMM is shown by statistically correlating the ranks and weights of scores obtained by MPMM with other MCDM methods.

The CPEE process using the MPMM cannot be uniformly conducted for all employees across an organization, and is limited to comparison among employees with similar job profiles. Therefore, the organizational alignment or generalizability has not been addressed in this study. An absolute measurement mode can also be included in the future. This is relevant when the team composition is dynamic. When a new employee joins the team or an employee leaves the team, the absolute mode ensures rank stability (avoiding rank reversal). The proposed application needs practical validation to empirically analyze the workability of the process. The selection of TOPSIS, PROMETHEE and VIKOR was random and other MCDM methods such as ELECTRE and DEA were not included in the analysis. The proposed linking of the CPEE with an organization's existing PAS needs to be studied. This is another possible area for future research. This CPEE can be sustained by including any visible output linked with it such as reward and recognition, which is an immediate future research direction.

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