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Multi-Criteria Decision-Making Model for Rank Strategy to Overcome Barriers to Integrating the AI and Cloud Systems in the IT Industry

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Abstract

This study proposed a decision-making framework for identifying key barriers when implementing Artificial Intelligence (AI) and cloud systems in the Information Technology (IT) industry. Then, it proposed a set of strategies to overcome these barriers. We proposed a Multi-Criteria Decision-Making (MCDM) methodology for various criteria. Multiple barriers, such as cost, technology, environment, and digitization, should be analyzed. The Evaluation Based on Distance from Average Solution (EDAS) method is an MCDM method logy used to rank the alternatives. The criteria weights are computed by the average method. This study used ten barriers and ten strategies. The results show that technological barriers have the highest importance in this study. The sensitivity analysis is conducted to show the stability rank of alternatives. There are eleven cases in which criteria weights are proposed. Then, the EDAS method is used to rank the other options. The results show the stability of the rank under different cases.

Keywords: Artificial intelligence, Cloud systems, IT industry, Barriers, Multi-criteria decision making, Strategy.

1 | Introduction

Most businesses depend entirely on Cloud Computing (CC) and Artificial Intelligence (AI) technologies to safeguard and manage resources. Since every company owner wants to automate their activities, the need for CC and AI technologies has increased dramatically. Advanced technology-equipped organizations provide great flexibility and scalability while being relatively easy to administer. With time, people started interacting

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with different technologies increasingly, becoming dependent on new developments. The CC industry is growing daily to achieve automated procedures that aid in improving operations, saving expenses, and accelerating corporate development [1], [2].

According to current predictions, the worldwide public CC industry is expected to rise at a Compound Annual Growth Rate (CAGR). According to Shift research, eighty-one percent of businesses use cloud infrastructure, which is expected to increase in the coming years. This circumstance makes it evident that to compete in today's market, most organizations are becoming digital and introducing cutting-edge CC technology. Information Technology (IT) is thus essential for efficiently arranging corporate structures and developing future market strategies [3], [4].

With the invention of novel innovations and the rising demand for digital services, the IT industry has seen tremendous growth in recent years. The industry is expected to expand as technology becomes more pervasive in our everyday lives. Therefore, it is essential that the business closely monitors the factors impacting the cloud system [5], [6].

Multi-Criteria Decision-Making (MCDM) techniques are simple but dependable instruments for deciding intricate and multifaceted real-world issues [7], [8]. Using MCDM techniques, decision-makers may compare and contrast several options based on endless criteria, then choose the option that receives the most incredible score while considering the requirements. Generally speaking, the development of MCDM techniques aims to tackle two critical difficulties in decision-making [9], [10]: 1) determining the significance of the choice criteria, and 2) ranking or prioritizing a set of options about the requirements. A significant development in management science and related subjects has been the development of MCDM techniques [11]-[14].

The main contribution of this study:

1. Identify the critical barriers of AI and cloud systems in implementation with IT industry systems.
2. Identify the critical strategies for overcoming these barriers.
3. We developed an MCDM methodology named the Evaluation Based on Distance from Average Solution (EDAS) method to rank the alternatives.

2 | EDAS Method

The EDAS method is an MCDM methodology used to run the alternatives from various options. This study used this method to rank the key strategy to overcome the barriers to implementing AI and cloud systems in the IT industry [15]-[18]. *Fig. 1* shows the steps of the EDAS MCDM method.

Phase 1. Build the decision matrix.

The decision matrix is built between a set of criteria in the key barriers and a set of strategies to overcome the barriers to implementing AI and cloud systems in the IT industry.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix}_{m\times n} \quad i = 1,2, \dots, m; j = 1,2, \dots, n. \tag{1}$$

Phase 2. Compute the average solution.

The average solution is computed as:

$$V_j = \frac{\sum_{i=1}^{m} a_{ij}}{m}. \tag{2}$$

Phase 3. Compute the positive and negative distance.

The positive and negative distances from every alternative are computed for each beneficial and non-beneficial criterion as:

$$P_{ij} = \frac{\max\left(0, \left(a_{ij} - V_j\right)\right)}{V_j}. \quad (3)$$

$$P_{ij} = \frac{\max\left(0, \left(V_j - a_{ij}\right)\right)}{V_j}. \quad (4)$$

$$N_{ij} = \frac{\max\left(0, \left(V_j - a_{ij}\right)\right)}{V_j}. \quad (5)$$

$$N_{ij} = \frac{\max\left(0, \left(a_{ij} - V_j\right)\right)}{V_j}. \quad (6)$$

Phase 4. Compute the criteria weights.

Phase 5. Compute the weighted P_{ij} and N_{ij}.

The weighted positive and negative distance are computed as:

$$WP_i = \sum_{j=1}^{n} P_{ij} \cdot w_j. \quad (7)$$

$$WN_i = \sum_{j=1}^{n} N_{ij} \cdot w_j. \quad (8)$$

Phase 6. Compute the weighted normalized P_i and N_i.

$$CWP_i = \frac{WP_i}{\max_i(WP_i)}. \quad (9)$$

$$CWN_i = \frac{WN_i}{\max_i(WN_i)}. \quad (10)$$

Phase 7. Compute the appraisal score.

$$S_i = \frac{1}{2}(CWP_i + CWN_i). \quad (11)$$

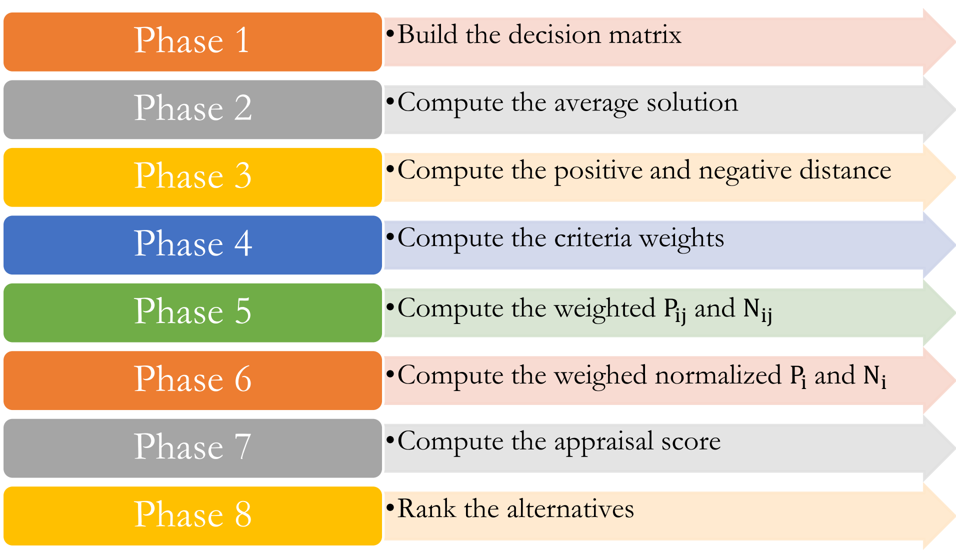

Fig. 1. The steps of the EDAS method.

3 | Application

This section introduces the results of the EDAS method for identifying key strategies of the key barrier in implementing AI and cloud systems in the IT industry. This study uses ten key barriers, as shown in *Fig. 2*.

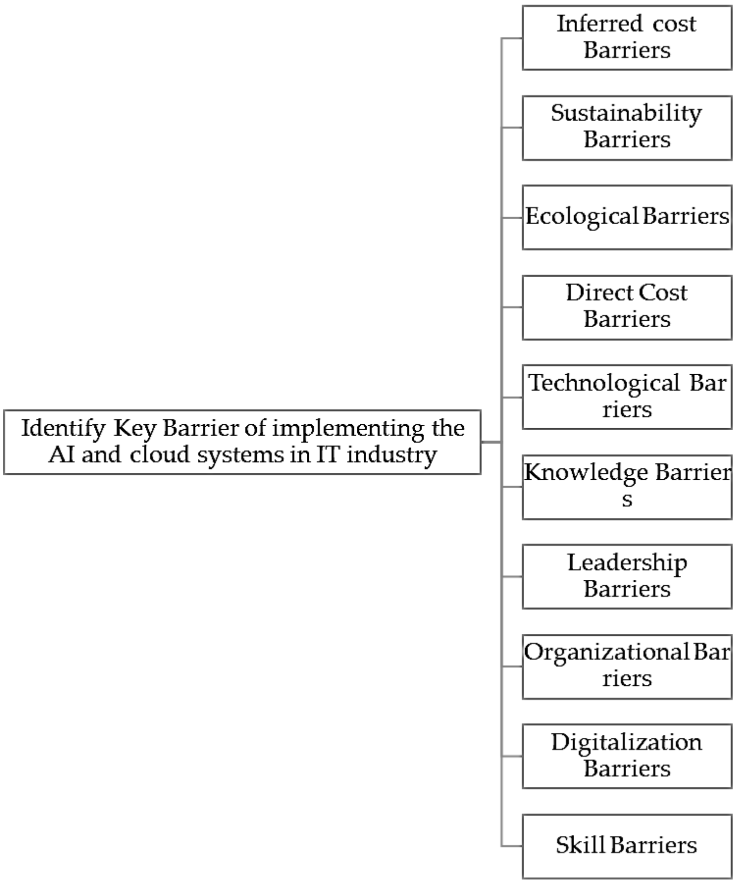

Fig. 2. The key barrier to implementing AI and cloud systems in the It industry.

Phase 1. Build the decision matrix.

The decision matrix is built between a set of criteria in the key barriers and a set of strategies to overcome the barriers to implementing AI and cloud systems in the IT industry. The decision matrix is built by using Eq. (1).

Phase 2. Compute the average solution.

The average solution is computed by using Eq. (2).

Phase 3. Compute the positive and negative distance by using Eqs. (3)-(6). The cost criterion is negative.

The positive and negative distances from every alternative are computed for each beneficial and non-beneficial criterion, as shown in *Tables 1* and *2*.

Table 1. The positive distance.

	KBC_1	KBC_2	KBC_3	KBC_4	KBC_5	KBC_6	KBC_7	KBC_8	KBC_9	KBC_{10}
KBA_1	0	0.117647	0.21875	0	0	0	0	0	0.2	0.21875
KBA_2	0.137931	0	0	0.027778	0.365079	0.152542	0	0.433962	0.6	0.21875
KBA_3	0	0.264706	0.0625	0.305556	0.365079	0.661017	0.387755	0	0	0
KBA_4	0	0.411765	0.21875	0.166667	0	0	0.183673	0	0.2	0
KBA_5	0	0	0.375	0	0	0	0	0	0.6	0
KBA_6	0.310345	0	0	0.027778	0.206349	0	0	0.056604	0.4	0
KBA_7	0	0	0	0.027778	0	0	0.183673	0.622642	0	0
KBA_8	0.137931	0.264706	0	0	0.047619	0.152542	0.183673	0	0	0.375
KBA_9	0.655172	0.117647	0	0	0	0.152542	0.183673	0.433962	0	0.21875
KBA_{10}	0.310345	0	0.21875	0.166667	0.52381	0.661017	0	0.245283	0	0.0625

Table 2. The negative distance.

	KBC_1	KBC_2	KBC_3	KBC_4	KBC_5	KBC_6	KBC_7	KBC_8	KBC_9	KBC_{10}
KBA_1	0.37931	0	0	0.111111	0.111111	0.525424	0.632653	0.320755	0	0
KBA_2	0	0.323529	0.25	0	0	0	0.22449	0	0	0
KBA_3	0.034483	0	0	0	0	0	0	0.132075	0	0.09375
KBA_4	0.551724	0	0	0	0.428571	0.355932	0	0.698113	0	0.25
KBA_5	0.37931	0.029412	0	0.111111	0.428571	0.355932	0.22449	0.509434	0	0.40625
KBA_6	0	0.323529	0.09375	0	0	0.016949	0.020408	0	0	0.25
KBA_7	0.206897	0.176471	0.25	0	0.269841	0.525424	0	0	0.2	0.09375
KBA_8	0	0	0.25	0.25	0	0	0	0.132075	0.8	0
KBA_9	0	0	0.25	0.25	0.269841	0	0	0	0.6	0
KBA_{10}	0	0.323529	0	0	0	0	0.020408	0	0.4	0

Phase 4. Compute the criteria weights as shown in *Fig. 3*. The technological barriers have the highest weight.

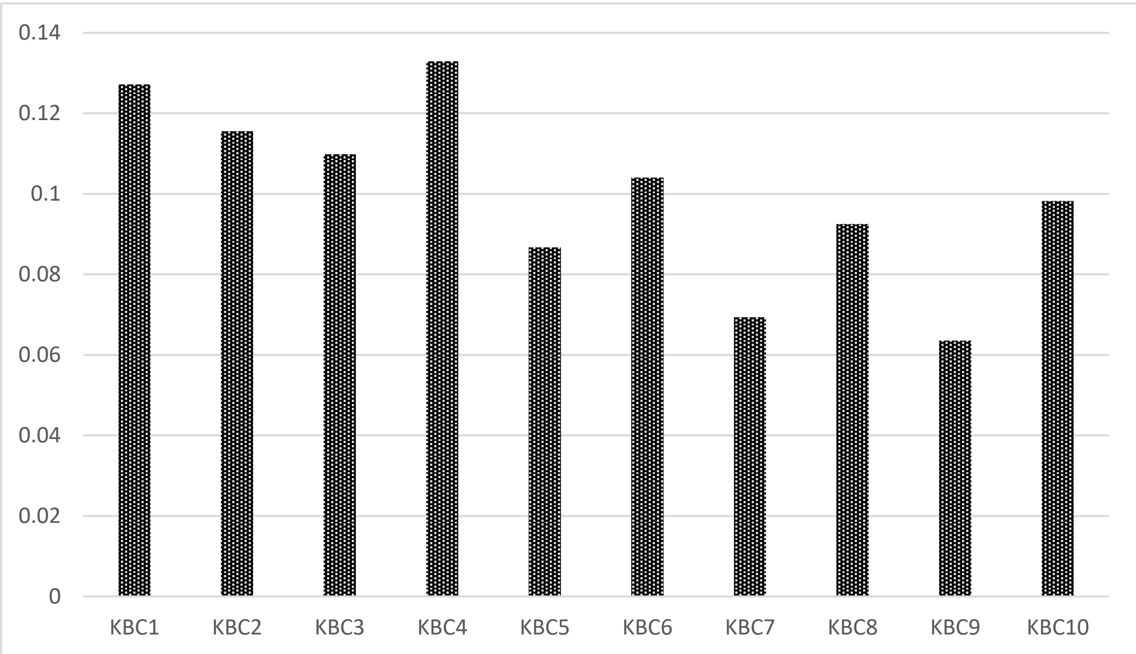

Fig. 3. The key barrier weights.

Phase 5. Compute the weighted P_{ij} and N_{ij}.

The weighted positive and negative distances are computed using Eq. (7) and Eq. (8), as shown in *Tables 3* and *4*.

Table 3. Weighted positive distance.

	KBC_1	KBC_2	KBC_3	KBC_4	KBC_5	KBC_6	KBC_7	KBC_8	KBC_9	KBC_{10}
KBA_1	0	0.013601	0.024025	0	0	0	0	0	0.012717	0.021496
KBA_2	0.01754	0	0	0.003693	0.031654	0.015871	0	0.040135	0.03815	0.021496
KBA_3	0	0.030602	0.006864	0.040623	0.031654	0.068776	0.026896	0	0	0
KBA_4	0	0.047603	0.024025	0.022158	0	0	0.01274	0	0.012717	0
KBA_5	0	0	0.041185	0	0	0	0	0	0.03815	0
KBA_6	0.039466	0	0	0.003693	0.017892	0	0	0.005235	0.025434	0
KBA_7	0	0	0	0.003693	0	0	0.01274	0.057585	0	0
KBA_8	0.01754	0.030602	0	0	0.004129	0.015871	0.01274	0	0	0.03685
KBA_9	0.083317	0.013601	0	0	0	0.015871	0.01274	0.040135	0	0.021496
KBA_{10}	0.039466	0	0.024025	0.022158	0.045417	0.068776	0	0.022685	0	0.006142

Table 4. Weighted negative distance.

	KBC_1	KBC_2	KBC_3	KBC_4	KBC_5	KBC_6	KBC_7	KBC_8	KBC_9	KBC_{10}
KBA_1	0.048236	0	0	0.014772	0.009634	0.054668	0.043883	0.029665	0	0
KBA_2	0	0.037402	0.027457	0	0	0	0.015572	0	0	0
KBA_3	0.004385	0	0	0	0	0	0	0.012215	0	0.009212
KBA_4	0.070161	0	0	0	0.037159	0.037033	0	0.064565	0	0.024566
KBA_5	0.048236	0.0034	0	0.014772	0.037159	0.037033	0.015572	0.047115	0	0.039921
KBA_6	0	0.037402	0.010296	0	0	0.001763	0.001416	0	0	0.024566
KBA_7	0.026311	0.020401	0.027457	0	0.023397	0.054668	0	0	0.012717	0.009212
KBA_8	0	0	0.027457	0.033237	0	0	0	0.012215	0.050867	0
KBA_9	0	0	0.027457	0.033237	0.023397	0	0	0	0.03815	0
KBA_{10}	0	0.037402	0	0	0	0	0.001416	0	0.025434	0

Phase 6. Compute the weighted normalized P_i and N_i by using Eq. (9) and Eq. (10).

Phase 7. Compute the appraisal score using Eq. (11), as shown in *Fig. 4*. Alternative 4 is the best, and alternative 6 is the worst.

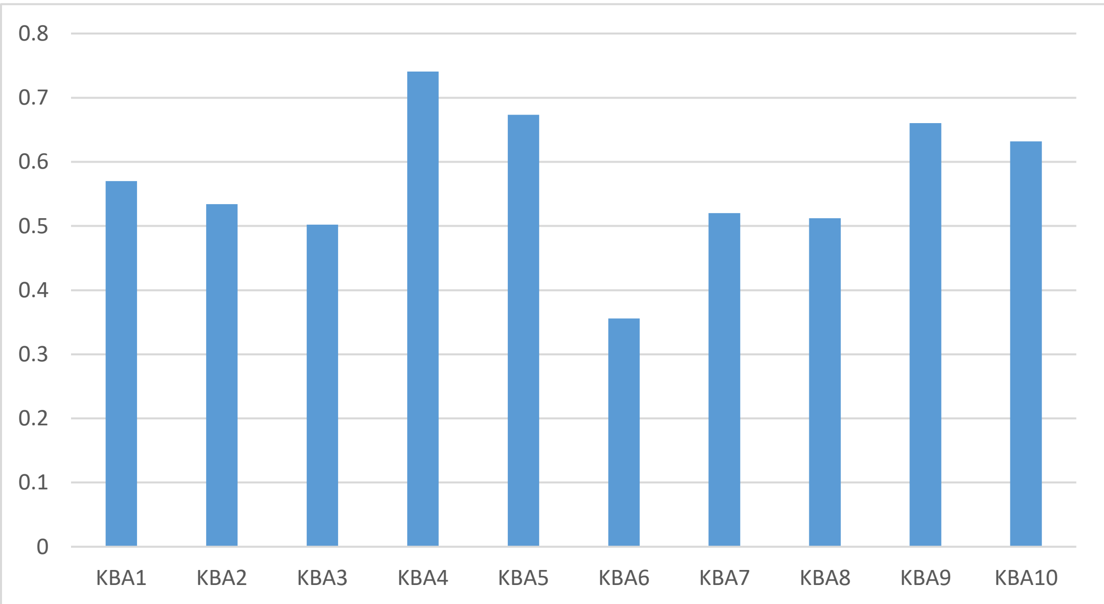

Fig. 4. The appraisal score.

4 | Sensitivity Analysis

This study changes the criteria weights under different cases to show the rank of alternatives under different cases. We proposed 11 cases in criteria weights. In the first case, we put all criteria in equal weight. In the second case, we put one criterion with 0.12 weight; the other criteria are equal, as shown in *Fig. 5*. Then, we used the EDAS method to rank the alternatives under different cases. *Fig. 6* shows the appraisal score under different cases. The results show the rank is stable, as shown in *Fig. 7*.

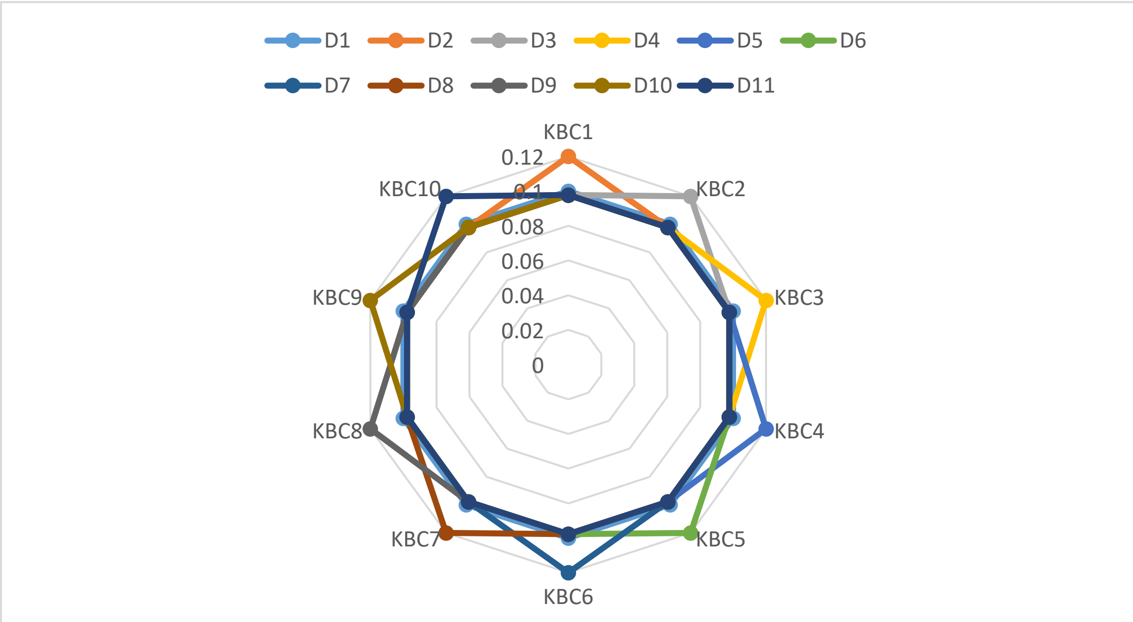

Fig. 5. The 11 cases in criteria weights.

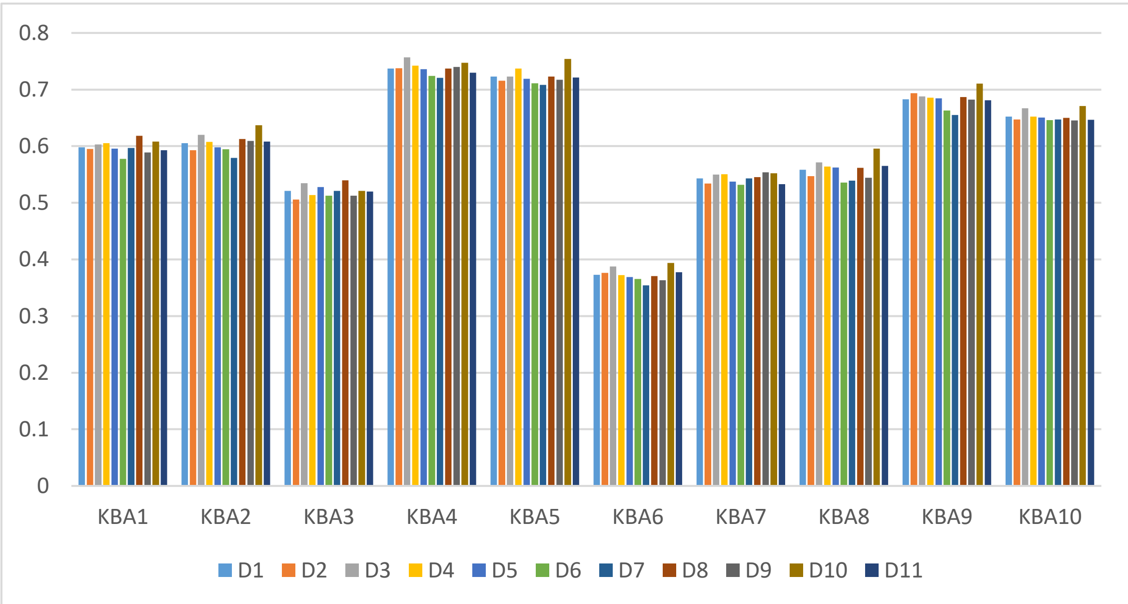

Fig. 6. The appraisal score under different cases.

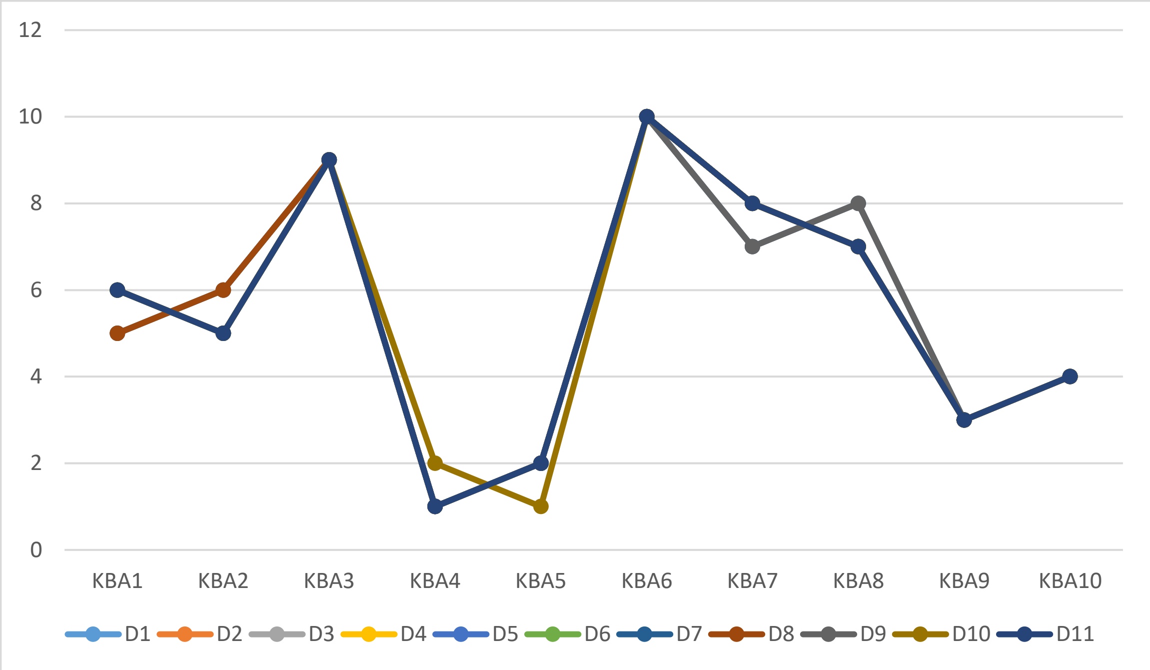

Fig. 7. The rank of alternatives under different cases.

5 | Conclusion

This study proposes a decision-making model for identifying key barriers when implementing cloud systems and AI in the IT industry. We proposed an MCDM method logy to rank the alternatives. The EDAS method is an MCDM method used to rank the options. Ten barriers and ten strategies are used in this study. The mean method is used to complete the criteria weights. The technological barrier has the highest weight. The EDAS method starts with the decision matrix between criteria and alternatives. Then, the positive and negative criteria are computed. Then, the weighted normalized positive and negative criteria are calculated by multiplying the criteria weights by the positive and negative criteria. The cost criterion is negative, and all other criteria are positive. The EDAS shows that alternative 4 is the best and alternative 6 is the worst. The sensitivity analysis is conducted to show the stability of the results. There are 11 cases proposed in this study. The first case has equal weights; in the other case, we put one criterion with 0.12 weight, and the equal criteria are equal. The results show the rank of alternatives under different cases is stable.

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