Enabling Smart Cloud Decisions: A Reference-Based MCDA Framework for VPS Selection in SMEs

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Abstract

This paper introduces a novel reference point-based multi-criteria decision analysis (MCDA) framework for Virtual Private Server (VPS) selection tailored to small and medium-sized enterprises (SMEs) undergoing digital transformation. Unlike traditional MCDA methods that often recommend excessively powerful or costly solutions, the proposed approach allows decision-makers to define a target solution based on specific software and operational requirements. The empirical study demonstrated that this method provided VPS rankings more aligned with actual SME needs, optimizing resource allocation without over-provisioning. The results showed stable, reliable recommendations, offering a cost-effective and practical approach for VPS selection in digital transformation.

Keywords: reference point-based MCDA, virtual private servers (VPS), SME digital transformation, resource optimization, decision-making

1. Introduction

Digital transformation is a critical challenge for small and medium-sized enterprises (SMEs) aiming to remain competitive in an increasingly digitized world [12]. A core component of this transformation involves selecting appropriate technological infrastructure, such as virtual private servers (VPS), which directly impacts the efficiency, scalability, and cost-effectiveness of the digitalization process [11]. SMEs, however, often face a complex decision-making environment when choosing VPS solutions, as they must evaluate multiple, sometimes conflicting, criteria including performance, cost, resource usage, and scalability.

Traditional multi-criteria decision analysis (MCDA) methods, such as TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) [4] or VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) [13], have been widely applied to such multi-attribute decision-making problems. These methods are effective in ranking alternatives based on predefined criteria, often maximizing efficiency or minimizing cost [2]. However, as it will be demonstrated in this paper, since they are based on synthetic ideal and anti-ideal solutions, they can recommend solutions that are overly optimized, leading to unnecessarily powerful and expensive VPS configurations that do not reflect the actual needs of SMEs. As a result, there is a need for MCDA approaches that better align with real-world requirements, particularly in the context of digital transformation, where resource allocation should be cost-effective and appropriately scaled to the actual operational demands.

To address this gap, we propose a novel reference point-based MCDA framework tailored specifically for VPS selection in the digital transformation journey of SMEs. This framework introduces the concept of a "target solution" based on a decision-maker's specific software and operational requirements, enabling the selection of VPS alternatives optimized for actual usage, rather than simply maximizing efficiency. By ranking VPS options using Euclidean distance from this reference point, our method ensures that the selected solutions are not only resource-efficient but also cost-effective and better aligned with the SME's unique digitalization goals.

The empirical study presented in this paper demonstrates the effectiveness of the proposed approach, highlighting its ability to produce rankings that are better adjusted to SMEs' software requirements. In contrast to traditional methods, which often lead to the selection of excessively powerful or inefficient solutions, our approach offers a more practical and tailored framework for VPS selection. Furthermore, the sensitivity analysis component of the proposed approach allows for verifying the robustness and reliability of the rankings under varying weight configurations.

This paper contributes to the literature by introducing a framework utilizing a reference-based MCDA method that integrates real-world operational constraints into the decision-making process. The proposed framework offers significant potential for SMEs undergoing digital transformation and can be easily extended to other domains, such as cloud computing and IT procurement, where decision-making involves optimizing resources within predefined targets.

The remainder of the paper is organized as follows: Section 2 reviews existing MCDA methods and their limitations in reference-based decision-making scenarios. Section 3 presents the proposed framework methodological foundations. Section 4 describes the empirical study on VPS selection for SMEs, and Section 5 concludes the paper.

2. Literature Review

Multi-Criteria Decision Analysis methods have long supported decision-makers in evaluating alternatives when multiple, often conflicting, criteria must be considered simultaneously. These approaches integrate diverse criteria into structured models, enabling more informed, transparent, and balanced decisions [5].

MCDA techniques are typically classified into two main groups: the American and European schools [3]. Methods developed under the American approach, such as Multi-Attribute Utility Theory (MAUT) [1] and Analytic Hierarchy Process (AHP) [17], focus on aggregating all evaluation criteria into a single composite utility score, thereby generating a complete ranking of alternatives. In contrast, the European approach emphasizes outranking techniques with prominent methods like ELECTRE [8] and PROMETHEE [16]. These compare alternatives pairwise, producing preference relations without necessarily building a full ranking of options.

Distance-based MCDA methods are particularly relevant in decision-making where closeness to an ideal solution matters. Approaches such as TOPSIS [4] and WEDBA [15] evaluate alternatives based on their proximity to both ideal and anti-ideal points. Similarly, EDAS [14] assesses alternatives based on their positive and negative distances from an average solution, while CODAS [9] prioritizes alternatives based on Euclidean distances from the worst option, using the Taxicab distance to break ties. VIKOR [18] applies both Taxicab and Chebyshev distances in its compromise ranking approach.

Most of these distance-based MCDA methods rely on the synthetic construction of ideal, worst, or average alternatives derived from the actual performances of the available options. SPOTIS [7], on the other hand, defines the ideal solution based on externally set criterion bounds rather than calculating it from the existing alternatives.

However, many real-world decision-making scenarios, such as selecting a Virtual Private Server (VPS) for SMEs undergoing digital transformation, revolve around meeting specific software requirements rather than simply pursuing maximum performance or minimal cost. SMEs often seek VPS solutions that are sufficiently capable to support their intended applications, without incurring unnecessary excess in computing power, storage, or other resources. Over-provisioned servers not only lead to increased operational costs but also contribute to resource wastage and a higher carbon footprint, undermining sustainability goals [10].

Traditional MCDA approaches, which typically construct synthetic ideal points or emphasize maximization strategies, may prove inadequate in contexts where alignment with concrete operational requirements matters. This reveals a significant methodological gap that this study addresses by introducing a novel reference point-based MCDA framework, specifically tailored to support VPS selection for SMEs engaged in digital transformation. The proposed method promotes strategic innovation while ensuring economic rationality and operational resource optimization, thereby aligning infrastructure choices more precisely with actual application demands.

3. Methodology

This paper proposes a novel MCDA-based framework to support the selection of Virtual Private Servers (VPS) for SMEs undertaking digital transformation initiatives. The method centers on modeling the decision-maker's ideal solution — referred to as the target solution (A^*) — and evaluating how closely available VPS alternatives match this target. A graphical overview of the framework is presented in Fig. 1.

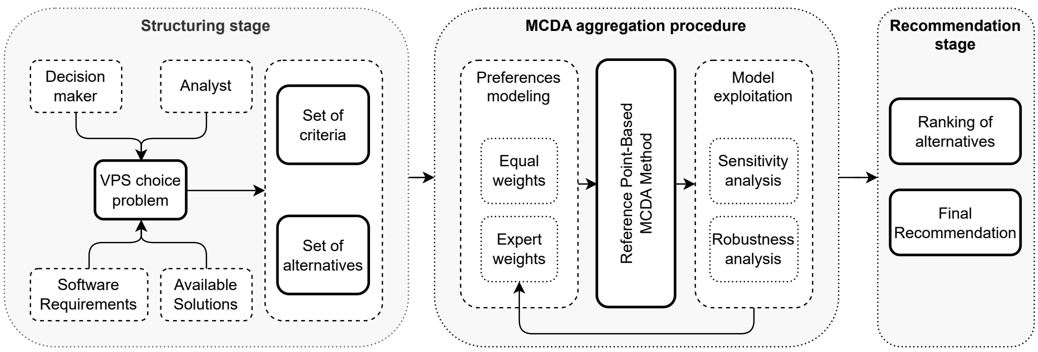

Fig. 1. Proposed reference point-based MCDA framework for VPS selection to support SMEs' digital transformation.

The proposed framework consists of three main stages. First, in the structuring stage, in collaboration with an analyst, the decision-maker formulates the VPS selection problem based on the specific requirements of the software to be deployed and the available VPS offerings. As a result, a set of alternatives (VPS options) and evaluation criteria (such as vCores, RAM, storage, upgradeability, bandwidth, backup availability, and price) are established.

Second, in the MCDA aggregation procedure, preference modeling is conducted – relative importance weights are set and adjusted to match the decision maker's preferences. The proposed reference point-based MCDA method is applied, followed by a sensitivity analysis to assess the robustness of the results. If needed, feedback from the sensitivity analysis can be used to refine judgments on the criteria weights.

Finally, in the recommendation stage, a final ranking of VPS alternatives is produced, and a recommendation is made, indicating the solution best aligned with the SME's needs.

The detailed steps of the MCDA aggregation process are described below:
Step 1. The VPS alternatives' performances across the defined evaluation criteria are organized into a decision matrix X:

$$X = [x_{ij}]_{m \times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{1}$$

where m denotes the number of VPS alternatives, n the number of evaluation criteria and x_{ij} performance of alternative i on criterion j.

Step 2. The decision-maker specifies an ideal configuration (e.g., desired RAM, storage, price), represented by the target solution vector:

$$A^* = \begin{bmatrix} x_{*1} & x_{*2} & \cdots & x_{*n} \end{bmatrix} \tag{2}$$

Instead of specifying an exact target value for criterion j, the decision-maker may prefer to indicate that it should either be minimized ($x_{*j} \to -\infty$) or maximized ($x_{*j} \to +\infty$). In such cases, the corresponding target value should be set to $\left(\min_i x_{ij}\right)$ for minimization or $\left(\max_i x_{ij}\right)$ for maximization, based on the values of available alternatives. It is important to note that the ideal VPS configuration the decision-maker defines may or may not be achievable among the existing options.

Step 3. The criteria relative importance weights are set:

$$w = \begin{bmatrix} w_1 & w_2 & \cdots & w_j & \cdots & w_n \end{bmatrix} \tag{3}$$

where w_j indicates the importance of criterion j.

Step 4. Because criteria values may differ in units and scales, normalization is necessary. The target solution vector A^* is appended at the bottom of the decision matrix X and form a temporary matrix X'. Normalization is performed:

$$\overline{X'} = [\overline{x_{ij}}]_{m+1 \times n} \mid \overline{x_{ij}} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{4}$$

Simultaneously, the weights are normalized to ensure they sum to 1:

$$\overline{w} = [w_j]_{1 \times n} \mid \overline{w_j} = \frac{w_j}{\sum_{k=1}^{n} w_k} \tag{5}$$

Step 5. The normalized matrix values are weighted to reflect the relative importance of each criterion, forming a normalized-weighted matrix $\hat{X}'$:

$$\hat{X}' = [\hat{x_{ij}}]_{m+1 \times n} \mid \hat{x_{ij}} = \overline{x_{ij}} \cdot \overline{w_j} \tag{6}$$

From $\hat{X}'$, the normalized-weighted decision matrix $\hat{X}$ and the normalized-weighted target solution vector $\hat{A}^*$ are separated.

Step 6. Finally, the distance of each VPS alternative from the target solution is computed using the Euclidean distance formula:

$$d_i = \sqrt{\sum_{j=1}^{n} (\hat{x_{ij}} - \hat{x_{*j}})^2} \tag{7}$$

Alternatives are then ranked in ascending order of their distance to $\hat{A}^*$. A smaller distance indicates a better match to the SME's requirements.

Table 1. Criteria used to differentiate the analyzed VPS alternatives. Criteria: C1 – number of vCores; C2 – RAM [GB]; C3 – possibility to upgrade RAM [bool]; C4 – storage size, SSD drive [GB]; C5 – possibility to upgrade storage size [bool]; C6 – bandwidth [Mbps]; C7 – availability of automatic backups option [bool]; C8 – monthly price [PLN].

Alternative Criterion	VPS Starter A1	Value A2	Essential A3	Comfort A4	Elite A5	VLE-2 A6	VLE-4 A7	VLE-16 A8
C1	1	1	2	4	8	2	4	16
C2	2	2	4	4	8	2	4	16
C3	0	1	1	1	1	0	0	0
C4	20	40	40	80	160	40	80	160
C5	0	1	1	1	1	0	0	0
C6	100	250	500	1024	2048	500	1024	2048
C7	0	1	1	1	1	1	1	1
C8	16	26	49	72	151	24	48	192

Following the initial ranking, a sensitivity analysis is conducted by varying criteria weights to evaluate the stability of the recommendation. This step ensures that minor changes in expert preferences do not lead to drastic shifts in the final recommendation. If significant sensitivity is detected, the weights can be revised accordingly.

In the final stage, a ranked list of VPS options is produced. The best-matching alternative is recommended to the SME, supporting a sustainable and cost-effective digital transformation aligned with their specific application needs.

4. Empirical Study

This section demonstrates the application of the proposed reference-based MCDA framework for VPS selection in SMEs through three representative case studies. Each case reflects a distinct level of computational demand: (1) deploying a basic website powered by WordPress, (2) implementing a more complex web application using Python's Django framework, and (3) setting up a high-performance machine learning solution developed in Python. These scenarios illustrate how the framework adapts to varying software requirements and supports informed decision-making in cloud infrastructure selection.

In all three case studies, a common set of eight VPS configurations offered by a single provider[1] is evaluated. These alternatives differ in several key aspects, including processing power (vCPUs), storage capacity, bandwidth speed, and pricing. A comprehensive overview of the eight criteria used to differentiate the VPS options, along with the corresponding values for each alternative, is provided in Table 1.

4.1. VPS Selection for a Lightweight WordPress-Based Website

In the first case study, the available VPS configurations were evaluated to identify the most suitable option for deploying a basic website powered by WordPress. WordPress is a widely used content management system (CMS) built with PHP, renowned for its flexibility, user-friendliness, and a vast ecosystem of both free and commercial plugins and themes. As of 2024, it powered over 43% of websites globally [6], a figure largely attributed to a strong network effect: the more users adopt WordPress for blogs and CMS applications, the more it gains visibility and credibility, encouraging further adoption. This makes WordPress an ideal entry point for SMEs beginning their digital transformation and establishing an online presence.

For this scenario, the recommended VPS configuration includes: 2 virtual CPU cores (vCores),

[1] https://www.ovhcloud.com/pl/vps/compare/

Table 2. VPS evaluation results.

Platform	Weights		A1	A2	A3	A4	A5	A6	A7	A8
WordPress	equal	distance	0.1107	0.0613	0.058	0.0609	0.1151	0.0954	0.0975	0.1906
		rank	6	3	1	2	7	4	5	8
	expert	distance	0.108	0.070	0.0649	0.0650	0.123	0.0642	0.066	0.210
		rank	6	5	2	3	7	1	4	8
Django	equal	distance	0.110	0.058	0.054	0.051	0.104	0.093	0.092	0.182
		rank	7	3	2	1	6	5	4	8
	expert	distance	0.107	0.067	0.060	0.056	0.111	0.061	0.057	0.201
		rank	6	5	3	1	7	4	2	8
Machine Learning	equal	distance	0.154	0.121	0.109	0.095	0.089	0.139	0.122	0.117
		rank	8	5	3	2	1	7	6	4
	expert	distance	0.181	0.159	0.145	0.125	0.098	0.152	0.126	0.079
		rank	8	7	5	3	2	6	4	1

1 GB of RAM with upgrade capability, at least 1 GB of storage with expansion options, maximum available bandwidth, support for automatic backups, and a minimal monthly cost. Therefore, the target solution for this case can be defined as $A^* = [2, 1, 1, 1, 1, +\infty, 1, -\infty]$.

Following the problem structuring phase, which established a decision matrix comprising eight criteria and eight VPS alternatives, the MCDA aggregation procedure was initiated. All criteria were assigned equal weights in the initial analysis to ensure a neutral baseline. The proposed reference point-based MCDA method was then applied, calculating the Euclidean distance between each VPS alternative and the ideal reference configuration corresponding to the recommended WordPress setup. The alternatives were subsequently ranked in ascending order of distance, with shorter distances indicating closer alignment with the target requirements. The ranking results are summarized in Table 2 and are visually illustrated in Fig. 2.

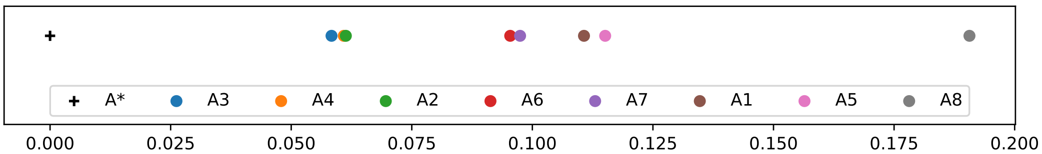

Fig. 2. Visual demonstration of the distance between the target solution (+) and the evaluated alternatives when equal weights are applied.

The analysis of computed distances reveals that alternative A3 is the most suitable VPS option for the WordPress-based website, achieving the lowest Euclidean distance to the target solution (0.058). It is closely followed by alternatives A4 (0.0609) and A2 (0.0613), both of which also demonstrate a strong alignment with the reference configuration. The top-ranked alternative, A3, features 2 vCores, 4 GB of RAM (upgradeable), 40 GB of SSD storage (also upgradeable), moderate bandwidth of 500 Mbps, and a competitive monthly price of PLN 49. Alternative A4, which ranks second, represents a slightly more powerful configuration – offering double the CPU, storage, and bandwidth – at a higher cost of PLN 72 per month. In contrast, A2, ranked third, offers a more modest setup with just 1 vCore and 2 GB of RAM, but at a much lower monthly cost of PLN 26, making it a budget-friendly option for very lightweight websites.

On the other end of the ranking, alternative A8 was identified as the least suitable option for this particular use case. As the most powerful (and expensive) VPS in the set, it includes 16 vCores, 16 GB of non-upgradeable RAM, 160 GB of non-upgradeable SSD storage, and a high bandwidth capacity of 2048 Mbps. However, it also carries a significantly higher monthly cost of PLN 192. With a distance of 0.191 from the reference solution – more than three times greater than that of A3 – it is clear that A8 exceeds the requirements of a basic WordPress website, making it an inefficient and economically unjustifiable choice for SMEs. This over-specification is further illustrated in the parallel coordinates plot shown in Figure 3, where A8 markedly overshoots the ideal levels in criteria C1, C2, C4, and C8, while underperforming in criteria C3 and C5. In contrast, A3 remains consistently close to the ideal target A* across all evaluated criteria.

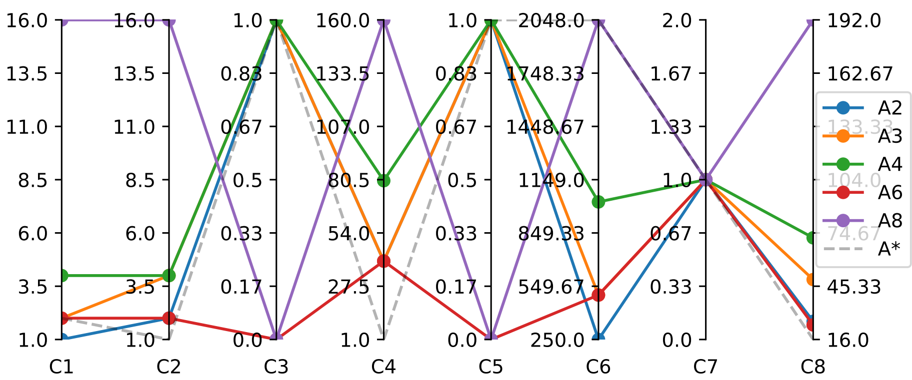

Fig. 3. Performance values of selected VPS alternatives plotted on a parallel coordinates chart.

4.2. Sensitivity Analysis

In the next stage of the research, the robustness of the ranking results was assessed through a sensitivity analysis. For this purpose, each criterion was individually assigned a weight varying from 0% to 100% in 1% increments, while the remaining criteria were distributed equal weights such that the total weight always summed to 100%. This approach allowed for an examination of how changes in the importance of each criterion influenced the final ranking of the VPS alternatives. The results of the sensitivity analysis are presented in Figure 4. In all subplots, the blue dashed vertical line denotes the point of equal weighting across all criteria, corresponding to the baseline ranking shown in Table 2, where alternative A3 was ranked first, followed by A4, A2, A6, A7, A1, A5, and A8.

A closer examination of the sensitivity plots yields several interesting insights. For criterion C1 (processing power), changes in its weight have minimal impact on the VPS recommendation. Only when C1 is given full weight (100%), effectively disregarding all other criteria, does A6 rise to share the top rank with A3 – both alternatives having two vCores.

Criterion C2 (RAM) shows a more pronounced effect. As its weight increases, A3's ranking gradually declines, reaching fourth place when C2's importance exceeds approximately 40%. This indicates that A3's RAM configuration is relatively less aligned with the ideal reference in comparison to some other alternatives.

The rankings remain largely stable under variations in criteria C3 (RAM upgradeability), C5 (storage upgradeability), and C7 (backup support). However, criterion C4 (storage size) yields more dynamic behavior. If the weight of C4 is slightly reduced relative to the others, A3 drops to second place, overtaken by A4. Interestingly, as the weight of C4 increases, A4's rank deteriorates significantly, falling to fifth place at its peak – this is likely due to A4's 80 GB of SSD storage exceeding the reference value of 1 GB, resulting in overperformance penalization. When the weight of C4 surpasses 40%, A3 again drops to second place, this time with A1 taking the lead.

Significant volatility is observed with criteria C6 (bandwidth) and C8 (monthly cost). Small

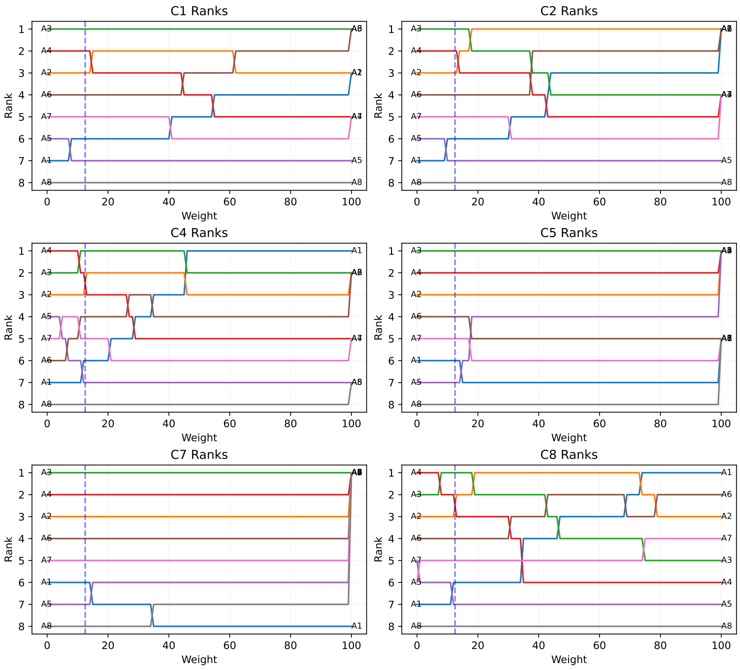

Fig. 4. Sensitivity analysis of the WordPress case study.

changes in the weighting of these criteria lead to substantial fluctuations in the rankings. Moreover, the stability window for A3 remaining at the top position is relatively narrow – approximately 5% for C6 and 10% for C8 – indicating that the leading alternative is highly sensitive to how bandwidth and price are prioritized in the decision-making process.

4.3. Expert Weights

The analysis of how varying the relative importance of individual criteria impacts the ranking of alternatives provided valuable insight into the role of preference modeling in the decision process. In the next stage of the study, expert-derived weights were applied in place of equal weights to reflect more realistic prioritization. The relative importance of each criterion was determined through a series of pairwise comparisons, resulting in the weight vector $w_i = [5.5, 4, 1, 3.5, 1, 4, 6, 3]$. According to these values, criteria C7 (automatic backups) and C1 (processing power) were considered most important, while C3 and C5 (RAM and storage upgradeability) were deemed least important.

Applying the proposed reference point-based MCDA method using the expert weights produced a new ranking of VPS alternatives (see Table 2). While the resulting ranking remains strongly correlated with the previous one based on equal weights (rank correlation coefficient of 0.81 and distance correlation of 0.93), the top alternative has changed. Under expert-weighted preferences, alternative A6 emerges as the top-ranked option, followed by A3 and A4, which were previously ranked first and second, respectively.

A closer examination of the parallel coordinates plot in Fig. 3 reveals that A6 performs relatively poorly in criteria C3 and C5. However, the diminished importance assigned to these criteria under expert judgment significantly reduced their impact on the final ranking. This shift in weighting allowed A6, previously ranked fourth under equal weights, to rise to the top position.

It is worth noting that the top three alternatives – A6, A3, and A4 – are very close in terms of their proximity to the ideal solution. As shown in Table 2 and visualized in Fig. 5, their respective distances to the reference point are 0.0642, 0.0649, and 0.0650, indicating a high

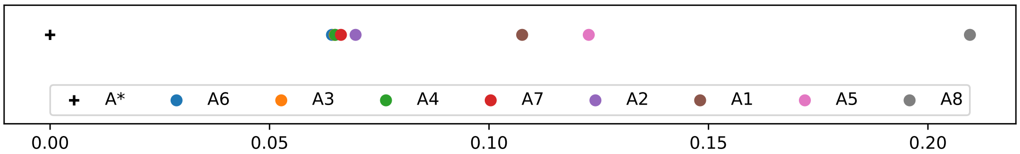

Fig. 5. Visual demonstration of the distance between the target solution (+) and the evaluated alternatives when expert judgment weights are applied.

Table 3. TOPSIS evaluation results of WordPress case study with expert-derived weights.

Alternative	A1	A2	A3	A4	A5	A6	A7	A8
TOPSIS score	0.220	0.451	0.470	0.525	0.666	0.458	0.521	0.760
TOPSIS rank	8	7	5	3	2	6	4	1

degree of similarity in their suitability for the target WordPress configuration.

4.4. Comparison to Traditional MCDA Approach

In the final stage of the WordPress case study, a comparative analysis was conducted to evaluate how the proposed reference-based MCDA framework performs against a traditional MCDA approach. For this purpose, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) was selected as a representative baseline. Unlike the reference point-based approach, TOPSIS does not incorporate a target configuration. Instead, it classifies each criterion as either a benefit (to be maximized) or a cost (to be minimized).

In this context, criterion C8 (monthly price) was identified as a cost criterion, while all other criteria (C1–C7) were treated as benefit criteria. The results of the TOPSIS evaluation using the same expert-derived weights as applied in Section 4.3 are presented in Table 3. In the case of TOPSIS, higher scores indicate better alternatives.

The TOPSIS-based ranking identified alternative A8 as the top choice, followed by A5. These are the two most powerful VPS configurations in the set, offering 8–16 vCores and 8–16 GB of RAM. However, their monthly costs are PLN 192 and PLN 151 respectively – more than six times higher than alternative A6, which was identified as the most suitable option by the proposed reference-based method.

This result highlights a fundamental limitation of traditional MCDA methods in scenarios where overperformance is undesirable or inefficient. In the context of deploying a basic WordPress website for an SME, the excessive hardware resources and costs of A8 and A5 are unjustified. By failing to incorporate a target configuration that reflects actual software requirements, TOPSIS prioritizes raw performance regardless of need. This comparison underscores the value of reference point-based MCDA in supporting more context-aware, efficient decision-making.

4.5. VPS Selection for More Complex Applications

To further validate the applicability of the proposed approach, it was tested in two additional case studies involving the deployment of more demanding web applications. The first of these scenarios considers a more complex application built using Python's Django framework – a significantly heavier technology stack than WordPress. Consequently, this setup requires a more capable VPS configuration.

For this scenario, the recommended reference solution includes 2 vCores, 2 GB of RAM (double that of the WordPress case), and substantially more storage – 30 GB. As such, the ideal target configuration can be expressed as $A^* = [2, 2, 1, 30, 1, +\infty, 1, -\infty]$, reflecting the preference for higher bandwidth (C6), availability of automatic backups (C7), and minimal monthly cost (C8), alongside the necessary hardware requirements.

The results of the MCDA evaluation for this case – using both equal and expert-derived weights – are presented in Table 2. While the rankings share some similarities with the previous WordPress case, they exhibit notable shifts. Under equal weighting, alternative A4 now ranks first, while A3 takes second place – essentially reversing their positions from the previous case. As before, alternative A8 is deemed overly powerful and not suitable for the specified application needs.

When expert-derived weights are applied, A4 retains its top position, but A7 moves up to second place, pushing A3 to third. A7 offers a similar configuration to A4, but at a lower price point. However, unlike A4, A7 lacks upgradeability. Since upgrade options (C3 and C5) were assigned lower importance in the expert-weighted scenario, the absence of these features did not significantly penalize A7, allowing it to outperform A3 in this instance.

The final case study focused on a highly demanding machine learning application, representative of the upper end of VPS requirements in the context of SME digital transformation. In this scenario, maximum processing power is desirable, alongside 16 GB of RAM and 100 GB of storage. The remaining criteria in the reference model remain consistent with the previous cases. As such, the ideal target configuration can be defined as $A^* = [+\infty, 16, 1, 100, 1, +\infty, 1, -\infty]$ emphasizing high-performance values for majority of criteria at minimal cost.

When equal weights are applied, alternative A5 ranks first. This VPS offers high performance along with upgradeable RAM and storage. It is followed by A4 and A3, which offer relatively strong performance, albeit at a slightly lower tier. At the opposite end, A1 is ranked last due to its minimal specifications, despite its very low price.

In contrast, applying expert-derived weights results in a significant shift in the rankings. Alternative A8 – previously ranked lowest in both the WordPress and Django case studies – emerges as the top choice. Its high processing capacity (16 vCores, 16 GB RAM, and 160 GB of storage) outweighs its shortcomings, particularly the lack of upgradeability (criteria C3 and C5), which are deprioritized in the expert-weighting scenario. A5, which ranked first under equal weights, is now second, followed by A4 and the non-upgradeable A7 in fourth place.

When examining the results across all three case studies in Table 2, a clear pattern emerges. As the computational requirements of the target application increase, the highest-ranked alternatives gradually shift toward the more powerful (right-hand side) configurations in the table. This stands in stark contrast to the ranking produced by the traditional TOPSIS method (Table 3), which consistently favored high-end servers regardless of actual need.

These findings further reinforce the advantage of the proposed reference point-based MCDA framework. By tailoring the evaluation to specific software requirements, it facilitates more efficient and sustainable decision-making, ensuring that SMEs adopt infrastructure that is appropriately scaled to their actual digital transformation goals.

5. Conclusions

This paper introduces a novel reference point-based MCDA framework explicitly tailored for Virtual Private Server (VPS) selection in the context of SMEs undergoing digital transformation. Traditional MCDA methods, such as TOPSIS and VIKOR, often focus on maximizing overall efficiency, frequently recommending VPS alternatives that are either excessively powerful or costly for the given requirements. These methods, which rely on synthetic ideal or anti-ideal solutions, can result in solutions that are overly optimized and not aligned with practical, real-world needs. In contrast, the proposed framework focuses on selecting VPS alternatives that align more closely with the actual operational requirements of SMEs, ensuring that resources are allocated effectively without over-provisioning, which could result in unnecessary costs and wasted energy.

This paper's key innovation lies in using a reference point-based approach, which allows decision-makers to specify a "target solution" based on software and operational requirements. By using Euclidean distance to rank alternatives in relation to this user-defined target solution, the proposed method ensures that the recommended VPS options are both cost-effective and sufficiently resource-efficient for the specific digitalization goals of the SME. The empirical study demonstrated that the proposed approach outperforms traditional MCDA methods by avoiding the common pitfall of recommending excessively high-end solutions that exceed the practical needs of SMEs.

Future work could expand the methodology to include flexibility in the form of range-based preferences or fuzzy reference points, particularly in cases where multiple acceptable configurations exist. Additionally, enhancing the visualization of decision-making results could further assist decision-makers in understanding which criteria have the most influence on the recommended VPS solutions.

The proposed reference point-based MCDA framework offers a promising, cost- and resource-effective approach for VPS selection, with potential for broader applications in fields such as cloud infrastructure, IT procurement, and other decision-making scenarios requiring resource optimization to predefined targets.

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