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Hybrid CRITIC–VIKOR method for objective-based component selection in ICT infrastructure planning for university laboratory systems

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ABSTRACT

Selecting appropriate hardware materials is a critical aspect in planning computer laboratory infrastructure at higher education institutions, aiming to support effective technology-based learning. This study aims to evaluate and identify the optimal hardware material alternatives by applying an integrated CRITIC–VIKOR approach to multi-criteria decision making (MCDM). The CRITIC method is employed to determine objective weights for each criterion based on standard deviation and inter-criteria correlation, while the VIKOR method is used to rank the alternatives through a compromise solution approach. Nine hardware material alternatives including types of casings, cooling systems, and cables were assessed against five key criteria: cost, durability, energy efficiency, compatibility, and availability. The analysis results show that Energy Efficiency had the highest objective weight (0,260563785), followed by Durability (0,234238828) and Availability (0,211419693). Based on the compromise index (Q), the best alternatives in each category were Steel Casing (Q = 0,059737547), Liquid Cooler (Q = 0,350101862), and Braided Cable (Q = 0.0000). These findings demonstrate that the integrated CRITIC–VIKOR method effectively produces objective and balanced evaluations. This model may serve as a strategic decision-making tool for higher education institutions in the procurement of computer laboratory hardware based on data-driven considerations.

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1. INTRODUCTION

The rapid advancement of information and communication technology (ICT) has become a pivotal driver for governments across the globe in promoting transparency and accountability in public service delivery, including in the education sector (Rade Nugraha et al., 2025) in higher education, ICT plays a crucial role in facilitating information sharing and optimizing institutional resources (Leng et al., 2014), particularly in enhancing student services (Anam et al., 2023) As a result, computer laboratories have emerged as essential facilities within universities, especially in departments related to informatics engineering, information systems, and computer technology. Computer laboratories function not only as spaces for academic instruction such as programming practicums and system simulations but also serve as hubs for research, software development, and digital skills training. These facilities support experimental learning and provide an environment for analysis and observation involving various digital tools and technological equipment (Noptrina et al., 2024). To ensure the effectiveness and efficiency of computer laboratory utilization, the proper selection of hardware is critical. This includes considerations of quality (Setyaedhi, 2021), durability, and operational suitability (Maulana et al., 2021), (Sugiarti et al., 2025). The availability of reliable and context-appropriate hardware directly contributes (Maidin et al., 2025) to the smooth execution of both academic and non-academic activities in higher education settings.

However, in practice, many computer laboratories in higher education institutions face significant challenges in the procurement and renewal of hardware components. Common issues include the use of low-quality components that lack durability, hardware overheating due to inadequate cooling systems, connector or internal cables that fail to meet required specifications leading to connectivity disruptions or even device damage and the selection of PC casings that do not support proper airflow or are difficult to access for maintenance purposes. These problems are generally rooted in conventional hardware selection practices that rely heavily on technician experience or past purchasing habits, without systematically considering a range of other critical criteria such as power consumption, noise levels, ease of maintenance, spare part availability, technical specifications, and the specific operational requirements of the laboratory.

The complexity of hardware selection for computer laboratories continues to grow in line with the increasing diversity of products available on the market and the necessity to balance technical requirements with limited budget allocations. The absence of a quantitative and objective approach in the selection process often leads to budget inefficiencies, more frequent maintenance, and a gradual decline in laboratory performance over time. To address these challenges, a systematic approach is essential one that objectively incorporates both technical and non-technical criteria in the decision-making process. In this context, the Multi-Criteria Decision Making (MCDM) approach (Vania & Utama, 2025), (Anaam et al., 2024 offers a suitable and robust solution (Leng et al., 2014), (Mukhopadhyay, 2000) MCDM is capable of accommodating the inherent complexity of decision-making scenarios (Radwan et al., 2021) that involve numerous alternatives and multiple evaluation criteria. Its structured framework enables decision-makers to arrive at more rational, transparent, and justifiable outcomes, particularly in environments characterized by competing priorities and resource constraints.

The Multi-Criteria Decision Making (MCDM) method is capable of structuring and categorizing a set of alternatives based on multiple evaluation criteria, accommodating both quantitative and qualitative attributes. It enables rational and transparent justification of decisions, enhances objectivity in the selection process, reduces the dominance of subjective opinions, and facilitates the ranking of criteria related to innovation (H. Gupta & Barua, 2018). MCDM is also effective in addressing real-world Quality Function Deployment (QFD) challenges by integrating fuzzy set theory (Wu et al., 2017). MCDM is also effective in addressing real-world Quality Function Deployment (QFD) challenges by integrating fuzzy set theory (Gul, 2020). One relevant combination of MCDM methods is the integration of CRITIC (Criteria Importance Through Intercriteria Correlation) and VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje). The CRITIC method (Arivendan et al., 2025), (Xu et al., 2020), (S. Gupta et al., 2021) is employed to determine the objective weights of criteria (Wei et al., 2020) based on the variability of data and the correlation among criteria. This approach minimizes human subjectivity commonly associated with manual weighting methods, thus producing more representative weights aligned with actual conditions. According to (Keshavarz Ghorabaee et al., 2017), the objective weights derived from CRITIC can be combined with subjective weights from decision-makers to obtain more accurate and realistic criteria weights. These weights are subsequently applied in the VIKOR method to evaluate and rank alternatives based on their closeness to an ideal solution free from bias. The integration of these two methods forms a complementary decision-making process.

Meanwhile, the VIKOR method serves to determine the most suitable alternative using a compromise solution approach (Mardani et al., 2016). VIKOR evaluates the relative closeness of each alternative to the ideal solution, both individually and collectively, making it highly appropriate for material selection contexts that involve multiple considerations and trade-offs among criteria. Additionally, VIKOR ranks alternatives by considering their distance from both the positive and negative ideal solutions. As a result, the final outcome reflects not only a single preference but also presents alternatives based on the most rational compromise solution (Ma et al., 2019), (Liu & Wu, 2012). Previous studies have demonstrated the effectiveness of the VIKOR method in evaluating and selecting the best alternative (Karami et al., 2021) such as in supplier selection within complex environments (Alimardani et al., 2013). The primary strength of VIKOR lies in its ability to balance collective satisfaction with individual dissatisfaction across alternatives (Jamshaid et al., 2025).

This capability is particularly valuable in hardware selection scenarios, where trade-offs frequently exist between price, performance, energy efficiency, and component lifespan.

Through the application of the VIKOR approach combined with q-Rung Orthopair Fuzzy Sets (q-ROFS), individuals and organizations can more effectively navigate the complexities of health insurance selection, thereby improving satisfaction with the decisions made and achieving more optimal overall outcomes (Seikh & Dey, 2025). The fuzzy VIKOR method plays a crucial role in supporting and facilitating decision-makers in identifying the most suitable alternative in supplier selection processes (Christanto et al., 2025). In Shimla, India a mountainous region undergoing rapid urbanization—the feasibility assessment of landfill site selection was conducted by integrating Remote Sensing and Geographic Information System (RS-GIS) technologies with the Analytical Hierarchy Process (AHP) and VIKOR methods. This integrated approach produced a zonation map of landfill suitability and ranked potential sites based on their levels of appropriateness (Chaturvedi et al., 2025). Furthermore, the VIKOR method, when combined with Type-2 Intuitionistic Fuzzy Sets, has demonstrated higher effectiveness in ranking system component risks under uncertainty (Y. Fu et al., 2021). Research findings also indicate that VIKOR integrated with fuzzy AHP can be employed to overcome minor limitations in stochastic frontier analysis and data envelopment analysis approaches (H. P. Fu et al., 2011).

The proposed hybrid CRITIC–VIKOR framework takes into account the latest hardware technology developments indirectly through the formulation of evaluation criteria such as thermal performance, durability, cost-efficiency, energy efficiency, maintainability, and environmental impact. Although emerging technologies like modular cooling systems, green computing components, and advanced cabling (e.g., braided or fiber modular cables) are not included as separate criteria, their technological advantages are captured through multi-dimensional indicators that influence the decision-making process. For instance, in the selection of PC casing materials (ABS Plastic, Aluminum, Steel), newer material technologies that offer better thermal dissipation and recyclability (e.g., aluminum casing) are favored when cooling efficiency and environmental friendliness are prioritized, for heatsink/cooler types, options like AIO Liquid Coolers that represent modern modular cooling approaches are rated higher if they provide superior thermal performance, noise reduction, and ease of integration in laboratory environments, in choosing cable types, advanced solutions such as braided or modular fiber cables reflect modern trends in green ICT and flexible infrastructure. These are positively evaluated under criteria such as durability, installation ease, and long-term reliability.

The CRITIC method ensures that weights assigned to criteria are objective and reflect the real variance and conflict among alternatives, thus allowing technologically superior options to emerge as optimal when they offer clear advantages. The VIKOR method then identifies the best compromise solutions considering multiple conflicting objectives. Therefore, even though the framework does not explicitly list "latest technologies" as evaluation items, its adaptive and data-driven structure ensures that newer, more efficient, and environmentally aligned components naturally gain preference, provided that the criteria reflect such dimensions. The integration of the two methods, the decision-making process for selecting computer laboratory hardware materials can be conducted in a more objective, rational, accurate, and transparent manner. This approach is expected to improve procurement quality, reduce long-term operational costs, and foster the development of more stable, efficient, and sustainable laboratory systems. The objectives of this study are to determine the objective weights of hardware selection criteria using the CRITIC method, to select the optimal computer laboratory hardware alternatives using the VIKOR method, and to develop a CRITIC–VIKOR-based decision support system that facilitates effective and efficient hardware material selection. This study proposes the integration of the CRITIC and VIKOR methods as an innovative approach to the selection of computer laboratory hardware materials in higher education institutions. The CRITIC method is employed to objectively determine the weights of selection criteria based on data variability and inter-criteria correlations, thereby minimizing subjective bias. Subsequently, the VIKOR method applies the principle of compromise solutions to identify the most suitable alternatives amidst conflicting criteria. The specific focus on selecting PC casings, heatsinks, and cables in university laboratories represents a novel contribution that has been rarely explored, offering significant value to the advancement of MCDM studies within the context of academic laboratory management. Accordingly, this research provides a practical solution that can assist laboratory managers in enhancing the quality of hardware procurement and improving the long-term operational efficiency of laboratory environments.

2. RESEARCH METHOD

This study employs a quantitative approach using Multi-Criteria Decision Making (MCDM) by integrating two primary methods: a) CRITIC (Criteria Importance Through Intercriteria Correlation), to objectively determine the weights of criteria based on data variability and inter-criteria correlations; b) VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje), to rank the alternatives based on the compromise solution principle relative to the ideal solution.

These methods are applied to evaluate and select the most optimal hardware material alternatives for computer laboratories based on multiple criteria. The selected criteria include Cost, Durability, Energy Efficiency, Compatibility, dan Availability. The alternatives and sub-alternatives evaluated in this study are PC Case Types: ABS Plastic, Aluminum, and Steel, Heatsink/Cooler Types: Air Cooler, Liquid Cooler (AIO), and Passive Cooler Cable Types: Copper Cable, Braided Shielded Cable, and Premium Modular/Fiber Cable. The stages of this research are as follows: a) Identify relevant alternatives and evaluation criteria; b) Collect assessment data for each alternative with respect to the criteria; c) Normalize the data and calculate objective weights using the CRITIC method; d) Apply the obtained weights in the VIKOR method to compute the S, R, and Q values; e) Rank the alternatives based on the Q value and analyze the results.

Validation of Cost and Benefit Criteria Classification

To ensure the objectivity and consistency of the decision model, the classification of cost and benefit criteria was conducted through a structured approach. Cost criteria (e.g., price, energy consumption) were defined as attributes where lower values are preferred, while benefit criteria (e.g., thermal performance, material strength) were associated with higher desirable values. Expert validation was carried out by ICT infrastructure specialists and laboratory technicians to confirm the appropriateness of the classification across all component types (PC case, cooler, and cable). Normalization techniques were applied distinctly:

a) For benefit criteria

$$r_{ij} = \frac{x_{ij} - min(x_j)}{max(x_j) - min(x_j)} \quad (1)$$

b) For cost criteria

$$r_{ij} = \frac{max(x_j) - x_{ij}}{max(x_j) - min(x_j)} \quad (2)$$

This ensured directional consistency in utility calculations. A sensitivity analysis was conducted by adjusting weight distributions, and the resulting rankings remained stable. This demonstrated the robustness of the classification and confirmed the absence of bias toward specific alternatives.

3. RESULTS AND DISCUSSIONS

Alternative Data and Evaluation Criteria

This study employs three primary alternatives, each comprising three sub-alternatives, evaluated against five key criteria. The defined alternatives and their respective sub-alternatives include: PC Case Types (ABS Plastic, Aluminum, and Steel), Heatsink/Cooler Types (Air Cooler, Liquid Cooler (AIO), and Passive Cooler), and Cable Types (Copper Cable, Braided Shielded Cable, and Premium Modular/Fiber Cable). The evaluation data for these alternatives were obtained from 30 purposively selected respondents, consisting of computer laboratory technicians, faculty members, practicum instructors, and hardware procurement staff. The assessment was conducted using a five-point Likert scale ranging from 1 (Very Poor) to 5 (Very Good). This rating scale was used to capture expert judgments regarding the performance of each sub-alternative in relation to the established criteria. A summary of the data is presented in Table 1.

Table 1. Alternative data based on respondent evaluations

Alternative	Cost	Durability	Energy Efficiency	Compatibility	Availability
Case Types ABS	4.31034	4.27586207	4.413793103	4.206896552	4.13793103
Case Types Aluminum	4.13793	4.44827586	4.275862069	4.448275862	4.10344828
Case Types Steel	4.13793	4.37931034	4.275862069	3.965517241	4.4137931
Heatsink/Cooler Types Air Cooler	4.13793	4.34482759	4.310344828	4.068965517	4.03448276
Heatsink/Cooler Types Liquid Cooler	4,24138	4.31034483	4.448275862	4.24137931	4.10344828

Heatsink/Cooler Types Passive Cooler	4.34483	4.10344828	4.172413793	4.068965517	4.4137931
Copper Cable	4.27586	4.34482759	4.034482759	4.103448276	4.44827586
Braided Shielded Cable	4.17241	4.37931034	4.310344828		4.44827586
remium Modular/Fiber	4.34483	4.4137931	4.344827586	4.413793103	4.17241379

Based on the respondents' evaluations, the highest score for the cost criterion was awarded to the passive cooler with a value of 4.34483 followed closely by the fiber/modular cable and ABS plastic casing, both scoring above 4.30. Conversely, the lowest scores for this criterion were recorded for the aluminum and steel casings, each receiving a score of 4.13793, indicating a perception of relatively higher cost or lower economic value compared to other alternatives. For the durability criterion, the aluminum casing achieved the highest rating, with a score of 4.44827586, highlighting its superior physical strength. It was followed by the fiber/modular cable (4.4137931) and steel casing (4.37931034). The lowest score was observed in the passive cooler, with a value of 4.10344828, which may be attributed to its limited resistance to heat or long-term operational stress due to its passive components.

For the energy efficiency criterion, the liquid cooler achieved the highest score of 4.448275862. indicating its superior thermal performance and optimized power usage. In contrast, the copper cable received the lowest score of 4.034482759, suggesting that this type of cable is relatively less efficient, possibly due to higher resistance in power transmission. Regarding compatibility, the aluminum casing and the fiber/modular cable obtained the highest ratings of 4.448275862 and 4.413793103, respectively. These results indicate a high degree of flexibility and integration with various hardware configurations. On the other hand, the lowest compatibility scores were recorded for the steel casing (3.965517241) and the braided cable (4.00), which may reflect limitations in their adaptability with other components. In terms of availability, both copper and braided cables achieved the highest ratings of 4.44827586, reflecting their widespread presence in the market. Conversely, the air cooler received the lowest score of 4.03448276. The following horizontal bar chart illustrates the average scores for each hardware material alternative across the five evaluation criteria: cost, durability, energy efficiency, compatibility, and availability.

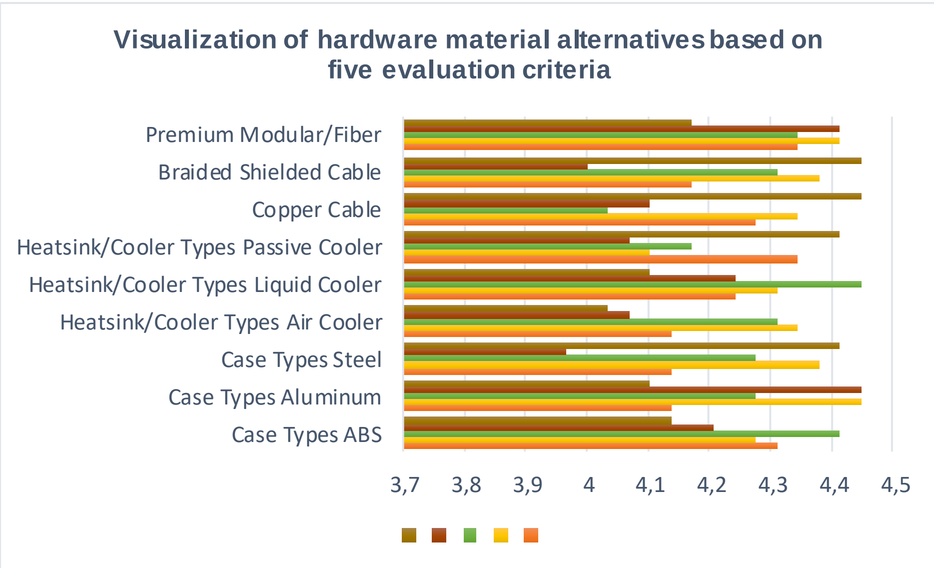

Figure 1. Visualization of hardware material alternatives based on five evaluation criteria

In the multi criteria decision-making process using the CRITIC–VIKOR method, each criterion is classified into two types: cost criteria and benefit criteria. In this study, cost refers to the price criterion, as hardware material selection in laboratory settings must account for cost-efficiency. This implies that the lower the perceived price of a material (as rated by respondents), the more preferable the alternative is considered. On the other hand, the criteria of durability, energy efficiency, compatibility, and availability are categorized as benefit criteria, as they represent positive attributes that are desired to be maximized in the decision-making process.

Normalization of the Decision Matrix

The normalization process is conducted by comparing each performance value of an alternative to the maximum value within the corresponding criterion. Conversely, for cost-type criteria such as price, normalization is performed by comparing the minimum value to each alternative’s score to ensure that the direction of preference remains consistent i.e., the lower the cost, the better the alternative. The outcome of this process is a normalized decision matrix, which reflects the relative performance of each alternative on a standardized scale ranging from 0 to 1. A value approaching 1 indicates that the alternative exhibits the best performance for a given criterion, while a value near 0 signifies the weakest performance. The results of the normalization are presented in Table 2.

Table 2. Normalized decision matrix

Alternative	Cost	Durability	Energy Efficiency	Compatibility	Availability
Case Types ABS	0	1	1	0.333333333	0
Case Types Aluminum	0.66667	0	0.5	0.333333333	1
Case Types Steel	0.66667	0	1	0.333333333	0.5
Heatsink/Cooler Types Air Cooler	0.33333	0.33333333	0.5	0.333333333	0
Heatsink/Cooler Types Liquid Cooler	1	0.66666667	0.5	0.666666667	1
Heatsink/Cooler Types Passive Cooler	0.66667	0	0	1	1
Copper Cable	0.33333	0	0	0	0
Braided Shielded Cable	0.66667	0	0.5	0.333333333	0.5
Premium Modular/Fiber	1	0	0	0.666666667	1

As shown in Table 2, the ABS plastic case demonstrates strong performance in both durability and energy efficiency criteria. The liquid cooler achieves the highest normalized score for cost, while also excelling in compatibility and availability, indicating a well-balanced alternative. The passive cooler stands out in terms of compatibility and availability, but registers the lowest score in energy efficiency, suggesting limitations in its thermal performance. In contrast, the copper cable exhibits the weakest performance across almost all evaluation criteria, highlighting its relative inferiority compared to other alternatives.

Criteria Weighting Using the CRITIC Method

Standard Deviation of Each Criterion

After completing the normalization of the decision matrix and the initial assessment of alternatives' performance against each criterion, the next step involves calculating the standard deviation of each criterion. In the CRITIC method, standard deviation is used to measure the extent to which a criterion can differentiate among the alternatives. A higher standard deviation indicates that a criterion carries more significant information, and therefore, is assigned a greater weight in the decision-making process. The standard deviation values for each criterion are presented in Table 3.

Table 3. Standard deviation of each evaluation criterion

Cost	Durability	Energy Efficiency	Compatibility	Availability
0.323941772	0.372677996	0.39086798	0.288675135	0.463980364

The highest standard deviation value is observed for the availability criterion (0.46398), indicating that it contributes the most significant informational value compared to the other criteria. In contrast, the compatibility criterion registers the lowest standard deviation (0.28868), suggesting it has the least discriminative power in distinguishing among the evaluated alternatives.

Inter-Criteria Correlation Coefficients

The correlation coefficients between criteria are used to measure the degree of redundancy or informational dependence among criteria in the multi-criteria decision-making process. These coefficients not only assess the relationships between variables but also contribute to the objective determination of each criterion’s importance. By incorporating correlation analysis, the CRITIC method ensures that final weights are not biased toward highly similar criteria, and instead prioritizes those that provide more unique and informative contributions to the decision model. The correlation coefficients among the criteria are presented in Table 4.

Table 4. Correlation coefficients between evaluation criteria

Alternative	Cost	Durability	Energy Efficiency	Compatibility	Availability
Cost	1	-0.4218307	-0.365636212	0.544581149	0.86245755
Durability	-0.4218	1	0.524404424	0	-0.3212877
Energy Efficiency	-0.3656	0.52440442	1	-0.307728727	-0.3254818
Compatibility	0.54458	0	-0.307728727	1	0.72586619
Availability	0.86246	-0.3212877	-0.325481822	0.725866186	1

A very high positive correlation is observed between Cost and Availability 0.86246, indicating that these two criteria tend to increase or decrease together. This suggests that hardware materials with higher prices are often more widely available, or vice versa. A moderate positive correlation is also found between Durability and Energy Efficiency (0.52440442), implying that alternatives with higher durability often exhibit better energy performance. Conversely, a moderate negative correlation exists between Cost and Durability (-0.4218307), as well as between Cost and Energy Efficiency (-0.3656), indicating that higher-cost materials do not necessarily offer better durability or energy efficiency. Additionally, the correlation between Compatibility and Availability is relatively high (0.72586619), suggesting that materials with better system compatibility are also more readily available in the market.

Final Weights of Evaluation Criteria

These final weights reflect the relative importance of each criterion in the decision-making process. A higher weight indicates that the criterion contributes more significantly to differentiating between available alternatives. Conversely, criteria with lower weights are considered to provide less unique information or exhibit redundancy with other criteria. The final weights derived through the CRITIC method are used as input in the VIKOR method and are presented in Table 5.

Table 5. Final weights of evaluation criteria

Cost	Durability	Energy Efficiency	Compatibility	Availability
0,163148739	0,234238828	0,260563785	0,130628955	0,211419693

Table 5 shows that Energy Efficiency received the highest weight 0.260563785, indicating that this criterion has the most dominant influence in differentiating among computer hardware material alternatives. It is followed by Durability and Availability, with weights of 0.234238828 and 0.211419693, respectively both playing a significant role in the decision-making process. Sebaliknya, In contrast, Cost has a lower weight 0.163148739 while Compatibility has the smallest weight 0.130628955, suggesting that these criteria contribute less unique information or may overlap with other criteria. These final weights are then used to construct the weighted decision matrix, which forms the basis for calculating the compromise index (Q) in the VIKOR method to determine the overall ranking of alternatives.

Evaluation of Alternatives Using the VIKOR Method

After obtaining the objective weights through the CRITIC method, the evaluation of alternatives was carried out using the VIKOR method, which aims to identify the best alternative based on the concept of a compromise solution. VIKOR considers a balance between total utility (S) and maximum individual regret (R), then calculates the compromise index (Q) for each alternative. The Q value represents the degree of closeness of an alternative to the ideal compromise solution, taking into account both collective satisfaction and individual dissatisfaction. A lower Q value indicates that the alternative is closer to the ideal compromise. Table 6 presents the evaluation results, showing the final Q values and the corresponding ranks of the nine hardware material alternatives for the University Laboratory Systems.

Table 6. Results of VIKOR method evaluation

Alternative	Final Q Scores	Rank
Case Types ABS	0.39834	3
Case Types Aluminum	0.20018	2
Case Types Steel	0.05974	1
Heatsink/Cooler Types Air Cooler	0.55451	2
Heatsink/Cooler Types Liquid Cooler	0.3501	1
Heatsink/Cooler Types	0.90549	3

Alternative	Final Q Scores	Rank
Passive Cooler		
Copper Cable	0.80638	3
Braided Shielded Cable	0	1
Premium Modular/Fiber	0.29665	2

Table 6 presents the evaluation results, showing that the Steel Case obtained the lowest Q-value (0.05974) and ranked first, indicating that it is the closest to the ideal solution among the casing alternatives. The Aluminum Case follows in second place (Q = 0.20018), while the ABS Case ranks third (Q = 0.39834), suggesting that the steel case offers the best overall balance across the evaluation criteria. In the cooling category, the Liquid Cooler ranks first (Q = 0.3501), outperforming the Air Cooler, which ranks second (Q = 0.55451), The Passive Cooler ranks third with the highest Q-value (0.90549), indicating the furthest distance from the ideal compromise solution in this group.

Meanwhile, in the cable category, the Braided Cable ranks first (Q = 0) indicating that it is the optimal alternative with a compromise value equal to the ideal solution. This is followed by the Modular/Fiber Cable in second place (Q = 0.29665), and the Copper Cable in third place (Q = 0.80638). Overall, these findings demonstrate that the VIKOR method effectively identifies the best alternative within each category by considering all evaluation criteria that have been objectively normalized and weighted using the CRITIC method. Alternatives with lower Q values are considered more balanced and superior in terms of trade-offs among the assessment aspects. A comparison of Q values for each alternative is illustrated in Figure 2.

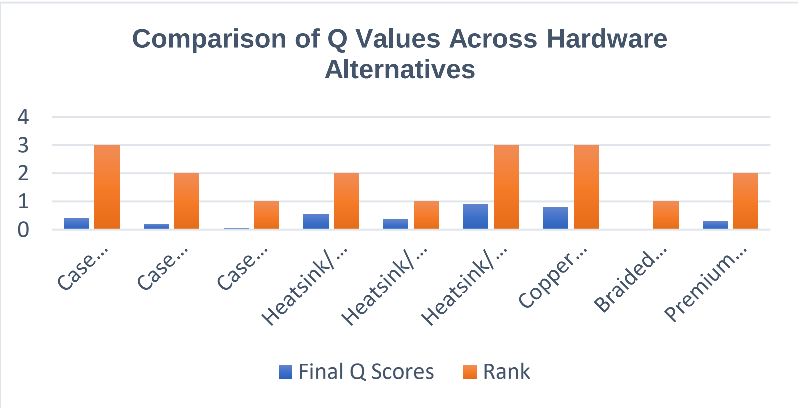

Figure 2. Comparison of Q values across hardware alternatives

Discussion

This study integrates the CRITIC (Criteria Importance Through Intercriteria Correlation) and VIKOR (VIšekriterijumsko KOmpromisno Rangiranje) methods within a multi-criteria decision-making framework to identify the optimal alternative in selecting hardware materials for computer laboratories. This methodological integration aims to obtain objective criterion weights while facilitating compromise-based decision-making that balances collective utility and individual dissatisfaction.

The CRITIC method offers an objective approach to weighting by evaluating the degree of variation (standard deviation) and the level of conflict (correlation) among criteria. The results indicate that energy efficiency holds the highest weight at 0.260563785, followed by durability (0.234238828) dan Ketersediaan (0.211419693). Hal ini mengindikasikan bahwa ketiga kriteria tersebut memainkan peran paling signifikan dalam membedakan kualitas alternatif, karena memiliki variasi data yang tinggi dan korelasi rendah dengan kriteria lain. Sebaliknya, Harga hanya memperoleh bobot sebesar 0.163148739, and availability 0.130628955. These three criteria are the most influential in distinguishing among alternatives due to their high data variability and low correlation with other criteria.

After obtaining the objective weights, alternative evaluation was conducted using the VIKOR method to generate a ranking based on a compromise solution. The compromise index (Q) was calculated based on total utility (S) and maximum individual regret (R), with a balance parameter (v) set at 0.5. Alternatives with the smallest Q values are considered the best choices, as they are closest to the ideal solution. In the casing category, Steel Case emerged as the best alternative (Q = 0.05974), followed by Aluminum Case (Q = 0.20018) and ABS Case (Q = 0.39834). For cooling systems, Liquid Cooler ranked first (Q = 0.3501), with Air Cooler and Passive Cooler in the subsequent positions. In the cable category, Braided Cable achieved a Q value of 0, indicating it as the absolute best alternative, followed by Fiber/Modular Cable (Q = 0.29665), and Copper Cable (Q = 0.80638).

These findings demonstrate that the CRITIC–VIKOR approach can objectively and fairly identify the most suitable alternatives by balancing all evaluation criteria. This method is particularly valuable in technical decision-making contexts, such as hardware selection for computer laboratories, where conflicts between criteria such as cost efficiency versus quality are common. Moreover, the use of objective weights derived from CRITIC eliminates subjectivity, while VIKOR ensures a compromise solution acceptable to multiple stakeholders. Therefore, the integration of these two methods presents a robust model for decision support systems in the fields of technology and education.

4. CONCLUSION

This study successfully implemented the integration of CRITIC–VIKOR methods in the multi-criteria decision-making process for selecting hardware materials in computer laboratories. The CRITIC method objectively determines the weight of each criterion based on data variability and informational independence, while the VIKOR method evaluates and ranks the alternatives according to the principle of compromise solutions. The results indicate that Energy Efficiency, Durability, and Availability are the most critical criteria in distinguishing the performance of alternatives. The evaluation using VIKOR produced the best-ranked alternatives in each category: Steel Case as the optimal casing, Liquid Cooler as the best cooling system, and Braided Cable as the most suitable cable type, with an ideal compromise value (Q = 0).

The findings of this study not only contribute to effective component selection for ICT infrastructure in university laboratories but also offer a practical foundation for sustainable asset management. The hybrid CRITIC–VIKOR method enables institutions to make objective, criteria-based decisions that consider both short-term procurement efficiency and long-term hardware rejuvenation. By incorporating factors such as lifecycle value, energy efficiency, and component durability, this framework supports informed upgrade planning, promotes green computing initiatives, and ensures continuity in decision-making aligned with sustainability objectives.

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