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Multi-Criteria Evaluation of Open Source HRIS Using the AHP-TOPSIS Method

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Abstract: Organizations are increasingly adopting open-source Human Resource Information Systems (HRIS) due to their cost-efficiency, configurability, and scalability. However, selecting the most suitable platform remains a major challenge due to diverse functional requirements. This study aims to determine the most appropriate Free and Open Source Software (FOSS) HRIS based on key decision-making criteria. A comparative evaluation was conducted on three platforms, IceHRM, OrangeHRM, and Sentrifugo, using the Analytic Hierarchy Process (AHP) to calculate criterion weights and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to rank the alternatives. Seven HR functional domains, including employee management, attendance, recruitment, and payroll, formed the evaluation framework. The results indicate that IceHRM achieved the highest relative closeness score ($RC = 0.7892$), followed by OrangeHRM ($RC = 0.7428$), and Sentrifugo ($RC = 0.0133$). Based on the evaluation model, IceHRM is identified as the most suitable option due to its alignment with prioritized functional criteria. The proposed AHP-TOPSIS approach provides an objective and replicable decision-support model for organizations undertaking HRIS selection as part of digital transformation initiatives.

Introduction

Organizations across sectors increasingly rely on digital infrastructure to streamline human resource (HR) functions (1-4). However, the high implementation and licensing costs associated with commercial Human Resource Information Systems (HRIS) remain a significant barrier, particularly for small and medium-sized enterprises (SMEs) (5-7). As a result, interest in Free and Open-Source Software (FOSS) HRIS has increased, as these solutions offer cost-effectiveness, flexibility, and long-term sustainability (8, 9). Despite the expanding availability of FOSS HRIS options, selecting a system that aligns with organizational needs remains complex due to variations in functionality, usability, security, and technical support.

The urgency of this issue is reinforced by the increasing rate of HRIS adoption globally, coupled with documented operational inefficiencies arising from the implementation of unsuitable systems (10-12). Historical evidence shows that HRIS solutions have existed since the 1980s, with each option offering distinctive capabilities and limitations (13). When there is a misalignment between HRIS features and organizational requirements, such as payroll, recruitment, attendance tracking, and employee self-service, the result can be workflow disruption and reduced HR performance, especially in resource-constrained operational environments

(12).

Existing approaches to HRIS selection often rely on subjective judgment or limited benchmarking, without leveraging systematic and replicable evaluation frameworks (14, 15). While some studies utilize surveys or comparative assessments, many lack structured decision-support methodologies and do not integrate multi-criteria decision-making models (16, 17). Furthermore, unlike proprietary HRIS platforms that typically benefit from consistent vendor support, FOSS HRIS solutions vary significantly in maturity, development activity, and community engagement (18). Despite growing research attention toward HRIS evaluation, no prior comparative study has applied a combined Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) framework specifically for evaluating open-source HRIS tools, highlighting a clear research gap.

To address this gap and the complexity of software selection, this study introduces a structured Multi-Attribute Decision Making (MADM) model using AHP to define and weight evaluation criteria and TOPSIS to rank platform alternatives based on their relative closeness to an ideal solution. The evaluation focuses on three widely used FOSS HRIS platforms, OrangeHRM, IceHRM, and Sentrifugo, based on essential HR management functionalities. By integrating both methods into a unified framework, this research offers a

replicable, data-driven approach to software benchmarking and decision-making.

The aim of this study is to recommend the most suitable FOSS HRIS based on organizational functional priorities using a structured and objective evaluation process. The outcomes are expected to support organizations in making informed HRIS adoption decisions that enhance operational efficiency and reduce implementation risks.

Methodology

Study Design and Rationale

This study employed a descriptive quantitative research design using a multi-criteria decision-making (MCDM) approach. The primary objective was to compare three free and open-source Human Resource Information Systems (FOSS HRIS) based on software requirement specifications. The integration of the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was chosen to ensure objective evaluation and prioritization of alternatives. AHP was used to determine the relative weights of evaluation criteria, while TOPSIS ranked the alternatives based on their proximity to the ideal solution.

Sample and Selection Criteria

The study focused on three FOSS HRIS platforms: OrangeHRM, IceHRM, and Sentrifugo. These systems were selected based on four justification criteria: (1) full open-source licensing under OSI-approved terms, (2) availability of stable releases and active development repositories, (3) broad adoption among organizations and research studies, and (4) completeness of features aligned with core HRM functions. These three platforms represent the most widely referenced FOSS HRIS solutions in recent literature and usage communities, making them suitable candidates for comparative evaluation. The study focused on three FOSS HRIS platforms: OrangeHRM, IceHRM, and Sentrifugo. Functional data were obtained through direct testing and review of official software documentation.

Tools and Techniques

The evaluation was conducted using AHP and TOPSIS methods. The pairwise comparison process in the AHP phase was carried out by three evaluators, consisting of one HR information systems practitioner and two academic experts in information systems management. The involvement of these evaluators ensured informed judgment and contributed to the reliability of the weighting process by minimizing subjective bias. Microsoft Excel was utilized to construct pairwise comparison matrices, perform consistency checks, and execute final calculations. Functional testing for each HRIS alternative was conducted using scenario-based procedures aligned with standard HRM practices. Key features such as payroll, leave management, attendance, recruitment, employee self-service, reporting, and organizational structure were used as core evaluation criteria.

Procedures

The evaluation procedure was conducted in three structured phases: identification of functional requirements, determination of criteria weights using the Analytic Hierarchy Process (AHP), and final ranking of alternatives using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

(TOPSIS).

In the first phase, a set of seven functional criteria was established to reflect the core activities commonly managed within Human Resource Information Systems. These included leave management, payroll processing, attendance tracking, recruitment, employee self-service, reporting capabilities, and organizational administration. The selection of these criteria was grounded in standard HRM functions, ensuring relevance and applicability across organizational contexts.

Next, the AHP methodology was applied to quantify the relative importance of each criterion. A pairwise comparison matrix was constructed using a 1-9 scale to capture expert judgments on the comparative significance of each criterion. From this matrix, eigenvalues and consistency ratios (CR) were calculated to validate the logical consistency of the judgments. The consistency ratio (CR) was calculated following Saaty's formula: $CR = CI / RI$, where $CI = (\lambda_{\max} - n) / (n - 1)$ and RI refers to the Random Index based on matrix size. The eigenvalue approach was applied to derive λ_{\max} , and all steps were executed using the same normalized matrix shown in Tables 3-5. The resulting CR value of 0.08 indicates acceptable logical consistency (< 0.1). A consistency ratio threshold of 0.1 was adopted, and the CR value obtained in this study was 0.08, indicating an acceptable level of consistency. The normalized priority weights derived from AHP were then carried forward for use in the TOPSIS analysis.

In the final phase, the TOPSIS method was employed to assess and rank the three HRIS alternatives, OrangeHRM, IceHRM, and Sentrifugo. A decision matrix was constructed by evaluating the functional performance of each software against the established criteria. The matrix was normalized and then multiplied by the corresponding AHP weights to generate a weighted normalized decision matrix. Subsequently, positive ideal and negative ideal solutions were identified for each criterion. The Euclidean distance of each alternative from both the ideal and anti-ideal solutions was computed. Finally, the relative closeness coefficient (CI^*) was calculated for each alternative, providing a quantitative basis for ranking the software solutions from most to least preferred.

Data Analysis

Quantitative data analysis followed the principles of MCDM. AHP provided a structured approach to criteria weighting and mitigated inconsistencies in expert judgment. TOPSIS enabled ranking of alternatives based on their closeness to the ideal solution. The analysis revealed IceHRM as the top-performing alternative ($CI^* = 0.7892$), followed by OrangeHRM (0.7428), and Sentrifugo (0.0133).

Ethical Considerations

As no human participants or personal data were involved, formal ethical approval was unnecessary. Ethical consideration in this study focused instead on open-source compliance, including verification of software licensing terms, version tracking through public repositories (e.g., GitHub releases), and responsible reporting of comparative findings.

Results

This section presents the results of implementing the Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), followed

Table 1. Functional requirement mapping of FOSS HRIS platforms.

No.	Feature	IceHRM	OrangeHRM	Sentrifugo
1	Search employee data	✓	✓	X
2	Add new employee	✓	✓	✓
3	Deactivate employee	✓	X	✓
4	View employee data	✓	✓	X

by a discussion of their functional performance evaluation and ranking of the FOSS HRIS alternatives.

Functional Testing

The evaluation was conducted using a system equipped with an Intel® Celeron® N3050 1.60GHz processor and 4GB RAM, running Windows 10 and accessed through a Brave browser with XAMPP versions 5.6.40, 7.1.33, and 8.0 configured for compatibility testing. The three selected FOSS HRIS platforms, OrangeHRM, IceHRM, and Sentrifugo, were installed locally under identical server environments to ensure consistent testing conditions. A standardized dummy HR dataset was developed and imported into each system to evaluate workflows under equivalent scenarios, including employee record creation, attendance logging, payroll configuration, and recruitment processing. This approach ensured a fair comparison across platforms and minimized bias arising from dataset variations or differing deployment environments.

Table 1 provides a concise comparison of functional coverage across the evaluated platforms, complementing the tabular presentation and enabling clearer interpretation of feature availability patterns among IceHRM, OrangeHRM, and Sentrifugo. The evaluation results indicate that the three HRIS platforms exhibit differing levels of functionality across key modules.

AHP Results

Using AHP, seven functional criteria (K1-K7) were compared pairwise to determine their relative weights. The consistency

ratio (CR) was calculated at 0.078 (7.8%), indicating acceptable consistency ($CR < 0.1$). The most significant criterion received the highest weight based on stakeholder prioritization. The dominance of payroll and attendance as the highest weighted criteria reflects their centrality in operational HR workflows, particularly within small and medium-sized enterprises (SMEs) where regulatory compliance, wage accuracy, and workforce time management are mission-critical. These criteria frequently represent the first modules automated during HRIS adoption and are highly associated with organizational efficiency, error reduction, and measurable return on investment. Therefore, their prioritization in the AHP results aligns with established HR process criticality and technology adoption theory in resource-constrained environments. The eigenvalue method was used to derive final priority vectors and confirm logical consistency across all comparisons (**Figure 1**).

TOPSIS Evaluation and Final Ranking

The TOPSIS method was applied to assess each alternative's proximity to the ideal solution. A normalized decision matrix was created, followed by weighting based on AHP results. Ideal positive and negative solutions were identified, and the relative closeness (Ci^*) for each HRIS was calculated. The initial step in the TOPSIS analysis involves constructing the decision matrix (X_{ij}), which contains the performance values of each HRIS alternative against all evaluation criteria. These raw values are shown in **Figure 2A**. This displays the unnormalized decision matrix (X_{ij}), which serves as the foundation for subsequent normalization and weighting steps in the TOPSIS method. After constructing the initial decision matrix, the next step in the TOPSIS process was normalization. This study applied vector normalization to transform the values and ensure comparability across all criteria. The results of this normalization are shown in **Figure 2B**.

Normalization was performed using vector normalization for each criterion. Minor numerical similarities observed across different criteria values resulted from rounding during the normalization process. To maintain readability, values

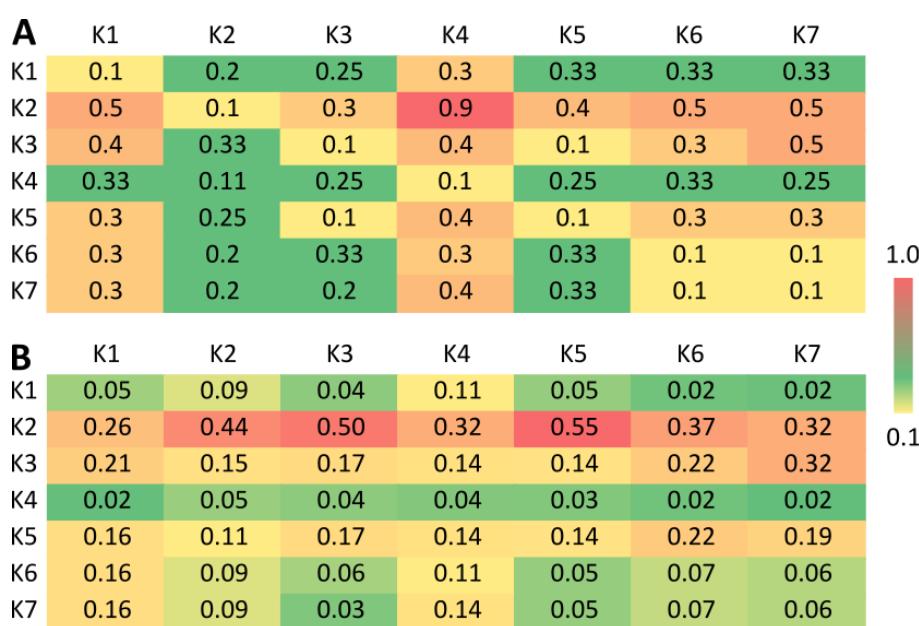


Figure 1. Heatmap of AHP functional criteria comparisons. Panel A shows the raw pairwise comparison matrix, and Panel B shows the normalized matrix used to calculate priority weights.

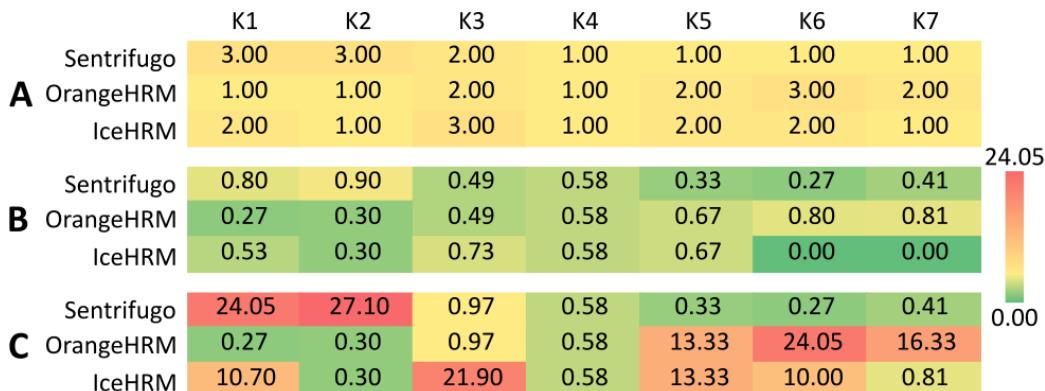


Figure 2. Heatmap visualization of the TOPSIS matrix transformations: (A) Initial Decision Matrix, (B) Normalized Decision Matrix, and (C) Weighted Normalized Decision Matrix.

Table 2. Priority vector, weighted sum, and consistency analysis.

Criterion	Weighted Sum (Σ)	Priority Vector (Weight)	λ_{\max}
K1	0.3792	0.0542	1.0474
K2	2.7516	0.3931	0.9019
K3	1.3391	0.1913	1.1542
K4	0.2177	0.0311	0.8709
K5	1.1227	0.1604	1.1628
K6	0.5880	0.0840	1.1481
K7	0.6017	0.0860	1.3394
Total	7.0000	1.0000	7.6247

were rounded to four decimal places, although the analysis was performed using full-precision outputs generated in Microsoft Excel. The rounding did not influence the Euclidean distance computations or the final ranking results. Weights were derived from the AHP priority vector and applied by multiplying each normalized value with its respective criterion weight (Table 2 and Figure 2C).

While some weighted normalized values in Tables 6–8 appear numerically larger than conventional TOPSIS normalization ranges (0–1), this is a result of multiplying normalized scores with AHP-derived criterion weights. This approach is consistent with standard AHP-TOPSIS procedures where weighted values may exceed the original normalization scale depending on relative criterion importance. Despite scale variation, the ranking outcomes remain mathematically valid because the TOPSIS distance and closeness coefficient rely on relative difference rather than absolute range constraints. IceHRM achieved the highest ranking ($C_i^* = 0.7892$), followed by OrangeHRM (0.7428), while Sentrifugo ranked last (0.0133).

Discussion

The application of the AHP-TOPSIS hybrid methodology in this study provides a structured and transparent approach to evaluating Free and Open-Source Software (FOSS) Human Resource Information Systems (HRIS). The results corroborate the findings of Milena K. (2022), who also identified IceHRM as the most functionally complete HRIS platform in their comparative analysis (19). However, unlike prior studies that relied primarily on qualitative assessments

or unweighted scoring systems, this research integrates a quantifiable multi-criteria decision-making (MCDM) framework. This methodological enhancement not only reduces subjectivity in HRIS selection but also ensures replicability of results, addressing a noted gap in earlier literature.

The seven evaluation criteria, covering essential HR functions such as employee management, attendance tracking, time management, recruitment, and payroll, reflect widely recognized best practices in HRIS deployment (20). The results positioned IceHRM as the top-performing alternative, with the highest relative closeness ($RC = 0.7892$) to the ideal solution (see Table 3 and 4). The narrow performance margin between IceHRM and OrangeHRM ($RC = 0.7428$) suggests that both systems offer competitive capabilities, particularly in core HR functions, though IceHRM demonstrates broader feature integration.

Sentrifugo's low relative closeness ($RC = 0.0133$) indicates limitations in functional coverage, especially in training and payroll modules. This finding contrasts with Majeed Z. and Ozyer S. (2016), who reported moderate adoption of Sentrifugo in certain organizations due to its ease of use and customizable interface, highlighting the role of context-specific requirements in HRIS selection (21).

The functional gaps observed in Sentrifugo, particularly in training, travel, and payroll modules, are strategically important because these modules support compliance, employee development, and financial accountability, which are recurring priorities in digital HR transformation initiatives. HRIS adoption literature highlights that systems lacking these capabilities create reliance on external spreadsheets or parallel tools, reducing perceived usefulness and slowing adoption. Thus, limited availability of mission-critical modules directly contributes to lower adoption likelihood, especially among organizations seeking a single integrated HR platform.

From a practical perspective, these results provide valuable insights for small and medium-sized enterprises (SMEs) or budget-conscious organizations seeking cost-effective HRIS solutions. The integration of AHP-TOPSIS ensures that the selection process is evidence-based, transparent, and adaptable to varying organizational priorities. Future research should extend this evaluation framework by incorporating qualitative feedback from end-users, real-time performance benchmarking, and comprehensive security audits to provide a more holistic assessment of FOSS HRIS platforms. Additionally, exploring

Table 3. Results of positive and negative ideal solutions.

Criteria	A ⁺ (Ideal Positive)	A ⁻ (Ideal Negative)
K1	2.4054	0.2673
K2	2.7136	0.3015
K3	2.1828	0.9701
K4	0.5774	0.5774
K5	1.3333	0.3333
K6	2.4054	0.2673
K7	1.6330	0.4082

Table 4. Final ranking results based on relative closeness (TOPSIS method).

Alternative	S ⁺	S ⁻	Relative Closeness	Result	Rank
Sentrifugo	14.8494	0.1905	0.0133	Least Preferred	3
OrangeHRM	3.6087	10.4209	0.7428	Preferred	2
IceHRM	2.5611	9.5869	0.7892	Most Preferred	1

cloud-based deployment performance and scalability could further strengthen decision-making for organizations undergoing digital transformation.

In addition to extending the evaluation scope through usability and security perspectives, future research may also incorporate computational advancements such as fuzzy AHP for handling uncertainty in expert judgment, entropy weighting to derive objective criterion weight, or grey-TOPSIS to manage incomplete or imprecise decision data. These extensions may further strengthen the robustness, flexibility, and applicability of the proposed multi-criteria evaluation framework.

Ethical and Theoretical Integration: Islamic Perspective

To provide a broader interpretive lens linking technical evaluation with ethical considerations, the following subsection integrates Islamic ethical principles relevant to responsible HRIS decision-making. In alignment with Islamic ethical principles, this study aims to assist organizations in making well-informed decisions regarding the selection of open-source Human Resource Information Systems (HRIS). Islamic teachings emphasize mutual assistance, knowledge dissemination, and time efficiency, values that closely align with the aims of this research.

This ethical foundation is exemplified in a hadith of the Prophet Muhammad (peace be upon him):

"A Muslim is a brother to another Muslim. He neither oppresses him nor leaves him helpless. Whoever fulfills the needs of his brother, Allah will fulfill his needs. Whoever alleviates the hardship of a Muslim, Allah will alleviate one of his hardships on the Day of Judgment. And whoever conceals the fault of a Muslim, Allah will conceal his faults on the Day of Judgment." (Sahih Bukhari, No. 2262)

Imam an-Nawawi explained that this hadith underscores the virtue of helping others in all aspects of goodness, whether through advice, knowledge, support, or resources, according to one's capacity. In this context, the present research serves as a contribution by offering a comparative

evaluation of FOSS HRIS platforms to support practical, informed, and ethical organizational decision-making.

Furthermore, the Qur'an promotes cooperation in righteousness, as stated in Surah Al-Maidah (5:2):

"...And cooperate in righteousness and piety, but do not cooperate in sin and aggression. And fear Allah; indeed, Allah is severe in penalty."

According to *Tafsir al-Jalalayn*, this verse prohibits the violation of sacred values and calls for mutual assistance in what is good and lawful. Accordingly, initiatives such as providing open, unbiased information to enhance organizational practices are consistent with Islamic ethical guidance.

Time management, a core function facilitated by HRIS, also holds great importance in Islam. Surah Al-'Asr (103:1-3) emphasizes the value of time and its purposeful use in faith, righteous deeds, truth, and perseverance. Classical scholars, including Imam al-Shafi'i, regarded this chapter as a sufficient foundation for moral and productive living. In modern organizational contexts, this underscores the relevance of systems that promote discipline, structure, and efficiency.

In conclusion, values such as helping others, optimizing time, and contributing to organizational excellence are deeply rooted in Islamic teachings. Though technical in nature, this study ultimately serves as a form of service, aimed at easing burdens and delivering benefits in accordance with both ethical and spiritual principles.

Conclusion

This study identified IceHRM as the most suitable FOSS HRIS alternative based on a multi-criteria evaluation using the integrated AHP, TOPSIS method. IceHRM achieved the highest relative closeness score (RC = 0.7892), demonstrating a measurable advantage over OrangeHRM (RC = 0.7428) and a substantial lead over Sentrifugo (RC = 0.0133). The magnitude of this performance gap reflects IceHRM's broader functional coverage, particularly in mission-critical HR modules such as payroll processing, attendance management, and employee self-service, as well as more balanced performance across supporting modules.

In practical terms, the findings demonstrate that the proposed evaluation framework may serve as a decision-support instrument for organizations, especially small and medium-sized enterprises (SMEs) with limited implementation resources, to identify a shortlist of suitable HRIS alternatives before proceeding to pilot deployment, usability testing, or vendor consultation. The structured scoring and ranking model also improves transparency and reduces subjectivity in the software selection process.

While the results offer meaningful insights, the evaluation was limited to functional criteria and did not assess usability, security, scalability, or performance under real-world workloads. Future studies may address these limitations by integrating end-user perception, cybersecurity metrics, system responsiveness, and additional computational techniques such as fuzzy-AHP, entropy weighting, or grey-TOPSIS to enhance the robustness and adaptability of the decision model.

Declarations

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Conflict of Interest

The authors declare no conflicting interest.

Data Availability

The unpublished data is available upon request to the corresponding author.

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Not applicable.

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Additional Information

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