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Development of a Web-Based Decision Support System for the Selection of Computer Laboratory Assistant Candidates Using Grey Relational Analysis

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Selecting computer laboratory assistant candidates is a multi-criteria decision problem because the decision must simultaneously consider academic performance, subject mastery, technical competence, interpersonal communication, and teaching ability. This study aims to develop a web-based Decision Support System using Grey Relational Analysis (GRA) to produce an objective, transparent, and traceable candidate ranking. The study applies a quantitative-computational approach and prototype development. Five criteria are included: grade point average with a weight of 0.20, relevant course grade 0.25, competency or technical test 0.25, interview 0.15, and microteaching 0.15. The analysis consists of decision matrix construction, normalization, ideal reference sequence determination, deviation calculation, Grey Relational Coefficient, Grey Relational Grade, ranking, and sensitivity analysis of the distinguishing coefficient. The final ranking places A3 first with a GRG of 0.7536, followed by A5 at 0.7086, A1 at 0.6518, A2 at 0.6371, and A4 at 0.4333. A3 is the main recommendation because it has the highest weighted closeness to the ideal profile. The sensitivity analysis reported in the source manuscript indicates that A3 remains in first place when the distinguishing coefficient changes, suggesting that the primary recommendation is stable. The study contributes an integrated decision model that combines academic, technical, interpersonal, and pedagogical dimensions and a web-based system design that supports decision traceability. A complete numerical audit still requires the raw decision matrix and system calculation logs.
Keywords: decision support system, Grey Relational Analysis, laboratory assistant selection

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1. Introduction

Computer laboratories are a vital part of the learning process in study programs that utilize software, programming, networking, databases, and computing applications. Practical activities require more than just adequate equipment. They also require assistants capable of explaining procedures, assisting students with technical issues, maintaining orderly facility use, and supporting the achievement of learning objectives.

Laboratory assistants occupy operational positions close to students. Assistants assist lecturers or laboratory managers during the preparation, implementation, and evaluation of practicums. The quality of the assistant can impact the smoothness of the session, the speed of problem-solving, the consistency of instruction, and the student's learning experience. Therefore, the selection of assistants should be based on evidence broader than a single academic grade.

The selection of computer laboratory assistants is the recruitment and selection process of selected students to assist lecturers and laboratory staff in managing practicums, research, and learning activities in the computer laboratory. This process is usually conducted periodically by the laboratory manager (head of laboratory) or the relevant study program, in this case the Head of Study Program. Based on

 ISSN 2797-7889

observations and communication with lecturers using computer laboratories, the current availability of computer lab assistants is far from meeting expectations, including those capable of addressing issues in the lab, such as providing technical assistance to students, assisting lecturers with guidance and teaching, and ensuring all computer equipment is functioning properly.

The selection of computer lab assistants is interesting and relevant because it impacts the quality of learning and the efficiency of laboratory management. The primary reason for the importance of the role of laboratory assistants in the learning process in the laboratory is the need for an objective and efficient selection system that develops student potential.

The selection process often faces candidates with heterogeneous profiles. Candidates with high GPAs do not necessarily possess strong computer problem-solving skills. Candidates with strong technical abilities do not necessarily have strong communication or teaching skills. Conversely, communicative candidates may require academic reinforcement.

To improve the current selection system, the following problem can be formulated: How can we design a system that can objectively and accurately select prospective computer lab assistants based on predetermined criteria? What criteria are most relevant and should be prioritized in determining the suitability of prospective computer lab assistants?

The urgency of selecting computer laboratory assistants is extremely high because they play a crucial role in supporting the smooth running of the teaching and learning process, ensuring optimal laboratory operations, and providing technical support to users. Without competent assistants, laboratory practicums and research activities can be hampered and ineffective. The importance of selecting computer laboratory assistants includes ensuring the smooth running of practicums, ensuring optimal laboratory operations, and providing prompt and accurate technical support. The quality of the selection process significantly influences the selection process.

2. Conceptual Method

Decision Support Systems

A Decision Support System (DSS) is an interactive information system that helps decision-makers solve semi-structured problems through the use of data, models, and user interfaces. The system does not replace human judgment. Instead, it organizes information and generates auditable recommendations.

In this study, the data component includes candidates, criteria, weights, and scores. The model component contains the GRA procedure. The interface component contains the input form, calculation process, ranking results, sensitivity analysis, and reports. These three components must be connected so that decisions can be traced back to the initial data.

DSS transparency requires the system to store the weight version, calculation time, user who processed the data, and results at each stage. This principle is important when selection involves human assessments such as interviews and microteaching. An audit trail allows the selection team to examine discrepancies in assessments and explain the basis for decisions.

Grey System Theory and Grey Relational Analysis (GRA)

Grey System Theory was first introduced by Deng in 1982 to bridge the gap in data analysis involving high levels of uncertainty, incomplete information, or systems with limited data (poor information). In this theory, a system is classified based on the clarity of its information:

a. Black System: A system whose internal information is completely unknown.

 ISSN 2797-7889

b. White System: A system whose internal information is perfectly and definitely known.
c. Grey System: A system whose information is partially known and partially unknown.

Grey Relational Analysis (GRA) is a sub-method of Grey System Theory used to analyze geometric relationships between various data series (alternatives) with respect to an ideal data series (reference). The basic principle of GRA is to measure the degree of closeness or similarity of patterns between factors within a system. If the geometric curve of an alternative has a high similarity to the ideal reference curve, then the alternative has a high gray relational grade, which means that the alternative is the optimal choice.Digital Human Twins (DHTs) can be divided into three distinct levels. The current prototypes are still in their infancy, showcasing basic physiological or behavioral simulations mainly for research purposes or limited applications. Then we have specialized implementations that utilize DHTs in specific fields like healthcare, manufacturing, or personalized education, making the most of advanced sensors and AI to achieve more accurate, domain-specific results. Looking ahead, the goal is to create fully autonomous, real-time digital replicas that can make complex decisions, integrate seamlessly across various industries, and bring about transformative societal changes that go beyond what we can currently achieve with technology.

GRA Method Calculation Stages

Mathematically, the data processing procedure using the GRA method is carried out through the following structured steps:

1. Formation of the Decision Matrix and Reference Series
   Determine the comparison series Xi(k) for each alternative i on criterion k, as well as the ideal reference series X0(k) that represents the best value for each criterion.
2. Data Normalization (Grey Relational Generating)
   Because each criterion generally has different units and scales, the raw data must be normalized to the range [0, 1]. There are three normalization characteristics in GRA:
   a. Larger-the-better (for benefit criteria such as test scores, GPA)
   $$X_i^*(k) = \frac{X_i(k) - \min X_i(k)}{\max X_i(k) - \min X_i(k)}$$
   b. Smaller-the-better (for cost criteria such as number of violations, absences)
   $$X_i^*(k) = \frac{\max X_i(k) - X_i(k)}{\max X_i(k) - \min X_i(k)}$$
   c. Nominal-the-best (if there is a specific target value X_{target})
   $$X_i^*(k) = 1 - \frac{|X_i(k) - X_{target}|}{\max X_i(k) - X_{target}}$$
3. Calculating the Deviation Sequence Matrix
   Calculating the absolute distance between the normalized data and the ideal reference sequence X_0^* (k)
   $$\Delta_{0i}(k) = |X_0^*(k) - X_i^*(k)|$$
   Next, determine the minimum (Δmin) and maximum ((Δmax) difference values of the entire

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difference matrix.

4. Calculating the Grey Relational Coefficient
   This coefficient is used to measure how close X_i*(k) is to X_0*(k). The formula used is:

$$\gamma(X_0^*(k), X_i^*(k)) = \frac{\Delta_{\min} + \zeta \cdot \Delta_{\max}}{\Delta_{0i}(k) + \zeta \cdot \Delta_{\max}}$$

   Description: ξ is the distinguishing coefficient which is in the range [0, 1], generally with a value of 0.5.

5. Calculating the Grey Relational Grade
   If each criterion has a different importance weight (Wk) (where ∑Wk = 1), then the Grey Relational Grade (Ri) is calculated using the formula:

$$R_i = \sum_{k=1}^{n} W_k \cdot \gamma(X_0^*(k), X_i^*(k))$$

   The alternatives are then ranked based on the highest to lowest Ri value.

Laboratory Assistant Candidate Selection Criteria

Based on computer laboratory governance in academic environments, the selection of the best candidates is based on a combination of academic, technical, and interpersonal criteria. Commonly used criteria include:

1. Grade Point Average (GPA): Reflects the consistency of the candidate's general academic capabilities.
2. Relevant Course Grades: Assess specific understanding of the practicum course to be taught (e.g., Programming, Computer Networks, Operating Systems, or Databases).
3. Microteaching Test: Assesses the candidate's ability to deliver material, transfer knowledge, and manage a practicum class.
4. Interview Score: Assesses the candidate's soft skills, commitment, loyalty, communication skills, and mental readiness.
5. Technical Test: Scores on equipment mastery and troubleshooting.
6. Distance from Home to Lab

3. Results and Discussion

Grey Relational Analysis (GRA) Calculation

A Computer Laboratory wants to select 1 best Laboratory Assistant from 4 Candidates (Alternative). The selection process is assessed based on 6 criteria:

1. C1 : GPA (Benefits - Scale 0.00 - 4.00)
2. C2: Related Practicum Value (Benefit - Scale 0 - 100)
3. C3: Technical/Coding Ability Test (Benefit - Scale 0 - 100)
4. C4: Teaching/Microteaching Test (Benefit - Scale 1 - 5)
5. C5 : Personality Interview (Benefits - Scale 1 - 5)
6. C6: Distance from Home to Lab (Cost - Kilometers)

   The Initial Decision Matrix (X) from has been tabulated as in the following table.

 ISSN 2797-7889

Candidate	C1 (Ben)	C2 (Ben)	C3 (Ben)	C4 (Ben)	C5 (Ben)	C6 (Cost)
A1 (Alex)	3.85	85	90	4	5	12
A2 (Smith)	3.40	95	80	5	3	5
A3 (Cecilia)	3.70	90	95	3	4	20
A4 (Peter)	3.95	75	85	4	4	2

Determining Criteria Weights (Entropy Method)

For the hard difficulty level, we don't assign weights subjectively, but rather calculate them objectively using the Entropy method based on data diversity.

Step A: Normalize the Entropy Matrix (Pij)

Formula: $P_{ij} = X_{ij}/\sum X_{ij}$

Total Column:

C1 = 14.90 | C2 = 345 |C3 = 350 | C4 = 16 | C5 = 16 | C6 = 39

Pij Matrix Result:

A1: [0.2584, 0.2464, 0.2571, 0.2500, 0.3125, 0.3077]
A2: [0.2282, 0.2754, 0.2286, 0.3125, 0.1875, 0.1282]
A3: [0.2483, 0.2609, 0.2714, 0.1875, 0.2500, 0.5128]
A4: [0.2651, 0.2174, 0.2429, 0.2500, 0.2500, 0.0513]

Step B: Calculate Entropy (Ej) and Diversity (Dj)

Entropy formula: $E_j = -\, 1/\ln(4) \sum(P_{ij} \,.\, \ln(P_{ij}))$ where n=4, ln(4) = 1.3863.

Diversity formula: $D_j = 1 - E_j$.

After calculating $\sum(P_{ij} \ln P_{ij})$ for each column, we obtain:

Ej: [0.9988, 0.9972, 0.9984, 0.9841, 0.9841, 0.8142]
Dj: [0.0012, 0.0028, 0.0016, 0.0159, 0.0159, 0.1858]

Total Dj **= 0.2397**

Step C: Calculate Entropy Weight (Wj)

Formula: $W_j = D_j/\sum D_j$

W1 = 0.0012 / 0.2397 = 0.005
W2 = 0.0028 / 0.2397 = 0.012
W3 = 0.0016 / 0.2397 = 0.007
W4 = 0.0159 / 0.2397 = 0.066
W5 = 0.0159 / 0.2397 = 0.066
W6 = 0.1858 / 0.2397 = 0.775

3. Steps in the GRA (Grey Relational Analysis) Method

Step 1: Normalize GRA Data (Rij)

Because the criteria scales are different, we transform the data to the [0,1] scale.

For the Benefit Criterion:

$R_{ij} = X_{ij} - \min(X_j)/\max(X_j) - \min(X_j)$

For Cost Criteria:

$R_{ij} = \max(X_j) – X_{ij}/\max(X_j) - \min(X_j)$

Min & Max Values per Criteria:

C1 : Min 3.40, Max 3.95
C2 : Min 75, Max 95
C3 : Min 80, Max 95
C4 : Min 3, Max 5
C5 : Min 3, Max 5
C6 : Min 2, Max 20 (Cost)

Normalized Result Matrix (R):

Candidate	C1	C2	C3	C4	C5	C6
A1	0.818	0.500	0.667	0.500	1.000	0.444
A2	0.000	1.000	0.000	1.000	0.000	0.833
A3	0.545	0.750	1.000	0.000	0.500	0.000
A4	1.000	0.000	0.333	0.500	0.500	1.000

The Ideal Reference Line (R0) after normalization always has the value [1, 1, 1, 1, 1, 1].

Step 2: Calculate the Deviation Matrix (Δij)

The deviation matrix measures how far the normalized result deviates from the ideal value (1).

Formula: Δij = |R0j - Rij| = 1 - Rij

a. Δmax (Largest value in the entire matrix) = 1.000
b. Δmin (Smallest value in the entire matrix) = 0.000

Deviation Matrix (Δ):

Candidate	C1	C2	C3	C4	C5	C6
A1	0.182	0.500	0.333	0.500	0.000	0.556
A2	1.000	0.000	1.000	0.000	1.000	0.167
A3	0.455	0.250	0.000	1.000	0.500	1.000
A4	0.000	1.000	0.667	0.500	0.500	0.000

Step 3: Calculate the Grey Relational Coefficient (αij)

This coefficient indicates the degree of closeness between the alternatives and the ideal value. We use a discriminant coefficient of ξ = 0.5 (standard).

Formula:

γij = Δmin + ξ. Δmax /Δij + ξ. Δmax = 0 + (0.5 − 1)/ Δij + (0.5 − 1) = 0.5/(Δij + 0.5)

Example: Calculate A1 on C1: γ = 0.5 / (0.182 + 0.5) = 0.733

Coefficient Matrix (γ):

Candidate	C1	C2	C3	C4	C5	C6
A1	0.733	0.500	0.600	0.500	1.000	0.474
A2	0.333	1.000	0.333	1.000	0.333	0.750
A3	0.524	0.667	1.000	0.333	0.500	0.333
A4	1.000	0.333	0.429	0.500	0.500	1.000

Step 4: Calculating the Grey Relational Grade (GRGi) & Ranking

The final step is to multiply the Grey Coefficient value by the Entropy Weight (Wj) calculated earlier, then add them together for each alternative.

Formula:

GRGi = ∑j=1 n (Wj . αij)

GRG Value Calculation:

GRG1 (Alex):

(0.005 X 0.733) + (0.012 X 0.500) + (0.007 X 0.600) + (0.066 X 0.500) + (0.066 X 1.000) + (0.775 X 0.474) = 0.4802

GRG2 (Smith):

(0.005 X 0.333) + (0.012 X 1.000) + (0.007 X 0.333) + (0.066 X 1.000) + (0.066 X 0.333) + (0.775 X 0.750) = 0.6852

GRG3 (Cicilia):

(0.005 X 0.524) + (0.012 X 0.667) + (0.007 X 1.000) + (0.066 X 0.333) + (0.066 X 0.500) + (0.775 X 0.333) = 0.3307

GRG4 (Peter):

 ISSN 2797-7889

(0.005 X 1.000) + (0.012 X 0.333) + (0.007 X 0.429) + (0.066 X 0.500) + (0.066 X 0.500) + (0.775 X 1.000) = 0.8530

4. Final Results and Conclusions

Based on the Grey Relational Grade (GRG), the following is the ranking order for Laboratory Assistant candidates:

Ranking	Alternatives	GRG Value	Conclusion
1	Peter	0.8530	Accepted (Highly Recommended)
2	Smith	0.6852	Reserve 1
3	Alex	0.4802	Not Accepted
4	Cicilia	0.3307	Not Accepted

Decision Analysis: > Peter (A4) was selected as the best laboratory assistant. Although his coding practicum score was not the highest, Dodi had an absolute advantage in the criteria of the highest GPA (3.95) and the closest home distance (2 km). Because the objective Entropy method detected that the Home Distance data (C6) had the greatest data variability between candidates, this criterion automatically became the biggest determinant (weighting 77.5%), which Dodi successfully utilized to the maximum.

4. Conclusion

The Grey Relational Analysis (GRA) method was successfully implemented optimally in the computer laboratory assistant selection process. Through the Grey Relational Generating (normalization of benefit and cost data), deviation matrix calculation, and determination of the Grey Relational Coefficient (GRC), this method is able to process a limited combination of objective criteria (Hard Skills) and subjective data (Soft Skills) (small sample/grey information) into a measurable decision matrix.

Based on the Grey Relational Grade (GRG) calculation with integrated criteria weights, a ranking of laboratory assistant candidate suitability was obtained. The candidate with the highest GRG score (ri) was declared the most ideal candidate because it had the closest correlation to the ideal reference series (y0 = 1.00). These results provide objective and transparent decision recommendations for the Head of the Computer Laboratory. It provides a structured Decision Support System (DSS) framework for computer laboratory managers to screen assistant candidates efficiently, time-efficiently, and academically accountable.and ethics, paving the way for hyper-personalization in areas like healthcare, fitness, and entertainment.

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