JOURNAL OF TECHNOLOGY AND OPERATIONS MANAGEMENT

https://e-journal.uum.edu.my/index.php/jtom

BEYOND THE CV: MULTI-CRITERIA DECISION MODELING FOR STRATEGIC INTERNSHIP SELECTION

[1]Siti Syahirah Umanah, [2]Ahmad Taufik Nursal*, [3]Azim Azuan Osman, [4]Khairunnisa Abdul Aziz, and [5]Nurul Ashykin Abd Aziz

[1,2,4,5] Faculty of Industrial Management,Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuhraya Tun Razak, 26300, Gambang, Pahang, Malaysia.

[3]School of Technology Management and Logistics, Universiti Utara Malaysia, Sintok, Malaysia

*Corresponding author: ahmadtaufik@umpsa.edu.my

ABSTRACT

The process of internship selection is an important phase of organisational talent development, especially in the consultancy market, where interns are expected to fit into the working environment quickly. The process of making decisions, however, is mostly subjective and not based on a structured assessment system. The objective of this study is to create a guided decision model of internship selection based on a fuzzy multi-criteria decision-making model. This study has developed a Fuzzy Technique for Order Preference by Similarity to an Ideal Solution (Fuzzy TOPSIS) to rank internship applicants. The current model is illustrated in a case study conducted at an engineering consultancy firm in Malaysia. Based on the case study, several main criteria were used to develop the decision model, including demographic factors, academic background, communication competency, interpersonal competency, and managerial competency. The findings suggest that behavioural and organizational capabilities have a more substantial impact on a candidate's suitability than academic factors alone. The candidate with the top score has shown moderation across various criteria rather than leadership in one attribute. A sensitivity analysis was conducted to assess the robustness of the ranking outcomes. Empirical research has demonstrated the applicability of the approach to the strategic vendor selection issue.

Keywords: Fuzzy, TOPSIS, MCDM, internship selection, human resource management.

INTRODUCTION

Internship programs have also become a strategic talent pool for organizations, especially in the consulting sector. In addition to serving as a source of academic learning followed by a practicum, internships are increasingly becoming initial recruitment processes for firms, as they allow evaluating and developing potential future employees (Cheong et al., 2014; Martin and Wilkerson, 2006; Negrut et al., 2015; Popov, 2020). Internships in Malaysia have been part of higher education programs since the 1970s, with timelines of 3 to 6 months and academic credit, which strengthens their significance to higher education systems and business-related stakeholders. The selection of an intern is not a simple choice although it is a strategic issue. Frequently, organizations have to interview candidates with a mix of both quantitative indicators (like education level) and qualitative attributes (like communication skills, interpersonal competence, and control) (Perusso and Baaken, 2020; Wells et al., 2023; Xu et al., 2023).

Practically, these assessments are usually made informally or using a subjective process, potentially resulting in time-consuming, biased, and unequivocal outcomes, especially when several decision-makers are involved. The challenge particularly resonates in engineering consultancy firms, where the performance of interns can directly inform the quality of project delivery, team productivity, and the development of human capital in the long term. Although organizations acknowledge the importance of using appropriate interns, most lack a formal, clear decision-support system to harmonize evaluation criteria in ambiguous or language-biased contexts (Xu et al., 2023). Multi-Criteria Decision Making (MCDM) has been increasingly used in personnel selection to address this gap. One of those is the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which is used for its easy-to-understand logic and computational efficiency. However, standard TOPSIS assumes precise numerical inputs and is therefore not effective when decision makers base their evaluations on subjective or linguistic criteria. The blend of fuzzy set theory with the TOPSIS addresses this drawback because it makes it more realistic to model unpredictability, uncertainty, and human judgment.

Even though Multi-Criteria Decision Making (MCDM) methods have been previously used by other researchers in relation to internship and personnel selection, the current applications are mostly focused on the startup or healthcare and general employee selection environments (de Souza Rocha Junior et al., 2021; Priyadharshini et al., 2020; Tan et al., 2023). There are several applications in the Malaysian engineering consultancy environment, and there are limited studies that provide a comprehensive step-by-step demonstration of the Fuzzy TOPSIS method that a practitioner can easily rely on in real-world decision-making. The research given is a reaction to the obvious necessity of the internship selection model. The study focuses on filling the gap in the context of MCDM and offering organizations and companies an effective tool to choose the most suitable candidates in the internship program. MCDM, which screens and interviews candidates based on various factors, is a highly structured and orderly method that breaks the constraints of traditional methods (Priyadharshini et al., 2020).

LITERATURE REVIEW

With the ever-growing consultancy sector, the need to have a well-crafted workforce that is flexible has been of utmost importance. The interns have long been seen as an efficient tool for acquiring such capabilities due to their early exposure to the professional setting. Introductions to previous research identify the internship as a structured encounter linked to the employment sphere and structured to gain knowledge on how to manage career growth during the college years (Cheong et al., 2014). On the same note, Fong et al. (2014) describe internships as guided work experiences where the students get supervision and feedback, as opposed to working in an 77mphasizes77n on their own. In a broad sense, internships can

be regarded as experiential learning experiences and include fieldwork, practicum, cooperative education, and similar training approaches that enable students to combine theoretical and practical aspects (Gross et al., 2020; Negrut et al., 2015). Empirical studies have consistently emphasized the positive effects of internships on students' academic and professional growth. For example, 132 accounting students at Wake Forest University (Martin and Eka, 2019) found that internships helped them gain deeper insights into academic coursework and appreciate business subjects. It was also demonstrated that internships enhance self-management skills, workplace self-awareness, and student confidence in the professional environment (Baert et al., 2021). These effects are found across different types of internship, such as credit-bearing placements that engage academic institutions and industry partners, and short-term, service-oriented internships in both non-profit and profit organisations (Feijoo et al., 2019; Silva Piovani et al., 2020).

In term of individual skill growth, internships play a critical role in helping students transition into the workforce. Some interns return to their academic study following their placements while others progress straight into full-time paid positions (Popov, 2020). Through the internships, students will learn practical skills, including teamwork, supervisory awareness, and customer management, which help them better integrate into the workplace after completing their studies (Cheng et al., 2023). Consequently, organisations that do not prepare and integrate effectively with their recruits could be at risk of dealing with adaptation and productivity issues, especially in uncertain or quickly transforming economic conditions (Yi Lin et al., 2019). While numerous studies affirm that internships can achieve both educational and 78mphasizes78nal goals, the effectiveness of the programmes is highly dependent on their design and implementation. Poorly structured internships or expectations that fail to meet their needs can lead to disengagement and less-than-expected learning results. This 78mphasizes not only the importance of designing meaningful internship programmes, but also the need to select suitable candidates through well-considered, systematic evaluation processes.

Core Competencies Criteria

The process of selecting an intern involves evaluating various candidate attributes that play a combined role in determining individual performance and organisational fit. Of them, demographic factors, educational background, communication skills, interpersonal skills, and managerial skills are usually discussed as one of the most crucial factors influencing the outcomes of an internship. Aspects of demography, especially gender and age, are increasingly being considered in the selection of interns, and organisations are trying to foster themes of inclusion and diversity in the work environment. It is well known that gender diversity can be recognized as a strategy to encourage diverse perspectives, creativity, and equal team relations (Tan et al., 2023). In sectors where the industry composition of the workforce has traditionally been skewed, specific initiatives aimed at inviting less represented subgroups are frequently implemented with the view to promote equity and inclusivity (Campero, 2023).

Although it is not always a direct selection criterion, age may be related to team dynamics and learning processes. Many internship programmes are usually open to students at various educational levels, and due to their youthfulness, younger interns may bring technological savvy and a new outlook to the institution. Compared with younger interns, older interns might possess greater maturity or experience working in a professional environment (Cheong et al., 2014). An equal age distribution thus facilitates knowledge sharing and teamwork. Academic background is also a significant factor, as it is an indicator of a candidate's basic level of knowledge and their formal preparation. Educational attainment - From diplomas to postgraduate education, organisations can match internship positions to candidates' capabilities and learning goals (Tan et al., 2023). For example, by taking academic background into account, organisations can better plan internship work aligned with interns' competences, which can improve learning and the

overall effectiveness of such programmes (Clark et al., 2018). Communication competency is another important criterion, especially in consultancy-oriented environments where collaboration and client interaction are crucial. Effective verbal communication helps interns convey ideas clearly, engage in discussions, and interact effectively with colleagues and clients (Tan et al., 2023). Equally important are non-verbal and written communication skills, as you will recognize to include skills to communicate digitally (e.g., email and messaging tools). Proficiency in these forms of communication helps with efficient team work, reduces misunderstandings, and helps coordinate work smoothly in a professional setting (Card et al., 2023). Interpersonal competency also influences an intern's capacity to function effectively in various organisational situations. Intercultural sensitivity and awareness enables interns to identify and appreciate cultural differences that contribute towards a more inclusive and harmonious workplace (Martin & Wilkerson, 2006). Understanding organisational norms, values, and behavioural expectations is also essential, as it enables interns to adapt more readily to workplace culture and professional etiquette (Navío-Marco et al., 2023). Also, intercultural effectiveness, i.e., the skill to communicate appropriately across cultural borders and to apply supportive tools when needed, contributes to collaboration and mutual understanding in more globalised workplaces (Tan et al., 2023).

Managerial competency is inclusive of organisational and self-management skills, which affect the efficacy and growth of an intern. Organisational skills, team-working, and interpersonal relations with colleagues and clients facilitate the effective implementation of projects and help improve a team's overall performance (Navío-Marco et al., 2023). Most interns can develop their personalities through self-management skills, such as active learning, self-regulation, and reflective evaluation (Perusso and Baaken, 2020). Those interns who demonstrate strong competency in managerial and self-management are better able to play a significant role in consultancy activities, as they acquire skills that will serve them well in the long-term professional life. Collectively, these requirements present the complexity of internship selection and emphasize the importance of systematic decision-making strategies that would be able to incorporate attributes of different sorts, including qualitative and quantitative ones. This complexity justifies the appropriateness of multi-criteria decision-making techniques in facilitating informed and consistent intern selection decisions.

Multi-Criteria Decision Making (MCDM)

MCDM has a wide range of applications in cases where a considerable number of criteria are to be considered. For example, Puspitarani et al. (2023) used MCDM to determine student qualifications for participation in educational programs, whereas Junior et al. (2021) used MCDM to select internship students for a start-up company. MCDM employs distinctive mechanisms, such as normalization procedures, parameter introduction and configuration, and the identification and treatment of ideal solutions (Ma & Li, 2024). MCDM is a branch of Operations Research (OR) that focuses on decision problems with multiple decision criteria. While MCDM problems are not identical in nature, they share common features, including multiple conflicting criteria, criteria measured using different units, and the aim of MCDM to either develop optimal solutions or identify the most favourable alternatives (Zhu et al., 2022). MCDM has a wide scope and application in situations where we have to consider a large number of criteria. For example, Puspitarani et al. (2023) used MCDM to determine eligibility of a student for participation of an educational program, and Junior et al. (2021) used MCDM to select internship students for business startup.

Fuzzy TOPSIS

Fuzzy TOPSIS is a decision-making technique that integrates fuzzy set theory and TOPSIS to address uncertainties and vagueness in decision-making (Buyuozkan and Ifi, 2012). This method has been widely used due to its ability to provide more realistic variations than conventional approaches. Fuzzy TOPSIS is the best method when decision-making criteria or input data are vague and uncertain. It supports the ambiguity among the real-world decision problems by integrating fuzzy logic which gives a better depiction of the decision environment (Chen, 2000). With Fuzzy TOPSIS, the decision-makers have a more sophisticated opportunity to define their preferences and verdicts. Traditional approaches might fail to represent things rigidly, whereas fuzzy sets offer greater flexibility for more realistic modeling of decision criteria and decision alternatives. Fuzzy TOPSIS is suitable for expressing subjective preferences and judgments (Hung et al., 2014). Decision-makers can provide their subjective opinions in the form of linguistic terms or fuzzy numbers to make the decision model more closely aligned with human intuition. In contrast to some methods, which require precise numerical weights for the criteria, Fuzzy TOPSIS can handle situations where it is difficult to assign exact weights (Kumar et al., 2023). Fuzzy weights can be assigned to criteria, which allows for a more realistic statement of the decision maker's uncertainty in weight assignment and the consideration of interdependence and interaction among decision criteria (Koltharkar & Sridharan, 2020).

This is very important in cases of complex decisions when the significance of one criteria to another is incredible. Traditional techniques may oversimplify these interactions and have a more limited predictive power. Fuzzy TOPSIS provides a more robust treatment of inconsistencies in decision-maker preferences. It can handle conflicting information and produce meaningful rankings (Büyüközkan & Ifi, 2012), making it a desirable tool in situations where decision-makers may give inconsistent judgments. Real-world decision problems are often complex, having multiple criteria and alternatives. Fuzzy TOPSIS is ideal for handling this complexity and providing a comprehensive analysis of various factors simultaneously. Fuzzy TOPSIS is unique for its capability to handle uncertainty, flexibility in representation, incorporation of subjective judgment, versatility in criteria weighting, OD m interactions, and adaptability to real-world complexity. These advantages make it a powerful tool for making decisions, especially in situations where other techniques may be lacking.

METHODOLOGY

The research methodology was structured into three sequential phases to ensure methodological rigor and practical relevance.

Phase 1: Literature Review and Problem Structuring

Phase 1 commenced with a comprehensive literature review to establish a strong theoretical foundation for the study. An extensive review of prior research in multi-criteria decision-making (MCDM), internship selection, and fuzzy decision models was conducted to identify relevant decision criteria and decision-making requirements. This phase served as the conceptual grounding for the subsequent stages by synthesizing existing knowledge and clarifying the key attributes required for effective undergraduate internship candidate selection.

Phase 2: Data Collection and Conceptual Decision Model Development

The second phase focused on data collection and the development of the conceptual decision model. Data were obtained through a case study approach involving a consultancy company, where decision-making requirements were extracted through structured analysis and direct engagement with key decision-makers. This process ensured that practitioner insights and real-world constraints were incorporated into the model.

Based on the collected data, a conceptual decision model was developed to represent the internship candidate selection problem. The model was designed to be sufficiently flexible for application across different decision-making contexts. To enhance practicality and transparency, the model was operationalized using Microsoft Excel, providing a concrete computational platform for implementing the Fuzzy TOPSIS method and facilitating further refinement.

Phase 3: Model Evaluation and Validation

The final phase involved the evaluation and validation of the proposed decision model. The effectiveness of the model was assessed by examining its ability to rank internship candidates in a manner consistent with managerial expectations and organizational priorities. Validation was further strengthened through sensitivity analysis, which examined the robustness of the model by analyzing the effects of variations in criteria weights on the final rankings. This process ensured that the model remained stable and reliable under different decision scenarios.

Table 1

Research phase

Phase	Activity	Method
Phase 1	Literature Review	Systematic and intensive review of literature on MCDM, Fuzzy TOPSIS, and internship candidate selection
	Data Collection (Decision-Making Requirements)	Case study approach involving documented analysis and semi-structured questionnaires with key decision-makers
Phase 2	Conceptual Decision Model Development	Development of a conceptual decision model based on identified criteria and decision-maker preferences; implementation and testing of the Fuzzy TOPSIS model using Microsoft Excel
Phase 3	Evaluation and Validation of Decision Model	Assessment of model effectiveness and robustness through sensitivity analysis

Description of the Case Study

The case study was conducted in an engineering consultancy firm established in 2016, operating within the Malaysian engineering consultancy sector. The firm specializes in providing engineering consultancy services with a primary focus on the energy, power, industrial, and building services domains. It is formally registered as an Engineering Consultancy Practice (ECP) with the Board of Engineers Malaysia (BEM) and the Ministry of Finance Malaysia (MOF), ensuring compliance with national regulatory requirements.

The organization is supported by a multidisciplinary team of experienced engineers with expertise in civil, structural, mechanical, and electrical engineering. Its consultancy services span a wide range of project phases, including feasibility and operational studies, planning, engineering design, project management, and contract administration. The firm has undertaken projects across Malaysia and selected Southeast Asian markets, serving both public and private sector clients.

In consultancy-based organizations, decision-making is often guided by organizational mission and vision, which define strategic priorities and operational goals (Çipi et al., 2023). This context makes the firm an appropriate case for examining structured decision-support approaches in internship candidate selection.

MODEL DEVELOPMENT AND RESULT

Phase 1: Literature Study and Data Collection

To pursue the study's primary goal, an extensive literature review was conducted to identify the criteria for selecting an internship. Several papers were examined, leading to the identification of five key criteria. The exploration then delves further into these main criteria, breaking them down into sub-criteria before presenting them to the decision maker. A datasheet that compiles information on authors and their criteria for selecting interns from diverse backgrounds, including fields such as nursing and business, has been documented at the early stage of the literature review. After completing a literature review of the criteria used to select internship students, a questionnaire to identify these criteria has been compiled and presented to decision-makers at the consultancy company. The selection of main and sub-criteria was determined by identifying the most frequently mentioned criteria across all the papers studied. Table 2 shows the results from 2 decision makers, and Table 2 below illustrates each main criterion based on the selected sub-criteria.

Table 2

Decision Makers Criteria

Main Criteria	Sub-Criteria	Decision Maker 1	Decision Maker 2
Demographic	Gender	√	√
	Age	√	√
	Experience	Critical Thinking	Problem-solving skill
Academic Background	Education Level	√	√
Communication Competency	Comprehensive and verbal ability	√	√
	Non-Verbal	√	√
Interpersonal Competency	Intercultural Sensitivity	√	√
	Intercultural Awareness	√	√
	Intercultural Effectiveness	√	√
Management Competency	Organization and coordination ability	√	√
	Self-management ability	√	√

The proposed sub-criteria from the decision-maker will be incorporated only if both decision-makers agree on the same criteria. The findings indicate that experience will not be included in the demographic criteria, as neither decision-maker opted for it.

Table 3
Final Criteria

Main Criteria	Sub Criteria
Demographic	Gender
	Age
Academic Background	Education Level
Communication Competency	Comprehensive and verbal ability
	Non-Verbal
Interpersonal Competency	Intercultural Sensitivity
	Intercultural Awareness
	Intercultural Effectiveness
Management Competency	Organization and coordination ability
	Self-management ability
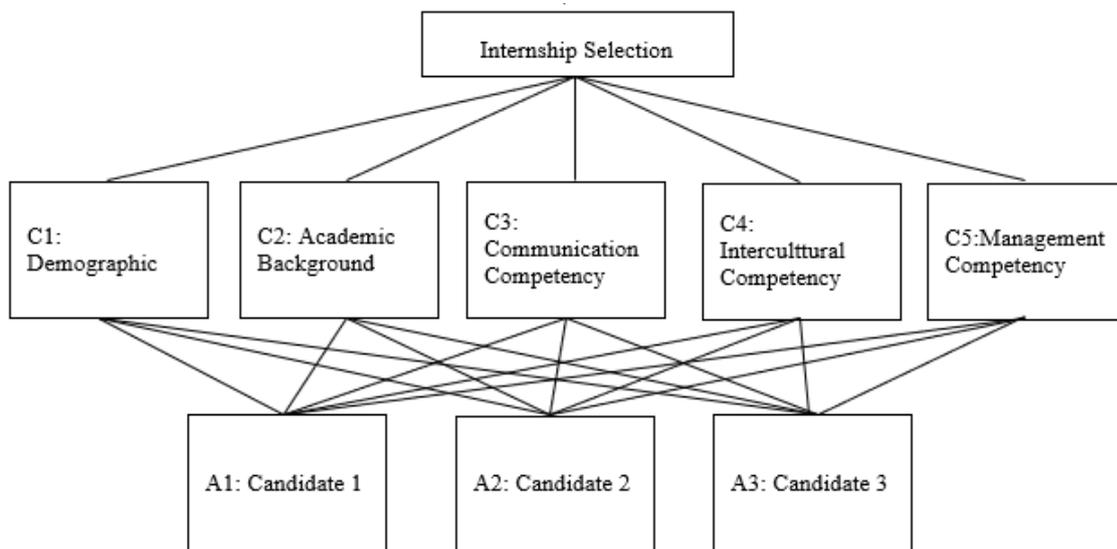
Figure 2
The hierarchical structure

Phase 2: Conceptual Decision Model Development

As mentioned in the literature review, the technique to be used for developing the decision model is fuzzy TOPSIS. The fuzzy method, with its linguistic weighting, ensures the decision model can adapt to the diverse and nuanced perspectives of decision-makers (Maity et al., 2023), thereby supporting a more adaptive, contextually appropriate process for intern selection. This approach aligns with the dynamic nature of talent acquisition and reflects the complex real-world considerations involved in selecting the most suitable internship candidates for the consultancy company. To develop the decision model, Chen's (2000) linguistic variables for the importance weights of each criterion provide a standardized, well-defined linguistic framework for the fuzzy method presented in Table 4. Chen's linguistic variables typically include terms like "Very Low", "Low", "Medium Low", "Medium", "Medium High", "High", and "Very High" to express varying degrees of importance.

Table 4
Linguistic variable for the importance weight of each criterion

Lingusitic Variables	Rating
Very Low (VL)	(0,0,0.1)
Low (L)	(0,0.1,0.3)
Medium Low (ML)	(0.1,0.3,0.5)
Medium (M)	(0.3,0.5,0.7)
Medium High (MH)	(0.5,0.7,0.9)
High (H)	(0.7,0.9,1.0)
Very High (VH)	(0.9,1.0,1.0)

Then, the linguistic variable is assigned to each criterion in Table 5. This is based on the decision-makers' decisions and the literature review conducted earlier.

Table 5
Final weight for each criterion

Main Criteria	Weighted	
Demographic	H	(0.7,0.9,1.0)
Academic Background	MH	(0.5,0.7,0.9)
Communication Competency	M	(0.3,0.5,0.7)
Interpersonal Competency	VH	(0.9,1.0,1.0)
Management Competency	MH	(0.5,0.7,0.9)

The development of the decision model consists of 8 steps that must be carried out one by one Chen, 2000). Step 1 involves decision-makers using linguistic weighting variables (as depicted in Table 5) to evaluate the significance of the criteria and present their assessments in Table 6.

Table 6
Linguistic variables for rating of the candidate

Lingustic Variables	Rating
Very Poor (VP)	(0,0,1)
Poor (P)	(0,1,3)
Medium Poor (MP)	(1,3,5)
Fair (F)	(3,5,7)
Medium Good (MG)	(5,7,9)
Good (G)	(7,9,10)
Very Good (VG)	(9,10,10)

Moving on to Step 2, decision-makers employ linguistic rating variables (outlined in Table 6) to assess the alternatives' ratings for each criterion, as shown in Table 7.

Table 7
Ratings for each criterion for the candidate

Criteria	Candidate	Decision Makers	
		DM1	DM2
C1	A1	F	F
	A2	MP	MG
	A3	G	MP
C2	A1	MG	F
	A2	F	P
	A3	VG	MG
C3	A1	VG	MG
	A2	MG	G
	A3	MP	VG
C4	A1	G	VP
	A2	F	G
	A3	MP	VG
C5	A1	G	MP
	A2	VG	G
	A3	MP	MG

In Step 3, the linguistic evaluations from Table 7 are transformed into fuzzy numbers. This process is pivotal for constructing the fuzzy decision matrix and ascertaining the fuzzy weight assigned to each criterion, as illustrated in Table 8 for decision maker 1 and Table 9 for decision maker 2.

Table 8
The fuzzy weights from decision maker 1's ratings.

	C1			C2			C3			C4			C5		
A1	3	5	7	5	7	9	9	10	10	7	9	10	7	9	10
A2	1	3	5	3	5	7	5	7	9	3	5	7	9	10	10
A3	7	9	10	9	10	10	1	3	5	1	3	5	1	3	5

Table 9
The fuzzy weights from decision maker 2's ratings.

	C1			C2			C3			C4			C5		
A1	3	5	7	3	5	7	5	7	9	0	0	1	1	3	5
A2	5	7	9	0	1	3	7	9	10	7	9	10	7	9	10
A3	1	3	5	5	7	9	9	10	10	9	10	10	5	7	9

Step 4 is to find the combined decision matrix and normalize the fuzzy decision matrix. The combined decision matrix is using the following formula:

$$a_{ij} = min_k\{a_{ij}^k\}, \; b_{ij} = average\{b_{ij}^k\}, \; c_{ij} = max_k\{c_{ij}^k\} \tag{1}$$

Where a, b, and c are the fuzzy weight ratings for the first, second, and third numbers, respectively. Triangular fuzzy numbers can describe these linguistic variables.

$$\tilde{x} = \left(a_{ij}, b_{ij}, c_{ij} \right) \; of \begin{bmatrix} a_{11} & b_{12} & c_{13} \\ a_{21} & b_{22} & c_{23} \\ a_{31} & b_{32} & c_{33} \end{bmatrix} \tag{2}$$

The combined decision matrix from both decision makers is shown in Table 10 below.

Table 10
Combine decision matrix

	C1			C2			C3			C4			C5		
A1	3.0	3.3	7.0	3.0	6.0	9.0	5.0	8.5	10.0	0.0	4.5	10.0	1.0	6.0	10.0
A2	1.0	3.3	9.0	0.0	3.0	7.0	5.0	8.0	10.0	3.0	7.0	10.0	7.0	9.5	10.0
A3	1.0	4.0	10.0	5.0	8.5	10.0	1.0	6.5	10.0	1.0	6.5	10.0	1.0	5.0	9.0

Next, is to find a normalized fuzzy decision matrix. There are two formulas to find a normalized fuzzy decision matrix for benefit criteria and cost criteria, or non-benefit criteria. The formula is shown below as c^*j for benefit criteria and a^-j for cost benefits.

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c^{\cdot}_{j}}, \frac{b_{ij}}{c^{\cdot}j}, \frac{c_{ij}}{c^{\cdot}j} \right), \; and \; c^{\cdot}j = max_i(c_{ij}) \tag{3}$$

$$\tilde{r}_{ij} = \left(\frac{a^-_{ij}}{c_{ij}}, \frac{a^-_{ij}}{b_{ij}}, \frac{a^-_{ij}}{a_{ij}} \right), \; and \; a^-j = min_i(a_{ij})$$

The normalized fuzzy decision matrix is shown in Table 11.

Table 11
Normalize fuzzy decision matrix

	C1			C2			C3			C4			C5		
A1	0.43	0.48	1.00	0.33	0.67	1.00	0.50	0.85	1.00	0.00	0.45	1.00	0.10	0.60	1.00
A2	0.11	0.37	1.00	0.00	0.43	1.00	0.50	0.80	1.00	0.30	0.70	1.00	0.70	0.95	1.00
A3	0.10	0.40	1.00	0.50	0.85	1.00	0.10	0.65	1.00	0.10	0.65	1.00	0.11	0.56	1.00

Step 5 is to compute the weighted normalized fuzzy decision matrix using the following formula:

$$\tilde{v}_{ij} = \tilde{r}_{ij} \times w_j$$ where, i = 1,2, …, m,., where j = 1,2, …, m,. and w_j is the weighted fro the criteria that have been decided in Table B. The weighted normalized fuzzy decision matrix is shown in Table 12.

Table 12
Weighted normalized fuzzy decision matrix

	C1			C2			C3			C4			C5		
A1	0.30	0.43	1.00	0.17	0.47	0.90	0.15	0.43	0.70	0.00	0.45	1.00	0.05	0.42	0.90
A2	0.08	0.33	1.00	0.00	0.30	0.90	0.15	0.40	0.70	0.27	0.70	1.00	0.35	0.67	0.90
A3	0.07	0.36	1.00	0.25	0.60	0.90	0.03	0.33	0.70	0.09	0.65	1.00	0.06	0.39	0.90

Step 6 is to find the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS) by using the formula, considering $\tilde{v}^*_j = (1,1,1)$ *and* $\tilde{v}^-j = (0,0,0)$, *where* $j = 1,2,…,m$

$$A^* = \left(\tilde{v}^*_1, \tilde{v}^*_2, ..., \tilde{v}^*_n \right), \text{ where } \tilde{v}^*_j = max_i \{v_{ij3}\} \text{ for FPIS and,} \qquad (5)$$

$$A^- = \left(\tilde{v}^-_1, \tilde{v}^-_2, ..., \tilde{v}^-_n \right), \text{ where } \tilde{v}^-_j = min_i \{v_{ij1}\} \text{ for FNIS.} \qquad (6)$$

The FPIS and FNIS are shown in Table L. The A* is he maximum number in the weighted normalized fuzzy decision matrix, and A- is the minimum number in the weighted normalized fuzzy decision matrix.

Table 13
FPIS and FNIS

	C1			C2			C3			C4			C5		
A1	0.30	0.43	1.00	0.17	0.47	0.90	0.15	0.43	0.70	0.00	0.45	1.00	0.05	0.42	0.90
A2	0.08	0.33	1.00	0.00	0.30	0.90	0.15	0.40	0.70	0.27	0.70	1.00	0.35	0.67	0.90
A3	0.07	0.36	1.00	0.25	0.60	0.90	0.03	0.33	0.70	0.09	0.65	1.00	0.06	0.39	0.90
A*	0.30	0.43	1.00	0.25	0.60	0.90	0.15	0.43	0.70	0.27	0.70	1.00	0.35	0.67	0.90
A-	0.07	0.33	1.00	0.00	0.30	0.90	0.03	0.33	0.70	0.00	0.45	1.00	0.05	0.39	0.90

Step 7 is to find the distance between each weighted normalized fuzzy decision matrix in Table 13 to the FPIS and FNIS by using the formula:

$$d(\tilde{x}, \tilde{y}) = \sqrt{\frac{1}{3}\left[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2 \right]} \qquad (7)$$

Table 14
Distance from FPIS

	C1	C2	C3	C4	C5	Sum, d^*_i
A1	0.000	0.088	0.000	0.212	0.224	0.524
A2	0.140	0.223	0.014	0.000	0.000	0.377
A3	0.139	0.000	0.090	0.108	0.233	0.570

Table 15
Distance from FNIS

	C1	C2	C3	C4	C5	Sum, d^-_i
A1	0.144	0.136	0.090	0.000	0.018	0.388
A2	0.004	0.000	0.082	0.212	0.235	0.534
A3	0.015	0.223	0.000	0.127	0.567	0.932

Step 8 is to calculate the closeness coefficient, CCi, for each candidate using the formula:

$$CC_i = \frac{d^-_i}{d^-_i + d^*_i}, \text{ where i = 1,2, ..., m,.} \qquad (8)$$

Table 16

Ranking for each candidate

Candidate	d_i^*	d_i^-	CCi	Ranking
A1	0.524	0.388	0.425	3
A2	0.377	0.534	0.586	2
A3	0.570	0.932	0.621	1

From Table 16, the study can conclude the ranking for each candidate by assigning the highest CCi a ranking of 1, followed by the others as 2 and 3. Candidate 3 (A3) has the highest ranking for being selected by higher management to be an intern at their company, as A3 meets all the criteria they require.

Phase 3: Evaluation of Decision Model

From Table 16, the study can conclude the ranking for each candidate by assigning the highest CCi a ranking of 1, followed by the others as 2 and 3. Candidate 3 (A3) has the highest ranking for being selected by higher management to be an intern at their company, as A3 meets all the criteria they require. The evaluation of our Fuzzy TOPSIS decision model involves a critical component: sensitivity analysis. This method is instrumental for assessing how changes in input parameters the model's output, thereby gauging its robustness and reliability (Álvarez-Miranda et al., 2023). Specifically, in the Fuzzy TOPSIS decision model, sensitivity analysis enables us to examine the impact of variations in criterion weights or linguistic variables on the final results. To perform a sensitivity analysis, we set the weights for all criteria to zero, except for C1, which was assigned a "Very High" (VH) linguistic variable. The result is shown in the Table below.

Table 17

Sensitivity Analysis

Candidate	d_i^*	d_i^-	CCi	Ranking					
A1	0.000	0.181	1.000	1	C1	VH	0.9	1	1
A2	0.176	0.006	0.032	3	C2	/	0	0	0
A3	0.176	0.017	0.088	2	C3	/	0	0	0
					C4	/	0	0	0
					C5	/	0	0	0

The results showed a significant change in the ratings for each candidate. This outcome confirms that the data is of a high sensitivity, meaning that slight changes to the weights of the criteria or linguistic variables can lead to substantial changes in the output of the whole decision model. It is important to understand that the sensitivity of data is favorable to the decision model per se. A very sensitive model indicates that the results are sensitive to variations in the input parameters, which suggests a sophisticated and adaptive system (Álvarez-Miranda et al., 2023). In the context of our Fuzzy TOPSIS decision model, this sensitivity means that the model can be affected by subtle changes in the criteria's preferences or linguistic interpretations, making it more effective as a comprehensive and responsive decision-making model. The data's detected sensitivity speaks volumes to the Fuzzy TOPSIS decision model's ability to capture subtle details, making it a powerful and reliable tool for informed decision-making.

DISCUSSION AND CONCLUSION

Intern selection is a complex process that involves a range of standards and subjective assessments. The development of Fuzzy TOPSIS to address the challenges posed by this complexity holds a bright future for enhancing decision accuracy. This paper will explore the creation of a decision model for intern

selection and apply Fuzzy TOPSIS to address the uncertainties associated with these decisions. Fuzzy TOPSIS can be described as a powerful decision-making tool, as it can handle the vagueness and uncertainties present in the internship selection process. With the introduction of fuzzy logic, the model provides a more realistic depiction of decision scenarios by accommodating imprecise and ordinal assessments. The results of the current research are consistent with the previous literature, which suggests that selecting an internship is a multi-dimensional decision-making process and that it is necessary to evaluate beyond academic performance. As in previous research, the findings also show that academic background is more of a minimum criterion than a decisive independent variable in differentiating candidates (Baert et al., 2021; Cheng et al., 2023). This is in line with the results provided by Martin and Eka (2019), who were able to realise that although academic understanding is boosted by the role of an internship, employment efficiency is linked with applied skills more than professional behaviour. Compared to MCDM-based internship selection research studies in startup and healthcare settings (de Souza Rocha Junior et al., 2021; Tan et al., 2023), the study emphasizes the relevance of competency-based evaluation and extends the usage of the approach to the engineering consultancy domain where the collaborative work and interaction with clients are primary factors. Fuzzy TOPSIS was used in this study as an addition to crisp decision models or survey-based ranking studies because subjective judgments and linguistic assessments associated with the selection were effectively captured through its application. The focus on the competencies of communication, interpersonal, and managerial skills can be explained by the fact that the initial studies have already significantly underlined the increased role of soft skills, awareness of other cultures and self-control in professional service settings (Perusso et al., 2020). Nevertheless, unlike some previous MCDM applications that reported almost consistent candidate rankings, the sensitivity analysis in our case revealed that the candidate rankings are sensitive to adjustments in the weights of different criteria. This result indicates that the outcomes of the internship selection are highly aligned with the organisational priorities and situation, which confirms Chen's (2000) statement that fuzzy models that are flexible and fuzzy are more applicable in real-world decision-making. On the whole, the findings support and build on the available literature and indicate that a transparent Fuzzy TOPSIS framework offers both methodological and practical reflectiveness to the internship selection in consultancy-driven settings.

REFERENCES

Álvarez-Miranda, E., Pereira, J., & Vilà, M. (2023). Analysis of the simple assembly line balancing problem complexity. *Computers and Operations Research*, *159*. https://doi.org/10.1016/j.cor.2023.106323

Baert, B. S., Neyt, B., Siedler, T., Tobback, I., & Verhaest, D. (2021). Student internships and employment opportunities after graduation: A field experiment. *Economics of Education Review*, *83*. https://doi.org/10.1016/j.econedurev.2021.102141

Büyüközkan, G., & Ifi, G. (2012). A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers. *Expert Systems with Applications*, *39*(3), 3000–3011. https://doi.org/10.1016/j.eswa.2011.08.162

Çalış, Ş., Tan, E., Maç, S. D., & Turan, Ş. A. (2022). A critique of the internship measurement scales in higher education. *Educational Research Review*, *37*. https://doi.org/10.1016/j.edurev.2022.100491

Campero, S. (2023). Racial disparities in the screening of candidates for software engineering internships. *Social Science Research*, *109*. https://doi.org/10.1016/j.ssresearch.2022.102773

Card, E., Bellini, S. G., Williams, D. P., & Patten, E. V. (2023). Current Dietetic Internship Admission Criteria and Selection Processes: Results From an Electronic Survey of Directors. *Journal of the Academy of Nutrition and Dietetics*, *123*(4), 643-654.e6. https://doi.org/10.1016/j.jand.2022.08.126

Çetinkaya, C., Erbaş, M., Kabak, M., & Özceylan, E. (2023). A mass vaccination site selection problem: An application of GIS and entropy-based MAUT approach. *Socio-Economic Planning Sciences*, *85*. https://doi.org/10.1016/j.seps.2022.101376

Chen, C.-T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. In *Fuzzy Sets and Systems* (Vol. 114). www.elsevier.com/locate/fss

Cheng, C. K. C., Chow, E. Y. H., Lam, K. C. K., & Lee, J. H. Y. (2023). Participation in internship, professional competition and overseas exchange and accounting students' subsequent academic and job market performance. *International Journal of Management Education*, *21*(3). https://doi.org/10.1016/j.ijme.2023.100887

Cheong, A. L. H., Yahya, N. binti, Shen, Q. L., & Yen, A. Y. (2014). Internship Experience: An In-Depth Interview among Interns at a Business School of a Malaysian Private Higher Learning Institution. *Procedia - Social and Behavioral Sciences*, *123*, 333–343. https://doi.org/10.1016/j.sbspro.2014.01.1431

Chiang, Y.-H. (2014). *Join an Internship Course or not? Evaluation from the Perspective of College Students in Taiwan*.

Çipi, A., Fernandes, A. C. R. D., Ferreira, F. A. F., Ferreira, N. C. M. Q. F., & Meidutė-Kavaliauskienė, I. (2023). Detecting and developing new business opportunities in society 5.0 contexts: A sociotechnical approach. *Technology in Society*, *73*. https://doi.org/10.1016/j.techsoc.2023.102243

Clark, H. L., Cole, R. E., & Funderburk, L. L. K. (2018). US Military Dietetic Internship and Graduate Program: Retrospective Analysis of Selection Criteria and Student Success. *Journal of the Academy of Nutrition and Dietetics*, *118*(6), 1057–1064. https://doi.org/10.1016/j.jand.2017.12.002

de Souza Rocha Junior, C., Moreira, M. Â. L., & dos Santos, M. (2021). Selection of interns for startups: An approach based on the AHP-TOPSIS-2N method and the 3DM computational platform. *Procedia Computer Science*, *199*, 984–991. https://doi.org/10.1016/j.procs.2022.01.124

Feijoo, G., Arce, A., Bello, P., Carballa, M., Freire, M. S., Garrido, J. M., Gómez-Díaz, D., González-Álvarez, J., González-García, S., Mauricio, M., Méndez, R., Moreira, M. T., Mosquera-Corral, A., Navaza, J. M., Palacios, M. C., Roca, E., Rodil, E., Rodríguez, H., Rodríguez, O., … Moreira, R. (2019). Potential impact on the recruitment of chemical engineering graduates due to the industrial internship. *Education for Chemical Engineers*, *26*, 107–113. https://doi.org/10.1016/j.ece.2018.08.004

Fong, L. H. N., Lee, H. A., Luk, C., & Law, R. (2014). How do hotel and tourism students select internship employers? A segmentation approach. *Journal of Hospitality, Leisure, Sport and Tourism Education*, *15*(1), 68–79. https://doi.org/10.1016/j.jhlste.2014.06.003

Gross, C., O'Halloran, C., Winn, A. S., Lux, S. E., Michelson, C. D., Sectish, T., & Sox, C. M. (2020). Application Factors Associated With Clinical Performance During Pediatric Internship. *Academic Pediatrics*, *20*(7), 1007–1012. https://doi.org/10.1016/j.acap.2020.03.010

Hung, C.-Y., Wang, K.-I., Huang, Y.-H., & Chang, C. W. (n.d.). *Medical Students' Choices of Specialty-the Application of Fuzzy MCDM*. https://www.researchgate.net/publication/228716168

Hussain, M. M., Gaval, V. R., & Pratap, A. P. (2022). Selection of vegetable oil based biolubricant using TOPSIS MCDM model. *Materials Today: Proceedings*, *62*, 512–516. https://doi.org/10.1016/j.matpr.2022.03.585

Koltharkar, P., & Sridharan, R. (n.d.). *Application of fuzzy TOPSIS for the prioritization of students' requirements in higher education institutions: a case study A multi-criteria decision making approach*.

Kumar, R., Gandotra, N., & Suman. (2023). A novel pythagorean fuzzy entropy measure using MCDM application in preference of the advertising company with TOPSIS approach. *Materials Today: Proceedings*, *80*, 1742–1746. https://doi.org/10.1016/j.matpr.2021.05.497

Lin, S. S., Zhou, A., & Shen, S. L. (2023). Safety assessment of excavation system via TOPSIS-based MCDM modelling in fuzzy environment. *Applied Soft Computing*, *138*. https://doi.org/10.1016/j.asoc.2023.110206

Ma, Q., & Li, H. (2024). A decision support system for supplier quality evaluation based on MCDM-aggregation and machine learning. *Expert Systems with Applications*, *242*. https://doi.org/10.1016/j.eswa.2023.122746

Magableh, G. M., & Mistarihi, M. Z. (2022). Applications of MCDM approach (ANP-TOPSIS) to evaluate supply chain solutions in the context of COVID-19. *Heliyon*, *8*(3). https://doi.org/10.1016/j.heliyon.2022.e09062

Maity, R., Mishra, R., Kumar Pattnaik, P., & Pandey, A. (2023). Selection of sustainable material for the construction of UAV aerodynamic wing using MCDM technique. *Materials Today: Proceedings*. https://doi.org/10.1016/j.matpr.2023.12.025

Martin, B., & Eka, S. (2019). Developing the Students' Ability in Understanding Mathematics and Self-confidence with VBA for Excel. In *Journal of Research and Advances in Mathematics Education* (Vol. 2019, Issue 1). http://journals.ums.ac.id/index.php/jramathedu

Martin, D. R., & Wilkerson, J. E. (2006). An Examination of the Impact of Accounting Internships On Student Attitudes and Perceptions. In *THE ACCOUNTING EDUCATORS' JOURNAL: Vol. XVI*.

Navío-Marco, J., Sánchez-Figueroa, C., & Galán, A. (2023). Business internships for bachelor's degrees at blended learning universities: A pilot study to assess the transition from hybrid studies to the workplace. *International Journal of Management Education*, *21*(2). https://doi.org/10.1016/j.ijme.2023.100821

Negrut, M. L., Mihartescu, A.-A., & Mocan, M. L. (2015). Aspects of the Internships Importance in Human Resource Training. *Procedia - Social and Behavioral Sciences*, *191*, 308–314. https://doi.org/10.1016/j.sbspro.2015.04.620

Perusso, A., & Baaken, T. (2020). Assessing the authenticity of cases, internships and problem-based learning as managerial learning experiences: Concepts, methods and lessons for practice. *International Journal of Management Education*, *18*(3). https://doi.org/10.1016/j.ijme.2020.100425

Popov, J. (2020). Boundary crossing and identity re-negotiation in internships: The integrative, future-oriented and transformational potential of interns' identity project. *Learning, Culture and Social Interaction*, *24*. https://doi.org/10.1016/j.lcsi.2020.100383

Priyadharshini, D., Gopinath, R., & Poornappriya, T. S. (2020). A Fuzzy MCDM Approach for Measuring the Business Impact of Employee Selection. *International Journal of Management (IJM)*, *11*(7), 1769–1775. https://doi.org/10.34218/IJM.11.7.2020.159

Puspitarani, Y., Rumaisa, F., Violina, S., Sulianta, F., & Rosita, A. (n.d.). *Puspitarani, Rumaisa, Violina, Sulianta, and Rosita-Decision Support System for Determining Student Eligibility to Participate Of MBKM in The Informatics Study Program Using AHP and TOPSIS 73 DECISION SUPPORT SYSTEM FOR DETERMINING STUDENT ELIGIBILITY TO PARTICIPATE OF MBKM IN THE INFORMATICS STUDY PROGRAM USING AHP AND TOPSIS*.

Reza, V., Kurniawan, B., Yulianti, T., & Puspitasari, F. H. (2021). *Employee Performance Evaluation in an Indonesian Metal Casting Manufacturer using an Integrated MCDM Approach*.

Silva Piovani, V. G., Vieira, S. V., Both, J., & Barbosa Rinaldi, I. P. (2020). Internship at Sport Science undergraduate courses: A scoping review. *Journal of Hospitality, Leisure, Sport and Tourism Education*, *27*. https://doi.org/10.1016/j.jhlste.2019.100233

Tan, X., Ning, N., Hua, N., Wiley, J., & Sun, M. (2023). Determining the core competencies for international postgraduate nursing students in internship programs: A delphi study. *Nurse Education in Practice*, *70*. https://doi.org/10.1016/j.nepr.2023.103654

Tüysüz, N., & Kahraman, C. (2023). An integrated picture fuzzy Z-AHP & TOPSIS methodology: Application to solar panel selection. *Applied Soft Computing*, *149*. https://doi.org/10.1016/j.asoc.2023.110951

Wells, M. W., Deleonibus, A., Kotha, V. S., Chang, I. A., & Rampazzo, A. (2023). Defining the Role of Resident Mentorship for Senior Medical Students in Sub-internship Selection in Plastic Surgery. *Journal of Surgical Education*, *80*(4), 490–491. https://doi.org/10.1016/j.jsurg.2023.01.002

Xu, W., Feng, L., Huang, H., Liu, S., Ye, M., Tang, F., Chuang, Y. C., & Cai, F. (2023). Evaluation and improvement of workplace vertical violence of nursing interns based on the Importance-Performance Analysis method. *Frontiers in Medicine*, *10*. https://doi.org/10.3389/fmed.2023.1210872

Yi Lin, C., Anantharajah, S., Kim, M., Han, B., Kim Ernst, J. M., Korea, Y., Narayanan, E., Devi Rajaratnam, S., Tibère, L., Laporte, C., Poulain, J.-P., Mognard, E., & Aloysius, M. (2019). International Tourism and Economic Growth: A Panel Causality Analysis of the Three Northeast Asian Countries of China, Japan, and Korea 17 The Effect of Leadership Styles on Service Quality Improvement: The Mediating Role of Organizational Learning 27 Staging a National Dish: The Social Relevance of Nasi Lemak in Malaysia 51. In *Asia-Pacific Journal of Innovation in Hospitality and Tourism (APJIHT)* (Vol. 8, Issue 1).

Zhu, L., Xu, M., Xu, Y., Zhu, Z., Zhao, Y., & Kong, · Xiangjie. (n.d.). *A Multi-attribute Decision Making Approach based on Information Extraction for Real Estate Buyer Profiling*.