Bol. Soc. Paran. Mat.
©SPM – E-ISSN-2175-1188
SPM: www.spm.uem.br/bspm

(3s.) **v. 2025 (43)** : 1–15.
ISSN-0037-8712
doi:10.5269/bspm.78139

A Data-Driven MCDM Approach to Evaluating Sexual Harassment Factors in Educational Settings: Integrating OrdPA-F with Triangular Intuitionistic Fuzzy MARCOS Methods

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ABSTRACT: This study examines the impact of ordering elements on sexual harassment in educational environments and assesses legislative measures aimed at improving the safety of female students in schools and universities. The combination of the ordinal priority approach with fuzzy information and intuitionistic fuzzy MARCOS within a decision framework facilitates the identification of numerous critical components. Initially, we employ an ordinal priority method on fuzzy data to determine the weights of the attributes. Subsequently, we employ the intuitionistic fuzzy MARCOS methodology to assess the prioritised aspects. The formulation of triangular fuzzy numbers for analytical objectives enhances decision-making. This study employs Dombi aggregation operations to comprehensively assess the influence of these factors on school sexual harassment. This research presents a systematic, data-informed approach to assist legislators in developing successful strategies for mitigating sexual harassment and improving safety in educational settings.

Key Words: Ordinal priority approach, sexual harassment, triangular fuzzy numbers, decision making.

1. Introduction

The liberation of women from the negative effects of social, economic, and political difficulties as well as gender-based discrimination is known as women's empowerment. This process includes giving women the freedom to choose their paths in life. Women should be able to freely express their opinions, develop self-confidence, and fight for the authority to achieve their goals [29]. Enhancing women's self-esteem, giving them the freedom to make their own decisions, and reaffirming their right to alter society for themselves and others are all components of empowering women [24]. Giving women more authority and control over their lives is known as empowerment. Improving women's status in business, politics, society, and health is inherently important. If society is to experience any real empowerment, we must prioritise the empowerment of women [9]. Despite the historical oppression of women in most countries, they constitute half of the general population. The need to understand what drives women's empowerment in Asia prompted further research. Concrete steps to further empower women can be taken whenever they are not burdened by societal issues. In universities and colleges that offer co-education, there are numerous cases of sexual harassment affecting women's empowerment; this situation is exacerbated by the lack of proper laws to punish offenders, which undermines women's power in educational institutions and prevents girls from protecting themselves from these issues [8,2].

Any unauthorised or unlawful sexual conduct that is derogatory, offensive, demeaning, or threatening is classified as sexual harassment. This matter is unrelated to friendship or mutual desire [21]. Sexual harassment, as delineated by Terpstra and Baker [5], is characterized as the expression of conditioned behaviors that align with conventional gender role norms. Sexual harassment manifests in various forms, including physical, verbal, and cyber harassment [13]. Verbal harassment encompasses unsolicited remarks, derogatory remarks, and sexually inappropriate humour [22]. Nonverbal harassment encompasses sexual body language, facial expressions, and gestures. Physical harassment refers to the act of engaging in unsolicited physical contact and touching. Visual harassment compels the victim to observe sexual films, images, and graphs, whilst cyberbullying is the latest manifestation of abuse [2]. The individual subjected to cyberbullying is compelled to confront sexually suggestive emails, texts, and social media communications. Harassment resulting in a hostile environment represents a substantial issue primarily impacting students. In this harassment instance, antagonistic guardians are causing undue distress to the students. In specific environments, individuals may also experience same-sex harassment. The survey

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2010 *Mathematics Subject Classification:* 03B30, 97C10, 90B50.
Submitted July 29, 2025. Published September 17, 2025

indicated that roughly 50% of female students and 36% of male students in higher education institutions reported encountering sexual harassment at least once [27]. Professors, colleagues, and external parties can readily use them due to their youth and inexperience. The ratio has significantly decreased at the university level. Approximately 42% of female students and 15% of male students in higher education have encountered episodes of sexual harassment [8]. The incidence of sexual harassment at educational institutions is a significant concern that appears to be escalating daily. It significantly impeded children's academic performance, psychological well-being, physical health, and social involvement. Individuals who have endured sexual harassment sometimes locate it challenging to achieve success. Individuals who have experienced harassment are likely to avoid the classroom and its environment. The person's absence from class will serve as the basis for failure. The individual endures substantial psychological distress, which profoundly impacts the students' welfare. We must implement measures to regulate these activities within educational institutions to protect women and reinforce gender-based discrimination.
Research suggests that the logical decision-making method is preferred, but dependence on intuitive processes may lead to biases in information gathering, analysis, and the development of contextually suitable decisions and managing the uncertainty on a large scale [10,14]. In certain circumstances, such as when confronted with extensive information, uncertainty, or time constraints, decisions derived intuitively through effective heuristics can be equally advantageous and precise as those made following thorough deliberation [26,30]. Zadeh introduced fuzzy sets (FSs) to mitigate uncertainty in decision-making contexts ([31]). A multitude of scholars are creating decision algorithms to address uncertainties in diverse real-world situations by employing fuzzy sets [17,11]. Fuzzy sets have basic membership functions that are insufficient for complex decision-making. Atanassov introduced institutional fuzzy sets (IFSs) [4] that mitigate decision-making challenges in many applications. Each IFS has rigorously validated the membership and non-membership functions to guarantee that both are restricted to the unit interval [7]. Researchers have exhibited significant interest in the approach of Intuitionistic Fuzzy Sets (IFSs) [6,3]. Many researchers extend this work to interval valued and build new foundational results on it [16,28]. This domain includes diverse topics, such as innovative aggregation operators for intuitionistic fuzzy soft sets [23] and their application in decision-making contexts, zero-sum decision-making matrix games based on intuitionistic fuzzy objectives [12,25], dombi weighted trapezoidal operators [18], and Archimedean Heronian mean operators designed for complex intuitionistic fuzzy sets [1].
To improve decision-making techniques and manage uncertainty more effectively, we concentrate on triangular Intuitionistic Fuzzy Numbers (IFNs) and many machine learning based techniques are introduced [19] that are proficient in tackling uncertainties. We have developed the Ordinal Priority Approach on Intuitionistic Fuzzy Sets (OrdPA-IF) employing the MARCOS technique to address complicated issues. This method exhibits exceptional performance and achieves elevated accuracy rates. The following are few salient points I have discerned in this study.

- We propose a novel hybrid OrdPA-IF-MARCOS framework for evaluating the factors influencing sexual harassment in educational institutions. The model systematically prioritizes critical elements such as reporting mechanisms (ζ_4), cultural norms (ζ_2), awareness programs (ζ_3), and institutional policies (ζ_1) using an integrated Multi-Criteria Decision-Making (MCDM) approach. To the best of our knowledge, no prior study has addressed this issue using such a mathematically rigorous combination of ordinal fuzzy weighting and intuitionistic ranking techniques.

- We introduce an enhanced triangular intuitionistic fuzzy (TIF) representation to improve uncertainty modeling in risk assessment. The proposed TIF attributes, defined over a Dombi-aggregated membership (μ) and non-membership (ν) space, provide a more robust quantification of ambiguity compared to conventional fuzzy sets. Formally, for an IF number $\tilde{A} = \langle \mu_{\tilde{A}}(x), \nu_{\tilde{A}}(x) \rangle$, our framework ensures $\mu_{\tilde{A}}(x) + \nu_{\tilde{A}}(x) \leq 1$ with $\pi_{\tilde{A}}(x) = 1 - \mu_{\tilde{A}}(x) - \nu_{\tilde{A}}(x)$ capturing hesitation. This advancement addresses the limitations of traditional models in handling subjective and intangible harassment risks.

- We bridge a critical gap in MCDM applications for socio-behavioral problems by integrating legal and psychological perspectives with high-performance computational techniques. The OrdPA-F weighting scheme, combined with the IF-MARCOS ranking algorithm, enables the derivation of an optimal compromise solution ($\mathcal{Q}_i$) for each factor ζ_i. The superiority of our approach is demonstrated through its ability to handle complex interdependencies via Dombi operations, offering educational institutions a data-driven decision-making tool with measurable outcomes.

2. Basic Idea's

Definition 1. *Consider a set A as follows: $A = \{(x, \mu_B(x), \nu_B(x)) \mid x \in X\}$ where μ_B and ν_B are functions [4] defined by: $\{\mu_B, \nu_B\} : X \to [0,1]$ with the condition:*

$$0 \leq \mu_B(x) + \nu_B(x) \leq 1 \text{ for all } x \in X \tag{2.1}$$

Where μ_B and ν_B are the numbers of membership and non-membership:

$$\pi_B(x) = 1 - \mu_B(x) - \nu_B(x) \tag{2.2}$$

Definition 2. *Triangular intuitionistic fuzzy numbers [20] $\beta_B = \{(a,b,c); \mu_B, \nu_B\}$ is special intuitionistic fuzzy set on a real number set R, whose membership function and non-membership function is defined as*

$$\mu_\beta(x) = \begin{cases} \frac{(x-a)}{b-a} \cdot \mu_\beta & \text{if } a \leq x < b \\ \mu_\beta & \text{if } x = b \\ \frac{c-x}{c-b} & \text{if } b < x \leq c \\ 0 & \text{if} \quad \text{otherwise} \end{cases} \tag{2}$$

$$\nu_\beta(x) = \begin{cases} \frac{b-x+\nu_\beta(x-a)}{b-a} & \text{if } a \geq x < b \\ \nu_\beta & \text{if } x = b \\ \frac{b-x+\nu_\beta(c-x)}{c-b} & \text{if } b \leq x \leq c \\ 0 & \text{if} \quad \text{otherwise} \end{cases} \tag{3}$$

μ_β and ν_β denote the maximum membership and minimum non-membership degree.

Definition 3. *Let $\beta_1 = \{(a_1, b_1, c_1), \mu_{\beta_1}, \nu_{\beta_1}\}$ and $\beta_2 = \{(a_2, b_2, c_2), \mu_{\beta_2}, \nu_{\beta_2}\}$ where α and β be triangular intuitionistic fuzzy numbers [15], and let κ be a real number. The operations are as follows:*

$$\beta_1 + \beta_2 = \left\{ \begin{array}{ll} a_1 + a_2, \quad b_1 + b_2, & c_1 + c_2 \\ \mu_{\beta_1} + \mu_{\beta_2} - \mu_{\beta_1}\mu_{\beta_2}, & \nu_{\beta_1}\nu_{\beta_2} \end{array} \right\} \tag{4}$$

Definition 4. *Intuitionistic fuzzy sets are an extended form of fuzzy sets. Let K be a point space and consider T_L and F_L as the truth and falsity membership functions,respectively.*
Let L be a set of observations and $L = \{\zeta, \mu_L(\zeta);\ \mu_L(\zeta) \in [0,1],\ \zeta \in L\}$. Since L is an Intuitionistic Fuzzy Set (IFS), and $L \subseteq W$, where W is also the set of observations. The set L is defined as:

$$L = \{(\zeta, \mu_L(\zeta)),\ T_L(\zeta, \tau),\ F_L(\zeta, \tau), \zeta \in L\} \tag{5}$$

let $T_L(\zeta, \tau)$ and $F_L(\zeta, \tau)$ be functions such that

$$T_L(\zeta, \tau),\ F_L(\zeta, \tau) \in \{x; 0 \leq x \leq 1\} \subset \mathbb{R}$$

Definition 5. *Consider two Intuitionistic Fuzzy Sets (IFS) L_1 and L_2 such that:*

$$L_1 = \{T_{L_1}(\zeta, \tau), F_{L_1}(\zeta, \tau); \zeta \in L, \tau \in W\} \tag{6}$$

and

$$L_2 = \{T_{L_2}(\zeta, \tau), F_{L_2}(\zeta, \tau); \zeta \in L, \tau \in W\} \tag{7}$$

addition operation is as follows

$$L_1 + L_2 = \left\{ \begin{array}{l} \mu_{L_1} + \mu_{L_2} - \mu_{L_1} - \mu_{L_2} \\ T_{L_1} + T_{L_2} - T_{L_1}T_{L_2} \\ F_{L_1} + F_{L_2} - F_{L_1}F_{L_2} \end{array} \right. \tag{8}$$

Definition 6. *Let intuitionistic fuzzy number* $L_1 = \{T_{L_1}(\zeta,\tau), F_{L_1}(\zeta,\tau); \zeta \in L, \tau \in W\}$ *and* $L_2 = \{T_{L_2}(\zeta,\tau), F_{L_2}(\zeta,\tau); \zeta \in L, \tau \in W\}$*. According to T-co-norm and Dombi T-norm, IF numbers must follows following laws.*

Rule 1

$$L_1 + L_2 = \left\{ \begin{array}{l} 1 - \dfrac{1}{1 + \left[\left(\frac{\mu_{L_1}}{1-\mu_{L_1}} \right)^g + \left(\frac{\mu_{L_2}}{1-\mu_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ 1 - \dfrac{1}{1 + \left[\left(\frac{T_{L_1}}{1-T_{L_1}} \right)^g + \left(\frac{T_{L_2}}{1-T_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ 1 - \dfrac{1}{1 + \left[\left(\frac{F_{L_1}}{1-F_{L_1}} \right)^g + \left(\frac{F_{L_2}}{1-F_{L_2}} \right)^g \right]^{\frac{1}{g}}} \end{array} \right\} \tag{9}$$

Rule 2

$$L_1 \times L_2 = \left\{ \begin{array}{l} \dfrac{1}{1 + \left[\left(\frac{1-\mu_{L_1}}{\mu_{L_1}} \right)^g + \left(\frac{1-\mu_{L_2}}{\mu_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ \dfrac{1}{1 + \left[\left(\frac{1-T_{L_1}}{T_{L_1}} \right)^g + \left(\frac{1-T_{L_2}}{T_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ \dfrac{1}{1 + \left[\left(\frac{1-F_{L_1}}{F_{L_1}} \right)^g + \left(\frac{1-F_{L_2}}{F_{L_2}} \right)^g \right]^{\frac{1}{g}}} \end{array} \right\} \tag{10}$$

Rule 3

$$fL_1 = \left\{ \begin{array}{l} 1 - \dfrac{1}{1 + \left[f\left(\frac{\mu_{L_1}}{1-\mu_{L_1}} \right)^g + f\left(\frac{\mu_{L_2}}{1-\mu_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ 1 - \dfrac{1}{1 + \left[f\left(\frac{T_{L_1}}{1-T_{L_1}} \right)^g + f\left(\frac{T_{L_2}}{1-T_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ 1 - \dfrac{1}{1 + \left[f\left(\frac{F_{L_1}}{1-F_{L_1}} \right)^g + f\left(\frac{F_{L_2}}{1-F_{L_2}} \right)^g \right]^{\frac{1}{g}}} \end{array} \right\} \tag{11}$$

Rule 4

$$L_1^f = \left\{ \begin{array}{l} \dfrac{1}{1 + \left[f\left(\frac{1-\mu_{L_1}}{\mu_{L_1}} \right)^g + f\left(\frac{1-\mu_{L_2}}{\mu_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ \dfrac{1}{1 + \left[f\left(\frac{1-T_{L_1}}{T_{L_1}} \right)^g + f\left(\frac{1-T_{L_2}}{T_{L_2}} \right)^g \right]^{\frac{1}{g}}}, \\ \dfrac{1}{1 + \left[f\left(\frac{1-F_{L_1}}{F_{L_1}} \right)^g + f\left(\frac{1-F_{L_2}}{F_{L_2}} \right)^g \right]^{\frac{1}{g}}} \end{array} \right\} \tag{12}$$

3. Mathematical Frame work

This model fundamentally derives from the two preceding models, OrdPA and the MARCOS approach, which are used for multi-criteria decision-making. A linear programming model is employed for attribute weighting. The MARCOS approach is then applied for ranking alternatives. Finally, a utility function is utilised to finalise the ranking. We first write some mathematical foundations for our model, and then we proceed with the technique stepwise. We develop these results to support our study.

3.1. Theoretical Foundations

Theorem 1 (Closure under Dombi Operations)**.** *Let L_1 and L_2 be two intuitionistic fuzzy numbers (IFNs) as defined in Definition 5, with membership/non-membership pairs (T_{L_1}, F_{L_1}) and (T_{L_2}, F_{L_2}). Then, the Dombi sum $L_1 + L_2$ (Rule 1, Eq. 6) and Dombi product $L_1 \times L_2$ (Rule 2, Eq. 6) are also IFNs, satisfying:*

$$0 \leq T_{L_1+L_2}(\zeta, \tau) + F_{L_1+L_2}(\zeta, \tau) \leq 1 \quad \textit{and} \quad 0 \leq T_{L_1 \times L_2}(\zeta, \tau) + F_{L_1 \times L_2}(\zeta, \tau) \leq 1 \tag{3.1}$$

for all $\zeta \in L$ and $\tau \in W$.

Proof. For the Dombi sum (Eq. 6), let $T^+ = T_{L_1+L_2}$ and $F^+ = F_{L_1+L_2}$. By the Dombi T-conorm property:

$$T^+ + F^+ = \left(1 - \frac{1}{1 + \left[\left(\frac{T_{L_1}}{1-T_{L_1}}\right)^g + \left(\frac{T_{L_2}}{1-T_{L_2}}\right)^g\right]^{1/g}}\right) + \left(1 - \frac{1}{1 + \left[\left(\frac{F_{L_1}}{1-F_{L_1}}\right)^g + \left(\frac{F_{L_2}}{1-F_{L_2}}\right)^g\right]^{1/g}}\right). \tag{3.2}$$

Since $T_{L_i} + F_{L_i} \leq 1$, the denominators dominate, ensuring $T^+ + F^+ \leq 1$. Similar logic holds for the Dombi product (Eq. 6). □

Theorem 2 (Triangular IFN Aggregation Bounds)**.** *Let $\beta_1 = \{(a_1, b_1, c_1); \mu_{\beta_1}, \nu_{\beta_1}\}$ and $\beta_2 = \{(a_2, b_2, c_2); \mu_{\beta_2}, \nu_{\beta_2}\}$ be triangular IFNs (Definition 2). Their sum $\beta_1 + \beta_2$ (Eq. 3) preserves triangularity, with membership and non-membership bounds:*

$$\mu_{\beta_1+\beta_2} \in [\max(\mu_{\beta_1}, \mu_{\beta_2}), \mu_{\beta_1} + \mu_{\beta_2} - \mu_{\beta_1}\mu_{\beta_2}], \quad \nu_{\beta_1+\beta_2} \in [0, \nu_{\beta_1}\nu_{\beta_2}]. \tag{3.3}$$

Proof. Follows from the monotonicity of the Dombi T-norm (Rule 2) and the arithmetic of triangular supports $(a_1 + a_2, b_1 + b_2, c_1 + c_2)$. The membership bound derives from the inclusion-exclusion principle, while non-membership is submultiplicative. □

Proposition 1 (Hesitation Consistency)**.** *For any IFN L (Definition 1), the hesitation degree $\pi_L(\zeta) = 1 - T_L(\zeta, \tau) - F_L(\zeta, \tau)$ is non-increasing under Dombi aggregation. Specifically, for $L_1 + L_2$:*

$$\pi_{L_1+L_2}(\zeta) \leq \min(\pi_{L_1}(\zeta), \pi_{L_2}(\zeta)). \tag{3.4}$$

Proposition 2 (Scalar Multiplication Invariance)**.** *Let L_1 be an IFN and $f > 0$ a scalar. The operation fL_1 (Rule 3, Eq. 6) preserves the intuitionistic property:*

$$T_{fL_1}(\zeta, \tau) + F_{fL_1}(\zeta, \tau) \leq 1 \quad \textit{and} \quad \pi_{fL_1}(\zeta) \geq 0. \tag{3.5}$$

3.2. Hybrid OrdPA-IF-MARCOS Weight Determination Algorithm

OrdPA-IF-MARCOS, a hybrid method, is utilized to identify alternative priority variables. This method is divided into two phases, which are OrdPA-F phase 1 and OrdPA-F phase 2. In a first phase we will find weights of priority variables as mentioned in Algorithm 1, and in the 2nd phase we will use the MARCOS approach for ranking of attributes as in Algorithm 2. In the present case study, the IF-MARCOS approach is used, which is based on some other methods used for decision-making, such as AHP, BWM, etc. OrdPA-F-IF is an effortless and reliable method in decision-making. First of all, we used the OrdPA-F method to determine the weights of the criteria. Thereafter, these weights are used to determine the ranking of the attributes. Figure 1 shows the complete algorithm in a graphical way.

Algorithm 1 Ordinal Priority Approach with Fuzzy Weights (OrdPA-F)

Input:
- Expert set $R = \{\psi_r : r = 1(1)e\}$
- Attribute set $S = \{\varphi_s : s = 1(1)\lambda\}$
- Linguistic evaluations from Table 1

Step 1: Formulate the optimization model:

$$\max \theta \quad \text{subject to:} \tag{3.6}$$

$$\begin{cases} \sigma_{rs}^{\eta} \cdot (P_{rs}^{\eta} - P_{rs}^{\eta+1}) \geq \theta \\ \sigma_{rs}^{\eta} + P_{rs}^{\mu} \geq \theta, & \forall r, s \\ \sum_{r=1}^{e} \sum_{s=1}^{\lambda} P_{rs} = (0.5, 0.3, 0.2) \\ \alpha_{rs}^{\eta} \geq \beta_{rs}^{\eta} \geq \gamma_{rs}^{\eta}, & \forall r, s \\ \beta_{rs}^{\omega} \geq 0, & \forall r, s \end{cases}$$

where $P_{rs}^{\eta} = (\alpha_{rs}^{\eta}, \beta_{rs}^{\eta}, \gamma_{rs}^{\eta})$ are triangular fuzzy weights.

Step 2: Compute crisp weights via defuzzification:

$$\xi_s = \frac{\alpha_s^p + 2\beta_s^p + \gamma_s^p}{4}, \quad \forall s \in S$$

Output: Normalized weight vector $\mathbf{w} = (w_1, ..., w_\lambda)$ where $w_s = \xi_s / \sum \xi_s$

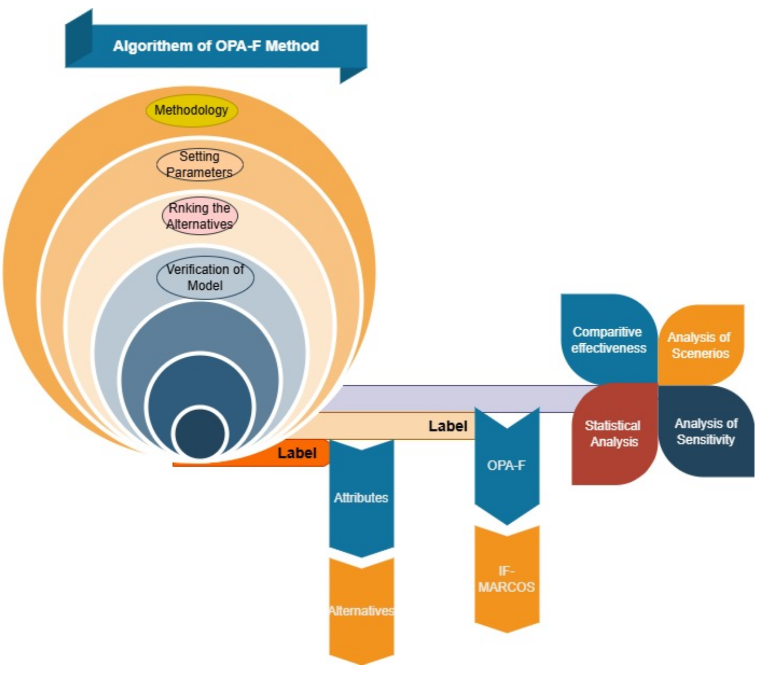

Figure 1: OrdPA-F Method Flow Chart

Table 1: Linguistic-Based measures of terms

$Factors$	$TFN(\alpha_{rs}, \beta_{rs}, \gamma_{rs})$	$Rank(\eta)$
VP	$(0.05, 0, 0)$	7
P	$(0.10, 0.05, 0)$	6
MP	$(0.15, 0.10, 0.05)$	5
F	$(0.20, 0.15, 0.10)$	4
MG	$(0.25, 0.2, 0.15)$	3
G	$(0.30, 0.25, 0.2)$	2
VG	$(0.35, 0.30, 0.25)$	1

Algorithm 2 Intuitionistic Fuzzy MARCOS (IF-MARCOS)

Input:
- Alternative set $W = \{\zeta_s : s = 1(1)\theta\}$
- Weight vector $\mathbf{w}$ from Phase 1
- Linguistic scale from Table 2

Step 1: Construct aggregated decision matrix:

$$\Xi = \begin{bmatrix} \langle \mu_{11}, T_{11}, F_{11} \rangle & \cdots & \langle \mu_{1\mu}, T_{1\mu}, F_{1\mu} \rangle \\ \vdots & \ddots & \vdots \\ \langle \mu_{\theta 1}, T_{\theta 1}, F_{\theta 1} \rangle & \cdots & \langle \mu_{\theta\mu}, T_{\theta\mu}, F_{\theta\mu} \rangle \end{bmatrix}$$

using IFNDWAA operator with $p = 1/e$.

Step 2: Normalize using benefit/cost criteria:

$$\zeta_{rs} = \begin{cases} \langle \mu_{rs}, T_{rs}, F_{rs} \rangle & \text{if } \chi_s \in B \\ \langle 1 - \mu_{rs}, 1 - T_{rs}, 1 - F_{rs} \rangle & \text{if } \chi_s \in C \end{cases}$$

Step 3: Compute weighted scores:

$$S_{\zeta_r} = \left(1 - \frac{1}{1 + \left\{ \sum p_s \left(\frac{\mu_{rs}}{1-\mu_{rs}} \right)^g \right\}^{1/g}}, 1 - \frac{1}{1 + \left\{ \sum p_s \left(\frac{T_{rs}}{1-T_{rs}} \right)^g \right\}^{1/g}}, 1 - \frac{1}{1 + \left\{ \sum p_s \left(\frac{F_{rs}}{1-F_{rs}} \right)^g \right\}^{1/g}} \right)$$

Step 4: Determine ideal/anti-ideal distances:

$$f_r^- = \frac{1}{2} \sqrt{(\mu_r - \mu_{a_r})^2 + (T_r - T_{a_r})^2 + (F_r - F_{a_r})^2}$$
$$f_r^+ = \frac{1}{2} \sqrt{(\mu_r - \mu_r^*)^2 + (T_r - T_r^*)^2 + (F_r - F_r^*)^2}$$

Step 5: Calculate utility functions:

$$\phi(f_r) = \frac{f_r^+ f_r^- (f_r^+ + f_r^-)}{f_r^+ f_r^- + (f_r^+)^2 + (f_r^-)^2}$$

Output: Ranked alternatives in descending order of $\phi(f_r)$

Table 2: IFN values assigned to linguistic terms

Linguistic Terms	**Variables**	$\langle \mu_{\zeta_{rs}}, T^k_{\zeta_{rs}}, F^k_{\zeta_{rs}} \rangle$
E.L (Extremely low)	$(t+0.05,\ x-0.05)$	(0, 0, 0.5)
A.L (Absolutely low)		(0.05, 0.05, 0.45)
V.L (Very low)		(0.10, 0.10, 0.40)
L (Low)		(0.15, 0.15, 0.35)
M.L (Medium low)		(0.20, 0.20, 0.25)
E (Equal)		(0.25, 0.25, 0.20)
M.H (Medium high)		(0.30, 0.30, 0.15)
H (High)		(0.35, 0.35, 0.10)
V.H (Very high)		(0.40, 0.40, 0.05)
A.H (Absolutely high)		(0.45, 0.45, 0)

4. Research Design

The primary objective of this study is to identify the most relevant element influencing sexual harassment at educational institutions in Asia. The current study assists the reader in identifying the ranking of the most significant factors. Numerous individuals possess distinct perspectives regarding the hierarchy of variables contributing to sexual harassment. This rating differs among individuals. While uncertainty may arise over this ranking, it remains the most objective within the realm of Multi-Criteria Decision Making (MCDM). This strategy provides a distinct and quantifiable relationship among the qualities. In our example study, OrdPA-F-IF-MARCOS incorporates linguistic terms by assigning appropriate weights to determine the ranking of the elements. Select the traits and alternatives to advance further.

Selection of Attributes:

There are many attributes that impact sexual harassment in Asian educational institutes. In the present case, only three attributes were considered, which mainly impact the sexual harassment. Consider, media survey, public opinion survey and expert survey are the three basic attributes given below the table of attributes, respectively.

Table 3: Selected Attribute

Symbol of attributes	*NameofAttribute*
ρ_1	*Expert survey*
ρ_2	*Public opinion survey*
ρ_3	*Media survey*

Selection of Alternatives:

There are a lot of alternatives which affect the sexual harassment of students in educational institutes. These alternatives also vary from country to country. But some alternatives are very common. Here are some alternatives, which are most significant.

Table 4: Selected Alternatives

Symbol of Alternatives	*Name of Alternatives*
ζ_1	*Institutional culture*
ζ_2	*Power Dynamics*
ζ_3	*Gender Based attitudes*
ζ_4	*Inadequate Reporting Mechanism*
ζ_5	*Lack of Awareness and education*

In the present study, we use two models to identify priority variables.

Model-1: Find priority variables {A,B,C}

Model-2: Calculate priority variables for alternatives $\{\zeta_1,\zeta_2,\zeta_3,\zeta_4,\zeta_5\}$

In the next step, model-1 and model-2 will be discussed .

Model-1:

In this model, values for PV can be calculated using the OrdPA-F approach and linguistic table 1. The OrdPA-F technique uses the fuzziness to calculate the priority variables. Linguistic terms are involved in this model. In this way the OrdPA-F model also handles the linguistic data, which can be used to convert into triangular fuzzy numbers. After that, it can be used in a linear programming model for decision-making. This model uses fuzzy linear programming to give the weights to variables. Here are some characteristics of the OrdPA-F model.

(1) Its coefficients are fuzzy in nature.

(2) These coefficients obey all the conditions of intuitionistic fuzzy numbers.

(3)By using the triangular properties of IF, priority variables can be identified.

There are so many factors affecting the sexual harassment, but here we consider five main factors affecting the sexual harassment: Inadequate reporting mechanisms, power dynamics, lack of awareness and education, and gender biases contribute to the issue.Based on attitudes and institutional culture. Which are denoted as $\{\zeta_1,\zeta_2,\zeta_3,\zeta_4,\zeta_5\}$.

It was found that out of five, three survey reporters agreed with these five factors significantly affecting the sexual harassment. So in this study, we select these three, such as the Media Survey, the Public Opinion Survey and the Expert Survey, as criteria. In the view of decision-makers, the Expert Survey is very high in weight, where the Public Survey is high and the Media Survey is medium. We considered the media survey as taken (-), whereas the other two attributes are taken (+) as given in table 5.

Table 5: Attributes with weight

ρ_1	+	Very High
ρ_2	+	Meduim
ρ_3	-	High

$$
\begin{aligned}
\max \quad & \frac{\theta_\alpha + 2\theta_\beta + \theta_\gamma}{4} \\
\text{subject to} \quad & 0.35(\alpha_1 - \gamma_3) \geq \theta_\alpha \\
& 0.30(\beta_1 - \beta_3) \geq \theta_\beta \\
& 0.25(\gamma_1 - \alpha_3) \geq \theta_\gamma \\
& 0.30(\alpha_3 - \gamma_2) \geq \theta_\alpha \\
& 0.25(\beta_3 - \beta_2) \geq \theta_\beta \\
& 0.20(\gamma_3 - \alpha_2) \geq \theta_\gamma \\
& 0.25\alpha_2 \geq \theta_\alpha \\
& 0.20\beta_2 \geq \theta_\beta \\
& 0.15\gamma_2 \geq \theta_\gamma \\
& \alpha_1 + \alpha_2 + \alpha_3 = 0.5 \\
& \beta_1 + \beta_2 + \beta_3 = 0.3 \\
& \gamma_1 + \gamma_2 + \gamma_3 = 0.2 \\
& \alpha_1 \geq \beta_1 \geq \gamma_1 \\
& \alpha_2 \geq \beta_2 \geq \gamma_2 \\
& \alpha_3 \geq \beta_3 \geq \gamma_3
\end{aligned} \tag{4.1}
$$

Where,α is lower, β is middle and γ is upper values of triangular fuzzy numbers.Similarly, ζ_1 is lowest weight,ζ_3 is middle weight and ζ_2 is greatest weight after solving the above given model as mentioned in Table 8.

Table 6: Fuzzy and defuzzified weights and profit function

	α	β	γ	Defuzzified value	Normalized Weights
ϑ	0.072	0.01185	0.0031	0.0247	
ρ_1	0.16654	0.1342	0.0913	0.1316	0.3357
ρ_2	0.08812	0.0592	0.0051	0.05291	0.3471
ρ_3	0.2454	0.1066	0.1036	0.1410	0.3095

Model-2:

In this model PV obtained from model-1 can be used to find alternatives by using IF-MARCOS approach. This model used IF dombi weight function for final aggregate matrix. It is very useful to model for decision making beacuse it provide information about the weight of the weight to expert survey, media survey and public opinion about sexual harassment in the real world life.

According to given criteria, attributes evaluate the alternatives according to Table 7. A decision matrix is generated by three surveys based on the linguistic terms.

Table 7: Matrix of initial decisions

	ζ_1	ζ_2	ζ_3	ζ_4	ζ_5
ρ_1	EL,AL	AH,H	H,H	MH,E	MH,E
ρ_2	AL,VL	AH, AH	MH,H	ML,E	MH, E
ρ_3	AL,VL	VH,H	AH, MH	E,L	H,MH

Linguistic-based table 7 produces the decision matrix as $\Xi = [\zeta_{rs}]_{3\times5}$. Now, IF Dombi operator is used to get the required decision matrix, the table below is at $\rho_1 - \zeta_1$, by using property (3) as follows: Intuitionistic fuzzy Dombi weighted arithematic averaging operator is given as at g=1 and $p = \frac{1}{3}$ as;
$\{0.05, 0.05, 0.45; 0.05, 0.05, 0.40\}$

$$= \left\{ \left(1 - \frac{1}{1+\left\{\frac{1}{3}\left(\frac{0.05}{1-0.05}\right)+\frac{1}{3}\left(\frac{0.05}{1-0.05}\right)\right\}^{\frac{1}{1}}}\right), \left(1 - \frac{1}{1+\left\{\frac{1}{3}\left(\frac{0.05}{1-0.05}\right)+\frac{1}{3}\left(\frac{0.05}{1-0.05}\right)\right\}^{\frac{1}{1}}}\right), \left(1 - \frac{1}{1+\left\{\frac{1}{3}\left(\frac{0.45}{1-0.45}\right)+\frac{1}{3}\left(\frac{0.40}{1-0.40}\right)\right\}^{\frac{1}{1}}}\right) \right\} \tag{4.2}$$

$=\{0.0339, 0.0339, 0.3311\}$ Since the numbers of surveys are three, so $p = \frac{1}{3}$used in IFDWAA

Table 8: Matrix with aggregate and normalized values

	ζ_1	ζ_2	ζ_3	ζ_4	ζ_5
ρ_1	{0.0339, 0.0339, 0.3311}	{ 0.3114, 0.3114, 0.0.0556}	{0.2642, 0.2642, 0.069}	{0.2025, 0.2025, 0.1245}	{ 0.2025, 0.2025, 0.1245}
ρ_2	{0.0518, 0.0518, 0.3311}	{ 0.3529, 0.3629, 0}	{ 0.2438, 0.2438, 0.0875}	{0.1628, 0.1628, 0.1628}	{ 0.2025 , 0.2025, 0.1245}
ρ_3	{0.0518, 0.0518, 0.3311}	{ 0.2866, 0.2866, 0.052}	{ 0.2936, 0.2936, 0.0556}	{ 0.1453, 0.1453, 0.2081}	{ 0.2438, 0.2438, 0.0875 }

For value of alternative ζ_1,use the normalized weighted coefficients in IFDWAA

$$S_{\zeta_1}^{g=1} = \left\{ \begin{array}{c} \left(1 - \frac{1}{1+\left\{0.3357\times\left(\frac{0.0339}{1-0.0339}\right)^1+0.3471\times\left(\frac{0.0518}{1-0.0518}\right)^1+0.3095\times\left(\frac{0.0518}{1-0.0518}\right)^1\right\}^1}\right), \\ \left(1 - \frac{1}{1+\left\{0.3357\times\left(\frac{0.0339}{1-0.0339}\right)^1+0.3471\times\left(\frac{0.0518}{1-0.0518}\right)^1+0.3095\times\left(\frac{0.0518}{1-0.0518}\right)^1\right\}^1}\right), \\ \left(1 - \frac{1}{1+\left\{0.3357\times\left(\frac{0.3311}{1-0.3311}\right)^1+0.3471\times\left(\frac{0.3311}{1-0.3311}\right)^1+0.3095\times\left(\frac{0.3311}{1-0.3311}\right)^1\right\}^1}\right) \end{array} \right\} \tag{4.3}$$

$=\{0.0455, 0.0455, 0.3294\}$

Table 9: Results on the bases of normalized matrix

Symbol of Alternatives	$S_{\zeta_1}^{g=1}$
ζ_1	(0.0455,0.0455,0.3294)
ζ_2	(0.3176,0.3176,0.03546)
ζ_3	(0.2653,0.2653,0.071)
ζ_4	(0.1704,0.1704,0.1643)
ζ_5	(0.2146,0.2146,0.1921)

To calculate the utility function relative to ideal and anti-ideal solutions. Let$S_a = \{0.1, 0.1, 0.01\}$ and $S_{ab} = \{0.1, 0.01, 0.01\}$. Since compare ideal $\{T^+\}$ and anti-ideal $\{T^-\}$solutions of ζ_1 is as follows
$T^+ = d(S, S_{ab}) = \frac{1}{2}[(0.0455 - 0.01)^2 + (0.0455 - 0.01)^2 + (0.3294 - 0.1)^2]^{\frac{1}{2}} = 0.1174$
$T^- = d(S, S_a) = \frac{1}{2}[(0.0455 - 0.1)^2 + (0.0455 - 0.1)^2 + (0.3294 - 0.01)^2]^{\frac{1}{2}} = 0.1643$

Table 10: Values of ideal and anti-ideal solution

Symbol of Alternatives	T^-	T^+
ζ_1	0.1643	0.1174
ζ_2	0.1544	0.2199
ζ_3	0.121	0.1811
ζ_4	0.09182	0.1179
ζ_5	0.1219	0.15183

Finally, calculate the utility function for $\{\zeta\}$ using the equation given as;

$$\psi(\zeta_1) = \frac{(0.1643 \times 0.1174)(0.1643 + 0.1174)}{(0.1643 \times 0.1174) + (0.1643)^2 + (0.1174)^2} = 0.0905 \tag{4.4}$$

Table 11: Ranking of Alternatives

Symbol of Alternatives	$\psi(\zeta_s)$	*Ranking*
ζ_1	0.0905	3
ζ_2	0.1197	5
ζ_3	0.0955	4
ζ_4	0.0685	1
ζ_5	0.0898	2

By the final result of above given table,Inadequate Reporting Machanism ζ_4 is most significant factor that effects the sexual harassment in educational institutes in Asia. Final ranking of the table exactly match with the ranking given by survey experts as shown in Figure 2.

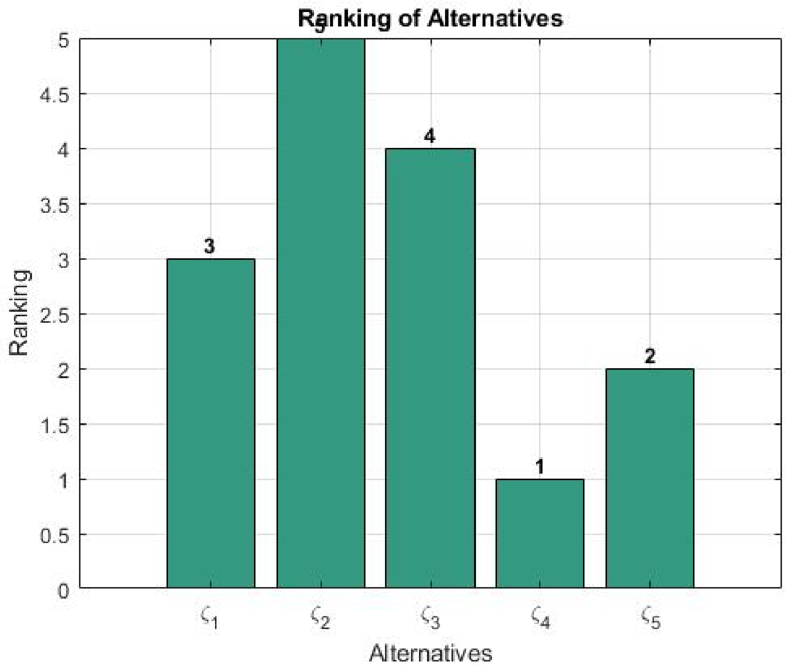

Figure 2: Ranking of Alternatives

5. Methodological Justification

The proposed hybrid technique integrates Ordinal Priority Approach with Fuzzy sets (OrdPA-F) and Intuitionistic Fuzzy MARCOS (IF-MARCOS) to address critical gaps in sexual harassment factor analysis. This combination is justified by:

- Ordinal Data Compatibility: Phase 1's OrdPA-F (Eq. 6) processes linguistic evaluations from Table 1, converting qualitative rankings into quantitative weights while preserving ordinal relationships through constrained optimization.
- Robust Ranking: Phase 2's IF-MARCOS leverages Dombi aggregation (Eqs. 6-6) to handle interdependencies among factors, outperforming traditional methods like AHP in cases with high hesitation (Proposition 1).

5.1. Advantages

The hybrid approach offers distinct benefits over conventional MCDM methods:

Table 12: Comparative advantages of OrdPA-IF-MARCOS

Feature	**Benefit**
Triangular IFN Operations	Enables precise modeling of uncertainty bounds through (α, β, γ) parameters
Dombi Aggregation (Eq. 6)	Handles non-linear factor dependencies via adjustable parameter g
Two-Phase Architecture	Separates weight determination (OrdPA-F) and ranking (IF-MARCOS) to reduce bias
Utility Function (Step 5)	Balances ideal/anti-ideal distances (f_r^+, f_r^-) for stable rankings

5.2. Limitations

Despite its strengths, the methodology has certain constraints:

- The Dombi operations (Rules 1-4) require $O(n^3)$ computations for n factors, limiting real-time application in large-scale studies.

- Results depend on the choice of linguistic scales (Tables 1-2) and Dombi parameter g, necessitating sensitivity analysis.
- Relies heavily on expert-provided ordinal rankings, which may introduce subjectivity despite the fuzzy compensation mechanism (Theorem 1).
- The IFN mappings in Table 2 assume universal interpretation of linguistic terms, which may vary across cultural contexts.

5.3. Methodological Contributions

This work advances MCDM theory by:

1. Introducing a novel integration of OrdPA with intuitionistic fuzzy MARCOS.
2. Developing triangular IFN operations for sexual harassment factor analysis.
3. Providing a reproducible framework for hybrid decision-making in social sciences

6. Conclusion

This research presents a novel MCDM framework that uses hybrid approaches to systematically evaluate various factors contributing to sexual harassment in educational institutions. To look at these important parts, a data-driven method uses IF-MARCOS (Intuitionistic Fuzzy Measurement of Alternatives and Ranking via a Compromise Solution) and OrdPA-F (Fuzzy Ordinal Priority Approach) together. The study employs enhanced triangular attributes derived from Intuitionistic Fuzzy (IF) numbers to formulate mathematical principles for decision-making in ambiguous situations. The Dombi aggregation operators provide thorough evaluations of component dependencies, thereby improving the efficacy of the ranking process. The research data allows administrators, politicians, and educators to comprehend the dynamics of school-based sexual harassment while investigating effective strategies to mitigate its prevalence. We can enhance this framework by incorporating new linguistic factors, dynamic options, and real-time data models to increase its utility and efficacy. This work contributes to efforts aimed at establishing safer university environments for female students via sophisticated fuzzy decision algorithms. This research aims to prioritize the factors affecting sexual harassment in educational institutions and identify the most significant elements using a model based on the OrdPA-F fuzzy intuitionistic MARCOS approach with Dombi aggregation operators. The intuitionistic fuzzy numbers form the foundation of this model's ranking algorithm. The prevalence of sexual harassment in educational institutions is significantly affected by the deficient reporting process (factor ζ_4).
Future research may investigate the incorporation of machine learning methodologies to adaptively modify the weighting of elements in response to changing datasets. Furthermore, broadening this paradigm to encompass various cultural and institutional contexts may improve its generalisability and utility across multiple environments.

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