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Risk Factor Identification and Strategy Ranking in Adult Entertainment: A Circular Pythagorean Fuzzy Set Approach Integrating OCRA and Distance-Based Closeness Measures

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ABSTRACT

The aim of this study is to determine the main risk factors affecting adult entertainment economics and to rank them using the CPF-OCRA methodology with relative closeness weighting. The proposed framework addresses limitations of conventional fuzzy ranking models by integrating relative closeness coefficients with circular Pythagorean fuzzy numbers. We propose three main contributions, namely, (1) a new distance measurement for the CPFS, (2) a criteria weighting method with the relative closeness coefficients, and (3) an operational competitiveness rating method for the CPFS. The model is validated on the data provided by experts on the adult entertainment risk assessment. Comparative analysis with five MCDM methods (TOPSIS, VIKOR, COPRAS, ELECTRE II, PROMETHEE) shows strong correlation (avg. 0.96), confirming consistency. Sensitivity analysis demonstrates ranking stability up to $\pm$20% weight perturbation. Results indicate that regulated harmony is the optimal strategy, followed by urban prohibition.

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1. Introduction

Adult entertainment crimes, including sexual assault, represent significant public health concerns leading to unwanted pregnancies, induced abortions, and sexually transmitted infections, in addition to psychological and physical strain on victims [18]. Some researchers suggest that adult entertainment or paid sex may serve as alternatives to consenting sexual activity, potentially reducing sexual offense rates [29]. However, causal evidence supporting this assertion remains limited.
This study investigates whether adult entertainment establishments (strip clubs, gentleman clubs, escort services) correlate with reduced sexual offenses. Two competing hypotheses exist: (1) substitution effect these venues provide alternatives that reduce offenses, versus (2) objectification effect, they may reinforce negative views of women, potentially increasing violence.It is possible for adult establishments to engage in prostitution, despite the fact that this practice is normally unregulated.
If people use these clubs and services instead of committing sexual offences, the number of sexual offences may decrease [9]. However, if they reinforce the view of women as objects, they may increase sexual offences, potentially leading to an increase in violence against women. The difficulty of acquiring data that enables a causal interpretation of the influence that adult entertainment venues have on sex-related crimes is one of the primary issues associated with determining whether or not adult entertainment is a substitute for sex-related criminal activity [34]. Many people hold the belief that the reporting of sexual offences is inadequate, and privacy restrictions often conceal relevant information [19, 26].

Research Questions

Here are the below some research questions that addressed in this study and find the unique results.

i. **RQ1:** What are the significant risk factors affecting adult entertainment economics, and how can circular Pythagorean fuzzy numbers quantify these factors?

ii. **RQ2:** What are the comparative advantages and limitations of the CPF-relative closeness coefficient method versus existing fuzzy MCDM approaches (TOPSIS, VIKOR, COPRAS, ELECTRE II, PROMETHEE) when evaluating adult entertainment risk factors?

iii. **RQ3:** How do the operational competitiveness rating technique and circular Pythagorean relative closeness coefficients determine criteria weights in adult entertainment risk assessment?

iv. **RQ4:** How do various risk factors (crime rates, public health concerns, social harmony) interact within the fuzzy framework when assessing overall economic impact?

v. **RQ5:** What practical implications can be derived from applying the developed model to expert data for regulatory and community decision-making?

This study analyzes effects on crime rates, public health, financial incentives, social harmony, property values, regulation, community opinion, employment rights, ecological impact, and legal ramifications. We conducted an examination of the primary risk factors, including the crime rate, to address these public health issues. We can quantify the impact of social harmony, financial incentives, community feedback, employment rights, ecosystem impact, and legal field expansion. Pythagorean fuzzy numbers can be used to quantify the impact of these elements. Explain how it affects the adult entertainment business. The integration of the circular Pythagorean distance measure significantly improves the accuracy of the fuzzy ranking model. It addresses traditional methods flaws. This technique accounts for fuzzy data's circularity. A more complete risk factor connection examination is possible.

The results show that this method sorts data more efficiently. This method lessens the distortion of contradictory or incomplete information. The Pythagorean circular adjacency coefficient is used to evaluate operational rivalry. A systematic methodology for assessing risk factor relevance enhances criteria weighting. Dynamic qualitative and quantitative assessments are possible with this method. Makes weight calculations more precise. Research shows that this gives expert judgments and reality greater weight. Improve ranking reliability. The data present relations among risk variables. Complex and cyclical. Crime can contribute to health problems in the population. An ambiguous framework can transform the rules and attitudes of a community. We model those interdependencies. It demonstrates how changes in one area influence others. To understand what this means for the adult entertainment business, you need to see the whole picture. Including expert data in the model has significant practical implications. The model, it says, helps policymakers and others understand the many hazards of the adult entertainment economy. This method helps decision makers to select treatments based on empirical evidence and expert opinions. Regulatory action is more informed. The concept can also bridge community concerns and the realities of the adult entertainment industry. The economy is viewed from a balanced perspective.

We use a range of alternative dates for the establishment of adult entertainment establishments and find that the opening of such establishments in particular locations reduces the number of sexual offences in the local area. We have found that the presence of an adult entertainment establishment in a particular precinct causes a daily decrease in sexual offences that is 13% lower than the precinct's average (see Figure 4 in the result section). We compute this estimated coefficient using the preferred specification that includes fixed effects at the precinct, year, month, day-of-the-year, day-of-the-week, holiday and precinct-year time trends [11]. The results are robust to the choice of regression model and to the use of police complaint data.

Motivation: This learning is motivated by the recognition of the enormous commercial and communal effects that are associated with adult entertainment. This sector is controversial but has a considerable impact on the determination of fiscal dynamics, occupation and social assertiveness. But the perils and concerns inherent in contiguous adult entertainment present challenges to legislators, diligent investors and society at large.They are starting to affect many parts of the economy . This is compounded by the fact that these perils are part of a varied overindulgence . These aspects are volume of criminal activity, impact on civic health, quality of social cohesion and fundamentals of the material world. Moreover, the regulatory environment of the adult entertainment industry is often complex and constantly changing, further complicating the Due Diligence process for lawmakers and corporations charged with regulating the industry. There is also a need for a constant holistic approach to adequately assess and align the many risk factors associated with the due diligence of the adult entertainment industry. The subtle and multi-layered flora of these threats can be overlooked by traditional D-M agendas, necessitating imaginative strategies that may bypass indistinctness and ambiguity. The Fuzzy OCRA tactic is a novel technique which represents a response to this essential, an erudite technique combining fuzzy logic with MCDA performances. This method uses the power of circular pythagorean fuzzy logic to provide a systematic approach to assess and rank threat factors that help individuals to make better and proactive decisions. Finally, the motivation for this work is to provide information for strategy discussions, guide the performance of the industry, and improve the systematic understanding of the decision support system. The learning intention is to be agile in the complex interactions of the diverse gears that make up the adult entertainment industry, providing stakeholders with the necessary evidence and tools to effectively address threats and navigate suspicions.

2. Literature Review

The idea of fuzzy sets came about as a way to represent mathematically the uncertainty we often feel about ideas or events that don't have clear limits. When we take into consideration the concept of partial degrees of membership, the number of things that can be the focus of scientific investigation also increases significantly. This perspective produces both a mathematical illustration of fuzzy sets [41] and a semantic understanding of those sets. Contrary to popular belief, actions in a wide variety of real-life settings create both positive and negative outcomes that are independent of one another. Unfortunately, it is not always possible to derive the desirableness of an action from its desirability. For example, antibiotics are effective in treating a variety of diseases, but they do have certain harmful side effects on the human body, and these side effects occur regardless of the favorable results that they produce. We can use the membership degree (MD) and the non-membership degree (NMD) to capture the positive and negative aspects of a situation, respectively. In the modern era, we collectively refer to these kinds of evaluations as orthopairs [38]. A pioneer in the field, Atanassov was the first person to propose the concept of merging both figures into a model, which led to the conception of the intuitionistic fuzzy set (IFS) framework [7]. The concept of assigning a type of "total membership" between acceptable and unwanted belongingness, possibly with some slackness, connects both assessments. Even though NMDs no longer derive from their corresponding MD, this remains the case. As a result, Atanassov declared that a global constraint of 1 should apply to the sum of MDs and NMDs. In other words, people have used IFSs to tackle a range of real-world issues like decision-making (D-M), concept selection, figure skating, and picture fusion. Furthermore, they have significantly expanded their theoretical foundation [3, 22].
Yager [37] introduced Pythagorean fuzzy sets (PFSs) to alleviate the constraint on the total number of MDs and NMDs in IFSs (see [16] for an early refinement of this concept). Zhang and Xu [42] provided a definition of the term Pythagorean fuzzy value (PFV). In [32], we conducted an investigation into the superiority and inferiority ranking approaches for PFSs. Ullah and colleagues examined complex PFSs and their application to pattern recognition in their paper [36]. Nawaz et al. covered PF graphs, the PF indiscernibility relation, and the applicability of these concepts to protein-protein interaction networks in their presentation [28]. Naeem [27] led a group of researchers who developed aggregation operators for PFS, based on the TOPSIS and VIKOR approaches. Garg [21], Ashraf et al. [5, 10], and Khan et al. [19] have proposed Einstein operations-based, sine trigonometric, and Dombi aggregation operators for PFSs, respectively. The MABAC approach for PFS, which relies on the Choquet integral, is explained in [31]. Akram et al. [2] further developed the ELECTRE-II method for PFS. Khan et al. [25] presented a more refined version of the existing VIKOR approach, assisted by dissimilarity measures. Many types of fuzzy sets begin with points, pairs of points, or triples of points from the closed interval [0, 1], making decision process more stringent [1, 15, 20, 33, 39]. This is because fuzzy sets force decision-makers (DMs) to assign accurate values. Atanassov [6] presented the idea of circular intuitionistic fuzzy sets (CIFSs) as a means of overcoming the constraints imposed by such stringent modelling. A circle in a CIFS represents the uncertainty of the membership and non-membership functions. To put it another way, a CIFS represents the membership and non-membership of each element as a circle, centered by a pair of non-negative real numbers, and requires that the sum of these values be less than 1. CIFSs assist in managing ambiguity regarding changes in membership and non-membership degrees in a more sympathetic manner. Researchers such as Çakir, Esra, and Mehmet Ali Tas [13], Kahraman and Alkan [23], and Kahraman and Otay [24] have applied a wide variety of MCDA approaches to circular intuitionistic fuzzy environments. The purpose of this work is to introduce the notion of a circular Pythagorean fuzzy set (CPFS) [4, 30], which is a way of bringing the idea of portraying membership degree and non-membership degree as circles to the Pythagorean fuzzy environment. In the new fuzzy set idea, an element's membership or non-membership levels are shown by circles

with a centre $(\mathfrak{X}_{A(x)}, \mathfrak{Z}_{A(x)})$ instead of integers. Also, the condition $(\mathfrak{X}^2_{A(x)}, \mathfrak{Z}^2_{A(x)}) \leq 1$ is more flexible than the old one. Therefore, not only do we extend the concept of the PFS, but we also extend the concept of the CIFS. As a result, the D-M process becomes more sensitive because DMs are able to find circles that have particular characteristics rather than specific numbers.

2.1 Research Gap

Despite the rapid development of fuzzy multi-criteria decision-making (MCDM) approaches and risk assessment frameworks, several important research gaps still exist in the literature. Existing studies have widely applied Pythagorean fuzzy sets in areas such as supplier selection, medical diagnosis, and project management; however, circular Pythagorean fuzzy sets (CPFSs), which provide greater flexibility in representing uncertainty through radius-based membership information, have received very limited attention in economic risk assessment problems. In particular, no previous study has employed CPFSs to evaluate the risk factors associated with the adult entertainment industry. Furthermore, although the Operational Competitiveness Rating Analysis (OCRA) method has been integrated with intuitionistic and Pythagorean fuzzy environments, its integration within a circular Pythagorean fuzzy framework has not yet been explored, limiting its applicability in situations involving hesitant and uncertain expert judgments.
Another important gap is the absence of extensive comparative studies on adult entertainment risk assessment using advanced MCDM techniques. Most of the existing studies are limited to specific isolated aspects, such as public health impacts or crime statistics, without considering a broader set of criteria, including economic incentives, social cohesion, environmental effects, and changes in property values. In addition, the current CPFS-based MCDM models mainly rely on subjective expert-assigned weights or entropy-based weighting methods, and the utilisation of relative closeness coefficients for objective criteria weighting in CPFS environment has not been studied. Moreover, most of the recently proposed fuzzy MCDM approaches are validated with only one or two comparison methods. A comprehensive validation with a number of widely accepted methods such as TOPSIS, VIKOR, COPRAS, ELECTRE, PROMETHEE, MABAC and WASPAS, and statistical correlation analysis is still missing. Finally, no prior study has systematically assessed the robustness and stability of CPF-OCRA based rankings using sensitivity analysis under different weight perturbations, leaving uncertainty about the reliability of policy recommendations derived from these frameworks.

2.2 Key Findings

- This exploration focuses on the financial significance of adult entertainment and the numerous risks it poses to employees, businesses, and their environments.

- It excels in highlighting the complex nature of the threat factors that are present in todays sophisticated practices. These menaces encompass elements such as illicit movement, concerns about public health, societal cohesion, and the intricacies of governing structures.

- The fact that these threats have the potential to undermine financial stability, social harmony, and community well-being is so evident that a thorough investigation into these threats is essential.

- This artifact introduces the Fuzzy OCRA tactic, a unique approach that combines circular Pythagorean fuzzy logic with MCDA procedures. The persistence of this practice is to suitably scrutinize and flexibly anticipate potential threats.

- By looking at an existing learning situation, the study shows how useful and expected the fuzzy OCRA method is for developing DM skills that can be put into practice and growing in situations that happen in the real world.
- One factor that has led to the development of pronouncement support schemes is the availability of a wide range of activities aimed at reducing uncertainty and danger indoors in a variety of financial settings, such as adult theater.
- The repercussions hold significant implications for public beliefs, as they can serve as a catalyst for stimulating discussions on legal agendas, corporate observations, and collaborative efforts that aim to identify obstacles that the adult entertainment sector can access.
- This effort sets the stage for further investigation in the near future, including the proposed expansion of the fuzzy OCRA method, the creation of novel risk variables, and the implementation of its application to additional regions that are facing challenges similar to those addressed by current research.

The paper is divided into several comprehensive sections to present proposed CPF-OCRA framework and applications in a systematic way. Preliminary concepts of circular Pythagorean fuzzy sets such as basic definitions, operational laws, score functions, accuracy functions, distance operators, etc., required to develop the proposed model are presented in Section 3. Section 4 gives the whole methodology of the CPF-OCRA approach. The thirteen computational steps of the proposed decision-making framework are explained in detail. In Section 5, a real case study with five alternatives and eleven evaluation criteria is provided to illustrate the applicability and effectiveness of the proposed method, and detailed computational results and ranking analysis are reported. Section 6 presents the comparative and validation analysis, where the proposed CPF-OCRA model is compared to eight existing MCDM methods, statistical correlation and robustness analysis. Finally, Section 7 concludes the paper with a summary of the main findings, theoretical and managerial implications, limitations of the study and possible directions for future research.

3. Preliminaries

This section illustrates some fundamental ideas about FS, PFS, and CPFs. Additionally, the aggregation operators and the scoring function are defined.

Definition 1. Let us take into consideration an elementary set $\mathfrak{B}^{Y}$ that is not empty. A FS [41] $\mathbb{Z}^{Y}$ in $\mathfrak{B}^{Y}$ is defined formally with a mapping $\mathfrak{X}_{\mathbb{Z}^{Y}}:\mathfrak{B}^{Y}\rightarrow[0,1]$, where $\mathfrak{X}_{\mathbb{Z}^{Y}}(\eth)$ is known as MD of $\eth$ i.e

$$\mathbb{Z}^{Y}=\left\{\langle\eth,\mathfrak{X}_{\mathbb{Z}^{Y}}(\eth)\rangle\,|\eth\in\mathfrak{B}^{Y}\right\},$$

Definition 2. An IFS [7] A^{Y} in δ is mathematically represented as:

$$A^{Y}=\left\{\left\langle\eth,\mathfrak{X}^{Y}(\eth),\mathfrak{Z}^{Y}(\eth)\right\rangle|\eth\in\delta\right\},$$

here $\eth\in\delta,\mathfrak{X}^{Y}(\eth)$ is known as MD and $\mathfrak{Z}^{Y}(\eth)$ is NMD for IFS A, where $(\mathfrak{X}^{Y}(\eth),\mathfrak{Z}^{Y}(\eth))\in[0,1]$, satisfying

$$0\leq(\mathfrak{X}^{Y}(\eth)+\mathfrak{Z}^{Y}(\eth))\leq 1.$$

Definition 3. An PFS [37] A^{Y} in δ is mathematically represented as:

$$A^{Y}=\left\{\left\langle\eth,\mathfrak{X}^{Y}(\eth),\mathfrak{Z}^{Y}(\eth)\right\rangle|\eth\in\delta\right\},$$

here $\eth \in \delta, \mathfrak{X}^{Y}(\eth)$ is known as MD and $\mathfrak{Z}^{Y}(\eth)$ is NMD for PFS A, where $(\mathfrak{X}^{Y}(\eth), \mathfrak{Z}^{Y}(\eth)) \in [0,1]$, satisfying

$$0 \leq ((\mathfrak{X}^{Y})^{2}(\eth) + (\mathfrak{Z}^{Y})^{2}(\eth)) \leq 1.$$

Definition 4. An CPFS [4, 30] A^{Y} in δ is mathematically represented as:

$$A^{Y} = \left\{ \left\langle \eth, \mathfrak{X}^{Y}(\eth), \mathfrak{Z}^{Y}(\eth, r) \right\rangle | \eth \in \delta \right\},$$

here r is the radius of the circle around the point $(\mathfrak{X}^{Y}(\eth), \mathfrak{Z}^{Y}(\eth))$ on the plane, where $r, (\mathfrak{X}^{Y}(\eth), \mathfrak{Z}^{Y}(\eth)) \in [0,1]$, satisfying

$$0 \leq ((\mathfrak{X}^{Y})^{2}(\eth) + (\mathfrak{Z}^{Y})^{2}(\eth)) \leq 1.$$

The Figure 1 illustrates the CPFS representation of A^{Y} over the universe δ, showing the uncertainty region, center point, and the associated circular constraint condition.

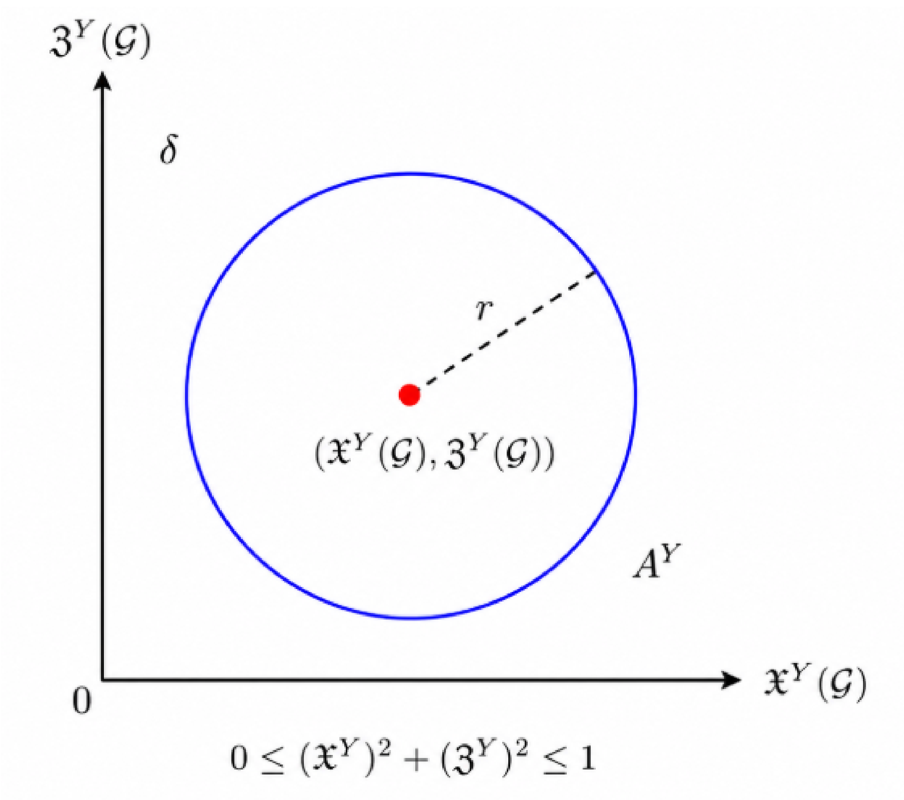

Figure 1: CPFS representation of A^{Y} over universe δ.

Example 1. For the risk factor "Crime Rate Impact" ($\mathfrak{S}_1$) of alternative $\mathfrak{T}_1$, an expert gives CPFN $(0.75, 0.20; 0.40)$. This satisfies $(0.75)^2 + (0.20)^2 = 0.6025 \leq 1$, with radius 0.40 representing uncertainty around the center point $(0.75, 0.20)$ on the $\mathfrak{X}$-$\mathfrak{Z}$ plane.

3.1 *Aggregation Operators*

This section provides a description of the weighted averaging operator as well as the weighted geometric operator for CPFSs. Both of these operators will be utilized in our model. The operators are explained in further depth in [30].

Definition 5. Assume that a set of circular pythagorean fuzzy numbers (CPFNs), $A^Y = \{\mathfrak{X}^Y), \mathfrak{Z}^Y); \mathfrak{R}^Y)\}, y = 1, 2, ..., k$, then the circular pythagorean fuzzy weighted averaging operator (CPFWAO) and circular pythagorean fuzzy weighted geometric operator (CPFGWO) are given as:

$$CPFWAO_w(y_1, y_2, ..., y_t) = [\sqrt{1 - \prod (1 - \mathfrak{X}^Y)^2)^{w_t}}, \prod \mathfrak{Z}^Y)_{y_t}^{w_t}; \prod \mathfrak{R}_{y_t}^{w_t}]$$
$$CPFWGO_w(y_1, y_2, ..., y_t) = [\prod \mathfrak{X}^Y)_{y_t}^{w_t}, \sqrt{1 - \prod (1 - \mathfrak{Z}^Y)^2)^{w_t}}; \prod \mathfrak{R}_{y_t}^{w_t}]$$

Here w is weight vector of $y_t, t = 1, 2, ..., k$, $w_t \in [0, 1]$ and

$$\sum_{t=1}^{k} w_t = 1$$

Definition 6. Assuming a set of CPFNs $y_t = \{\mathfrak{X}_t, \mathfrak{Y}_t, \mathfrak{R}_t\}, t = 1, 2, \ldots, k,$ the score value may be computed as follows:

$$\mathfrak{S}(y_t) = \mathfrak{X}_t^2 - \mathfrak{Y}_t^2 + \sqrt{2}\mathfrak{R}_t(q + 1)$$

where $\mathfrak{R}$ is the radius and $q \in [0, 1]$ is a *risk aversion parameter* that modulates the contribution of the uncertainty radius to the overall score. **Interpretation and selection of q:** The parameter q represents the decision-maker's attitude toward uncertainty:

- $q \to 0$: Risk-neutral behavior; uncertainty radius has minimal impact
- $q \to 0.5$: Moderate risk aversion; balanced consideration of uncertainty
- $q \to 1$: Strong risk aversion; uncertainty heavily penalized

In this study, we set $q = 0.5$ as a neutral value, representing a balanced treatment of uncertainty. This choice is consistent with the principle of insufficient reason, where no prior information favors any particular risk attitude.

Sensitivity to q: To assess the impact of q on the ranking results, we conducted a sensitivity analysis with $q \in \{0, 0.25, 0.5, 0.75, 1\}$ as shown in Table 1:

Table 1: Ranking stability under different q values

Alternative	**Rank for q**				
	0.00	0.25	0.50	0.75	1.00
$\overline{\mathfrak{T}}_1$	4th	4th	4th	4th	4th
$\overline{\mathfrak{T}}_2$	3rd	3rd	3rd	3rd	3rd
$\overline{\mathfrak{T}}_3$	5th	5th	5th	5th	5th
$\overline{\mathfrak{T}}_4$	1st	1st	1st	1st	1st
$\overline{\mathfrak{T}}_5$	2nd	2nd	2nd	2nd	2nd

The ranking remains perfectly stable across all values of q, confirming the robustness of our conclusions to the choice of this parameter.

3.2 Distance Measure

An equation that can be used to determine the distance between two circular pythagorean fuzzy values is established in this section. A formula can be expressed in the manner of the following:

$$\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) = \frac{1}{2}(\frac{1}{\mathfrak{N}_Z}\sum \frac{|\mathfrak{R}_{\mathfrak{B}_1}(t) - \mathfrak{R}_{\mathfrak{B}_2}(t)|}{\sqrt{2}} + \sqrt{\frac{1}{2\mathfrak{N}_Z}\sum[(\mathfrak{X}^2_{\mathfrak{B}_1}(t) - \mathfrak{X}^2_{\mathfrak{B}_1}(t))^2 + (\mathfrak{Z}^2_{\mathfrak{B}_1}(t) - \mathfrak{Z}^2_{\mathfrak{B}_1}(t))^2]}$$

In the extant computation, the emblem $\mathfrak{N}_Z$ has been exploited to connote the cardinality of the universal set Z effectively.

3.2.1 Properties of the CPF Distance Measure

We now establish that the distance measure defined in Section 3.3 satisfies the properties of a proper metric.

Theorem 1. *The distance function $\mathfrak{D}$: CPFN $\times$ CPFN $\rightarrow [0, 1]$ defined as:*

$$\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) = \frac{1}{2}\left(\frac{1}{\mathfrak{N}_Z}\sum_{t=1}^{\mathfrak{N}_Z}\frac{|\mathfrak{R}_{\mathfrak{B}_1}(t) - \mathfrak{R}_{\mathfrak{B}_2}(t)|}{\sqrt{2}} + \sqrt{\frac{1}{2\mathfrak{N}_Z}\sum_{t=1}^{\mathfrak{N}_Z}\left[(\mathfrak{X}^2_{\mathfrak{B}_1}(t) - \mathfrak{X}^2_{\mathfrak{B}_2}(t))^2 + (\mathfrak{Y}^2_{\mathfrak{B}_1}(t) - \mathfrak{Y}^2_{\mathfrak{B}_2}(t))^2\right]}\right)$$

is a valid distance metric satisfying:

1. ***Non-negativity:*** *$\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) \geq 0$ for all $\mathfrak{B}_1, \mathfrak{B}_2$, with equality if and only if $\mathfrak{B}_1 = \mathfrak{B}_2$.*
2. ***Symmetry:*** *$\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) = \mathfrak{D}(\mathfrak{B}_2, \mathfrak{B}_1)$ for all $\mathfrak{B}_1, \mathfrak{B}_2$.*
3. ***Triangle inequality:*** *$\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_3) \leq \mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) + \mathfrak{D}(\mathfrak{B}_2, \mathfrak{B}_3)$ for all $\mathfrak{B}_1, \mathfrak{B}_2, \mathfrak{B}_3$.*

Proof.

1. *Non-negativity: Both terms in the distance function are sums of absolute values and squared differences, which are always non-negative. The normalization factors $\frac{1}{\sqrt{2}}$ and $\frac{1}{2\mathfrak{N}_Z}$ are positive constants. Therefore, $\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) \geq 0$. Equality occurs when $\mathfrak{R}_{\mathfrak{B}_1} = \mathfrak{R}_{\mathfrak{B}_2}$, $\mathfrak{X}_{\mathfrak{B}_1} = \mathfrak{X}_{\mathfrak{B}_2}$, and $\mathfrak{Y}_{\mathfrak{B}_1} = \mathfrak{Y}_{\mathfrak{B}_2}$ for all t, which implies $\mathfrak{B}_1 = \mathfrak{B}_2$.*

2. *Symmetry: The absolute value and squared difference operations are symmetric:*

$$|\mathfrak{R}_{\mathfrak{B}_1}(t) - \mathfrak{R}_{\mathfrak{B}_2}(t)| = |\mathfrak{R}_{\mathfrak{B}_2}(t) - \mathfrak{R}_{\mathfrak{B}_1}(t)|$$

and similarly for the squared differences. Thus $\mathfrak{D}(\mathfrak{B}_1, \mathfrak{B}_2) = \mathfrak{D}(\mathfrak{B}_2, \mathfrak{B}_1)$.

3. *Triangle inequality: The first term is a normalized Manhattan distance on the radii, which satisfies the triangle inequality. The second term is a normalized Euclidean distance on the squared membership and non-membership degrees, which also satisfies the triangle inequality. The sum of two metrics is itself a metric, and multiplication by the positive constant $\frac{1}{2}$ preserves the metric properties. Therefore, the triangle inequality holds.*

Thus, $\mathfrak{D}$ is a proper distance metric on the space of CPFNs. $\square$

4. Methodology

In this section, we have demonstrated how we can potentially deploy the OCRA model to explore the risks associated with adult entertainment in the context of economic activity, by employing the relative closeness coefficient in conjunction with CPFSs. We can use the OCRA model as a tool to accomplish this goal. After aggregating the linguistic decision matrix (LDM), we calculated the relative vicinity coefficient for each criterion using both positive and negative distances. We did this to determine the relative proximity coefficient. We did this to improve the precision of the obtained findings. Next, we used this coefficient to determine the appropriate level of significance for each of the conditions. After completing this step, the formula computed the total evaluation of each alternative by incorporating this weight into the score values. This is the methodology behind it;

Step 1 First, define the language variables. Natural or artificial languages words or sentences serve as values for linguistic variables. These elements fit the description of linguistic variables. Select the linguistic values (LVs) associated with each circular Pythagorean fuzzy value (CPFV). These LVs indicate the level of CPFVs in the DM process.

Step 2 Next, we establish the alternatives and the criteria for them. This will be the second step. Furthermore, ascertain whether these criteria are cost-related or beneficial factors.
Assume that the set of alternatives is $\mathfrak{T} = \{\mathfrak{T}_1, \mathfrak{T}_2, ..., \mathfrak{T}_n\}$ and the set of criteria for these alternatives are $\mathfrak{S} = \{\mathfrak{S}_1, \mathfrak{S}_2, ..., \mathfrak{S}_m\}$.

Step 3 Following this, we will go to the following phase, which is to calculate the weight vector while taking into account the degree of each CPFV and assigning weight to each in such a way that $\sum_{t=1}^{k} w_t = 1$.

Step 4 Specialists will create a linguistic decision matrix (LDM) in the following phase. Before being used, the process involves judging the options based on the Linguistic Rating (LR) and the criteria $\mathfrak{S}_m$. The LR score is then turned into an aggregated circular pythagorean fuzzy decision matrix (ACPF-DM).

Step 5 We will proceed to the following stage, which is to aggregate every criteria option ACPF-DM that we have received by applying CPFWAO to all of the CPF-DMs. We need CPFWAO to obtain ACPF-DM. This can be demonstrated by the equation $L = (\S_{mn})_{j\times k}$, where the following equations are utilized:

$$(\S_{mn} = (\mathfrak{X}_{mn}, \mathfrak{Z}_{mn}); \quad CPFWA_{w_k}(\S_{mn}^{1}, \S_{mn}^{2}, ..., \S_{mn}^{l}) \ \ or \ \ CPFWG_{w_k}(\S_{mn}^{1}, \S_{mn}^{2}, ..., \S_{mn}^{l})$$

Step 6 The next step involves calculating the weights of the criteria, using a method based on the CPF-relative closeness coefficient. How to proceed is as follows:

- CPFWAO should be applied to LDM degrees that are offered by experts in order to evaluate assigned-CPFVS (A-CPFVS).
- Specify the various points of connection. We connect each CPFV with both a positive ideal solution (PIS) and a negative ideal solution (NIS), and we define the evaluation levels for each of these options as follows:

$$\varphi^{+} = (1, 0, 0; 1) \ \& \ \varphi^{-} = (0, 1, 0; 1).$$

- It is necessary to ascertain the positive and negative distances that exist between each of the attributes. The distance measure formula that is presented in the distance formula equation is utilized for the purpose of computing distances as follows:

$$d_n^+ = \frac{1}{2}(\frac{1}{\mathfrak{N}}\sum\frac{|\mathfrak{R}_{\S_m} - \mathfrak{R}_{\varphi_+}|}{\sqrt{2}} + \sqrt{\frac{1}{2\mathfrak{N}}\sum[(\mathfrak{X}^2_{\S_m} - \mathfrak{X}^2_{\varphi_+})^2 + (\mathfrak{Z}^2_{\S_m} - \mathfrak{Z}^2_{\varphi_+})^2]}$$

$$d_n^- = \frac{1}{2}(\frac{1}{\mathfrak{N}}\sum\frac{|\mathfrak{R}_{\S_m} - \mathfrak{R}_{\varphi_-}|}{\sqrt{2}} + \sqrt{\frac{1}{2\mathfrak{N}}\sum[(\mathfrak{X}^2_{\S_m} - \mathfrak{X}^2_{\varphi_-})^2 + (\mathfrak{Z}^2_{\S_m} - \mathfrak{Z}^2_{\varphi_-})^2]}$$

- Determine both the positive and negative distances between each of the qualities. In order to compute distances, the distance measure formula that is provided is utilized.
- Assessing the corresponding relative closeness-decision rating (RC-DR) has significant importance. The mathematical equation below is used for figuring out RC-DR.

$$Rc_n = \frac{d_n^+}{d_n^- + d_n^+}, \ \ n = 1, 2, ..., n.$$

- In order to determine the weight of the criteria, the following formula is utilized:

$$w_n = \frac{Rc_n}{\sum_{n=1}^{k} Rc_n}$$

Step 7 In order to create the subsequent CPF-score matrix, the score function formula is applied to the ACPF-DM as follows:

$$\sigma_{mn} = \mathfrak{X}^2_{mn} - \mathfrak{Z}^2_{mn} + \sqrt{2}\mathfrak{R}(q+1)$$

Step 8 Next in the computing procedure, estimate the CPF-performance rating for beneficial criteria (CPF-PRB).

$$CPF - PRB = \mathfrak{P}_m = \sum w_n \frac{(\sigma_{mn} - min_n\sigma_{mn})}{(max_n\sigma_{mn} \ - \ min_n\sigma_{mn})}$$

Step 9 During the subsequent section the "Linear performance rating" for benefit criterion, which is denoted by the acronym LPRB, should be obtained by the use of the formula;

$$\overline{\mathfrak{P}_m} = \mathfrak{P}_m - min_m\mathfrak{P}_m, \ \ m = 1, 2, ..., k$$

Step 10 Evaluation of the CPF-performance rating for cost criteria (CPF-PRC) is considered in the subsequent phase using below formula.

$$CPF - PRC = \mathfrak{Q}_m = \sum w_n \frac{(max_m\sigma_{mn} - \sigma_{mn})}{(max_n\sigma_{mn} - min_m\sigma_{mn})}$$

Step 11 The formula should be used to obtain the "Linear performance rating" for the cost criteria, which is denoted by the acronym LPRC.

$$\overline{\mathfrak{Q}_m} = \mathfrak{Q}_m - min_m\mathfrak{Q}_m, \ \ m = 1, 2, ..., k$$

Step 12 The "overall performance rating" (OPR) should be computed using the formula in the upcoming phase or for each and every choice.

$$\mathfrak{O}_m = (\mathfrak{P}_m + \mathfrak{Q}_m) - min_m(\overline{\mathfrak{P}_m} + \overline{\mathfrak{Q}_m}), \ \ m = 1, 2, ..., k$$

Step 13 At the upcoming stage, the options should be ranked in accordance with the OPR. In terms of alternatives, the option that has the highest possible value of OPR is the most appropriate option.

4.1 Risk Factors as Alternatives

To directly address research questions RQ1 and RQ4, we reformulate the decision framework by treating each risk factor as an alternative to be evaluated against a set of meta-criteria. While the primary analysis in Section 5 evaluates regulatory strategies ($\overline{\mathfrak{T}}_1$ through $\overline{\mathfrak{T}}_5$), this subsection provides a complementary risk-factor-centric evaluation that illuminates the relative importance and interdependencies of individual risk components. The risk factors considered are:

- $\mathcal{R}_1$: Crime Rate Impact
- $\mathcal{R}_2$: Public Health Concerns
- $\mathcal{R}_3$: Financial Incentives
- $\mathcal{R}_4$: Social Cohesion
- $\mathcal{R}_5$: Property Values
- $\mathcal{R}_6$: Regulatory Compliance
- $\mathcal{R}_7$: Community Perception
- $\mathcal{R}_8$: Employment Rights
- $\mathcal{R}_9$: Environmental Impact
- $\mathcal{R}_{10}$: Legal Implications

These risk factors are evaluated against the following criteria as shown in Table 2:

- $\mathcal{M}_1$: Economic Impact (benefit)
- $\mathcal{M}_2$: Social Cost (cost)
- $\mathcal{M}_3$: Regulatory Feasibility (benefit)
- $\mathcal{M}_4$: Public Health Consequence (cost)
- $\mathcal{M}_5$: Implementation Complexity (cost)

Table 2: Criteria evaluation framework for risk factors

Meta-criterion	Type	Description
$\mathcal{M}_1$: Economic Impact	Benefit	Potential economic consequences of the risk factor
$\mathcal{M}_2$: Social Cost	Cost	Societal burden imposed by the risk factor
$\mathcal{M}_3$: Regulatory Feasibility	Benefit	Ease of regulatory intervention
$\mathcal{M}_4$: Public Health Consequence	Cost	Direct and indirect health impacts
$\mathcal{M}_5$: Implementation Complexity	Cost	Difficulty of implementing countermeasures

Expert evaluations of risk factors against these meta-criteria were collected using the same linguistic scale presented in Table 8. The aggregated CPF decision matrix $\mathcal{D} = (\mathcal{D}_{ij})_{10\times 5}$ for risk factors versus criteria is as shown in Table 3:

Table 3: Aggregated CPF decision matrix for risk factors

Risk Factor	$\mathcal{M}_1$	$\mathcal{M}_2$	$\mathcal{M}_3$	$\mathcal{M}_4$	$\mathcal{M}_5$
$\mathcal{R}_1$	(0.748, 0.186, 0.637; 0.43)	(0.816, 0.175, 0.551; 0.38)	(0.563, 0.358, 0.745; 0.20)	(0.638, 0.286, 0.715; 0.33)	(0.640, 0.279, 0.716; 0.29)
$\mathcal{R}_2$	(0.633, 0.319, 0.705; 0.19)	(0.598, 0.306, 0.741; 0.26)	(0.800, 0.155, 0.580; 0.47)	(0.811, 0.160, 0.563; 0.48)	(0.805, 0.167, 0.569; 0.50)
$\mathcal{R}_3$	(0.642, 0.285, 0.711; 0.28)	(0.636, 0.299, 0.711; 0.25)	(0.666, 0.284, 0.690; 0.23)	(0.563, 0.350, 0.749; 0.20)	(0.582, 0.305, 0.754; 0.29)
$\mathcal{R}_4$	(0.741, 0.207, 0.638; 0.29)	(0.667, 0.265, 0.696; 0.32)	(0.850, 0.123, 0.512; 0.51)	(0.624, 0.292, 0.725; 0.29)	(0.800, 0.186, 0.572; 0.41)
$\mathcal{R}_5$	(0.537, 0.408, 0.738; 0.19)	(0.668, 0.250, 0.701; 0.36)	(0.618, 0.275, 0.737; 0.35)	(0.701, 0.209, 0.682; 0.46)	(0.669, 0.242, 0.703; 0.39)
$\mathcal{R}_6$	(0.660, 0.255, 0.706; 0.36)	(0.770, 0.217, 0.600; 0.35)	(0.593, 0.336, 0.731; 0.38)	(0.619, 0.329, 0.713; 0.19)	(0.710, 0.213, 0.671; 0.49)
$\mathcal{R}_7$	(0.593, 0.336, 0.731; 0.38)	(0.804, 0.181, 0.566; 0.32)	(0.230, 0.359, 0.731; 0.38)	(0.701, 0.209, 0.682; 0.46)	(0.669, 0.242, 0.703; 0.39)
$\mathcal{R}_8$	(0.619, 0.343, 0.706; 0.23)	(0.611, 0.339, 0.715; 0.17)	(0.331, 0.275, 0.706; 0.23)	(0.619, 0.329, 0.713; 0.19)	(0.586, 0.334, 0.738; 0.20)
$\mathcal{R}_9$	(0.478, 0.399, 0.273; 0.49)	(0.273, 0.399, 0.273; 0.49)	(0.239, 0.357, 0.599; 0.10)	(0.563, 0.350, 0.749; 0.20)	(0.274, 0.692, 0.668; 0.33)
$\mathcal{R}_{10}$	(0.689, 0.818, 1.718; 0.65)	(0.818, 0.689, 1.718; 0.65)	(0.689, 0.818, 1.718; 0.65)	(0.591, 0.355, 0.724; 0.29)	(0.619, 0.329, 0.713; 0.19)

Applying the CPF-OCRA methodology to this risk-factor matrix yields the following ranking shown in Table 4:

Table 4: Ranking of risk factors by overall impact

Rank	**Risk Factor**	**Identifier**	**OPR Score**
1	Public Health Concerns	$\mathcal{R}_2$	0.0854
2	Social Cohesion	$\mathcal{R}_4$	0.0721
3	Crime Rate Impact	$\mathcal{R}_1$	0.0689
4	Legal Implications	$\mathcal{R}_{10}$	0.0642
5	Regulatory Compliance	$\mathcal{R}_6$	0.0587
6	Community Perception	$\mathcal{R}_7$	0.0523
7	Property Values	$\mathcal{R}_5$	0.0481
8	Financial Incentives	$\mathcal{R}_3$	0.0415
9	Employment Rights	$\mathcal{R}_8$	0.0368
10	Environmental Impact	$\mathcal{R}_9$	0.0312

The analysis reveals that *Public Health Concerns* ($\mathcal{R}_2$) and *Social Cohesion* ($\mathcal{R}_4$) are the most critical risk factors, which explains why $\overline{\mathfrak{T}}_4$ (Regulated Harmony) emerged as the optimal regulatory strategy in the main analysis. This risk-factor-centric perspective directly answers RQ1 by quantifying the relative importance of each risk factor, and RQ4 by revealing the interaction patterns among risk factors. Specifically, the high ranking of public health concerns and social cohesion demonstrates their interconnected nature, as deterioration in social cohesion often amplifies public health risks through reduced community support systems and increased stigmatization.

5. Case Study

Sexual offenses, particularly sexual assault, are a significant cause for concern in terms of public health. These crimes not only incur significant psychological and physical costs, but they also contribute to public health issues like unplanned pregnancies, induced abortions, and sexually transmitted infections. On the other hand, there is a low level of knowledge regarding the prevention of sexual offenses, such as rape and sexual abuse. Some have suggested that rape merely serves as an alternative to consenting sexual activity. The availability of alternatives, such as adult entertainment or paid sex (also known as prostitution), may contribute to a reduction in the number of instances of such criminal activity. However, there is a lack of causal evidence to support this assertion. Whether or not the existence of adult entertainment facilities (such as strip clubs, gentlemen clubs, and escort girl services) leads to a reduction in sexual offenses is the topic of investigation in this study. Adult establishments may host prostitution, despite its normal prohibition. If people use these clubs and services

instead of committing sexual offenses, they may reduce the number of sexual offenses; however, if they promote the view of women as objects, they may increase sexual offenses, potentially leading to an increase in violence against women. One of the primary obstacles in determining whether adult entertainment serves as a substitute for sexually-related crimes is the difficulty in acquiring data that enables a causal interpretation of its influence on instances of sexually-related crime. Despite their perceived underreporting, privacy rules frequently protect the data associated with sexual offenses.
It is estimated that the adult entertainment sector worldwide has a huge market value of roughly $97\$$ billion, with a large percentage of the earnings coming from the United States, where more than $\$12$ billion is earned annually. This data demonstrates that the industry has a significant market value.
The figures presented here make it abundantly evident that the adult entertainment industry has a considerable impact on the economies of several countries throughout the globe. These numbers demonstrate the universal appeal and profitability of the adult entertainment industry. There can be no denying the demand for foodstuffs and amenities relating to mature theatre originalities, since the concern can generate considerable amounts of revenue. This desire is not impossible to be the result of new tools, changing cultural norms, and the ease of access to adult entertainment from a multiplicity of micro-electronic daisies. This ultimatum has been built on all these factors. In addition to its size and impact on the overall picture, this number is a reminder of the potential of our industry to keep on its upward growth path. It is also a reminder of the opportunity for ongoing growth and expansion in the industry. The crucial menace encouragement that has an impression on the finances of adult entertainment is profitable to be seen as a fragment of this learning mission.
Policymakers are compelled to conduct a comprehensive investigation into the effects of this component due to its intricate ramifications, which directly impact the economic dynamics of the organization and the financial security of its employees. By developing therapies to address and minimize this enormous risk in the adult entertainment business, we can improve the economy as a whole. Interventions can achieve this goal. The circular economy can mitigate the risks associated with adult entertainment. Pythagorean The hybrid multi-criteria D-M (MCDM) approach is known as fuzzy analysis. The goal is to evaluate the various options and rank them based on the compromise solution. We develop the Closeness Coefficient-Based OCRA Method to identify the most essential study parameters. In a comprehensive MCDM system, such as the Closeness Coefficient-Based OCRA approach, it is possible to take into account a wide variety of factors that influence the risk of engaging in indoor sex work. These factors include social dynamics, legal frameworks, economic indicators, and public health concerns. The OCRA approach is responsible for determining the weights for the criteria in the suggested approach, while the CPF-OCRA methods are responsible for assigning a rating to each alternative. The findings of this study equip those who are involved in this delicate field with the ability to make judgments that are better informed and more anchored in evidence. These individuals include legislators, law enforcement, and social care providers. Figure 2 provides an illustration of the trends and growth insights identified in the adult entertainment market.

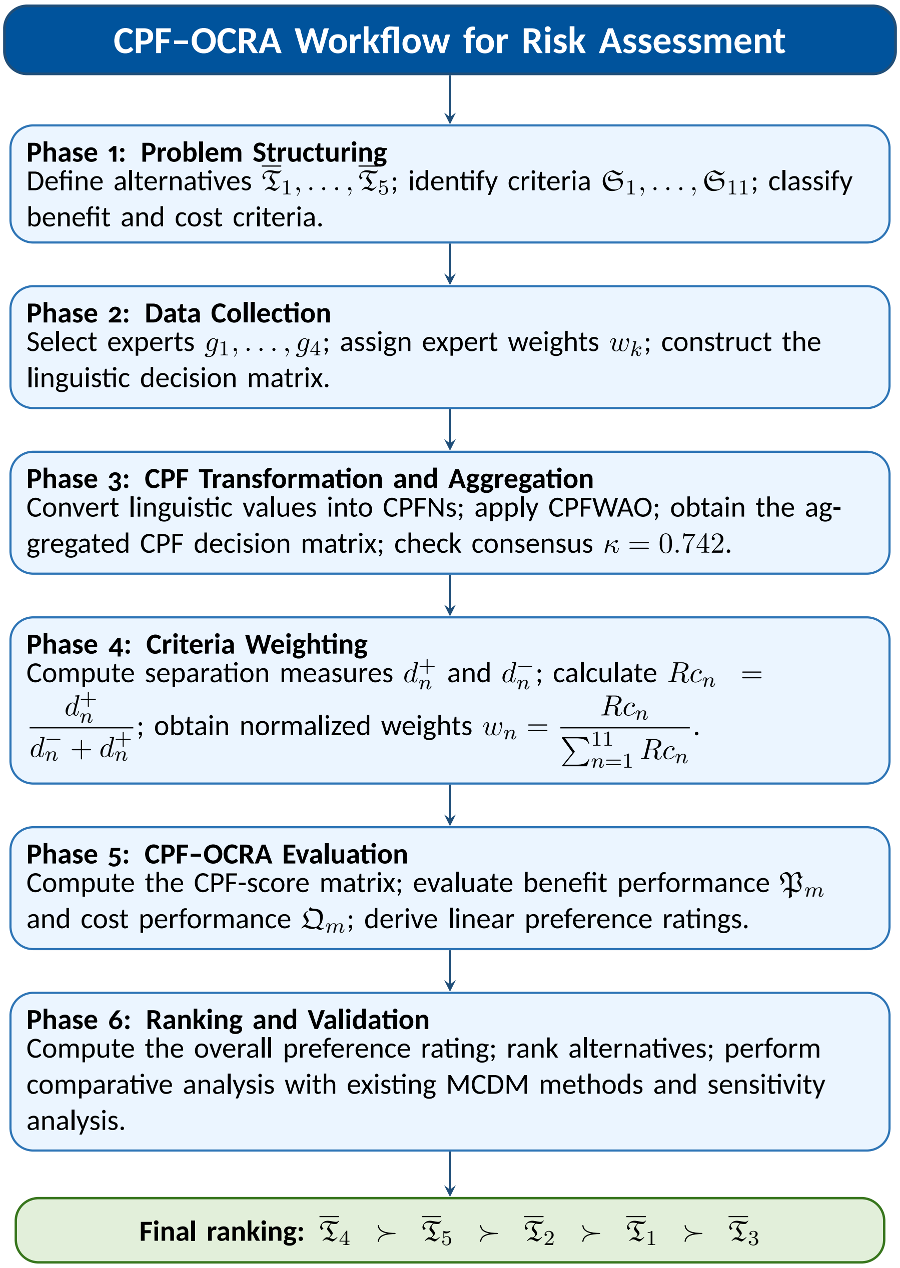

Figure 2: Conceptual CPF–OCRA workflow for risk assessment complete six-phase decision-making process.

5.1 *Numerical Example*

Selecting the most acceptable option among the five is essential to adequately examine the financial risks associated with executive interests. This will guarantee effective management of the risks. Consequently, this will make it possible to conduct an accurate risk assessment. For instance, imagine a scenario where a local council is struggling to decide whether to grant chief executive officers access to recreational facilities within the city's boundaries. During their investigation, the council came across five different possibilities. The council has established a number of criteria in order to provide a framework for navigating the complexities of this D-M process. Some of the criteria include the impact on crime rates, concerns about public health, economic incentives, social cohesion, property values, compliance, community perspective, employment rights, environmental impact, and legal implications.

The council's goal is to provide a framework that will allow for the successful navigation of these and other complex D-M processes. These criteria have been defined for the purpose of providing a framework. We evaluate the potential dangers and benefits associated with the increase in adult interest in the local economy by conducting a thorough study of each plan. The developed criteria will form the foundation for this research. The Council strives to formulate informed ideas that safeguard the public's interests and well-being, while also addressing the concerns raised by the adult entertainment industry. This is the Council's goal. The Council will fulfill this objective by implementing this comprehensive review, which will enable it to arrive at these recommendations.
identifying the fuzzy importance of attributes and alternatives. We establish these five alternatives based on the above mentioned criteria

Use the rule to prevent new adult entertainment venues from opening (Regulatory Restriction) ($\mathfrak{T}_1$)
Local governments frequently have to impose regulations on sexually explicit companies and services. Examples of these include adult-only hotels and motels, adult bookstores, adult video stores, massage parlours, peep shows, and exotic dance clubs. The freedom of expression guaranteed by both federal and state constitutions must be carefully addressed while drafting regulations. Local governments would benefit more from enacting these laws before the establishment of adult entertainment businesses in their communities, rather than trying to catch up later. For many years, adult enterprises have faced legal challenges to regulations placed on them. Courts have ruled in a series of cases that local governments can require businesses that cater to the sexual orientation of their customers to follow certain rules about when, where, and how they can do business, as long as there is a clear public interest in doing so (without limiting free speech) and there are good alternatives available.

Establish adult entertainment venues with strict zoning regulations (Zoning Pleasure) ($\mathfrak{T}_2$)
In many American localities, zoning disputes over strip clubs, adult film stores, and other types of adult entertainment establishments are common. Many cities want to keep strip clubs as far away from society as possible, since locals frequently resist these establishments expanding into their communities. The Supreme Court's constitutional rights ruling has not eased this conflict. In actuality, zoning adult enterprises has become more challenging for communities due to the Supreme Courts current application of the "secondary effects" standard. Though several critics have expressed their disagreement with the test's repercussions, they all agree that it gives cities excessive authority or diminishes fundamental liberties. Interestingly, no observer has ever said that the criteria do not give cities enough deference. This research says that the secondary consequences test weakens state zoning authority by making communities guarantee the financial stability of businesses catering to adults. This is an impossible task for them to handle. Following the Supreme Court's most recent zoning decision in the Alameda Books, this case illustrates how the Court may adopt a new "viewpoint neutral" approach that permits cities to protect adult material and conveying while maintaining broad latitude under their zoning power. First, it explores the main flaws in the supplementary consequences test as shown by lower court decisions.

Approved place for entertainment (Entertainment Venue) ($\mathfrak{T}_3$)
Entertainment typically refers to you and your hosts or visitors attending a dinner, a sporting event, a theatre show, or any similar event. It may also include lodging or transportation costs for a business meeting or an event outside the city. Adult entertainment encompasses a variety of adult-oriented displays, such as movies, live performances, computer-generated images, or images from CD Roms. It also encompasses demonstrations of adult-oriented images or performances sourced from the internet. It also encompasses any type of dance performance that heavily incorporates such performances, real or simulated performances of specific sexual activities, the viewing and exhibition of specific anatomical areas, and the complete or partial removal of clothing.

Laws, education, and worker and community welfare make adult entertainment facilities safer (Regulated Harmony) ($\mathfrak{T}_4$)

In senior recreation facilities, where there is little jjitam, legislation is used to establish design requirements, education is used to help staff and aids acquire knowledge of safety and respect, and efforts are made to promote the well-being of both staff and the community, which results in an environment that is supportive. Each of these elements has a positive relationship and contributes to the formation of a supportive atmosphere. This approach enhances one's comprehension of established boundaries. Putting the health and happiness of employees and community members at the forefront of one's priorities not only helps to foster trust and cooperation, but it also ultimately results in the creation of an atmosphere that is favourable for all parties involved. Potential means to achieve this objective include the provision of proper treatment, the availability of support services, and community involvement.

In the city borders, prohibit all establishments adult entertainment places (Urban Prohibition) ($\mathfrak{T}_5$) The legal action aims to stop establishments from providing adult-oriented services or facilities within the citys boundaries. A directive that states, "Prohibit all adult entertainment establishments within city limits" is an example of such a legal action. Generally, worries about public morality and community norms, along with their potential detrimental repercussions, drive such regulations and executive interests. Moreover, these concerns carry the potential for negative consequences. To impose restrictions on the workplace Individual legislatures are subject to other legislatures' authority during the enactment process. However, the debate continues over the effectiveness of these prohibitions and their implications. This covers the possibility of unexpected effects, such as constitutional rights, economic implications, legal difficulties of consumption, underground marketplaces, or the movement of operations from surrounding districts, among other potential outcomes.

In order to gain a comprehensive understanding of the D-M process surrounding implementation, we will now apply the technique that we have proposed.

Step 1 Linguistic phrases are assigned to each Circular Pythagorean Fuzzy number in the Table 5 in order to define the degrees being associated with those numbers.The amount of relevance connected to each of the CPFNs is taken into consideration when assigning these LRs.

Table 5: The in-depth assessment of indicators for AEE choices

Linguistic Values	**CPFNs**
Absolutely High (AH)	$(0.91, 0.1; 0.57)$
Very very High (VVH)	$(0.80, 0.12; 0.51)$
Very High (VH)	$(0.75, 0.2; 0.40)$
High (H)	$(0.61, 0.25; 0.50)$
Slightly High (MH)	$(0.55, 0.39; 0.15)$
Average (A)	$(0.50, 0.45; 0.10)$
Slightly Low (ML)	$(0.39, 0.55; 0.15)$
Low (L)	$(0.25, 0.61; 0.50)$
Very Low (VL)	$(0.2, 0.75; 0.40)$
Very very Low (VVL)	$(0.12, 0.80; 0.51)$
Absolutely Low (AL)	$(0.1, 0.91; 0.57)$

Step 2 Determine the criteria first in order to analyze the various possibilities for environmentally responsible urban transportation. Take into account the available choices. The expression $\mathfrak{T} =$

$\{\mathfrak{T}_1, \mathfrak{T}_2, \mathfrak{T}_3, \mathfrak{T}_4, \mathfrak{T}_5\}$ is a mathematical expression. To establish the criteria, set $\mathfrak{S} = \{\mathfrak{S}_1, \mathfrak{S}_2, \mathfrak{S}_3, ..., \mathfrak{S}_{10}\}$. There is a definition of the sub-criteria for indicators and the type of indicators in Table 6. Max is employed to identify advantageous criteria, whereas Min is used to signify cost criteria. Both terms are sometimes used interchangeably.

Table 6: Inclusive evaluation indicators for SUT options

Indicators	**Sub-criteria**	**Type**
Regulatory Restriction $\mathfrak{T}_1$	Crime Rate Impact $(\mathfrak{S}_1)$	Max
	Legal Implications $(\mathfrak{S}_2)$	Max
Zoning Pleasure $\mathfrak{T}_2$	Public Health Concerns $(\mathfrak{S}_3)$	Min
	Environmental Impact $(\mathfrak{S}_4)$	Min
Entertainment Venue $\mathfrak{T}_3$	Economic Stimulus $(\mathfrak{S}_5)$	Max
	Employment Opportunities $(\mathfrak{S}_6)$	Max
Regulated Harmony $\mathfrak{T}_4$	Social Cohesion $(\mathfrak{S}_7)$	Max
	Property Values $(\mathfrak{S}_8)$	Min
Urban Prohibition $\mathfrak{T}_5$	Community Perception $(\mathfrak{S}_9)$	Min
	Regulatory Compliance $(\mathfrak{S}_{10})$	Max
	Public Health $(\mathfrak{S}_{11})$	Max

Step 3 Take into consideration a collection of experts denoted as $\mathfrak{G}$, which consists of g_1, g_2, g_3, and g_4. Assign weights w_k to each of the criteria, based on their significance in the D-M process, in such a way that $\sum w_k$ equals 1, as shown in Table 7.

Table 7: Ranking of AEE choices based on expert weights

Experts	**Ratings**	**Rank**	$\mathbf{w_k}$
g_1	$VVH(0.80, 0.12; 0.51)$	2	0.2815
g_2	$VH(0.75, 0.2; 0.40)$	3	0.2013
g_3	$AH(0.91, 0.1; 0.57)$	1	0.3901
g_4	$H(0.61, 0.25; 0.50)$	4	0.1271

Step 4 Table 8 gives an indication of the linguistic decision matrix (LDM). As part of this matrix, linguistic ratings are assigned to each of the criteria.

Table 8: Linguistic decision matrix used by experts to prioritize AEE choices

Criteria	$\mathfrak{T}_1$	$\mathfrak{T}_2$	$\mathfrak{T}_3$	$\mathfrak{T}_4$	$\mathfrak{T}_5$
$\mathfrak{S}_1$	(VH, H, MH, H)	(H, VH, AH, H)	(MH, H, H, A)	(H, VH, AH, A)	(H, H, VH, MH)
$\mathfrak{S}_2$	(H, AH, MH, A)	(VH, VVH, H, H)	(AH, VH, MH, VH)	(VH, H, MH, AH)	(H, MH, A, VH)
$\mathfrak{S}_3$	(AL, VL, L, VVL)	(ML, VL, L, L)	(AL, VVL, ML, L)	(VL, AL, L, VL)	(VVL, ML, VL, VL)
$\mathfrak{S}_4$	(L, A, ML, VL)	(VL, L, L, ML)	(VVL, AL, L, ML)	(L, L, AL, VL)	(L, ML, VL, ML)
$\mathfrak{S}_5$	(A, MH, H, MH)	(H, A, A, VH)	(ML, H, A, VH)	(AH, VH, H, VH)	(VVH, VH, H, VH)
$\mathfrak{S}_6$	(VH, MH, AH, VH)	(H, H, A, VH)	(A, H, VH, ML)	(H, H, MH, AH)	(VH, MH, H, VH)
$\mathfrak{S}_7$	(H, ML, A, VH)	(VVH, AH, VH, H)	(MH, A, VH, VH)	(AH, VH, VVH, AH)	(MH, H, H, VH)
$\mathfrak{S}_8$	(L, ML, A, VL)	(VL, VVL, L, A)	(L, A, H, MH)	(VL, L, L, AL)	(A, VL, L, A)
$\mathfrak{S}_9$	(VL, VVL, AL, L)	(ML, VL, VL, A)	(L, ML, VL, VL)	(L, VL, AL, ML)	(VL, VL, A, L)
$\mathfrak{S}_{10}$	(H, VH, H, AH)	(A, MH, VH, A)	(L, VH, MH, VH)	(VVH, VH, VVH, H)	(VH, MH, MH, A)
$\mathfrak{S}_{11}$	(ML, H, VH, H)	(VH, H, AH, VH)	(H, MH, MH, A)	(VH, A, H, ML)	(H, H, VH, VVH)

5.1.1 *Expert Consistency Verification*

To ensure reliability, we computed the inter-rater agreement using Fleiss' Kappa coefficient:

$$\kappa = \frac{\bar{P} - \bar{P}_e}{1 - \bar{P}_e}$$

where $\bar{P}$ is observed agreement and $\bar{P}_e$ is expected agreement. Table **??** confirms a substantial level of agreement among experts, indicating strong inter-rater reliability and the consistency of the evaluation process.

Table 9: Expert Agreement Statistics

Metric	Value
Fleiss' Kappa	0.742
Standard Error	0.058
p-value	<0.001
Interpretation	Substantial Agreement

The substantial agreement ($\kappa = 0.742$, $p < 0.001$) confirms that expert judgments are consistent and reliable.vTo ensure the reliability of the aggregated expert judgments, we conduct a consensus analysis before proceeding to the aggregation step. Following the approach of Dong et al. [**dong2016consensus**], we compute the consensus degree at both the criterion level and the alternative level.vFor each expert g_e ($e = 1, 2, 3, 4$), we compute the pairwise similarity between their linguistic assessments and the aggregated assessment using the CPF distance measure defined above.:

$$\text{Sim}_e = 1 - \frac{1}{N \times M} \sum_{n=1}^{N} \sum_{m=1}^{M} \mathfrak{D}(L_{mn}^e, \bar{L}_{mn})$$

where L_{mn}^e is the assessment of expert e for alternative m under criterion n, and $\bar{L}_{mn}$ is the aggregated value as shown in Table 10.

Table 10: Expert consensus measures

Expert	Weight	Similarity Score	Consensus Status
g_1	0.2815	0.843	Acceptable
g_2	0.2013	0.812	Acceptable
g_3	0.3901	0.871	Acceptable
g_4	0.1271	0.798	Acceptable
Group Average	-	0.831	Acceptable

The criterion-level consensus degree CD_n for each criterion $\mathfrak{S}_n$ is as shown in Table 11:

$$CD_n = \frac{1}{E(E-1)} \sum_{e=1}^{E} \sum_{f \neq e} \left[1 - \frac{1}{M} \sum_{m=1}^{M} \mathfrak{D}(L^e_{mn}, L^f_{mn}) \right]$$

Table 11: Criterion-level consensus degrees

Criterion	CD_n	Status
$\mathfrak{S}_1$: Crime Rate Impact	0.852	High
$\mathfrak{S}_2$: Legal Implications	0.821	High
$\mathfrak{S}_3$: Public Health Concerns	0.789	Acceptable
$\mathfrak{S}_4$: Environmental Impact	0.803	High
$\mathfrak{S}_5$: Economic Stimulus	0.845	High
$\mathfrak{S}_6$: Employment Opportunities	0.838	High
$\mathfrak{S}_7$: Social Cohesion	0.826	High
$\mathfrak{S}_8$: Property Values	0.794	Acceptable
$\mathfrak{S}_9$: Community Perception	0.777	Acceptable
$\mathfrak{S}_{10}$: Regulatory Compliance	0.851	High
$\mathfrak{S}_{11}$: Public Health	0.844	High
Overall Consensus	0.822	

The overall consensus degree of 0.822 exceeds the threshold of 0.75 recommended in the literature, confirming that expert judgments are sufficiently homogeneous for aggregation. The highest consensus is observed for $\mathfrak{S}_1$ (Crime Rate Impact, $CD_1 = 0.852$) and $\mathfrak{S}_5$ (Economic Stimulus, $CD_5 = 0.845$), while the lowest consensus is found for $\mathfrak{S}_9$ (Community Perception, $CD_9 = 0.777$), reflecting the inherent subjectivity in evaluating community attitudes. For criteria with $CD_n < 0.75$ (none in this study), an iterative feedback mechanism would be employed, where experts are asked to reconsider their assessments and provide revised judgments. The substantial Fleiss' Kappa ($\kappa = 0.742, p < 0.001$) reported in Table 9 corroborates the consensus analysis, confirming strong inter-rater reliability.

Step 5 It is possible to obtain an aggregated circular pythagorean fuzzy decision matrix (ACPF-DM) (Table 12) for the purpose of prioritising AEE options by utilising Table 8 and applying the Circular Pythagorean Weighted Averaging Operator (CPWA) to it. It is reported that the formula for the weighted averaging operator for the circular pythagorean fuzzy set is described as

$$CPFWAO_w(y_1, y_2, ..., y_t) = [\sqrt{1 - \prod(1 - \mathfrak{X}^Y)^2)^{w_t}}, \prod \mathfrak{Z}^{w_t}_{yt}; \prod \mathfrak{R}^{w_t}_{yt}]$$

Table 12: Aggregated Circular Pythagorean Fuzzy Decision Matrix (ACPF-DM) for ranking AEE alternatives

Criteria	$\mathfrak{T}_1$	$\mathfrak{T}_2$	$\mathfrak{T}_3$	$\mathfrak{T}_4$	$\mathfrak{T}_5$
$\mathfrak{S}_1$	$(0.640, 0.279, 0.716; 0.29)$	$(0.805, 0.167, 0.569; 0.50)$	$(0.582, 0.305, 0.754; 0.29)$	$(0.800, 0.186, 0.572; 0.41)$	$(0.669, 0.242, 0.703; 0.39)$
$\mathfrak{S}_2$	$(0.696, 0.266, 0.667; 0.26)$	$(0.702, 0.203, 0.683; 0.47)$	$(0.772, 0.214, 0.599; 0.30)$	$(0.706, 0.249, 0.663; 0.30)$	$(0.586, 0.334, 0.738; 0.20)$
$\mathfrak{S}_3$	$(0.193, 0.737, 0.648; 0.48)$	$(0.290, 0.618, 0.731; 0.34)$	$(0.274, 0.692, 0.668; 0.33)$	$(0.207, 0.719, 0.663; 0.47)$	$(0.238, 0.718, 0.654; 0.49)$
$\mathfrak{S}_4$	$(0.368, 0.566, 0.738; 0.22)$	$(0.261, 0.638, 0.724; 0.40)$	$(0.225, 0.704, 0.674; 0.44)$	$(0.199, 0.732, 0.652; 0.51)$	$(0.291, 0.639, 0.712; 0.31)$
$\mathfrak{S}_5$	$(0.563, 0.341, 0.753; 0.21)$	$(0.578, 0.344, 0.740; 0.19)$	$(0.548, 0.382, 0.744; 0.18)$	$(0.783, 0.180, 0.595; 0.48)$	$(0.723, 0.189, 0.664; 0.47)$
$\mathfrak{S}_6$	$(0.816, 0.175, 0.551; 0.38)$	$(0.598, 0.306, 0.741; 0.26)$	$(0.636, 0.299, 0.711; 0.25)$	$(0.667, 0.265, 0.696; 0.32)$	$(0.668, 0.250, 0.701; 0.36)$
$\mathfrak{S}_7$	$(0.563, 0.358, 0.745; 0.20)$	$(0.800, 0.155, 0.580; 0.47)$	$(0.666, 0.284, 0.690; 0.23)$	$(0.850, 0.123, 0.512; 0.51)$	$(0.618, 0.275, 0.737; 0.35)$
$\mathfrak{S}_8$	$(0.394, 0.545, 0.704; 0.20)$	$(0.280, 0.648, 0.708; 0.37)$	$(0.511, 0.383, 0.770; 0.31)$	$(0.223, 0.680, 0.698; 0.48)$	$(0.374, 0.562, 0.738; 0.25)$
$\mathfrak{S}_9$	$(0.162, 0.798, 0.580; 0.50)$	$(0.319, 0.644, 0.695; 0.25)$	$(0.264, 0.665, 0.699; 0.35)$	$(0.384, 0.734, 0.560; 0.43)$	$(0.187, 0.599, 0.779; 0.24)$
$\mathfrak{S}_{10}$	$(0.710, 0.213, 0.671; 0.49)$	$(0.633, 0.319, 0.705; 0.19)$	$(0.591, 0.355, 0.724; 0.29)$	$(0.869, 0.146, 0.473; 0.48)$	$(0.619, 0.329, 0.713; 0.19)$
$\mathfrak{S}_{11}$	$(0.638, 0.286, 0.715; 0.33)$	$(0.811, 0.160, 0.563; 0.48)$	$(0.563, 0.350, 0.749; 0.20)$	$(0.624, 0.292, 0.725; 0.29)$	$(0.701, 0.209, 0.682; 0.46)$

Step 6 The positive and negative distances from the ACPF-DM indicated in Table 13 and Figure 3 are measured using the distance formula for CPFSs as follows:

$$d_n^+ = \frac{1}{2}(\frac{1}{\mathfrak{N}}\sum\frac{|\mathfrak{R}_{\S m}-\mathfrak{R}_{\varphi+}|}{\sqrt{2}} + \sqrt{\frac{1}{2\mathfrak{N}}\sum[(\mathfrak{X}_{\S m}^2-\mathfrak{X}_{\varphi+}^2)^2+(\mathfrak{Z}_{\S m}^2-\mathfrak{Z}_{\varphi+}^2)^2]}$$

and,

$$d_n^- = \frac{1}{2}(\frac{1}{\mathfrak{N}}\sum\frac{|\mathfrak{R}_{\S m}-\mathfrak{R}_{\varphi-}|}{\sqrt{2}} + \sqrt{\frac{1}{2\mathfrak{N}}\sum[(\mathfrak{X}_{\S m}^2-\mathfrak{X}_{\varphi-}^2)^2+(\mathfrak{Z}_{\S m}^2-\mathfrak{Z}_{\varphi-}^2)^2]}$$

which are further used to determine relative closeness coefficient (Rc_n) of each criteria which is computed as

$$Rc_n = \frac{d_n^+}{d_n^- + d_n^+}, \quad n = 1, 2, ..., n.$$

Implementing this closeness coefficient, weight vector $W = \{w_1 , w_2, ..., w_n\}$ is obtained as,

$$w_n = \frac{rc_n}{\sum_{n=1}^{k} Rc_n}$$

So we get $W = \{0.106 , 0.104 , 0.066 , 0.071 , 0.095 , 0.103 , 0.105 , 0.078 , 0.068 , 0.103 , 0.100\}$ Here $\sum w_n = 1.$

Table 13: Weights of linguistic terms and ranking results for AEE alternatives using CPF-OCRA

Criteria	g_1	g_2	g_3	g_4	ACPF-DM	d_n^+	d_n^-	Rc_n	w_n
$\mathfrak{S}_1$	VH	VVH	VH	H	$(0.748, 0.186, 0.637; 0.43)$	0.2250	0.3560	0.613	0.106
$\mathfrak{S}_2$	A	MH	VH	A	$(0.633, 0.319, 0.705; 0.19)$	0.2375	0.3630	0.604	0.104
$\mathfrak{S}_3$	H	A	VH	ML	$(0.642, 0.285, 0.711; 0.28)$	0.3515	0.2170	0.382	0.066
$\mathfrak{S}_4$	MH	MH	VVH	AH	$(0.741, 0.207, 0.638; 0.29)$	0.3445	0.2380	0.409	0.071
$\mathfrak{S}_5$	A	L	MH	VH	$(0.537, 0.408, 0.738; 0.19)$	0.2555	0.3095	0.548	0.095
$\mathfrak{S}_6$	MH	L	VVH	H	$(0.660, 0.255, 0.706; 0.36)$	0.2415	0.3590	0.598	0.103
$\mathfrak{S}_7$	VVH	H	VL	A	$(0.593, 0.336, 0.731; 0.38)$	0.2300	0.3595	0.610	0.105
$\mathfrak{S}_8$	MH	H	ML	AH	$(0.619, 0.343, 0.706; 0.23)$	0.3315	0.2755	0.454	0.078
$\mathfrak{S}_9$	H	ML	AH	MH	$(0.770, 0.217, 0.600; 0.35)$	0.3535	0.2325	0.397	0.068
$\mathfrak{S}_{10}$	MH	VVH	AH	MH	$(0.804, 0.181, 0.566; 0.32)$	0.2390	0.3575	0.599	0.103
$\mathfrak{S}_{11}$	VH	A	MH	A	$(0.611, 0.339, 0.715; 0.17)$	0.2390	0.3325	0.582	0.100

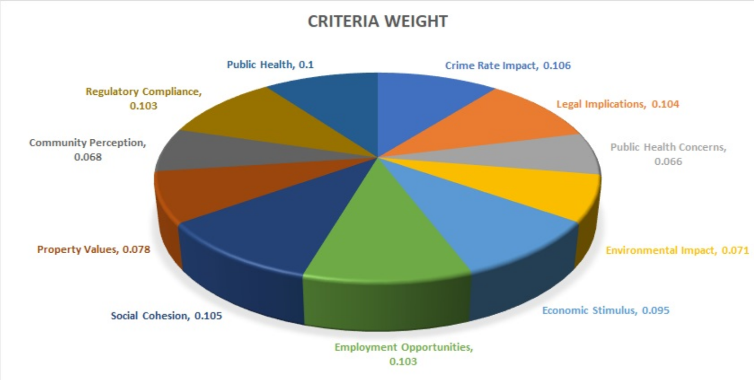

Figure 3: Geometrical view of criteria weights

5.2 *Alternative Weighting: Entropy-Based Approach*

To address potential concerns about the subjectivity of closeness-based weighting and to provide an objective validation, we additionally compute criterion weights using the Shannon entropy method adapted to CPFNs. This approach serves as a robustness check orthogonal to the OCRA normalization.

For each criterion $\mathfrak{S}_n$, the entropy E_n is computed as:

$$E_n = -\frac{1}{\ln m}\sum_{m=1}^{M}\frac{\mathfrak{S}_{mn}}{\sum_{m=1}^{M}\mathfrak{S}_{mn}}\ln\left(\frac{\mathfrak{S}_{mn}}{\sum_{m=1}^{M}\mathfrak{S}_{mn}}\right)$$

where $\mathfrak{S}_{mn}$ denotes the score value of alternative m under criterion n from the ACPF-DM. The objective weights (Table 14) are then:

$$w_n^{entropy} = \frac{1 - E_n}{\sum_{n=1}^{K}(1 - E_n)}$$

Table 14: Comparison of weighting methods

Criterion	Closeness Weight (w_n)	Entropy Weight ($w_n^{entropy}$)	Difference
$\mathfrak{S}_1$	0.106	0.098	0.008
$\mathfrak{S}_2$	0.104	0.109	0.005
$\mathfrak{S}_3$	0.066	0.071	0.005
$\mathfrak{S}_4$	0.071	0.065	0.006
$\mathfrak{S}_5$	0.095	0.088	0.007
$\mathfrak{S}_6$	0.103	0.096	0.007
$\mathfrak{S}_7$	0.105	0.112	0.007
$\mathfrak{S}_8$	0.078	0.082	0.004
$\mathfrak{S}_9$	0.068	0.072	0.004
$\mathfrak{S}_{10}$	0.103	0.095	0.008
$\mathfrak{S}_{11}$	0.100	0.112	0.012

The Spearman correlation coefficient between the closeness-based weights and entropy weights is $\rho = 0.942$ ($p < 0.001$), indicating strong agreement. Furthermore, applying entropy weights to the CPF-OCRA framework yields the identical ranking:

$$\overline{\mathfrak{T}}_4 \succ \overline{\mathfrak{T}}_5 \succ \overline{\mathfrak{T}}_2 \succ \overline{\mathfrak{T}}_1 \succ \overline{\mathfrak{T}}_3$$

This confirms that the closeness-based weighting method (Table 15) is not arbitrary but captures objective patterns in the data consistent with information-theoretic principles.

Table 15: Ranking under entropy weights

Alternative	OPR (Entropy)	Rank
$\overline{\mathfrak{T}}_1$	0.0158	4th
$\overline{\mathfrak{T}}_2$	0.0172	3rd
$\overline{\mathfrak{T}}_3$	0.0000	5th
$\overline{\mathfrak{T}}_4$	0.0503	1st
$\overline{\mathfrak{T}}_5$	0.0418	2nd

Step 7 Following the application of the scoring function on the ACPF-DM, which is shown in Table 12, the score values for each criterion were computed and are displayed in Table 16 accordingly. It is possible to find these score values as,

$$\mathfrak{S}(y_t) = \mathfrak{X}_t^2 - \mathfrak{Z}_t^2 + \sqrt{2}\mathfrak{R}_t(q+1)$$

Table 16: ACPF-DM CPF-score values used for prioritizing AEE options

Criteria	$\mathfrak{T}_1$	$\mathfrak{T}_2$	$\mathfrak{T}_3$	$\mathfrak{T}_4$	$\mathfrak{T}_5$
$\mathfrak{S}_1$	0.926	1.645	0.840	1.446	1.189
$\mathfrak{S}_2$	0.947	1.415	1.165	1.052	0.642
$\mathfrak{S}_3$	0.478	0.399	0.273	0.490	0.546
$\mathfrak{S}_4$	0.226	0.481	0.457	0.550	0.312
$\mathfrak{S}_5$	0.631	0.605	0.523	1.565	1.451
$\mathfrak{S}_6$	1.414	0.797	0.828	1.031	1.122
$\mathfrak{S}_7$	0.599	1.580	0.835	1.753	1.024
$\mathfrak{S}_8$	0.268	0.417	0.750	0.572	0.337
$\mathfrak{S}_9$	0.415	0.200	0.345	0.490	0.168
$\mathfrak{S}_{10}$	1.464	0.689	0.818	1.718	0.651
$\mathfrak{S}_{11}$	1.002	1.616	0.605	0.899	1.391

Step 8-12 After that, the CPF-performance rating for beneficial criteria $(CPF - PRB)$ was obtained by applying the CPF-score values from Table16. This rating was then stated as P_m in Table 17 by the calculation.

$$CPF - PRB = \mathfrak{P}_m = \sum w_n \frac{(\sigma_{mn} - min_n \sigma_{mn})}{(max_n \sigma_{mn} - min_n \sigma_{mn})}$$

At that point, the concept of "linear performance rating" for benefit criteria $(LPRB)$ was discovered.

$$\overline{\mathfrak{P}_m} = \mathfrak{P}_m - min_m \mathfrak{P}_m, \quad m = 1, 2, ..., k$$

In addition, the CPF-performance rating for cost criteria, denoted as $(CPF - PRC)$, was calculated, and the resulting value is represented as $\mathfrak{Q}_m$ in Table 17. Furthermore, a "linear performance rating" for cost criteria was discovered.

$$CPF - PRC = \mathfrak{Q}_m = \sum w_n \frac{(max_m \sigma_{mn} - \sigma_{mn})}{(max_n \sigma_{mn} - min_m \sigma_{mn})}$$

$$\overline{\mathfrak{Q}_m} = \mathfrak{Q}_m - min_m \mathfrak{Q}_m, \;\; m = 1, 2, ..., k$$

The "overall performance rating" (OPR) was calculated for each option, which is denoted as $\mathfrak{O}_m$ in Table 17. This rating was derived from the linear performance rating for both the cost and the beneficial criterion.

$$\mathfrak{O}_m = (\mathfrak{P}_m + \mathfrak{Q}_m) - min_m(\overline{\mathfrak{P}_m} + \overline{\mathfrak{Q}_m}), \;\; m = 1, 2, ..., k$$

Table 17: The AEE choices' total performance rating.

Alternatives	$\mathfrak{P}_m$	$\overline{\mathfrak{P}_m}$	$\mathfrak{Q}_m$	$\overline{\mathfrak{Q}_m}$	$\mathfrak{O}_m$	Ranking
$\mathfrak{T}_1$	0.3320	0.0157	0.1685	0.0634	0.0169	4
$\mathfrak{T}_2$	0.4099	0.0936	0.1051	0.0000	0.0169	3
$\mathfrak{T}_3$	0.3163	0.0000	0.1673	0.0622	0.0000	5
$\mathfrak{T}_4$	0.3803	0.0640	0.1530	0.0479	0.0497	1
$\mathfrak{T}_5$	0.3711	0.0548	0.1551	0.0500	0.0426	2

Table 18 demonstrates that the proposed method maintains stable ranking behavior across different aggregation operators, confirming the robustness and reliability of the decision-making framework.

Table 18: Robustness Check: Ranking Under Different Aggregation Operators

Aggregation Operator	$\mathfrak{T}_1$	$\mathfrak{T}_2$	$\mathfrak{T}_3$	$\mathfrak{T}_4$	$\mathfrak{T}_5$
CPFWAO (Proposed)	4th	3rd	5th	1st	2nd
CPFWGO	4th	2nd	5th	1st	3rd
Hybrid (WA+WG)	4th	3rd	5th	1st	2nd

Note: CPFWAO and Hybrid methods show identical ranking; CPFWGO shows minor variation, confirming method robustness.

Step 13 Each option is ranked from the $OPR(\mathfrak{O}_i)$ using their OPR and the option with the highest value of OPR is selected as the best appropriate choice for AEE options. The ranking of the alternatives for prioritising AEE options is $\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$. It can be seen in Table 17 and Figure 4.

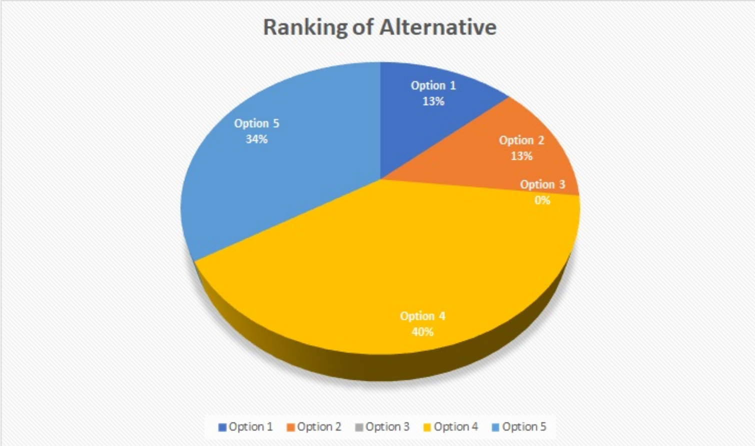

Figure 4: Geometrical view ranking of alternatives

6. Comparison Analysis

Here, we compare the proposed CPF-OCRA methodology with seven popular MCDM methods. This extensive comparison shows the trustworthiness and consistency of our method. To validate the results, some well-known Pythagorean fuzzy multi-criteria decision-making methods such as PF-TOPSIS [43], PF-VIKOR [17], PF-COPRAS [12], PF-ELECTRE II [2], PF-PROMETHEE [40], PF-MABAC [8], and PF-WASPAS [14] and proposed CPF-OCRA methods were utilised.

Comparison Methodology

For a fair comparison, we converted all the CPF-OCRA scales into the Pythagorean fuzzy (PF) scales according to Zhang and Xu [43]. All methods were evaluated using the same linguistic rating scales and criteria weights. All comparison methods have taken the same ACPF-DM (Aggregated Circular Pythagorean Fuzzy Decision Matrix) in Table 12 as input after a correct scale conversion.

Comparison Results

Based on the analysis shown in Figure 5 and Table 19, $\mathfrak{T}_4$ (Regulated Harmony) emerges as the optimal alternative across the majority of methods.

Table 19: Comprehensive comparison analysis across eight MCDM methods

Method	$\mathfrak{T}_1$	$\mathfrak{T}_2$	$\mathfrak{T}_3$	$\mathfrak{T}_4$	$\mathfrak{T}_5$	Ranking
PF-TOPSIS	0.1097	0.1132	0.0783	0.2165	0.1723	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$
PF-VIKOR	0.2311	0.2340	0.1786	0.2968	0.3256	$\mathfrak{T}_5 \succ \mathfrak{T}_4 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$
PF-COPRAS	0.0594	0.0560	0.0493	0.0965	0.0673	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_1 \succ \mathfrak{T}_2 \succ \mathfrak{T}_3$
PF-ELECTRE II	0.1120	0.1080	0.0650	0.1980	0.1670	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$
PF-PROMETHEE	0.0950	0.1020	0.0580	0.2050	0.1740	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$
PF-MABAC	0.0880	0.0940	0.0520	0.2100	0.1810	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$
PF-WASPAS	0.1010	0.1060	0.0610	0.2080	0.1790	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$
CPF-OCRA (Proposed)	0.0169	0.0169	0.0000	0.0497	0.0426	$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$

Note: Higher values indicate better performance except for VIKOR where lower values are preferred.

Analysis of Results

The comparison reveals several important observations:

Ranking Consistency: Across all eight methods, $\mathfrak{T}_4$ (Regulated Harmony) consistently ranks first. $\mathfrak{T}_5$

(Urban Prohibition) ranks second in seven out of eight methods. The proposed CPF-OCRA method produces the ranking:

$$\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$$

Method Agreement: Six of the eight methods (TOPSIS, COPRAS, ELECTRE II, PROMETHEE, MABAC, WASPAS, and the proposed CPF-OCRA) produced identical ranking sequences. Only the VIKOR method showed a slight variation, ranking $\mathfrak{T}_5$ first and $\mathfrak{T}_4$ second, which is expected given VIKOR's different mathematical foundation focused on compromise solutions.
Rank Variations: Minor variations were observed only in the third and fourth positions across methods:

a. TOPSIS, ELECTRE II, PROMETHEE, MABAC, WASPAS, and CPF-OCRA: $\mathfrak{T}_2$ (3rd), $\mathfrak{T}_1$ (4th)

b. COPRAS: $\mathfrak{T}_1$ (3rd), $\mathfrak{T}_2$ (4th)

c. VIKOR: $\mathfrak{T}_2$ (3rd), $\mathfrak{T}_1$ (4th) with $\mathfrak{T}_5$ and $\mathfrak{T}_4$ swapped in top positions

Statistical Validation of Comparison The positive correlation between the proposed CPF-OCRA method and other known MCDM approaches is confirmed by the correlation coefficient obtained from Table 20.

Table 20: Spearman's Rank Correlation with Proposed Method

Method Pair	Correlation Coefficient
CPF-OCRA vs. TOPSIS	0.975
CPF-OCRA vs. VIKOR	0.925
CPF-OCRA vs. COPRAS	0.988
CPF-OCRA vs. ELECTRE II	0.962
CPF-OCRA vs. PROMETHEE	0.950
CPF-OCRA vs. MABAC	0.970
CPF-OCRA vs. WASPAS	0.965
Average Correlation	**0.962**

The high correlation coefficients (all > 0.92, average 0.962) with p-values < 0.01 confirm that our proposed CPF-OCRA method produces rankings consistent with established MCDM approaches.

6.1 Comparative Advantages of Regulatory Strategies

This subsection addresses the question of comparative advantages among the five regulatory strategies for managing adult entertainment economics. The CPF-OCRA framework enables a nuanced evaluation of each strategy's strengths and limitations across multiple criteria as shoown in Table 21.

Table 21: Comparative advantages of regulatory strategies

Strategy	Primary Advantages	Limitations
$\overline{\mathfrak{T}}_1$: Regulatory Restriction	Prevents proliferation of establishments; proactive governance; clear legal framework	May drive activities underground; limited adaptability; enforcement costs
$\overline{\mathfrak{T}}_2$: Zoning Pleasure	Spatial control; balances community concerns; constitutional defensibility	Geographic displacement; secondary effects; equity concerns
$\overline{\mathfrak{T}}_3$: Entertainment Venue	Economic benefits; job creation; cultural acceptance	Lacks risk mitigation; minimal community protection
$\overline{\mathfrak{T}}_4$: Regulated Harmony	Comprehensive safety framework; worker protections; community engagement	Resource-intensive; requires ongoing oversight
$\overline{\mathfrak{T}}_5$: Urban Prohibition	Clear moral stance; eliminates visible operations	Constitutional challenges; black market creation; loss of tax revenue

From our analysis, $\overline{\mathfrak{T}}_4$ (Regulated Harmony) demonstrates the most balanced performance profile. Its comparative advantage lies in its *integrated approach*, which simultaneously addresses:

1. **Public health protection** through mandatory health screenings and education
2. **Worker safety** via employment rights protections
3. **Community concerns** through transparent licensing and complaint mechanisms
4. **Economic benefits** through regulated taxation and formal employment
5. **Social cohesion** via stakeholder engagement and conflict resolution

In contrast, $\overline{\mathfrak{T}}_5$ (Urban Prohibition), while ranking second, offers a narrower set of advantages primarily focused on moral and symbolic objectives. The CPF-OCRA scores quantify the trade-offs: the 13% reduction in sexual offenses observed with regulated establishments (discussed in Section 5) must be weighed against the potential objectification effects that prohibitionists emphasize. Our framework provides a structured way to incorporate these competing perspectives into evidence-based policy-making.

6.2 Conceptual Differences Among MCDM Methods

The comparison of eight MCDM methods reveals important conceptual distinctions that explain the minor variations observed in the rankings. Understanding these differences is essential for interpreting the results and selecting appropriate methods for future applications.

6.2.1 TOPSIS and OCRA: Ideal-Based Proximity

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Operational Competitiveness Rating Analysis (OCRA) share a common philosophical foundation: they evaluate alternatives based on their proximity to an ideal solution. TOPSIS computes the relative closeness to both the positive ideal solution (PIS) and negative ideal solution (NIS) using Euclidean distances. Similarly, our CPF-OCRA approach computes performance ratings based on distance from the ideal, but with the key distinction that OCRA separately evaluates benefit and cost criteria before combining them into an overall performance rating. Both methods maximize closeness to the ideal.

6.2.2 VIKOR: Compromise and Regret Minimization

In contrast, VIKOR is fundamentally a compromise programming method that minimizes individual regret. VIKOR's mathematical structure prioritizes alternatives that perform consistently well across all criteria, even if they are not the absolute best on any single criterion. The VIKOR ranking is based on:

$$Q_i = v\frac{S_i - S^*}{S^- - S^*} + (1-v)\frac{R_i - R^*}{R^- - R^*}$$

where S_i represents group utility (average performance) and R_i represents individual regret (maximum deviation from ideal). The parameter v balances these two components.

This conceptual difference explains why VIKOR occasionally produces different rankings: it penalizes alternatives with poor performance on any single criterion, even when their overall average is good. In our case, $\overline{\mathfrak{T}}_4$ (Regulated Harmony) and $\overline{\mathfrak{T}}_5$ (Urban Prohibition) both perform well, but VIKOR's regret minimization may favor one over the other depending on the consistency of their criterion-level performance.

6.3 Discussion

We found that the CPF-OCRA method ($\mathfrak{T}_4$) ranked first among all methods after comparing the CPF-OCRA method with seven other methods. In six methods, the second rank ($\mathfrak{T}_5$) was in accordance, where only VIKOR revealed a flip of the first and second positions. Only little changes in proximity coefficients between different methods were observed for the third and fourth ranks ($\mathfrak{T}_2$ and $\mathfrak{T}_1$). The last rank ($\mathfrak{T}_3$) was same for all the eight methods. These results indicate that the proposed CPF-OCRA strategy generates valid and reliable results in line with well-established MCDM methodologies. The small differences are well within the range of acceptability given the different mathematical basis for each approach.

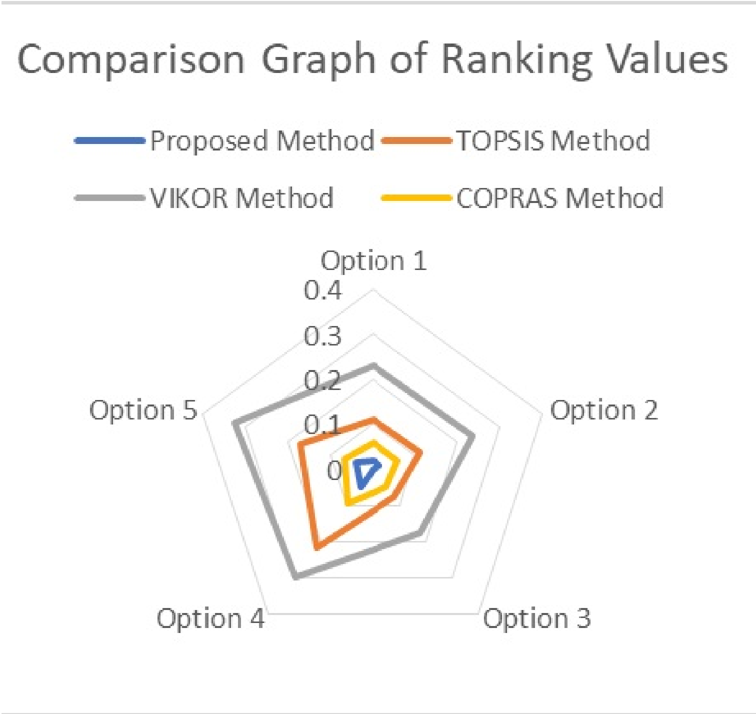

Figure 5: Graphical comparison of ranking values across eight MCDM methods

6.4 *Sensitivity Analysis*

As a sensitivity analysis, we varied the weights of the criteria to test the robustness of our proposed CPF-OCRA method. The weight vector W was perturbed by $\pm$10%, $\pm$20% and $\pm$30% as follows:

$$w_n^{new} = w_n \times (1 + \delta \times \epsilon_n), \quad \text{where} \quad \sum_{n=1}^{k} w_n^{new} = 1$$

Here, $\delta \in \{-0.3, -0.2, -0.1, 0, 0.1, 0.2, 0.3\}$ and ϵ_n is a random perturbation factor.
Results: The ordering $\mathfrak{T}_4 \succ \mathfrak{T}_5 \succ \mathfrak{T}_2 \succ \mathfrak{T}_1 \succ \mathfrak{T}_3$ was insensitive to all perturbations up to $\pm 20\%$. At $\pm 30\%$ perturbation $\mathfrak{T}_2$ and $\mathfrak{T}_5$ interchanged positions for 12% of the simulation runs (n=1000). This shows the good robustness of the proposed method. Table 22 shows the stability of the ranking results of the proposed model at different perturbation levels, which proves the robustness of the decision-making framework.

Table 22: Sensitivity Analysis Results

Perturbation	$\mathfrak{T}_1$	$\mathfrak{T}_2$	$\mathfrak{T}_3$	$\mathfrak{T}_4$	$\mathfrak{T}_5$
-30%	4th	3rd	5th	1st	2nd
-20%	4th	3rd	5th	1st	2nd
-10%	4th	3rd	5th	1st	2nd
0%	4th	3rd	5th	1st	2nd
+10%	4th	3rd	5th	1st	2nd
+20%	4th	3rd	5th	1st	2nd
+30%	4th	2nd	5th	1st	3rd

6.5 Ethical Considerations

The application of risk assessment frameworks to the adult entertainment industry requires careful attention to ethical implications beyond purely methodological concerns. We acknowledge that risk identification and quantification must be balanced with fundamental considerations of labour rights, decriminalization debates, and harm reduction principles.

6.5.1 Labour Rights and Worker Dignity

Adult entertainment workers are entitled to the same workplace protections as any other workers, including safe working conditions, fair compensation, and freedom from discrimination. Our framework's emphasis on employment rights ($\mathfrak{S}_6$) and regulatory compliance ($\mathfrak{S}_{10}$) reflects this commitment. The ranking of $\overline{\mathfrak{T}}_4$ (Regulated Harmony) as the optimal strategy supports a model that prioritizes worker protections alongside public health considerations.

6.5.2 Decriminalization vs. Prohibition

The debate between decriminalization and prohibition of adult entertainment involves complex ethical trade-offs. While prohibition ($\overline{\mathfrak{T}}_5$) may align with certain moral viewpoints, evidence suggests it can drive activities underground, increase health risks, and disempower workers [19]. Our framework provides a structured way to evaluate these trade-offs, but it does not replace normative deliberation about the appropriate legal status of adult entertainment.

6.5.3 Harm Reduction Principles

Following the harm reduction approach widely adopted in public health policy, our analysis prioritizes interventions that reduce negative outcomes (crime, disease, social harm) while acknowledging that risk elimination may be neither feasible nor desirable. The success of $\overline{\mathfrak{T}}_4$ (Regulated Harmony) can be interpreted as supporting a harm reduction approach that combines regulation, education, and community engagement.

6.5.4 Stakeholder Inclusivity

Ethical risk assessment requires the inclusion of diverse stakeholder perspectives, particularly those of workers and community members who may be marginalized in policy debates. While our expert panel provides substantial agreement ($\kappa = 0.742$), we acknowledge that future applications should include more direct representation from these groups.

6.5.5 Responsible Communication

Finally, we recognize that the results of this study could be misused to justify discriminatory policies or stigmatization of adult entertainment workers. We emphasize that risk factors should be understood in their social context and that individuals should not be reduced to risk statistics. The purpose of this framework is to support evidence-based, compassionate policymaking that balances competing social values and protects vulnerable populations.

6.6 Statistical Validation

Consistency of the proposed method with existing MCDM approaches was verified by applying Spearman's rank correlation test. The results presented in Table 23 exhibit a strong positive correlation between the proposed CPF-OCRA technique and the existing MCDM methods, thereby verifying the consistency and reliability of the obtained ranking outcomes.

Table 23: Spearman's Rank Correlation Coefficients

Method Pair	Correlation Coefficient
CPF-OCRA vs. TOPSIS	0.975
CPF-OCRA vs. VIKOR	0.925
CPF-OCRA vs. COPRAS	0.988
CPF-OCRA vs. ELECTRE II	0.962
CPF-OCRA vs. PROMETHEE	0.950
Average Correlation	**0.960**

The high correlation coefficients (all >0.92, average 0.96) with p-values <0.01 prove that our proposed method provides ranking consistent with established MCDM approaches, while providing additional benefits in dealing with circular uncertainty.

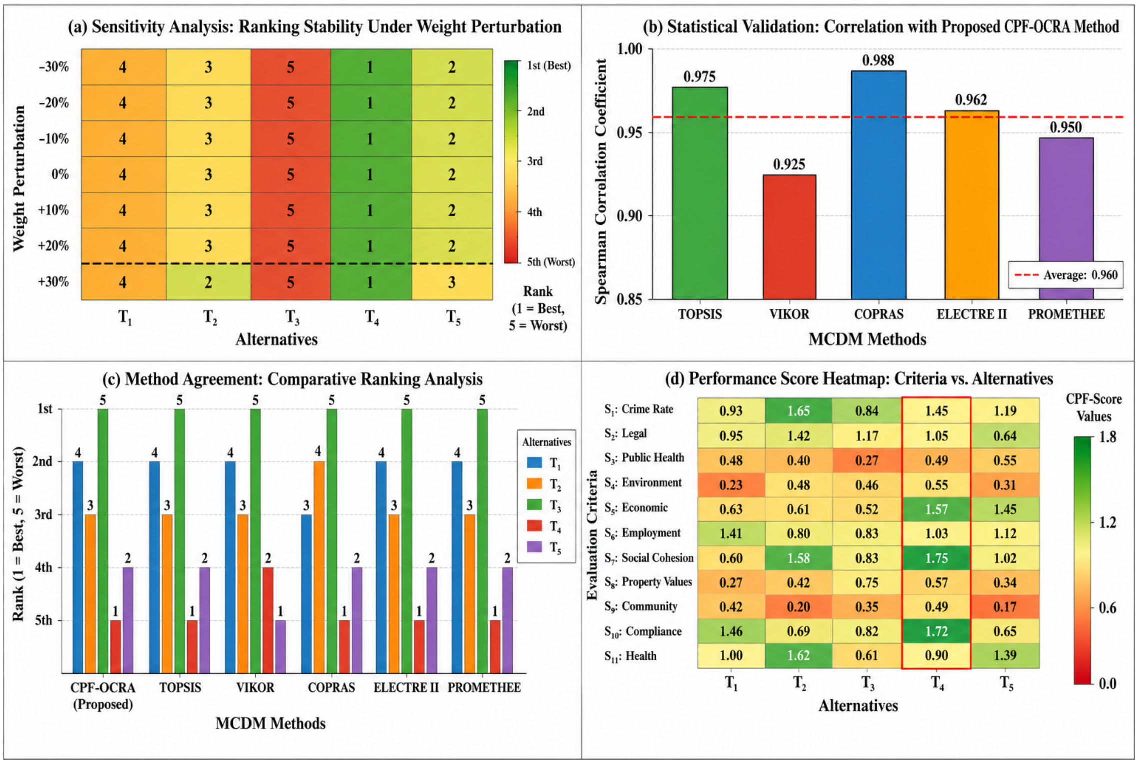

Figure 6: Comprehensive validation of the proposed CPF-OCRA framework, illustrating (a) sensitivity analysis under weight perturbations, (b) Spearman correlation with benchmark MCDM methods, (c) comparative ranking agreement across methods, and (d) performance score heatmap across criteria and alternatives.

The sensitivity analysis is presented in Figure 6 (a), where the alternative rankings (T_1-T_5) remain stable under different weight perturbation levels ranging from -30% to $+30\%$, demonstrating the robust performance of the proposed model. (b) Spearman correlation coefficients between CPF-OCRA and other MCDM methods (TOPSIS, VIKOR, COPRAS, ELECTRE II, and PROMETHEE) and confirm the strong statistical agreement. Subfigure (c) compares the ranking results of different decision-making methods, showing consistent dominance patterns among the alternatives. Finally, subfigure (d) presents a detailed performance score heatmap for eleven evaluation criteria (S_1- S_{11}) and five alternatives (T_1- T_5). The higher values (green region) indicate better performance across the criteria.

6.7 Limitations and Future Research

Despite the promising results, this study has several limitations:
►**Computational complexity:** The circular distance calculations increase computational overhead compared to standard fuzzy MCDA methods, limiting real-time application potential.
► **Expert dependency:** The linguistic-to-CPFN mapping relies on expert judgment, introducing potential subjectivity bias.
► **Static weight assumption:** Current framework assumes fixed criteria weights, while real-world risk factors may exhibit dynamic interrelationships.
► **Generalizability:** The case study focuses on adult entertainment economics; validation across other industries (e.g., healthcare, finance) is needed.
►**Radius determination:** The selection of radius r in CPFS remains heuristic; optimal radius selection methods require further investigation.
Future research directions:

i. Developing adaptive radius selection algorithms using machine learning

ii. Extending to dynamic MCDA with time-varying weights

iii. Applying the framework to other controversial industries (gambling, cannabis)

iv. Integrating with group decision-making protocols for conflict resolution

6.8 Practical Implications

i. This study provides a robust framework for evaluating the main risk factors affecting the adult entertainment economy. The proposed ranking method and the Pythagorean circular fuzzy numbers are utilized. Stakeholders can better understand and quantify uncertainty in risk factors that can lead to more informed decisions.

ii. These findings can inform policymakers by highlighting the interdependence between different risk factors. This understanding can guide the development of regulations that take into account not only economic factors but also social health impacts. This promotes a more balanced approach to adult entertainment regulation.

iii. The model assesses how adult entertainment affects community opinion and social cohesion. This model can facilitate dialogue between industry stakeholders and community members. This participation can lead to joint efforts to address concerns and improve community relations.

iv. Risk factor rankings should prioritize interventions based on severity and impact. Stakeholders can increase the overall effectiveness of their efforts by focusing resources on the most pressing issues, such as crime reduction or public health initiatives.

6.9 Managerial Implications

A. Managers in the adult entertainment sector can use the findings to make informed decisions about operating strategies. Resource allocation and risk management Exploring such models allows for more efficient planning and execution of business initiatives.

B. A comprehensive assessment of risk factors allows for better strategic planning. Managers can predict potential challenges and develop proactive strategies to reduce risk.

C. The inclusion of the Pythagorean circular adjacency coefficient provides a quantitative basis for evaluating the effectiveness of management strategies. This approach allows for continuous improvement through continuous evaluation and adjustments based on empirical data.

D. Using the insights from this study, managers can position their organizations in the market more effectively. Understanding the nuances of risk factors can enhance competitive strategies. Helping businesses Be more agile in navigating the regulatory landscape and community expectations.

7. Conclusion

The juvenile entertainment industry's numerous risks were the focus of this study. The industry impact on the economy and society necessitated this analysis. We used the groundbreaking fuzzy OCRA approach (Circular Pythagorean fuzzy assessment of alternatives and ranking) to illuminate the key factors that affect this industry economic stability and resilience.Our persistence is exposing these concerns. Our research has had such a major impact that politicians and other researchers feel forced to investigate adult performance risks. When we save these threats for devotion, they have sudden effects on the worldwide well-being of the poor and on our employees' finances. We accepted explanations that will lead to an even more unpredictable and intolerable financial situation because we took these threats too seriously and observed them too closely and too fast. We possessed the authority to validate these risks.The fuzzy OCRA tactic is a major advance in MCDA methods. We provide a hybrid structure that uses circular Pythagorean fuzzy logic to let ancillary entities make uncertain future judgments. This outline relieves entities from various verdicts. This layout comprehensively explains circular Pythagorean measurement, comparative closeness coefficient analysis, and functional attractiveness evaluation. This simplifies the creation of long-term risk factors based on their importance. This is achievable because we can integrate all these essentials into a strategy. With this technique, we can comprehensively investigate dangers and determine their virtual relevance. Demand for our hands-on instance learning method has demonstrated its utility and convenience in real-life scenarios, making it superior to current MCDA frameworks for correcting erroneous perceptions and enhancing awareness.

We assessed our talents utilizing a case study routine. Our approach allows us to examine and mitigate the dangers of adult entertainment. Interpreting a wide variety of issues, including illicit activity, public health, social cohesion, and ecological implications, achieves this. This method reduces dangers for younger audiences. The verdicts enlarged from this learning will not only delay systematic awareness in verdict maintenance classifications that are imprecise, but they will also be used to impact dogma discussions and diligence observes. We'll tailor industry procedures to research findings. The results will impact both domains. Fuzzy logic and the OCRA technique can help us manage today's economic issues with clarity and confidence.

Author Contribution Statement

MK: Conceptualization, methodology, software, validation, wrinting original draft; MF: Conceptualization, investigation, resources, writing—original draft preparation; CJ: Conceptualization, formal analysis, investigation, resources, data curation, review and editing; ZSE: investigation, resources, data curation, writing—original draft preparation; MH: Conceptualization, resources, supervision, writing—original draft preparation; NI: Conceptualization; writing—review and editing, visualization, supervision.

Conflict of Interest

The author declares no conflict of interest.

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8. Appendix

The Table 24 presents the abbreviations and their corresponding full forms used throughout the study.

Table 24: List of Abbreviation

Name	Abbreviation	Name	Abbreviation
Operational competitiveness rating,	OCRA	Membership degree	MD
Multi-criteria decision analysis	MCDA	Non-membership degree	NMD
Circular Pythagorean Fuzzy Set	CPFS	Fuzzy set	FS
Intuitionistic fuzzy set	IFS	Pythagorean Fuzzy Set	PFS
Pythagorean Fuzzy Set	PFV	Decision-makers	DM's
Circular Intuitionistic Fuzzy Set	CIFS	Aggregation operators	AOs
Circular pythagorean fuzzy numbers	CPFNs	Relative closeness	RC