



Spherical Fuzzy Multi-Criteria Decision-Making Approach for Risk Assessment of Natech

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Abstract

It is possible for a natural catastrophe to cause harm to numerous industrial facilities in the same region simultaneously. The natural catastrophe's Natech events may then affect the industrial facilities that are located nearby, so creating a coupling risk. The evaluation of the danger of Natech events coupling is conducted using the technique of multi-criteria decision-making (MCDM) methodology in this investigation. Additionally, the concept of spherical fuzzy is presented as a means of resolving the issue of ambiguity associated with the Natech coupling risk. The Natech Coupling Hazard Index is designed to include both tangible and operational resources in its calculations. The idea of an equal population is being floated as a means of contrasting the dangers presented by physical facilities with those posed by functional amenities. The spherical fuzzy set is an effective method for coping with ambiguity since it presents a broader decision-making region and identifies reluctance. Under this paper, a fuzzy MCDM technique using spherical fuzzy AHP is proposed as a solution to the challenge of managing the selection of process mining methods under settings that are unclear and vague. The AHP method is used to compute the weights of criteria and shows the rank and order of alternatives. The application is performed in steps of the spherical fuzzy AHP method.

Keywords: Spherical Fuzzy; AHP; MCDM; Natech; Risk Assessment; Climate Change

1. Introduction

Over the history of the last century, there has been an increase in the frequency of natural and technological collisions, in addition to an upsurge in the number of individuals and financial consequences that have been affected. Additionally, the repercussions of their concurrent occurrence, which are referred to as Natechs, have led to increasing worries on an international scale. It has come to everyone's attention that there is a pressing need to improve one's level of readiness and management of the danger posed by Natech, owing to the severe nature of its effects and its ability to spread across broad regions[1]–[3].

The events at Natech have shown the susceptibility of contemporary society to the ever-increasing complexity of natural catastrophes, making no difference between affluent nations, who are typically better prepared, and low-income nations[4]. In addition, the incidents that have occurred at Natech are more serious in terms of the damage they have caused, and they may have a wider range of effects on the ecosystem than natural catastrophes themselves. Lightning, floods, frost, rains, and windstorms are all examples of naturally occurring occurrences that may often set off Natech sensors[5], [6]. In past decades, industrial catastrophes have been caused by landslides, heat waves, and earthquakes, among other natural disasters. Accidents at Natech may include a wide variety of occurrences, including interruptions and technical failures, hazardous material spills, fire, explosions, and collapses of mining tailings dams, among other things. There is a good chance that there are several triggering connections and fuzzy connections involved in the entire operation of a Natech event[7], [8]. Following a natural disaster result in an engineering accident, domino impacts can happen among different pieces of industrial equipment. For example, the detonation of one tank

could lead to the explosion of a different tank. Natural disasters can also cause technological collisions[9], [10]. Besides the link between the trigger and the effect, the connection between the dangers and the uncertainty is also highly important[11]–[13].

The Analytic Hierarchy Process, or AHP for short, is one of the most widely used multi-criteria decision-making (MCDM) procedures that was first designed by Saaty. It is used to analyze, prioritize, rank, and evaluate different decision alternatives[14], [15]. The AHP technique involves classifying the various considerations relevant to a decision-making issue, which then leads to the formation of a hierarchy. When decomposing an issue into hierarchies, AHP relies on the opinions and assessments of those who will be making the decisions. The degree of difficulty of the task corresponds to the number of levels in the hierarchy[16]–[19].

Since Zadeh first presented the concept of ordinary fuzzy sets, its utilization in almost all subfields of research has increased significantly[20], [21]. In subsequent years, several academics have devised a few expansions of the traditional fuzzy sets. In recent years, several scholars have used these extensions in the process of finding solutions to issues involving MCDM[22]–[24].

In the literature, Wang and Weng [25] proposed a framework to assess risks in Natch. They used the fuzzy measure to solve the uncertainty issue. They made a case study in China. They used three criteria vulnerability center, economic centers, and the people. They used two case studies one in an industrial facility and the other in a hypothetical town. Two limitations are present in their works. The first is that the scoring and grading of variables will always include a subjective process. As a result, the accuracy of the assessment is dependent on the professionalism of scoring. Furthermore, the demographic and economic factors that were evaluated can only provide a preliminary reflection of the all-encompassing danger of Natch occurrences.

Jiajun Wang and Wenguo Weng [26] provided a system that can rapidly and creatively estimate the Natch risk in a multi-hazard scenario that includes flooding, wind, and hail. They used the Monte Carlo simulation methodology to examine the effects that the many distinct factors have on multi-hazard situations. So, this paper introduced the spherical fuzzy AHP method to show the risks Natch relationships and rank the risks.

Step 1: Organizing in a hierarchical design

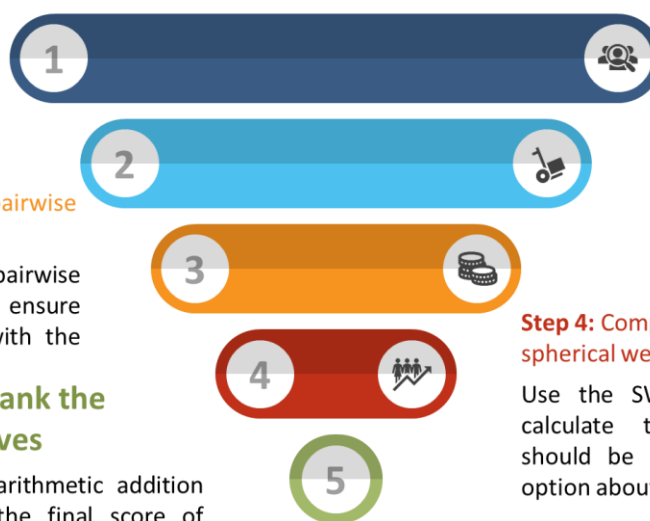
A hierarchical structure with at least three tiers is built.

Step 3: Examine every pairwise contrasting matrix

Examine every pairwise contrasting matrix to ensure that it is consistent with the other matrices.

Step 5: Rank the alternatives

Apply the arithmetic addition to obtain the final score of each alternative.



Step 2: Construct paired comparisons

Construct paired comparisons by making use of spherical fuzzy judgment matrices and basing them on the language words

Step 4: Computing the spherical weights

Use the SWAM operator to calculate the weight that should be assigned to every option about each criterion.

Figure 1: The steps of the spherical fuzzy AHP.

2. Spherical Fuzzy AHP Approach

There are many steps in the proposed approach presented in Figure 1 [27].

Step 1: Organizing in a hierarchical design.

During this stage of the process, a hierarchical structure with at least three tiers. Level 1 symbolizes a goal or an aim, which is determined by the score index and is "selecting the best alternative." Estimates of the score index is derived from a limited number of criteria denoted by the notation $C = \{C_1, C_2, \dots, C_n\}$ and shown at Level 2. As a result, at Level 3, a distinct set of m viable alternatives, denoted by $X = \{x_1, x_2, \dots, x_m\}$.

Step 2: Construct paired comparisons by making use of spherical fuzzy judgment matrices and basing them on the language words presented in Table 1.

Table 1: The linguistic terms used in this paper.

	(μ, ν, π)	Score Index
Absolutely Powerful (AP)	(0.9, 0.1, 0.0)	9
Very Powerful (VP)	(0.8, 0.2, 0.1)	7
Fairly Powerful (FP)	(0.7, 0.3, 0.2)	5
Slightly Powerful (SP)	(0.6, 0.4, 0.3)	3
Medium Powerful (MP)	(0.5, 0.4, 0.4)	1
Slightly Low (SL)	(0.4, 0.6, 0.3)	1/3
Fairly Low (FL)	(0.3, 0.7, 0.2)	1/5
Very Low (VL)	(0.2, 0.8, 0.1)	1/7
Absolutely Low (AL)	(0.1, 0.9, 0.0)	1/9

Step 3: Examine every pairwise contrasting matrix to ensure that it is consistent with the other matrices. Converting the linguistic phrases in the matrix of pairwise contrasts to their associated score indices is the first step in accomplishing this goal. After that, do the traditional check for consistency. Ten percent is the minimum acceptable level for the CR.

Step 4: Step four involves computing the spherical weights of the different requirements and options.

Use the SWAM operator that is provided in the following equation to calculate the weight that should be assigned to every option about each criterion. When calculating the spherical fuzzy weights, the weighted arithmetic mean is the method of choice.

$$\begin{aligned}
 SWAM_w(A_{S1}, \dots, A_{Sn}) &= W_1 A_{S1} + W_2 A_{S2} + \dots + W_n A_{Sn} \\
 &= \left(\left[1 - \prod_{i=1}^n (1 - \mu_{A_{Si}}^2)^{w_i} \right]^{0.5}, \right. \\
 &\quad \left. \prod_{i=1}^n (\nu_{A_{Si}})^{w_i}, \right) \\
 &\quad \left[\prod_{i=1}^n (1 - \mu_{A_{Si}}^2)^{w_i} - \prod_{i=1}^n (1 - \mu_{A_{Si}}^2 - \pi_{A_{Si}}^2)^{w_i} \right]^{0.5}
 \end{aligned} \tag{1}$$

Where $w = 1/n$

Defuzzify the criterion weights by applying the score function (S) in Equation (2), then normalize them using Equation (3), and finally use the spherical fuzzy multiplication formula found in Equation (4).

$$S(w_j^s) = \sqrt{\left| 100 * \left[\left(3\mu_{A_s} - \frac{\pi_{A_s}}{2} \right)^2 - \left(\frac{\nu_{A_s}}{2} - \pi_{A_s} \right)^2 \right]^{0.5} \right|} \tag{2}$$

Normalize the Weights of criteria as

$$W_j^s = \frac{S(w_j^s)}{\sum_{j=1}^n S(w_j^s)} \tag{3}$$

$$\begin{aligned} A_{S_{ij}} &= w_j^s \cdot A_{S_i} \\ &= \left\langle \left(\left[1 - (1 - \mu_{A_{Si}}^2)^{w_j^s} \right]^{0.5}, \right. \right. \\ &\quad \left. \left. (\nu_{A_{Si}})^{w_j^s}, \right. \right. \\ &\quad \left. \left. \left[(1 - \mu_{A_{Si}}^2)^{w_j^s} - (1 - \mu_{A_{Si}}^2 - \pi_{A_{Si}}^2)^{w_j^s} \right]^{0.5} \right. \right. \end{aligned} \tag{4}$$

Then apply the arithmetic addition to obtain the final score of each alternative.

$$\begin{aligned} F &= \sum_{j=1}^n A_{S_{ij}} = A_{S_{i1}} \oplus A_{S_{i2}} \oplus \dots \oplus A_{S_{in}} \\ &= \left\langle \left(\left(\mu_{A_{S_{i1}}}^2 + \mu_{A_{S_{i2}}}^2 - \mu_{A_{S_{i1}}}^2 \mu_{A_{S_{i2}}}^2 \right)^{0.5}, \right. \right. \\ &\quad \left. \left. \nu_{A_{S_{i1}}} \nu_{A_{S_{i2}}}, \right. \right. \\ &\quad \left. \left. \left((1 - \mu_{A_{S_{i2}}}^2) \pi_{A_{S_{i1}}}^2 + (1 - \mu_{A_{S_{i1}}}^2) \pi_{A_{S_{i2}}}^2 - \pi_{A_{i1}}^2 \pi_{A_{i2}}^2 \right)^{0.5} \right. \right. \end{aligned} \tag{5}$$

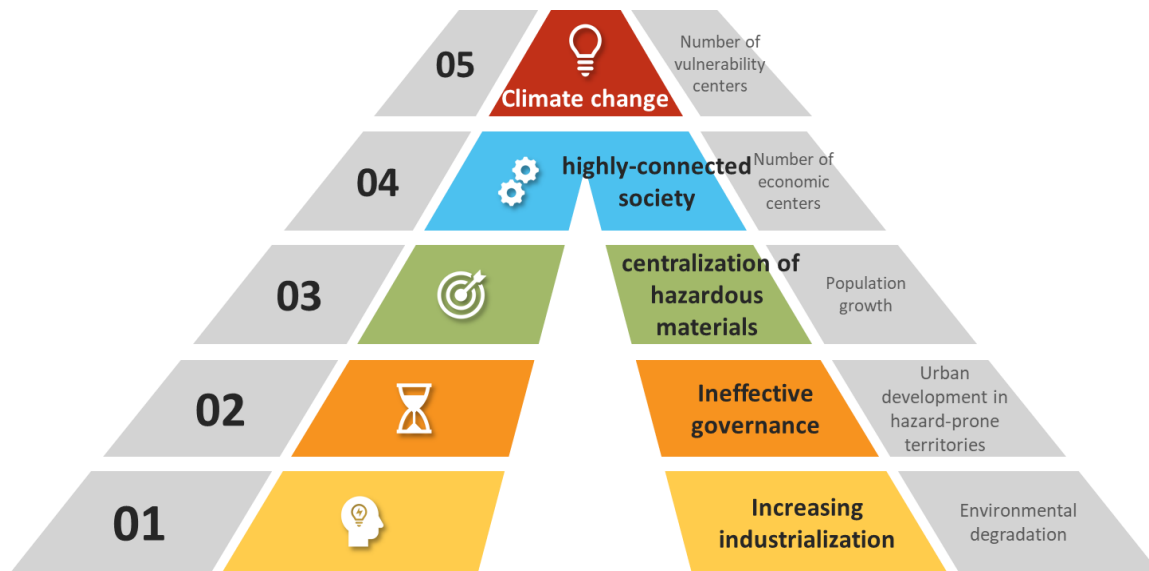


Figure 2: The ten criteria are used in this paper.

3. Case Study

The Nile Delta in Egypt serves as the setting for this case study of the chemical industry there. Climate change poses a threat to the Nile Delta and Egypt's Mediterranean coast, both of which are at risk of experiencing changes to their shorelines because of processes such as erosion and accretion, subsidence, and rising sea levels. In Egypt, floods are often brought on by heavy rainfall. Flooding caused by rain is responsible for the destruction of property, the loss of life, and the displacement of people. In Egypt, dust storms are another typical occurrence, and they can cover hundreds of km. There are ten physical facilities. From the literature there are ten criteria are collected in this study as shown in Figure 2.

The consistency ratios of the pairwise contrasting matrices are computed by using the relevant numerical values from the traditional AHP approach, which are shown in Table 1. The CR is less than 0.1. These values pertain to the linguistic dimension. Table 2 shows the comparison matrix. Then replace the linguistic terms with the score index and spherical fuzzy values as displayed in Table 3,4.

Table 2: The comparison matrix between criteria.

	RNT_1	RNT_2	RNT_3	RNT_4	RNT_5	RNT_6	RNT_7	RNT_8	RNT_9	RNT_{10}
RNT_1	MP	AP	FP	AL	AP	SL	FP	SL	FP	AP
RNT_2	AL	MP	FL	FP	AL	AP	AL	FP	AL	FP
RNT_3	FL	FP	MP	AP	VP	AL	SL	AP	SL	AP
RNT_4	AP	FL	AL	MP	FP	AP	FP	AL	AL	VL
RNT_5	AL	VP	VL	FL	MP	FL	VL	AP	FP	VL
RNT_6	SP	AL	AP	AL	FP	MP	FP	SP	VL	AP
RNT_7	FL	AP	SP	FL	VP	FL	MP	AL	SL	SP
RNT_8	SP	FL	AL	AP	AL	SL	AP	MP	FP	AP
RNT_9	FL	AP	SP	AP	FL	VP	SP	FL	MP	SL
RNT_{10}	AL	FL	AL	VP	VP	AL	SL	AL	SP	MP

Table 3: The scoring index of comparison matrix between criteria.

	RNT_1	RNT_2	RNT_3	RNT_4	RNT_5	RNT_6	RNT_7	RNT_8	RNT_9	RNT_{10}
RNT_1	1	9	5	1/9	9	1/3	5	1/3	5	9
RNT_2	1/9	1	1/5	5	1/9	9	1/9	5	1/9	5
RNT_3	1/5	5	1	9	7	1/9	1/3	9	1/3	9
RNT_4	9	1/5	1/9	1	5	9	5	1/9	1/9	1/7
RNT_5	1/9	7	1/7	1/5	1	1/5	1/7	9	5	1/7
RNT_6	3	1/9	9	1/9	5	1	5	3	1/7	9
RNT_7	1/5	9	3	1/5	7	1/5	1	1/9	1/3	3
RNT_8	3	1/5	1/9	9	1/9	1/3	9	1	5	9
RNT_9	1/5	9	3	9	1/5	7	3	1/5	1	1/3
RNT_{10}	1/9	1/5	1/9	7	7	1/9	1/3	1/9	3	1

Table 4: The spherical fuzzy values of the comparison matrix between standards.

	RNT_1	RNT_2	RNT_3	RNT_4	RNT_5	RNT_6	RNT_7	RNT_8	RNT_9	RNT_{10}
RNT_1	(0.5, 0.4, 0.4)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.1, 0.9, 0.0)	(0.9, 0.1, 0.0)	(0.4, 0.6, 0.3)	(0.7, 0.3, 0.2)	(0.4, 0.6, 0.3)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)
RNT_2	(0.1, 0.9, 0.0)	(0.5, 0.4, 0.4)	(0.3, 0.7, 0.2)	(0.7, 0.3, 0.2)	(0.1, 0.9, 0.0)	(0.9, 0.1, 0.0)	(0.1, 0.9, 0.0)	(0.7, 0.3, 0.2)	(0.1, 0.9, 0.0)	(0.7, 0.3, 0.2)
RNT_3	(0.3, 0.7, 0.2)	(0.7, 0.3, 0.2)	(0.5, 0.4, 0.4)	(0.9, 0.1, 0.0)	(0.8, 0.2, 0.1)	(0.1, 0.9, 0.0)	(0.4, 0.6, 0.3)	(0.9, 0.1, 0.0)	(0.4, 0.6, 0.3)	(0.9, 0.1, 0.0)
RNT_4	(0.9, 0.1, 0.0)	(0.3, 0.7, 0.2)	(0.1, 0.9, 0.0)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.1, 0.9, 0.0)	(0.1, 0.9, 0.0)	(0.2, 0.8, 0.1)
RNT_5	(0.1, 0.9, 0.0)	(0.8, 0.2, 0.1)	(0.2, 0.8, 0.1)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)	(0.3, 0.7, 0.2)	(0.2, 0.8, 0.1)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.2, 0.8, 0.1)
RNT_6	(0.6, 0.4, 0.3)	(0.1, 0.9, 0.0)	(0.9, 0.1, 0.0)	(0.1, 0.9, 0.0)	(0.7, 0.3, 0.2)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.2, 0.8, 0.1)	(0.9, 0.1, 0.0)
RNT_7	(0.3, 0.7, 0.2)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.3, 0.7, 0.2)	(0.8, 0.2, 0.1)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)	(0.1, 0.9, 0.0)	(0.4, 0.6, 0.3)	(0.6, 0.4, 0.3)
RNT_8	(0.6, 0.4, 0.3)	(0.3, 0.7, 0.2)	(0.1, 0.9, 0.0)	(0.9, 0.1, 0.0)	(0.1, 0.9, 0.0)	(0.4, 0.6, 0.3)	(0.9, 0.1, 0.0)	(0.5, 0.4, 0.4)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)
RNT_9	(0.3, 0.7, 0.2)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)	(0.3, 0.7, 0.2)	(0.8, 0.2, 0.1)	(0.6, 0.4, 0.3)	(0.3, 0.7, 0.2)	(0.5, 0.4, 0.4)	(0.4, 0.6, 0.3)
RNT_{10}	(0.1, 0.9, 0.0)	(0.3, 0.7, 0.2)	(0.1, 0.9, 0.0)	(0.8, 0.2, 0.1)	(0.8, 0.2, 0.1)	(0.1, 0.9, 0.0)	(0.4, 0.6, 0.3)	(0.1, 0.9, 0.0)	(0.6, 0.4, 0.3)	(0.5, 0.4, 0.4)

Then compute the weights of the standards. The SWAM is used to compute the weights of standards by using Equation. (1). Then compute the score index by using Equation. (2). Then normalize the score index values to compute the weights of criteria by using Equation. (3) as presented in Table 5.

Table 5: The spherical fuzzy matrix between criteria.

	μ	ν	π	Score Index	Weights
RNT_1	0.428767	0.577348	0.275779	11.4834	0.065205
RNT_2	0.605655	0.42581	0.205748	17.14075	0.097329
RNT_3	0.74198	0.273393	0.169199	21.41095	0.121576
RNT_4	0.633065	0.413735	0.163913	18.16731	0.103158
RNT_5	0.596669	0.434684	0.19717	16.91302	0.096036
RNT_6	0.667974	0.360745	0.195734	19.05994	0.108226
RNT_7	0.592822	0.434	0.225886	16.65499	0.094571
RNT_8	0.697982	0.332122	0.177148	20.0534	0.113868
RNT_9	0.693586	0.320087	0.206348	19.77041	0.112261
RNT_{10}	0.555288	0.469691	0.240196	15.45757	0.087771

Then use the linguistic terms in Table 2 to build the decision matrix between criteria and alternatives. Then replace these terms with the score index and the spherical fuzzy values as shown in Table 7,8.

Table 6: The decision matrix between criteria and alternatives.

	RNT_1	RNT_2	RNT_3	RNT_4	RNT_5	RNT_6	RNT_7	RNT_8	RNT_9	RNT_{10}
$RANT_1$	AP	FP	SP	VP	SP	VP	FP	FP	FP	AP
$RANT_2$	SP	VP	FP	FP	FP	AP	SP	SP	VP	SP
$RANT_3$	VP	FP	VP	AP	VP	VP	VP	FP	VP	FP
$RANT_4$	FP	FP	AP	VP	SP	SP	VP	AP	SP	AP
$RANT_5$	SP	AP	VP	SP	VP	FP	AP	AP	VP	VP
$RANT_6$	AP	FP	VP	VP	SP	VP	FP	SP	VP	SP
$RANT_7$	SP	FP	SP	AP	FP	AP	AP	AP	FP	SP
$RANT_8$	FP	VP	FP	SP	SP	FP	AP	VP	AP	FP
$RANT_9$	SP	FP	AP	AP	VP	AP	SP	AP	SP	SP
$RANT_{10}$	AP	VP	SP	AP	SP	FP	AP	FP	SP	AP

Table 7: The scoring index of the decision matrix between criteria and alternatives.

	RNT_1	RNT_2	RNT_3	RNT_4	RNT_5	RNT_6	RNT_7	RNT_8	RNT_9	RNT_{10}
$RANT_1$	9	5	3	7	3	7	5	5	5	9
$RANT_2$	3	7	5	5	5	9	3	3	7	3
$RANT_3$	7	5	7	9	7	7	7	5	7	5
$RANT_4$	5	5	9	7	3	3	7	9	3	9
$RANT_5$	3	9	7	3	7	5	9	9	7	7
$RANT_6$	9	5	7	7	3	7	5	3	7	3
$RANT_7$	3	5	3	9	5	9	9	9	5	3
$RANT_8$	5	7	5	3	3	5	9	7	9	5
$RANT_9$	3	5	9	9	7	9	3	9	3	3
$RANT_{10}$	9	7	3	9	3	5	9	5	3	9

Table 8: The spherical fuzzy values of the decision matrix between criteria and alternatives.

	RNT_1	RNT_2	RNT_3	RNT_4	RNT_5	RNT_6	RNT_7	RNT_8	RNT_9	RNT_{10}
$RANT_1$	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)

$RANT_2$	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)
$RANT_3$	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)
$RANT_4$	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)
$RANT_5$	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)
$RANT_6$	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)
$RANT_7$	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.9, 0.1, 0.0)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)
$RANT_8$	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)
$RANT_9$	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.6, 0.4, 0.3)
$RANT_{10}$	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)	(0.6, 0.4, 0.3)	(0.7, 0.3, 0.2)	(0.9, 0.1, 0.0)	(0.7, 0.3, 0.2)	(0.6, 0.4, 0.3)	(0.9, 0.1, 0.0)

Then use Equation. (4) to multiply the weights of standards by the decision matrix values. Then use Equation. (5) to compute the final score and rank the options affording the highest scores as shown in Table 9.

Table 9: The rank of alternatives.

Alternatives	Rank
$RANT_1$	8
$RANT_2$	9
$RANT_3$	7
$RANT_4$	5
$RANT_5$	4
$RANT_6$	10
$RANT_7$	2
$RANT_8$	6
$RANT_9$	1
$RANT_{10}$	3

4. Conclusion

Natural disasters have the potential to inflict harm to several manufacturing plants in the same region simultaneously. The Natech events that are created because of these industrial institutions being destroyed have the potential to cause additional industrial institutions in the vicinity to be impacted, creating Natech coupling risk in the process. In this work, the MCDM approach is used to perform the Natech risk evaluation. Additionally, the pertinent knowledge of spherical fuzzy measures is presented to tackle the ambiguity issue in the Natech coupling risk. In recent years, three-dimensional membership functions have gained a lot of popularity all around the world. These are the sorts of membership functions that are used by IFS, PFS, and NS, which stand for intuitive fuzzy sets, Pythagorean fuzzy sets,

and neutrosophic sets, respectively. To give a more comprehensive perspective on three-dimensional fuzzy sets, spherical fuzzy sets have been developed. In the previous research, we offered the theory of spherical fuzzy sets (SFS), together with their arithmetic operations and their aggregation operators. The expansion of fuzzy AHP to SF-AHP has made use of this new form of fuzzy sets as part of the process. The AHP is used to compute the weights of standards and ranks the alternatives. There are ten criteria and alternatives used in this research.

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