Network user interest mining method based on Neutrosophic cluster analysis

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Abstract:

These days' user interests have become more critical for companies and firms to introduce their content due to the growth in networks and the internet. So this method used neutrosophic sets for network user interest. In this paper, we proposed five main criteria and seventeen sub-criteria to show user interest in the network. The multi-criteria decision-making (MCDM) method is used to deal with various criteria and sub-criteria. So the Analytical Hierarchal Process (AHP) is used to show weights of criteria and sub-criteria to present the user interest in the network. An illustrative example provides to show calculations of the proposed method.

Keywords: AHP, Neutrosophic, Network, Mining, User Interest, Cluster algorithm

1. Introduction

Service of personalized is become more lively due to growth in network and internet. Service of personalized is an internet service. The collection of users is becoming an essential mission for internet companies[1]. So, for this reason, a great completion is built for collecting end-user. So, the best companies that have the best information for user interest for developing service of personalized. The collect and select user interest is an important decision for introducing the best service for users. There many papers study network user interests as [2]–[9].

So, this paper introduces the user's interests and how internet companies can use this work to introduce better services. We use five main criteria and sixteen sub-criteria. These criteria are conflict and complex, so MCDM is used for overcoming this problem. The AHP method is used to show weights of criteria and sun criteria to inform companies of essential criteria for considering while introducing services. AHP is an MCDM

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method. It is used in decision-making problems. It is an easy and perfect method. It used a pairwise comparison to compare criteria and sub-criteria. The AHP has many applications in several areas such as healthcare, industry and educations[10]–[14].

The AHP method is employed with the neutrosophic sets. Neutrosophic set is a tool for overcoming uncertainty and incomplete information. In this paper, we introduce triangular neutrosophic sets (TNSs), which contain six values and consider the indeterminacy value in calculations[15]–[17].

The main continuations in this paper introduce network user interests under neutrosophic sets for the first time. We use a significant dimension of data to deal with this problem.

The rest of this paper is organized as section 2 presents the AHP method. Section 3 presents the results of the proposed method. Section 4 presents conclusions.

Table 1. TNNs

TNNS
<1,1,1,><0,0,1>
<1,2,3> <0.85,0.15,0.15>
<2,3,4><0.25,0.75,0.75>
<3,4,5> <0.9,0.1,0.1>
<4,5,6><0.45,0.60,0.60>

2. The AHP method

In this section, we introduce the AHP method for calculating the weights of criteria and sub-criteria to present the network user interest to help internet companies and decision-makers introduce better service for users.

Stage 1: Identify the goal form this study and analyze the problem.
Stage 2: Identify set of experts, criteria and sub criteria
Stage 3: let expert's evaluate the criteria and sub criteria for building a pairwise comparison matrix between criteria and sub criteria by using TNNs in Table 1.
Stage 4: Convert TNNs into a one value then combine the matrix into one matrix by mean value.

$$S(D) = \frac{x+y+z}{9} * (2 + P - I + O) \quad (1)$$

Stage 5: Normalize a pairwise comparison matrix by divide each value in combine matrix by the sum of columns.
Stage 6: Compute the weights of criteria by row average.

3. An illustrative example.

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First, we would show the importance and weights of user interest's weight. We select three decision-makers who have experience in this field to evaluate the five main criteria. The five main criteria are C1: online newspapers, C2: user interest profile, C3: user representations, C4: user moulding, C5: Search engine. Then three experts evaluate the five main criteria to build a pairwise comparison matrix into Table 2-4. Then combined three matrices into one matrix in Table 5. Then normalize the combined pairwise comparison matrix into Table 6. Then compute the weights of criteria in Table 7. Fig 1. Present the weights of primary criteria. C1: online newspapers are the highest weight in user interests, and search engine is the lowest weight in user interest.

Table 2. Pairwise comparison matrix for five main criteria by first decision makers.

	C_1	C_2	C_3	C_4	C_5
C_1	1	6	4	2.3	2
C_2	0.166667	1	2	6	2.3
C_3	0.25	0.5	1	2	2
C_4	0.434783	0.166667	0.5	1	2.3
C_5	0.5	0.434783	0.5	0.434783	1

Table 3. Pairwise comparison matrix for five main criteria by second decision makers.

	C_1	C_2	C_3	C_4	C_5
C_1	1	2.3	6	2.3	6
C_2	0.434783	1	4	2.3	2
C_3	0.166667	0.25	1	2	4
C_4	0.434783	0.434783	0.5	1	6
C_5	0.166667	0.5	0.25	0.166667	1

Table 4. Pairwise comparison matrix for five main criteria by third decision makers.

	C_1	C_2	C_3	C_4	C_5
C_1	1	2	2	4	2
C_2	0.5	1	2	2.3	2.3
C_3	0.5	0.5	1	2	2
C_4	0.25	0.434783	0.5	1	4
C_5	0.5	0.434783	0.5	0.25	1

Table 5. Combined matrix for five main criteria.

	C_1	C_2	C_3	C_4	C_5
C_1	1	3.433333	4	2.866667	3.333333
C_2	0.36715	1	2.666667	3.533333	2.2
C_3	0.305556	0.416667	1	2	2.666667
C_4	0.373188	0.345411	0.5	1	4.1
C_5	0.388889	0.456522	0.416667	0.283816	1

Table 6. Normalized Combined matrix for five main criteria.

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	C_1	C_2	C_3	C_4	C_5
C_1	0.410714	0.607462	0.466019	0.296027	0.250627
C_2	0.150794	0.176931	0.31068	0.36487	0.165414
C_3	0.125496	0.073721	0.116505	0.20653	0.200501
C_4	0.153274	0.061114	0.058252	0.103265	0.308271
C_5	0.159722	0.080773	0.048544	0.029308	0.075188

Table 7. Weights.

	Weights of criteria
C_1	0.40617
C_2	0.233737
C_3	0.144551
C_4	0.136835
C_5	0.078707

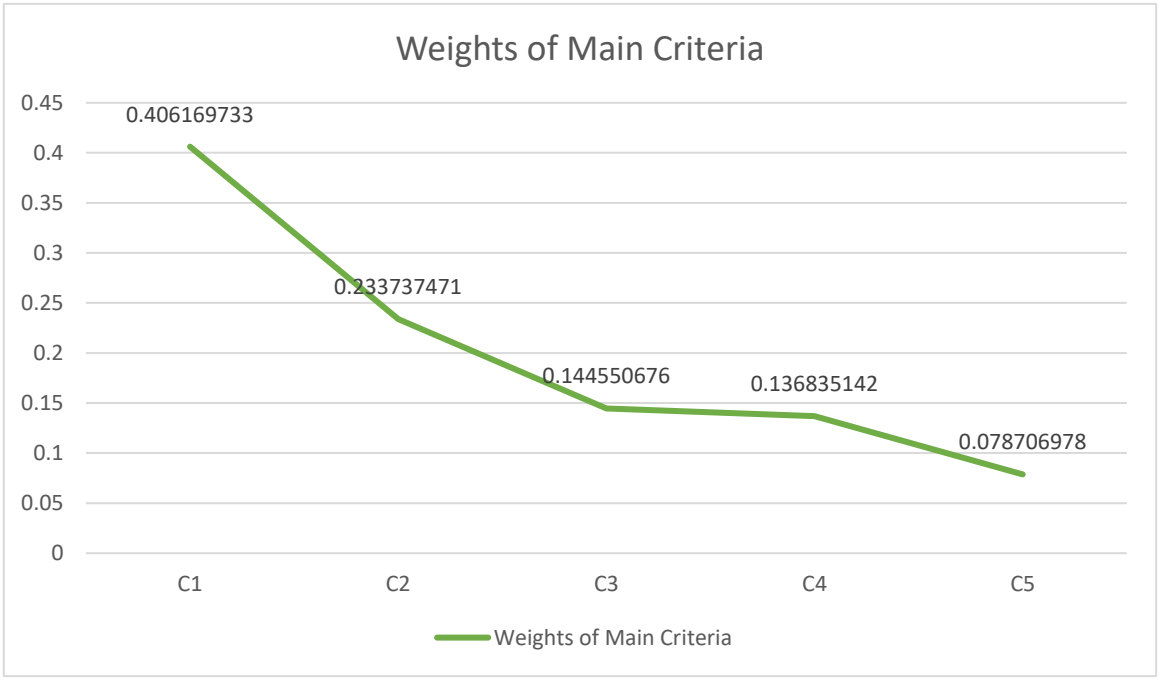

Fig 1. Weights of main criteria.

Then compute the weights of sub-criteria. Start with C1: online newspaper. C1: contain four sub-criteria. C1.1:rich information, C1.2: new technology, C1.3: several categories, C1.4: news pages. First, build a three comparison matrix in Table 8-10. Then combined pairwise comparison matrix into Table 11. Then normalize the matrix into Table 12. Then compute the weights of sub-criteria in Table 13. Rich information is the highest weight, and new pages are the lowest weight. Fig 2. Present the weights of sub-criteria.

Table 8. Pairwise comparison matrix for five main criteria by first decision makers.

	$C_{1.1}$	$C_{1.2}$	$C_{1.3}$	$C_{1.4}$

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$C_{1.1}$	1	2	6	2
$C_{1.2}$	0.5	1	4	2.3
$C_{1.3}$	0.166667	0.25	1	4
$C_{1.4}$	0.5	0.434783	1	1

Table 9. Pairwise comparison matrix for five main criteria by second decision makers.

	$C_{1.1}$	$C_{1.2}$	$C_{1.3}$	$C_{1.4}$
$C_{1.1}$	1	2.3	2	6
$C_{1.2}$	0.434783	1	2	4
$C_{1.3}$	0.5	0.5	1	2.3
$C_{1.4}$	0.166667	0.25	1	1

Table 10. Pairwise comparison matrix for five main criteria by third decision makers.

	$C_{1.1}$	$C_{1.2}$	$C_{1.3}$	$C_{1.4}$
$C_{1.1}$	1	2	2.3	2.3
$C_{1.2}$	0.5	1	6	2
$C_{1.3}$	0.434783	0.166667	1	6
$C_{1.4}$	0.434783	0.5	1	1

Table 11. Combined matrix for five main criteria.

	$C_{1.1}$	$C_{1.2}$	$C_{1.3}$	$C_{1.4}$
$C_{1.1}$	1	2.1	3.433333	3.433333
$C_{1.2}$	0.478261	1	4	2.766667
$C_{1.3}$	0.36715	0.305556	1	4.1
$C_{1.4}$	0.36715	0.394928	1	1

Table 12. Normalized Combined matrix for five main criteria.

	$C_{1.1}$	$C_{1.2}$	$C_{1.3}$	$C_{1.4}$
$C_{1.1}$	0.451965	0.552561	0.363958	0.303835
$C_{1.2}$	0.216157	0.263124	0.424028	0.244838
$C_{1.3}$	0.165939	0.080399	0.106007	0.362832
$C_{1.4}$	0.165939	0.103915	0.106007	0.088496

Table 13. Weights.

	Weights of Sub criteria
$C_{1.1}$	0.41808
$C_{1.2}$	0.287037
$C_{1.3}$	0.178794
$C_{1.4}$	0.116089

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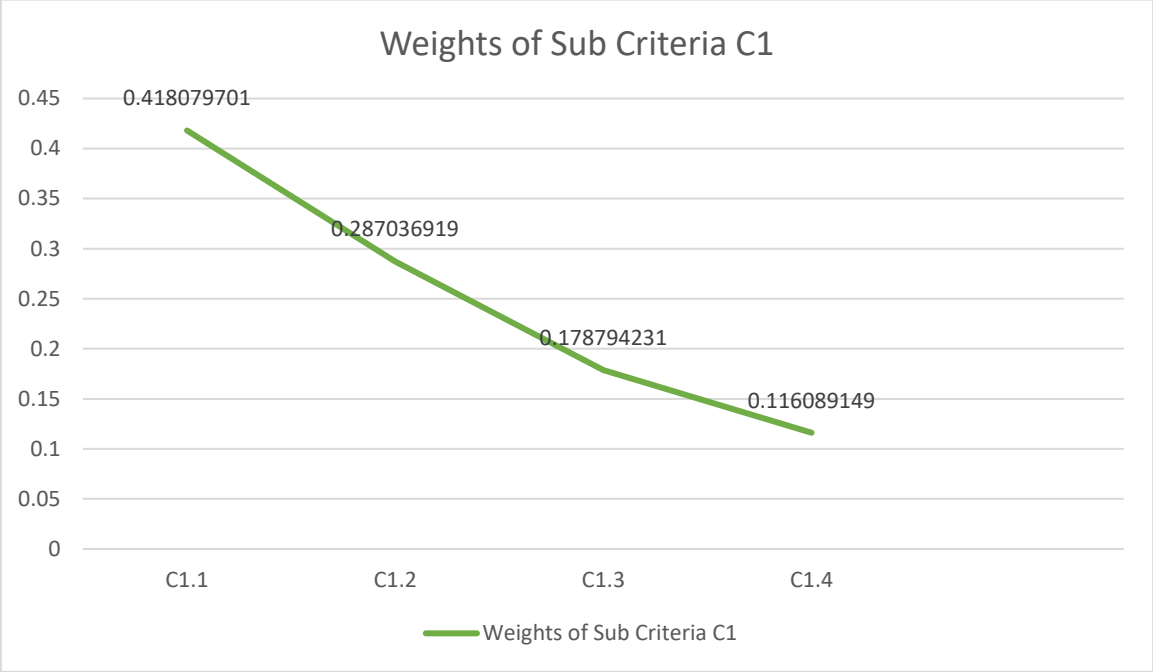

Fig 2. Weights of sub criteria C1.

Then compute the weights of C2: User interest profile. C2: contain three sub-criteria. C2.1: profile enhancement, C2.2: Weight scheme with profile, C2.3: temporal dynamic. First, build a three comparison matrix in Table 14-16. Then combined pairwise comparison matrix into Table 17. Then normalize the matrix into Table 18. Then compute the weights of sub-criteria in Table 19. Profile enhancement is the highest weight, and temporal dynamic is the lowest weight. Fig 3. Present the weights of sub-criteria.

Table 14. Pairwise comparison matrix for five main criteria by first decision makers.

	$C_{2.1}$	$C_{2.2}$	$C_{2.3}$
$C_{2.1}$	1	2.3	4
$C_{2.2}$	0.434783	1	2.3
$C_{2.3}$	0.25	0.434783	1

Table 15. Pairwise comparison matrix for five main criteria by second decision makers.

	$C_{2.1}$	$C_{2.2}$	$C_{2.3}$
$C_{2.1}$	1	4	6
$C_{2.2}$	0.25	1	4
$C_{2.3}$	0.166667	0.25	1

Table 16. Pairwise comparison matrix for five main criteria by third decision makers.

	$C_{2.1}$	$C_{2.2}$	$C_{2.3}$
$C_{2.1}$	1	2.3	4
$C_{2.2}$	0.434783	1	2.3
$C_{2.3}$	0.25	0.434783	1

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Table 17. Combined matrix for five main criteria.

	$C_{2.1}$	$C_{2.2}$	$C_{2.3}$
$C_{2.1}$	1	2.866667	4.666667
$C_{2.2}$	0.373188	1	2.866667
$C_{2.3}$	0.222222	0.373188	1

Table 18. Normalized Combined matrix for five main criteria.

	$C_{2.1}$	$C_{2.2}$	$C_{2.3}$
$C_{2.1}$	0.626798	0.676124	0.546875
$C_{2.2}$	0.233914	0.235857	0.335938
$C_{2.3}$	0.139288	0.088019	0.117188

Table 19. Weights.

	Weights of Sub criteria
$C_{2.1}$	0.616599
$C_{2.1}$	0.268569
$C_{2.3}$	0.114832

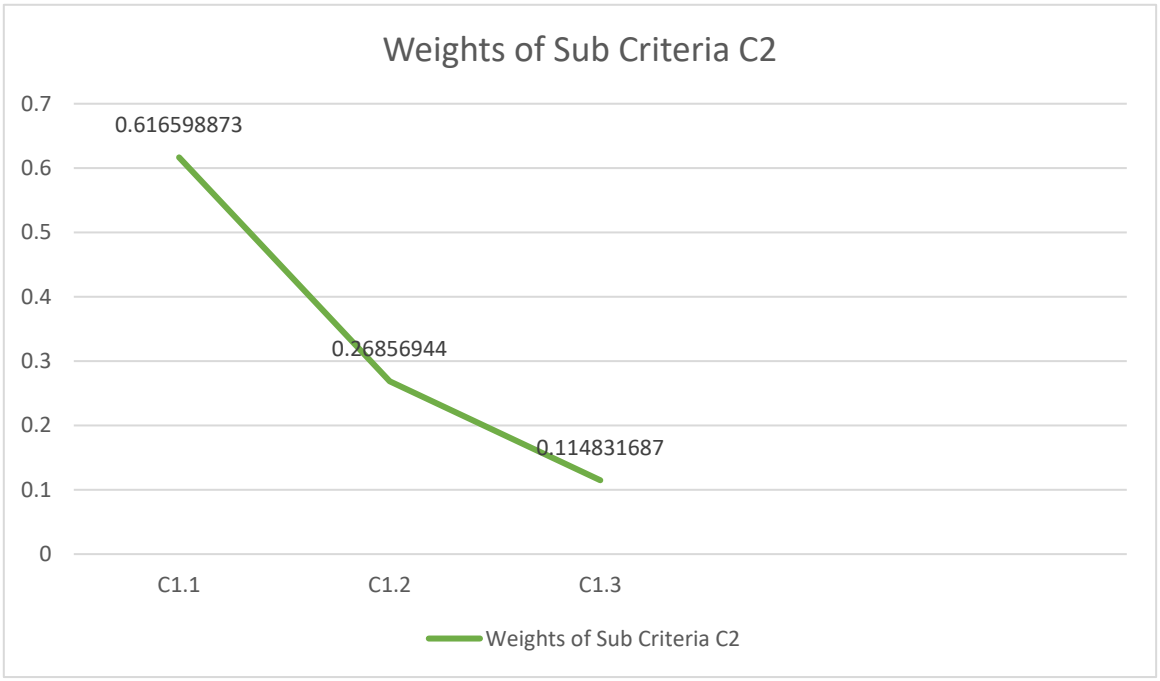

Fig 3. Weights of sub criteria C2.

Then compute the weights of C3: User representation. C2: contain three sub-criteria. C3.1: semantic network C3.2: keyword profile, C3.3: concept profile. First, build a three comparison matrix in Table 20-22. Then combined pairwise comparison matrix into Table 23. Then normalize the matrix into Table 24. Then

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compute the weights of sub-criteria in Table 25. Profile enhancement is the highest weight, and temporal dynamic is the lowest weight. Fig 4. Present the weights of sub-criteria.

Table 20. Pairwise comparison matrix for five main criteria by first decision makers.

	$C_{3.1}$	$C_{3.2}$	$C_{3.3}$
$C_{3.1}$	1	4	6
$C_{3.2}$	0.25	1	4
$C_{3.3}$	0.166667	0.25	1

Table 21. Pairwise comparison matrix for five main criteria by second decision makers.

	$C_{3.1}$	$C_{3.2}$	$C_{3.3}$
$C_{3.1}$	1	2	4
$C_{3.2}$	0.5	1	6
$C_{3.3}$	0.25	0.166667	1

Table 22. Pairwise comparison matrix for five main criteria by third decision makers.

	$C_{3.1}$	$C_{3.2}$	$C_{3.3}$
$C_{3.1}$	1	2	2.3
$C_{3.2}$	0.5	1	4
$C_{3.3}$	0.434783	0.25	1

Table 23. Combined matrix for five main criteria.

	$C_{2.1}$	$C_{2.2}$	$C_{2.3}$
$C_{2.1}$	1	2.666667	4.1
$C_{2.2}$	0.416667	1	4.666667
$C_{2.3}$	0.283816	0.222222	1

Table 24. Normalized Combined matrix for five main criteria.

	$C_{3.1}$	$C_{3.2}$	$C_{3.3}$
$C_{3.1}$	0.588068	0.685714	0.419795
$C_{3.2}$	0.245028	0.257143	0.477816
$C_{3.3}$	0.166903	0.057143	0.102389

Table 25. Weights.

	Weights of Sub criteria
$C_{3.1}$	0.564526
$C_{3.2}$	0.326662
$C_{3.3}$	0.108812

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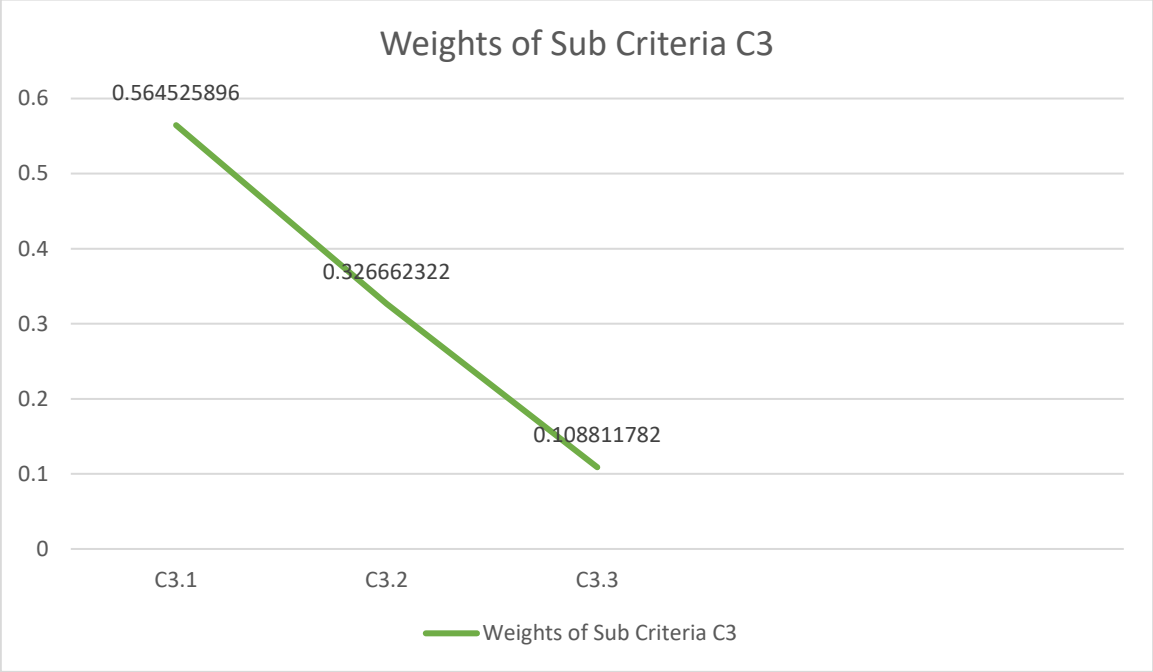

Fig 4. Weights of sub criteria C3.

Then compute the weights of C4: User representation. C4: contain three sub-criteria. C4.1: profile interests C4.2: profile presentation, C4.3: opportunities of users. First, build a three comparison matrix in Table 26-28. Then combined pairwise comparison matrix into Table 29. Then normalize the matrix into Table 30. Then compute the weights of sub-criteria in Table 31. Profile interests are the highest weight, and opportunities of the user is the lowest weight. Fig 5. Present the weights of sub-criteria.

Table 26. Pairwise comparison matrix for five main criteria by first decision makers.

	$C_{4.1}$	$C_{4.2}$	$C_{4.3}$
$C_{4.1}$	1	2	2.3
$C_{4.2}$	0.5	1	2
$C_{4.3}$	0.434783	0.5	1

Table 27. Pairwise comparison matrix for five main criteria by second decision makers.

	$C_{4.1}$	$C_{4.2}$	$C_{4.3}$
$C_{4.1}$	1	4	2
$C_{4.2}$	0.25	1	6
$C_{4.3}$	0.5	0.166667	1

Table 28. Pairwise comparison matrix for five main criteria by third decision makers.

	$C_{4.1}$	$C_{4.2}$	$C_{4.3}$
$C_{4.1}$	1	6	2
$C_{4.2}$	0.166667	1	2.3
$C_{4.3}$	0.5	0.434783	1

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Table 29. Combined matrix for five main criteria.

	$C_{4.1}$	$C_{4.2}$	$C_{4.3}$
$C_{4.1}$	1	4	2.1
$C_{4.2}$	0.305556	1	3.433333
$C_{4.3}$	0.478261	0.36715	1

Table 30. Normalized Combined matrix for five main criteria.

	$C_{4.1}$	$C_{4.2}$	$C_{4.3}$
$C_{4.1}$	0.560596	0.745275	0.321429
$C_{4.2}$	0.171293	0.186319	0.52551
$C_{4.3}$	0.268111	0.068407	0.153061

Table 31. Weights.

	Weights of Sub criteria
$C_{4.1}$	0.542433
$C_{4.2}$	0.294374
$C_{4.3}$	0.163193

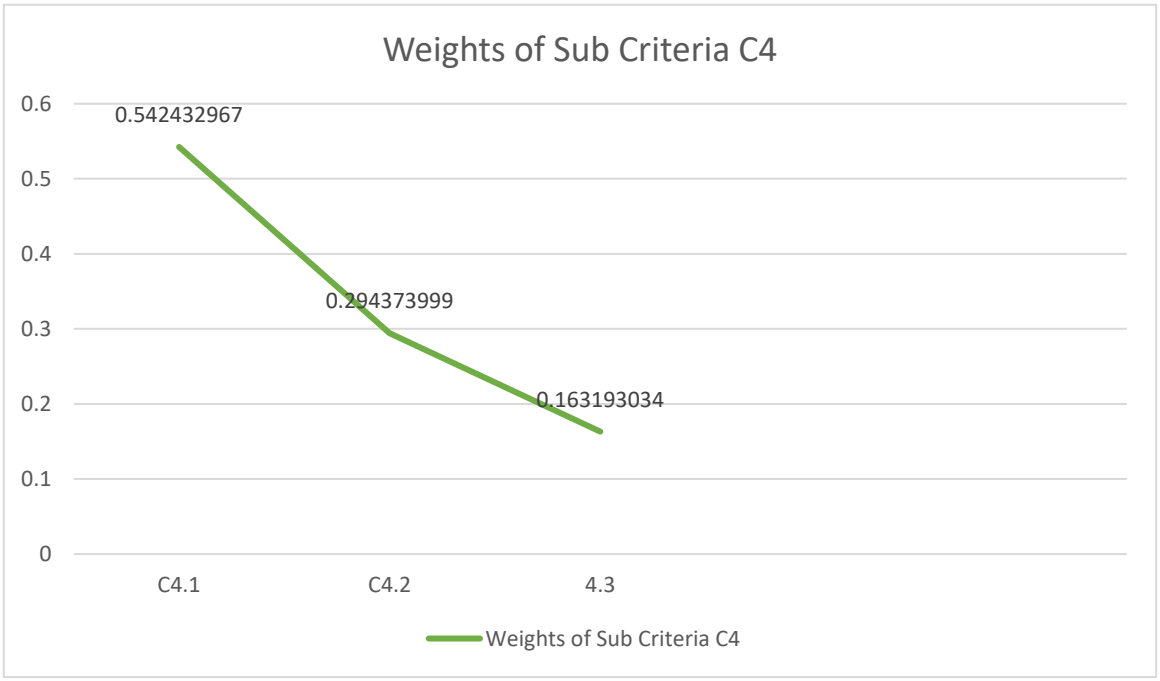

Fig 5. Weights of sub criteria C4.

Then compute the weights of C5: search engine. C5: contain three sub-criteria. C5.1: Simple C5.2: Time, C5.3: Cost. First, build a three comparison matrix in Table 32-34. Then combined pairwise comparison matrix into Table 35. Then normalize the matrix into Table 36. Then compute the weights of sub-criteria in Table 37. Simple is the highest weight, and the cost is the lowest weight. Fig 6. Present the weights of sub-criteria.

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Table 32. Pairwise comparison matrix for five main criteria by first decision makers.

	$C_{5.1}$	$C_{5.2}$	$C_{5.3}$
$C_{5.1}$	1	4	6
$C_{5.2}$	0.25	1	2.3
$C_{5.3}$	0.166667	0.434783	1

Table 33. Pairwise comparison matrix for five main criteria by second decision makers.

	$C_{5.1}$	$C_{5.2}$	$C_{5.3}$
$C_{5.1}$	1	2.3	4
$C_{5.2}$	0.434783	1	4
$C_{5.3}$	0.25	0.25	1

Table 34. Pairwise comparison matrix for five main criteria by third decision makers.

	$C_{5.1}$	$C_{5.2}$	$C_{5.3}$
$C_{5.1}$	1	6	2.3
$C_{5.2}$	0.166667	1	2
$C_{5.3}$	0.434783	0.5	1

Table 29. Combined matrix for five main criteria.

	$C_{5.1}$	$C_{5.2}$	$C_{5.3}$
$C_{5.1}$	1	4.1	4.1
$C_{5.2}$	0.283816	1	2.766667
$C_{5.3}$	0.283816	0.394928	1

Table 30. Normalized Combined matrix for five main criteria.

	$C_{5.1}$	$C_{5.2}$	$C_{5.3}$
$C_{5.1}$	0.637904	0.746143	0.521186
$C_{5.2}$	0.181048	0.181986	0.351695
$C_{5.3}$	0.181048	0.071871	0.127119

Table 31. Weights.

	Weights of Sub criteria
$C_{5.1}$	0.635078
$C_{5.2}$	0.238243
$C_{5.3}$	0.126679

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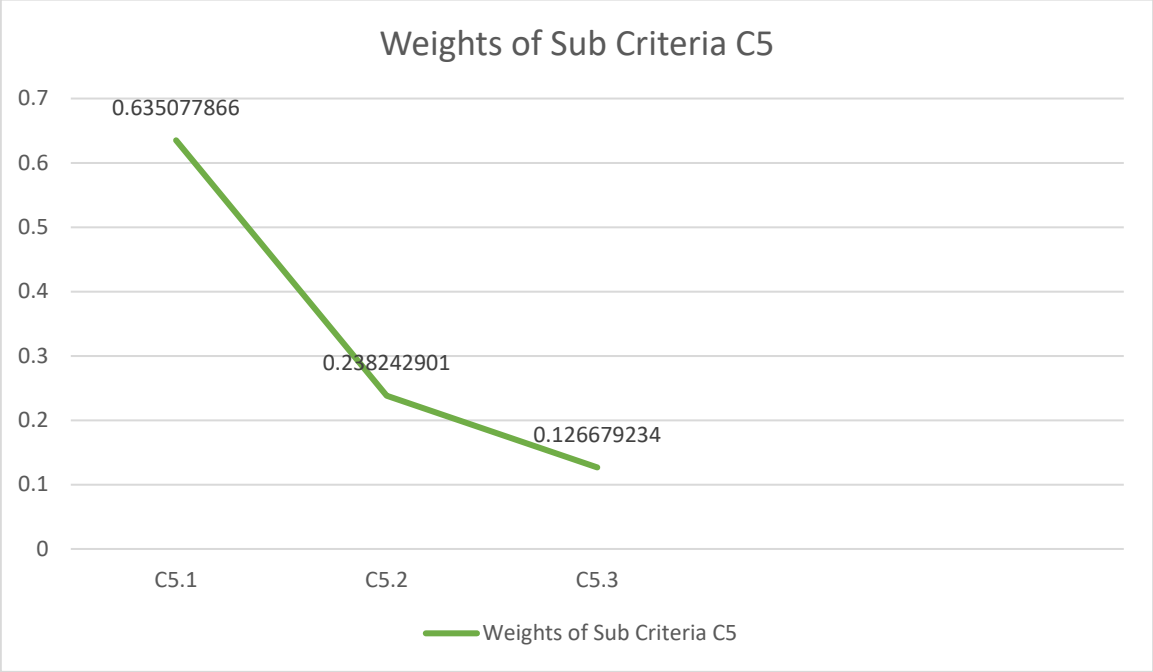

Fig 6. Weights of sub criteria C5.

4. Conclusions

This work uses an integrated DEMATEL MCDM method udder neutrosophic environment for network user intersects mining method cluster algorithm. We use five main criteria and sixteen sun criteria to show the importance of criteria in user interests.

The future study from this paper using another MCDM method under a neutrosophic environment.

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