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Application of Fuzzy - AHP - Topsis Model Integration to Select Green C2C Websites in Online Shopping

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Abstract:
In today's digital age, online shopping has become an indispensable part of daily life. The strong development of e-commerce platforms helps consumers easily search and choose products from around the world with just a few clicks. Making purchasing decisions is not simple when buyers have to consider many factors such as price, quality, brand and many other factors. To support smart consumers in shopping, the study applied the Fuzzy - AHP - Topsis integrated model to evaluate purchasing criteria on 4 popular C2C websites: Shopee, Tiki, Lazada and Sendo.

Keywords: Online shopping choice, online shopping, C2C website, fuzzy set theory, Fuzzy - AHP model, TOPSIS model, C2C e-commerce transaction model.

1. Introduce

Online shopping through C2C websites has become a popular trend in the digital age. However, consumers faced with choosing between thousands of products with uncertain reliability often have difficulty making the appropriate decision. Factors such as price, quality and many other criteria make the process of evaluating and choosing between products complicated. To help consumers more easily choose optimal products, the study applied the Fuzzy - AHP - TOPSIS integrated model to support consumers in optimizing shopping decisions on C2C websites.

2. Theoretical basis of research

Fuzzy Logic theory (fuzzy theory) was introduced by the Azerbaijani-American mathematician, Professor Lotfi A. Zadeh, in 1965. Up to now, fuzzy logic theory has developed very strongly and is applied in many fields. many areas of life. The AHP method proposed by Satty in 1977 is a widely used analytical tool in researching and solving complex multi-criteria decision problems and providing flexibility in qualitative and quantitative data analysis. quantity. TOPSIS is another multi-criteria decision-making method developed to rank alternatives based on their similarity to the ideal solution. The idea of this algorithm is built on the crisp values set, based on the positive ideal solution (PIS-positive ideal solution) and negative ideal solution (NIS-negative ideal solution). The research process is as shown in Table 1.

3. Research results

Based on the customer survey results and expert survey opinions, we have Table 2.

To perform pairwise comparisons between fuzzy parameters will be used (Table 3).

The results of comparing pairs of criteria are shown in tables 4 and 5.

The results of determining the weight of the criteria are shown in Table 6.

The websites selected for evaluation are Shopee, Lazada, Sendo, and Tiki, which will be denoted as W1, W2, W3, W4, respectively. The results of building the standardized matrix are as shown in Table 7.

Determine PIS, NIS, selection distance and CCi with results as shown in Table 8.

The final results in table 9 show that the closeness value of option W1 is the highest, indicating that this option is closest to the positive ideal solution. Therefore, the Shopee website is a more advantageous C2C online shopping option than Tikki, Lazada, and Sendo websites.

Table 1. Research protocol

Step 1: Create a hierarchical structure diagram	Information base
Step 2: Choose criteria for evaluating B2C websites	
Step 3: Survey customers and experts	
Step 4: Set up the pair comparison matrix	FUZZY - AHP
Step 4: Determine the weight of each criterion	
Step 6: Defuzzify the weights	
Step 7: Set up the decision standard matrix	TOPSIS
Step 8: Determine the normalization matrix	
Step 9: Calculate PIS and NIS index	
Step 10: Determine priority ranking order	
Step 11: Select C2C website	

Table 2. Table of criteria for evaluating C2C online shopping websites

No.	Criteria code	Criterion name
1	TC1	Green prices
2	TC2	Green product quality
3	TC3	Green brand
4	TC4	Green processing and delivery times
5	TC5	Green after-sale service
6	TC6	Green payment
7	TC7	Green product catalog
8	TC8	Green web interface
9	TC9	Green promotion
10	TC10	Green communication

Table 3. Table of criteria evaluation levels according to the triangular Fuzzy coefficient

Language variation	Language variable code	Corresponding triangular fuzzy numbers	Inverse triangular fuzzy numbers
Equally important (BN)	1	(1, 1, 3)	(1/3, 1/1, 1/1)
More important (TH)	3	(1, 3, 5)	(1/5, 1/3, 1/1)
More important (NH)	5	(3, 5, 7)	(1/7, 1/5, 1/3)
Very important (RT)	7	(5, 7, 9)	(1/9, 1/7, 1/5)
Extremely important (CT)	9	(7, 9, 9)	(1/9, 1/9, 1/7)

Table 4. Evaluation matrix comparing pairs of criteria TC1 - TC5

Matrix	TC1	TC2	TC3	TC4	TC5
TC1	(1, 1, 1)	(1, 7/3, 13/3)	(11/3, 17/3, 23/3)	(17/3, 23/3, 9)	(11/3, 17/3, 23/3)
TC2	(3/13, 3/7, 1)	(1, 1, 1)	(19/3, 25/3, 9)	(17/3, 23/3, 9)	(13/3, 19/3, 25/3)
TC3	(3/23, 3/17, 3/11)	(1/9, 3/25, 3/19)	(1, 1, 1)	(17/3, 23/3, 9)	(13/3, 19/3, 25/3)

TC4	(1/9, 3/23, 3/17)	(1/9, 3/23, 3/17)	(1/9, 3/23, 3/17)	(1, 1, 1)	(11/3, 17/3, 23/3)
TC5	(3/23, 3/17, 3/11)	(3/25, 3/19, 3/13)	(3/25, 3/19, 3/13)	(3/23, 3/17, 3/11)	(1, 1, 1)
TC6	(1/9, 3/23, 3/17)	(1/9, 3/25, 3/19)	(3/11, 3/5, 1)	(3/21, 1/5, 3/11)	(3/13, 3/7, 1)
TC7	(3/25, 3/19, 3/13)	(3/25, 3/23, 3/17)	(3/11, 3/5, 1)	(3/25, 3/19, 3/13)	(3/13, 3/7, 1)
TC8	(1/9, 3/25, 3/19)	(3/19, 3/13, 3/7)	(3/17, 3/11, 3/5)	(1/9, 3/25, 3/19)	(1/9, 3/25, 3/19)
TC9	(1/5, 1/3, 3/7)	(3/17, 3/13, 3/7)	(1/5, 1/3, 3/5)	(1/5, 1/3, 3/7)	(3/19, 3/13,3/7)
TC10	(3/17, 3/13, 3/5)	(3/19, 3/13, 3/7)	(3/11, 3/5, 1)	(3/17, 3/11, 3/5)	(3/19, 3/13, 3/7)

Table 5. Evaluation matrix comparing pairs of criteria TC6 - TC10

Matrix	TC6	TC7	TC8	TC9	TC10
TC1	(17/3, 23/3, 9)	(13/3, 19/3, 25/3)	(19/3, 25/3, 9)	(7/3, 3, 5)	(5/3, 11/3, 17/3)
TC2	(19/3, 25/3, 9)	(17/3, 23/3, 25/3)	(7/3, 13/3, 19/3)	(7/3, 11/3, 17/3)	(7/3, 13/3, 19/3)
TC3	(1, 5/3, 11/3)	(1, 5/3, 11/3)	(5/3, 11/3, 17/3)	(5/3, 3, 5)	(1, 5/3, 11/3)
TC4	(11/3, 5, 7)	(13/3, 19/3, 25/3)	(19/3, 25/3, 9)	(7/3, 3, 5)	(5/3, 11/3, 17/3)
TC5	(1, 7/3, 13/3)	(1, 7/3, 13/3)	(19/3, 25/3, 9)	(7/3, 13/3, 19/3)	(7/3, 13/3, 19/3)
TC6	(1, 1, 1)	(13/3, 19/3, 23/3)	(13/3, 19/3, 23/3)	(1, 5/3, 11/3)	(1, 5/3, 11/3)
TC7	(3/23, 3/19, 3/13)	(1, 1, 1)	(1, 7/3, 13/3)	(1, 7/3, 13/3)	(1, 7/3, 13/3)
TC8	(3/23, 3/19, 3/13)	(3/13, 3/7, 1)	(1, 1, 1)	(1, 5/3, 11/3)	(5/3, 11/3, 17/3)
TC9	(3/11, 3/5, 1)	(3/13, 3/7, 1)	(3/11, 3/5, 1)	(1, 1, 1)	(7/3,13/3, 19/3)
TC10	(3/11, 3/5, 1)	(3/13, 3/7, 1)	(3/17, 3/11, 3/5)	(3/19, 3/13, 3/7)	(1, 1, 1)

Table 6. Table of weighted values of criteria

Coefficient $\tilde{r}_j$	Value	Weight $\widetilde{w}_j$	Value obtained	Weight $\overline{w}_j$	Value	Weight w_j	Value
$\tilde{r}_1$	(2.926, 4.372, 5.810)	$\widetilde{w}_1$	(0.142, 0.298, 0.585)	$\overline{w}_1$	0.341	w_1	0.291
$\tilde{r}_2$	(2.638, 3.874, 5.082)	$\widetilde{w}_2$	(0.128, 0.264, 0.512)	$\overline{w}_2$	0.301	w_2	0.258
$\tilde{r}_3$	(0.998, 1.485,	$\widetilde{w}_3$	(0.048, 0.101,	$\overline{w}_3$	0.127	w_3	0.109

	2.319)		0.233)				
$\tilde{r}_4$	(1.070, 1.432, 1.904)	$\widetilde{w}_4$	(0.051, 0.097, 0.191)	$\overline{w}_4$	0.113	w_4	0.096
$\tilde{r}_5$	(0.620, 0.959, 1.389)	$\widetilde{w}_5$	(0.029, 0.065, 0.139)	$\overline{w}_5$	0.077	w_5	0.065
$\tilde{r}_6$	(0.539, 0.785, 1.196)	$\widetilde{w}_6$	(0.026, 0.053, 0.120)	$\overline{w}_6$	0.066	w_6	0.056
$\tilde{r}_7$	(0.327, 0.527, 0.840)	$\widetilde{w}_7$	(0.015, 0.035, 0.084)	$\overline{w}_7$	0.044	w_7	0.038
$\tilde{r}_8$	(0.268, 0.367, 0.586)	$\widetilde{w}_8$	(0.013, 0.025, 0.059)	$\overline{w}_8$	0.022	w_8	0.019
$\tilde{r}_9$	(0.312, 0.515, 0.814)	$\widetilde{w}_9$	(0.015, 0.035, 0.082)	$\overline{w}_9$	0.044	w_9	0.038
$\tilde{r}_{10}$	(0.227, 0.355, 0.665)	$\widetilde{w}_{10}$	(0.011, 0.024, 0.067)	$\overline{w}_{10}$	0.034	w_{10}	0.030

Table 7. Decision matrix according to criteria

Criteria	Decision matrix				Normalized matrix				MT normalizes the weights			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
TC1	8.33	5.00	5.67	9.00	0.578	0.347	0.393	0.624	0.168	0.100	0.114	0.181
TC2	9.00	4.33	4.33	9.00	0.637	0.306	0.306	0.637	0.164	0.078	0.078	0.164
TC3	7.67	8.33	7.00	9.00	0.477	0.518	0.435	0.560	0.051	0.056	0.047	0.061
TC4	7.67	5.67	7.67	8.33	0.518	0.382	0.518	0.562	0.049	0.036	0.049	0.053
TC5	8.33	5.67	5.67	8.33	0.584	0.397	0.397	0.584	0.037	0.025	0.025	0.037
TC6	9.00	7.00	6.33	7.67	0.594	0.462	0.418	0.506	0.033	0.025	0.023	0.028
TC7	7.00	8.33	9.00	7.67	0.435	0.518	0.560	0.477	0.016	0.019	0.021	0.018
TC8	7.67	5.00	6.33	7.67	0.567	0.369	0.468	0.567	0.010	0.007	0.008	0.010
TC9	7.67	4.33	6.33	5.67	0.626	0.353	0.517	0.463	0.023	0.013	0.019	0.017
TC10	5.67	3.67	3.67	5.67	0.593	0.384	0.384	0.593	0.017	0.011	0.011	0.017

Table 8. PIS and NIS table for each criterion

Criteria	A^+	A^-
TC1	0.181	0.100
TC2	0.164	0.078
TC3	0.061	0.047
TC4	0.053	0.036
TC5	0.037	0.025
TC6	0.033	0.023
TC7	0.021	0.016
TC8	0.010	0.007
TC9	0.023	0.013
TC10	0.017	0.011

Table 9. Table of distance between options and closeness index

Distance	Choice plan			
	W1	W2	W3	W4

d_i^+	0.070	0.088	0.090	0.083
d_i^-	0.088	0.070	0.054	0.089
$d_i^+ + d_i^-$	0.158	0.158	0.144	0.172
CC_i	0.556	0.443	0.375	0.517
Rating	1	3	4	2

The combined model Fuzzy - AHP - TOPSIS provides a comprehensive method to evaluate rankings and prioritize online shopping on C2C websites according to appropriate criteria.

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