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Evaluation Strategies of International Business Administration in the E-Commerce Sector Using Single-Valued Neutrosophic Sets

Ather Abdulrahman Ageeli
Management Department, Applied College, Jazan University, Jazan, KSA
Email: atherageeli@jazanu.edu.sa

Abstract
In today's digitally connected and globally interconnected corporate world, the assessment of International Corporate Administration in E-commerce is of the utmost importance. To help with the evaluation of such a program, this paper summarizes important topics. The evaluation covers a wide range of topics, such as strategies for entering and selecting markets, digital marketing for acquiring customers, logistics and supply chain management, payment, and security systems, customer experience and retention, data analytics for measuring performance, communication across cultures, and continuous learning. When considering an International Business Administration program in E-commerce, prospective students should take these factors into account. This will help them make informed decisions and ensure that they gain the knowledge and skills needed to succeed in the complex world of international e-commerce and make a positive impact on global businesses. So, we proposed a single-valued neutrosophic framework for dealing with uncertain information in the evaluation process. We used multi-criteria decision-making methods named the AHP and WSM methods. The AHP method is used to compute the weights of criteria. The WSM method is used to rank the alternatives. We used 15 criteria and 10 strategies in this study. We performed a sensitivity analysis to show the stability of the results.

Keywords: Single Valued Neutrosophic Sets; International Business Administration; E-Commerce; Strategies; AHP Method; WSM Method.

1. Introduction

The ever-changing subject of international business administration in e-commerce integrates the tenets of traditional international company management with the complexities of online trade. Companies are looking beyond local markets to take advantage of the enormous opportunities presented by global e-commerce as a result of the world's growing interconnection and digitization. Because of this, there is a need for experts in the field of e-commerce who also have a solid grasp of global business tactics[1,2].

Students majoring in International Business Administration with a concentration in E-commerce learn to deal with the challenges of doing business online on a worldwide basis. Digital marketing tactics, supply chain management, payment and security systems, analytics, customer experience optimization, cross-border legal and regulatory issues, and market research and selection are all part of the extensive study that is required[3,4].

Professionals who can see possibilities in global markets, create solid plans for online sales, and deal with the inevitable problems that arise from doing business across borders are in great demand

in today's fast-paced, cutthroat business environment. If a company wants to expand, gain market share, and solidify its position on the international stage, it needs these experts[3,5].

International business administration with a focus on e-commerce provides students with a well-rounded education in both traditional company management and innovative approaches to online sales and marketing. Because of this, they will be prepared to take advantage of the possibilities and overcome the obstacles that come with international e-commerce[6,7].

Career opportunities in international business administration with a focus on electronic commerce are also quite promising. A wide variety of positions are available to graduates, such as executives in company development, supply chain management, digital marketing, e-commerce management, and worldwide market analysis. They have a lot of options for where to work, from software and logistics firms to consumer goods stores, or they may start their international e-commerce businesses[8-10].

People who are enthusiastic about integrating their knowledge of global business with the rapidly developing field of Internet commerce will find an ideal fit with the International Business Administration in E-commerce programed. As a result of their extensive training in e-commerce best practices and strong academic background in business administration, individuals working in this area are well-positioned to succeed in today's interconnected world[10,11]. The evolution of international business administration in E-Commerce is a multi-criteria decision-making model (MCDM)[12,13].

Uncertainty, imprecision, inconsistency, and vagueness are given a fresh perspective in Florantin Smarandache's neutrosophic sets, which build upon the intuitionistic fuzzy sets (IFSs) proposed by Atanassov. Smarandache described a neutrosophic set as having three elements—truth membership, indeterminacy membership, and falsity membership—and added the degree of indeterminacy/neutrality as a distinct, separate component of fuzzy sets. Neutrosophic sets may improve decision-making because the indeterminacy parameter allows for a more precise formulation of membership functions[14–17]. However, a neutrosophic set presents greater challenges in practical scientific and technical contexts[18-19].

To differentiate between absolute truth and relative truth, absolute falsity and relative falsehood in logic, absolute membership and relative membership, absolute non-membership, relative non-membership, and so on[20-26], neutrosophic logic is a great tool. The requirement that the total of a membership function's components for a given event not exceed 1 is not satisfied when neutrosophic sets are favored. The total may go as high as three if those parts are unrelated.

2. Related work

In this section, we introduce some related studies in the single-valued neutrosophic set with the AHP method and the WSM method. Naderi et al. [27] proposed an adaptive candidate rely set based on the SVN-AHP method. They used the AHP method to compute the criteria weights. They proposed a model for adaption in vehicular networks. Karasan et al. [28] proposed a decision-making model for the design of a car seat. They integrated the neutrosophic set with the AHP method. The neutrosophic AHP was used for computing the weights of customers' requirements.

Gulum et al. [29]proposed a neutrosophic framework for post-earthquake fire risk evaluation. They proposed a neutrosophic AHP and neutrosophic TOPSIS for this evaluation. The neutrosophic AHP was used to compute the weights of criteria for post-earthquake fire risk problems. Kavus et al. [30] proposed a three-level framework for assessing airline service quality. They proposed a neutrosophic framework for overcoming the uncertainty of information. They used the neutrosophic AHP in their evaluation. They used the neutrosophic AHP for computing the criteria weights and sub-criteria. Fatih Yiğit [31] proposed a decision-making model for human resource decisions. He used the neutrosophic set in his process. He has used the neutrosophic AHP method. The neutrosophic AHP method was used to compute the weights of the criteria.

3. Single Valued Neutrosophic Framework

In this section, we introduce the mathematical equation based on operations of the single values neutrosophic numbers (SVNNs) and we introduce the SVN-AHP and the SVN-WSM. The SVN-AHP method is used to compute the weights of criteria[32-33]. The SVN-WSM is used to rank the strategies of IBA in the E-Commerce field as shown in Figure 1.

3.1 Single Valued Neutrosophic Sets

In this part, we introduce some mathematical operations of SVNSs.

The SVNSs can be defined by three membership degrees such as truth, indeterminacy, and falsity degrees as:

$$NS = \{A_{NS}(x), B_{NS}(x), C_{NS}(x)\} \tag{1}$$

$$0 \leq A_{NS}(x) + B_{NS}(x) + C_{NS}(x) \leq 3 \tag{2}$$

Let $y_1 = \left(A_{NS_1}(x), B_{NS_1}(x), C_{NS_1}(x)\right)$ *and* $y_2 = \left(A_{NS_2}(x), B_{NS_2}(x), C_{NS_3}(x)\right)$ be two neutrosophic numbers and the operation can be computed as:

$$y_1 \cup y_2 = \left(\max\{A_{NS_1}(x), A_{NS_2}(x)\}, \min\{B_{NS_1}(x), B_{NS_2}(x)\}, \min\{C_{NS_1}(x), C_{NS_2}(x)\}\right) \tag{3}$$

$$y_1 \cap y_2 = \left(\min\{A_{NS_1}(x), A_{NS_2}(x)\}, \max\{B_{NS_1}(x), B_{NS_2}(x)\}, \max\{C_{NS_1}(x), C_{NS_2}(x)\}\right) \tag{4}$$

$$y_1^c = \left(C_{NS_1}(x), 1 - B_{NS_1}(x), A_{NS_1}(x)\right) \tag{5}$$

$$y_1 \oplus y_2 = \left(A_{NS_1}(x) + A_{NS_2}(x), A_{NS_1}(x)A_{NS_2}(x), B_{NS_1}(x)B_{NS_2}(x), C_{NS_1}(x)C_{NS_2}(x)\right) \tag{6}$$

$$y_1 \otimes y_2 = \left(A_{NS_1}(x)A_{NS_2}(x), B_{NS_1}(x) + B_{NS_2}(x) - B_{NS_1}(x)B_{NS_2}(x), C_{NS_1}(x) + C_{NS_2}(x) - C_{NS_1}(x)C_{NS_2}(x)\right) \tag{7}$$

Figure 1. The steps of the single-valued neutrosophic model.

3.2 SVN-AHP Method

In this part, we introduce the steps of the SVN-AHP method to compute the criteria weights.

Step 1. Determine the single-valued neutrosophic scale.

Step 2. Determine the goal, criteria, and alternatives.

Step 3. Build the pairwise comparison matrix

The pairwise comparison matrix is built based on the single-valued neutrosophic numbers. This matrix is changed to the crisp valued as:

$$X_{ij} = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nn} \end{bmatrix} \tag{8}$$

Step 4. Compute the normalized matrix

The normalized pairwise matrix is computed by dividing the value in the pairwise matrix into a sum of each column as:

$$R_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_j} \tag{9}$$

Where j refers to the number of criteria and $j = 1,2, \dots n$

Step 5. Compute the mean of every row to compute the weights of the criteria.

Step 6. Test the consistency ratio (CR)

$$CR = \frac{CI}{RI} \tag{10}$$

Where CI refers to the consistency index and RI refers to the random index.

3.3 SVN-WSM Method

In this part, we introduce the steps of the SVN-WSM. The weighted sum method is used to compute the weights of criteria. The steps of the SVN-WSM are introduced as:

Step 7. Build the decision matrix

$$Z_{ij} = \begin{bmatrix} z_{11} & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{m1} & \cdots & z_{mn} \end{bmatrix} \tag{11}$$

Step 8. Normalize the decision matrix

$$E_{ij} = \frac{z_{ij}}{\sum_{j=1}^{m} z_{ij}} \tag{12}$$

Step 9. Compute the weighted normalized decision matrix

$$WE_{ij} = w_j * z_{ij} \tag{13}$$

Then we rank the strategies of IBA based on the largest value in the sum of each row of the weighted normalized decision matrix.

Figure 2. The goal, criteria, and alternatives in this study.

4. Results

In this part, we introduce the results of the applied proposed model and we discuss it by the criteria weights of the rank of alternatives.

Step 1. We identify the scale of the SVNSs.

Step 2. We identify the set of criteria and alternatives to rank and analyze the strategies of IBA in the E-Commerce sector as shown in Figure 2.

Step 3. Build the pairwise comparison matrix between criteria by Eq. (8).

Step 4. Compute the normalized matrix by Eq. (9) see Table 1.

Table 1. The normalized pairwise comparison matrix.

	ECI_1	ECI_2	ECI_3	ECI_4	ECI_5	ECI_6	ECI_7	ECI_8	ECI_9	ECI_{10}	ECI_{11}	ECI_{12}	ECI_{13}	ECI_{14}	ECI_{15}
ECI_1	0.031359	0.084985	0.121548	0.068771	0.050175	0.057435	0.084985	0.059619	0.060191	0.049619	0.068771	0.059619	0.17598	0.042053	0.054948
ECI_2	0.007987	0.021646	0.041151	0.033874	0.173164	0.034249	0.041151	0.022477	0.047468	0.034249	0.041151	0.17598	0.042053	0.054948	0.072098
ECI_3	0.009287	0.018935	0.035997	0.03738	0.140615	0.287979	0.068436	0.056689	0.079994	0.041906	0.037303	0.042053	0.054948	0.072098	0.110991
ECI_4	0.016512	0.023139	0.034871	0.036211	0.141448	0.057295	0.042292	0.079409	0.068842	0.153435	0.068842	0.054948	0.072098	0.110991	0.063745
ECI_5	0.023702	0.00474	0.009708	0.009708	0.037923	0.10476	0.072098	0.060005	0.160692	0.083165	0.039299	0.072098	0.110991	0.063745	0.197265
ECI_6	0.015514	0.017957	0.003552	0.017957	0.010286	0.028414	0.054018	0.087158	0.054328	0.068965	0.231005	0.110991	0.063745	0.197265	0.084527
ECI_7	0.015031	0.021426	0.021426	0.034876	0.021426	0.021426	0.040733	0.064451	0.331164	0.077439	0.077439	0.063745	0.197265	0.084527	0.073257
ECI_8	0.026563	0.048631	0.032067	0.023028	0.031916	0.016463	0.031916	0.0505	0.05244	0.058995	0.136856	0.197265	0.084527	0.073257	0.063807
ECI_9	0.037697	0.032994	0.03256	0.038059	0.017076	0.037842	0.0089	0.069678	0.072355	0.074979	0.097121	0.084527	0.073257	0.063807	0.063654
ECI_{10}	0.044678	0.044678	0.060725	0.016683	0.032236	0.029125	0.037184	0.060513	0.068219	0.070693	0.134397	0.073257	0.063807	0.063654	0.021251
ECI_{11}	0.02802	0.032321	0.059296	0.032321	0.059296	0.007558	0.032321	0.022674	0.045778	0.032321	0.061447	0.063807	0.063654	0.021251	0.059409
ECI_{12}	0.033482	0.007829	0.054488	0.041948	0.033482	0.016296	0.040675	0.016296	0.054488	0.061427	0.061299	0.063654	0.021251	0.059409	0.04365
ECI_{13}	0.052711	0.01959	0.062756	0.035279	0.027061	0.01959	0.043464	0.030299	0.048893	0.053043	0.021251	0.021251	0.059409	0.04365	0.102369
ECI_{14}	0.039236	0.021909	0.056332	0.030944	0.021883	0.035474	0.082318	0.044963	0.082318	0.044963	0.038979	0.059409	0.04365	0.102369	0.04365
ECI_{15}	0.044009	0.017341	0.104522	0.115404	0.07869	0.030615	0.054533	0.102369	0.04365	0.102369	0.04963	0.04365	0.102369	0.04365	0.102369

ECI_{13}	0.049385	0.091718	0.047616	0.085202	0.116329	0.120397	0.077794	0.138356	0.122844	0.11063	0.240026	0.24865	0.08301	0.021883	0.063012
ECI_{14}	0.068321	0.084454	0.054624	0.10003	0.148138	0.068467	0.042298	0.096007	0.075135	0.134397	0.134751	0.091589	0.324258	0.085481	0.030615
ECI_{15}	0.085216	0.149279	0.041187	0.037524	0.057634	0.110991	0.089327	0.058995	0.198233	0.082585	0.148064	0.174396	0.157544	0.333909	0.11959

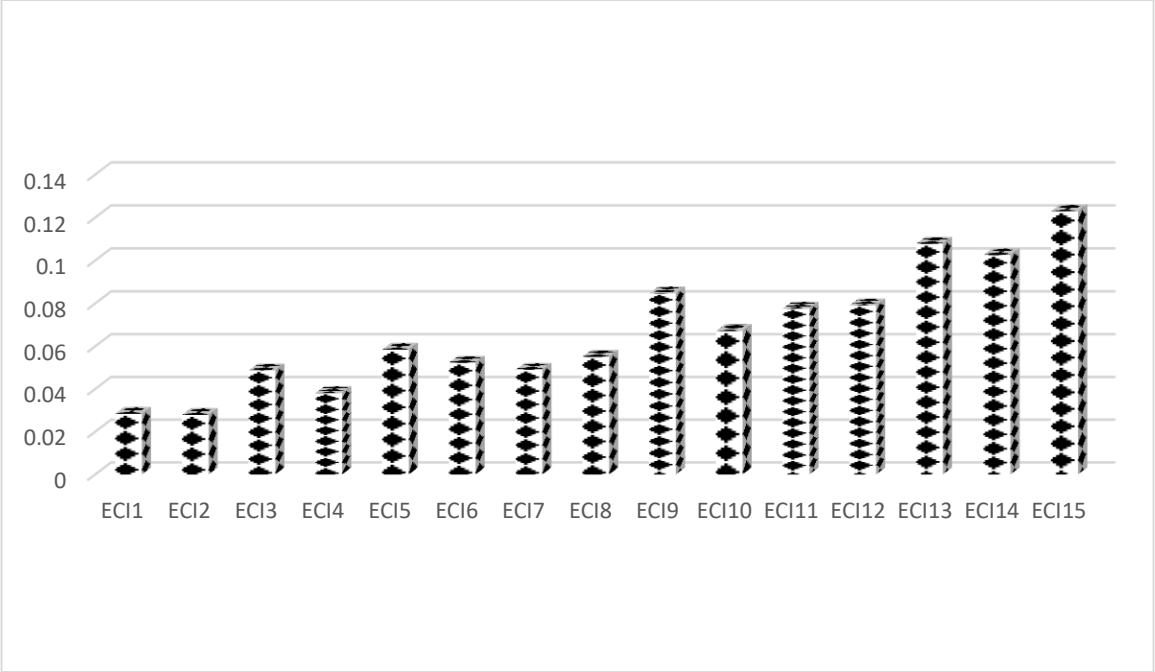

Figure 3. The criteria weights of international business administrations in E-Commerce.

Step 5. Compute the mean of every row to compute the weights of criteria as shown in Figure 3.

Step 6. Test the consistency ratio (CR). The CR is less than 0.1. This indicates the pairwise comparison is consistent.

3.3 SVN-WSM Method Results

Step 7. Build the decision matrix by Eq. (11).

Step 8. Normalize the decision matrix by Eq. (12) see Table 2.

Table 2. The normalized decision matrix.

	IES_1	IES_2	IES_3	IES_4	IES_5	IES_6	IES_7	IES_8	IES_9	IES_{10}
ECI_1	0.049486	0.133152	0.110296	0.132523	0.110296	0.146362	0.05368	0.132523	0.083456	0.048228
ECI_2	0.021481	0.16853	0.110898	0.113867	0.16853	0.044708	0.114914	0.091862	0.044708	0.120503
ECI_3	0.067414	0.156758	0.105913	0.151559	0.040611	0.160006	0.019981	0.156758	0.038337	0.102664
ECI_4	0.098034	0.118465	0.069167	0.184633	0.124651	0.061107	0.061107	0.098765	0.085475	0.098596
ECI_5	0.090487	0.101325	0.077757	0.113367	0.169448	0.090487	0.147256	0.109926	0.044039	0.055909
ECI_6	0.124679	0.08187	0.124679	0.103768	0.103768	0.128625	0.190373	0.052279	0.064312	0.025646
ECI_7	0.094468	0.1338	0.09393	0.113506	0.113506	0.058549	0.047593	0.113506	0.172953	0.05819
ECI_8	0.065943	0.100901	0.110912	0.083581	0.153338	0.099312	0.153338	0.083581	0.083581	0.065514
ECI_9	0.134551	0.134551	0.044757	0.134272	0.073341	0.134133	0.08812	0.097323	0.129671	0.029281
ECI_{10}	0.045985	0.154302	0.094485	0.153763	0.113526	0.113526	0.074546	0.117119	0.094485	0.038261
ECI_{11}	0.079724	0.11172	0.11172	0.170585	0.174121	0.045254	0.11172	0.131695	0.021743	0.041718
ECI_{12}	0.024169	0.113382	0.11587	0.110716	0.073218	0.110716	0.093478	0.171495	0.093478	0.093478
ECI_{13}	0.159848	0.074872	0.039092	0.039092	0.10916	0.108001	0.159848	0.141792	0.054	0.114295
ECI_{14}	0.127052	0.145689	0.101908	0.077799	0.093921	0.077799	0.126313	0.093921	0.077799	0.077799
ECI_{15}	0.137568	0.178192	0.120395	0.097129	0.04801	0.060013	0.076632	0.121688	0.116794	0.043579

Step 9. Compute the weighted normalized decision matrix by Eq. (13) see Table 3. The rank of strategies is shown in Figure 4.

Table 3. The weighted normalized decision matrix.

	ECI_1	ECI_2	ECI_3	ECI_4	ECI_5	ECI_6	ECI_7	ECI_8	ECI_9	ECI_{10}	ECI_{11}	ECI_{12}	ECI_{13}	ECI_{14}	ECI_{15}
IES_1	0.001405	0.000599	0.003285	0.003741	0.005289	0.006521	0.004629	0.003636	0.011399	0.003089	0.006191	0.001911	0.01723	0.013032	0.016916
IES_2	0.00378	0.004698	0.007639	0.004521	0.005922	0.004282	0.006556	0.005564	0.011399	0.010365	0.008675	0.008967	0.00807	0.014943	0.021911
IES_3	0.003131	0.003091	0.005161	0.00264	0.004545	0.006521	0.004603	0.006116	0.003792	0.006347	0.008675	0.009163	0.004214	0.010453	0.014804
IES_4	0.003762	0.003174	0.007386	0.007046	0.006626	0.005427	0.005562	0.004609	0.011376	0.010328	0.013246	0.008756	0.004214	0.00798	0.011943
IES_5	0.003131	0.004698	0.001979	0.004757	0.009903	0.005427	0.005562	0.008455	0.006214	0.007626	0.013521	0.00579	0.011766	0.009634	0.005904
IES_6	0.004155	0.001246	0.007798	0.002332	0.005289	0.006727	0.002869	0.005476	0.011364	0.007626	0.003514	0.008756	0.011641	0.00798	0.007379
IES_7	0.001524	0.003203	0.000974	0.002332	0.008606	0.009957	0.002332	0.008455	0.007466	0.005007	0.008675	0.007393	0.01723	0.012956	0.009423
IES_8	0.003762	0.002561	0.007639	0.003769	0.006425	0.002734	0.005562	0.004609	0.008245	0.007867	0.010226	0.013562	0.015284	0.009634	0.014963
IES_9	0.002369	0.001246	0.001868	0.003262	0.002574	0.003364	0.008475	0.004609	0.010986	0.006347	0.001688	0.007393	0.005821	0.00798	0.014362
IES_{10}	0.001369	0.003359	0.005003	0.003763	0.003268	0.001341	0.002851	0.003612	0.002481	0.00257	0.00324	0.007393	0.01232	0.00798	0.005359

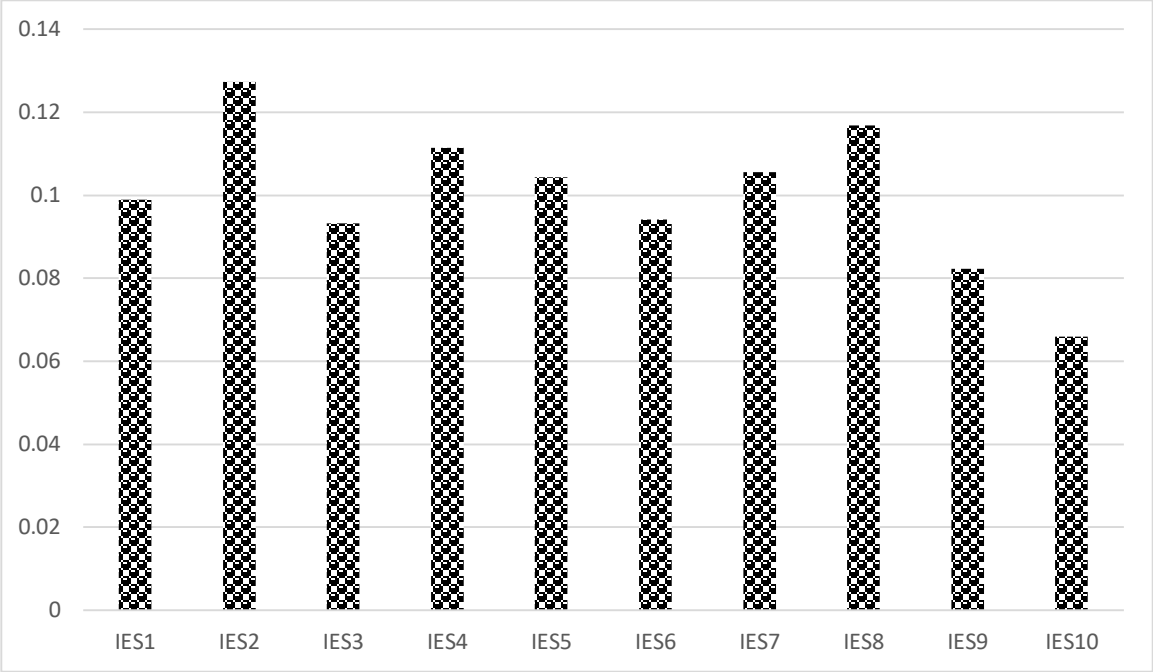

Figure 4. The ranking of strategies in international business administration in E-Commerce.

We applied the single-valued neutrosophic set framework for ranking and analyzing the strategies of international business administrations in E-Commerce. We applied to MCDM method named AHP and WSM method. We let the experts evaluate the criteria by building the pairwise comparison matrix between the criteria. We used 15 criteria and 10 alternatives in this study. The criteria and alternatives are collected based on the literature review and opinions of experts who have experience of more than 10 years in international business administration. The SVN-AHP is used to compute the criteria weights. The results show the ECI15 (Global Market Understanding) is the best criterion followed by ECI13 (Ethical and Sustainable E-commerce Practices) and ECI14 (Industry Reputation and Alumni Network) and the least weight is ECI2 (International Business and Legal Frameworks).

Then we applied the WSM method to the 15 criteria and 10 alternatives by building the decision matrix. Then we rank the strategies by the WSM method. The results show that IES2 (Market Selection and Entry Strategy) is the best strategy, followed by IES8 (Cultural Intelligence), and IES4 (Supply Chain and Logistics Management), and the lowest strategy is IES10 (Stay Updated with E-commerce Trends).

5. Sensitivity Analysis

We change the weights of the criteria and then rank the alternatives with the WSM method under different cases to show the stability of the results. We change the weights of criteria by 15 cases as shown in Figure 5. We put one criterion with 0.07 weight and all weights are equal. We show the rank of alternatives under different cases is stable as shown in Figure 5.

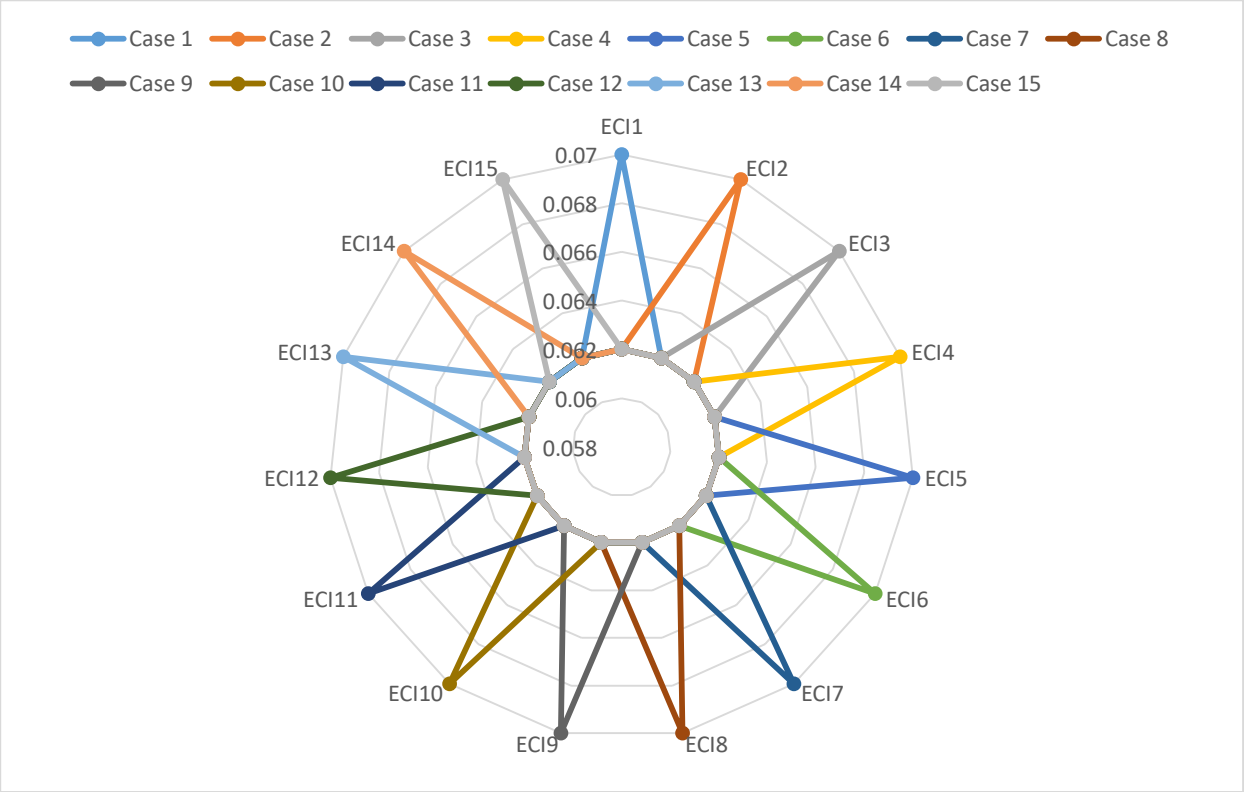

Figure 5. The 15 cases in criteria weights.

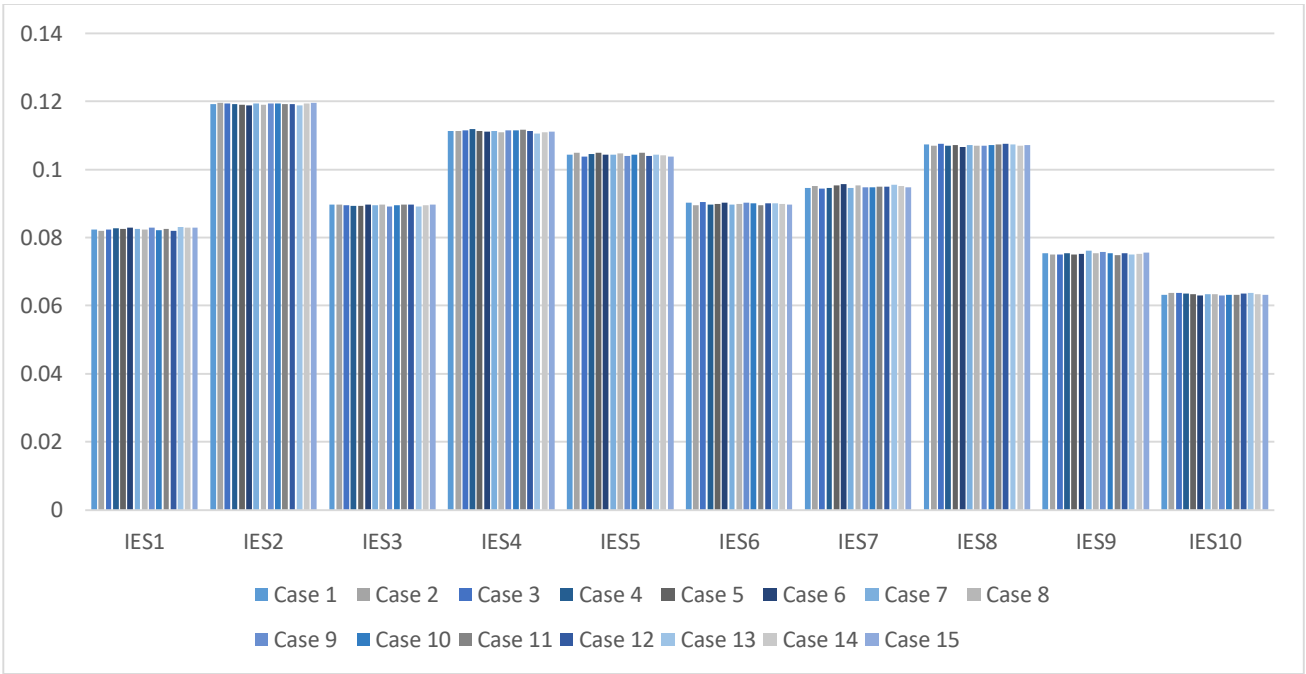

Figure 6. The rank of strategies under 15 cases.

6. Conclusions

The evaluation of International Business Administration in E-commerce is essential for individuals seeking a comprehensive education in the field. By considering market selection and entry strategies, digital marketing techniques, supply chain management, customer experience optimization, and other relevant factors, students can assess the program's suitability for their career goals. The integration of specialized e-commerce knowledge with international business principles equips graduates with the skills required to excel in the global e-commerce landscape. Moreover, the continuous learning mindset, cross-cultural understanding, and adaptation to emerging trends ensure that professionals remain competitive and contribute to the growth of businesses operating in the digital realm. Evaluating International Business Administration in E-commerce empowers students to make informed decisions and embark on a rewarding career path in this dynamic and rapidly evolving field.

We proposed a single-valued framework with the MCDM method to analyze the strategies in the international business administration in E-Commerce. The single-valued neutrosophic was used to deal with vague information. The two MCDM methods used in this study are the AHP and WSM methods. The SVN-AHP was used to compute the weights of the criteria. Then the SVN-WSM was used to rank the strategies. We used the 15 criteria and 10 strategies.

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