Evaluation of the Implementation of C2B, B2C, B2B, A2C and A2B Models of e-Commerce in Excellence Education System of Academic Institutions Using AHP and Fuzzy AHP

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Abstract: In this study, an innovative adoption of E-commerce models including C2B, B2C, A2C, A2B and B2B for excellence education systems regarding the thesis definition and examination is proposed. Prioritization of these models is performed by considering the imminent strength and potential of each model itemized by some criteria using AHP and fuzzy AHP. Results revealed that the first preferable model is C2B by which the most effective results can be obtained in academic systems. So, this model can be useful not only as a business model for the academic institutions and worldwide universities to manage their financial affairs and enhance their relations with industrial and commercial societies, but also as a preventing method for ill-managed projects or even as a prohibiting tool for plagiarism.

Key words: Analytic hierarchy process (AHP), e-commerce, excellence education, fuzzy AHP.

1. Introduction

International communications and data transfer by means of nowadays technologies have been flourished to virtual-reality level in recent decades [1], [2]. Business as a whole in all aspects and levels of its conception has been also developed by constructing electronic commerce (E-commerce) infrastructures. Academic institutions and universities are growing not only in quantity around the world but also in effectiveness and social fields of activities. In this respect, universities are developing their activities beyond routine students admission and education to industrial, social and commercial projects. Hence, it is obviously expected that there is an essential need in E-commerce infrastructure for such activities in any developing or developed country. Implementation of powerful features of E-commerce in academic institutions for theses and research management is expected to enhance applied theses in industrial and social affairs. Moreover, it could be also effective in prevention of misconducting theses, theses plagiarism or ineffective examinations. Specially for these reasons, the concept of electronic learning (E-learning) has been studied recently [3] and there has been many efforts to investigate new business models for higher education systems [4], [5]. This is the matter of the current study.

There has been proposed different E-commerce models among which, A2B, A2C, B2A, B2C, B2B, C2A, C2B, C2C, B2G, G2B, G2C, and G2G are the most known [6]-[8]. Among all of these models, only C2B, B2B, B2C, A2C and A2B can be applied for cooperation between universities and individual students. So, the aim of the current study is to investigate the importance level of these models and prioritize them according to some basic criteria. For this purpose, five academic systems were proposed as below. 1) C2B Model: students can define their own ideas based on an academic thesis and offer their idea to the electronic website of the academic institution which is like a business area collaborating with private sectors and investors. Any investor who was interested in any of the ideas provided by the students, he/she can purchase that idea and a financial work will be started in an academic education field. In this model, students educational expenditure may be supplied by the business sector of the university and the pivotal role of decision making as well as idea sharing is based on the students. 2) B2C Model: university is like a business area supporting by some private sectors which offer some academic educations and services to the students and willing applicants. However, in this model, students are like individual customers who will achieve only some material offered by the university policies and nothing more. In this model, students may be responsible to pay their own tuitions and they may be left alone after their graduation. Electronic business infrastructure in this model is limited to internal communications within the academic board. 3) B2B Model: university is supported by some private sectors which services some other private or public sectors or business. In this model, it is possible for both students and investors to define their own desirable thoughts and ideas as academic theses or projects and to share their ideas via electronic infrastructures. However, all of the students should only satisfy the interests of the target business area. 4) A2C Model: university is supported by government or state administrator which only services the students based on whole educational laws and policies defined by the education ministry. Students are like individual customers who can define their own ideas as their thesis or do some research based on their professors ideas. By the way in this model, university is not responsible for the future of the projects in business area. Electronic communications are also limited to internal academic board. 5) A2B Model: this model is similar to A2C with a little difference by which university can make collaborations with some private sectors electronically and there may be some opportunity for students to get involved in business area. However, there will not be any guaranty for the university to satisfy all of the students ideas and expectations. So, finding the most suitable model was performed by defining some criteria based on multi criteria decision making (MCDM) process like AHP.

Analytic Hierarchy Process (AHP) is a mathematical approach proposed by Saaty for ranking some choices based on some criteria [9]. In this method, alternative choices are compared and scored quantitatively pairwise. By implementation of some mathematical approach, it is possible to sort the choices by their importance as well as to evaluate the consistency of pairwise comparisons. This is why AHP is one of the most powerful methods for decision making (DM) analysis which is considered in this study. One knows that human DM process is so qualitative while in these methods, one should quantify the comparisons. Since Lotfi-Aliaskar Zadeh has introduced fuzzy logic, there has been applied fuzzy numbers in human decision making processes [10]. So, AHP is also modified for considering uncertainty in DM processes by using fuzzy numbers [11], [12].

Purpose of this research is to ask the question which of the E-commerce models with which strategy could be applied for academic systems. Importance of each model and prioritization among them was evaluated by AHP and fuzzy AHP.

2. Methodology of Models Prioritization

2.1. Criteria Selection

Potential internal and external opportunities expected to be satisfied by implementation of C2B, B2C, A2C, A2B and B2B models of E-commerce to academic systems were summarized in 8 criteria. These criteria were suggested to 16 experts to evaluate and select the most relevant ones from. Finally, 6 criteria were selected as presented in Table 1. Experts were again asked to evaluate these criteria quantitatively.

2.2. AHP Explanation

Table 1. Criteria and Alternatives Used for Pairwise Comparisons

Alternatives	Definition	Criteria	Definition
A_1	C2B	C_1	Potential for Correct Theses Management and Exact Examination
A_2	B2C	C_2	Potential for Data Protection and Plagiarism Prevention
A_3	B2B	C_3	Potential for Efficient Theses Definition for Social-Industrial Sections As Students' Future Job Opportunity
A_4	A2C	C_4	Potential for International Communications among Professors and Students
A_5	A2B	C_5	Potential for the Lowest Cost Education with the Highest Admission Capacity Reasonably Possible for All Applicants
		C_6	Potential for Finding the Students Talent and Leading Them for the Most Suitable Projects

Selected criteria as well as alternative models were ranked by the experts based on importance levels in AHP comparison table. For this purpose, each item was compared separately by the other items via a questionnaire. Evaluation of importance ranking from linguistic values to quantitative scale was made by formation of AHP pairwise comparison matrix (as matrix M in "(1)") with scales presented in Table 2. Academic experts were asked to rank these items. Then, all models were also compared pairwise by the experts' opinion based on each criterion.

$$M_{C(A)} = \begin{matrix} & \mathrm{C_1(A_1)} & \mathrm{C_2(A_2)} & \cdots & \mathrm{C_n(A_n)} \\ \mathrm{C_1(A_1)} & M_{11} & M_{12} & \cdots & M_{1n} \\ \mathrm{C_2(A_2)} & M_{21} & M_{22} & \cdots & M_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathrm{C_n(A_n)} & M_{n1} & M_{n2} & \cdots & M_{nn} \end{matrix}. \tag{1}$$

where subscripts C and A stand for comparison matrix for criteria and alternatives, respectively.

Table 2. Quantitative Scale for Importance Levels

Importance Level	Scale
Extremely Higher	9
Very Strongly Higher	7
Very Higher	5
Slightly Higher	3
Equally the Same	1
Slightly Lower	1/3
Very Lower	1/5
Very Strongly Lower	1/7
Extremely Lower	1/9

Then, consistency of each matrix for all experts' opinion was calculated by means of consistency index and consistency ratio defined by "(2)"and "(3)," respectively.

$$CR = \frac{\lambda_{\max} - n}{n - 1}. \tag{2}$$

$$CI = \frac{CR}{RI}. \tag{3}$$

in which $\lambda_{\max}$ is the maximum Eigen value of the matrix and n is the matrix size. RI is random index defined in Table 3.

Table 3. Random Index Values

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.46	1.49

In case of $CI < 0.10$, the corresponding matrix is considered as consistent. Otherwise, the corresponding matrix of is rejected.

Effective ranking score was calculated by geometric average of all elements of the consistent AHP matrices. Finally, resultant comparison AHP matrix (some matrix like "(1)" was normalized by calculating summation of each column to form matrix N as "(4)".

$$N = \begin{pmatrix} \frac{M_{11}}{\sum_{i=1}^{n} M_{i1}} & \frac{M_{12}}{\sum_{i=1}^{n} M_{i2}} & \cdots & \frac{M_{1n}}{\sum_{i=1}^{n} M_{in}} \\ \frac{M_{21}}{\sum_{i=1}^{n} M_{i1}} & \frac{M_{22}}{\sum_{i=1}^{n} M_{i2}} & \cdots & \frac{M_{2n}}{\sum_{i=1}^{n} M_{in}} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{M_{n1}}{\sum_{i=1}^{n} M_{in}} & \frac{M_{n2}}{\sum_{i=1}^{n} M_{i2}} & \cdots & \frac{M_{nn}}{\sum_{i=1}^{n} M_{in}} \end{pmatrix}. \tag{4}$$

Then, arithmetic average of each row was calculated as its weight factor. Thus, each row was ranked by considering the weight factors in matrix W.

$$W = \begin{pmatrix} \frac{\sum_{j=1}^{n} N_{1j}}{n} \\ \frac{\sum_{j=1}^{n} N_{2j}}{n} \\ \vdots \\ \frac{\sum_{j=1}^{n} N_{nj}}{n} \end{pmatrix}. \tag{5}$$

Finally, weight matrices for all alternatives based on each criterion and also the weight matrix of criteria comparisons among themselves, were mixed and multiplied together as the following equation.

$$R = \begin{pmatrix} \sum_{i=1}^{n} W_{ACi} W_{Ci} \\ \sum_{i=1}^{n} W_{ACi} W_{Ci} \\ \vdots \\ \sum_{i=1}^{n} W_{ACi} W_{Ci} \end{pmatrix}. \tag{6}$$

where W_{ACi} and W_{Ci} are weight matrices of all alternatives based on each criterion and based on the self-amongst comparisons, respectively.

Priority of each alternative in ranking matrix R is defined by the extent of the corresponding value in each row.

2.3. Fuzzy AHP Explanation

This method is fundamentally almost the same as routine AHP with a little difference in using fuzzy numbers instead of ordinary numbers. List of fuzzy numbers is presented in Table 4.

Table 4. Quantitative Fuzzy Scale for Importance Levels

Importance Level	Fuzzy Scale
Extremely Higher	$\tilde{9}$=(7,9,9)
Very Strongly Higher	$\tilde{7}$=(5,7,9)
Very Higher	$\tilde{5}$=(3,5,7)
Slightly Higher	$\tilde{3}$=(1,3,5)
Equally the Same	$\tilde{1}$=(1,1,1)
Slightly Lower	$\widetilde{1/3}=(1/5, 1/3, 1)$
Very Lower	$\widetilde{1/5}=(1/7, 1/5, 1/3)$
Very Strongly Lower	$\widetilde{1/7}=(1/9, 1/7, 1/5)$
Extremely Lower	$\widetilde{1/9}=(1/9, 1/9, 1/7)$

Fuzzy calculation rules by two fuzzy numbers; namely A and B, are also defined as relations in "(7)".

$$\begin{aligned} A &= (l_1, m_1, u_1) \\ B &= (l_2, m_2, u_2) \\ A \oplus B &= (l_1 + l_2, m_1 + m_2, u_1 + u_2) \\ A \otimes B &= (l_1.l_2, m_1.m_2, u_1.u_2) \\ A^{-1} &= (\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}) \end{aligned} \tag{7}$$

in which l, m and u are the lower, mean and upper limits of the fuzzy numbers in triangle form.

Considering all of these rules, fuzzy AHP calculations for summation of each row and column of the pairwise comparison matrix (similar to matrix M in "(3)") can be done almost the same as the routine AHP as below.

At first, synthetic matrix S was calculated as "(8)".

$$S = (\sum_{i=1}^{n}\sum_{j=1}^{n} M_{ij})^{-1} . \begin{pmatrix} \sum_{j=1}^{n} M_{1j} \\ \sum_{j=1}^{n} M_{2j} \\ \vdots \\ \sum_{j=1}^{n} M_{nj} \end{pmatrix} . \tag{8}$$

Then, weights matrix W was obtained by calculating the fuzzy degree by the following equation.

$$W = \begin{pmatrix} Min\{\deg(S_1, S_k)\} \\ Min\{\deg(S_2, S_k)\} \\ \vdots \\ Min\{\deg(S_n, S_k)\} \end{pmatrix} \Bigg| k = 1, 2, \ldots .n \quad . \tag{9}$$

in which fuzzy degree function is defined as below.

$$\deg(M_1 \geq M_2) = \begin{cases} 1 & m_1 \geq m_2 \\ 0 & u_1 \leq l_2 \\ \dfrac{u_1 - l_2}{u_1 - l_2 + m_2 - m_1} & \text{otherwise} \end{cases} \tag{10}$$

Finally, alternatives ranking was performed by considering the total weights yielded a matrix like "(6)" obtained by multiplication of criteria weights and each alternative.

3. Results and Discussion

3.1. AHP Calculations

Results revealed that priority of the criteria was in this order: C_2 (Data Protection), C_6 (Potential for Finding Talent), C_1 (Correct Management), C_3 (Efficient Projects), C_4 (International Communications) and C_5 (Opportunity for Low Cost Education) as shown below in "(11)".

$$\begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array}\!\!\begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 1 & 2.0098 & 0.9999 & 1.2037 & 1.5271 & 0.5271 \\ 0.4976 & 1 & 1.9467 & 2.6177 & 2.2332 & 0.8576 \\ 1.0001 & 0.5137 & 1 & 1.8764 & 1.1058 & 0.7512 \\ 0.8308 & 0.3820 & 0.5329 & 1 & 1.3440 & 1.0705 \\ 0.6548 & 0.4478 & 0.9043 & 0.7440 & 1 & 1.0705 \\ 1.8972 & 1.1660 & 1.3312 & 0.9341 & 0.9341 & 1 \end{pmatrix} \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.1701 & 0.3641 & 0.1489 & 0.1437 & 0.1875 & 0.0999 \\ 0.0846 & 0.1812 & 0.2899 & 0.3125 & 0.2742 & 0.1625 \\ 0.1701 & 0.0931 & 0.1489 & 0.2240 & 0.1358 & 0.1424 \\ 0.1413 & 0.0692 & 0.0794 & 0.1194 & 0.1650 & 0.2029 \\ 0.1114 & 0.0811 & 0.1347 & 0.0888 & 0.1228 & 0.2029 \\ 0.3226 & 0.2113 & 0.1982 & 0.1115 & 0.1147 & 0.1895 \end{pmatrix} \begin{array}{|c} weights \\ 0.1857 \\ 0.2175 \\ 0.1524 \\ 0.1295 \\ 0.1236 \\ 0.1913 \end{array} \tag{11}$$

$$\lambda_{max} = 6.4070, \ CI = 0.0814, \ CR = 0.0656$$

According to all of the criteria, top three alternatives were A_1 (C2B), A_3 (B2B) and A_5 (A2B). The first rank model was A_1 (C2B) based on criterion C_3 to C_6 (as shown in "(12)," "(13)," "(14)" and "(15)"). However based on criteria C_1 and C_2 (as shown in "(16)" and "(17)"), it was A_3 (B2B). Among the least important alternatives, i.e., A_2 (B2C) and A_4 (A2C), A_2 was superior than A_4 for all criteria except C_5.

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array}\!\!\begin{array}{c} \begin{array}{ccccc} A_1 & A_2 & A_3 & A_4 & A_5 \end{array} \\ \begin{pmatrix} 1 & 2.1293 & 1.1597 & 2.3546 & 1.2293 \\ 0.4696 & 1 & 0.5030 & 1.3097 & 0.8443 \\ 0.8623 & 1.9881 & 1 & 2.0205 & 1.5271 \\ 0.4247 & 0.7635 & 0.4949 & 1 & 0.4895 \\ 0.8135 & 1.1844 & 0.6548 & 2.0429 & 1 \end{pmatrix} \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.2801 & 0.3014 & 0.3042 & 0.2698 & 0.2415 \\ 0.1315 & 0.1415 & 0.1319 & 0.1501 & 0.1659 \\ 0.2415 & 0.2814 & 0.2623 & 0.2315 & 0.3000 \\ 0.1190 & 0.1081 & 0.1298 & 0.1146 & 0.0962 \\ 0.2278 & 0.1676 & 0.1718 & 0.2341 & 0.1965 \end{pmatrix} \begin{array}{|c} weights \\ 0.2794 \\ 0.1442 \\ 0.2633 \\ 0.1135 \\ 0.1996 \end{array} \tag{12}$$

$$\lambda_{max} = 5.0264, \ CI = 0.0066, \ CR = 0.0059$$

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 1 & 4.2590 & 1.4326 & 4.8123 & 3.6528 \\ A_2 & 0.2348 & 1 & 0.3644 & 1.3876 & 0.8177 \\ A_3 & 0.6980 & 2.7442 & 1 & 3.0198 & 1.9560 \\ A_4 & 0.2078 & 0.7207 & 0.3311 & 1 & 0.4999 \\ A_5 & 0.2738 & 1.2229 & 0.5112 & 2.0004 & 1 \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.4142 & 0.4282 & 0.3936 & 0.3938 & 0.4608 \\ 0.0972 & 0.1005 & 0.1001 & 0.1136 & 0.1032 \\ 0.2891 & 0.2759 & 0.2748 & 0.2471 & 0.2468 \\ 0.0861 & 0.0725 & 0.0910 & 0.0818 & 0.0631 \\ 0.1134 & 0.1229 & 0.1405 & 0.1637 & 0.1262 \end{pmatrix} \begin{array}{|c} weights \\ 0.4181 \\ 0.1029 \\ 0.2667 \\ 0.0789 \\ 0.1333 \end{array} \quad (13)$$

λ_{max} =5.0192, CI= 0.0048, CR= 0.0042

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 1 & 4.6587 & 2.1191 & 2.3056 & 1.9153 \\ A_2 & 0.2146 & 1 & 0.3027 & 0.376 & 0.3042 \\ A_3 & 0.4719 & 3.3036 & 1 & 1.9466 & 1.1472 \\ A_4 & 0.4337 & 2.6596 & 0.5137 & 1 & 0.6516 \\ A_5 & 0.5221 & 3.2873 & 0.8717 & 1.5347 & 1 \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.3784 & 0.3125 & 0.4408 & 0.3219 & 0.3817 \\ 0.0812 & 0.0671 & 0.0630 & 0.0525 & 0.0606 \\ 0.1786 & 0.2218 & 0.2080 & 0.2718 & 0.2286 \\ 0.1641 & 0.1784 & 0.1069 & 0.1396 & 0.1298 \\ 0.1976 & 0.2205 & 0.1813 & 0.2142 & 0.1993 \end{pmatrix} \begin{array}{|c} weights \\ 0.3671 \\ 0.0649 \\ 0.2217 \\ 0.1438 \\ 0.2026 \end{array}$$

λ_{max} =5.0428, CI= 0.0107, CR= 0.0095 (14)

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 1 & 2.5913 & 1.7519 & 3.3369 & 2.4311 \\ A_2 & 0.3859 & 1 & 0.5207 & 1.0158 & 1.2031 \\ A_3 & 0.5708 & 1.9205 & 1 & 2.3179 & 2.0961 \\ A_4 & 0.2997 & 0.9844 & 0.4314 & 1 & 0.6278 \\ A_5 & 0.4113 & 0.8312 & 0.4771 & 1.5928 & 1 \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.3748 & 0.3536 & 0.4190 & 0.3602 & 0.3304 \\ 0.1447 & 0.1365 & 0.1245 & 0.1096 & 0.1635 \\ 0.2140 & 0.2621 & 0.2392 & 0.2502 & 0.2849 \\ 0.1123 & 0.1344 & 0.1032 & 0.1080 & 0.0853 \\ 0.1542 & 0.1134 & 0.1141 & 0.1720 & 0.1359 \end{pmatrix} \begin{array}{|c} weights \\ 0.3676 \\ 0.1358 \\ 0.2501 \\ 0.1086 \\ 0.1379 \end{array} \quad (15)$$

λ_{max} =5.0396, CI= 0.0099, CR= 0.0089

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 1 & 1.4791 & 0.6113 & 1.3230 & 1.3660 \\ A_2 & 0.6761 & 1 & 0.4548 & 1.1653 & 0.8717 \\ A_3 & 1.6359 & 2.1988 & 1 & 2.8947 & 2.6883 \\ A_4 & 0.7559 & 0.8581 & 0.3455 & 1 & 0.4696 \\ A_5 & 0.7321 & 1.1472 & 0.3720 & 2.1295 & 1 \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.2083 & 0.2213 & 0.2196 & 0.1554 & 0.2136 \\ 0.1409 & 0.1496 & 0.1634 & 0.1369 & 0.1363 \\ 0.3408 & 0.3290 & 0.3593 & 0.3401 & 0.4203 \\ 0.1575 & 0.1284 & 0.1241 & 0.1175 & 0.0734 \\ 0.1525 & 0.1717 & 0.1336 & 0.2502 & 0.1564 \end{pmatrix} \begin{array}{|c} weights \\ 0.2036 \\ 0.1454 \\ 0.3579 \\ 0.1202 \\ 0.1729 \end{array} \quad (16)$$

λ_{max} =5.0664, CI= 0.0166, CR= 0.0148

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & 1 & 1.6179 & 0.7476 & 2.8640 & 2.1191 \\ A_2 & 0.6181 & 1 & 0.3223 & 1.2096 & 0.8138 \\ A_3 & 1.3376 & 3.1027 & 1 & 1.7697 & 1.4028 \\ A_4 & 0.3492 & 0.8267 & 0.5651 & 1 & 0.6871 \\ A_5 & 0.4719 & 1.2288 & 0.7129 & 1.4554 & 1 \end{array} \xrightarrow{normalized} \begin{pmatrix} 0.2648 & 0.2081 & 0.2233 & 0.3451 & 0.3518 \\ 0.1637 & 0.1286 & 0.0963 & 0.1458 & 0.1351 \\ 0.3542 & 0.3990 & 0.2987 & 0.2133 & 0.2329 \\ 0.0925 & 0.1063 & 0.1688 & 0.1205 & 0.1141 \\ 0.1249 & 0.1580 & 0.2129 & 0.1754 & 0.1660 \end{pmatrix} \begin{array}{|c} weights \\ 0.2786 \\ 0.1339 \\ 0.2996 \\ 0.1204 \\ 0.1675 \end{array} \quad (17)$$

λ_{max} =5.1020, CI= 0.0255, CR= 0.0228

The reason behind these findings can be interesting for the future of excellence education systems management around the world. B2B model of multilateral business-education system because of its completely interacting characteristics collaborating with private sectors is in need of being updated routinely to be able to fulfill the clients demands. So, it is obvious that in such an interacting system, correct management of the theses and desirable expectancy of data protection as well as plagiarism prohibition potentiality are of the highest value. In contrast, for the other models such as B2C, C2B, A2C and A2B, these factors are less important because one side of the business is either governmental administrator or private individuals who are not as much concerned with social expectancies as they are for their own themselves. Talent finding by which the best way of training can be handled, opportunity for low cost education which facilitates the students lifestyle, efficient projects and international communications which result in future job opportunities for the graduated students, are all more individualistic criteria than correct management and data protection. This is why C2B model which is the top most self-center model of education based on each students characteristics, was the most desirable model according to above mentioned individualistic criteria. This finding was also confirmed by another study comparing C2B with B2C concluding that C2B has higher efficiency [13].

Nowadays, data are of very significant value, especially for the electronic communications. Hence, it was such an obviously reasonable expectation that data protection was ranked as the most important criterion. At first one may think that based on global internet based communications in E-commerce area, international communications should be also among the top three criteria. However, results showed that this criterion was the second to last. It can be interpreted that globalization as one of the side effects of international communication is neither essential nor the most preferable. Instead, domestic developments in any society based on the efficient projects for that society beside data protection which implies some level of domestic security for some projects and talents finding and leading them into the correct positions are of higher importance and value. In this respect, educational institutions are expected to focus on their own societies interests more than they do for international communities even in electronic infrastructures based on internet. Therefore, it may imply that E-commerce activities or even electronic educations need considerable attention to develop domestic web servers and infrastructures. This is why a few researches are focused on investigation of disadvantages of globalization in educational systems or on finding alternative policies [14]-[17]. It also implies that brain-drain may be controlled for each society by focusing the academic strategies on talent findings and efficient projects in form of individualistic based models such as C2B. Because some studies have shown that the main reasons of students migrations are due to low economic growth and quality of the universities [18], [19]. So, such limitations are highly expected to be compromised by implementation of C2B model of business.

Another worthwhile result was rather low rank criterion of low cost education and also relatively lower rank governmental administrator involved models of education. It does not necessarily imply that academic institutions can increase their tuition fees without concern of dissatisfaction among students. Because B2C model by which free universities with considerable high tuition fees can be developed was ranked second to last and A2B model by which low costs of education by governmental support can be guaranteed, was ranked as the third choice. So, the reason why low cost education was ranked the less important criterion while C2B, B2B and A2B models were ranked as the most important models is behind the fact that in such models, investment of the academic theses and projects are funded by private sectors. So, it implies that experts found it so evident that low cost education is presumably supported by C2B and B2B models in such way that the other criteria may be considered more critical to evaluate the models from. Therefore by applying such models on higher education systems, entrepreneurship can be re-defined and shifted from the academic institutions to the students. In other words, in C2B and B2B models, not only there is no need of tuition increasing strategies by which a reduction of applicants is predicted in the literature [20], but also there will be a potential of entrepreneurship chance for the students to setup their own business.

Total ranking illustrated that the priority of the alternatives was as A_1 (C2B), A_3 (B2B), A_5 (A2B), A_2 (B2C) and A_4 (A2C), with total importance weight of 0.3108, 0.2815, 0.1676, 0.1254 and 0.1146, respectively.

One of the other interesting results worth considering was the fact that in all of the top three models, the target clients were business sectors. It means that the best educational systems have necessarily some effects on some business. Educational systems which cannot fulfill the real demands of the society in any aspect of a business, won't have considerable chance of success and desirability among their own students or alumni. It reveals that academic institutions have more responsibilities than individual educations for the students. They should collaborate with social affairs to be able to train interactive students for their societies or even, all of the world nations. As a confirmation to these interpretations, some studies have also shown that training the future experts in business, industry and society as a whole, need collective form of interactions and communications [21], [22].

3.2. Fuzzy AHP Calculations

Effective fuzzy AHP matrices based on the experts' opinion are shown in "(18)," "(19)," "(20)," "(21)," "(22)" and "(23)," for C_1 – C_6, respectively. Results showed that fuzzy AHP provided exactly the same priority for the alternatives as routine AHP. It reveals that both methods have no difference in whole evaluation of alternatives in MCDM process. The criteria of "data protection" and "potential of talents finding" were the most important factors in model selection process just the same as routine AHP. For the "data protection" criterion, B2B model was the best; while for the "talent finding" criterion, C2B model was the top choice. Prioritization among the criteria was also found the same order as routine AHP as shown in "(24)".

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array} \begin{array}{c} \begin{array}{ccccc} A_1 & A_2 & A_3 & A_4 & A_5 \end{array} \\ \begin{pmatrix} (1,\ 1,\ 1) & (0.9086,\ 1.4791,\ 2.3932) & (0.4291,\ 0.6113,\ 0.9386) & (0.9438,\ 1.3230,\ 1.8262) & (0.9638,\ 1.3660,\ 1.8854) \\ (0.4178,\ 0.6761,\ 1.006) & (1,\ 1,\ 1) & (0.2978,\ 0.4548,\ 0.8311) & (0.8267,\ 1.1653,\ 1.4258) & (0.7013,\ 0.8717,\ 1.1660) \\ (1.0654,\ 1.6359,\ 2.3305) & (1.2032,\ 2.1988,\ 3.3579) & (1,\ 1,\ 1) & (1.7796, 2.8947, 4.0805) & (1.5587,\ 2.6883,\ 3.8720) \\ (0.5476,\ 0.7559,\ 1.0595) & (0.7014,\ 0.8581,\ 1.2096) & (0.2451,\ 0.3455,\ 0.5619) & (1,\ 1,\ 1) & (0.3489,\ 0.4696,\ 0.8050) \\ (0.5304,\ 0.7321,\ 1.0376) & (0.8576,\ 1.1472,\ 1.4259) & (0.2583,\ 0.3720,\ 0.6416) & (1.2422,\ 2.1295,\ 2.8662) & (1,\ 1,\ 1) \end{pmatrix} \end{array} \rightarrow \begin{pmatrix} (0.1069,\ 0.1981,\ 0.3862) \\ (0.0817,\ 0.1429,\ 0.2607) \\ (0.1663,\ 0.3571,\ 0.7030) \\ (0.0716,\ 0.1175,\ 0.2226) \\ (0.0979,\ 0.1844,\ 0.3347) \end{pmatrix} \begin{array}{|c} weights \\ 0.5804 \\ 0.3059 \\ 1.0000 \\ 0.1903 \\ 0.4937 \end{array} \tag{18}$$

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array} \begin{array}{c} \begin{array}{ccccc} A_1 & A_2 & A_3 & A_4 & A_5 \end{array} \\ \begin{pmatrix} (1,\ 1,\ 1) & (0.9286,\ 1.6179,\ 2.5632) & (0.4895,\ 0.7476,\ 1.2038) & (1.5671,\ 2.8640,\ 4.1472) & (1.2893,\ 2.1191,\ 2.8193) \\ (0.3901,\ 0.6181,\ 1.0769) & (1,\ 1,\ 1) & (0.2089,\ 0.3223,\ 0.6087) & (1.0000,\ 1.2096,\ 1.4029) & (0.6446,\ 0.8138,\ 1.1472) \\ (0.8307,\ 1.3377,\ 2.0429) & (1.6428,\ 3.1030,\ 4.7870) & (1,\ 1,\ 1) & (1.8995,\ 1.7697,\ 3.0692) & (0.8134,\ 1.4028,\ 2.1995) \\ (0.2411,\ 0.3492,\ 0.6381) & (0.7128,\ 0.8267,\ 1.0000) & (0.3258,\ 0.5651,\ 1.1117) & (1,\ 1,\ 1) & (0.5355,\ 0.6871,\ 1.0324) \\ (0.3547,\ 0.4719,\ 0.7756) & (0.8717,\ 1.2288,\ 1.5514) & (0.4547,\ 0.7129,\ 1.2294) & (0.9686,\ 1.4554,\ 1.8674) & (1,\ 1,\ 1) \end{pmatrix} \end{array} \rightarrow \begin{pmatrix} (0.1278,\ 0.2857,\ 0.5543) \\ (0.0786,\ 0.1356,\ 0.2473) \\ (0.1499,\ 0.2947,\ 0.6187) \\ (0.0682,\ 0.1173,\ 0.2259) \\ (0.0884,\ 0.1666,\ 0.3034) \end{pmatrix} \begin{array}{|c} weights \\ 0.9792 \\ 0.3797 \\ 1.0000 \\ 0.2999 \\ 0.5451 \end{array} \tag{19}$$

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array} \begin{array}{c} \begin{array}{ccccc} A_1 & A_2 & A_3 & A_4 & A_5 \end{array} \\ \begin{pmatrix} (1,\ 1,\ 1) & (1.2686,\ 2.1293,\ 2.9728) & (0.7355,\ 1.1597,\ 1.7338) & (1.5105,\ 2.3546,\ 3.1993) & (0.7594,\ 1.2293,\ 1.9784) \\ (0.3364,\ 0.4696,\ 0.7883) & (1,\ 1,\ 1) & (0.3585,\ 0.5030,\ 0.7718) & (0.9484,\ 1.3097,\ 1.7059) & (0.5616,\ 0.8443,\ 1.3312) \\ (0.5768,\ 0.8623,\ 1.3595) & (1.2956,\ 1.9882,\ 2.7891) & (1,\ 1,\ 1) & (1.1411,\ 2.0205,\ 3.2010) & (0.9038,\ 1.5271,\ 2.4840) \\ (0.3126,\ 0.4247,\ 0.6620) & (0.5862,\ 0.7635,\ 1.0544) & (0.3124,\ 0.4949,\ 0.8764) & (1,\ 1,\ 1) & (0.3454,\ 0.4895,\ 0.7598) \\ (0.5055,\ 0.8134,\ 1.3168) & (0.7512,\ 1.1845,\ 1.7807) & (0.4026,\ 0.6548,\ 1.1064) & (1.3161,\ 2.0428,\ 2.8951) & (1,\ 1,\ 1) \end{pmatrix} \end{array} \rightarrow \begin{pmatrix} (0.1326,\ 0.2785,\ 0.5462) \\ (0.0806,\ 0.1460,\ 0.2806) \\ (0.1237,\ 0.2617,\ 0.5436) \\ (0.0643,\ 0.1122,\ 0.2184) \\ (0.0999,\ 0.2015,\ 0.4064) \end{pmatrix} \begin{array}{|c} weights \\ 1.0000 \\ 0.5276 \\ 0.9607 \\ 0.3404 \\ 0.7805 \end{array} \tag{20}$$

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array} \begin{array}{c} \begin{array}{ccccc} A_1 & A_2 & A_3 & A_4 & A_5 \end{array} \\ \begin{pmatrix} (1,\ 1,\ 1) & (2.3057,\ 4.2590,\ 5.9416) & (0.9186,\ 1.4326,\ 2.0427) & (2.9570,\ 4.8123,\ 6.5304) & (1.7237,\ 3.6528,\ 5.4058) \\ (0.1683,\ 0.2348,\ 0.4337) & (1,\ 1,\ 1) & (0.2462,\ 0.3644,\ 0.6728) & (1.0488,\ 1.3876,\ 1.6357) & (0.5499,\ 0.8178,\ 1.2428) \\ (0.4896,\ 0.6980,\ 1.0886) & (1.4864,\ 2.7442,\ 4.0614) & (1,\ 1,\ 1) & (1.4096,\ 3.0198,\ 4.7121) & (0.9484,\ 1.9560,\ 2.9909) \\ (0.1531,\ 0.2078,\ 0.3382) & (0.6114,\ 0.7206,\ 0.9535) & (0.2122,\ 0.3311,\ 0.7094) & (1,\ 1,\ 1) & (0.3880,\ 0.4999,\ 0.7094) \\ (0.1850,\ 0.2738,\ 0.5801) & (0.8046,\ 1.2229,\ 1.8186) & (0.3343,\ 0.5112,\ 1.0544) & (1.4097,\ 2.0002,\ 2.5773) & (1,\ 1,\ 1) \end{pmatrix} \end{array} \rightarrow \begin{pmatrix} (0.1763,\ 0.4193,\ 0.8959) \\ (0.0597,\ 0.1052,\ 0.2135) \\ (0.1056,\ 0.2605,\ 0.5933) \\ (0.0468,\ 0.0763,\ 0.1589) \\ (0.0739,\ 0.1385,\ 0.3011) \end{pmatrix} \begin{array}{|c} weights \\ 1.0000 \\ 0.1059 \\ 0.7242 \\ 0.0000 \\ 0.3077 \end{array} \tag{21}$$

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & (1,\ 1,\ 1) & (2.3805,\ 4.6587,\ 6.6743) & (1.2286,\ 2.1191,\ 2.9886) & (1.2096,\ 2.3056,\ 3.3939) & (1.0158,\ 1.9153,\ 2.6626) \\ A_2 & (0.1498,\ 0.2146,\ 0.4201) & (1,\ 1,\ 1) & (0.2288,\ 0.3027,\ 0.4770) & (0.2950,\ 0.3760,\ 0.5218) & (0.2533,\ 0.3042,\ 0.4158) \\ A_3 & (0.2346,\ 0.4719,\ 0.7760) & (2.0964,\ 3.3035,\ 4.3711) & (1,\ 1,\ 1) & (0.9839,\ 1.9466,\ 3.1194) & (0.7355,\ 1.1472,\ 1.6624) \\ A_4 & (0.2946,\ 0.4337,\ 0.8267) & (1.9165,\ 2.6594,\ 3.3901) & (0.3206,\ 0.5137,\ 1.0164) & (1,\ 1,\ 1) & (0.4427,\ 0.6516,\ 1.0886) \\ A_5 & (0.3756,\ 0.5221,\ 0.9844) & (2.4050,\ 3.2876,\ 3.9480) & (0.6015,\ 0.8717,\ 1.3595) & (0.9186,\ 1.5346,\ 2.590) & (1,\ 1,\ 1) \end{array} \rightarrow \begin{array}{c|c} & \textit{weights} \\ (0.1433,\ 0.3474,\ 0.7242) & 1.0000 \\ (0.0404,\ 0.0636,\ 0.1228) & 0.0000 \\ (0.1059,\ 0.2278,\ 0.4734) & 0.7340 \\ (0.0833,\ 0.1522,\ 0.3171) & 0.4710 \\ (0.1112,\ 0.2089,\ 0.4280) & 0.6727 \end{array} \tag{22}$$

$$\begin{array}{c|ccccc} & A_1 & A_2 & A_3 & A_4 & A_5 \\ \hline A_1 & (1,\ 1,\ 1) & (1.5919,\ 2.5913,\ 3.7503) & (1.0538,\ 1.7519,\ 2.8808) & (1.9784,\ 3.3369,\ 4.6563) & (1.5263,\ 2.4311,\ 3.2691) \\ A_2 & (0.2666,\ 0.3859,\ 0.6282) & (1,\ 1,\ 1) & (0.3073,\ 0.5207,\ 1.0833) & (0.7598,\ 1.0158,\ 1.2686) & (0.7241,\ 1.2031,\ 1.7806) \\ A_3 & (0.3471,\ 0.5708,\ 0.9489) & (0.9231,\ 1.9205,\ 3.2538) & (1,\ 1,\ 1) & (1.2287,\ 2.3179,\ 3.8514) & (1.2422,\ 2.0961,\ 2.9728) \\ A_4 & (0.2148,\ 0.2997,\ 0.5054) & (0.7883,\ 0.9844,\ 1.3161) & (0.2596,\ 0.4314,\ 0.8139) & (1,\ 1,\ 1) & (0.3922,\ 0.6278,\ 1.0324) \\ A_5 & (0.3059,\ 0.4113,\ 0.6552) & (0.5616,\ 0.8312,\ 1.3810) & (0.3364,\ 0.4771,\ 0.8050) & (0.9686,\ 1.5929,\ 2.5498) & (1,\ 1,\ 1) \end{array} \rightarrow \begin{array}{c|c} & \textit{weights} \\ (0.1610,\ 0.3608,\ 0.7488) & 1.0000 \\ (0.0688,\ 0.1339,\ 0.2773) & 0.3389 \\ (0.1068,\ 0.2567,\ 0.5789) & 0.8006 \\ (0.0598,\ 0.1086,\ 0.2247) & 0.2016 \\ (0.0714,\ 0.1400,\ 0.3076) & 0.3990 \end{array} \tag{23}$$

$$\begin{array}{c|cccccc} & C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \\ \hline C_1 & (1,\ 1,\ 1) & (1.4553,\ 2.0098,\ 2.4440) & (0.6652,\ 0.9999,\ 1.5033) & (0.6900,\ 1.2038,\ 2.1995) & (0.9038,\ 1.5271,\ 2.4840) & (0.4025,\ 0.2571,\ 0.7845) \\ C_2 & (0.4092,\ 0.4976,\ 0.6871) & (1,\ 1,\ 1) & (1.1411,\ 1.9466,\ 2.6897) & (1.4713,\ 2.6177,\ 3.8514) & (1.1472,\ 2.2332,\ 3.2716) & (0.4895,\ 0.8576,\ 1.4720) \\ C_3 & (0.6652,\ 1.0000,\ 1.5034) & (0.3718,\ 0.5137,\ 0.8764) & (1,\ 1,\ 1) & (1.1052,\ 1.8764,\ 2.7468) & (0.7163,\ 1.1058,\ 1.6887) & (0.6052,\ 0.7512,\ 0.8999) \\ C_4 & (0.4546,\ 0.8307,\ 1.4492) & (0.2596,\ 0.3820,\ 0.6797) & (0.3641,\ 0.5329,\ 0.9048) & (1,\ 1,\ 1) & (0.7202,\ 1.3440,\ 2.1773) & (0.5770,\ 1.0705,\ 1.0705) \\ C_5 & (0.4026,\ 0.6548,\ 1.1064) & (0.3057,\ 0.4478,\ 0.8717) & (0.5922,\ 0.9043,\ 1.3961) & (0.4593,\ 0.7440,\ 1.3885) & (1,\ 1,\ 1) & (0.5770,\ 1.0705,\ 1.0705) \\ C_6 & (1.2748,\ 1.8970,\ 2.4843) & (0.6793,\ 1.1660,\ 2.0428) & (1.1112,\ 1.3312,\ 1.6525) & (0.9342,\ 0.9342,\ 1.7330) & (0.9342,\ 0.9342,\ 1.7330) & (1,\ 1,\ 1) \end{array} \rightarrow \begin{array}{c|c} & \textit{weights} \\ (0.0900,\ 0.1765,\ 0.3735) & 0.8343 \\ (0.0995,\ 0.2309,\ 0.4652) & 1.0000 \\ (0.0785,\ 0.1576,\ 0.3125) & 0.7440 \\ (0.0594,\ 0.1302,\ 0.2611) & 0.6161 \\ (0.0587,\ 0.1216,\ 0.2451) & 0.5712 \\ (0.1044,\ 0.1832,\ 0.3818) & 0.8555 \end{array} \tag{24}$$

These findings confirmed that the results obtained by routine AHP were so solid that even consideration of uncertainty in fuzzy AHP concluded to the same result. It means that managerial strategies and plans for formation of such combined business-education models in the academic institutions can be undertaken confidently.

Fuzzy AHP was actually considered in calculations because of its proper compatibility with vagueness of human thinking and uncertainty as discussed in the literatures [12]. Although it is expected to obtain better results from Fuzzy AHP rather than routine AHP for such uncertainty feature, this work has shown that there is no meaningful difference between fuzzy AHP and routine AHP. As reference [23] has also discussed that fuzzy AHP has only slight difference with classic AHP in procurement processes, it can be concluded that even classic AHP can yield almost the same result as fuzzy AHP if an exact survey, questionnaire and relevant experts who evaluate the criteria and alternatives precisely, are being involved in the decision making process.

4. Conclusion

C2B, B2B and A2B models of E-commerce, as the best models, can be implemented to academic educational systems especially for theses definition and examination in order to enhance the general influence of the academic projects for both students and the academic institutions. It was shown that C2B model is the most superior model amongst the other models by which four criteria out of six were satisfied at the higher level of expectancy. It was discussed that implementation of C2B model to the educational systems, not only enhances the academic outcomes but also creates a business opportunity in which both students and private sectors can make entrepreneurial activities. So, C2B is a promising multilateral model of business and education for the future of academic institutions.

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