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AHP Approach for Choosing the Best Private School

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ABSTRACT

As there are many private schools competing, it is important to choose the best one based on School Profile, Education Quality, Infrastructure Quality, and other factors. Parents, when choosing schools to enroll their kids, not only want their kids to be good in school lessons but also in sports, arts and music which can enhance the child's ability. The objectives of this research are to provide the main evaluation criteria and sub-criteria for choosing a private school, to develop a system based on these criteria, and to assist parents in deciding the best choice for private school education. The system being developed take into consideration usability factor to decide users' acceptance. Analytical Hierarchy Process (AHP) is a multiple criteria decision-making tool that has been used in almost all the applications related to decision-making. This paper discusses the importance and some possible criteria for selecting private schools and demonstrates AHP in a step-by-step manner, where the resulting priorities are shown.

KEYWORDS: *Analytical Hierarchy Process (AHP); Criteria; Alternative; Multi-Criteria Decision Making (MCDM); Consistency Ratio (CR)*

INTRODUCTION

Parents make educational decisions for their children. Choosing their child's school may also make them more confident that they will be taught effectively and treated fairly. Choosing their child's school carefully is an important way and they can help their child achieve all that they can be.

This is ahead and a heart decision. To make decisions, we need access to information (or data) and to reach a decision we need to combine the data to obtain a final score for each candidate decision alternative (e.g. combining teaching style and learning opportunities to recommend). This paper builds a system that supports choosing the best private school. Multi-Criteria Decision Making (MCDM) methods rate and prioritize a set of alternatives that best satisfy a given set of criteria. Criteria are a set of requirements or independent attributes that have to be satisfied with several alternatives. Each criterion may be measured in different units (e.g. years, miles or dollars) but they all have to be normalized to obtain dimensionless classifications, i.e. a common numeric range/scale, to allow aggregation into a final score. Data normalization is an essential part of any decision-making process because it transforms the input data into numerical and comparable data, allowing using MCDM methods to rate and rank alternatives. The Analytic Hierarchy Process (AHP) was introduced by Saaty to solve unstructured problems in economics, social sciences, and management. The multi-criteria programming by using of the analytic hierarchy process is a technique for decision making in complex environments in which many facts, variables or criteria are considered in the prioritization and choosing of the best alternatives or projects. AHP is currently used in decision making for complex scenarios, where people work together to make decisions when human perceptions, judgments, and consequences have long-term repercussions (Bhushan & Rai, 2004). AHP has been attracting the interest of many researchers, mainly due to the mathematical features of the method and the fact that data entry is fairly simple to be produced (Triantaphyllou & Mann, 1995). Its simplicity is characterized by the pair-wise comparison of the alternatives according to specific criteria (Vargas, 1990).

METHODOLOGY

The problem must be decomposed into a hierarchy of criteria to be more easily analyzed and compared as shown in Figure 1. After the logical hierarchy is constructed, the decision-making process can systematically assign to get the target goal of selecting alternatives by making pairwise comparisons for each of the chosen criteria. This comparison may use concrete data from alternatives or human judgments as a way to input subjacent information (Saaty, 2008).

The AHP is a selection process that consists of the following steps (Saaty, 1990, 2008; Saaty and Vargas, 2001):

1. Define the problem and determine various types of criteria.
2. Structure of the decision hierarchy taking into account the goal of the decision.
3. Construct a comparison matrix by using the fundamental scale of pair-wise comparison shown in Table 1.
4. Calculate the weighted values for the weighting process by measuring the consistency ratio (CR). Accept the estimate weighted values if the consistency ratio is significantly small. If CR is not less than 0.1, revise the judgments.
5. Ranking by results by using Equations (1 to 5).

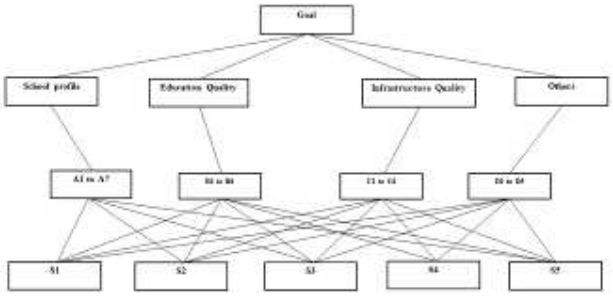

Fig. 1: AHP example of approaching goal for choosing the best private school

$$C_1 = \sum_{j=1}^{7} X_1 \times A_j \times C_{alternatives}$$

$$C_2 = \sum_{j=1}^{6} X_2 \times B_j \times C_{alternatives}$$

$$C_3 = \sum_{j=1}^{6} X_3 \times C_j \times C_{alternatives}$$

$$C_4 = \sum_{j=1}^{5} X_4 \times D_j \times C_{alternatives}$$

$$K_{ranking} = \sum_{i=1}^{4} C_i$$

Table1 Numerical relation scales

Intensity of important	Definition
1	Equal importance
3	More importance
5	Much More importance
7	Very Much More strong
9	Extremely More importance
2,4,6,8	Intermediate values

DETERMINING THE COMPARISON MATRIX AND WEIGHTED VALUES BY ENSURING CR

The first level of the hierarchy involved four major criteria: school profile criteria, education quality criteria, infrastructure quality criteria and other criteria. The 4 main criteria are decomposed into 24 sub-factors: A1 to A7, B1 to B6, C1 to C6 and D1 to D5. 4 first-level criteria and 24 sub-criteria are given in Table 1.

Table2 Definitions of criteria

Criteria	Definitions	Sub-Criteria	Definitions
X1	School Profile	A1	School location
		A2	Campus area
		A3	School policy
		A4	School size
		A5	Pass rate
		A6	Education fee
		A7	Security system
X2	Education Quality	B1	Teacher's qualification
		B2	Teaching aids
		B3	School's curriculum
		B4	Time table
		B5	Cooperation with local and International Institutions
		B6	Soft skill activity
X3	Infrastructure Quality	C1	Building type
		C2	Class-room
		C3	Furniture quality
		C4	Play-ground
		C5	Tennis ground
		C6	Swimming pool
X4	Others	D1	Excursion program
		D2	Transportation program
		D3	Health-care
		D4	Environmental Clearness
		D5	Happiness

After the hierarchy has been established, the main 4 criteria must be evaluated in pairs so as to determine the relative importance between them and their relative weighted values to approach the goal. The evaluation begins by determining the relative weighted values of the initial 4 criteria groups shown in Figure 1. Table 2 shows the normalization values between the criteria that have been determined by collecting data about the private school. The contribution of each criterion is determined by using the priority weight vector (or Eigenvector). The Eigenvector shows the relative weights between each criterion; it is obtained in an approximate manner by calculating the mathematical average of all criteria, as depicted in Table 2. We can observe that the sum of all values from the vector is always equal to one (1). The exact calculation of the Eigenvector is determined by ensuring CR.

The results from Table 2 show that the education quality of the private school is more important than other criteria. The second importance is school profile to select the best private school.

Table3 Normalization values of comparison matrix and weight vector (CR=0.0170)

Criteria	X1	X2	X3	X4	Eigen Vector
X1	0.2609	0.2222	0.3000	0.3636	0.2867
X2	0.5217	0.4444	0.4000	0.3636	0.4325
X3	0.0870	0.1111	0.1000	0.0909	0.0972
X4	0.1304	0.2222	0.2000	0.1818	0.1836

Tables (3 to 6) show the normalization values and Eigenvalues of comparison matrices for the criteria with the pair-wise comparisons already taken by the decision-makers. From Table 3-6, we can know the most important sub-criteria to approach the goal. The pass rate in school profile form main criteria, teacher's qualification in education quality form main criteria, building type in infrastructure quality form main criteria and happiness in others from main criteria are the most important in each main criterion for getting approach to goal.

Table4 Normalization values of Comparison matrix and Eigen vector focusing X1 (CR=0.0326)

X1	A1	A2	A3	A4	A5	A6	A7	Eigen Vector
A1	0.0606	0.0625	0.0444	0.1111	0.0594	0.0698	0.0455	0.0648
A2	0.0606	0.0625	0.0444	0.0556	0.0495	0.0930	0.0682	0.0620
A3	0.1212	0.1250	0.0889	0.2222	0.0743	0.0698	0.1364	0.1197
A4	0.0303	0.0625	0.0222	0.0556	0.0743	0.0698	0.0682	0.0547
A5	0.3030	0.3750	0.3556	0.2222	0.2970	0.2791	0.2727	0.3007
A6	0.2424	0.1875	0.3556	0.2222	0.2970	0.2791	0.2727	0.2652
A7	0.1818	0.1250	0.0889	0.1111	0.1485	0.1395	0.1364	0.1330

Table5 Normalization values of Comparison matrix and Eigen vector for focusing X2(CR=0.0021)

X2	B1	B2	B3	B4	B5	B6	Eigen Vector
B1	0.3822	0.2857	0.4390	0.3478	0.3704	0.4737	0.3831
B2	0.1911	0.1429	0.1463	0.1739	0.1481	0.1579	0.1600
B3	0.1274	0.1429	0.1463	0.1739	0.2222	0.0789	0.1486
B4	0.0955	0.0714	0.0732	0.0870	0.1481	0.0526	0.0880
B5	0.0764	0.0714	0.0488	0.0435	0.0741	0.0789	0.0655
B6	0.1274	0.2857	0.1463	0.1739	0.0370	0.1579	0.1547

Table6 Normalization values of Comparison matrix and Eigen vector for focusing X3 (CR=0.0281)

X3	C1	C2	C3	C4	C5	C6	Eigen Vector
C1	0.3000	0.2927	0.250	0.3333	0.3333	0.2857	0.2992
C2	0.3000	0.2927	0.250	0.3333	0.2500	0.2857	0.2853
C3	0.1500	0.1463	0.1250	0.0556	0.1667	0.1429	0.1311
C4	0.1000	0.0976	0.2500	0.1111	0.0833	0.1429	0.1308
C5	0.0750	0.0976	0.0625	0.1111	0.0833	0.0714	0.0835
C6	0.0750	0.0732	0.0625	0.0556	0.0833	0.0714	0.0702

Table7 Normalization values comparison matrix and Eigen vector for focusing X4(CR=0.0089)

X4	D1	D2	D3	D4	D5	Eigen Vector
D1	0.0714	0.0769	0.0526	0.0667	0.0811	0.0697
D2	0.2857	0.3077	0.3158	0.2667	0.3243	0.3000
D3	0.2143	0.1538	0.1579	0.1333	0.1622	0.1643
D4	0.1429	0.1538	0.1579	0.1333	0.1081	0.1392
D5	0.2857	0.3077	0.3158	0.4000	0.3243	0.3267

Table8 Eigen values for each alternative by determining CR

Criteria	S1	S2	S3	S4	S5	CR
A1	0.334	0.17	0.078	0.325	0.093	0.039
A2	0.156	0.287	0.078	0.095	0.384	0.056
A3	0.182	0.065	0.437	0.261	0.055	0.044
A4	0.143	0.414	0.098	0.24	0.105	0.039
A5	0.147	0.07	0.311	0.078	0.393	0.031
A6	0.34	0.132	0.067	0.119	0.342	0.047
A7	0.137	0.079	0.257	0.075	0.451	0.008
B1	0.384	0.102	0.203	0.108	0.203	0.002
B2	0.273	0.457	0.089	0.072	0.108	0.011
B3	0.156	0.077	0.195	0.487	0.085	0.021
B4	0.091	0.053	0.182	0.342	0.331	0.006
B5	0.331	0.316	0.133	0.151	0.07	0.03
B6	0.278	0.474	0.121	0.077	0.05	0.02
C1	0.331	0.125	0.161	0.065	0.318	0.008
C2	0.144	0.068	0.449	0.273	0.066	0.016
C3	0.16	0.297	0.06	0.424	0.058	0.035
C4	0.141	0.071	0.336	0.078	0.373	0.022
C5	0.159	0.445	0.042	0.291	0.064	0.03
C6	0.301	0.118	0.171	0.137	0.273	0.048
D1	0.318	0.071	0.318	0.17	0.124	0.025
D2	0.255	0.462	0.112	0.062	0.109	0.009
D3	0.317	0.07	0.246	0.274	0.093	0.048
D4	0.094	0.058	0.094	0.401	0.354	0.01
D5	0.27	0.458	0.141	0.059	0.072	0.011

By applying AHP, the decision-makers compare 5 private schools: S1, S2, S3, S4, and S5, taking into consideration every one of the twenty-four (24) established criteria. The results are shown in Table 7. CR values from Table 7 are < 5%, the comparison matrices making by decision-maker are accepted.

RANKING RESULTS

The overall priorities for each private school can be calculated after completed all pair-wise comparisons from the main 4 criteria to the alternative level of the hierarchy. The study results for school profile criteria show that S5 has the highest priority and the profile is higher than the other 4 schools. The results are showing that for education quality criteria, S1, for infrastructure quality criteria, S3 and for other criteria, S2, are higher than other schools. The final priority results are shown in Table 8.

Table9 Final priority results

Criteria	S1	S2	S3	S4	S5
X1	0.06117	0.03613	0.06108	0.03909	**0.0892**
X2	**0.12401**	0.09611	0.07116	0.0766	0.06457
X3	0.02081	0.01463	**0.02369**	0.01915	0.01896
X4	0.04626	**0.05743**	0.02851	0.02769	0.02373
Total	0.25226	0.2043	0.18444	0.16254	0.19646

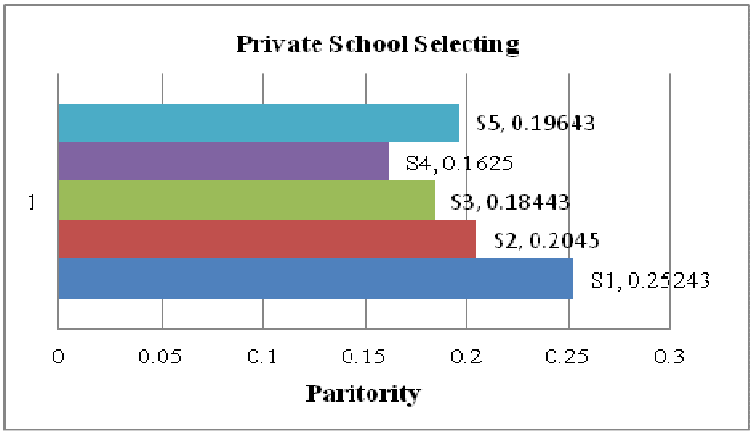

Fig. 2: Overall priorities of five schools.

Figure 2 shows that the priority of selecting a school with the highest level of adherence to the defined goal is "S1" and it contributes with 25.2% (0.252). In order to better illustrate the importance of the difference between the weights and priorities of each school, this school contributes with about 10% more to the goal than "S4", which contributes with only 16.2% (0.161) to the global goal. Figure 2 shows that S1 takes the highest priority [0.252], S2 and S5 has gotten [0.204] and [0.196], while S3 gets [0.184] and S4 gets the lower priority [0.163]. So that, we can determine that S1 deserves an excellent private school to compare to other 4 private schools.

CONCLUSION

The main conclusions in this article are:

1. Its application to select the best private school allows the decision-makers to have a specific and mathematical decision support tool. This tool not only supports and qualifies the decisions but also enables the decision-makers to justify their choices, as well as simulate possible results.
2. The intention in this paper is to show the main calculations performed during analysis, enabling decision-maker to have an adequate understanding of the technique, as well as the complexity involved in making the calculations by hand.
3. The quality of the evaluations made by decision-makers is very important. For a decision to be the most adequate possible, it must be consistent with organizational results. Although the results can be calculated by the inconsistency index. The inconsistency index allows only the evaluation of the consistency and regularity of the opinions from the decision-makers.
4. The overall weighted values in order of priority to the goal is S1 [0.252], S2 [0.204], S5 [0.196], S3 [0.184] and S4 [0.163].
5. Finally, it is important to emphasize that decision-making technique predicates human aspects and strategic analysis and they cannot and must not be used as universal criteria.

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