King Fahd University of Petroleum & Minerals

System Engineering Department

ISE 447

Project: House selection using AHP & TOPSIS, Riyadh

Prepared By

Sami Alharbi	201448140
Mohammed AL Saleem	201766890

executive summary:

This project aims to select house for certain buyer in Riyadh using AHP and (TOPSIS), by AHP we create the hierarchy tree and rank criteria, then get the weights for criteria to use it in TOPSIS. Then, we select the best house which is house 1. It is possible to take more considerations as criteria, Checking for Consistency, and use AHP Software Expert Choice to get more accurate results.

Introduction:

Most investment decisions involve the assessment of both qualitative and quantitative decisions including evaluation of a complex set of interplay among these factors. The house selection process exemplifies the type of investment decision where much of the evaluation is qualitative. The prospective house buyer faces the daunting task of evaluating a large and diverse array of information before being able to reach a rational decision. The proposed house buyer faces the many jobs of estimating a huge and various data before being ready to reach a reasonable judgment. In the beginning, he has to narrow the search for houses. After that, he could be a very large number of houses. Then, the purchaser requires collecting data from these houses. After that, even if data on each house were found, the buyer needs to estimate the myriad of characteristics connected with each property. Finally, the buyer needs to combine the judgmental evaluation of houses with the listed price both for purposes of ranking the final choices and for the negotiations process.

Purpose:

This project aims to select house for certain buyer in Riyadh using the Analytic Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

Methodology:

AHP:

The analytic hierarchy process (AHP) is a structured method for building and examining difficult decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s who partnered with Ernest Forman to develop Expert Choice in 1983 and has been widely analyzed and improved since then. It describes an objective approach for quantifying the weights of decision criteria. Individual experts' experiences are utilized to estimate the relative magnitudes of factors through pair-wise comparisons. Each of the respondents has to compare the relative importance between the two items under special designed questionnaire

TOPSIS:

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis system, which was originally developed by Ching-Lai Hwang and Yoon in 1981. TOPSIS is based on the concept that the chosen alternative should have the smallest geometric range from the positive ideal solution (PIS) and the largest geometric distance from the negative ideal solution. It is a process of compensatory aggregation that analyzes a set of alternatives by identifying weights for each criterion, normalizing scores for each criterion, and calculating the geometric distance between each alternative and the ideal alternative, which is the best score in each criterion. TOPSIS assumes that the criteria are monotonically increasing or decreasing. Normalization is usually required as the parameters or criteria are often of incongruous dimensions in multi-criteria problems. Compensatory methods such as TOPSIS allow trade-offs between criteria, where a poor result in one criterion can be negated by a good result in another criterion. This provides a more realistic form of modeling than non-compensatory methods, which include or exclude alternative solutions based on hard cut-offs.

analysis:

Data collection:

Set of houses has been considered in this project. The data collected are shown several information about the house:

- Cost
- Size
- Number of rooms
- Number of bathrooms
- Location

Exclusion criteria:

The four exclusion criteria were chosen based on buyer preferences:

- Price is less than 1900000 SR.
- Space above 300 m^2.
- Location in north Riyadh.
- Number of rooms 5 or above.
- Number of bathrooms 4 or above.

Appling the above exclusion criteria we were able to narrowed down the number of houses to 4.

Initial set:

	HOUSE1	HOUSE2	HOUSE3	HOUSE4	HOUSE5	HOUSE6	HOUSE7	HOUSE8	HOUSE9	HOUSE10
PRICE	1500000	1750000	1390000	2200000	1990000	2100000	1790000	1580000	1850000	2150000
# OF ROOMS	5	6	4	9	7	8	7	5	6	8
# OF BATHROOMS	4	4	3	7	5	6	5	4	6	8
SPACE	337	360	280	640	558	620	510	412	570	688
LOCATION	alearid	almunsia	alearid	alghurub	alnarjus	alnarjus	alyasimin	tawiq	alqirwan	alearid

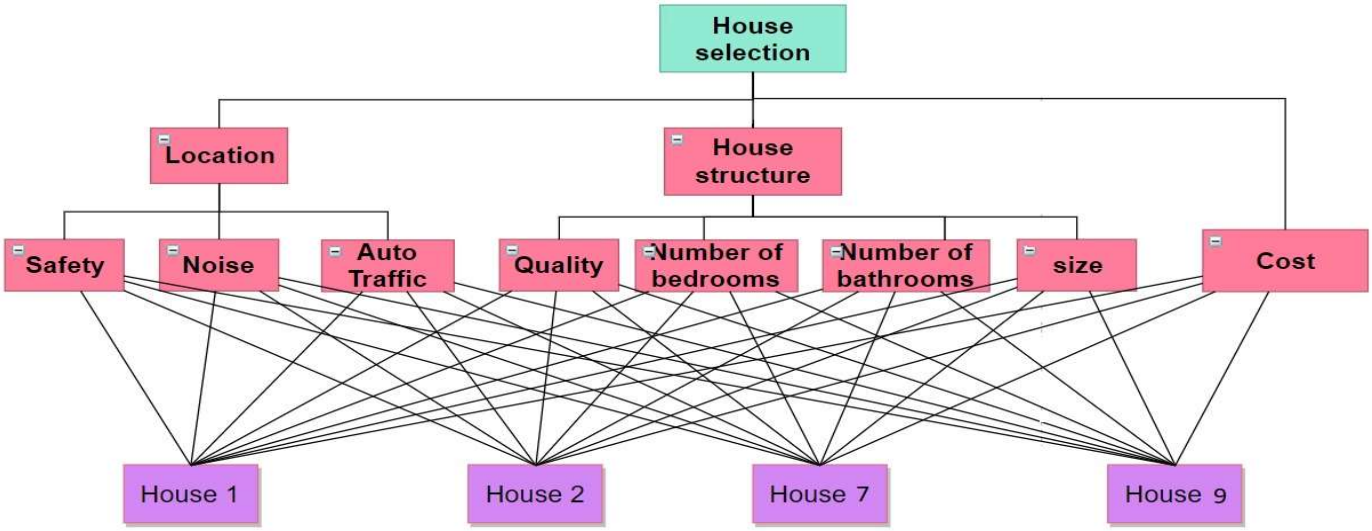
Final set:

	HOUSE1	HOUSE2	HOUSE7	HOUSE9
PRICE	1500000	1750000	1790000	1850000
# OF ROOMS	5	6	7	6
# OF BATHROOMS	4	4	5	6
SPACE	337	360	510	570
LOCATION	alearid	almunsia	alyasimin	alqirwan

The AHP and House Selection:

Hierarchy tree:

House selection using the AHP requires the construction of a hierarchy of attributes, the process of constructing the hierarchy often helps to focus and clearly articulate the preferences which otherwise may not have been done.



Ranking Scale for Criteria:

We create matrix of pairwise comparisons that made with the grades ranging from 1-9 (See Appendix 1).

	Safety	Noise	Auto traffic	Quality	No. bedrooms	No. bathrooms	Size	Cost
Safety	1.00	5.00	5.00	0.33	3.00	3.00	1.00	0.33
Noise	0.20	1.00	1.00	0.14	0.33	0.33	0.20	0.14
Auto traffic	0.20	1.00	1.00	0.14	0.33	0.33	0.20	0.14
Quality	3.00	7.00	7.00	1.00	5.00	5.00	3.00	1.00
No. bedrooms	0.33	3.00	3.00	0.20	1.00	1.00	0.33	0.20
No. bathrooms	0.33	3.00	3.00	0.20	1.00	1.00	0.33	0.20
Size	1.00	5.00	5.00	0.33	3.00	3.00	1.00	0.33
Cost	3.00	7.00	7.00	1.00	5.00	5.00	3.00	1.00

Calculations:

The following calculations used to find the weight for each criteria by AHP:

A^2								Row Sums	Eo
8.000	42.667	42.667	3.962	18.667	18.667	8.000	3.962	146.590	0.13253
1.879	8.000	8.000	0.838	3.962	3.962	1.879	0.838	29.359	0.02654
1.879	8.000	8.000	0.838	3.962	3.962	1.879	0.838	29.359	0.02654
18.133	88.000	88.000	8.000	42.667	42.667	18.133	8.000	313.600	0.28352
3.733	18.133	18.133	1.879	8.000	8.000	3.733	1.879	63.492	0.05740
3.733	18.133	18.133	1.879	8.000	8.000	3.733	1.879	63.492	0.05740
8.000	42.667	42.667	3.962	18.667	18.667	8.000	3.962	146.590	0.13253
18.133	88.000	88.000	8.000	42.667	42.667	18.133	8.000	313.600	0.28352

(A^2)^2								Row Sums	E1=X=Weight	D
571.435	2739.606	2739.606	268.461	1273.498	1273.498	571.435	268.461	9706.003	0.13106	-0.001
120.117	579.562	579.562	56.603	268.461	268.461	120.117	56.603	2049.486	0.02767	0.001
120.117	579.562	579.562	56.603	268.461	268.461	120.117	56.603	2049.486	0.02767	0.001
1229.613	5910.756	5910.756	579.562	2739.606	2739.606	1229.613	579.562	20919.07	0.28247	-0.001
255.783	1229.613	1229.613	120.117	571.435	571.435	255.783	120.117	4353.896	0.05879	0.001
255.783	1229.613	1229.613	120.117	571.435	571.435	255.783	120.117	4353.896	0.05879	0.001
571.435	2739.606	2739.606	268.461	1273.498	1273.498	571.435	268.461	9706.003	0.13106	-0.001
1229.613	5910.756	5910.756	579.562	2739.606	2739.606	1229.613	579.562	20919.07	0.28247	-0.001

TOPSIS:

We Determine the weight for each criteria by AHP, and obtained the score (x_{ij}) of each option (i) using each criteria (j).

	Location			House structure				Cost
	Safety	Noise	Auto traffic	Quality	No. bedrooms	No. bathrooms	Size	
House 1	8	4	4	5	5	4	3	3
House 2	6	5	4	6	6	4	4	5
House 7	4	6	5	9	7	5	7	6
House 9	3	7	6	8	6	6	8	8
weights	0.131	0.028	0.028	0.282	0.059	0.059	0.131	0.282

Ideal alternative (J): the one which has the best level for all attributes considered.

Negative ideal alternative (J'): the one which has the worst attribute values.

TOPSIS selects the alternative that is the closest to the ideal solution and farthest from negative ideal alternative.

Vij	Location			House structure				Cost	S*	S'	C*
	Safety	Noise	Auto traffic	Quality	No. bedrooms	No. bathrooms	Size				
House 1	0.0937	0.0100	0.0116	0.0982	0.0244	0.0245	0.0335	0.0731	0.0976	0.1355	0.5812
House 2	0.0703	0.0125	0.0116	0.1179	0.0293	0.0245	0.0446	0.1218	0.0926	0.0847	0.4778
House 7	0.0469	0.0150	0.0145	0.1768	0.0342	0.0306	0.0781	0.1462	0.0879	0.1040	0.5419
House 9	0.0352	0.0175	0.0174	0.1572	0.0293	0.0367	0.0892	0.1949	0.1370	0.0822	0.3750
A*	0.0937	0.0100	0.0116	0.1768	0.0342	0.0367	0.0892	0.0731			
A'	0.0352	0.0175	0.0174	0.0982	0.0244	0.0245	0.0335	0.1949			
The rank from the best to the worst is: House 1,House 7,House 2,House 9											

$$v_{ij} = w_j x_{ij} / (\sum_i x^2_{ij})^{0.5} \quad \text{for } i = 1, \ldots, m; j = 1, , n$$

$A^* = \{ v_1^*, \ldots, v_n^* \}$, where $v_j^* = \{ \max_i (v_{ij}) \text{ if } j \in J ; \ \min_i (v_{ij}) \text{ if } j \in J' \}$

$A' = \{ v_1', \ldots, v_n' \}$, where $v_j' = \{ \min_i (v_{ij}) \text{ if } j \in J ; \ \max_i (v_{ij}) \text{ if } j \in J' \}$

$S_i^* = [\Sigma_j (v_j^* - v_{ij})^2]^{1/2}$ $\qquad$ $S'_i = [\Sigma_j (v_j' - v_{ij})^2]^{1/2}$ $\qquad$ $i = 1, \ldots, m$

The relative closeness to the ideal solution $Ci^* = S'_i / (S_i^* + S'_i)$, $\qquad$ $0 < C_i^* < 1$

We select the option with C_i^* closest to 1 as the best solution.

Conclusion and Recommendations:

by AHP & TOPSIS methodology we select the best house, from AHP we create the hierarchy tree and rank criteria, then get the weight for each one to use it in TOPSIS method. By TOPSIS we select the most ideal alternative as the ideal.

The rank of houses starting from the best is: House 1, House 7, House 2, House 9.

For recommendations it is possible to take more considerations as criteria, Checking for Consistency, and use AHP Software Expert Choice to get more accurate results.

Appendix 1:

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgement slightly favour one over the other.
5	Much more important	Experience and judgement strongly favour one over the other.
7	Very much more important	Experience and judgement very strongly favour one over the other. Its importance is demonstrated in practice.
9	Absolutely more important.	The evidence favouring one over the other is of the highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed