A Fuzzy Framework for Selection of Appropriate Residential Flat

Bhagyashree S. Khartode and Ravindra K. Lad

Abstract— The construction of residential building developed rapidly and with variety of options so that the selection of appropriate flat for residential purpose becomes a complicated to the flat purchaser. This invention is related to selection of appropriate residential flats. The study highlights potential of appropriate flat for the fulfillment of client. Eight criteria, Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility have been considered for the potential of appropriate flat. By considering multi criteria, it is very difficult to take a decision as whether flat is appropriate or not? So an attempt has been made to formulate a fuzzy approach for selecting appropriate flat. Various sub criteria related to the selection of appropriate flat have been considered for this study. Appropriate flat selection is a multi-criteria decision problem and has a strategic importance for many customers. The aim of this study is to propose a fuzzy approach for appropriate flat selection. This study presents a case study of selecting appropriate flat under multiple criteria decision making that are fuzzy in nature. The AFPI model using Fuzzy Multiple Criteria Decision Making technique has been developed in the present study to evaluate AFPI to decide appropriate flat. By using fuzzy FMCDM, uncertainty and vagueness from subjective perception and the experiences of decision maker can be effectively represented and reached to a more effective decision.

Index Terms— Appropriate flat, Fuzzy Multi Criteria Decision Making, Expert opinion, linguistic terms, Appropriate Flat Potential Index

1 INTRODUCTION

Appropriate flat selection is the process of selecting the most appropriate flat to residential purpose which full of all needs and satisfaction of client so that the achievement of the best value of money is ensured. As the construction of residential building developed rapidly so that the selection of appropriate flat for residential purpose goes to the big problem to the flat purchaser. Selecting the appropriate flat has a major bearing on the human decisions regarding the importance of flat selection parameters. The Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility criteria have been considered for the determination of acceptability level of house. By considering multi criteria, it is very difficult to take a decision as whether flat is appropriate or not? Therefore, expressing maximum possibility or need on dichotomous scale needs a paradigm shift from crisp to fuzzy values. An attempt has been made to formulate a fuzzy model employing Fuzzy Multiple Criteria Decision Making (FMCDM) technique with a view to determine acceptability level of appropriate house. Making decisions is a part of our daily lives. The major concern is that almost all decision problems have multiple, usually conflicting, criteria.

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Multiple Criteria Decision Making (MCDM) is a structured (organized) approach to decision making. Values, beliefs and perceptions are the forces behind almost any decision-making activity. Making decisions is a part of our daily lives. The major concern is that almost all decision problems have multiple, usually conflicting criteria. Multiple Criteria Decision Making (MCDM) is a structured (organized) approach to decision making. Values, beliefs and perceptions are the forces behind almost any decision-making activity. They are responsible for the perceived discrepancy between the present and a desirable state. MCDM is classified into two categories: Multiple Attribute Decision Making (MADM) [5] and Multiple Objective Decision Making (MODM) [8]. Multiple attribute decision making would often employ analytic hierarchy process (AHP), which was developed by Thomas L. Saaty in 1971 [10],[11]

M. Medineckiene, E.K. and Zavadskas, Z. Turskis [8] were described model of dwelling selection, using fuzzy game theory. Fuzzy games are applied for decision aiding. The problem solution result shows that fuzzy matrix games theory is appropriate for such purposes.

Chien-Chang Chou [3] was evaluated an integrated short-term and long-term multiple-criteria decision-making (MCDM) model for solving location selection problems. The advantages of the proposed integrated short-term and long-term MCDM model in this study are not only to evaluate the short-term investment environment, but also consider the long-term operation environment.

Na Wu and Shengchuan Zhao [9] were investigated the impacts of housing affordability, which can be denoted as the ratio of housing price (HP) and monthly expense per person (EXP), travel time of the city center, Distance to a subway station, and schooling on residents' apartments purchasing behavior in Dalian, China. They concluded that the travel time from residence to city center plays an important role in deciding the housing purchase behavior.

Milena Medineckien, Zenonas Turskis, Edmundas Kazimieras Zavadskas, Jolanta Tamošaitien [7] gaves a multi-criteria selection of the one flat dwelling house, taking into account the construction ecological aspects, their impact on environment and their economic and social condition.

Ivy Drafor Amenyah & Ernest Afenyi Fletcher [6] studied the factors determining residential rental price. Due to the high demand for residential apartments, landlords take undue advantage of tenants and increase rent without adhering to rent regulations.

Changhyo Yi and Seungil Lee [2] were studied the factors of residential location choice by considering the characteristics of the Korean housing market. From various factors of the residential location choice of a household, this study focuses on the effect of opportunities to engage in other activities, represented by accessibility, and the variety of housing tenure.

There are so many websites are available for getting information of flats. Some of them studied and highlighted here.

D. Singh and Robert L. K. Tiong et.al [4] Gaves the contractor selection process of selecting the most appropriate contrac tor to deliver the project as specified so that the achievement of the best value for money is ensured. They developed a fuzzy decision framework for contractor selection. The nation of Shapley value is used to determine the global value or relative importance of each criterion in accomplishing the overall objective of the decision making process.

Magicbricks is a website that provides a common platform for property buyers & sellers to locate properties of interest in India and source information about all property related issues.

99 ACRES: Users can find new and upcoming projects in a particular locality or city. Website users can compare the prices of a property in different localities of a same city. It provides information about the current price rates and a quarter to quarter analysis of the area

2 METHODOLOGY

Figure 1 shows overview of the fuzzy decision framework for selection of appropriate flat.

2.1 Fuzzy sets and fuzzy logic

A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse, a value representing its grade of membership in the fuzzy set. This grade represents the degree to which that individual is similar or compatible with the concept represented by the fuzzy set. Thus, an individual may belong in the fuzzy set to a greater or lesser degree as indicated by a larger or smaller membership grade.

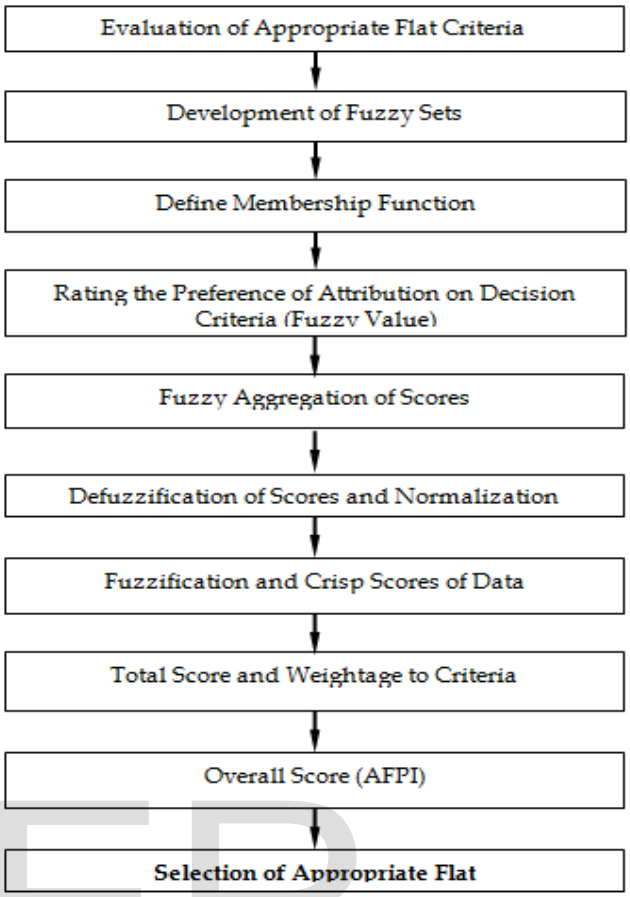

Fig. 1: A Fuzzy Decision Framework for Selecion of Appropriate Flat

These membership grades are very often represented by real-number values ranging in the closed interval [0, 1]. As fuzzy logic deals with values between 0 and 1, it is also multi-valued logic. The importance of fuzzy logic derives from the fact that most modes of human reasoning and especially common sense reasoning are approximate in nature [6].

2.2 Linguistice Variables

The concept of a fuzzy number plays a fundamental role in formulating quantitative fuzzy variables. These are variables whose states are fuzzy numbers. When, in addition, the fuzzy numbers represent linguistic concepts, such as very good, good, fair, and so on, as interpreted in a particular context, the resulting constructs are usually called linguistic variables.

Linguistic terms for the study used were: Very Important (VI), Important (I), Average (A) and Not Important (NI) or Least Important (LI). Table 1 shows the linguistic terms and fuzzy numbers used in this study. Figure 2 shows the graphical representation of fuzzy numbers for the linguistic terms.

numbers used in this study. Figure 2 shows the graphical representation of fuzzy numbers for the linguistic terms.

Table 1 Linguistic Terms and Fuzzy Numbers

LINGUISTIC TERMS	FUZZY NUMBER
Very Important	(0.777,0.888,1.000,1.000)
Important	(0.555,0.666,0.777,0.888)
Average	(0.333,0.444,0.555,0.666)
Least Important	(0.111,0.222,0.333,0.444)
Very Least Important	(0.000,0.000,0.111,0.222)

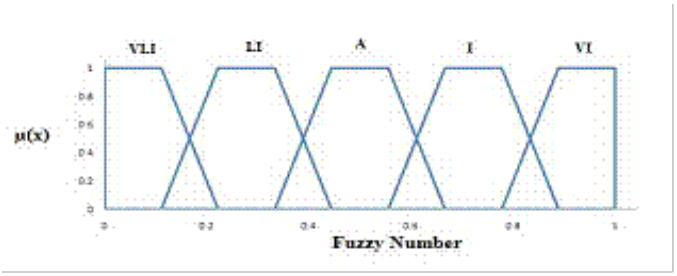

Figure 2 Fuzzy sets for the linguistic terms

Experts' opinions are required to be taken from academicians and professionals, who are involved in the field of civil construction engineering, for sub criteria of Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility. Then the importance weightage factors for these sub criteria can be calculated as follows.

2.3 Average Fuzzy Number (AFN)

The linguistic terms given by experts can be further simplified to calculate the Average Fuzzy Number (AFN).
The linguistic terms as assigned by the experts for each sub criterion of Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility can be converted to fuzzy numbers. Then AFN can be calculated by the following equation.

$$A_{pq}^{r} = \left(1/t\right) \cdot \left(a_{p1}^{r} + a_{p2}^{r} + \ldots + a_{ps}^{r}\right) \text{ for } p = 1, 2, \ldots, n \text{ and } q = 1, 2, \ldots, s \quad \text{(i)}$$

Where,

A_{pq}^{r} = the fuzzy number assigned to a sub criterion,
p = the number of experts and
n = the number of fuzzy numbers.

2.3 Defuzzification & Nnormalized Weight

It is an operation that produces a nonfuzzy or crisp value that adequately represents the degree of satisfaction of the aggregated fuzzy number. In this study, trapezoidal fuzzy numbers were used to represent the experts' opinion. An importance of sub criterion was considered as a range value but not with specific value. So, only trapezoidal fuzzy sets were considered. Let a trapezoidal fuzzy number be parameterized by x1, x2, x3 and x4 as shown in the Figure then its defuzzified value (crisp score) 'e' for the sub criterion can be obtained by using the following ii. [8]

$$e = (x1 + x2 + x3 + x4) / 4 \quad \ldots(ii)$$

2.4 Fuzzy Decision Matrix

$$X_C = \begin{matrix} \mu_1 & \mu_2 & \mu_3 \ldots\ldots\ldots & \mu_n \end{matrix} \\ \begin{bmatrix} a_1 & a_2 & a_3 \ldots\ldots\ldots & a_n \\ b_1 & b_2 & b_3 \ldots\ldots\ldots & b_n \\ c_1 & c_2 & c_3 \ldots\ldots\ldots & c_n \end{bmatrix} \begin{matrix} B1 \\ B2 \\ B3 \end{matrix}$$

Where a1, a2, a3... an, b1, b2, b3... bn and c1, c2, c3... cn are fuzzy values of Distance for Scheme B1, B2 and B3 respectively

2.5 The Crisp Scores

The crisp scores of the sub criterion for each building scheme can be obtained by using following equations:
B1 = (a1 + a2 + a3 + ... + an)/n
B2 = (b1 + b2 + b3 + ... + bn)/n
Bn = (c1 + c2 + c3 + ... + cn)/n

2.6 Total Score

Using simple additive weighing method [5], overall score (OS) for the different schemes were calculated using equation as shown below, with usual notations

$$TS_{cp} = \sum\left[X_{cs} \cdot W\left(C_{cs}\right)\right] \text{ for } s = 1, 2, \ldots n \quad \ldots.(iii)$$

Where,

TS_{cp} = total score of the scheme b against the criterion c

X_{cs} = crisp score of the scheme data against sub criterion s of the criterion c and

$W\left(C_{cs}\right)$ = weight (importance value) of sub criterion s of the criterion c.

Now, appropriate flat potential importance weight $W(C_{cs})$ of the criterion m for scheme i can be calculated as,

$$W\left(C_{cp}\right) = TS_{cp} \Big/ \sum TS_{cp} \ldots\ldots(iv)$$

2.7 Overall Score

Using simple additive weighing method [5], overall score (OS) for the different schemes were calculated using the following equation, with
usual notations.

$$OS = \sum\left[TS_{cp} \cdot W\left(C_{cs}\right)\right] \text{ for } c = 1, 2, \ldots n$$

Where,

TS_{cp} = Total Score of Criteria

$W(C_{cs})$ = Normalized Weight of Criteria

3 Case Study

The available data of flats from three construction sites located in Pimpri Chinchwad, Pune, in the State of Maharashtra, India were collected for this study. For the selection of appropriate

flat eight criteria were considered like Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility. The following sub criteria of defined criteria are considered for the study:

Clients needs: Budget/Cost EMI, Distance, Time, Travelling expenses, Traffic problem, Distance of Hospital, Distance of School, Distance of Market, Distance of Bus stand, Distance of Railway station and Distance of Airport.

Flat details: BHK system (e.g. 1/2/3 BHK etc), Floor, Flat with balcony, Flat without balcony, Flat as per Vastushastra, Principles of planning and Flat with Furniture.

Infrastructural facility: Internal Roads, Lift, Intercom, Parking, Solid waste collection system, Fire Fighting system and Maintenance Service.

Neighborhood amenities: Municipality supplied water, Availability of sewer, Availability of gas cable, Availability of high speed internet cable and Availability of telephone connection.

Public Utility Services: Electricity, Sewage disposal and Solid waste collection & disposal.

Environmental Friendly Systems: Solid waste treatment, Solar system, Rain water harvesting system and Sewage Treatment Plant.

Maintenance Charges: One Time, Building maintenance per month and Society charges.

Other facility: Swimming pool, Gymkhana, Open space and Security.

4 Results and Discussion

The fuzzy Multi Criteria Decision Making approach was used for the determination of AFPI. The normalized weight for each sub criterion of Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility was calculated by taking experts opinion.

4.1 Expert's Opinion

The questionnaire was prepared for taking importance weightage for sub criteria of Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility from Academicians and Professionals. Experts opinion is converted in to the average fuzzy number by using average fuzzy matrix.

4.2 Average Fuzzy Numbers

Then AFNs for client's need were calculated as follows:
Average Fuzzy Matrix for criteria Client's Need,

$$AF_{C_k} = \begin{bmatrix} 0.719, & 0.844, & 0.956, & 0.967 \\ 0.646, & 0.755, & 0.866, & 0.911 \\ 0.576, & 0.688, & 0.799, & 0.888 \\ 0.546, & 0.644, & 0.755, & 0.833 \\ 0.468, & 0.555, & 0.666, & 0.766 \\ 0.572, & 0.688, & 0.800, & 0.866 \\ 0.500, & 0.622, & 0.733, & 0.822 \\ 0.452, & 0.555, & 0.666, & 0.766 \\ 0.413, & 0.511, & 0.622, & 0.722 \\ 0.691, & 0.799, & 0.911, & 0.955 \\ 0.578, & 0.688, & 0.800, & 0.866 \\ 0.344, & 0.511, & 0.622, & 0.722 \end{bmatrix} \begin{matrix} \text{Budget/ Cost} \\ \text{EMI} \\ \text{Distance} \\ \text{Time} \\ \text{Travelling expenses} \\ \text{Traffic problem} \\ \text{Distance of Hospital} \\ \text{Distance of school} \\ \text{Distance of Market} \\ \text{Distance of Bus Stand} \\ \text{Distance of Railway Station} \\ \text{Distance of Airport} \end{matrix}$$

Fig. 3 Average Fuzzy Matrix

Similarly average fuzzy matrix is prepared for all the criteria. Table 2 shows sample calculations to find out average fuzzy numbers and crisp score for criteria clients need. Similarly,average fuzzy numbers and crisp score werw calculated for other criteria.

Average Fuzzy Numbers and crisp score respectively for sub criteria of Client's Need are as shown in Table 2.

Table 2 Average Fuzzy Numbers and crisp score

Sub Criteria	AFN1	AFN2	AFN3	AFN4	AVG(C_k)
Budget/Cost	0.719	0.844	0.956	0.967	0.871
EMI	0.646	0.755	0.866	0.911	0.794
Distance	0.576	0.688	0.799	0.888	0.738
Time	0.546	0.644	0.755	0.833	0.694
Travelling expenses	0.468	0.555	0.666	0.766	0.614
Traffic problem	0.572	0.688	0.800	0.866	0.731
Distance of Hospital	0.500	0.622	0.733	0.822	0.669
Distance of School	0.452	0.555	0.666	0.766	0.610
Distance of Market	0.413	0.511	0.622	0.722	0.567
Distance of Bus stand	0.691	0.799	0.911	0.955	0.839
Distance of Railway station	0.578	0.688	0.800	0.866	0.733
Distance of Airport	0.344	0.511	0.622	0.722	0.550

It is now required to convert the data to the fuzzy numbers

(membership functions) based on the maximum considerable value. For example, if Distance of School of a given data is 2km, the membership function of that sample would then be 0.5 (see Figure 4) as the maximum considerable distance is 4 km. Figure 4 shows fuzzy set for Not Acceptable (membership function one), for sub criterion Distance of School of criterion Client's Need. Similarly, fuzzy sets for other sub criteria of all Criteria were developed.

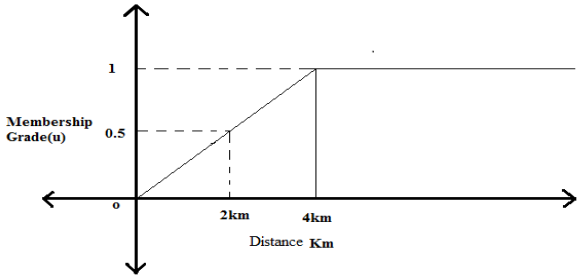

Fig. 4 Fuzzy set for not acceptable

4.3 Normalized Weight

The normalized weight for each sub criterion of all criteria can Be obtained by deviding the crisp score of each sub criterion by the sum of crisp score of all sub criteria where c is the criterion and s is the sub criterion. Table 3 shows Normalized Weight. Similarly normalized weight calculated for all the criteria

Table 3 Normalized Weights (Academician and Professional)

Sub Criteria	Weight	
	Academicians	Professionals
Budget/Cost	0.103	0.105
EMI	0.094	0.100
Distance	0.088	0.086
Time	0.083	0.083
Travelling expenses	0.073	0.070
Traffic problem	0.087	0.075
Distance of Hospital	0.080	0.077
Distance of School	0.073	0.080
Distance of Market	0.067	0.062
Distance of Bus stand	0.100	0.100
Distance of Railway station	0.087	0.090
Distance of Airport	0.065	0.072

Need	Professional	0.742	0.658	0.695
Flat details	Academician	0.237	0.065	0.065
	Professional	0.247	0.065	0.065
Infrastructural facility	Academician	0.594	0.271	0.142
	Professional	0.582	0.269	0.139
Neighborhood amenities	Academician	0.699	0.478	0.301
	Professional	0.708	0.513	0.292
Public Utility Services	Academician	0.837	0.500	0.326
	Professional	0.843	0.500	0.325
Environmental Friendly Systems	Academician	0.888	0.364	0.112
	Professional	0.877	0.368	0.123
Maintenance Charges	Academician	0.937	0.669	0.206
	Professional	0.938	0.669	0.207
Other facility	Academician	0.835	0.473	0.303
	Professional	0.827	0.471	0.316

4.4 Total Score for schemes

Using simple additive weighing method [5], the total score (TS), for each scheme, of Client's need, Flat details, Infrastructural facility, Neighborhood amenities, Public Utility Services, Environmental Friendly Systems, Maintenance Charges and Other facility criteria were calculated separately using the equation iii with usual notations.

Table 4 shows total score for scheme 1, 2 and 3 respectively.

Table 4 Total score for all schemes

4.5 Overall score as Appropriate Flat Potential Index

Using simple additive weighing method (Hwang and Yoon, 1981), overall score (OS) that is Appropriate Flat Potential Index for the different schemes were calculated is as shown in table 5

Table 5 Overall Score (Appropriate Flat Potential Index)

Overall Score for,	Overall Score of,		
	Scheme 1	Scheme 2	Scheme 3
Academician	0.782	0.513	0.392
Professional	0.780	0.520	0.395

On the basis of values of Appropriate Flat Potential Index (AFPI) client can see appropriateness of scheme with the help of AFPI scale (Table 6).

Table 6 Appropriate Flat Potential Index

Sr. No.	Scale	Linguistic Term
1.	0.00 - 0.20	Highly Appropriate
2.	0.21 - 0.40	Appropriate
3.	0.41 - 0.60	Moderately Appropriate
4.	0.61 - 0.80	Least Appropriate
5.	0.81 - 1.00	Not Appropriate

From the normalized weightage method, following points were observed:

[1] The AFPI of Scheme 1 is 0.782 & 0.780 in the range of 0.61 – 0.80 that is as per the scale (Table 6) scheme 1 is least appropriate for 2BHK flat.

[2]The AFPI of Scheme 2 is 0.513 & 0.520 in the range of 0.41 – 0.60 that is as per the scale (Table 6) scheme 2 is moderately appropriate for 2BHK flat.

[3]The AFPI of Scheme 2 is 0.392 & 0.395 in the range of 0.21 – 0.40 that is as per the scale (Table 6) scheme 3 is appropriate for 2BHK flatConclusion

4.6 Different Options

From the developed methodology the different options can be checked as per the requirement of client. The following are the results for different options.

4.6.1Discussion for 1BHK

If client wants to purchase 1BHK flat then this will be selected by entering data for only 1BHK and if 1BHK is not available in the data then there is provision to getting result as "Not Available" for that particular schemes Table 7 shows Appropriate Potential Index for 1BHK.

Table 7 Appropriate potential Index for 1BHK

Results for 1BHK Selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.823	0.822	Not Appropriate
2	-	-	Not Available
3	0.375	0.377	Appropriate

4.6.2 Discussion for 2BHK

Table 8 shows Appropriate Potential Index for 2BHK

Table 8 Appropriate potential Index for 2BHK

Results for 2BHK Selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.782	0.780	Least Appropriate
2	0.513	0.520	Moderately Appropriate
3	0.392	0.395	Appropriate

4.6.3 Discussion for 3BHK

Table 8 shows Appropriate Potential Index for 3BHK

Table 9 Appropriate potential Index for 3BHK

Results for 3BHK Selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	-	-	Not Available
2	0.528	0.535	Moderately Appropriate
3	0.346	0.348	Appropriate

4.6.4 Discussion for without Vastushastra Criteria

If a Vastushastra Sub Criterion is not considered then results are as follows. Some people do not believe on vastushastra while purchasing flat, but the consideration of vastushastra for the future is important, some people purchase their home for limited period and then sale for someone but that someone believe of vastushastra then he would not take that home.

Table 10 Appropriate potential Index without Vastushastra Criteria

Vastushastra is not considered (2BHK)			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.778	0.777	Least Appropriate
2	0.505	0.512	Moderately Appropriate
3	0.385	0.388	Appropriate

4.6.5 Discussion for some criteria not considered

If some criteria like flat with balcony, flat without balcony, Intercom, Availability of gas cable, Availability of high internet cable, Availability of telephone connection, Environmental Friendly Systems, Swimming pool, Gymkhana, Open space are not considered in this analysis then results are shown in below table.

Table 11 Appropriate potential Index for 2BHK

Some Criteria is not considered in 2BHK selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.727	0.727	Least Appropriate
2	0.535	0.538	Moderately Appropriate
3	0.436	0.440	Moderately Appropriate

4.6.6 Discussion for some criteria with all distances

If someone wants the flat for to give on rent that time they do not need to see the some criteria like Distance from working place to residence, Time required to reach the working place to residence, Distance of hospital, Distance of school, Distance of bus stand, Distance of railway station, Distance of market, Flat as per vastushastra, Flat with or without balcony, Internal roads, Intercom, Maintenance service, All neighborhood amenities, Environmental friendly systems, Maintenance charges, In other facilities like swimming pool, Gymkhana, Open spaces etc.

Table 12 Appropriate potential Index for 2BHK

Some criteria is not considered in 2BHK selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.697	0.696	Least Appropriate
2	0.523	0.530	Moderately Appropriate
3	0.474	0.478	Moderately Appropriate

4.6.9 Discussion for Budget/Cost Criteria

If some client selects the flat only on the basis of budget or cost of flat then results are as follows,

Table 13 Appropriate potential Index for 2BHK

Only Budget/Cost criteria considered for 2BHK selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.814	0.814	Not Appropriate
2	1.000	1.000	Not Appropriate
3	0.800	0.800	Least Appropriate

4.6.10 Discussion for various distances:

Various distances like distance between working place to flat, Distance of Hospital, Distance of School, Distance of Market, Distance of Bus stand, Distance of Railway station and Distance of Airport are not considered then occurring results are as shown in table 14

All distances not considered for 2BHK selection			
Scheme	Overall Score		Remark
	Academicians	Professionals	
1	0.788	0.787	Least Appropriate
2	0.506	0.512	Moderately Appropriate
3	0.318	0.320	Appropriate

Table 14 Appropriate potential Index for 2BHK

From the results, it seems that for different options appropriateness of selection of flat is changed. It is also seems that for appropriate flat as per the requirement of client it is required to consider relevant sub criteria. For example, if someone will select flat on the basis of budget/cost only, then flat would not be appropriate one. It means that for appropriateness or confortable life as per the status of person options should be required to select appropriate flat.

5 Conclusions

The following are the conclusion on the basis of the analysis:

Application of fuzzy approach to the selection of appropriate flat is found to be more appropriate compared to the current crisp approach. Time required choosing the flat is less. When the comparison is made among the linguistic terms assignments by Academicians, Professionals, the index value changes marginally. Some clients choose flat on the basis of only money like budget or cost then the selection is not done appropriately, there is a need to consider some criteria which are very important at the time of appropriate selection of flat to get comfortable life.

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References

[1] Changhyo Yi, Seungil Lee, "An empirical analysis of the characteristics of residential location choice in the rapidiy changing Korean housing market", cities 39 (2014) 159-163

[2] Chien-Chang Chou, "Integrated Short- Term and Long-Term MCDM Model for solving location selection problem" Vol. 135, No. 11, November 1, 2009, @ASCER.

[3] D. Singh and Robert L. K. Tiong, "A Fuzzy Decision Framework for Contractor Selection" Journal of construction Engineering and management @ Vol. 1, No. 62, January, 2005, @ASCE

[4] Hwang, C.L., and Yoon, K. (1981). Multiple attribute decision making: methods and applications, Springer Verlag, New York.

[5] Ivy Drafor Amenyah & Ernest Afenyi Fletcher,"Factors Determining Residential Rental Prices", Vol. 3 No. 1, 39-50, @ ASCE

[6] J. Klir and Bo Yuan (2003). Fuzzy Sets and Fuzzy Logic, Theory and applications, Prentice Hall of India Private Limited, New Delhi-110 001.

[7] Jain S. and Khare M; "Construction of fuzzy membership functions for urban vehicular exhaust emission madeling." J. Environmental Monitoring and Assessment, online DOI: 10.1007/s10661-009-1085-4.

[8] Kaufmann and M. M. Gupta, "Fuzzy mathematical models in engineering and management science" North-Holland, Amsterdam, The Netherlands, 1988

[9] Milena Medineckien, Zenonas Turskis, Edmundas Kazimieras Zavadskas, Jolanta Tamošaitien, "Multi-Criteria selection of the one Flat dwelling house, taking into account the construction impact of Environment" May 19-21, 2010, Vilnius, Lithuania, 10th International Conference.

[10] M. Medineckiene, E.K. and Zavadskas, Z. Turskis, "Dwelling selection by applying fuzzy game theory" Vol. XI, No. 3, @ Archives of civil and Mechanical engineering

[11] Na Wu and Shengchuan Zhao, "Impact of Transportaion Convenience, Housing Affordability, Location, and Schooling in Residence Choice Decision" @ ASCE.

[12] Saaty, T. L. (1977). "A scaling method for priorities in hierarchical structures." Journal of Mathematical Psychology, 15, 234-281.

[13] Saaty, T.L. (1980). The analytic hierarchy process, McGraw Hill, New York.