

MULTIPLE CRITERIA DECISION MAKING (MCDM) - APPROACH TO PREFERENCE RESIDENTIAL LOCATION: A CASE STUDY OF SOUTH ZONE, SURAT, GUJARAT

Mr. Yash Jayswal¹, Parate Divyesh², Mishra Rishabh³, Chaudhary Mohan⁴, Kushwaha Sonu⁵, Pathan Maherabanu⁶

^{2,3,4,5,6}Students of B.E. Civil Department at Bhagwan Mahavir College of Engineering and Technology.

¹Assistant Professor at Civil Department Bhagwan Mahavir College of Engineering and Technology, Surat, Gujarat, India

Abstract - Preferences to Residential location is a very complex nature of every household of an urban area. Studies of residential location choice show that many factors contribute to the choice of a given location like the characteristics of the housing unit, its location with respect to social and environmental features as well as access to jobs, services and other economic opportunities. Location choice change with city to city and state to state depending on above stated factors and city characteristics.

Keywords—Households, Multi criteria decision making, Parameters, Residential location

1. INTRODUCTION

The study considers residential choice for location shift of households in center zone of Surat and identification and measure the effect of various parameters enhancing the satisfaction of households and priority setting for suitable location of residents for that survey is done in various wards of in study area and found out where households want to shift.

Multiple criteria decision making (MCDM) refers to making decisions in the presence of multiple, usually conflicting, criteria. MCDM problems are common in everyday life. In personal context, a house or a car one buys may be characterized in terms of price, size, style, safety, comfort, etc.

Decision making, in general, is a vast area of study for a multitude of subject fields. It can be simply interpreted as the process of the selection of a sensible choice from a set of possible options. When it comes to humans, the decision-making process or the reasoning is complex and is affected by many factors which can be both internal and external.

Household are one of the core agents in the urban system. Household plays a vital role in urban system performance

and can deeply shape the urban landscape. Household choices of residence, work, shopping and entertainment condition individuals' travel patterns and a city's total travel demand and will be reflected in urban land uses. In any urban area, Residential location is an integral part of any urban planning. Selection of Residential location is a very complex nature of every household of an urban area. Citizens consider various parameters for selection of their residential location.

The residential choice, defined here as the choice of the place where the household lives, and, when it is unhappy with its current home, of when and where to move, is an equally complex issue. It involves many decisions, such as when to move, where to look for, or the choice of tenure, as well as various limitations which may be binding in terms of budget, commuting time, schooling, and so on. Residential mobility choices are influenced by various factors. Continuous even of household membership and family structures over time, job sitting changes, and other socioeconomic conditions impact households to change residential locations.

2. STUDY AREA PROFILE

South Zone is situated on the South side of Surat city.

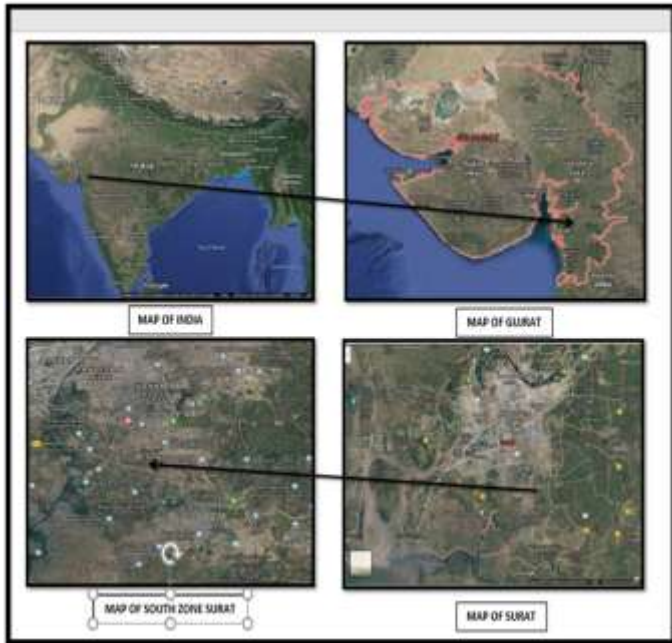
TABLE 1
Zones of Surat City

NO.	ZONE	AREA (Sq.km)
1	Central zone	8.18
2	South-West zone	111.912
3	South zone	61.764
4	South East Zone	19.764
5	East Zone	37.525
6	North Zone	36.363

7	West Zone	51.279
	Total	326.515

(Source: suratmunicipal.gov.in)

Map of South Zone:



3. DATA COLLECTION

For the study of location shift of households in South zone Surat, collection of existing situation is required and survey is important. From survey data is collected that which location households want to shift and which criteria citizens consider. For home interview survey details of households and their location choice shift has been collected from each ward of South zone. Home interview survey will give the households basic details, affecting parameters of location of residential like environmental parameters, infrastructural facilities, cost of home, transportation connectivity to work place and amenities. Migration details collection and in future at where location citizens want to locate and for what reason. For this survey work, 95% confidence level is taken. From this the above equation, total sample size is 384 ~ 400.

TABLE 2
Details of Main factors & Sub parameters

MAIN FACTORS	SUB FACTORS
ENVIRONMENTAL FACTORS	Pollution
	Gardens

	Open space
INFRASTRUCTURAL FACTORS	Water quality
	Sewage
	Solid waste
	Storm water discharge
AMENITIES	Health facilities
	Market facilities
	Educational facilities
	Security facilities
	Entertainment facilities
COST OF HOME OR PROPERTY	
TRANSPORTATION CONNECTIVITY	

Experts' survey interview was conducted from officials of Surat Municipal Corporation, Surat Urban Development Authority, private developers, architect, engineers, for finding out importance level and weightage level of all parameter

4. ANALYSIS AND RESULTS

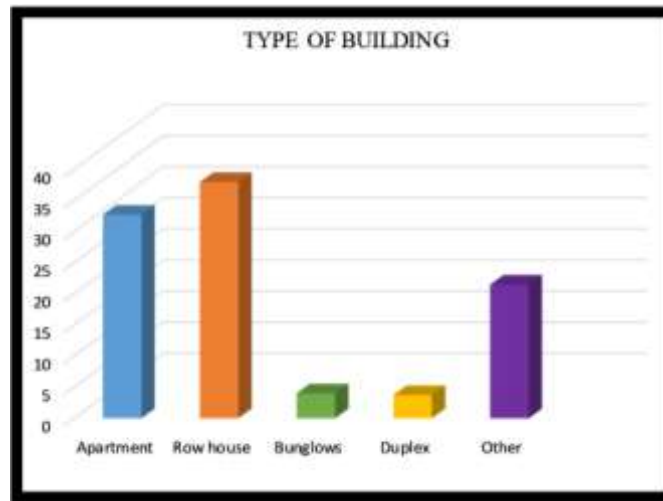
Survey samples were obtained from respondents residing in various wards of South zone. The random sampling was employed for the household survey. Based on the population in the Zone, a size of 400 samples were determined and responses were recorded by manual interviewing technique. All the responses were complete in a sense of providing answers to various aspects in the posed questionnaire.

4.1 TYPES OF TYPES OF HOME/BUILDING →

TABLE 3
Surveyed sample of types of home/building

TYPE OF BUILDING	SURVEY SAMPLE	% OF SURVEYED SAMPLE
APARTMENT	131	32.75
ROW HOUSE	152	38
BUNGLOWS	16	4
DUPLEX	15	3.75
OTHER	86	21.5
TOTAL	400	100

Graph Shown Below:



4.2 INCOME OF HOUSEHOLD PER MONTH →

TABLE 4
Income of Household per Month

CATEGORY OF INCOME OF HOUSEHOLD PER MONTH	NO. OF SURVEYED SAMPLES	% OF THE SURVEYED
<50000	174	43.5
50000-200000	163	40.75
200000-500000	52	13
>500000	12	3
TOTAL	400	100

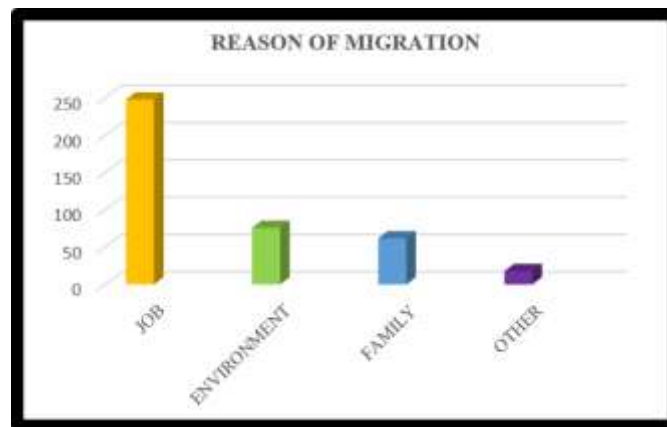
Based on pilot survey carried out in South zone of households of Surat above category were identified to be predominating and class

4.3 MIGRATION DETAILS →

TABLE 5
Migrate Details

MIGRATE DETAILS	RESPONSE OF NO. OF SURVEYED SAMPLE	PERCENTAGE (%)
MIGRATE FROM OUT STATE	207	51.75
MIGRATE WITHIN STATE	167	41.75
INNER CITY SHIFT	26	6.5
TOTAL	400	100

Graph Shown Below:



5. ANALYSIS OF AFFECTING PARAMETERS FOR RESIDENTIAL LOCATION CHOICE

For the analysis of residential location choice of household's lives in South zone is calculated using Rank and Weightage approach of multi criteria decision making.

The study is carried out in each ward of the South zone and home interviews were carried out in each wards of South Zone. For rating methodology, the descriptive variables and their values are given for above mentioned factors. They are scaled.

The Rating is given by descriptive variables to each factor. Each from the Home Interview, average rating was given to different factors for different income groups.

A total of 400 forms by household interview were obtained with information about details in various wards of the South zone with a view for future where his/her family wished to shift. Also, level of satisfaction about all criteria that satisfy him/her at where they want to shift in future.

From various wards information were collected of household's and location of shift is also collected during household interview. After interview of households in various wards of South zone, from that it was found that there 15 different location at which citizens want to shift for residential purposes. For that grouping of nearer location is require for decision making. Below table show the 6-different location of nearer locations for residential location choice of households

A. ANALYSIS FOR RESIDENTIAL LOCATION SHIFT USING MULTI CRITERIA DECISION MAKING OF RANGE AND RANKING APPROACH

TABLE 6
Shifting locations of household form sample surveyed

GROUP OF LOCATION SHIFT FOR RESIDENTIAL		NO. OF PREFERENCES FOR LOCATION	TOTAL NO. OF LOCATION PREFERENCES
LOCATION 1	VESU	60	137
	CITY LIGHT	42	
	ALTHAN	35	
LOCATION 2	ATHWALINE	22	61
	GHOD DOD ROAD	24	
	PIPLOD	15	
LOCATION 3	PARLE POINT	36	87
	PAL	39	
	ADAJAN	12	
LOCATION 4	RANDER	23	61
	JAHANGIRPURA	27	
	KOZVE	11	
LOCATION 5	VARACHHA	33	55
	KATARGAM	13	
	KAMREJ	09	
TOTAL		400	400

TABLE 7
Range approach in decision making

PARAMETERS	AREA				
	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4	LOCATION 5
POLLUTION	3.36	3.23	3.55	3.39	3.87
GARDEN	20.51	21.46	23.10	22.62	20.72
OPEN SPACE	3.1	3.29	3.62	3.52	3.14
WATER (QUALITY)	21.82	21.14	22.75	21.96	24.36
WATER (QUANTITY)	3.36	3.22	3.55	3.39	3.87
SEWAGE COLLECTION	21.82	21.14	22.75	21.96	24.36
SOLID WASTE COLLECTION	3.36	3.23	3.55	3.39	3.87
STORM WATER DISCHARGE	21.82	21.14	22.75	21.96	24.36
COST OF HOME	7.36	6.7	7.55	7.39	7.87
TRANSPORTATION CONECTIVITY	1.18	1.11	1.27	1.19	1.43
MODE OF TRAVEL	6.80	6.59	6.96	6.77	7.74
HEALH FACILITY	11.80	11.14	12.75	11.96	14.36
MARKET FACILITY	59.12	55.73	63.79	59.83	71.81
EDUCATION FACILITY	0.43	0.36	0.41	0.37	0.60
SOCIAL SECURITY	11.82	11.14	12.75	11.96	14.36
ENTERTAINMENT FACILITY	1.18	1.14	1.27	1.19	1.43
SCORE SUM	173.66	192.36	186.07	177.5	227.85
TOTAL SUM	957.42				
PERCENTAGE OF CHOICE	18.13	20.09	19.43	18.53	23.79

Calculation of each value of row is the sum of each parameters assign value defined in table and multiply with parameters assign value and response according of people’s opinion of that parameter.

Then after sum of each column was found out. Location 5 is normalized into $227.85/957.42$ (Sum of each column) $\times 100\%=23.79\%$ which shows that location 5 is higher choice among all location.

B. RANK BASED EVALUATION FOR LOCATION

TABLE 8
Converted New Score Based On Range

PARAMETER	AREA				
	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4	LOCATION 5
POLLUTION	4	5	2	3	1
GARDEN	5	3	1	2	4
OPEN SPACE	5	3	1	2	4
WATER	4	5	2	3	1
WATER	4	5	2	3	1
SEWAGE COLLECTION	4	5	2	3	1
SOLID WASTE COLLECTION	4	5	2	3	1
STORM WATER DISCHARGE	4	5	2	3	1
COST OF HOME	4	5	2	3	1
TRANSPORTATION CONECTIVITY	4	5	2	3	1
MODE OF TRAVEL	3	5	2	4	1
HEALH FACILITY	4	5	2	3	1
MARKET FACILITY	4	5	2	3	1
EDUCATION FACILITY	2	5	3	4	1
SOCIAL SECURITY	4	5	2	3	1
ENTERTAINMENT FACILITY	4	5	2	3	1
SCORE SUM	63	76	31	48	22
TOTAL SUM	240				
PERCENTAGE OF CHOICE	26.25	31.66	12.91	17.91	9.16

The values of each row show the rank. Since smaller rank value is more preferable than higher rank, need to normalize the sum using formula below: The total sum is 240

(=63+76+31+48+22). The normalized score of location 2 is $(100 \times 76) / 240 = 31.66\%$ which shows that location 2 is higher choice of household.

C. CONVERTED NEW SCORE BASED ON RANGE

TABLE 9
Converted New Score Based On Range

PARAMETER	AREA				
	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4	LOCATION 5
POLLUTION	0.59	0.5575	0.6375	0.5975	0.7175
GARDEN	4.8775	5.115	5.525	5.405	4.93
OPEN SPACE	0.525	0.5725	0.655	0.63	0.535
WATER	5.205	5.035	5.4375	5.24	5.84
WATER	0.59	0.555	0.6375	0.5975	0.7175
SEWAGE COLLECTION	5.205	5.035	5.4375	5.24	5.84
SOLID WASTE COLLECTION	0.59	0.5575	0.6375	0.5975	0.7175
STORM WATER DISCHARGE	5.205	5.035	5.4375	5.24	5.84
COST OF HOME	1.59	1.425	1.6375	1.5975	1.7175
TRANSPORTATION CONECTIVITY	0.045	0.0275	0.0675	0.0475	0.1075
MODE OF TRAVEL	1.45	1.3975	1.43	1.4425	1.685
HEALH FACILITY	2.7	2.535	2.9375	2.74	3.34
MARKET FACILITY	14.53	13.6825	25.6975	14.7075	17.7025
EDUCATION FACILITY	0.51	0.56	0.75	0.73	0.45
SOCIAL SECURITY	2.705	2.535	2.9375	2.74	3.34
ENTERTAINMENT FACILITY	0.045	0.035	0.0675	0.0475	0.1075
SCORE SUM	46.3625	44.66	59.93	47.6	53.5875
TOTAL SUM	252.14				
PERCENTAGE OF CHOICE	18.3876	17.71238	23.76854	18.8784	21.25307

Now transforming the score value of each parameter in to the same range value 0 to 1 by following formula based on simple geometric of a line segment;

$$\text{NEW SCORE} = (\text{nub} - \text{nlb}) / (\text{oub} - \text{olb}) \times (\text{original score} - \text{olb})$$

nub= New upper bound oub=Original upper bound nlb =New lower bound olb=original lower bound.

D. WEIGHTAGE BASED ON APPROACH

After obtaining expert survey forms in various field expert of town and urban planners, rating of various parameters were given by all expert in 1 to 5 scale, Around 25 forms were filled.

Calculation of weightages of all parameters are given below.

TABLE 10
Weightage Based On Approach

PARAMETERS	1	2	3	4	5	IMPORTANCE OF LEVEL	IMPORTANCE OF WEIGHTAGE
POLLUTION	1	6	9	7	2	3.12	6.409203
GARDEN	0	7	11	7	0	3	6.162695
OPEN SPACE	0	6	13	6	0	3	6.162695
WATER	0	2	13	9	1	3.36	6.902219
WATER	0	6	11	5	3	3.2	6.573541
SEWAGE COLLECTION	3	5	9	8	0	2.88	5.916187
SOLID WASTE COLLECTION	0	6	9	8	2	3.24	6.655711
STORM WATER DISCHARGE	1	8	10	5	1	2.88	5.916187
COST OF HOME	1	3	9	9	3	3.4	6.984388
TRANSPORTATION CONECTIVITY	0	0	10	8	2	2.88	5.916187
MODE OF TRAVEL	0	1	13	10	1	3.44	7.066557
HEALH FACILITY	0	8	11	6	0	2.92	5.998357
MARKET FACILITY	0	4	13	5	3	3.28	6.73788
EDUCATION FACILITY	2	12	6	4	1	2.6	5.341002
SOCIAL SECURITY	3	5	8	6	3	3.04	6.244864
ENTERTAINMENT FACILITY	5	6	12	2	0	2.44	5.01232
TOTAL SUM						48.68	100

Importance level of all parameter calculate by multiplication of rate of each parameter and number of response of it rate and sum of it and division by total number of forms. For example importance level of pollution is calculated using an equation as: $[(1 \times 1) + (2 \times 6) + (3 \times 9) + (4 \times 7) + (5 \times 2) / 25] = 3.12$ and percentage of each parameter were also calculated. Weight of each parameter found out by division of 10

TABLE 11
Weightage of each Parameters

PARAMETER	WEIGHT
POLLUTION	0.064092
GARDEN	0.061627
OPEN SPACE	0.061627
WATER (QUALITY)	0.069022
WATER (QUANTITY)	0.065735
SEWAGE COLLECTION	0.059162
SOLID WASTE COLLECTION	0.066557
STORM WATER DISCHARGE	0.059162
COST OF HOME	0.069844
TRANSPORTATION CONNECTIVITY	0.059162
MODE OF TRAVEL	0.070666
HEALH FACILITY	0.059984
MARKET FACILITY	0.067379
EDUCATION FACILITY	0.05341
SOCIAL SECURITY	0.062449
ENTERTAINMENT FACILITY	0.050123

E. CONCLUDING REMARK

Fixing a residential choice location is of a very complex nature for every households. Multi criteria decision making method helps among criteria having more choice by households out of multiple criteria and higher percentage location can also be obtained from this method. At the end of three different exercises using multi-criteria decision making methods, it was identified that the preference of citizens residing in the South Zone of Surat city have choice inclination towards 'location 3' i.e. Parle Point, Pal & Adajan locality. The value of each row calculated using value of table 8 of each row and multiplication with weight of each parameter and division by 100. For example, location 2 of pollution parameter calculate by $0.064092 \times (0.5575)/100 = 0.00030774$

Then after sum of each column is calculated and total sum of each column is find out. $(0.029751873+0.028528331+0.038845412+0.030324391+0.034663116) = 0.162113$

Normalized score of location 2 is found out by $(0.038845412 \times 100) / 0.162113 = 23.96191701\%$.

TABLE 12
Weightage Score of Each Location

PARAMETER	AREA				
	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4	LOCATION 5
POLLUTION	0.00032568	0.00030774	0.0003519	0.00032982	0.00039606
GARDEN	0.00249728	0.00261888	0.0028288	0.00276736	0.00252416
OPEN SPACE	0.000258825	0.000282243	0.000322915	0.00031059	0.000263755
WATER	0.003607065	0.003489255	0.003768188	0.00363132	0.00404712
WATER	0.00041595	0.000391275	0.000449438	0.000421238	0.000505838
SEWAGE COLLECTION	0.00356022	0.00344394	0.00371925	0.00358416	0.00399456
SOLID WASTE COLLECTION	0.00041182	0.000389135	0.000444975	0.000417055	0.000500815
STORM WATER DISCHARGE	0.00334161	0.00323247	0.003490875	0.00336408	0.00374928
COST OF HOME	0.00089676	0.000803	0.00092355	0.00090099	0.00096867
TRANSPORTATION CONECTIVITY	0.00003258	0.00001991	0.00004887	0.00003439	0.00007783
MODE OF TRAVEL	0.00086855	0.000837103	0.00085657	0.000864058	0.001009315
HEALH FACILITY	0.0017631	0.001655355	0.001918188	0.00178922	0.00218102
MARKET FACILITY	0.01014194	0.009550385	0.017936855	0.010265835	0.012356345
EDUCATION FACILITY	0.000272	0.000299	0.000401	0.00039	0.00024
SOCIAL SECURITY	0.001696035	0.001589445	0.001841813	0.0017179	0.00209418
ENTERTAINMENT FACILITY	0.000023805	0.000018515	0.00003212	0.00003112	0.00003382
SCORE SUM	0.029751873	0.028528331	0.038845412	0.030324391	0.034663116
TOTAL SUM	0.162113				
PERCENTAGE OF CHOICE	18.35253831	17.5977925	23.96191701	18.70569787	21.38205431

The value of each row calculated using value of table 8 of each row and multiplication with weight of each parameter and division by 100. For example, location 2 of pollution parameter calculate by $0.064092 \times (0.5575)/100 = 0.00030774$. Then after sum of each column is calculated and total sum of each column is find out. $(0.029751873+0.028528331+0.038845412+0.030324391+0.034663116) = 0.162113$

The very basic understanding from the results obtained from the exercises is that the city is developing nicely in these localities and have settlement preference of people nearby.

Normalized score of location 2 is found out by $(0.038845412 \times 100) / 0.162113 = 23.96191701\%$.

In all 3 methods percentage of location 3 is higher among all location which means majority of people wants to shift in location 3 (Pal, Adajan and Parle Point) From above three methods location 2 get higher percentage which means that majority of want to shift on location 3 i.e. in Pal, Adajan and Parle Point.

A similar attempt shall be made in the other parts of the city to understand the residential choices in a larger perspective.

ACKNOWLEDGMENT

The authors are grateful to the almighty and like to thank Dr. Kamal Padhiar, HOD of civil Department, BMCET for his motivation and thanks to Assistant Prof. Mr. Yash Jayswal, Assistant Professor of Civil engineering Department for advice and suggestions. At the juncture, the support from family members is also acknowledged along with colleagues.

REFERENCES

1. Darshika R. Patel, Bhasker Vijaykumar Bhatt. "Analysis of residential location choice using Multi criteria decision making"
2. Amnon Frenkel, E. b. (2013). Residential location choice of knowledgeworkers: the role of amenities, workplace and lifestyle. *Cities, Science Direct*, 33-41
3. E. Triantaphyllou, B. S. (1998). Multi-Criteria Decision Making: An Operations Research Approach. *Encyclopedia of Electrical and Electronics Engineering*, 175-186.
4. Asiyanbola, A. R. (2006). Residential location decision-making and gender in Nigeria. *GEOFORUM*, 1059-1065.
5. Bhat, J. G. (n.d.). Residential location choice modelling: accommodating sociodemographic, school quality and accessibility effects.
6. Literature, T. r. (2011). Modelling household residential choice using multiple imputation. *China*
7. Xiang HE, L. Z. (2012). Quantifying the self-selection effect in residential location and vehicle use choices with a structural equation model. *CICTP*, 3581-3592.
8. Veronika, g. A. (2013). Impact of urban planning on household's residential decisions: an agent-based simulation model for Vienna. *Environmental Modelling & Software*, 92-103
9. Francesca Pagliara, J. P.-H. (2002). Residential location choice behavior in Oxfordshire. *Association for European Transport*
10. Martin Aruldoss, T. M. (2013). A Survey on Multi Criteria Decision Making Methods and Its Applications. *American Journal of Information Systems*, 31-43.
11. Corporation, S. M. (n.d.). The City/Linkages. Retrieved from Surat Municipal Corporation: <https://www.suratmunicipal.gov.in/The City/Linkages>