Analysis of residential location choice using Multi criteria decision making

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Abstract—In any urban area, the residential location is an integral part of urban planning. Residential location choice of households are core agents in the urban dynamic system. Selection of 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 likes the characteristics of the housing unit, its location with respect to social and environmental amenities as well as access to jobs, services and other economic opportunities. Location choice change with city to city depending on above stated factors and city characteristics. The study considers residential choice for location shift of households in South-west 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. For analysis of location choice Ranking and Weightage approach of multi criteria decision making is used. Out of six different location shift was found in analysis and among all location which have higher percentage which means that majority households want to shift in that location

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

I. INTRODUCTION

HOUSEHOLDS 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 evolution of household membership and family structures over time, job sitting changes, and other socio-economic conditions impact households to change residential locations.

II. STUDY AREA PROFILE

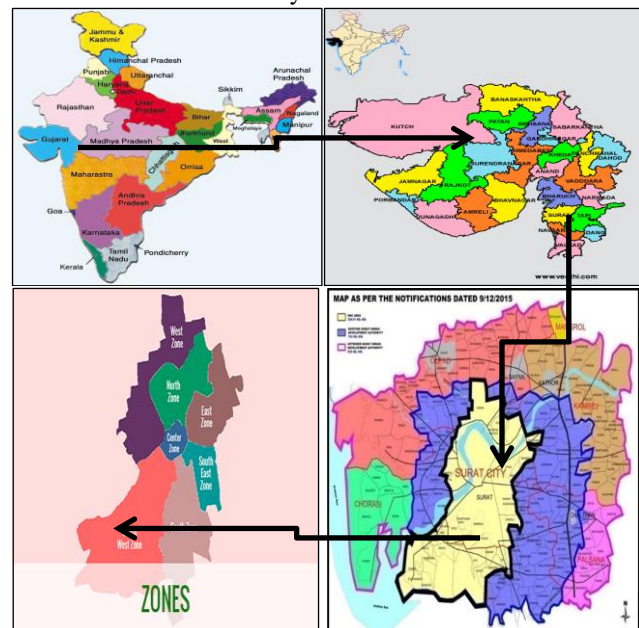South-West Zone also known as Athwa Zone is situated on the South-West side of Surat city.

Figure 1 Study area: South west zone

Table I
Zone wise Area of Surat City

Sr. 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
8	Total	326.515

(Source: suratmunicipal.gov.in)

III. DATA COLLECTION

For the study of location shift of households in South-West 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-West 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.

The sample size a formula used that is Hogg and Tannis 2009 for number of sample size. For this survey work, 95% confidence level is taken. From this the above equation, total sample size is 384 ~ 400.

Table II
Details of Main factors & Sub parameters

Main criteria	Sub criteria
Environmental parameters	Pollution
	Gardens
	Open space
Infrastructural Facilities	Water quality
	Sewerage collection
	Solid waste collection
	Strom water discharge
Amenities	Health facilities
	Market facilities
	Educational facilities
	Social security
	Entertainment facilities
Cost of home/ property	
Transportation connectivity to work place	

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.

IV. ANALYSIS AND RESULTS

Survey samples were obtained from respondents residing in various wards of South-west 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.

Table III
Surveyed sample of types of home/building

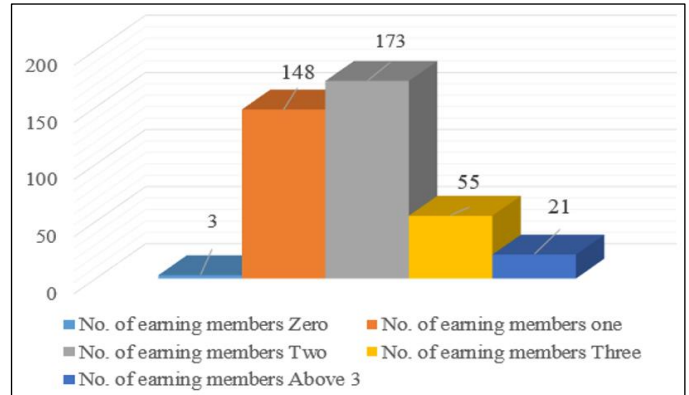| Category of types of homes	No. of surveyed samples	% of the surveyed sample
Apartment	151	38.10
Row house	66	16.40
Bungalow	79	19.70
Duplex	35	8.70
Other	69	17.20
Total	**400**	**100**

Figure 2 No. of earning members

Table IV
Surveyed sample of income of household per day

Category of income of household per month	No. of surveyed samples	% of the surveyed sample
Below 50,000	154	38.6
50,000-2 lakh	169	42.3
2 lakh-5 lakh	53	13.4
Above 5 lakh	23	5.7
Total	**400**	**100**

Based on pilot survey carried out in South-west zone of households of Surat above category were identified to be predominating and classified accordingly.

B. Migration details

Table V
Surveyed sample of migration details

Migrations details	Response	Response of no. of surveyed sample	Percentage (%)
Migration out of state	Yes	45	11.8
	No	336	88.2
Migration within state	Yes	96	27.4
	No	255	72.6
Migration in inner shift	Yes	84	24.8
	No	258	75.4

V. ANALYSIS OF AFFECTING PARAMETERS FOR RESIDENTIAL LOCATION CHOICE

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

The study is carried out in each ward of the South West zone and home interviews were carried out in each wards of South West 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-West 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-West zone, from that it was found that there 24 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.

Group of location shift for residential		No. of preferences for location	Total No. of location preferences
Location 1	Althan	58	90
	Bharthana	11	
	Bhimrad	21	
Location 2	Vesu	60	90
	VIP road	30	
Location 3	City light	30	73
	Ghod dod road	19	
	Parle point	24	
Location 4	Dumas	11	52
	Piplod	41	
Location 5	Adajan	32	53
	Anandmahal road	3	
	Pal	18	
Location 6	Ahmedabad	2	42
	Bardoli	5	
	Bharuch	3	
	Hazira	2	
	Kamrej	8	
	Mandvi	1	
	Navsari	4	
	Sachin	4	
	Vadodara	3	
	Valsad	2	
	Vyara	8	
Total		400	400

Table VI
Grouping of shifting locations of household form sample surveyed

A. Analysis for residential location shift using Multi criteria decision making of range and ranking approach

Calculation of each value of row is the sum of each parameters assign value defined in table 20 and multiply with parameters assign value and response according of people's opinion of that parameter.

Table VII
Range approach in decision making

Parameters	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Pollution	3.20	3.69	4.12	3.85	3.68	4
Garden	22.11	26.56	25.21	23.46	25.66	26.43
open space	2.98	4.07	3.49	3.65	3.68	4.05
water(quality)	21.56	23.89	25.07	24.03	22.83	24.29
water(quantity)	3.51	3.71	3.9	3.58	3.6	3.71
Sewage collection	20.56	24	21.92	22.11	22.08	20.95
`Solid waste collection	3.24	3.84	3.41	3.62	3.57	3.29
Storm water discharge	17.89	23.56	19.73	21.54	22.45	20
Cost of home	5.24	4.44	4.07	4.46	5.3	4.67
Transportation connectivity	1.37	1.49	1.41	1.44	1.62	1.76
Mode of travel	7.96	8.2	8.32	7.96	7.6	6.62
Health facility	17.11	19	16.56	16.35	16.98	17.86
Market facility	96.11	94.44	89.73	85.58	93.4	90.48
Education facility	0.51	0.76	0.55	0.58	0.62	0.57
Social security	17.11	19.44	17.23	16.54	18.11	17.38
Entertainment facility	1.44	1.76	1.64	1.62	1.66	1.64
Score sum	241.9	262.85	246.36	240.37	252.84	247.7
Total sum	1492.02					
Percentage of location choice	16.21	**17.62**	16.51	16.11	16.95	16.60

Then after sum of each column was found out. Location 2 is normalized into 262.85 /1492.02(Sum of each column) x 100%=17.62% which shows that **location 2 is higher choice** among all location.

B. Rank based evolution

In this step, instead of using arbitrary values for each parameter, just rank the choice for each parameter. Smaller rank value is preferable than higher rank. Transforming the score value of each parameter according to the range value such that each parameter will have the same range.

Table VIII
Rank based evaluation for location

Parameters	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Pollution	6	4	1	3	5	2
Garden	6	1	4	5	3	2
open space	6	1	5	4	3	2
water(quality)	6	4	1	3	5	2
water(quantity)	5	2	1	4	3	2
Sewage collection	6	1	4	2	3	5
Solid waste collection	6	1	4	2	3	5
storm water discharge	6	1	5	3	2	4
cost of home	2	5	6	4	1	3
transportation connectivity	6	3	5	4	2	1
mode of travel	3	2	1	3	4	5
Health facility	3	1	5	6	4	2
market facility	1	2	5	6	3	4
Education facility	6	1	5	3	2	4
Social security	5	1	4	6	2	3
entertainment facility	5	1	3	4	2	3
score sum	78	31	59	62	47	49
Total sum	326					
Normalized score	**38.04**	**45.25**	**40.95**	**40.49**	**42.79**	**42.48**

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:

Normalized Score= 0.5 x (1 - sum / Total sum)

The total sum is 326 (=78+31+59+62+47+49). The normalized score of location 2 is 0.5 x (1-31/326) = 45.25 % which shows that **location 2 is higher choice** of household.

C. Converted new score based on range

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;

New Score= (nub - nlb) / (oub - olb) x (original score – olb) + nlb

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

Table IX
Converted new score based on range for each location

Parameters	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Pollution	0.55	0.67	0.78	0.71	0.67	0.75
Garden	0.61	0.83	0.76	0.67	0.783	0.8215
open space	0.5	0.77	0.63	0.66	0.67	0.76
Water(quality)	0.58	0.69	0.75	0.7	0.64	0.71
Water(quantity)	0.63	0.68	0.73	0.65	0.65	0.68
Sewage collection	0.53	0.7	0.6	0.61	0.6	0.55
Solid waste collection	0.56	0.71	0.6	0.66	0.64	0.57
Storm water discharge	0.39	0.68	0.49	0.58	0.62	0.5
Cost of home	0.53	0.43	0.38	0.43	0.54	0.46
Transportation connectivity	0.19	0.25	0.21	0.22	0.31	0.38
Mode of travel	0.87	0.9	0.92	0.87	0.83	0.7
Health facility	0.71	0.9	0.66	0.6	0.7	0.79
Market facility	0.92	0.89	0.79	0.72	0.87	0.81
Education facility	0.51	0.76	0.55	0.58	0.62	0.57
Social security	0.71	0.944	0.72	0.65	0.81	0.73
entertainment facility	0.44	0.76	0.64	0.62	0.66	0.64
Sum	8.79	10.81	9.57	9.31	9.95	9.78
Total sum	58.21					
Normalized score	15.1	**18.57**	16.44	15.99	17.09	16.8

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: [(1x1)+(2x1)+(3x4)+(4x12)+(5x7)/25]=3.92 and percentage of each parameter were also calculated. Weight of each parameter found out by division of 100.

Table X
Percentage of each parameter converted in to weight

Parameters	Weight
Pollution	0.065
Garden	0.0633
Open space	0.062
Water(quality)	0.0725
Water(quantity)	0.0699
Sewage collection	0.0653
Solid waste collection	0.0659
Storm water discharge	0.0547
Cost of home	0.062
Transportation connectivity	0.0613
Mode of travel	0.0547
Health facility	0.0639
Market facility	0.0606
Education facility	0.06
Social security	0.0692
Entertainment facility	0.05

The value of each row calculated using value of table 27 of each row and multiplication with weight of each parameter and division by 100. For example, location 2 of pollution parameter calculate by 0.67 x (0.065)/100= 0.000435.

Then after sum of each column is calculated and total sum of each column is find out. (0.0057925+2.1085621+0.0064042+0.0066335+0.006541) = 2.1401452

Normalized score of location 2 is found out by (2.1085621 x 100)/ 2.1401452 = 98.52%.

In Range approach method percentage of location 2 is 17.62%, in ranking approach method percentage of location 2 is 45.25 % and in Weightage approach method percentage of location 2 is 98.52% which is highest percentage among all location.

In all 3 methods percentage of **location 2** is higher among all location which means majority of people wants to shift in location 2 **(Vesu & VIP road)** From above three methods **location 2** get higher percentage which means that majority of want to shift on location 2 i.e. in Vesu and VIP road.

A. *Reasons for shift to other zone or location*

From the graph, it shows that 72.2% households want infrastructure facilities, 65.5% better environment, 61.4%, better amenities, 34.5%, work place is nearer to, 27.5% low building cost and 10.5% any other reasons at shifting location.
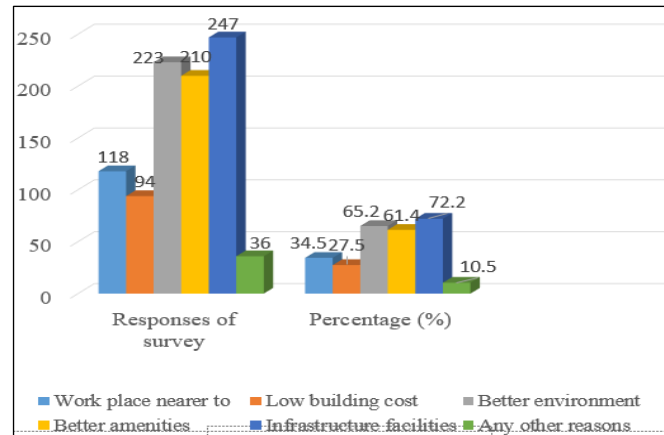

Figure 3 Graph of reasons for shift to other zone or location

VI. Concluding Remarks

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-West Zone of Surat city have choice inclination towards 'location 2' i.e. Vesu and VIP road locality. 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. A similar attempt shall be made in the other parts of the city to understand the residential choices in a larger perspective.

Table 1
Weightage score of each location

Parameters	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Pollution	0.0003575	0.0004355	0.000507	0.0004615	0.0004355	0.000488
Garden	0.0003861	0.220448	0.0004811	0.0004241	0.0004956	0.00052
Open space	0.00031	0.031339	0.0003906	0.0004092	0.0004154	0.000471
Water(quality)	0.0004205	0.164841	0.0005438	0.0005075	0.000464	0.000515
Water(quantity)	0.0004404	0.025228	0.0005103	0.0004544	0.0004544	0.000475
Sewage collection	0.0003461	0.168	0.0003918	0.0003983	0.0003918	0.000359
Solid waste collection	0.000369	0.027264	0.0003954	0.0004349	0.0004218	0.000376
Storm water discharge	0.0002133	0.160208	0.000268	0.0003173	0.0003391	0.000274
Cost of home	0.0003286	0.019092	0.0002356	0.0002666	0.0003348	0.000285
Transportation connectivity	0.0001165	0.003725	0.0001287	0.0001349	0.00019	0.000233
Mode of travel	0.0004759	0.0738	0.0005032	0.0004759	0.000454	0.000383
Health facility	0.0004537	0.171	0.0004217	0.0003834	0.0004473	0.000505

Parameters	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
Market facility	0.0005575	0.840516	0.0004787	0.0004363	0.0005272	0.000491
Education facility	0.000306	0.005776	0.00033	0.000348	0.000372	0.000342
Social security	0.0004913	0.1835136	0.0004982	0.0004498	0.0005605	0.000505
Entertainment facility	0.00022	0.013376	0.00032	0.00031	0.00033	0.00032
Sum	**0.0057925**	**2.1085621**	**0.0064042**	**0.0062121**	**0.0066335**	**0.006541**
Total sum	2.1401452					
Normalized score	0.2706569	**98.524253**	0.2992423	0.2902635	0.3099542	0.30563

R E F E R E N C E S

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