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WSM APPLICATION FOR ANALYSIS RESIDENTIAL WORK DISTANCE: A CASE OF NZ OF SURAT

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ABSTRACT

The residential location choice process has been studied for several decades using different approaches which in general shows that many factors contribute to the choice of a given location as characteristics of city infrastructure, transportation facilities, housing unit, social and environmental amenities, access to jobs, services and other economic opportunities. Urban citizens intend to live surrounding their work locations and city center. Denser localities are found around city centers and industrial areas. Present study represents locational preference of residence from HIG, HMIG, LMIG & LIG categories of residents in NZ of Surat City. The assessment of these ward locational preferences is done by developing the Weighted Sum Model (WSM). Also the impact of work location factors – specifically work distance analysis upon residential choice is studied and found that residents with lower income prefer work location while residents with higher income desire over environment and infrastructure.

Keywords: Factor, North Zone, Residential Location Choice, Surat, WSM Application.

1. BACKGROUND

Urban population chooses to settle in residential zones depending upon zonal attributes and preferences for each of the attributes. Surat city, which is headquarter of Surat district is situated in the south Gujarat, along the western coast of India almost at equi-distance between Mumbai and Ahmedabad. NZ (Katargam Zone) of Surat city has variety of income group residents. North Zone

(NZ, to be referred to hereafter), also known as Katargam Zone, is situated on the Northern side of Surat city enjoying partial length of both banks of River Tapi. The NZ of the city is oldest one and nearby to walled city area. The NZwas considered for present study as it is established mainly as residential and industrial mixed land use.

The residential choice provides key insight into housing demand characteristics in terms of location quality. Livability and attractiveness of an urban area are often closely interlinked with housing availability and its price.

2. ABOUT SURAT AND STUDY AREA

City of Surat is one of the oldest (300 B.C) historical trade centers of India. It has most vibrant present and an equally varied heritage of the past. NZ of Surat is a residential area reporting decadal growth rate of 69% in last decade. Also, NZ is very nearby to CBD and it is having good transportation connectivity with other areas. The study area is nearly 34.45 Sq. Km in area housing a population of 7.04 Lacs which is 15.76% of population in Surat (Census 2011). Zone boundaries have spread over 11.13% of the city area. The decadal census data of population and area in the zones of Surat city is shown in ***Table 1***. Important to note here, is the CBD area is within the Central zone just adjoining to the NZ.

Table1: Zone wise decadal growth of Surat

Zone	Area Sq. Km.	Population (in Lacs)		Growth (%)
		2001	2011	
East	37.53	7.12	11.39	60%
West	51.28	2.87	4.25	48%
North	34.45	4.16	7.04	69%
South East	19.49	3.97	7.46	88%
South	61.76	4.08	6.93	70%
Central	8.18	4.14	4.09	-1%
South West	111.91	2.42	3.47	43%
Total	**326.52**	**28.76**	**44.62**	

(Source: Surat Municipal Corporation)

The population growth rates are high, indicating the rapid growth of congestion in the residential areas. It is clearly observed from ***Table 2*** that as far as the decade growth is concerned for the NZ, Chhapra Bhatha has a highest growth during decade 1991-2001 where in Singanpor and Kosad has reported highest growth during 2001-2011 which are 348% and 207% respectively.

Table 2: Ward wise population and decadal variation of study area

Ward No.	Name of Area	Area in Sq.Km	Population	Decadal Growth Rate (%)	
			2011	1991-2001	2001-2011
29	TPS-1 Laldarwaja	0.4	10226	35.52	-18.28
31	TPS-3 Katargam Gotalawadi	1.76	63225	8.26	-10.32
38	Tunki	1.87	48034	120.81	58.35
39	Singanpor	2.62	32323	116.21	348.00
40	Dabholi	2.54	20153	143.37	152.92
41	Ved	2.84	6366	15.35	27.22
42	Katargam	7	328280	170.77	70.46
70	Chhapra Bhatha	2.962	46793	422.89	99.84
71	Kosad	9.532	88206	258.11	207.73
72	Amroli	0.413	28487	31.04	66.22
73	Utran	2.916	21456	48.67	66.40

(Source: Surat Municipal Corporation)

The NZ in particular has shown rise in population increase due to immigration of people from other cities as well as settlement of slum rehabilitation in areas such as Kosad. The area of Katargam specifically has industrial estate (majorly, cloth manufacturing and allied industry units) area surrounded by residential areas. In addition, Gotalawadi has many number of SSI units of diamond and allied industries. Also, in the NZ, new building construction activity has picked up pace with rise in population and housing demands. Reducing population growth rate in specific wards indicate the substantial change in the land use i.e. residential to commercial conversion of building use allowing more people to work in these particular areas. Also, the Surat Municipal Corporation, using funding aid from diverse sources (as JnNURM) has accelerated construction of infrastructure and facilities in the NZ wards to cater the needs of newly settling citizens in the area which again thrusts the settlement process.

Further, below shown ***Table 3*** represents the present growth scenario of the study area in terms of population density which is consistently showing a rising trend except TPS 1 and TPS 3. It is observed from the table that the highest population density is identified in Amroli and Katargam area while the density at Dabholi, Utran and Ved wards are respectively low.

Based on the table, one can predict that the wards of Amroli and Katargam are highly dense and saturated whereas in other wards, there lies a huge potential for residential development (notably in Kosad and Utran).

Table 3: Ward wise density pattern in NZ

Ward No.	Name of Area	Area (Sq. Km)	Population density (ppha)			
			1981	1991	2001	2011
29	TPS - 1 Laldarwaja	0.40	226.23	230.85	312.85	255.65
31	TPS-3 Gotalawadi	1.76	210.03	369.99	400.57	359.23
38	Tunki	1.87	13.12	73.47	162.22	256.87
39	Singanpor	2.62	8.05	12.74	27.54	123.37
40	Dabholi	2.54	7.22	12.89	31.37	79.34
41	Ved	2.84	14.42	15.27	17.62	22.42
42	Katargam	7.00	26.71	101.61	275.13	468.97
70	Chhapra Bhatha	2.96	6.09	15.12	79.05	157.98
71	Kosad	9.53	5.48	8.40	30.07	92.54
72	Amroli	0.41	139.39	316.66	414.96	689.76
73	Utran	2.92	4.31	29.74	44.22	73.58

(Source: Surat Municipal Corporation)

3. WSM APPLICATION

The *Weighted Sum Model* (WSM) is conceivably the most frequently used methodology, especially in single dimensional problems. The WSM refers to making of a preference ranking in the presence of multiple factors. WSM is an approach to get the preference ranking among the finite number of factors. The method specifies how group information is to be processed in order to derive a preference. Each preference table in WSM methods has three main parts, namely (a) factors, (b) groups and (c) weight or relative importance to each group.

In general, suppose that a given MCDA problem is defined on '*m*' alternatives and '*n*' decision criteria. Furthermore, let us assume that all criteria are benefit criteria, that is, higher the values are, better it is. Next suppose that 'w_j' denotes the relative weight of importance of the criterion 'C_j' and 'a_{ij}' is the performance value of alternative 'A_i' when it is evaluated in terms of criterion 'C_j'. Then, the total (i.e., when all the criteria are considered simultaneously) importance of alternative 'A_i', denoted as '$A_i^{\text{WSM-score}}$' which is defined as follows:

$$A_i^{\text{WSM-score}} = \sum_{j=1}^{n} w_j a_{ij}, \text{ for } i = 1, 2, 3, \ldots, m.$$

For the maximization cases, the best alternative is one that yields maximum total performance value. The urban housing location process has been a complex phenomenon of housing market imperfections and a locator's personal choice mechanism. For present study, direct method of weight assignment is adopted which is a simple yet an effective technique. The basis of rank evaluation of each factor depends on person's opinion. In order to evaluate direct ratings, descriptive variables received are converted to numerical variables. Descriptive variables and their values (factors) are shown in ***Table 4*** below. These variables are scaled between 0 and 10. The preference score 'P_i' can be calculated by formula give below for each factor wherein the factor with highest 'P_i' value is considered as a first preference among the groups of factors. Here, 'M_{ij}' is the measure of preference of each group with respect to various factors.

$$P_i = \sum w_j \text{ (normal)} \times M_{ij} \text{ (normal)}$$

Table 4: Variables and factors used

Sr. No.	Environment, Infrastructure and Amenities Factor		Cost Factor		Pollution Factor	
	Descriptive variables	Value	Descriptive variables	Value	Descriptive variables	Value
1	Very poor	0	Low	0	Worst	0
2	Poor	2	High	2	Highly Objectionable	2
3	Fare	4	Medium High	4	Objectionable	4
4	Good	6	Affordable	6	Acceptable	6
5	Very good	8	Costly	8	Low	8
6	Excellent	10	Very Costly	10	Very low	10

4. DATA COLLECTION & ANALYSIS

There are various types of surveys that are carried out to assess two main components of residential location choice behavior.

(i) Secondary data search and,
(ii) Field survey

The inventory data of the NZ were obtained from document resources of SMC, SUDA, and Census of India. The field interviews were carried out by:

- The data collection at home
- The data collection at the destination or office/workplace

The study area in present work is NZ of Surat City and it is taken up to understand the residential location choice behavior. The study analysis is based on survey data collected through *Home Interviews* conducted in eleven areas namely:Tunki (ward 38), Singanpor (ward 39), Dabholi (ward 40), Ved (ward 41), Katargam (ward 42), TPS–3 Katargam Gotalawadi (ward 31), TPS–1 Laldarwaja(ward 29), Chhaparabhatha (ward 70), Kosad (ward 71), Amroli (ward 72) and Utran (ward 73).

Collected data from the survey (considering the Income groups and same were classified as LIG, LMIG, HMIG and HIG) focuses on analysis towards choices related to:

- Work place and Travel time
- Housing Attributes
- Locational Ranking Analysis
- Income Based Preference

Demographic profile, Infrastructural facilities and the travel behavior are equally important in understanding the housing activities in the study areas and are discussed in the following sections. It is very important to select few necessary factors for the clear cut understanding of choice behavior for residential locations. In present study, following factors were taken into consideration.

1. Environment Factor
   - Pollution
   - Gardens
   - Open Spaces

2. Infrastructure factor
   - Water supply
   - Sewerage connection
   - Solid waste collection
   - Storm water connection

3. Cost

4. Amenities
   - Accessibility
   - Health facility
   - Market facility
   - Education facility

5. Work Location
   - Transportation Connectivity to Work Place

The rating is given by descriptive variables to each factor and, average rating was given to different factors for different income groups. For Example, environment factor, there are three sub-factors and each was given different rates by respondents of different income groups. The average rating was calculated by taking average rating of these three environmental sub-factors for particular income group. Similarly, average rating was found out for different factors according to different income groups; and the income based average rating was obtained. For the WSM, following were the group weight criteria assigned to each income group.

Income Group	% Weight
LIG	20
LMIG	30
HMIG	30
HIG	20

Table 3: Average preference rating for TPS-1 Laldarwaja ward

Factors	Income Group			
	LIG	LMIG	HMIG	HIG
Weight	**0.2**	**0.3**	**0.3**	**0.2**
Environment	5.75	7.66	7.08	8.38
Infrastructural	8.63	7.66	7.85	7.88
Cost	7.99	8.04	7.71	6.07
Amenities	7.99	7.71	7.89	7.73
Work location	8.31	7.48	8.08	6.36

Table 3 is showing the average preference matrix for the different factors in selecting their residence, of different income group in TPS-1 Laldarwaja ward. This Preference matrix was further analysed and converted into Normalised matrix form to find out the preference score of different income group and factors that are shown in ***Table 4*** below:

Table 4: Normalized matrix with Preference table for TPS-1 Laldarwaja

Factors	LIG	LMIG	HMIG	HIG
Weight	**0.20**	**0.30**	**0.30**	**0.20**
Environment	0.69	0.91	0.84	1.00
Infrastructural	1.00	0.89	0.91	0.91
Cost	0.68	0.68	0.73	1.00
Amenities	1.00	0.97	0.99	0.97
Work location	0.69	0.82	0.73	1.00

Further, to calculate preference score from normalized preference table, each normalized value of factor is multiplied with their respective income group weight and obtained summation of value becomes the preference score. Similar technique was adopted and applied for all wards to obtain the preference score. Here, for sample, following ***Table 5*** shows the same for TPS-1 Laldarwaja ward.

Table 5: Normalized matrix with preference score for TPS-1 Laldarwaja ward

Factors	LIG	LMIG	HMIG	HIG	Preference Score
Weight	**0.20**	**0.30**	**0.30**	**0.20**	
Environment	0.69	0.91	0.84	1.00	0.86
Infrastructural	1.00	0.89	0.91	0.91	0.93
Cost	0.68	0.68	0.73	1.00	0.77
Amenities	1.00	0.97	0.99	0.97	0.98
Work location	0.69	0.82	0.73	1.00	0.81

In the table above, it is clearly observed that maximum performance score for TPS-1 Laldarwaja ward is found to be 0.98 for the amenities factor, whereas infrastructure factors give second performance score was found out 0.93 and work locations and cost performance score was found to be of lower of all factors. This result help in predicting that the citizen in TPS-1 Laldarwaja prefer over amenities and infrastructure against other aspects for choosing residential location.

5. RESULTS

Following charts are showing the results of the analysis on the performed survey. ***Table 6*** show the preference factor influencing in particular ward for the residential location choice.

Table 6: Summary of peak factor rating in localities

Factors / Wards	Environment	Infrastructure	Cost	Amenities	Work Location
TPS - 1 Laldarwaja	**-**	**8.63**	**-**	**-**	**-**
TPS-3Gotalawadi	**-**	**-**	**9.12**	**-**	**-**
Tunki	**-**	**-**	**-**	**-**	**9.36**
Singanpor	**-**	**-**	**8.92**	**-**	**-**
Dabholi	**-**	**-**	**-**	**-**	**8.92**
Ved	**-**	**8.51**	**-**	**-**	**-**
Katargam	**-**	**8.53**	**-**	**-**	**-**
ChhapraBhatha	**-**	**-**	**-**	**-**	**9.48**
Kosad	**-**	**-**	**-**	**-**	**9.82**
Amroli	**-**	**-**	**-**	**-**	**9.06**
Utran	**-**	**-**	**8.96**	**-**	**-**

The table shows the peak values of factor rating for each of the influencing factors for each of the ward locality of the NZ. It is clearly understood from the table that infrastructure has the influence in TPS-1, Ved and Katargam whereas the cost of residence influences in TPS-3, Utran and

Singanpor area and above all, for the rest of the localities, the work location governs the preference over other factors.

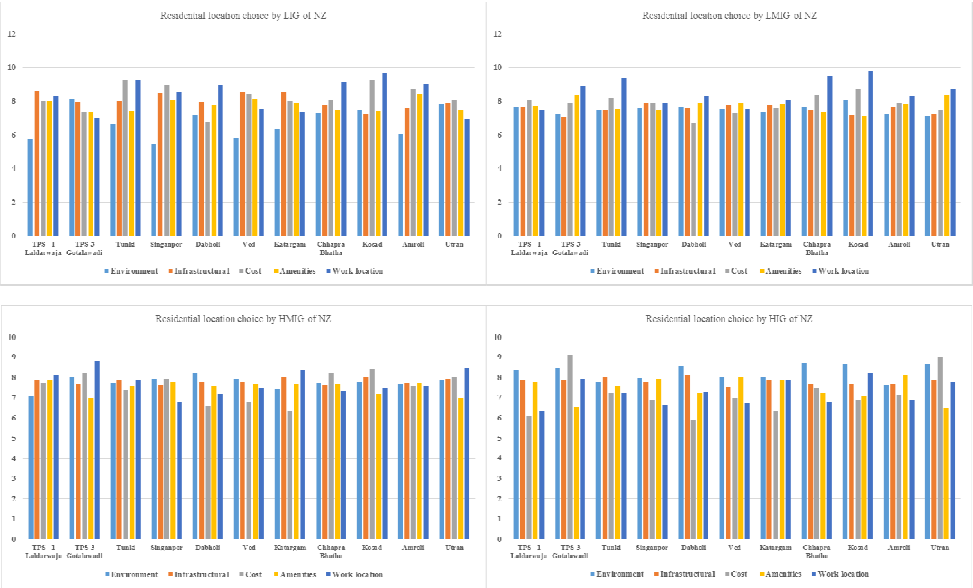

Figure 2: Residential locational choice by different income groups of NZ

Above Figure 2 show the individual values of residential locational choice of citizens wherein the influence of different factors can be visualized for various localities of the NZ.

6. CONCLUDING REMARKS

The NZ of Surat city having 12% of the total city area and accommodating 15.76% city population. This highly populated area of city having twelve different wards with major area occupied as residential zone. This residential zone is attracting yet more people from other parts of the city as present study indicate that the area is having high attraction factor (because of economic opportunities) for residential location choice of citizens. The findings from present study are summarized and discussed herewith.

Table 7: Locational preferences of citizens in North zone

Income Group / Factors	LIG	LMIG	HMIG	HIG	Average preference rating
	0.2	0.3	0.3	0.2	
Environment	6.72	7.51	7.77	**8.25**	7.56
Infrastructural	8.04	7.52	**7.81**	7.80	7.79
Cost	8.27	7.82	7.56	7.18	7.71
Amenities	7.77	7.76	7.52	7.44	7.62
Work location	**8.33**	**8.53**	7.78	7.24	**7.97**

Above ***Table 7*** well indicate that choice for a residential location of citizen/ respondents are under major influence of the work location (for LIG and LMIG) irrespective of other factors however, citizens belonging to HIG has preference for the environment conditions whereas HMIG citizens are influenced by the service infrastructure facilities. In general, it can be concluded from the study that on an average basis, irrespective of income group bifurcations, the preference of citizens for residential location choice is highly influenced by the "work location".

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