

Study of Spatial Variation for Provision of Public Utilities Services in the Jodhpur Municipal Area using Remote Sensing and GIS Technology

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Abstract: *The study shows the ward-wise disparity analysis and distribution of public amenities in Jodhpur Municipal area. Provision of three public amenities i.e. education facility, Gas Service and Petrol Pump were studied. The Location of Quietent technique and Gini coefficient were used to determine the spatial concentration and deficiencies of the three public Utilities. Remote Sensing (RS) data and Geographical Information System (GIS) Technology were used for mapping and visualisation of three public amenities. Lorenz Curve is used to examine the inequality in the distribution of public amenities in the study area. The analysis result shows that there is disparity in the distribution of amenities in the municipal wards. The amenities normally decrease from the center of the city to its fringes. The paper suggests that municipal authority must emulate with the urban growth in order to make the proper distribution of public amenities in the municipal area.*

Keywords: *Disparity, Public Utilities, RS & GIS, Lorenz Curve, Gini Coefficient.*

I. INTRODUCTION

Present study is an attempt to analysis and visualisation of the urban amenities in the light of changing dynamics, urban growth of the Jodhpur city. The growth of city without planning will lead to create many complex urban problems such as water, electricity, sewage etc. Remote sensing and GIS has been widely used in mapping of urban amenities. Various spatial analysis techniques is used for the mapping and visualisation of public amenities such as Education facility, gas Services and Petrol and pump their spatial distribution in various wards and affected populations.

The objective of this study is the need to impart RS and GIS technology in analysis of public amenities. The end result provides the spatial variations of public amenities in GIS maps.

- To examine the inequality in the distribution of public amenities using Lorenz Curve and Gini Coefficient.
- To examine and analyze the magnitude of spatial concentration and disparity in the city.

Study Area

Jodhpur is centrally situated in western region of the Rajasthan state. Jodhpur city is located at 26°18' N latitude and 73°04' E and at an average altitude of 224m above mean sea level. In general, the contours are falling from North to South and from North to Southeast with maximum level of 370m and minimum of 210m. The population of the city is about 11.38 lakh (Census, 2011) and area is about 78.6 sq km. Alongside, Jodhpur has been functioning as one of the engines powering the Indian economy. The Jaipur-Jodhpur corridor has emerged as the most vibrant economic belt of the nation. Jodhpur has strategic positioning apart from its close proximity to the state capital Jaipur. The establishment of large-scale core industries has led to the growth of ancillary and small-scale industries in and around this industrial belt. The landscape saw significant changes with each passing year as long stretches of farmland giving way to clusters of enclosed factory campuses. The basemap of the Jodhpur Municipal ward is given in Fig.1.

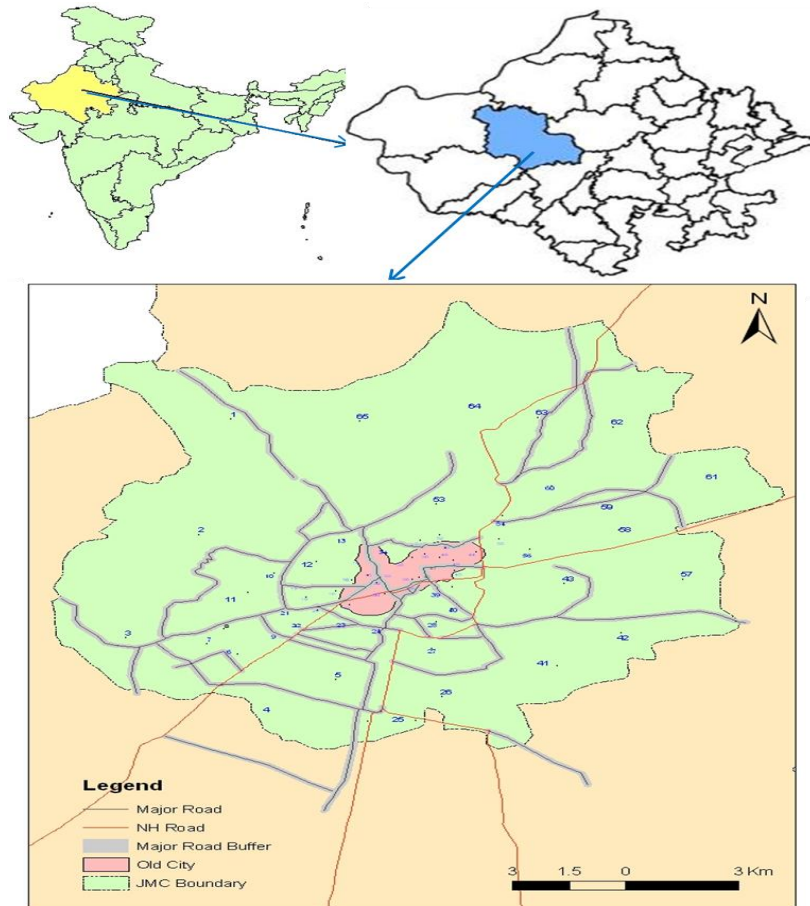


Figure1: Base Map of the Study Area

Data Used and Methodology

The Landsat data (2015) and Survey of India toposheets were used in this study. For georeferencing and subset of the study area ENVI software is used. ArcGIS software is used for preparation of basemap and visualisation of three public amenities in different minicipal wards. The spatial data are collected from field survey using GPS. The non spatial data of the facilities were collected from municipal department. The Location quotient method and Gini Coefficient with Lorenz curve were used for analysis of different public amenities of municipal ward of Jodhpur city. The detailed methodology is given in Fig.2.

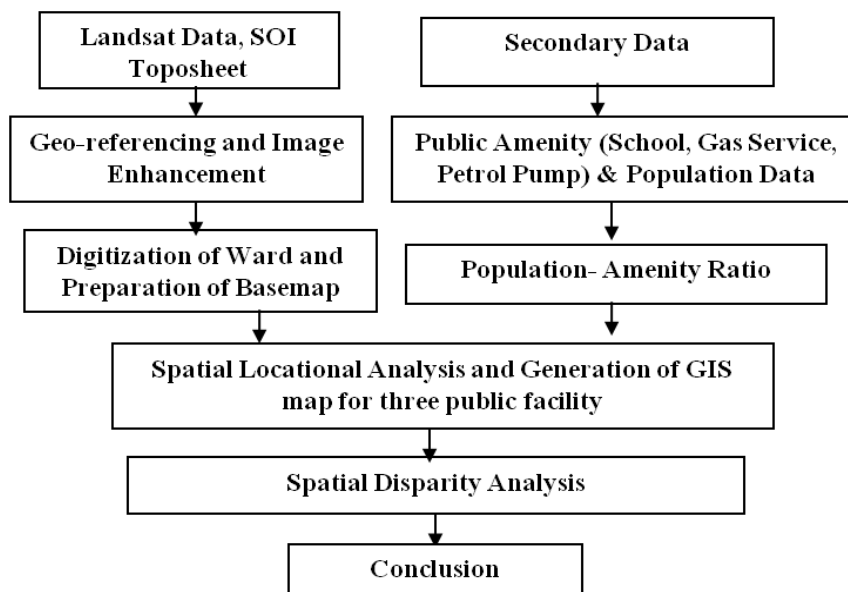


Figure2: Methodology Adopted

II. RESULT AND DISCUSSION

Spatial Analysis of Three Public Amenities

The spatial locational analysis of public amenities plays an important role in the formulation of locational planning and development of new utilities services. The spatial concentration of three public amenities is calculated by the statistical measure as 'Location Quotient'. The location quotient is a method for comparing a municipal ward's percentage share of a particular amenity with its percentage share of its population. The location quotient of different wards in Jodhpur city with respect to a particular facility provides knowledge about the level of concentration of that facility in those wards. For calculating the location quotient (L.Q.) for a particular facility 'i' in a particular ward, the following formula has been used (Equation-1).

$$LQ = (n_i / p) / (N_i / P) \quad (1)$$

Where n_i = Number of facility "i" in a given ward, p = Population of the concerned ward,

N_i = Number of facility "i" in Jodhpur city, P = Total Population of Jodhpur city.

If $L.Q < 1$, Indicates Deficiency,

$L.Q = 1$ Indicates self-sufficiency and

$L.Q > 1$, Concentration is indicated means the per capita availability of that public facility in the municipal ward exceeds that of the city as a total.

Location quotient of Education facility, Petrol Pump and Gas Service is given in Figure (3,4 & 5) and Table2.

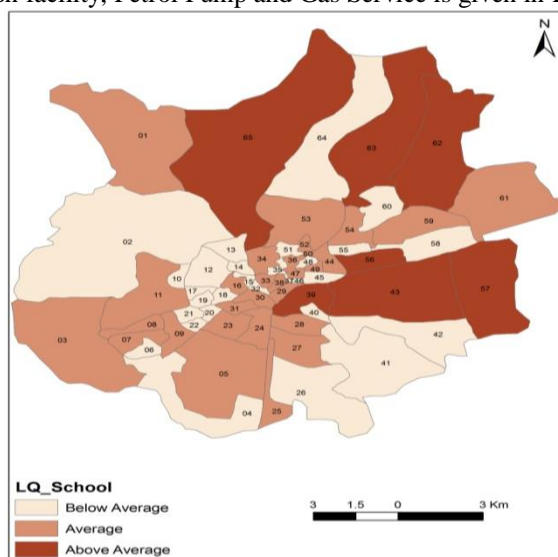


Figure3: Location of Quotient for Education Utilities

It is clear from the Fig.3 of Location of Quotient for Sr. Sec. School, 7 wards out of sixty five (10.7 percent) have above average concentration i.e. the per capita availability of the facility exceeds that of the city as a total, while as the twenty six wards (40 percent) have deficiency in the arrangement of provision of Sr. Sec. School facility.

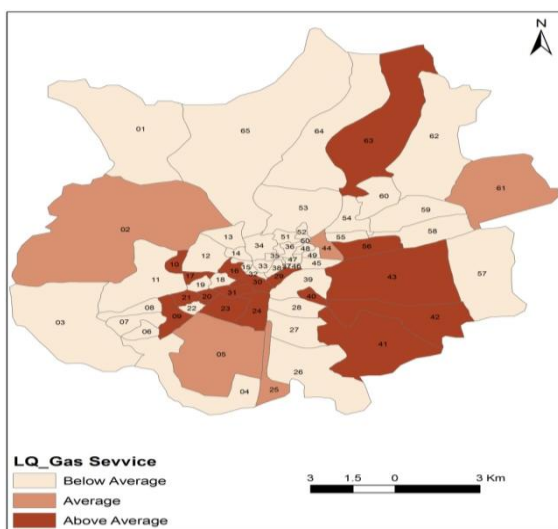


Figure4: Location of Quotient for Gas Service

In case of Gas Service, 16 wards out of sixty five (24.6 percent) have above normal concentration i.e; the per capita availability of the facility exceeds that of the city as a whole, while as the rest forty nine wards (75.3 percent) have deficiency in the arrangement of provision of Gas service facility (Fig.4). Similarly, in case of Petrol pump, 21 wards out of sixty five (32.3 percent) have above normal concentration i.e; the per capita availability of the facility exceeds that of the city as a whole, while as the rest forty four wards (67.7 percent) have deficiency in the arrangement of provision of Petrol pump (Fig.5).

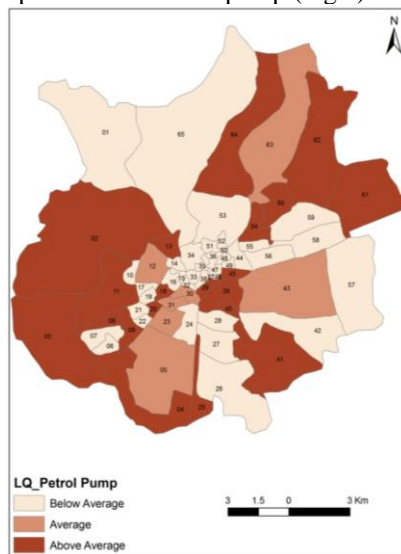


Figure5: Location of Quotient for Petrol Pumps

Spatial Disparity Analysis

The Gini coefficient is used with Lorenz curve that compares the distribution of a specific public amenity with the uniform distribution that represents equality (Epidemiological Bulletin, 2001). The diagonal line shows the equality distribution, and the larger deviations of the Lorenz curve from this line, the larger the inequality. By putting commutative percentage of a particular public facility in y axis and commutative percentage of population in x axis, the area of equality is calculated. The Gini coefficient is represent as a number between 0 and 1. Here number 0 represents the perfect equality and number for 1 total inequality (Gini Coefficient, 2007). Gini co-efficient is calculated using equation (2), for three public facility and given in table1.

$$G = 1 - \sum_{i=0}^{k-1} (Y_{i+1} + Y_i)(X_{i+1} - X_i) \quad (2)$$

Where,

Y = Cumulative proportion of the Public Amenity

X = Cumulative percentage of the population variable

G = Gini Coefficient

Table1: Gini Coefficient of three Public Amenities

Public Facility	Gini Coefficient
School Facility	.60
Petol Pump Facility	.67
Gas Service	.74

The degree of spatial inequality in the Jodhpur municipal area is highest for Gas Service followed by, Petrol Pump service stations and Lowest value is observed for School Facility.

(a) Spatial Disparity Analysis of Education Services

Spatial disparity exists in the provision of adequate higher secondary schools in Jodhpur city. It can be inferred, that seventy five percent population of the city share only 30 percent of the facility, while as the rest twenty five percent have the easy access to the remaining 70 percent of the facility which indicates the inequality in the provision of this facility (Fig.6).

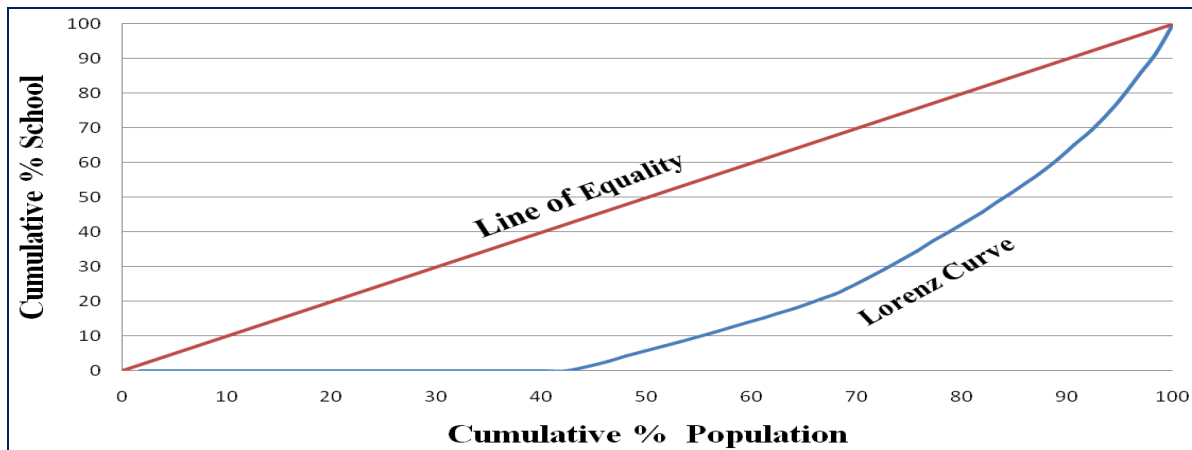


Figure6: Lorenz curves for Schools

(b) Spatial Disparity Analysis of Petrol Pump Service

Spatial disparity exists in the provision of Petrol pump in the Jodhpur city which is highlighted by the Fig.7. From the figure, it is evident that seventy percent population of the city have only 20 percent share of the facility, while as the rest 30 percent share the remaining 70 percent of the facility which is an indication of the inequality in the provision of this facility.

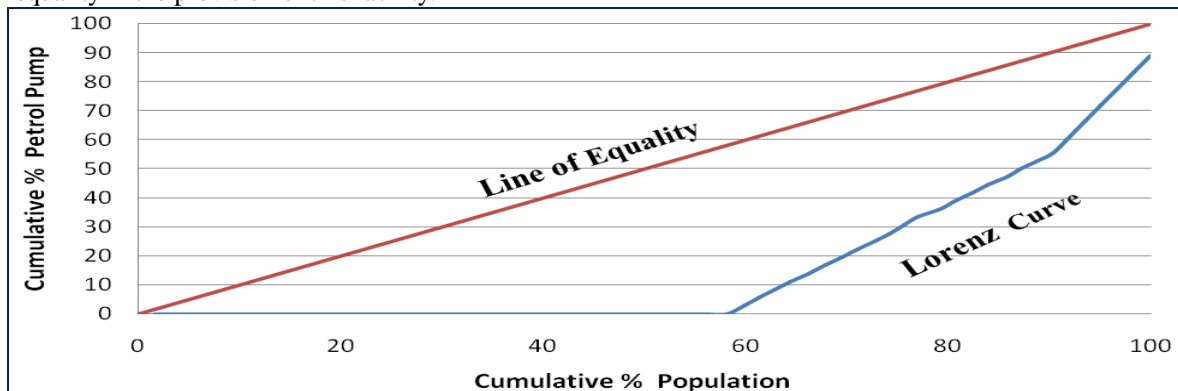


Figure7: Lorenz curves for Petrol Pumps

(c) Spatial Disparity Analysis of Gas Services

Spatial disparity exists in the provision of Gas Services in the Jodhpur city which is highlighted by the Fig.8. From the figure, it is evident that eighty percent population of the city have only 20 percent share of the facility, while as the rest 20 percent share the remaining 80 percent of the facility which is an indication of the inequality in the provision of this facility.

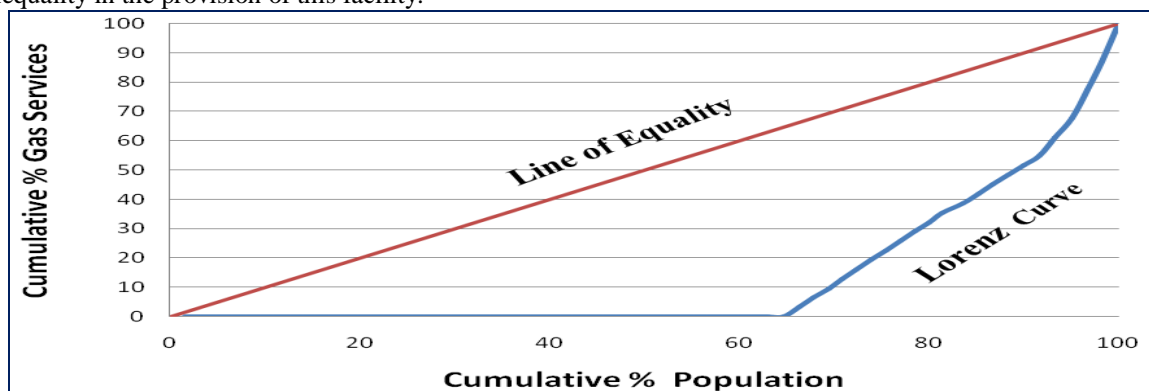


Figure8: Lorenz curves for Gas Services

III. CONCLUSION

The study shows that three public facilities such as School facility, Petrol Pump service and Gas Service are not evenly distributed among 65 municipal wards. The analysis of the distribution of three public amenities indicates that there is a lead-lag association among different wards in terms of the provision of public amenities. Some wards are more developed in terms of a particular public amenity while others lag far behind the average level of development of the city in terms of that amenity. The uneven distribution of public

amenities indicate that the existing planning might not produce acceptable results in terms of balanced development of different municipal ward. Since most of these amenities will be provided by the government, their availability and distribution must be planned carefully. Therefore, participatory approach is needed for ensuring the even distribution of urban amenities in Jodhpur city. The Result of this study can help policy-makers and Municipal authorities in proper planning in the distribution of public facility.

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Table2: Location of Quotient (LQ) for Three Public Amenities

Ward no.	Population Density	No. of School	No of Petrol Pump	No of Gas Agencies	LQ School	LQ Petrol	LQ Gas
1	1034.53352	2	0	0	1.723019607	0	0
2	596.2203155	0	1	3	0	0.602549667	0.172954
3	1236.370825	1	1	0	0.805674042	0.616626543	0
4	2033.362016	0	1	0	0	0.515077993	0
5	1346.009637	2	2	3	1.903212837	0.262923826	0.150938
6	19217.91513	0	0	0	0	0	0
7	11657.33182	1	0	0	0.811758182	0	0
8	13961.52711	1	1	0	0.88630239	0.560531039	0
9	10368.19401	1	1	1	0.907936273	0.547174967	0.471178
10	27305.8272	0	0	1	0	0	0.522294
11	2783.369224	2	1	0	1.567931819	0.638293061	0
12	6997.201429	0	2	0	0	0.298624819	0
13	13192.6659	0	1	0	0	0.616796144	0
14	33498.06798	0	0	0	0	0	0
15	52566.01417	0	0	0	0	0	0
16	23675.39618	2	0	1	1.830165589	0	0.470886
17	35549.47432	0	0	1	0	0	0.484943
18	32382.04443	0	1	0	0	0.611962518	0
19	31449.49945	0	0	0	0	0	0
20	35940.32073	0	1	1	0	0.521480428	0.449053
21	22798.72138	0	0	1	0	0	0.440728
22	34145.06145	0	0	0	0	0	0
23	9543.148382	2	2	1	1.730472551	0.289169568	0.498014
24	8713.212324	1	0	1	0.912390406	0	0.468878
25	9608.521986	2	1	2	1.64336459	0.608994502	0.262206
26	2121.112727	0	0	0	0	0	0
27	4785.071504	2	0	0	2.077785704	0	0
28	8101.842598	1	0	0	1.052260225	0	0
29	29535.18216	2	1	1	1.742866839	0.574226314	0.494473
30	18555.07176	2	2	1	1.849815486	0.270513467	0.465884
31	24630.47541	1	2	1	0.817022355	0.304030849	0.523609
32	63302.58897	0	0	0	0	0	0
33	41495.19064	1	0	0	0.847332774	0	0
34	10916.24873	2	0	0	2.01706081	0	0
35	45190.37505	0	0	0	0	0	0
36	30924.75884	2	0	0	2.068499308	0	0
37	152369.5658	0	0	0	0	0	0
38	44661.02291	2	0	0	1.799469818	0	0
39	5926.373044	4	1	0	3.926088756	0.509820364	0
40	24693.85322	0	1	1	0	0.480861007	0.414075
41	2330.201259	1	1	1	0.615384328	0.807300377	0.695175
42	2383.719204	0	0	1	0	0	0.479211
43	1282.866455	3	2	1	2.666507867	0.280816723	0.483629
44	18076.07106	1	0	2	0.812828137	0	0.263155
45	18881.6169	0	1	0	0	0.488450648	0
46	153882.3434	0	0	0	0	0	0
47	59279.3104	1	0	0	0.903386091	0	0
48	48767.30957	0	0	0	0	0	0
49	52382.88487	1	0	0	0.971068921	0	0
50	191199.5983	1	0	0	1.133164178	0	0
51	28201.05775	0	0	0	0	0	0
52	36519.17638	1	0	0	1.148604803	0	0
53	2823.65269	3	0	0	2.32662955	0	0
54	9041.098174	1	1	0	0.837760446	0.593009615	0
55	16544.38522	0	0	0	0	0	0
56	7930.909223	3	0	1	2.649307171	0	0.486769

57	1832.412614	4	0	0	3.005685165	0	0
58	3946.567753	0	0	0	0	0	0
59	3382.113146	1	0	0	1.055292948	0	0
60	7140.599979	0	1	0	0	0.627269001	0
61	1850.71125	1	1	4	0.763317107	0.650843529	0.140112
62	1039.841431	4	1	0	4.062240014	0.492733072	0
63	1177.287317	6	4	1	5.051498579	0.148411405	0.511195
64	1414.78467	0	1	0	0	0.607680095	0
65	496.9457489	4	0	0	3.708640993	0	0

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