

Spatial Analysis of Public Amenities Distribution in Jodhpur Municipal Area Using RS & GIS Techniques

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Abstract : The increase in population and area is causing lot of basic infrastructure and proper amenities problems in the Jodhpur city. Jodhpur is the second largest city of the Rajasthan and for establishing as an ideal city, factor like stability; health facility; education; and infrastructure, should be properly monitored. The paper examined the distribution of urban amenities in Jodhpur City. Spatial visualization and overlay analysis were carried out using Remote Sensing (RS) and GIS techniques. Landsat satellite data of 2015 and Survey of India map were used for georeferencing and digitization of 65 ward layers in Jodhpur city. The spatial distribution and concentration of three social amenities, viz, Educational, Gas Services and Petrol Pump were studied in the municipal wards. The Weighted Index Score has been used to determine the spatial concentration pattern in the provision of these amenities. The research outcomes would be of great importance for the government officials and urban planners to take necessary steps towards sustainable development of the city.

Keywords - Spatial Analysis, Public Amenities, Landsat Data, Weighted Index.

I. INTRODUCTION

The urban is a compound system of human and nature. It is also a high-dense geographical synthesis of population, resources, environment, social economic and so on. During the last fifty years the population of India has grown three times, but urban India has grown nearly five times. India is at an speeding up stage of the process of urbanization and expected to increase to over 533 million by the year 2021. Spatial techniques are used worldwide for urban facility management. Amenities throughout the world are facing unprecedented change. Privatization of government-owned amenities, competition for wholesale and even retail customers, and mergers and acquisitions have added new elements of risk to the management of amenities today. Better use of spatial data is one of the key areas of focus for many urban amenities mapping and management. In the present study amenities services are shown with the help of the database management systems by using GIS.

II. OBJECTIVE

The objective of this work is the need to infuse GIS technology in public amenities. The end result would provide spatial variations in the form of digital maps.

1. To identify three Amenity services as educational, Gas Services and Petrol Pump and their spatial distributional pattern in the City.
2. To examine and analyze the magnitude of spatial concentration and disparity in the city.
3. GIS based thematic maps will be generated for each Amenity services.

In the present study amenities services such as education, Gas service and petrol pump have been selected.

III. STUDY AREA

Jodhpur, one of the largest district of Rajasthan states is centrally situated in western region of the state. Jodhpur city is located at 26°N 18' latitude and 73° E 04' longitude 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 present population is about 1.05 million and has been functioning as one of the engines powering the Indian economy. As industry developed and the employment base widened, migrant population from all over flocked to Jodhpur. The city witnessed two types of immigration that of impoverished rural laborers and highly qualified professionals from other states. Jodhpur is now no longer regarded as a pensioners' heaven or just an administrative and educational centre as before; it has transformed into a young city with more and more professionals flocking into the city. These changes led to urban development in a ribbon form around the city along its peripheries (Fig.1).

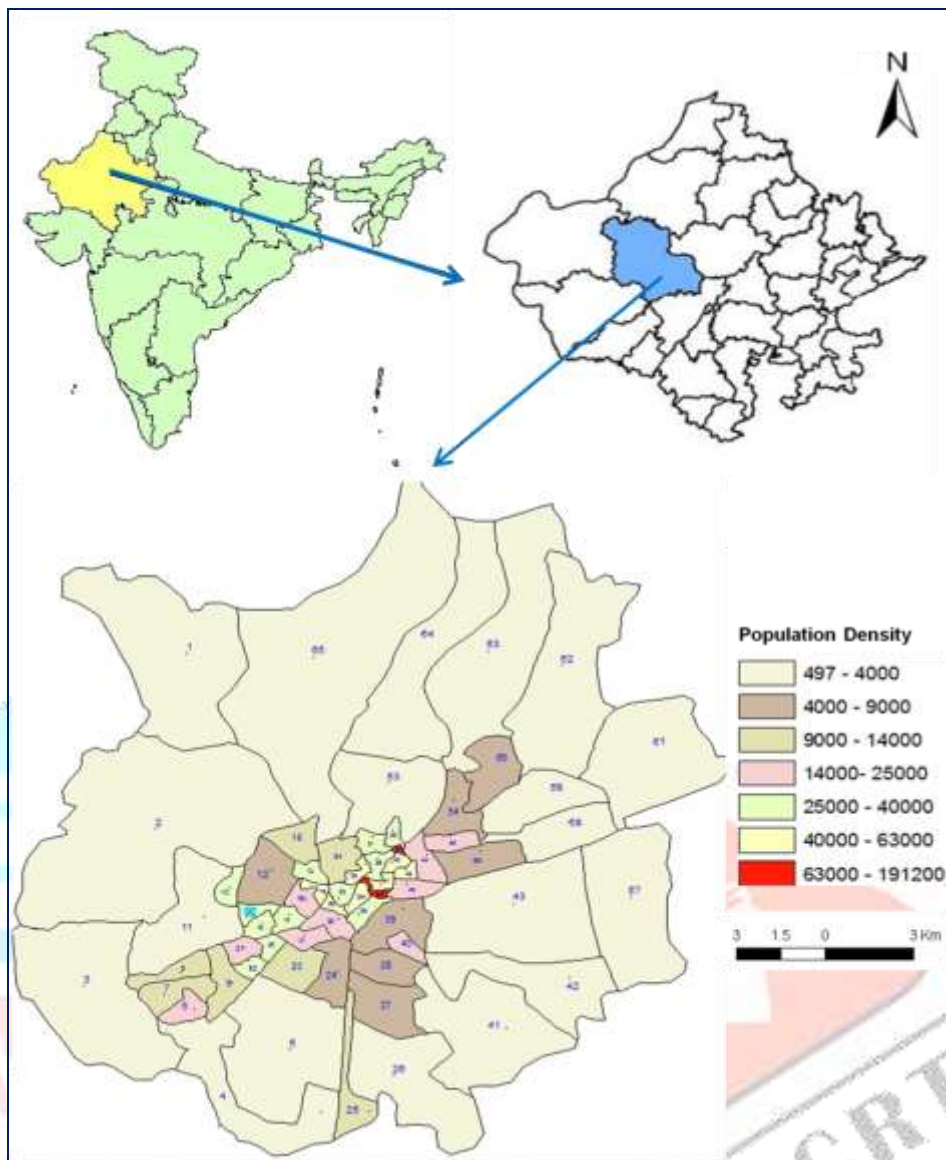


Fig.1 Population Density Map of the Jodhpur Municipal Area.

IV. DATA USED AND METHODOLOGY

In order to accomplish the objectives taken for the study, the methodology has been divided into two branches. First the base map was generated and subsequently by geo-referencing it was made compatible for making further maps. Secondly the data collected from different sources has been treated statistically by using the appropriate methods of determining the spatial distribution and spatial concentration. Image processing software ERDAS is used for geo-referencing and enhancement of satellite data. The enhanced data used in ArcGis software for digitization, preparation of base map and geodatabase generation. The Spatial data for three public amenities were collected from GPS field survey. The methodology flow chart is shown in Fig.2.

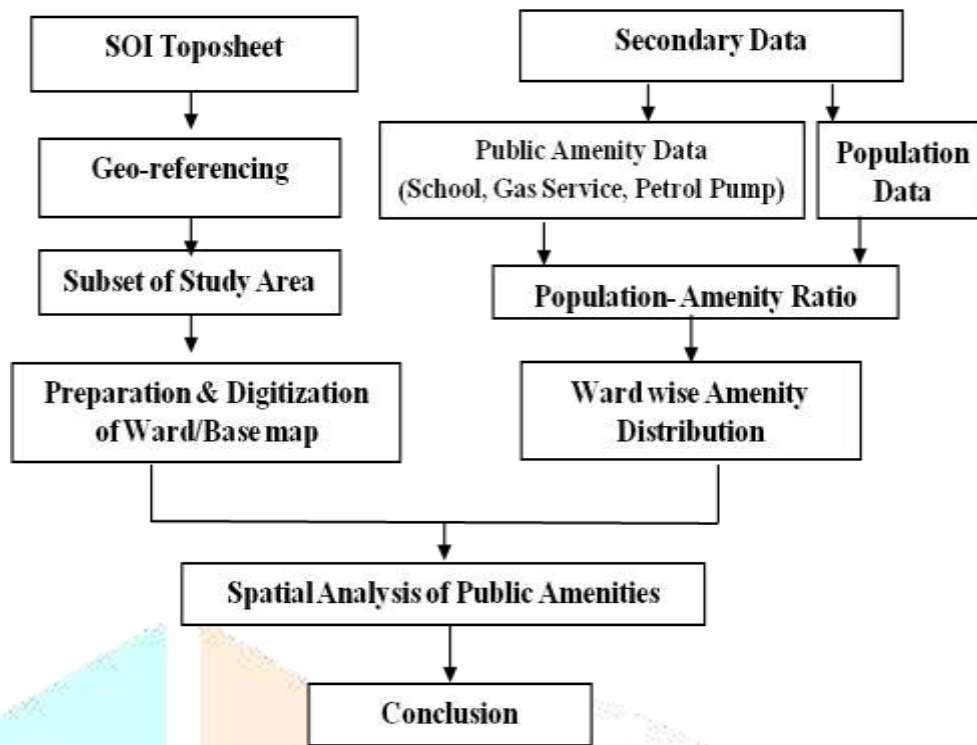


Fig.2 Methodology Flow Chart

V. RESULT AND DISCUSSION

5.1 Database Generation and Analysis of Educational Services

The education database consists of field GCP data and attributes data. Using these data, geospatial database is generated in ArcGIS Software. Jodhpur is well known as an educational hub in Rajasthan as well as in India. Study has got the best educational facilities right from nursery to higher education. It consists of schools colleges and other institutes. Table-1 indicates the attribute data of Sr. Sec. Schools, whereas Table-2 indicates attribute data of Higher Education in study area. The distribution of different educational institutions in the city has been presented in the Fig.3. Ward wise distribution of public amenities in Jodhpur city is presented in the Table-A1 in appendix A. A wide variation is observed in the availability of amenities across the wards.

Table-1 Number of Sr. Sec. School in the Study Area (2015).

S.N	Name & Address	NoofSt aff	Noof Student
1	K. V. No. 1 Air force, Near Polo Ground, Jodhpur.	86	1955
2	K. V. No. 1 Army, Military Area (Army), Jodhpur.	71	1612
3	K. V. No. 2 Air force, Air force Station, Jodhpur.	60	1405
4	K. V. No. 2 Army, Near Konark Auditorium, Banar, Jodhpur.	52	938
5	K. V. B.S.F. Mandore Road, Jodhpur	47	958
6	Govt. Girls Sr. Sec. School, Kissan Kanya, Nagori Bera, Mandore, Jodhpur.	45	434
7	Govt. Sr. Sec. School, In Front of Mandore Satellite Hospital, Chainpura, Jodhpur.	30	440
8	Shri Shiv Ram Nathu Ji Tak, Govt. Sr. Sec. School, Gokulji Ki Pion, Punjala, Jodhpur.	17	123
9	Govt. Girls Sr. Sec. School, Takoka Bass, Punjala, Jodhpur.	33	625

10	Govt. Sr. Sec. School, BhakarBera, BasniTambolia, Mata ka Than, Jodhpur.	16	86
11	Govt. Sr. Sec. School, Front of Mandore Police Station, Bhatanadi, Jodhpur.	11	96
12	Govt. Sr. Sec. School, Near, Mandore Police Choki, Mandore, Jodhpur.	9	56
13	Govt. Sr. Sec. School, MayaliMandawata, Mandore Road, Jodhpur.	8	61
14	Govt. Sr. Sec. School, Bhadwasia, Jodhpur.	21	275
15	Govt. Sr. Sec. School, NathjiKaMandir, Mahamandir, Jodhpur.	19	147

Source: Field Survey Data collection

Table -2 Higher Education Institute (2015)

Name	Address	No of Staff	No. of Student
Lucky Institute of Professional Studies	E.S.I. Hospital, Kamla Nehru Nagar, Jodhpur.	35	1200
Adarsh Mahavidhyalaya	Kamla Nehru Nagar, Jodhpur.	20	475
Aman T.T. College	3/9, K.B.H.B. Jodhpur.	14	80
Ashwarya College	Kamla Nehru Nagar, Jodhpur.	65	2000
Bharat Women B. Ed. College	Banar Road, Digari Kallan, Jodhpur,	20	200
Dr. S.NMedical College,	Shastri Nagar, Jodhpur.	215	625
G. D. Memorial College,	Sector-4, Kudi Bhatasni Housing Board, Jodhpur.	56	517
Industrial Training Institute College	Heavy Industrial Area, Jodhpur.	69	400
M.B.M. Engg College	Ratanada Circle, Jodhpur.	240	2500
Kamla Nehru College	Circuit House Road, Jodhpur.	65	4100
New Campus	New Pali Road, Jodhpur.	85	3000
Old Campus	Mohanpura Pulia, Jodhpur.	65	5500
Khataswar T.T. College	Nandri, Jodhpur.	11	100
K.M. S.Prashikshan Mahavaidhyalaya	Bhagawati Colony, High Court Road, Jodhpur.	8	100
Lachoo Memorial College of S & T	Sector A, Shastri Nagar, Jodhpur.	70	2200
Maharishi Dadhichi Mahila Mahavidyala	Sector-2, Madhuban Housing Board, Basni-1, Jodhpur.	9	200
Mahila P.G. Mahavidhalaya	Kamala Nehru Nagar, Soorsagar Road, Jodhpur.	42	3000
Mahila T. T. College	Soorsagar Road, Jodhpur.	20	100
Mahila Vidhi Mahavidhalaya	Kamala Nehru Nagar, Soorsagar Road, Jodhpur.	8	100
National Law University	Mandore. Jodhpur.	185	550
Natraheen Vikas Shansthan	D-Sector, Kamla Nehru Nagar, Jodhpur.	50	480
Polytechnic College ,	Near Nagar Nigam, Jodhpur.	107	1065
R. N. Memorial Women T.T College	Sector-2, Madhuban Housing Board, Basni-1, Jodhpur.	10	100
Shah Goverdhan Lal Kabra T. T. College	Umaid Hospital Road, Siwanchi Gate, Jodhpur.	40	215

Shri L B S Bed College	Paota C Road, Jodhpur.	8	100
Mahalaxmi GirlsCollege	Pratap Nagar, Jodhpur.	11	87
Shri P. S. R R. D Smriti Mahila Mahavidyalaya	Siwanchi Gate, Near Umaid Hospital, Jodhpur.	42	630
Trinity Women TT College	Tilak Nagar, Bhadasia Road, Jodhpur.	5	89

Source: Field Survey Data collection

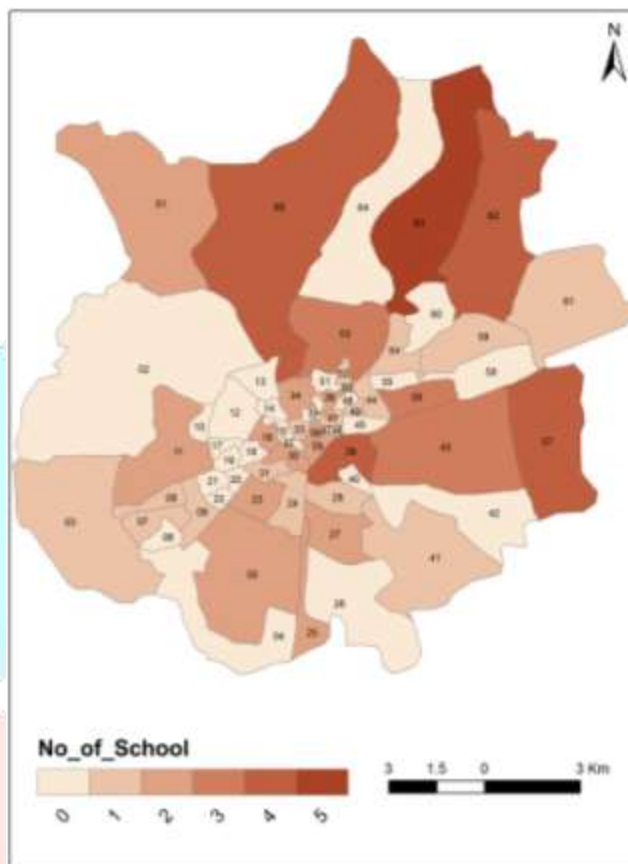


Fig.3. Distribution map of School in each Municipal ward .

Ward no 63, for example, accounts for the largest number of schools while ward no 2,4,6,10,12,13,14,15, 17,18,19,20,21,22,26,32,35,37,40,42,45,46,48,51,55,58,60 and 64 accounts for the zero number of school. Such variations indicate that the distribution of public facilities across wards is not proportional to the distribution of population. Ward no 12, 17, 19 accounts for the largest number of college while other ward accounts for the lowest number of college. Such variations indicate that the distribution of public facilities across wards is not proportional to the distribution of population.

5.2 Database Generation and Analysis of Petrol Pump Services

The petrol pump database consists of field GCP data and attribute data. Using these data, geospatial database is generated in ArcGIS Software. Table-3 indicates the number of Petrol Pump in the study area. The distribution of different Petrol pump in the city has been presented in the Fig.4. Ward no 5, 12, 23, 31, 30, 43 and 63 accounts for the largest number of Petrol Pump while other ward accounts for the lowest number of college. Such variations indicate that the distribution of Petrol pump facility across wards is not proportional to the distribution of population.

Table-3 Number of Petrol Pump in the Study Area.

Name	Address	Cap (K L)
Baba Ramdev Service	By Pass Road, Sursagar,Jodhpur	90
Basni Filling Station	Ind. Area Basni, Jodhpur.	70
Bharat Fuels	Kabir Nagar, Sursagar , Jodhpur.	75
Dalley Khan & Sons	Sursagar Road, Jodhpur.	122
Ganesh Auto Mobiles	Gujrabas, Banar Road, Jodhpur.	62
Ganeshlal& Sons	Residency Road, Jodhpur.	44
Gehlot Service Station	Sursagar Road, Jodhpur.	47
Himmat Petrol Service	Sursagar Road, Jodhpur.	23

K. K. Filling Station	Bhatinadi, Mandore, Jodhpur.	50
Marwar Automobile	1st Chopasni Road, Jodhpur.	99
Marwar Petrol Service	High Court Road, Jodhpur	9
ModhShaffi& Sons	Chopasni Road, Jodhpur	80
Nagar Filling Station	High Court Road, Jodhpur	45
Naman Fuel Center	Ratanada, Airport Road, Jodhpur	75
Narpat Petrol Pump	KishorBagh, Mandore.	100
Nasrani Petrol Pump	5th Road, Chopasni, Jodhpur	24
Nasrani Petrol Pump	Barmer Road, Pal, Jodhpur.	90
New RajnishMoters	NH 112, Pal Gaon, Jodhpur	30
NirmalMoters	Opp. Nasrani3rd Road, Jodhpur.	25
NirmalMoters	9 Meel, Nagore Road, Jodhpur.	34
Onkar Singh Tak& Co.	LalSagar, Jodhpur.	69
Puja Shree Filling Station	Mandore Industrial AreaJodhpur	60
Puroshottam Das J C	Bhagat Ki Kothi, Jodhpur.	69
P Das Jagdish Chandra	9th Chopasni Road, Jodhpur.	9
Raj Automobiles	2nd Pulia, CHBoard Road, Jodhpur.	43
Rajputana Automobile	Ratanada Circle, Jodhpur	70
Ram Petrol Service	Mahamandir Road, Jodhpur.	60
Ramdev Petrol Service	Fisusa, Chopar, Sursagar, Jodhpur.	60
Sanghi Brothers	Station Road, Jodhpur	19.5
SankarLal Ram Ratan	Near Jaljog Circle, jodhpur	85
Udai Service Station	Pali-Jodhpur Road, Jodhpur.	65
Umrao Khan & Sons	Chopasni Road, Jodhpur	70

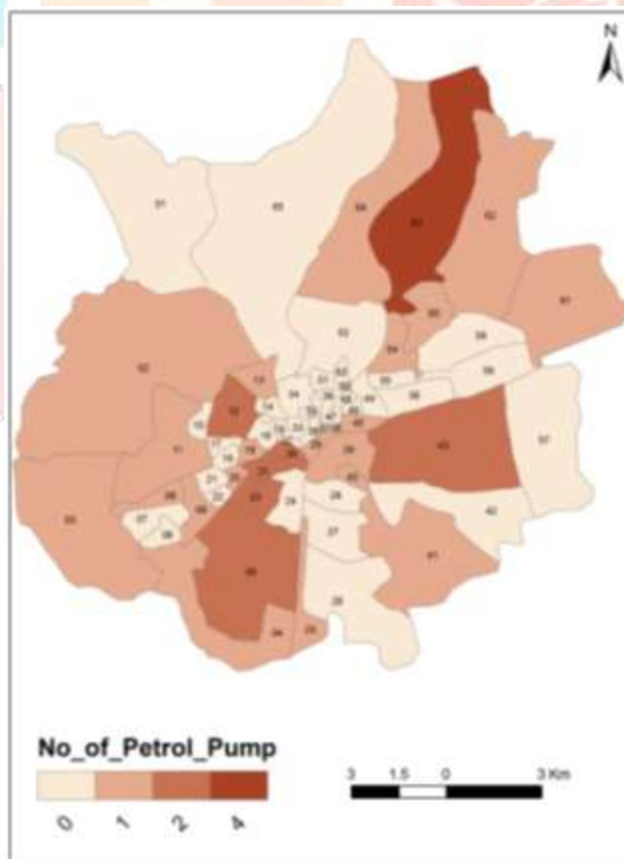


Fig.4. Number of Petrol Pump in each ward in Study Area.

5.3 Database Generation and Analysis of Gas Services

The gas service database consists of field GCP data and attribute data. Using these data, geospatial database is generated in ArcGIS Software. Table-4 indicates the number of Gas service in study area. The distribution of different Gas service in the city has been presented in the Fig.5. Similarly in case of Gas Service, Ward no 2, 5, 25, 44 and 61 accounts for the largest number while other ward accounts for the lowest number of Gas service facility. Such variations indicate that the distribution of Gas service facilities across wards is not proportional to the distribution of population.

Table-4 Number of Gas Service in the Study Area.

Name & Address	Storage Cap (K. L.)
HP Gas Bottling Plant	300 MT
HPC Chandra Gas(Godown)	12,000 Kg LPG
BPC Dev Gas(Godown)	12,000 Kg LPG
IOC H N Gas Service(Godown)	800 Cylinder
IOC Jodhpur Gas(Godown)	12,000 Kg LPG
HPC Kishan Gas (Godown)	900 Cylinder
IOC Mahaveer Gas(Godown)	900 Cylinder
BPC Mandore Gas(Godown)	840 Cylinder
HPC Marudhar Gas(Godown)	800 Cylinder
HPC Marwar Gas Service (Godown)	12,000 Kg LPG
IOC Mehrangarh(Godown)	12,000 Kg LPG
IOC Pawan Gas(Godown)	850 Cylinder
IOC Technocrats(Godown)	12,000 Kg LPG
HPC Triveni Gas(Godown)	700 Cylinder
IOC Veer Shiv Gas Service (Godown)	900 Cylinder
BPC Sushil Gas(Godown)	800 Cylinder
IOC SuryaNagri(Godown)	800 Cylinder
IOC Pal Gas Service(Godown)	12,000 Kg LPG

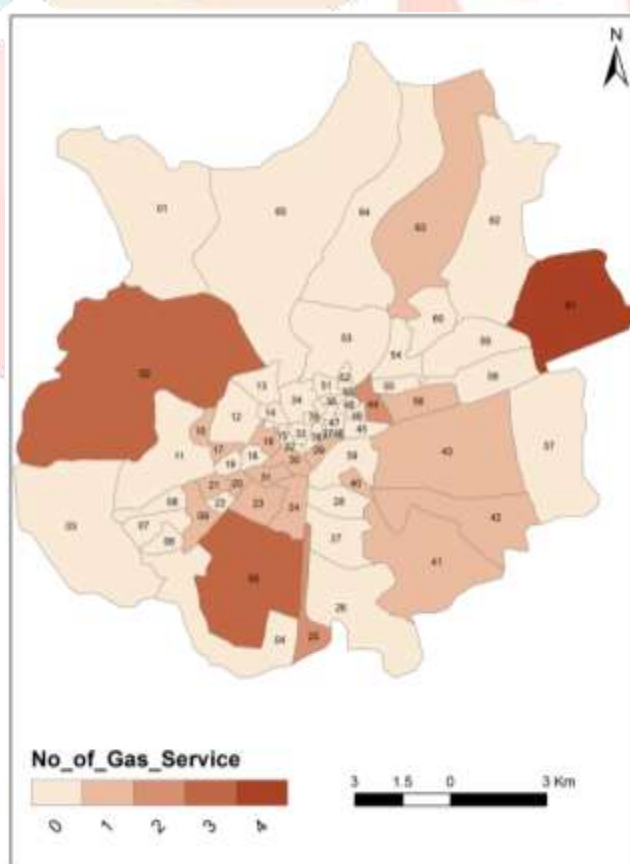


Fig.5. Number of Gas Service in each ward in Study Area.

5.4 GIS Based Spatial Analysis Three Public Urban Amenities

An attempt has been made to analyze the spatial distribution and status of public facilities in different wards of the city. The analysis of these facilities will be carried out as per the classification. Ward wise distribution of public amenities in Jodhpur city is prepared. The buffer map given below depicts that most of the civic amenity establishments are located within the five kilometer radius from the core of the city, which impinges on the planners to draft a comprehensive policy for ensuring equitable and balanced distribution of amenities in the city (Table-5 & Fig.6). Table-5 clearly shows that there is maximum concentration of civic amenity establishments within five kilometer radius from the center of the city zone-I (Buffer Zone-5km) and the concentration decreases slowly towards the peripheries.

Table-5. Distribution of Public amenities in different Buffer Zone.

Distance/ Amenities	Public	No of Sr. Sec. School	No. of College	No. of Gas Service	No. of Petrol Pump
Buffer Zone-5km		48	19	21	24
Buffer Zone-7.5km		21	2	2	8
Buffer Zone -10km		7	5	6	3

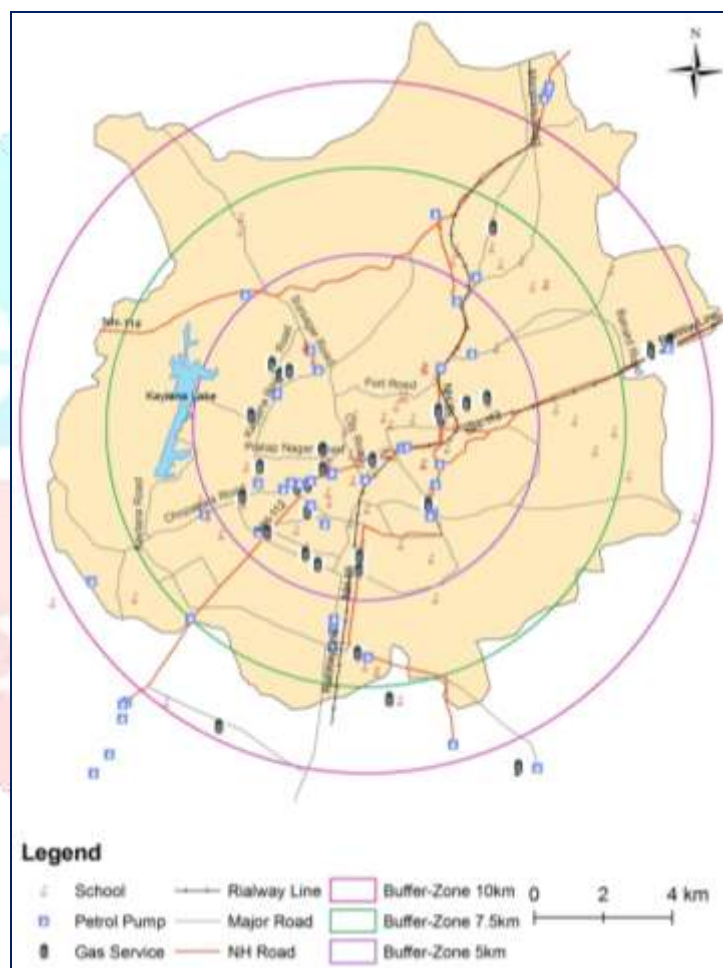


Fig.6. GIS Overlay Map of Three Amenities within the 5, 7.5 and 10 km Buffer.

5.5 Spatial Analysis on Provision of Three Public Amenities

In order to identify gaps in the provision of three public amenities to the Jodhpur city, a weighted index score has been used. The weightage has been given to each amenities as per their standard and number (Kundu, 1975 and Borysowich, 1988). The weightage of each amenity has been obtained by dividing the total number of amenities by the number of each amenity (Table-6). The individual weighted scores of different public amenities have been aggregated in order to derive the composite score of each ward (Table-A1). The aggregated weighted scores have been accordingly categorized to prepare the spatial concentration map (Fig.7). This figure indicates that three wards in the city namely 05, 61 and 63, have very high concentration of the selected public amenities under study followed by seven wards which possess high concentration. It shows that three wards enjoy highest share and six wards enjoy high share of different public facilities, while as on contrary twenty one wards face shortage of amenities. Moreover, the concentration of amenities decreases from core of the city to the peripheries especially in the north and north-western side of the study area. Mathematically, Composite Score of a ward is given in equation-1.

$$\text{Ward} = (W1 * N1 + W2 * N2 + W3 * N3 + \dots + Wn * Nn) \quad (1)$$

Where W1 to Wn= Weightage of Variables, N1 to Nn = Number of Amenities.

Table-6 Weightage of each unit of different Amenities

Number of Amenities			Total Number of All Amenities in the city	Weighted Score		
Sr. School	Sec. Pump	Gas Services	680	Sr. School (W1)	Sec. Pump (W2)	Gas Services (W3)
72	36	28		8.19	18.88	24.28



Fig.7. Weighted Index map for public amenities in Jodhpur Municipal Area.

VI CONCLUSION

The study shows that distribution of three public amenities viz. Education, Gas Service and Petrol Pump are not uniform in their spatial occurrence in different municipal wards of Jodhpur city. This is due to uneven population distribution, many other extraneous factors such as political consideration. The reasons for the disparity are: (1) The core of the city being oldest, so had an initial advantage of being the focal point for the establishment of different types of amenities, (2) The lack of urban policy for Jodhpur city resulted in the unplanned urban structures which also led to an uneven distribution of various amenities and (3) The peripheral wards being the newer ones are devoid of many amenities as it is difficult to ensure all amenities in an area within a short span of time. The varying degrees of concentration and dispersion of different types of urban amenities indicate that the existing planning efforts could not produce satisfactory results in terms of balanced development of different parts of the City. It is now expected that the population of Jodhpur City will increase quite significantly during the next decade thereby multiplying the need for different types of urban amenities. Since most of these amenities will be provided by the government, their availability and distribution must be planned carefully and a participatory approach is needed for ensuring the even distribution of public amenities in Jodhpur municipal area.

VII ACKNOWLEDGMENT

The authors are thankful to the Director DL, Jodhpur and Head, Department of Mining Engineering, Jai Narain Vyas University, Jodhpur for help and encouragement during the study.

Table-A1 Aggregate Weighted Index for Three Public Amenities.

Ward no.	Population Density	No. of School	No of Petrol Pump	No of Gas Agencies	Aggregate Weighted Score
1	1034.53352	2	0	0	16.38554217
2	596.2203155	0	1	3	90.0921659
3	1236.370825	1	1	0	32.47848537
4	2033.362016	0	1	0	24.28571429
5	1346.009637	2	2	3	130.7634224
6	19217.91513	0	0	0	0
7	11657.33182	1	0	0	8.192771084
8	13961.52711	1	1	0	32.47848537
9	10368.19401	1	1	1	54.41396924
10	27305.8272	0	0	1	21.93548387
11	2783.369224	2	1	0	40.67125645
12	6997.201429	0	2	0	48.57142857
13	13192.6659	0	1	0	24.28571429
14	33498.06798	0	0	0	0
15	52566.01417	0	0	0	0
16	23675.39618	2	0	1	38.32102604
17	35549.47432	0	0	1	21.93548387
18	32382.04443	0	1	0	24.28571429
19	31449.49945	0	0	0	0
20	35940.32073	0	1	1	46.22119816
21	22798.72138	0	0	1	21.93548387
22	34145.06145	0	0	0	0
23	9543.148382	2	2	1	86.89245461
24	8713.212324	1	0	1	30.12825496
25	9608.521986	2	1	2	84.5422242
26	2121.112727	0	0	0	0
27	4785.071504	2	0	0	16.38554217
28	8101.842598	1	0	0	8.192771084
29	29535.18216	2	1	1	62.60674033
30	18555.07176	2	2	1	86.89245461
31	24630.47541	1	2	1	78.69968353
32	63302.58897	0	0	0	0
33	41495.19064	1	0	0	8.192771084
34	10916.24873	2	0	0	16.38554217
35	45190.37505	0	0	0	0
36	30924.75884	2	0	0	16.38554217
37	152369.5658	0	0	0	0
38	44661.02291	2	0	0	16.38554217
39	5926.373044	4	1	0	57.05679862
40	24693.85322	0	1	1	46.22119816
41	2330.201259	1	1	1	54.41396924
42	2383.719204	0	0	1	21.93548387
43	1282.866455	3	2	1	95.0852257
44	18076.07106	1	0	2	52.06373883
45	18881.6169	0	1	0	24.28571429
46	153882.3434	0	0	0	0
47	59279.3104	1	0	0	8.192771084
48	48767.30957	0	0	0	0
49	52382.88487	1	0	0	8.192771084
50	191199.5983	1	0	0	8.192771084
51	28201.05775	0	0	0	0
52	36519.17638	1	0	0	8.192771084
53	2823.65269	3	0	0	24.57831325
54	9041.098174	1	1	0	32.47848537
55	16544.38522	0	0	0	0
56	7930.909223	3	0	1	46.51379712
57	1832.412614	4	0	0	32.77108434
58	3946.567753	0	0	0	0
59	3382.113146	1	0	0	8.192771084
60	7140.599979	0	1	0	24.28571429
61	1850.71125	1	1	4	120.2204209
62	1039.841431	4	1	0	57.05679862
63	1177.287317	6	4	1	168.2349675
64	1414.78467	0	1	0	24.28571429
65	496.9457489	4	0	0	32.77108434

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