

Problems and Prospects of Urban Compaction- A case of Jaipur City



By:

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Introduction

To achieve a sustainable urban environment, various countries have started making policies to make their cities compact. [UNCED Agenda 21 proposals].

The following paper talks about urban compaction related to the urban form and its various indicators. The study has been carried on Jaipur city to understand its compact urban form.



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What is urban compaction?



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Various Authors have defined...

- Newman and Kenworthy (1989) said *“more intensive land use, centralized activities and higher densities”*
- Elkin (1991) said *“Compact city is the Intensification of the use of space in the city with higher residential densities and centralisation”*
- Breheny (1993) said *“high density, mixed use city, where growth is encouraged within the boundaries of existing urban areas, but with no development beyond its periphery”*



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Characteristics of Urban Compaction

1. Higher residential density with mixed land uses.
2. Provision of centralized infrastructure facilities and within a walkable distance.
3. Efficient public transport system, low energy consumption and reduced pollution and better social interaction.



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Need of urban compaction



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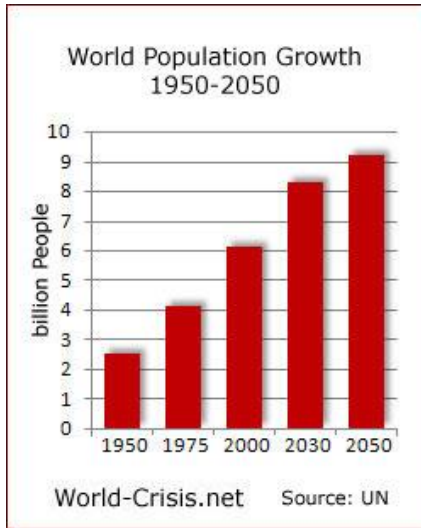
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1

POPULATION GROWTH



2

URBAN SPRAWL



3



RISING VEHICLE OWNERSHIP

The road length per vehicle was 3 km in 1971 which reduced to 2 km in 1981, 1.3 km in 1991, 0.68 km in 1998 and 0.23 km in 2004. *Source: MOSPI-Infrastructure status report*

CURRENT SCENARIO

4

LAND AVAILABILITY GOING DOWN

Per Capita Land Availability

Year	Cropped area	Total population	Overall average land per capita
1951	131.89	361.1	0.37
1971	165.79	548.2	0.30
1991	185.74	846.3	0.22
2001	190.76	1,027	0.19
2051	200	1,600	0.13

Source: Report on land and agriculture in India

Study Area



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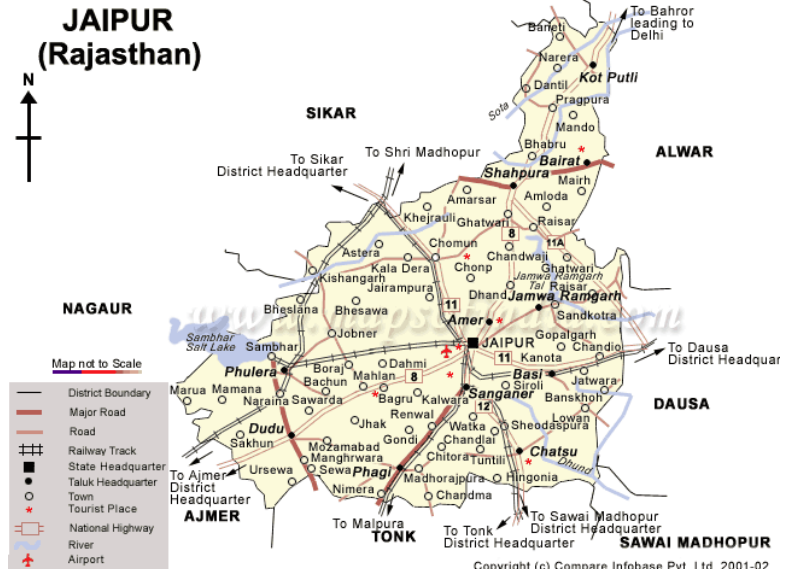


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- Jaipur is the capital city of Rajasthan and 10th most populous city in India with a population of 3,046,167 in 2011.
- Like many other Indian cities, Jaipur also faces a new issue of population influx. People from all around the country come to Jaipur **for employment, education and other opportunities.**



JAIPUR (Rajasthan)



Map not to Scale

- District Boundary
- Major Road
- Road
- Railway Track
- State Headquarter
- Taluk Headquarter
- Town
- Tourist Place
- National Highway
- River
- Airport

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Indicators of Compact Urban form



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Indicators of Compact Urban form :

Urban form Characteristics	Indicator	Urban form Characteristics	Indicator
1. Density	A. Gross (population) Density	5. Accessibility	A. Service Accessibility
			B. Public transport accessibility
2. Land use distribution	A. Land use distribution		
3. Density distribution/ Dispersion	A. Density profile	6. Shape	A. Dispersion index
4. Transportation network	A. Mode share		
	B. Congestion index		
	C. Walkability index		

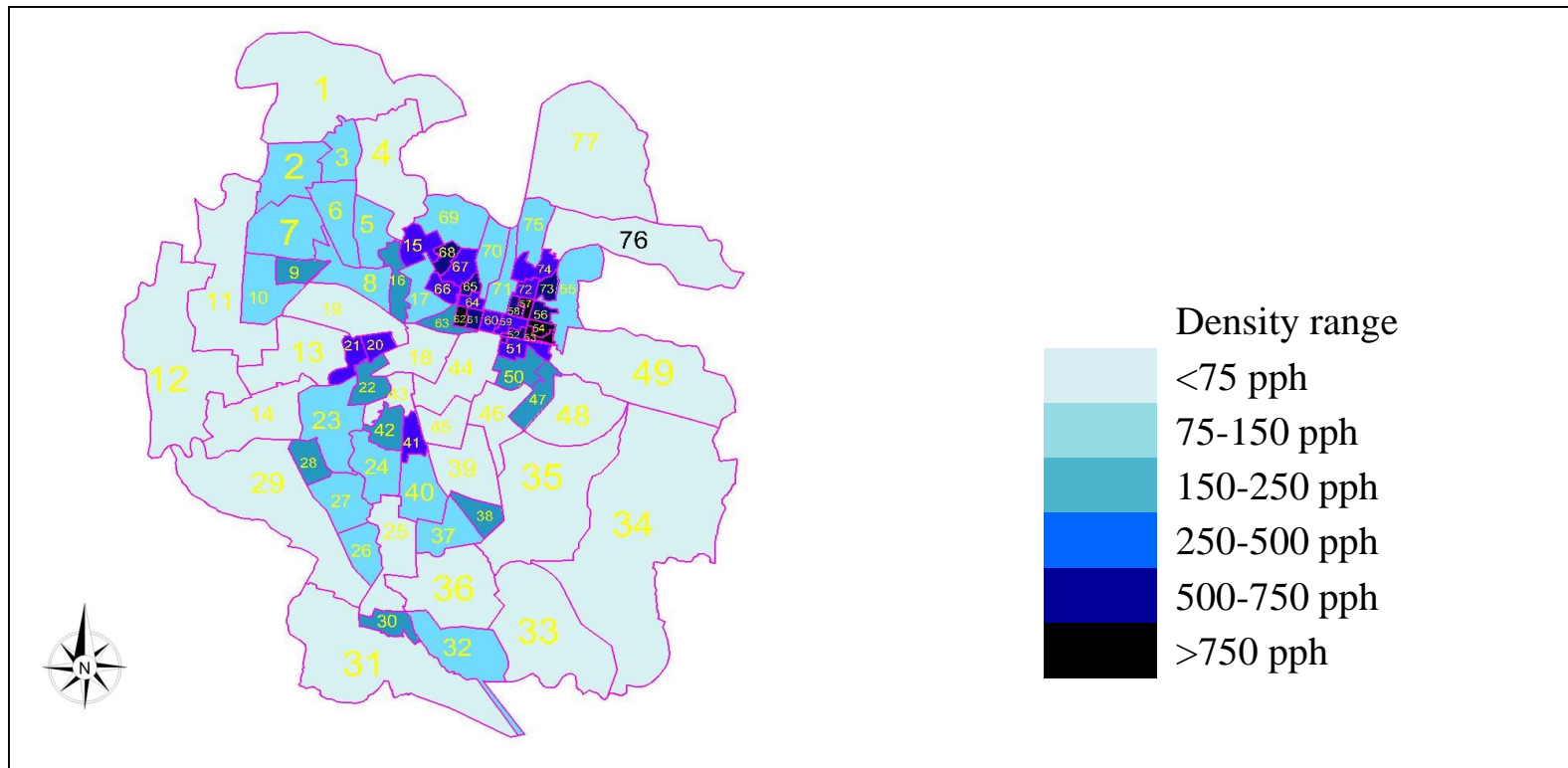
1. Density

- Density is the most important indicator of compact city.
- Higher the density lower the cost in money, energy and resources to build & maintain public transport.
- Higher density lower is the need to travel.

Year	Population	Developed Area	Population Density (pph of developed land)
1971	615258	4047	152
1981	977165	-	-
1991	1518235	10226	148
2001	2324319	-	-
2011	3046163	24800	123

The population increased twice but dev. area increased 2.5 times

- Density variation for a compact city should be minimum. However, the following map shows the variation in density in Jaipur from the city core to the boundary.



2. Land Use Distribution in Jaipur, 2011

S.no	Major Landuse Purpose	Area (ha)			Area % to Developed Land			
		1971	1991	2011	1971	1991	2011	UDPFI recommendations (%)
1	Residential	2023	6426	14000	50.00	62.80	66.22	35-40
2	Commercial	138	384	730	3.40	3.80	3.45	4-5
3	Industrial	287	1008	1600	7.10	9.90	7.57	10-12
4	Government	85	158	340	2.10	1.50	1.61	-
5	Recreation	134	214	448	3.30	2.10	2.12	18-20
6	Public and Semi Public	680	858	1200	16.80	8.40	5.68	12-14
7	Circulation	700	1178	2203	17.30	11.50	10.42	12-14
8	Mixed land use	-	-	620	-	-	2.93	-
Developed Area		4047	10226	21141				
9	Government reserved	805	692	701				
10	Agricultural	399	271	6900				
11	Vacant & undeveloped	581	487	3396				
12	Water bodies	-	142	520				
URBAN AREA		5832	11818	32658				

Source: Jaipur master development plan, 2025

- Residential land use far exceeds the norms where as all other land uses are far below the prescribed norms.
- Such a trend indicates inadequate.
- The fast growth of the built up area as compared to other land uses has adversely affected the availability of infrastructure in the system.
- There is need to avail more land for recreational purposes from the proportion of land earmarked for public and semi-public use. This will increase the proportion and accessibility of commercial and recreational uses to support high density and compact development.



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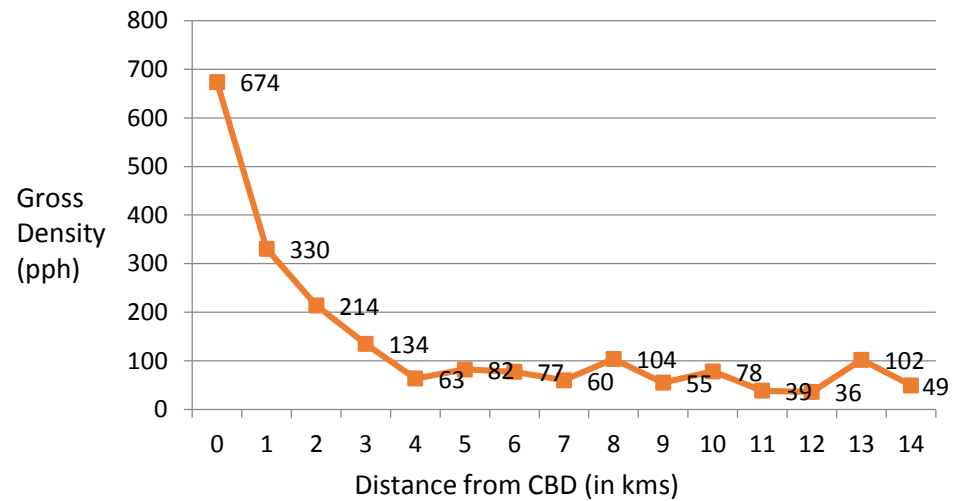
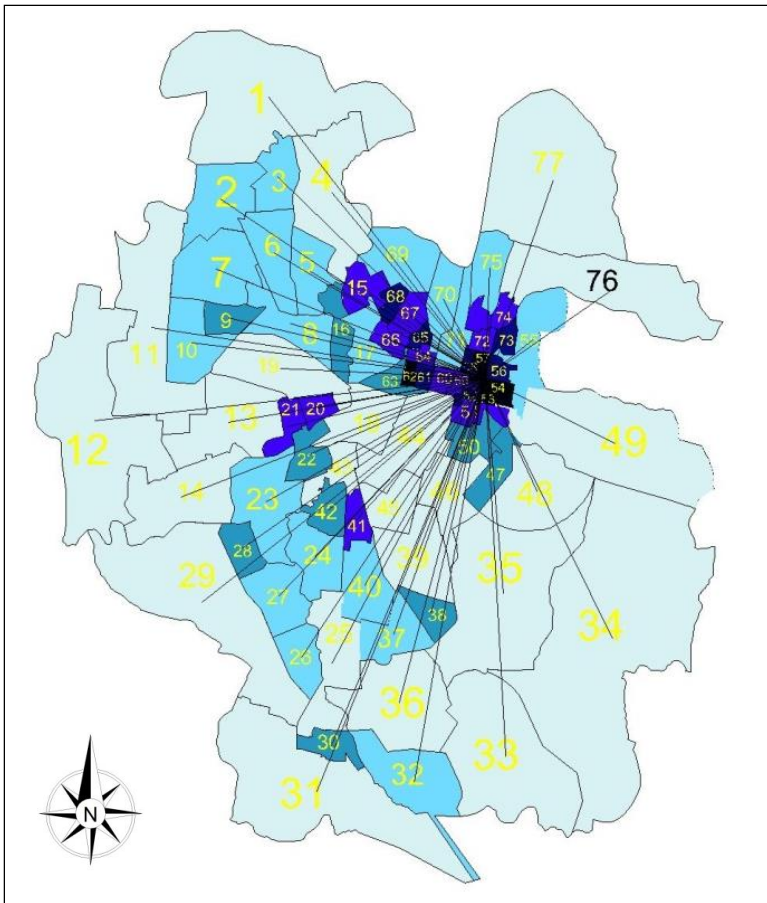
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3. Density Dispersion



- The spatial distribution of density in a metropolitan area determines the shape performance in terms of average travel distance from CBD or CG.
- The density gradient map of the city of Jaipur is negatively sloped curve majorly but there are a few junctions where the graph shows peaks of high density.
- These are because of the local factors and location of certain important centres. The south side of the city is far from the CBD but has a comparably higher density as Sanganer town is located here.
- Similarly, due to presence of natural barrier on the north east side of the city which is surrounded by hills on the major eastern and north eastern side leads to growth in the west, north and south western areas. These factors lead to the imperfections in the distribution of the density.



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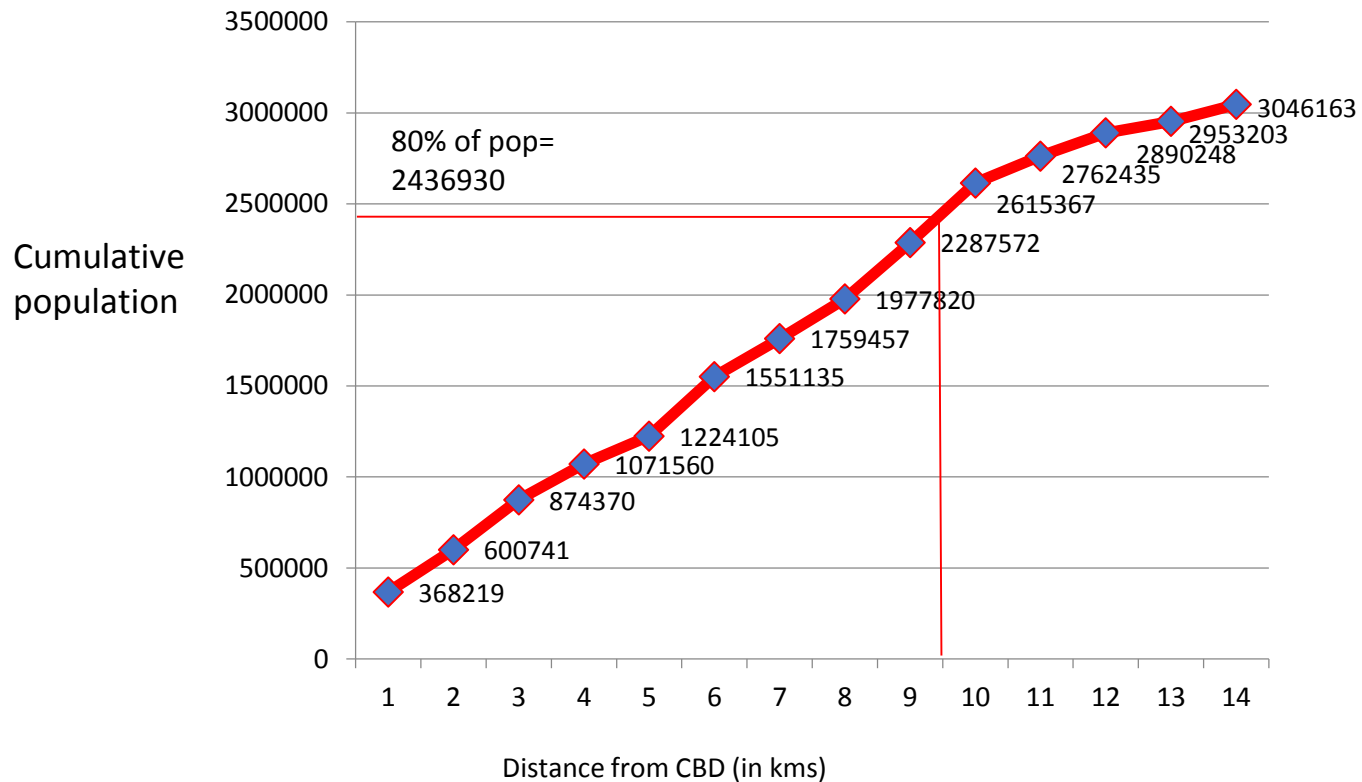


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Cumulative Population by distance from the CBD (Central Business District)



- The distribution of population around the CBD can be understood as the cumulative population around the CBD.
- For the Jaipur city, as of 2011, 80% of the population resides within 9-10 kms from the CBD.
- The closeness to the CBD also helps in determining the travel distances of the people. People within 5 km radius are considered close enough to the CBD and it is assumed the distance shall be covered within 15-20 mins by a bicycle.
- However, the travel distances in the city of Jaipur are to the order of 9-10 kms. For this we need a **strong public transportation system** to cater to the people in order to keep the city compact and reduce dependency on private vehicles.



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4. Transportation network

- A city can be effectively compact only when its public transport has ability to cater to the population being served.
- Mode share of the Jaipur city:

Transit Mode	% of Trips	Ideal Values (%) for this Category of City (2–4 million)
Non-Motorized mode (Walk)	32	-
Non-Motorized mode (Cycle Rickshaw and Bicycle)	-	15–20
Two-wheelers	27	10–15
Cars	8	
Bus	19	
Intermediate Public Transport (IPT)	14	60–70

- The share of NMT in Jaipur city is 32% which is considerably good. However, the share of private vehicles is more than twice the ideal values for a city with 2-4 million population.

Source: Wilber Smith Associates' Traffic and Transportation Study for DPR for Proposed Jaipur Metro Feb 2010



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Congestion index

- The congestion index is defined as $CI = 1 - (A/M)$, where **M** is Desirable Average journey speed on major road networks of a city during peak hour, which is assumed as 30 kmph, and **A** is Average journey speed observed on major corridors of the city during peak hours.
- Ideally its value should be 0
- Congestion index for Jaipur = 0.30 , reflecting an average road network system with certain congested corridors at peak hours.
- The congestion index for a compact city should be made low for a sustainable compactness. This can be achieved by better public transport and policies for reducing car dependency.



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Walkability Index

- Walkability Index = $[(W1 \times \text{Availability}) + (W2 \times \text{Facility rating})]$; where, W1 and W2 are Parametric weights (assumed 50% for both), Availability is Footpath length/Length of major roads in the city, and Facility Rating is a 'Score' estimated based on opinion on available pedestrian facility.
- Ideally 1.0, WI for Jaipur = 0.64
- City has an overall average pedestrianisation.
- Walking can be encouraged by higher density, mixed use developments with connected street networks.
- A residential neighborhood with facilities within smaller distances will have a better walkability.



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5. Accessibility Index

A. PUBLIC TRANSPORT ACCESSIBILITY INDEX

- Better public transport accessibility reduces the dependency on private vehicles.
- It is formulated as the inverse of the average distance (in km) required to be travelled to reach the nearest bus-stop/railway station (suburban/metro) by residents. Higher the index means better public transport accessibility.
- Public Transport Accessibility index for Jaipur =1.38



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B. SERVICE ACCESSIBILITY INDEX

- This index is based on the percentage of work trips completed within 15 & 30 min time for each city. Higher index indicates better service accessibility.
- 51% of total work trips within 15 min, 76% of total work trips within 30 min.
- Accessibility index value for Jaipur =0.7
- The majority of trips that are generated in a city are to work from home. So, the location of the services and accessibility of the work place from home determines the compact character of the city.



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6. Shape of the city

- Shape of the city determines its compactness.
- Linear cities have longer travel distances while circularly growing cities have smaller radial travel distances.
- Dispersion index is :
- $p = (\sum diwi)/[2/3(A/\pi)^{1/2}]$ or $p = (\sum diwi)/(2/3)r$
- where, ***di*** is the distance of the centroid of the *i*th tract (or ward or zone) from the CBD or CG, weighted by the tract's share of population ***wi***; A is the built-up area of the city; ***r*** is the radius of a circle with area A.



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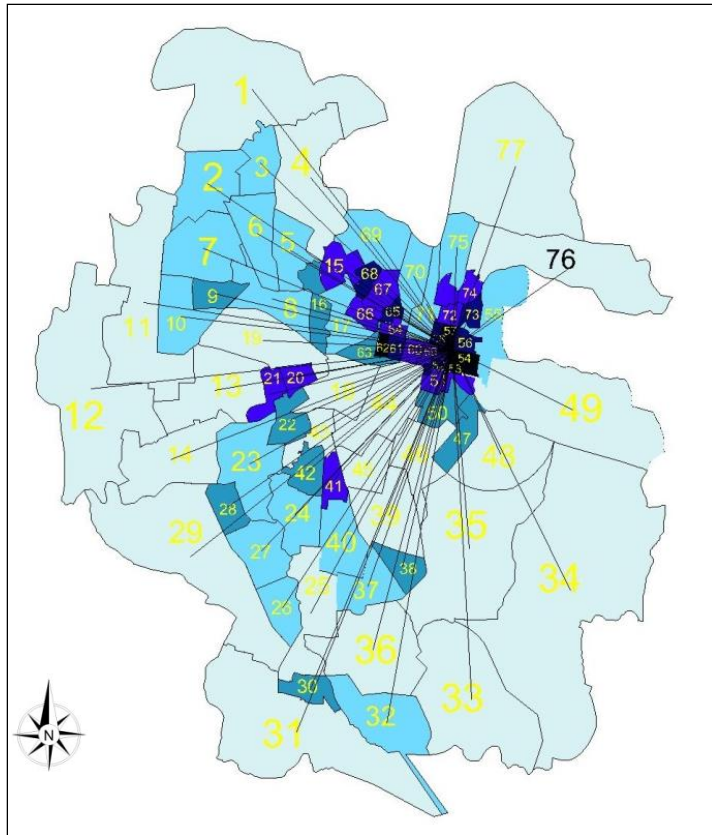


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Dispersion index



- The value of dispersion index as 1.0 is considered as the threshold between compactness and dispersion. Larger the index, less compact the city is.
- For Jaipur dispersion index is calculated as **1.166**.
- Jaipur has a lot of scope to become compact as it lags behind.

Inferences

- It has seen a sudden urbanization which has led to a growth of city which wasn't planned for.
- The study shows that Jaipur has all the components that are required for a compact city. The city at present is heading towards dispersion and there is an urgent requirement to contain its compactness.
- The **dispersion index** which was 1.166 suggests that there is a lot of scope for Jaipur to improve its compact character.



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Inferences

- The wards which have **densities** lower than 150 pph can be increased. These wards cover more than 40% of the city area.
- The **density distribution** follows the exponential curve as suggested by Clark's theory and the tendency of population moving from the center to the peripheral areas is observed.
- The measures for **transportation network** show that Jaipur has a high percentage of NMT (32%) but the cars and private vehicles compose the major share of the transportation mode. The public mode of transportation's share is poor and should be enhanced.



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Conclusion

- The compact urban form has a close relationship to the **sustainability** of the urban environment. The efficient public transportation system leads to reduced dependency on automobile.
- The **accessibility** to the public transport and service places also helps in containing the compact character of the city. The **proximity** to work places and commercial areas increases the compactness of the urban form.
- The compact city policies should be incorporated in the development strategies to control urban expansion caused by rapid population growth.
- For the residential areas to develop compactly, they need to be planned for higher densities with social and physical **infrastructure** which can cater to such high serving population.
- Compact city has a tendency of leading to congestion and poor environment if not well planned.



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Thank you



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