

# Problems and Prospects of Urban Compaction – A Case of Jaipur City

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## ABSTRACT

The compact city is an integrated form of city with high density, mixed uses and intensification of land uses with centralised activities and higher densities. It requires provision of facilities within a walkable distance and an efficient public transport system to reduce the energy consumption and the pollution so created. The compact city is a form of sustainable urban form as it becomes a solution to the present problem of urban sprawl and rapid development of cities towards the outskirts. Indian cities are expanding in size with their urban boundaries extending outwards. There is a lot of pressure on urban land which due to haphazard development is getting wasted. The compact city is a way to reduce the pressure on land by utilising it to the maximum with higher economic productivity and better environmental quality. The following paper discusses the various parameters which are used to measure compactness of a city and using them the urban compact form of Jaipur city has been analysed.

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## 1. INTRODUCTION

The term compact city was coined for the first time by George Dantzig & Thomas L. Saaty in 1973. The compact form has been studied in the planning literature mostly during the last twenty years to implement the sustainability within the urban environment. Sustainable urban development lays emphasis on having high residential density with mixed land uses, provision of infrastructure facilities within walkable distance, efficient public transport system, low energy consumption, reduced pollution and better social interaction.

According to various authors compact city can be defined as an intensified use of space in the city with higher residential densities and centralisation, more intensified land use and where the growth is encouraged within the boundaries of existing urban areas, but with no development beyond its periphery. It is one of the solution to the problem of the rapid development of the decentralisation outwards of the cities. The compact city includes wiser use of land as land uses are more intensified, thereby avoiding wastage of land. As the nature of the city is more compact, it reduces travel distances from office to home which saves user's travelling time. The sub-urban agricultural land can be preserved as it requires lesser land to be converted to urban area, thereby saving agricultural land. The per capita infrastructure spending also reduces as the provision of infrastructure in a compact city is made for higher serving population within smaller area. This saves spending on infrastructure to reach out to farther distances as in case of sprawl. It creates a healthy urban environment as there is lesser dependence on vehicles.

### 1.1 Urbanisation and compact city

At present, 50% of world population is residing in urban area which is assumed to rise to 70% by 2050. There has been a decrease in densities of cities of both developed and developing countries from 1990 to 2000. The reason for this being the space is not utilised entirely and sprawl. Large metro cities have more space as hinterland and which is underutilised. The cost of housing in suburbs is less but the hinterlands depend majorly on fuel and transport. A balance between density and sprawl, transportation, energy and resources is the need of the hour. There is a constant push for cities which can cater to higher densities.

## **2. EMERGENCE OF COMPACT CITY**

The UNCED Agenda 21 proposals had embodied resource conservation and waste minimization in the late eighties and early nineties to achieve a sustainable urban environment. The countries around the world have started making policies to make their cities compact. A compact urban form in built up areas facilitates local energy generation technologies and at urban fringes it conserves land resources for agriculture, recreation and water and energy provision.

### **2.1 Measuring the urban form**

Urban built form is the physical manifestation of various activity systems in a city, and is a reflection of preferences, perceptions and aspirations of the people. The activity systems are translated into various land uses on the ground. Different land uses generate different built forms. The spatial organization of the city allows planners to formulate policies for future development by incorporating the existing character of the city. The urban form of a city is suggestive of the degree of compactness that can be achieved and that exists in the city. It becomes important to know the level of compactness that exists in the built form if we plan to make it compact for future, given that compact city is accepted as the sustainable urban form.

### **2.2 Indicators of compact city**

Since compact city is the upcoming sustainable form of urban growth it becomes essential to know the parameters that define the compact city. Various researchers have worked upon computing the indicators that can be used to depict the compact city characteristics. The indicators are directly generated from the concept of compact city which are density, land use distribution, density dispersion, transportation, accessibility and shape of the city.

## **3. STUDY AREA**

The study area selected is Jaipur city. Jaipur is the capital city of Rajasthan and the 10<sup>th</sup> most populous city in India. The study includes measurement of various indicators of compact city for Jaipur to view its potential for future growth. Jaipur is witnessing a rapid growth in its trade and manufacturing industries. It is attracting investment opportunities from all over India. Big international companies and manufacturing industries are eyeing Jaipur as another hub for their growth in India. All these factors contribute towards a large influx of population that is moving to the city. As a result of this population growth the city boundaries have been expanding and the city is facing urban sprawl. The population has become twice from 1991 to 2011 and at the same time the area has become three times from 1991 to 2011. It suggests there has been wasteful use of land. There is a need to plan for higher density compact development which can accommodate this population growth within lesser area.

## **4. ANALYSIS OF THE STUDY AREA**

### **4.1 Density**

High density city is the most important indicator of a compact city. Urban sprawl is an outcome with low-density suburban residential. To preserve the precious sub urban land the compact city form should be incorporated in our cities. Density determines in large part the cost in money, energy, and resources to build and maintain public infrastructure. In addition to infrastructure, density also influences the amount of fuel needed for automobile travel. The greater the density in an urban area, the more its sewers and roads can be made compact.

The population of Jaipur is 3046163 as of Census 2011. The municipal area of Jaipur covers an area of 326 sq. km in 2011. The Jaipur Municipal Corporation (JMC) Area is further divided into the walled city and the rest of JMC area. The average developed density of Jaipur has changed from 152 pph in 1971 to 148 pph in 1991 and 123 pph in 2011. Thus there has been a continuous decline in the density of the city which shows there is a need to control the urban area per person which is increasing. There are 77 wards in the city as of 2011. Figure 1 shows the variation of the gross density in the various wards of the city. The highest gross density is found in the core area or the walled city area as high as 998 pph in ward 53. The density decreases as we go away from walled city. (Source: Census of India & Jaipur Master Development Plan)

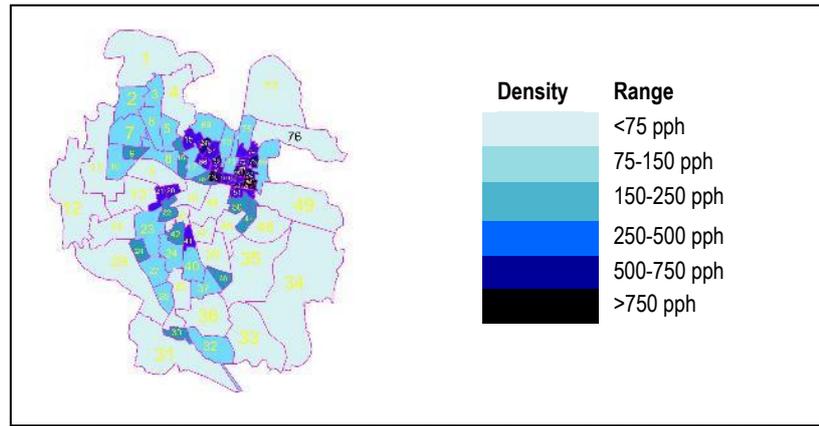


Figure 1: The gross density variation in the various wards of Jaipur city, 2011

#### 4.2 Land use distribution

The land use distribution can be studied to understand the intensity of land use. For a compact city, high density mixed land use is preferable with ample open spaces.

| Sr. No.                                       | Major Landuse Purpose  | Area (ha)    | % to Total Area | % to Developed Land         |                           |
|---|------------------------|--------------|-----------------|-----------------------------|---------------------------|
|   |                        |              |                 | Actual existing in city (%) | UDPFI recommendations (%) |
| 1   | Residential            | 14000        | 42.87           | 66.22                       | 35-40                     |
| 2   | Commercial             | 730          | 2.24            | 3.45                        | 4-5                       |
| 3   | Industrial             | 1600         | 4.90            | 7.57                        | 12-14                     |
| 4   | Public and Semi Public | 1200         | 3.67            | 5.68                        | 14-16                     |
| 5   | Government             | 340          | 1.04            | 1.61                        |                           |
| 6   | Circulation            | 2203         | 6.75            | 10.42                       | 15-18                     |
| 7   | Recreation             | 448          | 1.37            | 2.12                        | 20-25                     |
| 8   | Mixed land use         | 620          | 1.90            | 2.93                        | -                         |
| <b>Total Developed Area</b>                   |                        | <b>21141</b> | <b>64.73</b>    | -                           |                           |
| 9   | Agriculture            | 6900         | 21.13           | -                           | -                         |
| 10  | Government reserved    | 701          | 2.15            | -                           | -                         |
| 11  | Water bodies           | 520          | 1.59            | -                           | -                         |
| 12  | Vacant & undeveloped   | 3396         | 10.40           | -                           | -                         |
| <b>Total Area under Municipal Corporation</b> |                        | <b>32658</b> | <b>100</b>      | -                           | -                         |

Source: Jaipur Master Development Plan, 2025

Table 1: Existing land use distribution in Jaipur 2011

Residential land use far exceeds the norms where as all other land uses are far below the prescribed norms. Such a trend indicates wasteful use of land, inadequate infrastructure, and lack of employment opportunities in the study area. The fast growth of the built up area as compared to other land uses has adversely affected the availability of infrastructure in the system. The land use under recreation and circulation is much lower than recommended. Jaipur city is therefore, facing problems pertaining to road network, water supply, sewerage, drainage, traffic and transportation, etc.

#### 4.3 Density dispersion

Density is an important indicator of a compact city so is the type of density distribution that exists in the city. To understand the pattern of density in the Jaipur city we have studied the density profile, the distribution of density and cumulative population as the distance from the Central Business District (CBD) increases. The approach taken

to study the variation is by taking the centroid of each of the ward in the city and measuring its distance from the central point of the CBD and variation in density with this distance.

A negatively sloped exponential curve is formed if the densities are high at the center of city and decrease away towards periphery. The density gradient determines the travel distances in the city and the consumption of land across the city. 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 due to presence of certain important centres such as high density town Sanganer is located here. 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.

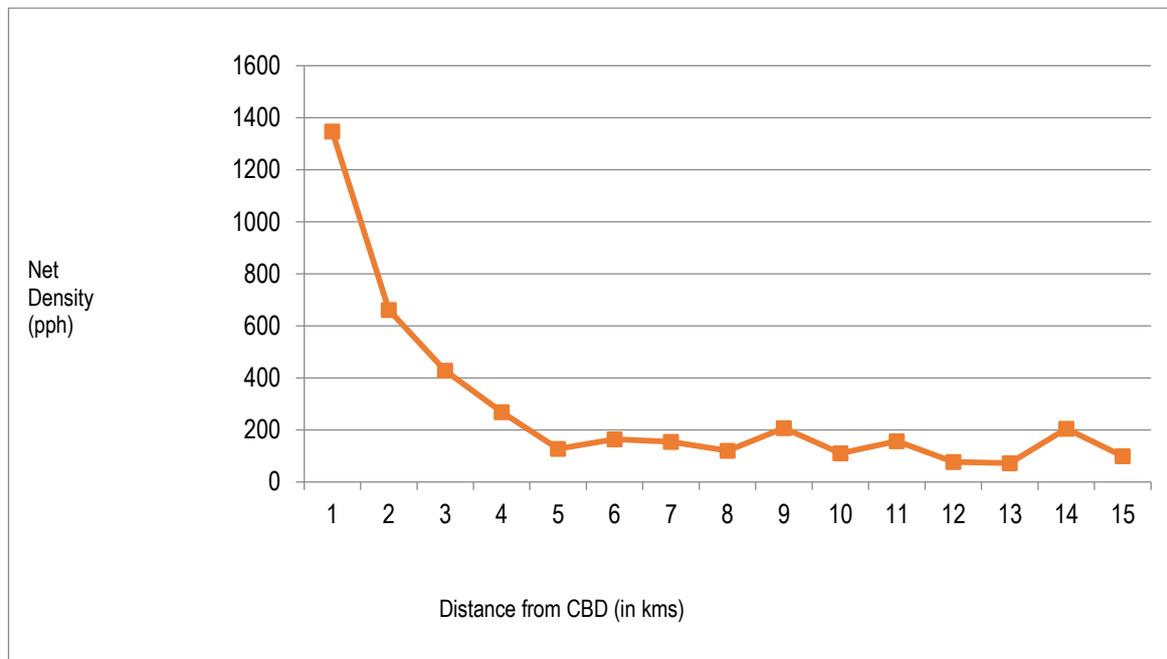


Figure 2: Density distribution pattern as the distance from the CBD increases, 2011

For the Jaipur city, as of 2011, 80% of the population resides within 9-10 kms from the CBD. The closeness to the CBD 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 cars.

#### 4.4 Transportation network

A compact city to be functional needs good connectivity and efficient movement of both goods and passengers. Therefore, public transport has a very important role to boost up activities and promote development in desired corridors. A city can be efficiently compact only when its public transport has the ability to cater to the population being served to reduce dependency on private vehicular use. Wilber Smith and Associates study shows the percentage mode share of trips that are made using each type of transit mode in Jaipur city. The non-motorized transit (NMT) is 32% which is considerably good; the share of private vehicles (35%) is more than twice the ideal values (10-15%) for a city with 2-4 million population. Jaipur city shows a very less share of transit or public transport modes (33%), which shows the lack of investment in public transport infrastructure even though we have seen that the travel distances are of the order 9-10 kms in the city which needs a strong public transport system.

For Jaipur, the evaluated value of congestion index is 0.30 which is slightly higher than the average congestion index (CI=0.26) in Indian cities reflecting an average road network system with certain congested corridors at peak hours. Chandigarh has the lowest congestion index (CI=0) which is very good quality road network.

The average walkability index in Indian cities is found to be 0.52. Jaipur has WI as 0.64 which is close to the average index which suggests that the city has an overall average pedestrianisation. The large cities have better

pedestrian facilities than small or medium towns. If we see developed countries, London has an index of 1.5-1.7 which is extremely good.

#### 4.5 Accessibility index

Accessibility or proximity of a service, place, or intended activity may be described as how efficiently with less time and travel distance a person can reach there. Two types of Accessibility indices are (i) Public Transport Accessibility Index and (ii) Service Accessibility Index.

Public Transport Accessibility Index 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. The Average Public Transport Accessibility index over the cities is found to be 1.05. For Jaipur, the Public Transport Accessibility index is 1.38 which is slightly higher than the average.

Service Accessibility index is based on the percentage of work trips completed within 15 min time. Higher index indicates better service accessibility. In Jaipur, 51% of total work trips are made within 15 min. The accessibility index value for Jaipur is 0.7. The average service accessibility index comes to 0.68 for Indian cities. However, it is close to the average value in Indian cities.

#### 4.6 Shape of the city

The shape of the city may affect the compactness of the city. Linear cities have longer travel distances while circularly growing cities have smaller radial travel distances. The travel distances for work, shopping and recreation vary as the shape of the city varies. The shape of the city is much affected by the locale factors which may include physical barriers, heritage sites, natural reserves, etc. The dispersion index is defined as follows:

$$p = (\sum diwi)/[2/3(A/\pi)^{1/2}] \text{ or } p = (\sum diwi)/(2/3)r$$

Where,  $d_i$  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  $w_i$ ;  $A$  is the built-up area of the city;  $r$  is the radius of a circle with area  $A$ .

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. There are 77 wards in Jaipur and the distance of each ward's centroid from the CBD has been calculated and the weighted population is multiplied to find the value of dispersion index for the city of Jaipur. It has been calculated as 1.166. It is evident that Jaipur is a lot of scope to become compact as it lags behind.

### 5. CONCLUSION

Jaipur city has seen a sudden urbanization which has led to a growth of city which wasn't planned for. The core was set up in the 18th century. The city has experienced a southward and westward growth majorly due to the presence of Aravalli range on the east and north. The growth boundaries are expanding with an alarming rate and there is a need to contain the urban form. 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. The wards having densities lower than 150 pph can be redensified. These wards cover more than 40% of the city area. The density distribution shows a tendency of population moving from the center to the peripheral areas. The public mode of transportation's share is poor and should be enhanced.

The compact urban form has a close relationship to the sustainability of the urban environment. The policy makers need to promote the public transportation and formulate policies to reduce car dependency/ ownership. 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 efficient supply of social infrastructure and public services within the neighborhood should be promoted. The compact city policies should be incorporated in the development strategies to control urban expansion caused by rapid population growth.

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