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# A Regression Analysis of Population Packing in the Municipal Corporations of West Bengal with Special Reference to Durgapur Municipal Corporation

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**Abstract:** ***The present study is an attempt to analyse the concentration of population in urban areas. Regression – power regression has been applied to indicate the nature of concentration (packing) as well as over concentration(spilling) of population in urban areas. The Municipal Corporations of West Bengal have been selected for study with a special focus on Durgapur Municipal Corporation. Power regression can be expressed in the form of $y=ax^b$. In order to express packing and spilling of population, two variables have been considered here, the independent variable 'area' and the dependent variable "population" of the urban areas. Further system component growth analysis in terms of population growth has been done.***

**Keywords**: Population Packing, Spilling, Power Regression, System Component Growth

## 1. Introduction

Population in an area is said to be well packed if there is a balance between the size of the area and the number of persons concentrating in that area. This balance between population and area can be numerically expressed through regression, specifically power regression. The two variables to express this balance or imbalance are area (independent variable) and population (dependent variable). It is very obvious that number of persons concentrating in an area is dependent upon the size of area. The form of power regression can be expressed as $y=ax^b$. The 'a' value will express concentration or packing of population and 'b' value will express overconcentration or spilling of population. The more the 'a' value, the more is the concentration or packing of population. In case of b values, if it is equal to unity, it will indicate an even distribution of population, a well balance between number of persons and size of the area. If the 'b' value is greater than unity it will mean that the population is over spilling and if it is less than unity, it means less spilling and more packed or concentrated population. The present paper attempts to study population concentration in the municipal corporations of West Bengal in 2001 and 2011, 2026 through regression analysis. Further the paper tries to analyse the population packing and unpacking in Durgapur Municipal Corporation (DMC) in particular.

## 2. Study Area

DMC is one of the seven municipal corporations in West Bengal. It is located in the Paschim Barddhaman district on the banks of Damodar River. Durgapur acquired the status of a municipal corporation in the year 1996. The total area of 154.20 square kilometres is administratively divided into 43 wards (Administrative Report, 2007-08). As per Census 2011 the total population of DMC is 566517. The six other municipal corporations in West Bengal at present are Kolkata, Howrah, Chandannagore, Siliguri, Bidhannagar and Asansol. The municipal corporations of Kolkata, Howrah, Chandannagar and Bidhannagar are located in the southern part of West Bengal. Siliguri municipal corporation and Asansol municipal corporations are located in the northern and western part of the state respectively. Asansol has 106 wards and the total area is 326.48 square kilometres, Howrah has 50 wards and the total area is 51.74 square kilometres, Bidhannagar has 41 wards and the total area is 55.51 square kilometres, Kolkata has 144 wards with total area of 206.08 square kilometres, Chandannagar has 33 wards and the total area is 22.03 square kilometres and Siliguri has 47 wards and the total area is 41.90 square kilometres (UDMA, 2026).

## 3. Objectives

The present study is an attempt to study the following:

1) To study the nature of population packing and spilling in the Municipal Corporations of West Bengal with a special focus on DMC.
2) To study the system component growth of the Municipal Corporations of West Bengal in general and of DMC in particular.

## 4. Materials and Methods

The present study is based on secondary data. Census data of 2001 and 2011 have been used which has been collected from the website. Data on the municipal corporations have been also collected from the website of urban development and municipal affairs of government of West Bengal with special reference to Bidhannagar Municipal Corporation (BMC). BMC was formed in 2015 so census 2011 data is not available. Since census 2021 data is not yet available, 2026 has been used as the reference year for a comparative study. Administrative Report of DMC have been used as a data source for ward-wise area and population of the 43 wards.

To determine the concentration of population expressed as packing and over concentration of population expressed as spilling, power regression has been applied. In power regression takes the form of $y=ax^b$. The two variables considered here are independent variable (area in square kilometres) and dependent variable (population inhabiting the area). Concentration of population is dependent upon the area. System component growth analysis in terms of population growth has been applied for understanding the nature of population dynamics.

## 5. Previous Works

The following research works in various disciplines have been conducted using regression analysis and system component growth analysis.

Guchhait S.K. and Dasgupta, A. (2012) in their research paper on "Spatio-Temporal Dynamics of Population Growth of Howrah District in India: An Experience in the 20th Century" has elaborated on the dynamics of population growth of Howrah district of West Bengal. Block-level study has been done to bring forth the dynamics of population growth and change using several statistical measures- coefficient of variation, linear regression, system component growth (using power regression). Differential calculus has also been applied in the study.

Sivaramakrishnan, L. and Bhowmick, S. (2014) in their research article on "Spatio-Temporal Changes in the Demographic Surface of Haora District in India: An Enquiry in the 21st Century" has discussed about the spatial distribution of population and the changes in demographic pattern of the most densely populated Haora district in West Bengal. The authors have applied system component growth analysis and mean centre of population shift to analyse the demographic characteristics.

Sam, Koyel (2014) in her research paper on "Analysis of Population Growth Dynamics-Situation and Trend: A Study on Barddhaman Planning Area (BPA), West Bengal, India" has discussed about the absolute population growth rate and relative population growth rate in Barddhaman Planning Area which includes Bardhaman municipality and the surrounding villages located in two community development blocks. Relative growth rate of population from 1951 to 2011 has been analyzed through system component growth. Three forms of allometric value have been found for every twenty-year period 1951-1971, 1971-1991, 1991-2011 indicative of different types of growth of the components with respect to the system. The author has suggested that rural to urban migration can be reduced by improving amenities in the rural areas.

Poongodai, A. et. al. (2019) in their research paper on "Regression Based on Examining Population Forecast Accuracy" have discussed about the importance and application of regression models for achieving accuracy in forecasting population in India. In their study they have constructed simple univariate regression model to establish a relation between growth rate and size of population and to achieve accurate forecasting results. They have also suggested for the application of multivariate regression model to achieve accurate forecast of population.

Fuad Mohd Fitri Izzatur and Kamarudin Najwa Adina (2022) in their research paper on "Multplie Linear Regression on Population Growth Rate in Malaysia" have applied multiple linear regression to analyse population growth rate. The study is based on secondary data on population from 1978 to 2018. They have discussed the importance of crude birth rate and crude death rate in determining population growth rate. They have found out a positive relationship between crude birth rate and population growth and a negative relationship between crude death rate and population growth.

Safii, M. and Setiana, R. (2024) in their research article on "Population Prediction Using Multiple Regression and Geometry Models Based on Demographic Data" have elaborated on the application of multiple regression model and geometry model to project population growth in Tanah Java sub-district of Simalungun Regency, Indonesia. The study uses three independent variable and one dependent variable. Birth rate, death rate and migration are the three independent variables and total population is the independent variable. Population projection results indicate that the population will increase during the time period of 2024 to 2028. They have concluded their study stating the importance of population projections for the government to decide on the welfare measures for the increasing population in the selected study area.

Sahani Kumar, S. and Mandal Hridya, R. (2024) in their research paper on "Predictive Analysis of Urban Population Growth Using Least Squares Regression" have elaborated on the use of least square regression for predicting population growth and its utility for accurate short to mid-term projection of population. The paper has a strong mathematical framework and concludes with the importance of population projection in any area for implementing good governance.

Several studies have been conducted earlier from various disciplines viz. engineering, mathematics, economics, geography etc which have shown the application of regression analysis for studying population growth, forecasting etc. The present paper is distinct from all these studies because it shows the application of power regression to determine the nature of population concentration and overconcentration in the municipal corporations of West Bengal over a temporal period (2001 to 2011, 2026). The ward level analysis of DMC in terms of population concentration (packing) and overconcentration (spilling) over two time periods 2001 and 2011 have not been done earlier. System component growth analysis which has been done in the present study considering the wards within a corporation to be the components and the entire corporation to be the system is assumed to provide a new insight into the relative analysis of population growth across any space.

## 6. Results and Findings

**Population packing and unpacking in the Municipal Corporations of West Bengal in 2001 and 2011.**

In 2001 there were six municipal corporations in West Bengal- Kolkata, Howrah, Chandannagore, Siliguri, Asansol

and Durgapur. In order to determine the packing of population in these municipal corporations, power regression was applied taking the area of these corporations as the independent variable and total population of these corporations as the dependent variable. The calculated 'a' value which indicates packing of population is 56294. The calculated 'b' value which indicates spilling of population is 0.5485.

BMC formed in 2015 was added to the existing list of six municipal corporations. The calculated 'a' value indicative of packed population is 31817. The calculated 'b' value indicative of spilled population is 0.7195.

Data of 2001 and 2011 are available for the municipal corporations of Kolkata, Howrah, Chandannagore, Siliguri, Asansol and Durgapur from the census website and also from the website of urban development and municipal affairs of government of West Bengal. BMC data is available from the website. While comparing the calculated values both for 2001 and 2026 it can be seen that population packing or concentration has declined in 2026 and spilling of population has enhanced in 2026.

**Population packing and unpacking in Durgapur Municipal Corporation (2001 & 2011)**

The population of DMC is distributed among the 43 wards. In 2001, population packing value (a) is 10610 and the overspilled (b) population is 0.0447. In 2011, the packing value (a) is 11880 and the spilling value (b) is 0.0618. Though the concentration of population has increased during the ten-year period, the spilling of population has also increased, an increase of 0.0171. But the calculated b value for both the years is less than unity which means that the population of the corporation is well packed within the forty-three wards. This is an indication that the population of Durgapur has increased enormously during 2001 and 2011. The population has increased from 493405 in 2001 to 566517 in 2011 i.e. an increase of 73112 persons. Durgapur acquired the status of a corporation in 1996, prior to that it was a Notified Area Authority constituted in 1962.

**System-Component Growth Analysis (2001-2011, 2026) of the Municipal Corporations of West Bengal**

There are seven municipal corporations in West Bengal in 2026- Kolkata, Howrah, Chandannagore, Bidhannagar, Asansol, Durgapur and Siliguri. In 2001 there were six municipal corporations and Bidhannagar did not exist. For system-component analysis, the six municipal corporations were assumed to be the components and the State as the system. Population growth (2001-2011,2026) of the components has been considered. The calculated 'b' values indicate that except Asansol Municipal Corporation (AMC) the rest six municipal corporations exhibit negative allometry with b values less than unity [Chandannagore-0.04, Howrah-0.096, Siliguri-0.12, Durgapur-0.199, Kolkata-(-0.193)]. AMC having b value greater that unity (1.291) indicates positive allometry which means the population of the corporation is growing faster than the State. Kolkata Municipal Corporation has a 'b' value of -0.193 indicating not only negative allometry i.e. the population of the corporation is growing slower than the State but also a decline in population in 2011 than that of 2001.

**System-Component Growth Analysis (2001-2011) of Durgapur Municipal Corporation**

While trying to further study the growth dynamics of population, system component growth analysis has been applied. The 43 wards of the corporation have been assumed to be the components and the corporation has been assumed to be the system. Power regression has been applied to understand the relative growth of the components with respect to the system. The relative growth can be understood in terms of allometry with values less than unity (negative allometry), value equal to unity (isometry) and value greater than unity (positive allometry) (Sivaramakrishnan and Bhowmick 2014). Negative allometry means the components are declining in terms of population growth when compared to the system, isometry means the growth of the components are equal to the growth of the system and positive allometry means the growth of the components are faster with respect to the growth of the system. Population growth in the wards between 2001 and 2011 has been taken as a parameter to understand the growth of the components with respect to the system. Eight wards have negative 'b' values, all less than unity. In these wards the population in 2011 has declined than that of 2001. The remaining thirty-five wards have positive 'b' values but all the values are less than unity. All the calculated 'b' values for the wards are less than unity indicating negative allometry i.e. the population growth of the components (wards) is slower or declining than the system (corporation).

## 7. Conclusion

A comparative analysis of population concentration in the municipal corporations of West Bengal shows that packing within the area has decreased between 2001 and 2011, 2026. The 'a' value in 2001 is 56294 and in 2026 it is 31817. The coefficient of unpacked population i.e. 'b' in 2001 is 0.5485 and in 2026 it is 0.7195, an increase of 0.171. Since 'b' value equal to 1 indicates a balanced distribution of population with respect to area so it can be said that population in these municipal corporations are well concentrated with respect to their area as the 'b' values are less than 1. System component growth analysis indicates that only in AMC population is growing at a faster rate as compared to the state. DMC exhibits increased packing as well as spilling of population between 2001 and 2011. But it can be said that population is well packed within the corporation area with 'b' value less than unity for both the years. The population growth of the wards is slower or on the decline compared to the corporation as a whole.

Development and management of infrastructural facilities within the urban areas is needed for proper population concentration and distribution. This is very much needed to prevent urban sprawl and related unnecessary encroachment upon the adjoining non-urban areas.

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