UTILITY ASSESSMENT OF HUMAN DEVELOPMENT INDICATORS: CASE OF KOLKATA URBAN AGGLOMERATION

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Abstract

The present paper attempts to establish a set of variables to find out the extent and levels of inequality in Human Development Indicators (HDIs) driven development based on a geographic delineation of Kolkata Urban Agglomeration (KUA). The study is based on the geographic delineation of the region of KUA. Given this background, it assesses health, education and economic scenario of the study area by variables of rates of mortality, literacy and working population, respectively. For the purpose of analysis, initially percentage distributions of variables over the study area have been computed and subsequently, assessed through Gini's Coefficient, which is an indicator of inequality in distribution over a geographic space. Then reviews of variations by virtue of spatial aggregation and disaggregation in the form of agglomerations of core vis-à-vis periphery, east bank versus west bank differentials have been presented. The analysis is supplemented by correlation studies.
United Nations Development Program (UNDP) supports the fact that inequalities in development can be better addressed through assessment of qualitative indicators of Human Development Index. This very concept is also reflected in recent urban development researches conducted by organizations like Indian Council for Research on International Economic Relations (ICRIER, 2010), National Council of Applied Economic Research (NCAER, 2009) and London School of Economics (LSE, 2009). The organizations suggest that the holistic objective of India's metropolitan development can be best approached if objectives of minimization of income based inequalities proceed in its multiple dimensions like Human Development Indicators (HDIs). The present paper attempts to meet such goals in the perspective of KUA.

Key words: *Multiple dimensions of inequality; Spatial aggregations: Spatial disaggregation; Human Development Index; Human Development Indicators (HDIs); Gini's coefficient; Lorenz curve.*

1 Introduction

The aim of this paper is to meet the demand of a basic query regarding imbalances in distribution of Human Development Indicators (HDIs), which directly complements the three prime indices of Human Development Index. Initially, a geographic space of parts of six districts namely, Nadia, North 24 Parganas, Kolkata, South 24 Parganas, Hooghly, and Howrah, on either side of the river Hooghly is positioned as the spreadsheet of analyses. The spreadsheet has been taken as the study area due to several reasons:

• First of all, Govt. of India conceived Kolkata Urban Agglomeration (KUA) as a contiguous agglomeration of urban areas on both the banks of the river Hooghly with KUA comprises the parts of these six districts, including Kolkata core as a whole (State Planning Board, 1990)[1]. Hence these parts serve as constituent backdrop to KUA.

• Secondly, the Basic Development Plan (BDP) Plan had identified the various 'missing linkages' leading to imbalances between the two banks (CMPO, 1966).[2] BDP indicated imbalances which has affected variations in economic and other developments between a) various sub-regions in the east bank and b) between sub-regions in the east and west banks.

In the case of developing countries, it has been realized by practicing physical planners and policy makers that a more appropriate scale for understanding the spatial framework and quality of development is the larger regional framework of the metropolis (Krugman et al, 1995; Burgess and Jenks, 2000).[3,4] Instead of a single, homogeneous and compact metropolitan form, planners are more interested to focus on a distribution of settlements, exhibiting a scale and hierarchy of agglomeration having varying development levels. These variations in development levels are indicated by a variety of factors ranging from general income based economic parameters to multi dimensional factors of social and other frontiers of development addressing Quality of Life (QoL). The inclusion of HDIs is a significant multi-dimensional factor, in this regard.

Moreover, spatial inequality is an important feature of many developing countries and the inequality seems to increase with economic growth and development (Kim, 2008).(5) Classical literature says that an inverted U-Curve based relationship between economic growth and inequality (Kuznets, 1955)(6) prevails. Therefore, some increase in inequality is a common scenario during the early stages of economic development. But in the long run the inequality becomes an impediment to growth. Now, it is important to identify sources of inequality, and to explore the most important indicator causing inequality.

Over the years, conventional quantitative economic-geographic techniques provide only a partial view to assess levels of inequality. According to André and Bitondo (2001) there is a need to create a pool of statistics, which would more accurately reflect well-being of the society (ENVIS Centre on Human Settlement, 2009).[7] Therefore, it can be said that the role of qualitative parameters is significant to understand a relatively more comprehensive scenario of metropolitan area, like KUA.

As a qualitative technique the concept of Human Development Index is considered more comprehensive as it focuses on needs rather than material possessions. The original concept of the Human Development Index sprang from authentic humanitarian motivations. Based on the same motivation,–renowned economist, the late Mahbub Ul Haq (1990), tried to bring the quantifiable elements of human deprivations under one common index called Human Development Index (Basu, 2005)[8]. According to Haq (Human Development Reports – Concept, 2009) [9] the basic purpose of development is to enlarge people's choice, which can be infinite and can change over time and the choices may be of: greater access to knowledge, better nutrition and health services, more secure livelihoods, etc. Hence the objective of development is to create an environment for people to enjoy long, healthy and creative lives. Of late, Economist Amartya Sen (1998), also, has pointed out the forms and causes of human deprivations (Human Development Reports – Origins, 2009).[10] According to Sen, Human Development Index is the basic development idea, which helps in advancing the richness of human life, rather than the richness of the economy.

Recent researches conducted by Indian Council for Research on International Economic Relations (ICRIER) have further emphasized the necessity to plan for better functioning cities, larger cities and metropolis in a regional scale or system of cities (Ahluwalia, 2010)[11]. It is predominantly at this scale of a network of system of settlements within a metropolitan agglomeration, the goals of a comprehensive and balanced agglomeration can be best targeted and achieved (Atkinsons, 1992).[12] Accordingly, future studies can be positioned to assess agglomeration at this scale of development.

Researchers at ICRIER and LSE feel that it is just not about building mega cities, but also about connecting rural hinterland to agglomeration of urban areas, of which the metropolitan region is the highest representative. Henceforth, the integration of spatial and qualitative aspects of development as caused by indicators of economic geography and human development driven economic geography within a regional framework of metropolis has also been felt by a common pool of Indian and global researchers.

The present paper attempts to provide a deeper and meaningful insight of inequality variations within KUA with the help of HDIs, keeping in mind the earlier works on the very concept of Human Development Index. To fulfill the aims of the paper, three indicators have been taken. The indicators are:

1. child mortality rate
2. literacy rate and
3. rate of working population

As pointed out earlier, the three indicators are related to the three prime index of Human Development Index, i.e., life expectancy index, education index, and gross domestic product index, respectively. Through the aforesaid indicators, the paper tries to show the extent of variations inequality, explaining the overall imbalances in distribution of the HDIs within KUA.

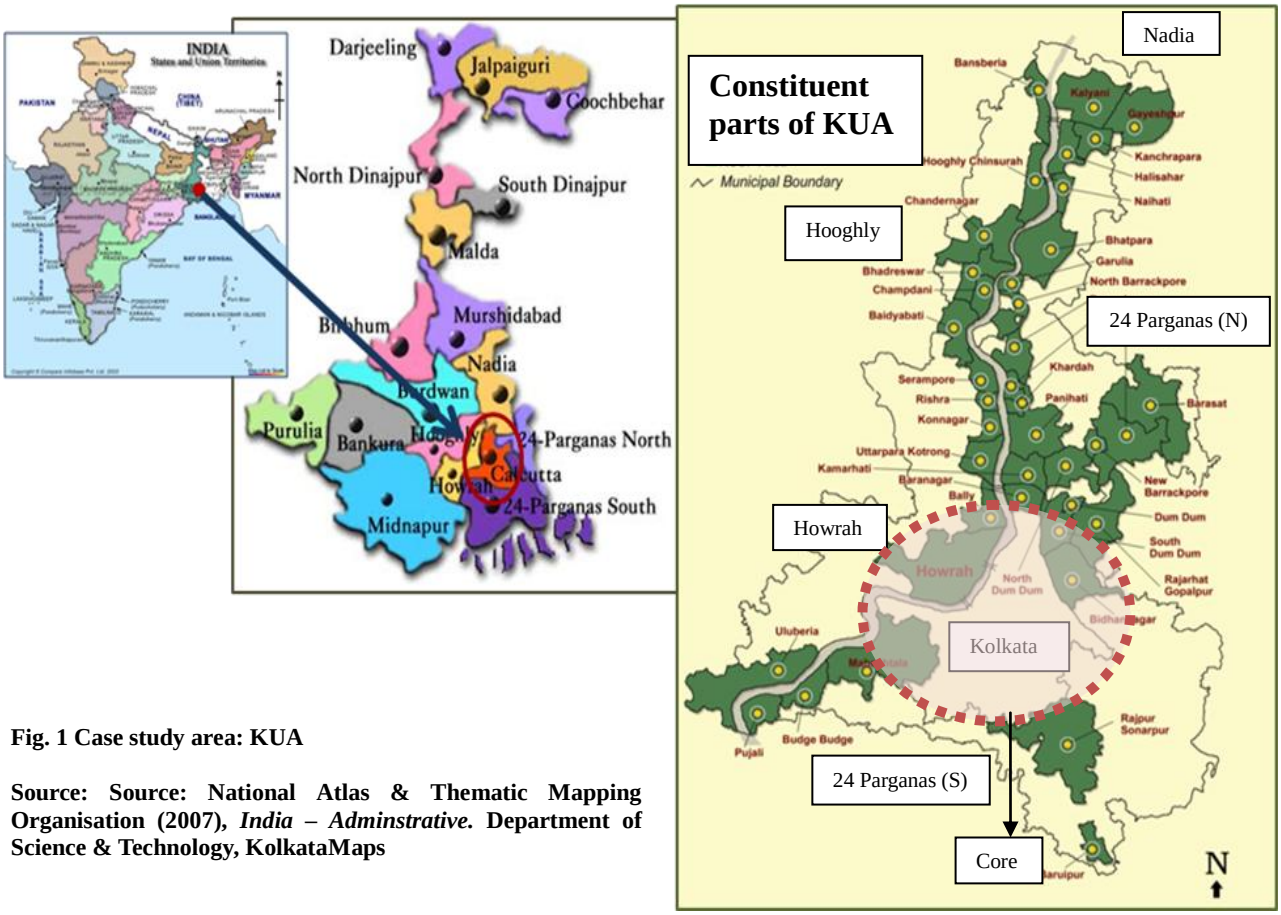


Fig. 1 Case study area: KUA

Source: Source: National Atlas & Thematic Mapping Organisation (2007), *India – Adminstrative.* Department of Science & Technology, KolkataMaps

2 The Methodology

Analyses are based on the application of chosen indicators on KUA through four techniques of evaluation. The first one is the percentage distribution of the chosen indicators. The particular technique based on a comparative study of distribution of HDIs of six mother districts, parts of which comprise KUA. The second technique is the analysis of inequalities of HDIs over six districts through Gini's Coefficient and Lorenz Curve. The third technique is the standard deviation of parameters which analysise the extent of variations of HDIs within KUA at the level of administrative units, i.e., Urban Local Bodies (ULBs). Finally, through the regression analyses, how far the parameters of HDIs are responsible for unequal distribution of a basic demographic parameter over space, say population , within ULBs has also been calculated.

3 Results and Discussion

Here all the analyses are discussed under the following sub-headings:

a. Percentage Distribution

To have a vivid picture of the six districts various intra level comparisons have been made. These are as follows:

- East bank and west bank comparison
- Core and periphery comparison
- A general relational study

A map of KUA (National Atlas & Thematic Mapping Organisation, 1997, 2007)[13, 14] here is shown to have a geographic idea of the same (refer Fig. 1) and all the analyses are based on secondary data (Bureau of Apllied Economics & Statistics , 2001).[15]

East Bank – West Bank Comparison

The east bank districts of the river Hugli are Nadia, North 24 Parganas, Kolkata, and South 24 Parganas. The west bank districts are the rest of the two, i.e., Howrah and Hooghly. As mentioned earlier, the comparison has been made on the basis of three indicators of:

- rate of literacy
- rate of working population and
- rate of child mortality

Fig. 2 depicts that in the case of literacy rate, the share of 72% literacy rate goes to the east bank

districts. This is due to a large share of literacy rate of the two districts of 24 Parganas, north and south those are 27% and 18% respectively. The rest of share i.e. only 28% goes to west bank districts and this is due to low literacy rate in Howrah i.e., 13% and Hooghly, which is 15%.

Fig. 2 depicts that the maximum share of working population is concentrated in the east bank districts and the value is 73%. The maximum share is because of the presence of Kolkata, which is the heart of the entire region. Here, Kolkata individually has a share of a maximum percentage of working population i.e., 25% of the total working population of aggregate six districts. This is followed by South 24 Parganas, which is 19% and North 24 Parganas, which is 16%.

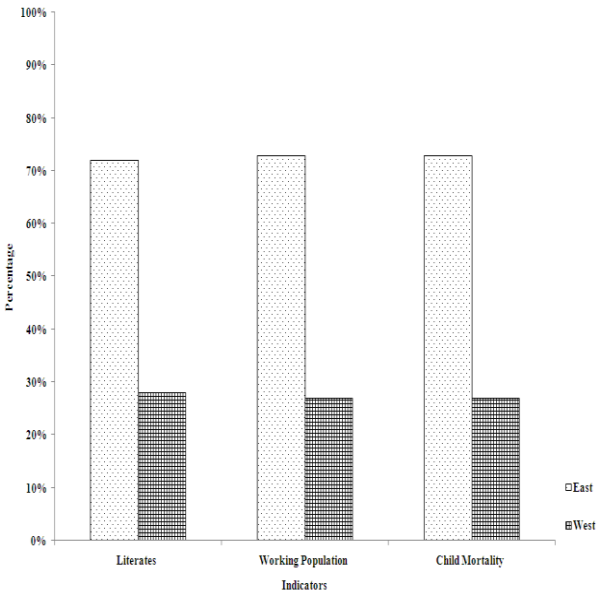


Fig. 2 East Bank – West Bank Comparison

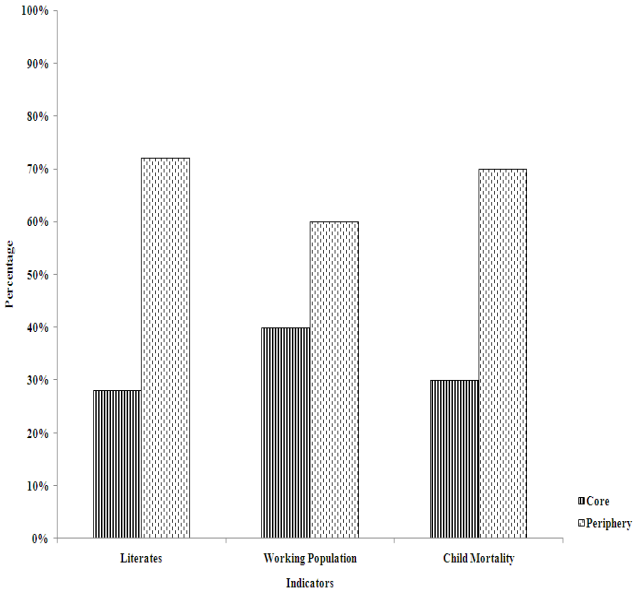


Fig. 3 Core – Periphery Comparison

Additionally, because of relatively lesser economic importance to Kolkata, only 27% working population is found in the districts of Howrah and Hooghly, which are individually 15% and 12% respectively.

Furthermore, Fig. 2 also shows that in districts lying on the east bank, the share of child mortality is maximum i.e., 73% in respect of the west bank, which is only 27%. Though Kolkata has the lowest child mortality rate of 8%, due to the highest contribution of Nadia and North 24 Parganas, both having 22%, and followed by South 24 Parganas which is 21%, child mortality rate in overall east bank districts eventually become higher. Though the entire east bank districts have higher rate of literacy and working population, due to lack of awareness regarding health, the difference with the west bank districts of Howrah and Hooghly is significant.

Core – Periphery Comparison

With the help of core – periphery comparative analysis, another scenario has emerged. Here core comprises of two municipal corporations of Kolkata and Howrah (refer Fig. 1). It is important to analyse Howrah along with Kolkata by virtue of aforesaid indicators, as both form the entire core area, though belonging to opposite banks. Fig. 3 depicts that Kolkata and Howrah contribute 28% of the total literacy rate among the six districts portions constituting KUA. Various socio-economic reasons are behind lower literacy rate of core. But one of the most important reasons may be the presence of larger concentrations of slum population adjoining the places of economic opportunities in the core urban areas. Remaining 72% of the total literacy rate is contributed by other four peripheral districts of Nadia, North and South 24 Parganas and Hooghly

Fig. 3 shows that in the case of working population, the percentage is slightly higher in the core. It may be due to economic advantages of the two core corporation areas, as the core contributes 40% of the total working population. In other words, the rest of four peripheral districts contribute 60% of the total.

Again, Fig. 3 shows that the core. i.e., Kolkata and Howrah together have relatively lower child mortality rate of 22% than the rest of four peripheral districts. Other four districts contribute as high as 78% of the total child mortality. A key reason is that the four districts have maximum rural population concentrations along with presence of relatively lesser health care facilities along with similar degree of awareness and affordability / accessibility to better health services.

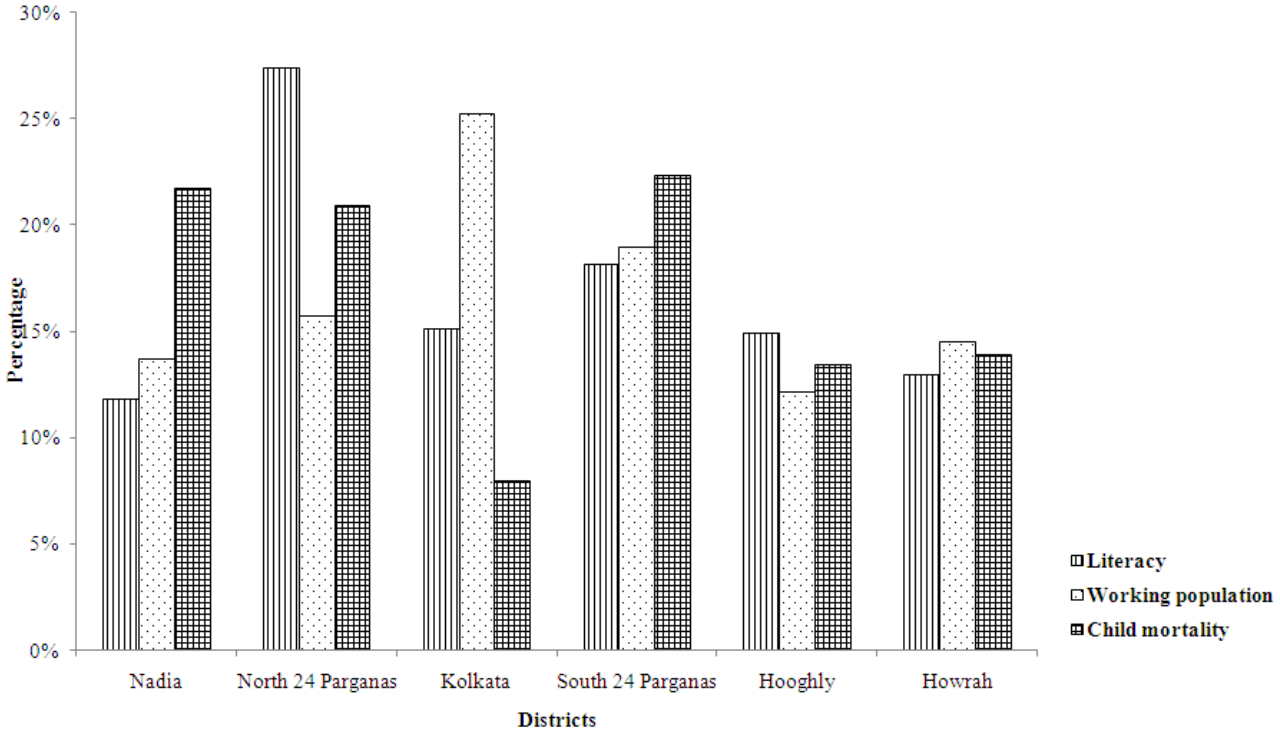


Fig. 4 Distribution of Literacy, Working Population and Child Mortality

A General Relational Study

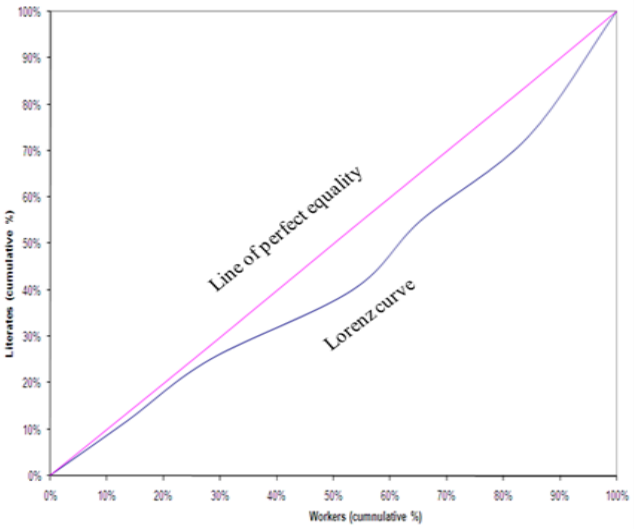
A comparative scenario among the indicators has become evident in Fig. 4. The two west bank districts – Hooghly and Howrah have moderate percentage of rate of literacy, working population and child mortality. But sharp variations are found in the cases of the four other districts of east bank. Among the four districts of east bank, literacy rate of Kolkata is moderately high with higher percentage of working population and relatively lower child mortality rate. For the districts of Nadia and North 24 Parganas, variations among the indicators are very significant. Contrary to this, South 24 Parganas shows a relatively higher distribution of all the three indicators.

Additionally, it is important to note from Fig. 4 that both Howrah and South 24 Parganas have relatively higher literacy rate with high mortality rate. This is a contradiction as it is universally true that higher the literacy rate, lower will be the child mortality rate and vice versa. The lopsidedness among the parameters is explicit here. Therefore, it can be said that a certain level of acceptable homogeneous development in the three HDIs is far from being evident.

For Nadia, literacy rate is relatively lower with higher child mortality rate. For other three districts of Kolkata, North 24 Parganas and Hooghly, child mortality rates are relatively lower with relatively higher literacy rate.

Gini's Coefficient and Lorenz Curve

Lorenz curve and Gini's coefficient are also calculated on the basis of the aforesaid indicators. The Gini's coefficient is developed to measure the degree of concentration (inequality) of an indicator in a distribution of its elements. Gini's coefficient represents the area of concentration between the Lorenz curve and line of perfect equality. The Gini's coefficient ranges between 0, where there is no concentration i.e. perfect equality, and 1,



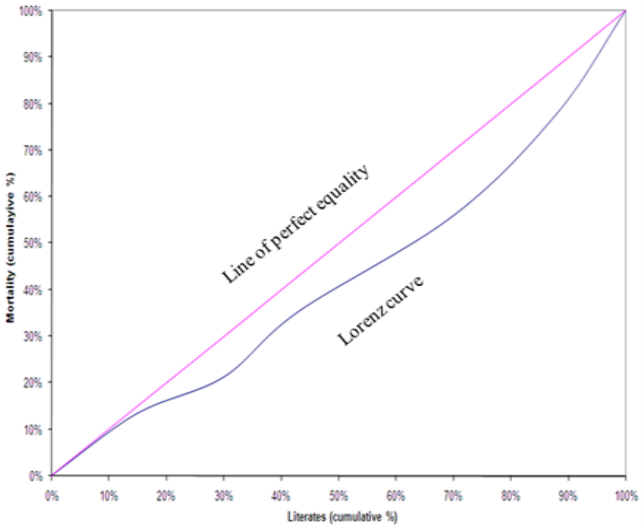


Fig. 5 Distribution of rate of literacy and child mortality

where there is total concentration i.e. perfect inequality. The closer the coefficient is to 1, the more unequal the distribution. The interpretation of the coefficient is usually done in comparative terms, by contrasting the
calculated value to that of other geographic units, population groups etc. Formula for Gini's coefficient (Rodrigue et al, 2009)[16] is:

$$G = 1 - \sum_{0}^{N} (\delta Y_{i-1} + \delta Y_i)(\delta X$$

where, δX and δY are cumulative percentages of Xs and Ys (in fractions) and N is the number of elements (observations). Using the same example as above, Table 1 demonstrates the calculation of the Gini's coefficient.

Table 1 Calculation of Gini's coefficient

Bank	Correspon-ding literacy (%) X	Ascendig child mortality (%) Y	Cumulative literacy (δX)	Cumulative mortality (δY)	$\delta X_1 - \delta X$ (B)	$\delta Y_1 + \delta Y$ (A)	A*B
West	0.28	0.27	0.28	0.27	0.28	0.27	0.076
East	0.72	0.73	1.0	1.0	0.72	1.27	0.914
							0.990

Gini's coefficient for this distribution is 0.01 (|1 – 0.99|).

To show the imbalances through the chosen indicators over the entire area Lorenz curve has been taken for further analysis. For both the Figures (Fig. 5 and Fig. 6), as Lorenz curve is far from the line of equal distribution, it means that the imbalances in distribution in rate of literacy, working population and child mortality over the six districts is high, i.e. the aforesaid three indicators are not equally distributed, rather concentrated in several districts throughout the area.

The total areas of the six districts have been taken for each indicator to calculate Gini's coefficient. Table 2 shows that when Gini's coefficient calculated to compare the east bank and west bank districts of river Hooghly, the coefficient value is comparatively low and as insignificant as 1% for the indicator of rate of literacy against other two indicators of rate of child mortality and working population, as both the Gini's coefficient values are 7%.

Based on the calculation made for comparing core and periphery, it is evident that rate of working population is relatively significant i.e., 37% than the rate of child mortality and literacy, where the Gini's coefficient values are 23% and 21%, respectively.

Table 2 Values of Gini's coefficient for three indicators

Category	Parameters	Gini's coefficient
East – West	a) Child mortality	7%
	b) Literacy	1%
	c) Working population	7%
Core – Periphery	a) Child mortality	23%
	b) Literacy	21%
	c) Working population	37%

b. Standard Deviation of Parameters

To have a further detailed scenario of KUA, instead of taking the KUA forming six districts, now only ULBs

within the KUA have taken into consideration. Here aforesaid parameters have been transformed to more specific parameters. These are:

- rate of literacy
- number of educational institutes
- rate of working population
- number of medical institutes and
- total number of beds in medical institutes
- total number of doctors in medical institutes

Standard deviation technique has been used to establish how much variation there is from the "average" or mean. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data is spread out over a large range of values (Elhance, 1968),)[17].

Formula for standard deviation (δ) is:

$$\delta = \sqrt{\frac{1}{N}\sum_{i=1}^{N} (X_i - \mu)^2}$$

where, N is the number of observations, X_i random variables and μ mean of random variables.

Table 3 shows the calculated value of mean and standard deviation of the aforesaid parameters. Here, a similar calculation has been repeated, taking Kolkata into consideration, the heart of the KUA, and a further analysis not considering it. Kolkata, as a metropolitan city enjoys better provision of public utility services, and for this reason, among the six parameters, the four parameters namely, number of educational institutes, number of medical institutes, total number of beds in medical institutes, and total number of doctors in medical institutes are highly spatially concentrated in Kolkata. For these four parameters mean and standard deviation are sufficiently high. For example, the average number of educational institutes is 235.57 with a standard deviation of around 670, when

Table 3 Values of standard deviation for five parameters

Parameters	Considering Kolkata or not	Mean	Standard Deviation
Rate of literacy	Considering	83.56	5.72
	Not considering	83.64	5.79
Number of educational institutes	Considering	235.57	670.81
	Not considering	123.12	87.22
Rate of working population	Considering	32.83	2.20
	Not considering	32.67	2.07
Number of medical institutes	Considering	19.66	68.86
	Not considering	8.64	22.67
Total number of beds in medical institutes	Considering	948.94	4390.07
	Not considering	207.53	185.63
Total number of doctors in medical institutes	Considering	100.17	396.31
	Not considering	29.88	31.08

Kolkata is being considered. It is evident that most of the number of educational institutes i.e. about 68% is found within 670 of the mean, one standard deviation. But without considering Kolkata, the mean value becomes only 123 with a standard deviation of around 87. Again it implies that most of the number of educational institutes i.e. about 68% is found within 123 (36-210) of the mean, one standard deviation.

c. Correlation Analyses

To evaluate how far the aforesaid five parameters are responsible for spatial distribution of population in the urban environment of KUA, regression analyses, namely single, partial and multiple, have been calculated. For this, at first another parameter namely, population of all thirty five ULBs along with Kolkata has been calculated. The formula for single regression (Gujrati and Sangeetha, 2007)[18] is:

$$Y = \beta_1 + \beta_2 X + u$$

where Y is the dependent variable, i.e., population, X exploratory variables, u is the error term and β_1 is the intercept term. R^2 values for each parameter in relation with population have been shown in the following table.

Table 4 R^2 values for five parameters

Name of parameters	R^2 values	
	Considering Kolkata	Not considering Kolkata
Total number of literates	0.99	0.98
Number of educational institutes	0.99	0.49
Total number of working population	0.99	0.98
Number of medical institutes	0.87	0.02
Total number of beds in medical institutes	0.98	0.21
Total number of doctors in medical institutes	0.98	0.08

From the table 4 it is evident that except total number of literates and total number of working population, regression results remain almost same (variation is only 0.99 and 0.98 for both the cases) if we consider Kolkata or not in the analyses. But for parameters related to health, i.e. total number of medical institutes, total number of beds in medical institute, and total number of doctors in medical institutes, have high values of regression (0.87, 0.98, 0.98 respectively) when we take Kolkata into consideration; while the values become lower (0.02, 0.21, 0.08 respectively) if we do not consider Kolkata in the analyses. For the calculation of educational institutes, differences in R^2 values, i.e. considering Kolkata or not, are almost same as parameters of health. It means that better public utility services in terms of health and education in Kolkata is one of the major causes for high population concentration here. But these services have very low or insignificant impact for population distribution other than Kolkata.

Furthermore, R^2 values for partial regressions are not much impressive to show varying degree of inequality variations among the chosen parameters.

Finally, multiple regression is used to test how far the parameters are statistically significant in the model. The formula for multiple regression is:

$$Y = \beta_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + u$$

where Y is the dependent variable, i.e., population, X_2, X_3, X_4, X_5, and X_6 exploratory variables, i.e., literates, number of educational institutes, working population, number of medical institutes, total number of beds in medical institutes, and Total number of doctors in medical institutes, β_2, β_3 etc are the partial regression coefficient, u is the error term and β_1 is the intercept term.

Here the formula is:

Population = β_1+ β_2 Literates+β_3 Number of educational institutes+β_4 Working population+β_5 Number of medical institutes+β_6 Total number of beds in medical institutes+ Total number of doctors in medical institutes+ u

Now, R^2 = 0.99 means that 99% of the variation of population density around its mean is explained by the all five aforesaid regressors. From analysis of variance (ANOVA) it is also found that: significance F=7.8232E-50 and F-test statistic is 21136.18. Since, 7.8232E-50<0.05, R^2 is statistically significantly different from zero at 5% level of significance. From here it can be well concluded that the all the parameters are statistically significant at significance level 0.05. The scenario is almost same without taking Kolkata into consideration.

4 Conclusions

In this paper the six districts along with their parts constituting KUA have been analysed. East bank of KUA shows a significant difference in terms of the three indicators, where the percentages for rate of literacy, concentration of working population are very high in comparison to west bank districts. Contradictorily, child mortality is also high in the case of east bank districts. The reason of the contradiction may be the various degrees of inequality in health and settlement-related health issues in the urban areas of the east bank districts. An additional explanatory factor is the presence of unlivable squatter and slum settlements abutting the areas of highest economic opportunities as reflected by the working population. So the contradiction actually explains a certain degree of disconnect between the two parameters of HDI i.e., working population and child mortality. Overall, a fair degree of lopsidedness among the parameters is evident. Additionally, it is explicit that a certain level of acceptable homogeneous development in the three HDIs within KUA, as a whole, is still a bit far from being satisfactory.

Though Howrah is a complementary growth centre to core Kolkata, still it could not reach the level as Kolkata as advanced in terms of utility services and it is portrayed by virtue of Howrah's high child mortality rate. In view of child mortality rate, the core experiences relatively lower percentage than the rest of four peripheral districts. So a sharp variation has been established between core and periphery based on rate of child mortality. As the mortality rate is related to literacy rate of a particular area, it is also evident that the districts sharing relatively higher literacy rate are experiencing low percentage of mortality rate, like Kolkata and North 24 Parganas. It implies a good level of awareness and affordability regarding health and hygiene services. It further implies a built

environment with relatively good level of livability.

As a metropolitan city, Kolkata has a strong appeal among the large number of working population. Howrah as a significant growth centre also acquires relatively higher rate of working population. It signifies that the rate of working population is concentrated in two areas, Kolkata and Howrah, constituting the total core.

Furthermore, both the 24 Parganas Districts have higher working population than total population. This is because of industrial concentration of these districts, which results into in-migration of daily workers. There is also an imbalance between east bank and west bank based on the percentage of working population.

Moreover, Lorenze curve and Gini's coefficients have furnished an unequal distribution of indicators. Higher the coefficient value, higher is the inequality. In this study, Gini's coefficients have been found very effective in the case of core – periphery comparisons.

With the help of mean and standard deviation of six parameters, it is evident that spatial imbalances are there in terms of basic utility services of number of educational institutes, number of medical institutes, total number of beds in medical institutes, and total number of doctors in medical institutes. These services have relatively higher concentration in core Kolkata. But it is interesting to note that rate of literacy and working population is nearly homogeneously distributed over the area of KUA, as the standard deviation of rate of literacy and working population is relatively as lower as 5.72 and 2.20, respectively. The variations in parameters of HDIs, as implied from various analyses, across core – periphery, east - west etc, are the representation of the backdrop variations in quality of built environment which encompasses factors, like intensity, age of obsolete or augmented, character of the metropolitan built-scape.

Through regression analysis it is strongly established that all the chosen parameters are statistically significant and they are further explaining the parameter of population. So, all the parameters play a satisfactory role in understanding imbalances in the metropolis in terms of health, education and economy.

In summary, it can be inferred that the present paper has attempted to identify the multifaceted variation and associated imbalances through the parameters of HDIs, which are significant representations of the quality of the metropolitan built-environment. The paper has attempted to meet the objectives forwarded by various current researches conducted by organizations of ICRIER, National Council of Applied Economic Research (NCAER) and London School of Economics (LSE) (Shukla and Bauer, 2009)[(19)]. Consequentially, the paper has been able to correlate and integrate quality of life indicators like HDIs with the quality of physical built-environment in the context of metropolitan development.

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