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SOME AREALLY-ASSOCIATED FACTORS IN INTRA-URBAN VARIATION OF POPULATION : PATNA

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ABSTRACT : The principal objective of the paper is to examine the role of some areally-associated factors in intra-urban variation of population in the metropolitan community of Patna. The city has been the focus of centralisation of social, political, economic and religious movements for the last several hundred years and has experienced differential growth patterns. Apart from the historical and physical reasons, there are many social and economic factors (i. e. commercial area, accessibility, urban function, literacy and scheduled castes & scheduled tribes etc.) which have some definite bearing on the spatial structure of population. The result of analysis of data and diagrams also reveal that out of five selected indicators, commercial area is one independent variable which has been found to make the greatest contribution to the explanation of intra-urban spatial variation of population in Patna, followed by accessibility, urban function and literacy.

Introduction

The areal differentiation of population within urban areas is the result of interaction of many complex historical, physical, social and economic factors. The age of cities, their physico-cultural setting and the processes of their growth have produced varied and varying patterns of intra-urban distribution of population. In olden days, people preferred most the central city because of reasons of defence, commerce and religio-cultural necessities, whereas in modern times this tendency owes most to preference for vicinal location in respect of places of work in relation to places of residence of people engaged in secondary and tertiary sectors of economy. It has generally resulted in crowding in the central wards of the city. Of course, the changing patterns of intra-urban mobility based on modern transportation technology have had their impact on centripetal and centifugal tendencies. Majority of the Indian cities which have ancient / medieval origins show a marked concentration in the core region. The British colonial administration in India caused a considerable shift of the cen're of population from the old nucleus and led to the development of a bi-nodal pattern of the indigenous city and the modern city with distinct characteristics. During the post-independence period, new economic and social dimensions have added many distortions in the morphology and demographic structure, but the caste and communal elements have a manifest leaving on social segregration of population.

Objective and Methodology

Here an attempt has been made to examine the role of some areally associated factors which have produced difterential patterns of intra-urban density of population. For the purpose of present analysis, five factors, viz. (i) commercial area, (ii) accessibility, (iii) urban functions, (iv) scheduled castes and scheduled tribes and, (v) literacy, have been taken into consideration. It is hypothesized that each of these factors has influenced the intra-urban distribution of population in Patna. For a statistical analysis, population density has been regarded as the dependent variable and the five selected factors as independent variables. The data for the first two variables, viz., commercial area and accessibility were obtained by the analysis of the existing land use maps as well as road maps and field surveys of the city by the author. The data for the remaining variables were derived from secondary sources, particularly the District Census Hand-book (1971). In order to show the spatial variation of these variables and their association with population distribution, the average absolute percentage values for all census tracts falling in successive zones from the centre have been calculated.

The Role of Selected Factors

Commercial Area : It is noteworthy that the central commercial core in Indian cities is the focus of population concentration. It is, therefore, hypothesized that parts of the city having greater amount of commercial areas would experience relatively heavier concentration of population. In contrast to western cities where the principal commercial areas are almost devoid of residential population, Indian cities have usually mixed commercial and residential land uses. Within the city, commercial activities start growing at the central chowk and gradually spread in narrow streets and lanes – the process is followed by thinning out of residential areas and thereby intensifying both residential and commercial uses of land. The commercial and residential areas are, therefore, inseparable. Even the dominant commercial areas are occupying the oldest part of the city usually associated with the place of origin. On the outer fringe of the CBD, the high density residential areas develop and are converted into slums and blighted areasp consequent upon the maximum congestion and overcrowding of houses and people.

Accessibility : Accessibility plays an effective role in the integration of all human activities. As people prefer to settle at the place of the greatest convenience, they tend to cluster in areas of maximum accessibility. It is, therefore, hypothesized that those areas where accessibility is highest, are most densely populated. Accessibility patterns within a city reflect the whole complex of consumers travel behaviour pertaining to distance, time and transfer costs. It is, thus, inversely related to distances from the city centre but has considerable positive correlation with residential land uses.

Of course, for different activities, the most accessible site varies but it is usually one where travel / transfer / time cost are at a minimum. Both in the past and at the present travel time cost effectiveness has reigned supreme. In modern times, though the expansion of the city following the increased transport facilities and planned development has diffused the character of residential segregation the overall patterns are the same (Everson and Fitzgerald, 1972, p. 159).

Urban Function : The most fundamental reason for population concentration in urban areas is that towns and cities are centres of diverse functions and large scale employment. But the pertinent question is as to how the city dwellers are spatially distributed over the urban space. In developing countries like India because of costly and inadequate transport facilities working forces in urban areas prefer to settle very close to their work place. It is therefore, hypothesized that the concentration of workers in certain employment is found in areas of their functional establishments. In other words, the density of workers engaged in trade and commerce is maximum around the commercial core which diminishes sharply as one moves out from there. " A characteristic feature of the pre-industrial city was the close proximity of work place and residence " (Sjoberg, 1960, . 161). Weavers and craftmen get greater privileges by having industries in their homes. The time and travel cost that a worker takes to cover a certain distance from his home to his work place and to central shopping area is obviously a vital factor in determining the pattern of residential areas within a city. In western cities, there has been the growth in recent years of street cars, electric railways, mortar ways and fast coach services which have allowed people to live further away from the work place (Wolforth, 1971, p. 241).

Scheduled Castes & Scheduled Tribes:

Scheduled castes and scheduled tribes constitute a considerable proportion of India's urban population (15·35%). These minority people are considered to be socio-economically weaker segments of the society. Members of these groups experience a wide range of discriminatory treatment and frequently are related to positions relatively low in the status structure of our society. These groups in urban areas are very often found to have settled in most under-developed localities. As a result of their low income and low standard of living, they prefer to reside in old blighted residential areas in almost clustered form because of low residential value. Thus, it has been observed that city wards having greater proportion of scheduled castes and scheduled tribes are characterized by relatively high population density. The validity of this assumption has been examined from the census data available on ward basis which make it possible to assess the spatial variation of scheduled castes and tribes in Patna.

Literacy : Literacy has been taken as a measure for variation of population within cities, though it may not directly be a causal factor. It is evident that considerable illiteracy exists in urban India which varies significantly in different parts of the city. Field investigations revealed that areas having high literacy were characterized by relatively low density of population. As a matter of fact the elite occupy the best developed residential localities within cities. It is therefore, hypothesized that those areas of the city having high amount of literacy are scarcely populated and those with low literacy are thickly populated. The validity of this hypothesis has been tested on the basis of census tracts data availale.

Results of Correlation & Regression Analysis : The analysis of data shows that the first three of the five hypotheses are strongly supported by the result of correlation regression analysis. That is those areas of Patna which have greater amount of commercial areas, good accessibility and nucleation of urban functions are characterized by heavier concentration. In contrast, the other two hypotheses are not confirmed by the analysis of data, i. e., the results are not in favour of the assumption that the areas of greater proportion of scheduled castes and tribes would correspond with areas of higher population densities and areas with higher literacy would have lower population densities. The proportion of these socially and economically backward communities increases in distance from the city centre, while the general population density declines with the increase in distance. As such, people of these minority groups come in the lower strata of the society and they are forced to occupy the peripheral areas where they huddle together to create slums or increase urban sprawl. This presents a contrasting situation with regard to western cities where the poor occupy the central city and the wealthy live at the outskirt of the city (Northan, 1975, p. 146).

Literacy, on the other hand is positively related to population density, i. e. the highest literacy exists in areas of highest population density. Singh (1975, pp. 283–298) also observed high level of positive correlation of literacy and employment in trade and commerce in the densely inhabited core areas of the city and a negative correlation of scheduled castes population, usually located on the urban periphery. Both decline with the increase in distance from the central city. In western cities again, though illiteracy is almost non-existent the elite occupy the fringe areas of the city. In India, the elite as will as the wealthy people are still occupying the central city (Mahadeo, 1972). The fringe area of the city as a matter of fact also includes a large number of rural enclaves (busties) where workers mostly derive their livelihood from primary occupation and considerable illiteracy as in the countryside exists. Thus, the basic assumption that higher the literacy lower the density of population, is rejected and follows the principle of distance decay function.

TABLE I

Some indicators of Intra-Urban Spatial Variation of Population, Patna (1971)

Distance from City Centre (Kms.)	Persons per Acre	Commercial Area in Acres	Accessi-bility	Urban Function	S. Castes & S. Tribes	Literacy
0.80	109 55	145.65	16.84	29.45	6.53	61.04
1.60	60.92	110.55	14.90	26.29	5.89	63.70
2.40	41.31	85.60	13.82	23.82	8 37	56.45
3.20	38.39	141.65	12.70	19.80	8.34	55·34
4.00	36.86	65.30	12.92	17.79	8.59	55.40
4.80	35.07	61.80	12.86	17.26	7.89	56.83
5.60	22.75	43.85	10.65	16.69	8.75	54.28
6.40	24.37	84.72	9.80	17.18	9.24	53.93
7.20	40.66	105.55	13.65	17.99	9.29	49.53
8.00	57.97	135.45	14.05	20.60	9.40	47.97
8.80	48.94	103.82	12.46	19.87	12.88	45.18
9.60	30.22	44.44	13.15	17.31	14.48	41.34
10.40	12 40	25.00	12.58	15.45	13.65	35.10
11.20	12.20	12.40	11.55	14.70	13.90	35.13
Correlation Coeff.–		.75	.76	.90	—.98	.59
Coeff. of Detem. –		.56	.58	.81	—.97	.35

Variables : Dependent Variable

1. Population Density (Persons per acre)

Independent Variables

2. Commercial Area (Acres)
3. Accessibility (metres road per acre)
4. Urban Function (% of commercial workers)
5. S. Castes & S. Tribes (%ge of Total pop.)
6. Literacy (Percentage)

The examination of correlation coefficients and coefficient of determination between dependent and independent variables unravel several significant points of the irassociation. For all except one independent variable, however, the proportion of explained variation in the dependent variable as given by the coefficient of determination (r^2) is considerably high. The analysis of data gives a maximum coefficient of correlation (0.90) and coefficient of determination (0.81) for one independent variable (urban functions) which means that out of the three other important determinants, urban functions have the closest association with population density. Accessibility to road and commercial area are the next important variables affecting the pattern of population distribution in Patna with correlation coefficients 0.76, 0.74 and coefficient of determination 0.58 and 0.56 respectively. Literacy has the lowest coefficient value (0.59) which means that only 35% of variance of population density is explained by the regression. The proportion of scheduled castes and tribes on the other hand, has inverse association with population density. The pattern of geographical variations can also be examined from the diagram (Fig. 1) which reveals the extent of closeness among a set of variables. The visual impression can also be verified by calculating the correlations between all sets of scores taken in turn as pairs. They are listed in the form of an intercorrelation matrix in the table II.

TABLE II

Inter – Correlation Matrix (Patna, 1971)

	Y	X_1	X_2	X_3	X_4	X_5
y	—	0.7476[1]	0.7646[1]	0.9011[1]	– 0.9836[1]	0.5911[1]
X_1		—	0.4277	0.7250[1]	– 0.6198[1]	0.6033
X_2			—	0.7994[1]	– 0.5932	0.2951
X_3				—	– 0.6469[1]	0.2253
X_4					—	0.9576[1]
X_5						—

$R_{y\,12345} = 0.9988$ $R^2_{y\,12345} = 0.9870$

1. Significant at 95 per cent. confidence level

Dependent Variable : Y – Population Density

Independent Variables : X_1 – Commercial Area,

X_2 – Accessibility,

X_3 – Urban Functions,

X_4 – Proportion of Scheduled Castes & Tribes,

X_5 – Literacy

The table II reveals a fairly close correspondence between all except one of the five variables and close agreement with the general population distribution. Even without speculating on possible causal relationship, some interesting observations can be traced out. The commercial area as a variable has a correlation of at least 0·43 which means that all indicators selected for analysis of intra-urban variation of population are themselves significantly correlated with commercial area of the city. Similarly, accessibility and urban functions have intimate positive correspond-

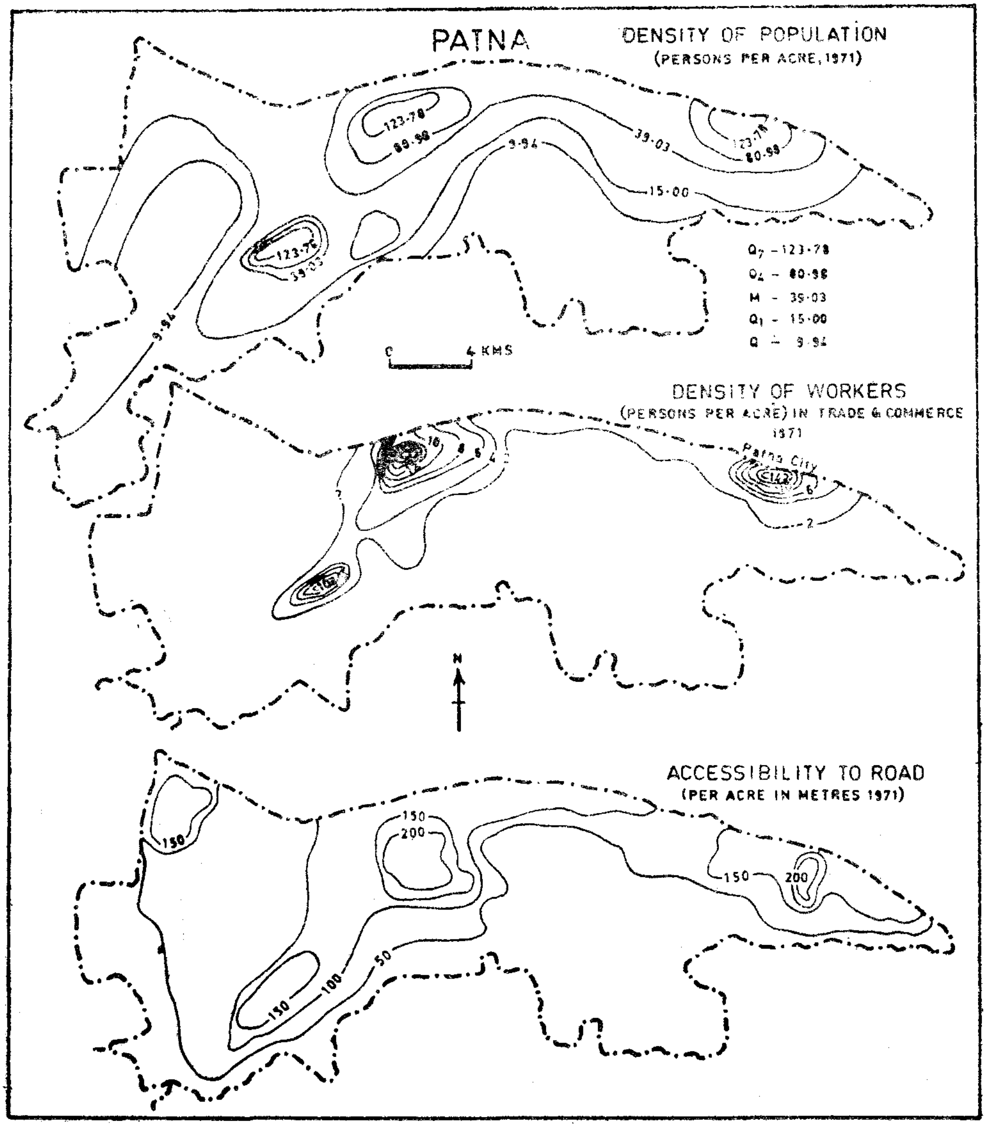

Fig. 1

ence with other determinants which justify the fact that these paramètres besides having profound causal relationships with population density are themselves closely associated. Literacy as a factor exhibits the lowest coefficient values with other factors.

Deviation of Residuals from Regression :

The deviant case analysis or the study of residuals from regression has been used in order to obtain clues in the attempt to achieve additional explanation of variation in the dependent variable. The coefficient of correlation and coefficient of determination are simple measures to show the degree of closeness between a set of variables. The standard method of measuring the goodness of fit of a regression is to calculate the extent to which the regression accounts for the variation in the observed values of the dependent variable.

An examination of the scatter diagram reveals clearly the pattern of deviations from the regression. The regression lines were drawn and individual observations plotted in order to show the extent of closeness of the deviations along the regression lines. It appears that in Patna because of diffused character of commercial and residential areas, there is considerable deviation from regression lines. The degree of deviation is found to be maximum outside the central commercial area because of dualism imposed by the British Colonial administration. In the old Patna city and Muradpur commercial areas, the land is given to an intensive residential and commercial uses so that the areas are located above the regression line and even above the confidence limit. The extent of dispersion is quite considerable in the intermediate and transitional zones of the city because of spread of commercial areas in relatively sparcely populated census tracts. 'The commercial areas of a city are not fixed or permanent but keep on changing in their location, function and morphology in response to the changes in the size, population and structure of urban settlements' (Dayal and Thakur, 1976, p. 165). The attributes of the city have been responsible for a considerable departure from the line of best fit, though a little over 90 per cent. of deviations are within the confidence interval (i. e., ± 29·170) from the regression line. The central zone with 1·6 kms. radius from the commercial core of Muradpur and having 22 per cent. of the total commercial land is the most densely populated part of Patna.

Analysing the patterns of residuals from regression in the case of accessibility to means of communication as a measure of distribution of population, some relevant features are traced out from the scatter diagrams. Barring a few exceptions, the overall patterns are the same, i. e. population tends to concentrate in areas of maximum accessibility. Within a city accessibility is found to be maximum at the centre which diminishes sharply outwards with the increase in distance from the central city. This high transport network primarily results from attractive forces exerted on residential population by the central business district. In large cities, the observed values when plotted along the regression lines make considerable departure from linearity and some of the extreme values lie above and below the cenfidence limit. In Patna, for instance, the central city with a relatively high accessibility (i. e. 14·3 metres road per acre) is characterized by the heaviest concentration of population (i. e. over 200 persons per acre). But the density of road per acre is also high in outer zones of Patna, especially in the planned residential colonies of Rajendra Nagar, Kankarbagh, Rajbanshi Nagar, Patliputra coloney etc. with relatively low population density. This attribute has been responsible for considerable degree of deviation from regression line in the marginal areas of the city.

Coming to the deviant case analysis of the other two variables, namely, urban function and literacy, they seem to have some definite bearing upon the intra-urban variation of population. The urban function is usually examined by employment data of different services. In the present analysis, the working force engaged in secondary function especially those in trade and commerce has been taken into account. Labour force employed in this function shows positive relationship with very high concentration of people and commercial activities. Accessibility to employment opportunities is positively related to residential land values. This relationship is sometimes swamped by the existence of satellite employment and shopping centres (Brigham, 1965 pp. 325–34). The density of workers is similar to the trend of general density of workers and also the density of total population of the city (Sami, 1975). The isopleth map of workers in trade and commerce clearly reveals that high density zones are almost identical with the zones of general population density. The proportion of workers is maximum in the central zone and drops radically outwards. Brush (1977, p.85) also observed that employment in this function shows the highest percentage in the river front wards, i. e. the densely populated city centre. Thus, the correspondence between population density and concentration of workers in trade and commerce bears a close resemblance and the observed values along the regression line tend to occur with a high degree of linearity. Deviation of residuals from the estimating line occurs mostly in large size city like Patna where the introduction of public transport services has offered opportunities to people seeking residences at the fringes.

As regards literacy as a detetermінant of population distribution, it was hypothesized that those areas of a city having high literacy would be scarcely populated and vice-versa. The analysis of data shows that the opposite is true, i.e. there is positive correlation of these attributes in Patna. Literacy in the central Patna is little over 62 per cent. It gradually decreases outwards and is reduced to 35 per cent. at the margin of the city. In this city, some significant departure from conformity is chiefly accounted for by the redistribution of population due to areal expansion and emergence of planned residential areas at the outskirt of the city.

The scheduled castes and scheduled tribes on the contrary display a typical geographical pattern with the highest ralative percentage on the periphery of the main city and in certain outlying areas which have low literacy rates. This demographic attribute in urban area, therefore, does not appear to be a causal factor in the explanation of population variation within the city as it was hypothesized earlier. Analysis of data and scatter diagrams of Patna confirm the validity of the assumption that there is inverse association between the distribution of population and these weaker sections of the society.

Conclusion

Althouh the spatial variation of population within a city is the result of interaction of complex of physical, socio-economic and cultural factors, it is possible to account for the major variation of the dependent variable by using a small number of independent variables. Commercial area is one independent variable which has been found to make the greatest contribution to the explanation of spatial variation in the dependent variable. In both the simple and multiple correlation analyses, the commercial area has been found to be most closely associated with population density patterns.

As a result of diffused character of commercial areas in Patna, the extent of association between dependent ant independent variables is relatively weaker than the cities characterized by single predominant population and commercial centres.

Next to commercial area, accessibility to means of communication is important independent variable for the explanation of areal variation of population. Residential areas within a city tend to grow at the most accessible sites and are, therefore, closely associated with transportation networks. It is, therefore, apparent that high accessibility at the centre has been responsible for incredible residential segregation. The other two variables viz. the urban function and literacy have relatively little impact on the distribution of population.

Analysis of the patterns of residual deviations from regression make it apparent that the large growing metropolis of Patna because of complex morphological structure show relatively weak association between dependent variables. Brush (1969) observed that larger cities in India are passing through the stage of rapid areal expansion while the smaller cities are yet to undergo an intensive land utilisation and are still confined to small compact areas.

All except one independent variable namely, the scheduled castes and tribes are themselves inter-correlated besides having their causal relationship with population density patterns. As a matter of fact, these minority people have inverse association with the general population distribution.

Finally, it may be noted that identification of the reasons for the predictive success of the independent variables is very complex, though a support of the concept has been found by testing of the hypotheses by statistical techniques. Until recently, commercial area and accessibility to communication lines have been the most powerful determinants of the extraordinary concentration of population at the centre of the city. The influence of these factors is declining in modern times because of the areal, expansion of the city concurrent with rapid growth of population and improvement in communication facilities. The result, therefore, is likely to be modified as soon as these cities after attaining a stage of intensive land use and population concentration come to face outward expansion and redistribution of population.

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