DYNAMICS OF EMPLOYMENT DISTRIBUTION AND ACCESSIBILITY INDEX: CASE OF DELHI*

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(1) Introduction

Many metropolitan regions in Asia and Africa are still growing in terms of their economy, population and spatial extension in line with the fundamental urban trend of the twentieth century, which has been the decentralization of people, jobs and services from inner dense core of cities to less densely-developed suburbs as the consequences of either market forces or planned intervention. However, the poly-centric dynamics for spatial re-structuring of employment cluster formation outside the old CBD, relevant residential location choices and associated commuting characteristics are subject to many factors and have not yet been well understood hence requiring findings from different cities with different characteristics especially from those of developing counties[1].In particular we attempt to address the following two research questions that have been long discussed for the non mono-centric urban form taking Delhi as the study area. First is the accessibility of the employment clusters, since firms agglomerations tend to locate at places that often have relative locational advantage in terms of the accessibility provided by highway and public transportation. Second is the impacts of poly-centrism on residential location choices and commuting patterns, where the issues are mode share at the employment destination, and the mean trip lengths (journey times) of those workers.

Between 1991 and 2001 the population in Delhi grew by 4.1%, making it the fastest growing metropolis in India. Employment opportunities have steadily increased over the years and the annual economic growth rate stands at 9.9%. Policies further plan to decongest the city centre by relocating the employment centers and restricting the establishment of new centers in the core city. The concept of the master plan 2021 is based on a poly-nodal, polycentric distribution of work centers, largely based on road transport nodes. Given the highly urbanized character of the city, a high population growth rate and the increasing number of employment opportunities, in order to achieve spatial balance development should take place according to new corridors of mass movement. This has implications in terms of land use planning along major transport corridors and the mass rapid transit system.

The primary aim of this paper is to explore the multi-centric employment formation and the relevant accessibility changes and commuting behaviours in Delhi, the capital of India and one of the most populated cities in the world. In order to understand the dynamics of employment distribution certain specific metrices are employed. These include the rank size distribution and the employment preference functions, which are elaborated in the first section. In section 2, gravity-based accessibility measures are employed to estimate the accessibility to work, education, health services and commercial centers within NCR Delhi. Section 3 outlines some results of the perceptions of accessibility to work, education, health services and commercial centers, which is an important component of Quality of Life (QoL)[2] of the respondents in Delhi. Finally section 4 concludes the results.

(2) , Employment Distribution Pattern and Relevant Commuting Trip Profiles

Early research attempts of identifying sub-centers were not generalizable; but rather case specific especially for those in North American cities. Here, on the purpose of deciding the clusters of employment stock in developing countries, where almost in most cases the data is aggregated into medium, or large-scale, traffic analysis zones, we propose a simple and compatible way of defining clusters by employing Zipf's Law of rank frequency distribution byplotting logarithmic employment density against rank size. Next we decide classification of employment agglomerations through breaks of gradient in the rank-size distribution. There is a tendency for grouping zones into four clusters, or tiers, but the actual number will arise from the data depending on the size of the city. Here, for the degree of spatial detail aimed in this analysis, we divide the zones into four clusters. The diagram is visually inspected and divided into parts indicated by obvious break of the first slope for the old city center as the highest density zones with

the highest ranks and the last slope for the zones with the least dense zones as the zones that are not necessarily accommodating many job opportunities. The medium part of the line is divided in to two parts defining Tier II and Tier III zones (Figure 1).Figure 2 further shows the location and distribution of each tier excluding the metropolitan area fringe agglomerations namely the satellite cities due the lack of the necessary data in terms of traffic analysis zones. Table 1 enumerates the details of the tiers. Evidently Tier II type of zones has the largest share of employment stock (49%) as compared to Tier I (26%) most of which are the old city center zones. Tier II zones are the agglomerations around the old CBD recently grown as strong urban attraction nodes proving that the share of CBD in total employment is decreasing. This is the results of not only the market forces by also the policies which plan to decongest the city centre by relocation of employment centers and policies which restrict the establishment of new employment centers in the core city.
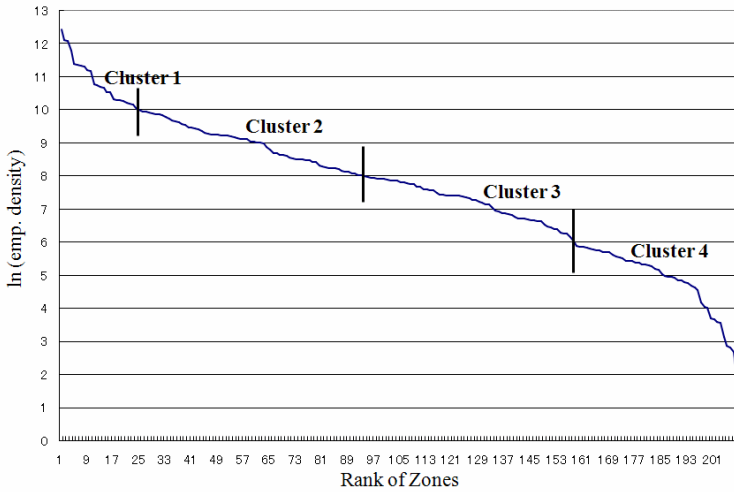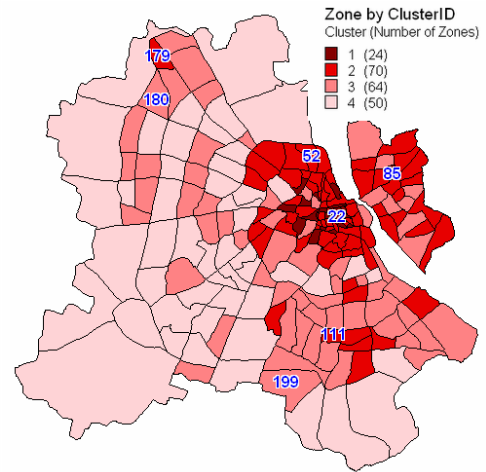

Fig 1.Rank size distribution, Delhi 2003

Fig 2.Clusters based on Rank size distribution

Table 1: Details of the different employment stock tiers (2003)

Tier type	I	II	III	IV
Employment	563,855	1,058,360	339,133	186,186
Share over total (%)	26	49	16	9
Number of zones	24	70	64	50

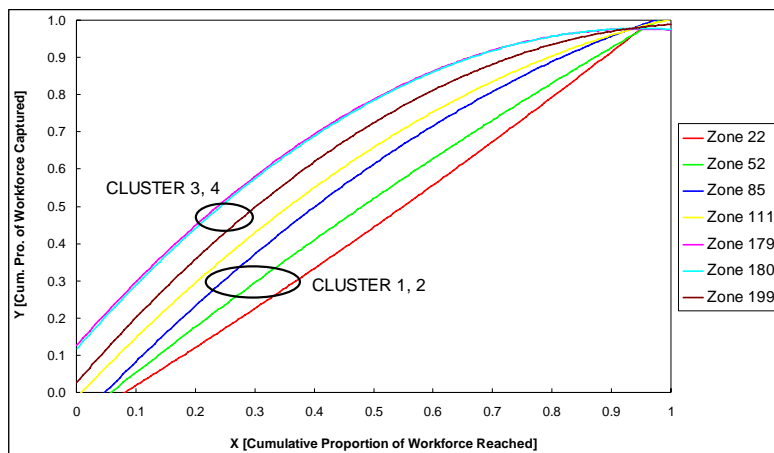For understanding the linkage in between emerging sub-center and associated residential location choices and hence commuting profiles in terms of time and distance, one analytical way is to plot the destination specific employment preference function based on the form of intervening opportunity model[1]. For each employment zone, residential zones are ranked according to increasing distance, or transportation travel time, by car or public transportation, or a weighted combination of the two. The number of residential workers living in each zone is a proxy for housing opportunities. By plotting the cumulative distribution of residential workers reached, a

Fig 3: Employment Location Specific Preference Function for selected zones in Delhi

"housing" opportunity surface around that employment zone is constructed. Steep gradients imply a nearby choice of residential location; shallow gradients imply a broader, metropolitan wide spatial labor market. Figure 3 shows the employment preference function plot for the selected zones. The graph shows that the CBD and nearby zones have a wider catchments areas, meaning that people tend to make longer trips to this area. This implies that these zones have the largest spatial housing markets with very few workers living in that employment zone or relatively nearby. On the other hand, the zones located in the outlaying zones, tend to attract shorter trips. This is thought to reflect that the

people are showing more tendency to take advantage of choosing residential location closer to where they work in case they commute to the suburban sub-center to lessen the cross commuting.

3) Tracking accessibility and individual perception for urban facilities

Accessibility has a long history in urban planning and increasingly gaining more interest as a tool and key concept in transport and land use development plans[4].It is an important component of QoL which may influence the decision of residential location. In order to assess the perceptions of the residents regarding accessibility in Delhi, a questionnaire survey was conducted at six different sites (Connaught Place, Chandini Chowk, Vasant Vihar, Sarojini Nagar, Janak Puri and Shadara) over a total sampling size of 338 respondents. Out of the total sample size 92 % respondents were men. This is likely results of a higher ratio of man population and higher ratio of men engaging in daily activities. As one of the questions within this survey, people were asked to reveal their preferences by weighting among the accessibility to: work places, education facilities, health care facilities and commercial centers. The results are aggregated by gender, age group, occupation and family income and given in Figure 4.
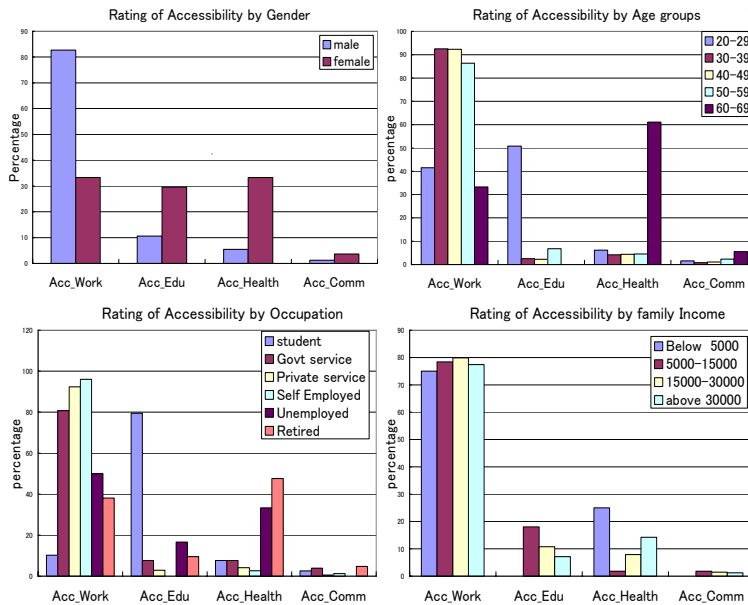
Figure 4(a) shows that while men rated accessibility to work as the most important, women rated accessibility to work, education and health services almost equally. In the different age group categories shown in Figure 4(b), respondents in the age group of 30-59 rated accessibility to work as the most important. The age group of 20-29 rated accessibility to education as equally important. Accessibility to health services was rated as the most important by the respondents in the age group of 60-69. Accessibility to work is also rated as the most important by respondents who are engaged in work, (Figure 4c) where as students rated the accessibility to education as the most important. The elderly rated the accessibility to health services as the most

Fig 4. Rating of Accessibility by (a) Gender, (b) Age Groups, (c)Occupation and (d) Family Income

important. Figure 4(d) further presents that accessibility to work has been rated almost equally important by all the respondents in different categories of family income. An important observation is that accessibility to commercial centers is not perceived to be an important factor for the respondents in all the categories, for their choice of residential location. In general access to the work places has received the highest weight from the respondents, underpinning the need to investigate the job agglomerations and the relevant accessibility variations in the cities re-structuring in the form of decentralized concentration. It is not wrong to claim that till date there has been only very few work on the poly-centric dynamics and accessibility changes in the growing metropolitan regions of the developing countries. Since an increase in the accessibility of emerging sub-centers may either be the evidence of a combined transport and land use plans or the dynamics bringing the jobs and houses closer.

In order to discuss the compatibility between the accessibility of different tiers of zones with the non mono-centric urban formation in Delhi we have computed gravity type accessibility indices as the measures indicating the efficiency of reaching opportunities. The basic form of gravity based accessibility function is given by equation 1. Where, A_{ij} = Accessibility of origin zone i by the destination zones j; L is the number of opportunities in zone j; $f(t_{ij})$ is impedance function in terms of C_{ij} as travel time between zones i and j for all type of trips.

$$A_i = \sum_j L \ \exp^{-\beta t_{ij}}$$
(1)

We have calculated the housing accessibility for different types of land-use activities within National Capital Territory (NCT) of Delhi as shown in Figure 5 together with the spatial distribution of associated urban facilities (Accessibility of work (5a), education (5b), health services (5c) and commercial centers (5d)). Notably, Figure 4a shows that the business centers which accommodate firm office stock tend to locate in the old CBD and the new sub-centers around the old city centers. Evidently, the city centre produced the highest accessibility which decreases towards the city periphery. However, certain agglomerations, most of which are belonging to Tier II, also generated relatively higher accessibility compared to tier III and IV in most cases. In addition, satellite cities of Delhi, which are included in the
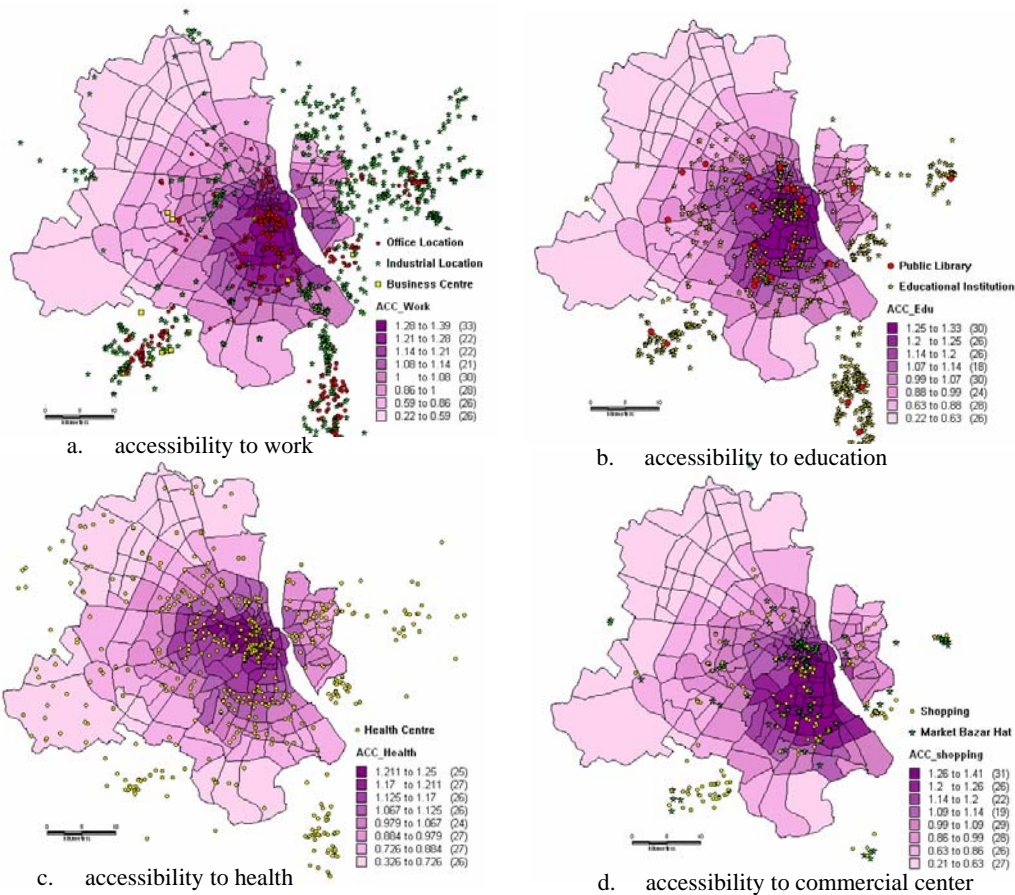
a. accessibility to work

b. accessibility to education

c. accessibility to health

d. accessibility to commercial center

Fig 5. Accessibility for different types of land-use activities

NCR also proved to be areas showing higher accessibility values as compared to the peripheral zones on NCT. The city is therefore expanding its limits into the satellite cities in order to accommodate the overflow of work centers. One central issue, although not examined here, is to manage a well combined public transport improvements in accordance with a multi-centric urban form evolving in many growing metropolises of the developing countries. Unless such non CBD stocks are served with a public transport network, these sub-centers will add more to the vehicle-kilometers traveled by car as in the case of the North American cities.[4] Even more crucially, the cities where two-wheeler and three-wheeler trips are dominating the transport but experiencing a shift from such vehicle to cars will attract more car trips to such sub-centers. Similarly, between 1990 and 2002, the share of two and three-wheeler trips have decreased from to 71% to 66 % and replaced by car trips of which the share has increased from 22 % to 28 %. Although this paper proved the accessibility variations and increases in the sub-centers these were for the whole trips within the limitation of available data to authors but it is extremely important to explore not only the tier but also the mode specific accessibility changes.

4) Conclusion

The study tries to explore the dynamics of employment distribution based on the analytical framework of employment tiers and associated employment preference curves and accessibility with reference to work, education, health care and commercial centers to understand impacts of non CBD formation residential location and on trip profiles for Delhi. Results indicate that besides the CBD, many areas within the region show a strong tendency towards making an employment centre. Also, relocation of work centers to the satellite cities is leading to further concentration of work centers here, which is shown by the high agglomeration of work centers accompanied by relatively higher accessibility nearby satellite towns. Results of one QoL survey indicate that accessibility to work has been perceived as the most important by the respondents. It is therefore important to target the policies towards better jobs-housing balance. It is evident that the job location into the satellite cities is concentrating along the present highway or the rail network which needs to be further evaluated in line with the public transport improvements.

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