ANALYZING URBAN DYNAMICS IN MULTI-CENTRIC CITIES: THE CASE OF ISTANBUL*

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1. Introduction

Our concern is with rapidly growing cities with non-monocentric structure of developing countries where the dynamics of spatial structure and re-structuring are less well understood. This paper contributes to research on multi-centric employment centers by proposing an analytical framework suitable for application in developing countries and illustrating it with particular reference to Istanbul – a large city (10 million populations) straddling Asia and Europe and also the largest settlement of Turkey. The city has shown a polycentric growth rather than saturated since the last three decades not only by market forces but also Metropolitan Area Sub-Region Master Plan promoting such a structure (Figure 1).

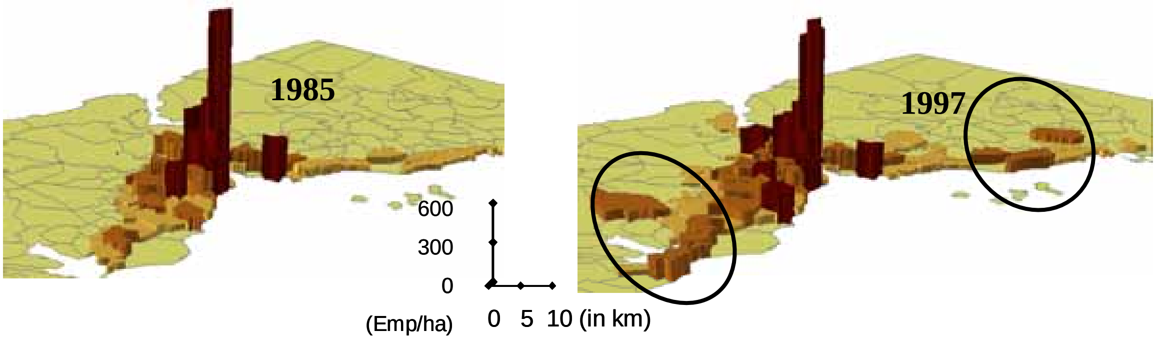

Figure 1: Employment density changes in Istanbul, 1985 - 1997

The methods described and illustrated in this paper provide a more rational basis for analyzing the dynamics of sub-center formation and impacts on commuting patterns for large, polycentric cities. First, given the nature of the problem on clustered employment distributions, four different clusters of employment densities are defined and classified by a simple methodology that can be generalized, especially when there is a lack of precise data, as is often the case in developing countries. Cluster dynamics together with the employment density gradient changes are analyzed. Changing patterns of commuting trips with the emerging sub-centers are discussed together with the level of transport provision. Average trip times, distances and modal splits are examined for the four different clusters. The argument is that as multi-centric structure becomes dominant, longer and more auto trips are likely to occur. Employment zone specific preference functions are drawn for a better understanding of labor force preferences with their choices for housing and job locations.

2. Analytical Methodology

Literature review illuminated that a number of empirical studies on USA cities and theoretical modeling challenges on sub-center have been presented but to our understanding, there is no convenient reference to analytical methods. This lack of a general analytic and systematic methodology covering all relevant issues is most acute in planning schemes for growing cities of multi-centric structure in the developing world where precise land use data is sometimes lacking. We propose a four-step methodology for analyzing multi-centric urban form, within a framework of study purpose, appropriate analytical technique(s), and the expected outcome for planning and policy, as simplified in Figure 2. This will shed light into understanding the urban

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dynamics and relevant necessary policies of multi-centric structure which is rather more complex urban pattern.

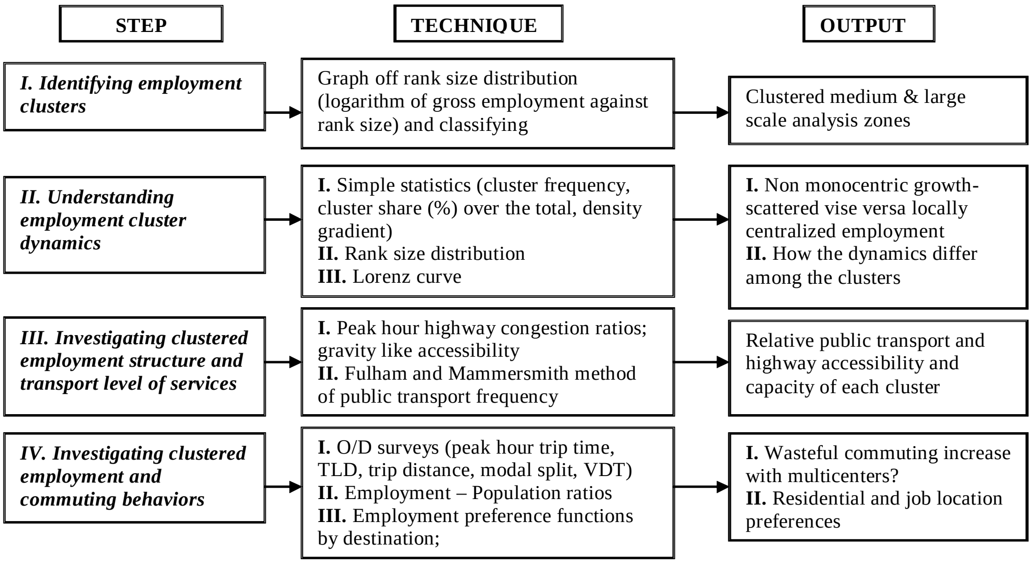

Figure 2: Scheme for analyzing multicentric urban dynamics

STEP I: Identifying employment clusters

We show how to define employment clusters in any city. Our methodology is simple and generalizable way of clustering employment locations particularly when the data is more aggregate with medium or large scale of traffic analysis zones that most of the trip data in developing cities is based on. In order to identify the clusters of sub-centers, Zipf's Law of rank frequency distribution was applied for gross employment density of zones. As the data are plotted at a two-dimensional graph, simple techniques of "Cluster Analysis"- Pearson coefficient, equal intervals and Minkowski distance similarity between the variables were used to cluster the zones as defined in Table 1 (for more details see Alpkokin et al).

STEP II: Understanding employment cluster dynamics

Rank size distribution and Lorenz curve can tell us more about the pattern of growth by comparing two time periods. A number of simple descriptive statistics such as zone frequencies in clusters, ratios for cluster shares over the total, employment density gradients can be used for comparing how locally peaked or flat a distribution is from the CBD.

STEP III: Investigating clustered employment structure and transport level of services

Center relative accessibility or congestion effects have been mentioned by many but less been less utilized to analyze the labor force commuting cost among the empirical analysis. Another means to calculate the potential accessibility of a centre - suitable for public transport- is to use the accessibility indices pioneered by Hammersmith and Fulham (see Black and Cheung, 2003).

STEP IV: Investigating clustered employment structure and commuting behaviors

A number of studies though less compared to employment location dynamics, examined the impacts of polycentrism on residential location choices and commuting patterns, where the issues are mode share at the employment destination and the mean trip lengths of those workers. There are two contrary arguments and empirical findings. With a decentralized employment and spatial mismatch, cross commuting increases, resulting in more wasteful, or excess commuting in terms of longer distances traveled. A more analytical way of grasping the residential location preferences for a given employment center is to plot graphically cumulative distribution of residential workers reached a "housing" opportunity surface around that employment zone is constructed. Steep gradients imply a nearby choice of residential location; shallow gradients around a sub-center imply a broader spatial labor market.

3. Employment Cluster Dynamics In Istanbul

Table 1 outlines the cluster dynamics by simple descriptive statistics. It is evident that the real urban dynamics are occurring outside the cluster 1 zones all of which are down town. Istanbul kept developing its traditional CBD centre without loosing its

Table 1: Simple descriptive statistics for cluster dynamics

Type	Employment (Share-%) (1985)	Employment & (Share-%) (1997)	Change(%) (1985-1997)
CBD	243,295 (12.9)	249,549 (8,9)	2.57 (-30.71)
Cluster 1(Mature old center)	626,213 (33.2)	773,347 (27.7)	23.5 (-16.5)
Cluster 2 (Developed as sub-center)	496,514 (26.3)	954,975 (34.2)	92.3 (29.9)
Cluster 3 (Emerging as sub-center)	449,955 (23.8)	766,793 (27.4)	70.4 (15.1)
Cluster 4 (Likely to be sub-center)	308,966 (16.4)	209,108 (10.7)	-3.2 (-34.6)

primacy. The largest growth was observed for cluster 2 and 3 zones proving an urban form of locally centralized rather than saturated development. The rank size distribution changes for 1985 and 1997 (Figure 3) also proves a more multicentric growth pattern for the city. However, when only Lorenz curve (Figure 4) was drawn for the two years, as expected it would have only given an idea of more flatness for 1997 since it approached to the diagonal compared to that of 1985. Though the word flatness may mean more saturated and homogenous distribution or sometimes more sub-centers with rather high densities, though for the case of Istanbul more local peaks, it is difficult to distinguish by only Lorenz curve. Therefore the authors emphasize the rank size distribution analysis.

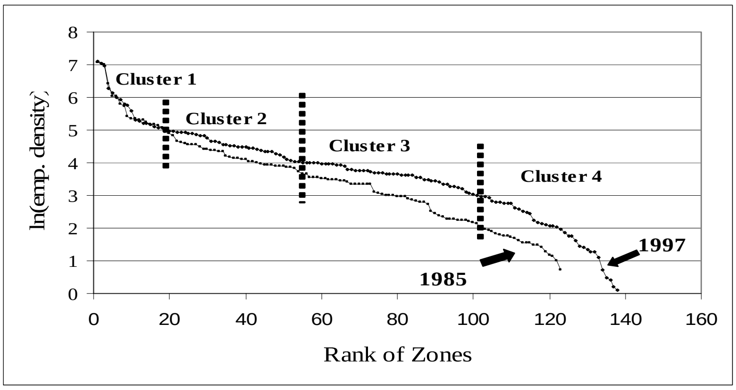

Figure 3: Rank size distribution and employment clusters

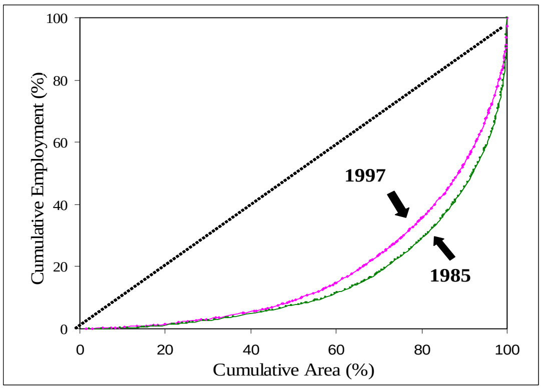

Figure 4: Lorenz curve for employment

4. Cluster Specific Commuting Behavior

This section further analyses commuting behaviors by means of commuting times, locational preferences and mode choices mentioned in Figure 1. We have analyzed ten zones , based on location and representative examples of the clusters to which each was belonging in 1985 and 1997 (Figure 5).

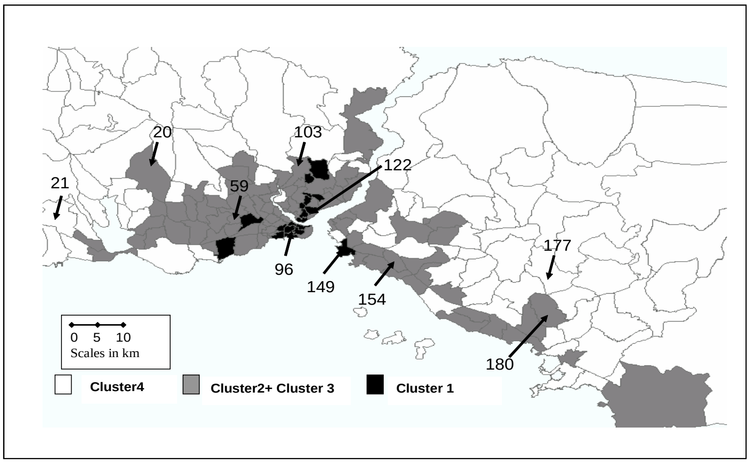

Figure 5: Location of zones examined for their commuting

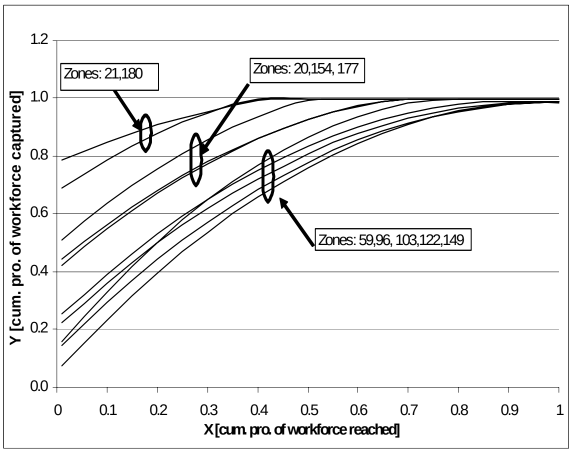

Figure 6: Preference functions,1997

The spatial extent of trips attracted to each zone in 1997 was examined using the employment location-specific preference function and the trip length frequency distribution of those commuter journeys to that employment zone for generalized cost. Table 2 further summarizes the location and cluster of zones examined and found to be worth mentioning here. Zones 21, 154 and 180 are envisaged as sub-centers of the future by the Master Plan, 1995.

Table 2: Examined zones for commuting patterns

Zones (cluster)	Location	Modal split (P.T)
96 / (1)	CBD west	58 %
149 / (1)	Downtown east	54 %
180 / (2)	Far east	48 %
154 / (3)	East	47%
21 / (4)	Far west	38 %

The noticeable feature of figure 6 is the different patterns in the zonal preference functions, as highlighted by the three black oval lines. Employment zones 21 and 180, capture a very high proportion of workers from very nearby residences (from 70 to 80 per cent of all commuter trips) indicating a minimizing approach to the journey to work. On the other hand, for zones 96 ad 149 only from 5 to 20 per cent come from nearby residential opportunities and these curves, extreme to the right of the other two groupings depict a metropolitan-wide labor market. In between, zone 154 is representative of zones capturing both local (about half) and wider metropolitan commuters. The trip length frequency distributions also tell us that that the old town zones have a more flat distribution and the sub-centres attract a considerable portion of their trips from close to the centre, although they do attract trips from greater distances too.

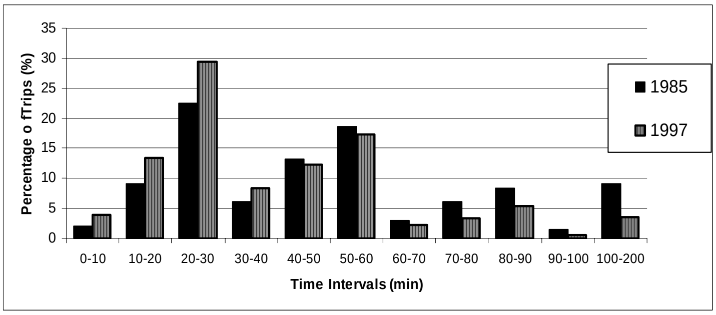

Table 7: Trip length distribution for morning peak

Over the whole of the region, average peak hour motorized trip time dropped from 53 min. in 1985 to 41 min. in 1997 (Figure 7). Such a 12-min. decrease is explained by two reasons. First, construction of the second Bosporus Bridge with its expressways improved travel times or secondly, the multicentric growth of the city has put more jobs within reach of suburban residences.

When considering modal split (Table 2), results are similar to other empirical findings in the literature. But they are much more moderate in the case of Istanbul as public transport system is based on an extensive bus system through the whole city. Public transport share is the highest for the CBD with 58 % (zone 96). For the suburban clusters there are rather mixed results. There is a low public transport share with 38 % for zone 21 but higher shares for other suburb zones with 47 % and 48 % for zones 154 and 180, respectively.

5. Conclusions

The spatial structure of very large metropolitan regions has evolved with some major concentrations of employment. The literature suggests that the understanding of polycentric employment formations and dynamics of change are limited to North American cities. This paper had two objectives. First, offering a generalizable methodology based on research objectives, suitable analytical techniques, and outcomes for analyzing non-monocentric structure through identification of employment clusters and their evolution with particular reference to the transport needs of cities in the developing world where data limitations and more aggregate zone sizes are present. Second,. contributing to the American cities dominant research by analyzing Istanbul with its specific characteristics to provide a better explanation of polycentrism. Further analysis is necessary for transport level of service in terms of public transport and highway network accessibility and congestion for different clusters.

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