

# **A COMPARATIVE ANALYSIS OF METROPOLITAN POLY-CENTRIC EMPLOYMENT GROWTH AND ITS IMPACTS ON COMMUTER TRAVEL PATTERNS**

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## **ABSTRACT**

In the current debate on urbanization, one concern is about the process of urban development resulting in the re-location of firms outside the CBD, in particular to emerging employment centers. The non-mono-centric urban form of employment location, variously termed poly-centric or multi-centric, is defined as a decentralized, but clustered, formation of work agglomerations in sub-centers rather than substantial employment concentrating in one central business district. Such poly-centric urban dynamics have been extensively explored in North American cities, and in some European cities, but this poly-centric employment growth and its impacts on trip profiles appear poorly understood in many developing countries. In this paper, we aim to fill this research gap with illustrative case study findings. Our comparative research covers six case areas from developed and growing metropolitan areas: Bangalore, Istanbul, Jakarta, Shanghai, Sydney, and Tokyo. In selecting suitable case studies we searched for diversity in terms of population size, urban planning regimes, whether the dominant urban spatial structure was centralized or poly-centric, and the broad stage of economic development. We review the past and present land-use and transport master plans to find answers to the research questions of: what are the urban location and transport policy objectives, measures and programs that underpin a decentralized concentration urban configuration?; and how successful have been non-mono-centric policy making? We also apply a methodology to empirically explore how such non-mono-centric dynamics influence the spatial re-structuring of employment cluster formation outside the old central business; and we further analyze the impacts of poly-centric employment agglomerations on trip making, particularly on commuting characteristics.

**Key Words: Poly-centric; Sub-centers; Employment Clusters; Developing Cities**

## **1. INTRODUCTION**

Cities evolve over space and time with the specifics of development being intimately related to the geographical and environmental constraints, the socio-economic development and the geo-political conditions of each country. All very large metropolises, whether in developing or developed countries, sooner or later have to face the problem of spatial re-organization from a mono-centric structure to a dispersed or a multi-centric structure. Poly-centric, or multi-centric, employment is defined as the decentralized, but clustered, formation of work agglomerations in sub-centers rather than employment concentrating in one central business districts. In the current debate on urbanization, especially in developing countries, it is the brute power of the forces of “globalization” that has determined substantial outcomes in urban spatial arrangements (Dick and Rimmer, 1998). That is, the processes of urban development result in the re-location (decentralization and further de-concentration) of firms and houses outside the CBD - in particular to emerging employment centers. White (1999) suggests the three main reasons as to how the clusters occur. One is the concept of agglomeration economies, or external scale economies, that determine why high-density central cities developed. The second factor is that as the city gets larger, the CBD reaches its physical capacity to accommodate more employment and it also forces up centralized land prices. The third factor is a transportation-related issue. Conflict between agglomeration economies and diseconomies of transportation is another reason why new business developments do not prefer city centers, where substantial traffic congestion occurs in the peak hours, especially for commuters and deliveries.

The poly-centric urban structure is advocated by some as revealing a promising research agenda - open to both theoretical and empirical findings from different cities with different characteristics (Anas, 1987; Anas, 1998; Hall and Pfeiffer, 2000; and Banister, 2007), yet there is a dearth of studies from cities in the developing world. Poly-centric dynamics have been extensively explored in American cities (for example, see, Cervero, 1989; Cervero, 1995; McDonald and McMillen, 1990; Cervero and Appleyard, 1999; and McMillen and Lester, 2003). There are some research on European cities, for example, Schimitt and Henry (2000), Boiteux-Orien (2004), Aguilera (2005), Aguilera (2007), Guillain et al., (2006) for French cities, Keeble and Nachum (2002) for London, and Naess (2006) for Copenhagen. Pivo (1990) and Pivo (1993) have analyzed Canadian cities. Various viewpoints on Asian cities are found in the literature such as Rae and Banister (2006) for Seoul. Robinson (1995) notes that many Asian mega cities have promoted poly-nucleated metropolitan-regional spatial patterns as one of the objectives in their master plans.

However, there is a lack of empirical data and analytical approach to explore the urban re-structuring process, its impacts on trip profiles and policy directions in large and growing Asian cities. This led us initiate a collaborative study to enable a better understanding of multi-centric urban growth and its associated commuting patterns. Funding from The Eastern Asia Society for Transportation Studies (EASTS) has supported this research through its International Cooperative Research Activity (ICRA). We undertook this international collaborative research project from late 2005 to September, 2007, and now it is timely to

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provide a synthesis of our main findings. The primary aim of the research was to illuminate the current status of growing and decentralizing cities, especially in developing countries, and to study urban policy-making governing spatial development and transport re-structuring. For this we selected case cities mainly from Asian countries and from Australian cities and included the examples from the developed countries as well (Klug et al., 2007; and Alpkokin et al., 2007 (a)).

In this paper, we summarize our research project with illustrative case study findings so our selection here is somewhat arbitrary although it does introduce cities less common in the transport literature. The main questions are: what are the urban location and transport policy objectives, measures and programs that underpin a decentralized concentration urban configuration?; and how successful have been poly-centric policy making? We review the past and present land-use and transport master plans. In the next step, we empirically explore how such poly-centric dynamics influence the spatial re-structuring of employment cluster formation outside the old central business districts, and on trip making, particularly in terms of trip distance and modal choice. The paper is organized into five sections. Section 1 provides an introduction to the context and aim of the research. Section 2 gives an overview of the main characteristics of each city. Section 3 evaluates the policy-making practices in the context of poly-centric development. Section 4 and Section 5 empirically evaluate the location dynamics and travel pattern changes over time and space. Finally, Section 6 concludes the results to provide some guidance on poly-centric policy-making in rapidly growing metropolitan regions.

## **2. CASE CITIES**

In selecting suitable urban case studies for collaborative research we searched for diversity in terms of population size, urban planning regimes (from planned new towns to dominant market-driven development), whether the dominant urban spatial structure was centralized or poly-centric, and the broad stage of economic development. Our project covered eleven case areas: Bangalore, Bangkok, Canberra, Dalian, Delhi, Istanbul, Jakarta, Sapporo, Shanghai, Sydney, and Tokyo. Each was represented by teams of local researchers to provide the required data and analysis. However, within the scope of this paper, some results for only six of the case study cities are included here. Bangalore, Shanghai and Jakarta are subject to the policy analysis in Section 3 and Tokyo, Istanbul and Sydney are examined in Sections 4 and 5 to discuss the extent of employment sub-center formation and its related trip characteristics.

Bangalore has one of the highest GDPs in India at US\$ 1,200 per capita, which slightly exceeds that of Delhi, at US\$ 1,100. With the impact of global economic forces since the beginning of the 1980s, the population of the metropolitan area has increased from 2.8 million in 1980 to 6.5 million today in an area of 1,306 km<sup>2</sup>. The whole region is home to a population of approximately 8.5 million including all peripheral villages and small towns in a total area of 5,184 km<sup>2</sup>. The city is expected to continue this course of consistent growth and will reach a projected 15 million by 2050 according to one United Nations report, making it

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the 20<sup>th</sup> largest city in the world by population. The city is typical as a rapidly developing mega-city that has long been suffering from a shortage of urban services and urban management. With a city center that can not accommodate any more new developments, and one with extremely high rents, the urban region is growing towards a poly-centric structure. Plans also promote such a poly-nodal spatial re-configuration. High-tech industries, such as automobile and IT enterprises, have been agglomerating in the area in recent years. Today, there are two major sub-centers developed predominantly by IT technology companies. At the metropolitan level (Bangalore Metropolitan Area-BMA), the Bangalore Development Authority (BDA) supports secondary centers; and at the regional level (Bangalore Metropolitan Region-BMR) the Bangalore Metropolitan Regional Development Authority (BMRDA) has taken up development of five integrated townships.

The Istanbul metropolitan area, where the Bosphorus Strait separates the metropolitan area into two main land areas, also provides a good example as a fast-growing city in a developing country where market-driven forces and high economic and population growth have been dominant in the poly-nodal urban development formulation (a 12 million population generates 25% of the total national GDP in the metropolitan area of Istanbul). Another underlying reason for a concentrated decentralization is the policy that has been long enforced of preserving the historical identity of the CBD. For example, in the Spatial Master Plan of 1995 "Target 9" is strongly worded as: "Abandoning the concept of concentric development as the single biggest danger that can destroy the historical identity of Istanbul" (Alpkokin et al., 2008). High growth rates (the current population growth rate is 4.3% per annum) together with the driving forces of spatial dynamics, brought about a poly-centric and mixed urban pattern over an area of more than 150,000 ha. In contrast to many Western cities experiencing growth, commuting times have surprisingly declined for the journey to work.

Jakarta comprises five cities: Central, North, East, South and West Jakarta, each headed by a Mayor. Politically, there is one legislative body at the provincial level which speeds up decision making. It is a Special Capital Province covering 740 km<sup>2</sup> or 0.04% of the national area and accommodating 3.7% of total population of Indonesia (8.5 million people in 2005). Jakarta is the center of the economy with the GDP of US\$ 48 billion (2005), or around 16% of national GDP with growth rate of 15.6% per annum (2004). All of this leads to rapid job creation in the region. There are examples of big commercial complexes - consequences of the market mechanism - mostly along the main roads, such as Jalan Thamrin. Dick and Rimmer (2002) explain the growth in Jakarta as ribbon-like development of industrial estates along the toll roads feeding into the city's outer ring road. As from 2004, when the Jakarta bus ways were first in operation, there is a strong demand for developers to observe the opportunity in establishing new centers along these bus routes. The proposed Jakarta metro will give additional opportunities for spatial re-structuring.

Shanghai is an Asian mega city, which was already a large metropolis before the People's Republic of China was declared in 1949 (Murphey, 1988). The city has been expanding in all directions and is emerging as one of the great economic, commercial, trade and shipping

centers in the world (Hall and Pfeiffer, 2000), where its annual GDP growth rate is 13.6% and GDP per capita is US\$6,000 in 2007. Starting in the 1940s, the decentralization of Shanghai's urban facilities has long been acknowledged. The rate of industry output in the suburbs to the output in the central Shanghai increased from 46% in 1999 to 56% in 2004. Nevertheless, the successful completion of multi-centric growth centers has not been as extensive as expected (by 1990, only 95.4 km<sup>2</sup> of the planned 294 km<sup>2</sup> satellite town developments have been realized). However, there is also a positive side: many challenges in developing the Pudong new area development have been met successfully. It is a non-CBD development that has captured almost a third of total office building completions in Shanghai by 2005 (followed by Huangphu with 12 % of the total city stock) and is the big source of local government revenue.

The collaborative research also drew on experiences from cities of the developed world. Spatial plans for Sydney have long acknowledged the biggest urban problem as “the great and increasing concentration of employment in the metropolitan city center” (the total number of jobs in 2005 was 1.6 million - half of the total population). Despite a series of spatial plans since 1949 advocating decentralization of employment, and strong suburban centers, competition amongst the competing local government councils to attract development in the successive 60 years have witnessed pre-dominantly a private-sector led suburban housing boom (see, for example, Forsyth, 1999) with jobs lagging behind (Paez et. al., 2002). The result is that Parramatta, as Sydney's “second CBD”, has taken longer to build up its employment, and other sub-centers have failed to reach their employment potential. The latest spatial plan aims to build up employment in 5 regional centers (the CBD, North Sydney, Parramatta, Liverpool and Penrith).

Tokyo is by far one of the largest agglomerations and economies (GDP per capita is approximately US\$40,000) in the world, and is by far the largest city among the eleven case study cities we have analyzed. Today, the Tokyo capital region is a global economic center that accommodates 40 million people and 19 million jobs. It has an extensive and well-connected suburban commuter railroad and subway system (the average daily Tokyo metropolitan region railway patronage is approximately 51 million passengers). Railways have been highly influential in shaping the urban form of the Tokyo metropolitan region. This dominant network of rail lines serving the city center (defined as being within the Yamanote circle line) has been one of the factors explaining why the successful implementation of alternative spatial structural plans have largely remained beyond reach (Alpkokin et al., 2007 (b)). The fourth and fifth metropolitan plans firmly designated “Business core cities”, and defined these as the high density core settlements within the Tokyo central area; and “Bases for large cooperation” - defined as the large centers outside the Tokyo central area.

### **3. SPATIAL PLANS AND POLICY ANALYSIS**

All case study cities in the collaborative research have formulated spatial plans. In fact, an idealized urban structure associated with major sub-centers is part of the planning in most case study areas, dating back, in the case of Shanghai, to the 1940s. The cities in our

research have problems with limited space, some of them have been overwhelmed by the sheer pace of urbanization and inability of governments to manage and pay for the implications of growth (e.g. Jakarta). Here, three case cities will be examined from a policy perspective with particular reference to: "Spatial plans with special reference to the treatment of sub-centers and New Towns"; and "Land-use and transport policy instruments".

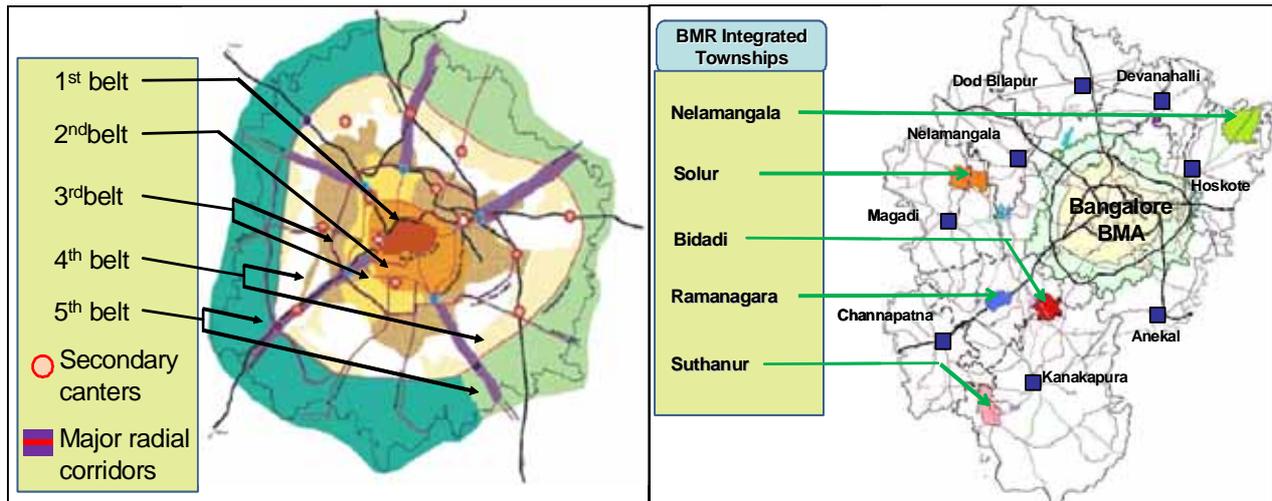
### **3.1 Bangalore**

The increase of population through immigration, combined with natural increase, is accelerating the urbanization process, and rapidly transforming Bangalore into a mega-city spilling over into the Karnataka region. The city stands at the initial stage of developing and implementing its decentralization policies. The Bangalore city planning authority has been expanding its jurisdictional limits and including more peripheral areas. Therefore, the need for systematic urban and transport planning is one of the most urgent priorities in the city.

The Structure Plan prepared by the BMRDA (for 2015) is based on the governing principle of "structured continuity." This principle directs that development in existing urbanized areas and new extensions must be "structured" spatially and functionally to avoid unmanageable urban sprawl. Existing urban patterns must be strengthened through urban renewal, and proposed developments must be "continued" selective extensions of already developed areas. This is to avoid new developments leap-frogging to distant outskirts that are not serviced by infrastructure and transportation. This plan has the character of a broad area development plan for the entire BMR and requires the preparation of detailed sector and area plans.

The local plans developed by BDA for BMA envision that development will be spatially organized into sub-centers in five concentric circles. Main recommendations of the plan in connection with the poly-centric structure are: "Promote a distinct CBD"; "Develop city scale sub-centers that serve as activity nodes"; "Linearly along major radial roads (National / state highways"; and "Develop transport interchange hubs at the junctions of main corridor, ring roads and railway lines to decentralize bus and railway stations by moving them out of city center" (Figure 1(a)).

The regional scale poly-centric configuration is governed by BMRDA (Figure 1(b)). BMRDA has undertaken the development of five integrated townships following an all-round Work-Live-Play concept at Bidadi, Ramanagara, Sathanur, Solur and Nandagudi. The concept behind this policy is the development of thematic townships. Each township is to be designated for specific economic activities, for example: "T-BT City," "Health City," "Education City," "Finance City" etc. The development of the new integrated urban settlement will aim in each case to create a self-contained habitat within the Work-Live-Play concept. To support decentralization into the new towns, the BMRDA is proposing the development of mainly ring roads (large-scale highway developments) and also railway lines in line with the regional poly-centric development. However, the highways plans appear to be developed more, and earlier, than those plans for the railways.



**Figure 1(a): Bangalore metropolitan area      Figure 1(b): Bangalore metropolitan region**  
**Figure 1: BMA and BMR development plans**

For example, the Bidadi Integrated Township Project (BITP) is located 35 km distance from Bangalore city, but the nearest railway station (Bidadi station on the Bangalore-Mysore Railway line) is 9 km away. The location is straddled on either side by large industrial zones – the Bidadi Auto Industrial Park and the proposed Harohalli Industrial zone. The picturesque location and landscape (existing Golf Course, Theme Park) make this site highly suitable for township development, and has the highest priority among the five satellite townships as a self-contained habitat for the two main economic activities of information technology, and an auto industrial park. The plan projects a mixed land-use in which the shares will be 25 % each for industrial, residential, and parks / open spaces, leaving 15 % for civic amenities, and the rest for roads and utilities. BITP has been implemented as the first pilot project through private-sector investments on a competitive bid basis. The total area designated for development of BITP is approximately 40 km<sup>2</sup> and less than 1/3 of this is under the responsibility of the government. BMRDA invited bids for the selection of the preferred developer, and received responses from 32 firms/consortia. The Master Plan for this township is to be prepared by the developer, and then to be approved by the Government. Monitoring of implementation is undertaken by BMRDA to ensure compliance with the project objectives. BMRDA will provide external infrastructure by way of access roads and radial and ring roads for speedy access to and from downtown Bangalore and the new International Airport. The private developer is required to finance and develop the entire internal project infrastructure, including roads, storm water drains, civic amenities, telecom connectivity, water and power supply, and waste treatment and disposal, as well as bearing the capital cost of bringing drinking water and power up to the periphery.

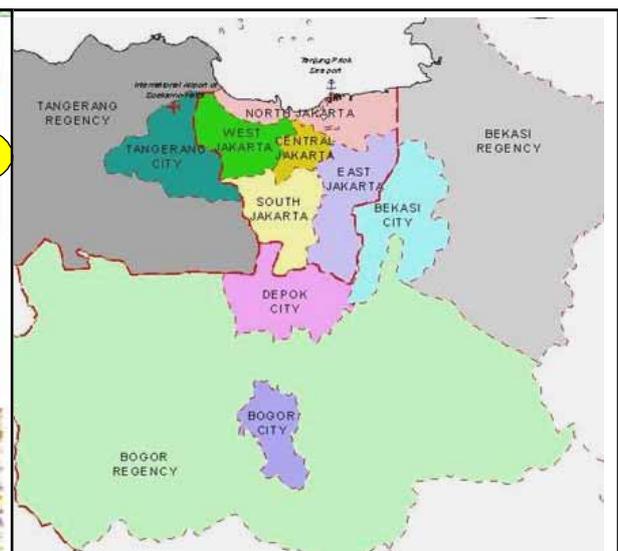
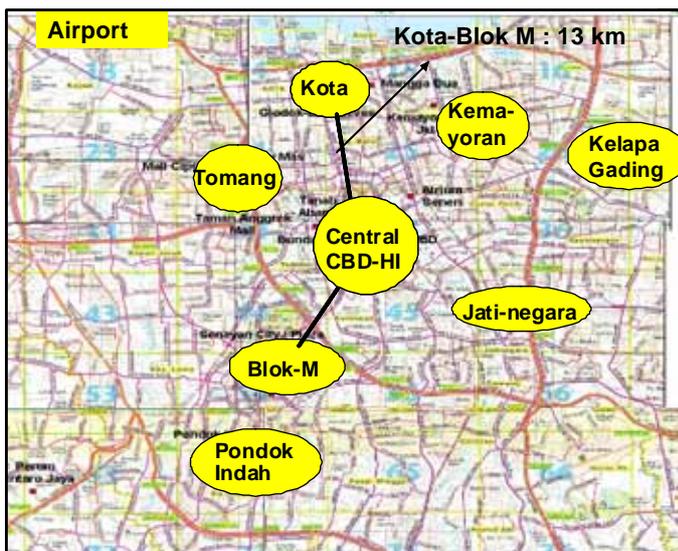
The Bangalore development plan takes, as its starting point, a pattern of mixed land-use, especially for the third ring urban sub-centers and the five suburban townships. Implementation is unlikely to go according to the spatial plan. The two information technology sub-centers have not proved a great success to date with regard to mixed land-use. For example, in Whitefield, due to the lack of affordable housing, most of the employees of the

industrial works and information technology firms live in distant neighborhoods and commute around 25 km a day for two-way.

### 3.2 Jakarta

The origin of Jakarta (Batavia) is associated with what is now known as The Old City or “Kota (Lama)” with Kota railway station as the center. The city evolved as a dual core city. A very strong corridor in between was developed, which is now the Jakarta main economic center with its focal point in Hotel Indonesia Roundabout about the halfway between the two cores. Historically, the initial phases of urban development can be summarized as: first, the original CBD at Kota (Dutch colonial city); and secondly, the impetus of hosting Asian Games in 1962 that created a sub-center at Kemayoran (where the airport was once located). The latter could be regarded as the first attempt to disperse the mono-centric city of Jakarta (Figure 2(a)). The next phase was the development of satellite towns and, finally, parallel growth of cities in the region (Greater Jakarta) and residential development filling in spaces (Figure 2(b)).

In fact, after the development of Kemayoran Baru, land-use and transport planning had little effect on the direction of development. Since there was no attempt to spread the employment from the CBD area of Sudirman-Thamrin to sub-centers, Jakarta is still characterized by its shape of very centralized jobs. The nature of mono-centric of Jakarta of two nodes connected by a spine has created a strong morning inflow and evening outflow of road traffic resulting in congestion in its radial roads and road in the suburban areas. The congestion is made worse due to the poor public transport service - both buses and railways. The public transport share was around 38% and rail was estimated as being under 5%. The reliance on private vehicles (cars and motorcycles) simply chokes the road network, even when an intra-urban toll-highway network was constructed in early 1980s.



**Figure 2(a): Central Jakarta urban sub-centers**

**Figure 2(b): Greater Jakarta**

**Figure 2: Location of agglomerations in Jakarta city and region**

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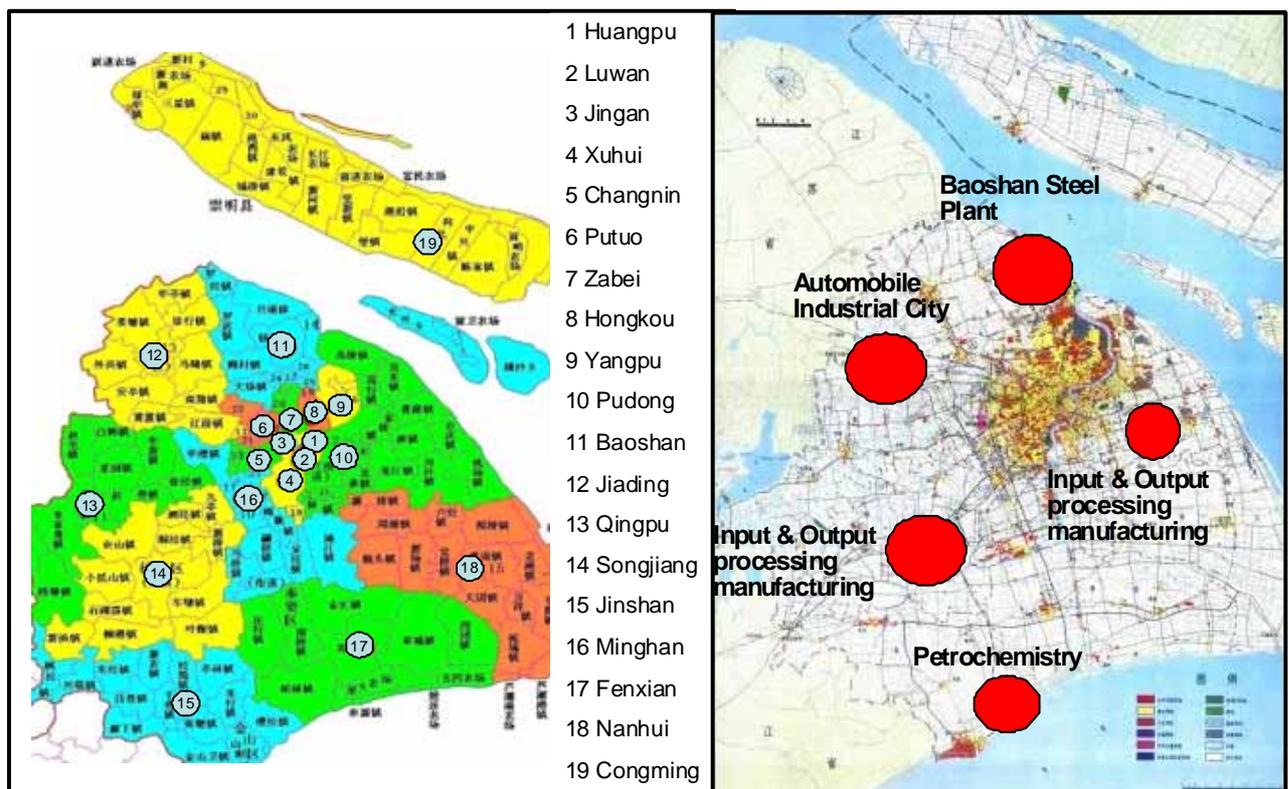
Bumi Serpong Damai (BSD) is a satellite town of Jakarta built from scratch and claimed as a self-contained city in the mid 1980s. It is located around 25 km from the city center to the south west area, and is in the neighboring Tangerang regency (not within the Jakarta administrative jurisdiction). There are several government offices and it has a reasonably large commercial and shopping center. However, no major public transport service was provided during the development of this town. It has turned out to be a sub-center that its residents commute to the city centers along the severely congested toll road. The rate of car users is higher than the average. However, after the operation of new bus rapid system (BRT) in Jakarta, this satellite town has been provided with feeder bus system to access to the BRT line, and this has attracted many city center commuters.

Not only has Jakarta experienced a high economic growth but also the neighboring towns like Tangerang, Bekasi, Depok and Bogor, have experienced substantial growth. It is inevitable that an agglomeration of Jakarta is forming at a fast pace, making up what is known as Jabodetabek (Jakarta, Bogor, Depok, Tangerang and Bekasi) or the Jakarta metropolitan area. This area covers almost double that of the province of Jakarta, i.e. 1,450 km<sup>2</sup> with the population of around 26 million (2004). The sprawling development, filling empty spaces in between Jakarta and those four cities, is occurring rapidly, especially for the development of housing in suburban areas that was formerly agricultural land. The development of each city is based on its own master-plan within its administrative boundaries. The Jakarta metropolitan area lacks an integrated land-use plan which is important to control the development of the rapidly growing area as a whole. The attractiveness of such suburban development has an effect on the inner city settings. It is evident that the population density in the central city has decreased steadily over time. This is associated with housing shift from the city center to these newer suburban areas.

One important characteristic of the Jakarta metropolitan region is that conflicts have occurred amongst government agencies, the private sector and local communities, but, importantly, "among the government agencies themselves" (Dharmapatn and Firman, 1988), where, in general, government responses have been too little and too late. There is no clear and definite classification of sub-centers in Jakarta. By 1996, over 90,000 hectares outside the capital city region was approved for new developments by the government in Jakarta. However, the newly emerging centers are accommodating more residential lots than planned and therefore the central city is still the most attractive business district and this adds to longer trips traveled (the average trip distance traveled 6.7 km in 1985 increased to 9.6 km in 2000). Another important aspect of Jakarta is that the BRT systems recently have been operating and creating a strong demand for developers to establish new centers along these bus routes (from the total 15 routes planned, 7 are operating reasonably well the in the Jakarta area). However, there are no specific local government policies to utilize the BRT corridor for planned development.

### 3.3 Shanghai

Since the 1990s, 18 million permanent residents live in Shanghai, meaning that the population of each district amounts to a big city in its own right. This, in turn, generates heavy management loads on the city government. Somewhat different to other metropolises in China, district governments are granted considerable autonomy in administrative affairs. The administrative region of Shanghai includes the central city, near suburbia, distant suburbia and the Pudong New District. The central district is comprised of nine districts, while near suburbia includes Baoshan, Jiading and Minhang, and distant suburbia has Chongming, Qingpu, Songjiang, Jinshan, Fengxian and Nanhui under its name (Figure 3(a)).



**Figure 3(a): Districts in Shanghai region**

**Figure 3(b): Industrial sub-centers**

**Figure 3: Shanghai region**

The ambitious multi-level, hierarchical urban system, comprising the central city, new towns, central towns and town fairs, that is proposed is a “poly-centric, multi-axis” spatial structure, including the seaside developmental axis, Shanghai-Nanjing, Shanghai-Hangzhou developmental axes, and various levels of towns. The central city is inside the outer-ring road, with a targeted population control not exceeding 8 million and a city developmental land-use of 600 km<sup>2</sup>. New towns are medium-sized cities developed out of towns where district governments propose the building of major industry and infrastructure for the city. The eleven planned new towns are Baoshan, Jiading, Songjiang, Jinshan, Minhang, Huinan, Qingpu, Nanqiao, Chengqiao, Airport and Seaport New Towns. The average planned population ranges from 200,000 to 300,000 people. Central towns are the small cities that develop out of town fairs growing on the foundation of industrial development. Such town fairs are

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“scientifically” located, have superior locations and economic development conditions. Their populations range from 50,000 to 100,000. Town fairs are such towns that can be created by a merger of currently registered towns (for now about 170) on the basis of location, transport and resource reserves, with populations of from 10,000 to 30,000.

The location of industrial centers is usually near highways or expressways. The express network covers most of the city, so that industrial parks are easily accessible. However, there are also convenient public transport links between central city residence and workplaces, and some companies provide employees with shuttle bus services. In some of the industrial parks, many immigrant workers reside inside the factory compound, or rent a house nearby or in the countryside. Hence, they often walk to work or ride a bike.

Action Plans for Implementing the Master Plan for the City of Shanghai (1999 - 2020) were directed at realizing, and enhancing the Master Plan and the short-term development plan. In each action plan, city layout focuses on the total development of Shanghai and the Yangtze Triangle Zone. Central Towns are to harmonize on structure layout, to strengthen environmental protection and development. In order to attract industrial investment into Shanghai, the city concentrates its manufacturing industries, moving those manufacturers inside the inner city to the outer city, and setting up numerous, variously-typed, industrial gardens (there is a 1,000 km<sup>2</sup> planned area for industrial estates in the suburbs by 2010). The plans for suburbia is to concentrate on building new towns in an orderly pace with focuses clearly articulated, by making full use of the important role that suburban towns play in population concentration, industry integration, and the economical use of land. Job opportunity centers will include concentration zones of centers for service industries and manufacturing industry concentrations with assigned unique function to each of the big sub-centers: Jia Ding; Automobile city, Songjiang; University city, Lingang; the Port city (Figure 3(b)). This is being done with support from the development of the Greater Transportation Plan and the Greater Industries Plan on a “triple concentration” basis. A number of fully-functioning new towns “scientifically” located among industries, with populations larger than 300,000 are planned up to 2010, to have concentration and scale-benefit effects. This action plan shows “the wide and smooth road” that Shanghai suburban towns are to travel on their way to suburban, industrial and environmental harmony (Figure 4(a)). It will be of considerable interest for researchers to monitor outcomes against these ambitious expectations.

The Master Plan aims to increase green space and public space in order to decrease the density and floor space in the central part of the Shanghai. Therefore, at the urban level, Shanghai is directed to grow in four sub-centers in addition to the CBD. This CBD consists of Lujiazui Mior (area between Pudong South Avenue and Dongchang Road) in Pudong and Outer Beach (area East of Henan Road, between the Port of Hongkou and the Xinkai River) in Puxi with a planned area of 3 km<sup>2</sup>. This area incorporates finance, trade, information, shopping, culture, entertainment, metropolitan travel and business operation functions, and will accommodate a certain number of residents. The four sub-centers are Xujiahui, Huamu, Jiangwan-Wujiaochang and Zhenru. The Xujiahui sub-center serves mainly the south-

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western area of the city with a planned land-use of some 2.2 km<sup>2</sup>. The Huamu sub-center serves mainly the Pudong New Area, with a planned land-use of some 2 km<sup>2</sup>. The Jiangwan-Wujiaochang sub-center serves mainly the north-eastern area of the city with a planned land-use of about 2.2 km<sup>2</sup>. The Zhenru sub-center serves mainly the north-western area of the city and the planned land-use is around 1.6 km<sup>2</sup> (Figure 4(b)).



**Figure 4(a): Regional centers and highways**

**Figure 4(b): Urban centers**

**Figure 4: Shanghai region and urban area**

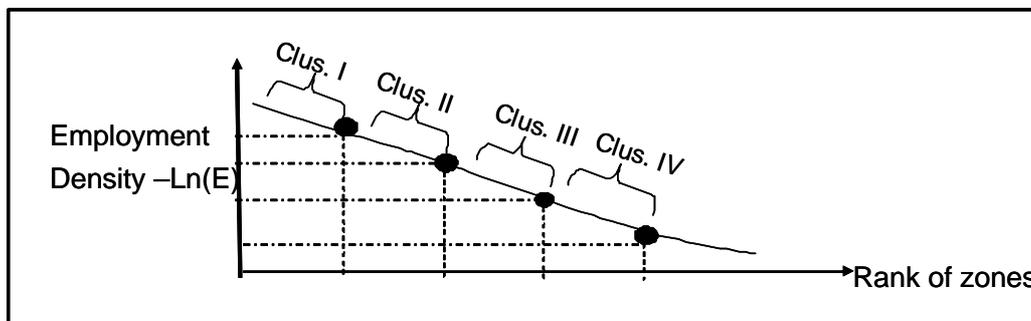
The purpose of setting up sub-centers in Shanghai's central city is to enhance the total development of urban service industries, to split the service industry functions into smaller regional proportions, to lower population density and to alleviate the pressure on the CBD and the city center, and, with the support of highways and urban rail, to control scattered, small-sized developments. However, the policy aim for the growth of well-designed sub-centers has not been successful mainly because of five shortfalls in implementation: lack of the spatial structure strategy with the transport strategy; lack of coordination between various local stakeholders; in comparison with the city center of Shanghai, there is a low level of service in the sub-centers, that render it difficult to attract people away from the city center; lack of well-paid jobs in the sub-centers to attract professional people; and relatively low standards in the design of the built environment.

Given the aspirations that Bangalore, Jakarta and Shanghai have in common with urban spatial re-structuring through their spatial plans an important research question in evidence-based planning (when data becomes available) is how successful have these plans been in shaping the direction and location of development? It is a generic question relevant to any metropolitan region under going rapid growth. Thus, we have developed a five-step framework composed of simple and analytical techniques in the early stage of the EASTS ICRA APEC-TR research proposal as a tool to explore the poly-centric dynamics that will illuminate further into modeling and policy-making issues in growing multi-centric cities.

#### 4. ANALYSIS OF EMPLOYMENT LOCATION DYNAMICS

This framework proposes a simple methodology to define employment clusters in any city for the purposes of comparative analysis. This is crucial to any research investigation because different findings are likely for the same data set with different classifications, as observed for some American cities (for example, see for different definition of sub-centers: Greene, 1980; McDonald, 1987; McDonald and McMillen, 1990; Giuliano and Small, 1991; Pivo, 1993; McDonald and Prather, 1994; Small and Song, 1994; Cervero, 1995; Cervero and Wu, 1997; Cervero and Wu, 1998; McMillen and McDonald, 1998; Bogart and Ferry, 1999; Giuliano and Small, 1999; Craig and Ng, 2001; Boiteaux-Orain and Guillain, 2004; McMillen, 2001; and Aguilere, 2005). In most of the existing studies, when attempting to define tiers by employment density, there is the 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 our analysis, we divide the zones into four clusters.

The next step is to decide the number of major employment clusters, and their classification, through breaks of gradient in the rank-size distribution. In order to identify the clusters or tiers of job agglomerations, the rank size rule that the traffic analysis zones, with their gross employment density on the y-axis (natural logarithm of gross employment density was used here) and the ranks on the x-axis, can be adapted for identifying and classifying the zones into clusters or tiers by their employment densities. After plotting the rank-size distributions as a two-dimensional graph, the next crucial step is to decide the number of major employment clusters and their classification through breaks of gradient, as depicted by Figure 5.



**Figure 5: Rank-size distribution and classification into clusters (or tiers)**

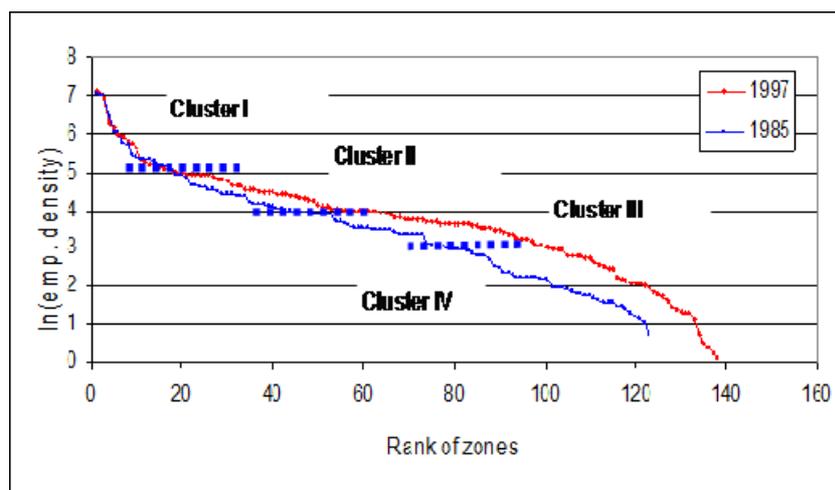
There are simple techniques of cluster analysis where the zones can be grouped. However, in the context of APEC-TR project, we choose to visually inspect the diagram and divide into parts indicated by obvious break of the first slope for the old city center as the highest density zones with the highest ranks (cluster or tier I) and the last slope for the zones with the least dense zones as the zones that are not necessarily accommodating many job opportunities (cluster or tier IV). The medium part of the line is divided in to two parts defining cluster (or tier) II and cluster (tier) III zones. The methodology is a simple and a generalizable way of clustering employment locations, particularly when the data are more aggregate, with

medium or large-scale traffic analysis zones on which the trip data from metropolitan transport studies are often based.

Once the rank-size distribution is plotted for each year, and the clusters are defined for a chosen base year, a number of simple descriptive statistics can be used for their simplicity and relevant explanatory power such as employment share of each cluster. Examining the clusters rank-size distribution changes with the available data set for two (or more) time points is needed to understand the change in job location patterns and the embryonic emergence of some new sub-centers. If the increment of employment growth is exactly the same in every zone then the two distributions are parallel. Other theoretical patterns are possible: smaller increments in the big centers and larger increments in the smaller zones – decentralization; larger increments in the big centers and smaller increments in the smaller zones – centralization; and the possibilities of absolute declines in employment in the larger zones (or in the smaller zones).

#### 4.1 Istanbul

The rank-size distributions for 1985 and 1997 are given in Figure 6. The change over the 12 years in Istanbul revealed a pattern that the real urban dynamics of change are occurring outside the cluster I zones - all of which are in the old historical city center. As Istanbul has kept developing to preserve this traditional CBD center without losing its primacy, there is almost no change for the first tier of zones in absolute terms. One of the three main strategies of the Istanbul Metropolitan Area Sub-Region Master Plan (Turkish Republic, Greater Istanbul Municipality, 1995) is, “Abandoning the concept of concentric development as the single biggest danger that can destroy the historical identity of Istanbul”. The largest growth in employment is occurring in cluster II and III type zones, which has led to an urban form of local centralization.



**Figure 6: Rank-size distribution and clusters of employment; Istanbul, 1985, 1997**

The changes as percentages are also given in the last column of the Table 1. Because of a very slight growth in the CBD and downtown employment, their percentage shares over the

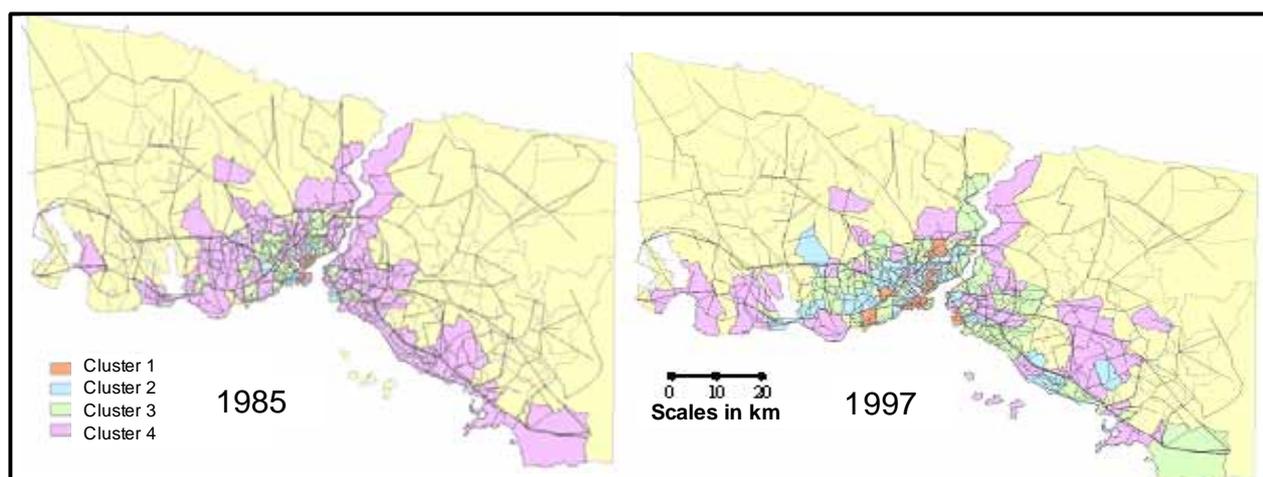
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metropolitan area, dropped from 12.9% to 8.9% and from 34.5% to 23.5%, respectively. Cluster I, which includes all of the CBD zones, and most of the downtown zones, has only shown a 1% increase in absolute terms in 12 years but has lost its regional share. Type II and III clusters demonstrate that the highest growth occurred in most of these types of zones revealing a more multi-centric urban form. Cluster II has the largest increase in jobs from 496,514 to 954,975 – about 78 % of the job growth from 1985 to 1997 – and gained a considerable amount of the overall share (from 26.3% in 1985 to 34.2% in 1997). The employment share of cluster IV has also fallen, from 16% to 11% as evidence of decentralized concentration rather than the employment saturation of those zones.

**Table 1: Employment clustering changes; Istanbul 1985, 1997**

	Year 1985		Year 1997	
	Total employment	Share over total	Total employment	Share over total
Cluster I	626,213	33.2%	773,347	27.7%
Cluster II	496,514	26.3%	954,975	34.2%
Cluster III	449,955	23.8%	766,793	27.4%
Cluster IV	308,966	16.4%	209,108	10.7%
	Change 1985-1997			
Cluster I		23.5%		
Cluster II		92.3%		
Cluster III		70.4%		
Cluster IV		-3.2%		

The maps in Figure 7 visualize a concentric decentralization around the old CBD and an obviously expanded sub-center in the northern part of the European side along the Bosphorus Strait near by the beltways of the second Bosphorus Bridge that opened in 1988. There are also newly emerging centers along the southern coastal side towards the east and west defined as “Wing Attraction Nodes” by the Istanbul Sub-region Plans.



**Figure 7 Employment cluster distribution; Istanbul, 1995, 2005**

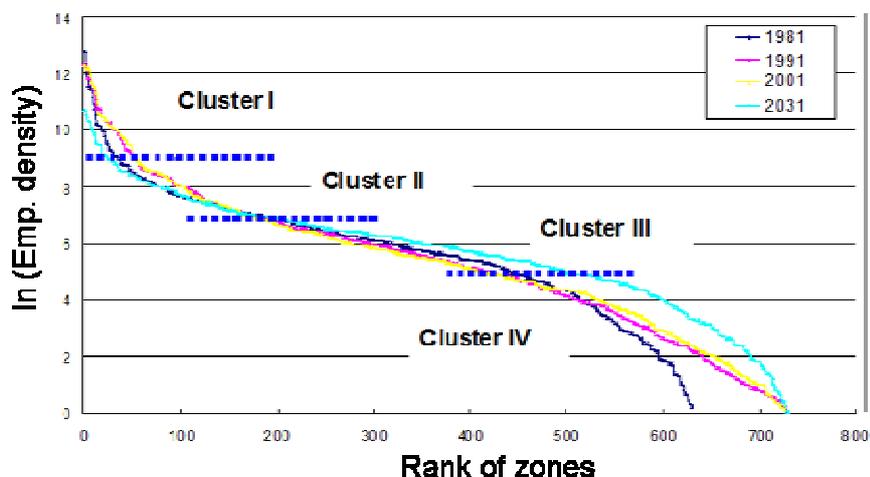
Although, the Sub-Region Master Plan was not well combined with the policy measures and implementation programs to support the envisaged sub-center formation to restrict the saturated spatial pattern, the city has shown a growth according to the plan in many aspects.

In particular, the largest growth in employment has been observed for cluster II and III zones suggestive of an urban form of locally centralized, rather than saturated development as discussed above. The city of Istanbul constitutes a good example of market-driven forces that lead to a preference for clustered multi-centric firm location.

## 4.2 Sydney

Metropolitan Sydney provides a good example of where planning authorities have consistently attempted to influence the location of employment following the Royal assent of the first spatial plan in 1951. Employment change across the Sydney region over time has been similarly analyzed by conducting a rank-size plot of the logarithm of the employment density in each zone. As shown in Figure 8, rank-size distributions are plotted from Census data for 1981, 1991 and 2001, where the spatial unit of analysis is the traffic zone. An estimate is made for its shape in 2031 according to distributions of jobs projected in the latest spatial strategy (2005).

In the 20 years from 1981 to 2001 there has been an increase in the employment density in all zones. Higher density zones have shown the least change over this period, whilst the biggest change has occurred in lower density zones between 1981 and 1991. Relatively little difference has occurred between 1991 and 2001. The rank-size distribution for 2031 shows a continuance of the current trend with little evidence of an overall increase in decentralization. When endorsing a decentralized employment strategy of the Sydney Region Outline Plan (1968) it confirmed (as was also stated in the 1948 County of Cumberland Planning Scheme) that the biggest single urban problem was “the great and increasing concentration of employment in the metropolitan city centre.” Employment decentralization did take place, but access to employment remained an issue in the outer suburbs at the 1971 Census. Our analysis is from 1981 to 2001. Table 2 shows the shares of regional employment in the four clusters: the shares are very similar – intensifying a little in cluster I and reducing slightly in cluster II.



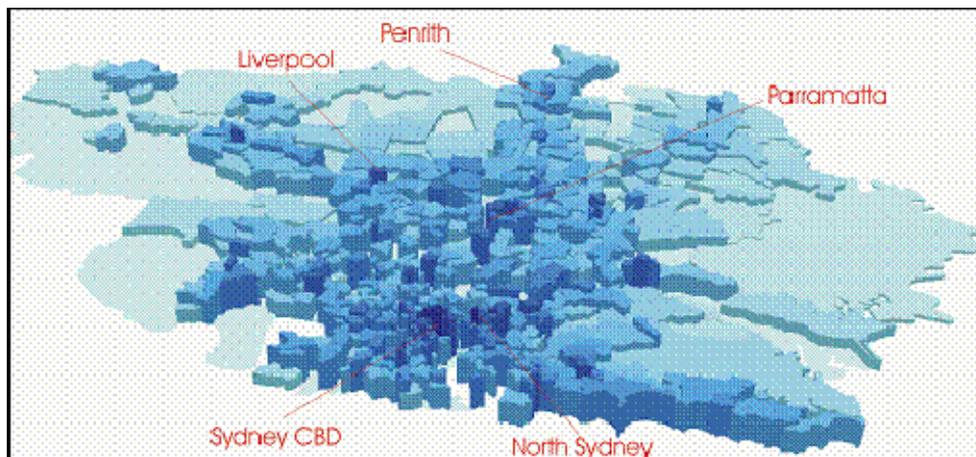
**Figure 8: Rank size distribution and clusters of emp.; Sydney, 1981, 1991, 2001, 2031**

It is instructive to examine where these changes in jobs density have taken place from one Census period to the next. Again, if the spatial plans had been effective we would expect that the majority of jobs would be created in the designated employment centers and in the outer suburbs.

**Table 2 Employment clustering changes; Sydney 1981, 1991, 2001**

	Year 1981		Year 1991		Year 2001	
	Total employment	Share over total	Total employment	Share over total	Total employment	Share over total
Cluster I	262,734	28.1%	363,612	28.6%	425,469	30.2%
Cluster II	359,066	38.4%	457,222	26.0%	500,756	35.6%
Cluster III	247,720	26.5%	445,889	27.2%	369,896	26.3%
Cluster IV	66,429	7.1%	103,949	8.2%	110,449	7.9%
	Change 1981-1991		Change 1991-2001		Change 1981-2001	
Cluster I		38.4%		17.0%		61.9%
Cluster II		27.3%		9.5%		39.5%
Cluster III		39.6%		6.9%		49.3%
Cluster IV		56.5%		6.3%		66.3%

Figure 9 is a three-dimensional visualization of where the new work trip attractions from 1981 to 2001 have taken place (correctly, the 2001 zone density value minus the 1981 zone density value). In this 20-year period, the increment of jobs has taken place in central areas, as well as in the designated planned centers, but, also, elsewhere in a highly fragmented pattern. From this evidence, we cannot conclude that spatial employment restructuring has resulted in a clear poly-centric pattern in metropolitan Sydney but it is salutary to note the stability of distributions over time suggesting that there is considerable inertia in urban systems despite the best intentions of planners and their spatial plans.

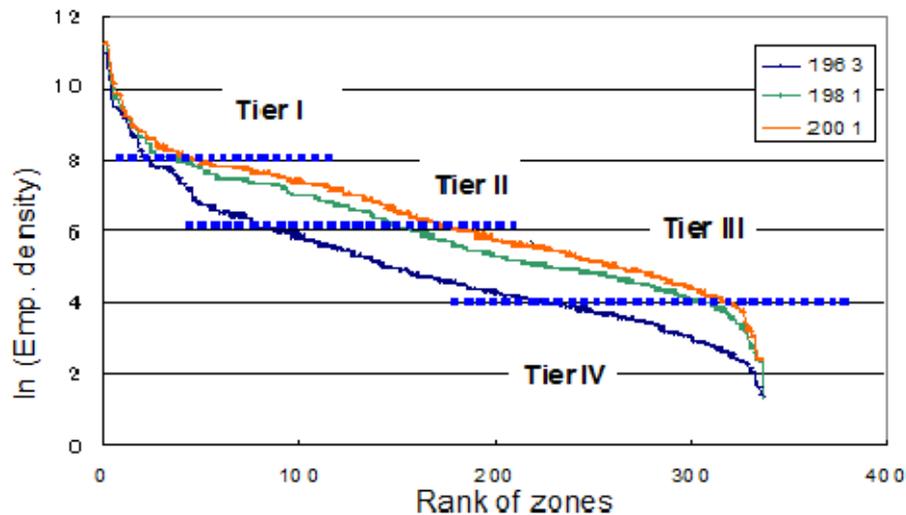


**Figure 9: Changes in employment density by traffic zone, Sydney, 1981 to 2001**

### 4.3 Tokyo

The Tokyo metropolitan region contains one of the world's heaviest concentrations of population. Person trips surveys over the 337 traffic analysis zones have long been conducted, and this allows us to track the changes almost over the last three decades and at

three time points (1963, 1981 and 2001). The rank-size distribution for gross employment density reveals that there has been no change in the shape of the tier I zones in the core of Tokyo. Applying the criteria for classification of the zones suggested in the context of our APEC-TR project, we have defined the four tiers as: tier I: old CBD and high density zones; tier II: agglomerations outside the core city; tier III: suburban zones that are likely to develop; tier IV: low density zones (Figure 10). Table 3 also shows the primary role of tier I type of zones in Tokyo, accommodating approximately half of the total employment stock with almost no change over the last three decades (from 56% in 1963 to 53% in 2001).



**Figure10: Rank size distribution and clusters of employment; Tokyo, 1963, 1981, 2001**

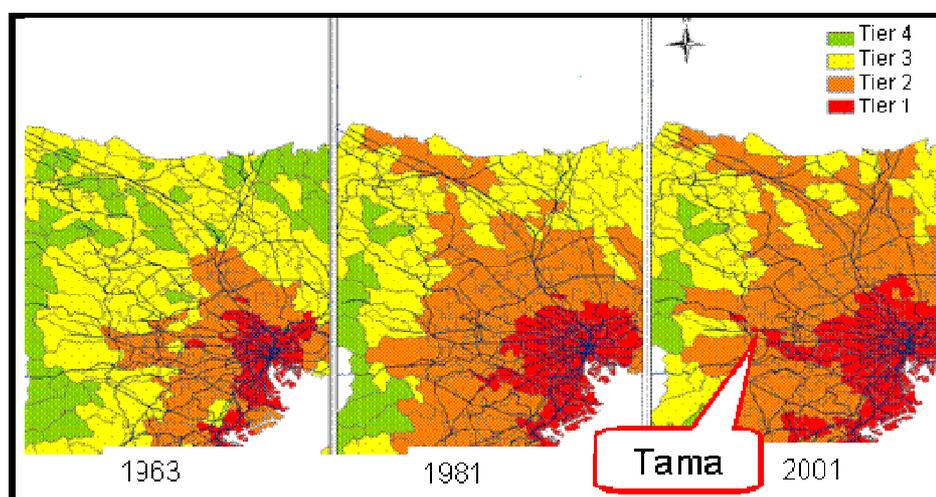
**Table 3: Employment clustering changes; Tokyo, 1963, 1981, 2001**

	Year 1963		Year 1981		Year 2001	
	Total employment	Share over total	Total employment	Share over total	Total employment	Share over total
Tier I	4,530,000	56.8%	7,680,000	52.4%	10,015,000	53.2%
Tier II	2,100,000	26.3%	5,370,000	32.6%	7,210,000	37.8%
Tier III	1,140,000	14.3%	1,530,000	10.4%	1,660,000	8.7%
Tier IV	210,000	2.6%	77,000	0.6%	51,000	0.3%
	Change 1963-1981				Change 1981-2001	
Tier I		69.5%				32.2%
Tier II		155.7%				34.2%
Tier III		34.2%				8.5%
Tier IV		-63.3%				-33.8%

A different pattern is identified compared to those of large North American cities, where notable dynamics have been occurring outwards and the old CBDs have been losing their shares over the total. In one of these studies, it was reported that the share of CBD is only 7.4% on average in a number of large American cities (Heikkilä, et al, 1989; McMillen and McDonald, 1998; Giuliano and Small, 1999). On the other hand, between 1963 and 1981, Tokyo has shown a fairly concentrated decentralized pattern with a substantial increase in the tier II type of zones. These zones increased their total employment stock by 155% and their share of metropolitan total from 26.3% to 32.6%. However, there has been a more moderate increase between 1981 and 2001 in the tier II zones followed by the tier III type of zones.

Land-use developments, and the re-generation plans, have been addressing a multi-centric structure over the whole metropolitan area in order to mitigate the stress on the city center and to ensure a more balanced growth. The emergence of very important sub-centers has been observed, although the central area is still strongly dominating. In the planning terminology of the 1960s, “urban spots” with little employment were chosen to develop as satellite cities. Big steps up in the rank-size distribution were observed for most of them (for example, Tsukuba Isehara, Kamisu and Kashima). During the 1970s and 1980s, as one consequence of the rapid economic boom, higher shifts in the ranks of some growing zones in the rank-size distribution between 1963 and 1981 were observed and a considerable amount of jobs were located in the second tier, particularly compared to those increases between 1981 and 2001.

The fourth (1986) and fifth (1999) metropolitan plans firmly designated: “Business core cities”, and defined these as the high density core settlements within the Tokyo central area; and “Bases for large cooperation” - defined as the large centers outside the Tokyo central area. Plans articulate their primary aim as poly-centric spatial re-structuring within a circular development of stronger urban nodes outside the Tokyo central area. In 1986, the government defined a number of suburban center candidates for growth around the core. Most of them were tier I and II type of zones relatively near to the central areas (Yokohama and Kawasaki). They were already mature centers and therefore there was not a notable step upwards in rank. Similarly, sub-centers further from the city center did not develop as expected (such as, Kisarazu, and Oume) except for Tama New Town (Figure 11) which was part of an integrated land-use rail development in the former “green-belt” encircling Tokyo.



**Figure 11: Employment cluster distribution and rail network; Tokyo, 1963, 1981, 2001**

Tama New Town is a good example of a rapidly growing center, with many offices and commercial facilities, and its position in the rank-size distribution increased remarkably between 1981 and 2001. There are some other zones with remarkable shifts in their ranks that have been strongly consistent with the land-use development plans that have

designated these nodes as sub-centers. However, it should be noted that not all sub-centers included in the development plans have been successful.

## **5. COMMUTING TRIP PATTERNS**

Here, only a general overview of commuting trips patterns will be provided without going into the details and mathematical analysis that have been provided in the APEC-TR framework, and published elsewhere. Whether or not a poly-centric employment distribution leads to shorter commutes and more travel by public transport (and cycling and walking) is an important question in terms of the long-term sustainability of cities. Employment clusters are located at places that often have relative locational advantage in terms of the accessibility provided by highway and public transport. Better accessibility as a pre-condition to poly-centric development is one of the important policy concepts for supporting a poly-centric urban growth. A number of studies have examined 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 or distances) 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. This is defined within the context of the “travel-time budget theory”, implying that the people tend to maintain a total travel-time budget and adjust their trips accordingly (Garrison and Ward, 2000). Dubin (1991) discussed that as cities get larger in terms of area and population, they might produce more cross commuting for mono-centric cities than in poly-centric cities, as the workers will possibly tend to reduce their commuting time by taking opportunities provided by a multi-centric structure. Gordon, et al., (1986) found similar results for Los Angeles as to Dubin, but Cervero and Wu (1998) showed that, for San Francisco between 1980 and 1990, the average trip distance and time increased by 12%, and 5%, respectively. However, Gordon (1991) noted a shortened automobile commuting time for 20 USA cities.<sup>1</sup> A similar argument on the undesirable impacts of sub-centers is that they add more to the vehicle-distance kilometers and unbalanced mode share favoring longer kilometers by automobiles. The empirical findings proved in many cases that as the distance from the CBD increases, the share of public transport decreases. This difference has been very marked in many North American cities. For example, the public transport share in the downtown of San Francisco is 28%, whereas, it is only 2 % in the most of the far away sub-centers.

### **5.1 Istanbul**

Istanbul is a somewhat unusual case study because, over the whole region, the average morning peak-hour trip times for motorized travel decreased from 53 minutes in 1985 to 41 minutes in 1997. This means that each inhabitant spends almost one and a half hours per

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<sup>1</sup>Automobile commuting time 1980-1985: New York, from 28.1 to 26.3 minutes; Boston, from 22.0 to 20.4 minutes; and Chicago, from 25.4 to 23.9 minutes.

day for transport on a congested network which makes the movement a time-poor and costly activity. The main reasons for such a decrease in trip times are discussed by the local planners: first, it was the construction of the second Bosphorus Bridge and its beltways, which increased the road network speed, and which prompted land development along its corridor; and secondly, it was the poly-centric structure, as people benefited from the sub-centers through choosing to live closer where they work or work closer to where they live.

Sub-center specific, one-way, commuting time and mode shares were calculated in order to grasp the variations between the old city center and the emerging sub-centers. Between 1985 and 1997, where a poly-centric spatial re-structuring was evident, the average trip time decreases were higher for the eastern and western traffic zones which were promoted as wing attraction at an average of 25 % (for example, from 70 minutes to 52 minutes) reduction in travel time. The highest decrease was observed for a sub-center which is nearby a rapidly growing zone at the intersection of the second Bosphorus Bridge beltway. Network improvements in the outer parts of the city is one explanation for the shift from shorter to longer commuting distances as centers grow in employment size. However, in the case of trips attracted to the city center, the average commuting time was either stable or it only very slightly decreased. Center-specific mode-share variations are much more moderate compared to those in North American cities. The mode shares varied in a range between 38% and 50% over the whole metropolitan area of Istanbul, and were the highest for the city center. The public transport shares for the journey to work to the ten different employment centers representing the four clusters is not very different - varying only by 11%. This is probably a result of the uniformly ubiquitous public transport coverage of buses and modes of para-transit throughout Istanbul. Because of the extensive public transport network of buses and minibuses they carry 90% of public transport passengers, and the routes are being extended in line with the physical expansion of the city.

## **5.2 Sydney**

There are three points to make about changes in trip lengths in Sydney. First, it is clear that jobs have lagged behind residential expansion at the metropolitan fringe of Sydney. All areas have a deficit of locally available jobs. Penrith (SLA 6350) – one of the designated major centers in recent metropolitan strategy – shows a continuously deteriorating balance over time. Secondly, these imbalances between the spatial residential and employment markets result in increasingly long commuting distances for outer suburban workers. For example, the mean journey-to-work trip length of workers living in Penrith (55 km from CBD) in 2001 was 26 km (the metropolitan mean distance was 18 km). To complete the comparative picture for the other two major employment centers designated under the current metropolitan strategy: Parramatta (23 km from the CBD) has a mean trip length of 16 km and Liverpool (32 km from the CBD) a mean of 19 km. Thirdly, the decentralization of employment, and the greater accessibility to labor markets of job sites away from railways, together with the rise in private motor-vehicle ownership, has resulted in a dramatic change in the way commuters get to work.

The key travel characteristics of those people working in five selected centers are summarized here. The rail share is from 40 to 47% in the CBD and adjacent North Sydney and half that in Parramatta. Liverpool and Parramatta – both located on rail lines – attract a small rail mode share. As would be expected, the share of private transport to the CBD for the journey to work is low at 17% - a figure inflated by the provision of free parking, especially for executives as part of their remuneration package. The mean trip lengths for all centers by rail travel is surprisingly constant - from 21 to 22.6 km. Commuters by car travel shorter distances on average from 11.6 km to Penrith to 14.5 km to the CBD.

### **5.3 Tokyo**

Of all of our case study cities, Tokyo has the largest metropolitan railway network, including extensive subway and suburban commuter railways. The length of the total intra-urban rail network is 737.4 km and the share of the railways is the highest; approximately 42% amongst all the modes. Because of the predominant role of the railway network, the total length of the freeways and the car use is smaller than those of the North American cities despite the fact that Tokyo is one of the world's major economic power-house. Because of its rail network developed since the 1960s, Tokyo is one of the case study cities that serves as evidence for the existence of a travel-time budget theory because the average trip time over the whole metropolitan area has been rather stable with only very slight variations (42 minutes in 1968, 43 minutes in 1988, 44 minutes in 1998).

Because the core city is still dominant with inward commuting trips, severe in-rail carriage over-crowding and station congestion problems occur. To resolve these problems, rail-based decentralized concentration has been long promoted. Although the overall success of this policy has fallen behind expectations, there are some successful transport policy implementations. One growing suburban sub-center, Tsukuba (approximately 58 km from the city core), has been connected by the Scuba Express reducing the total trip time from the central city from 90 minutes to 45 minutes, where the average trip time for commuting trips in Tokyo is 44 minutes.

To discuss the balance, or imbalance, of the spatially distributed mode shares, we calculated the zone-specific mode choice ratios. The CBD of Tokyo, served by intensive rail network, attracts 80% of commuters by public transport. With increasing distance from the CBD, public transport mode share decreases - but not as dramatically as it is in many other case study cities, particularly those in North American. In Tokyo, even the outer employment zones attract as much as 50% of commuters by public transport.

## **6. CONCLUSIONS**

This paper is based on the results of the EASTS-funded project which examined the poly-centric employment formation in growing cities of Australasia. The methodologies developed are readily applicable to the analysis of any city. We have selected six cities from the eleven case cities undertaken during the project to illustrate specific research themes. Our case

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cities here are Bangalore, Jakarta, Istanbul and Shanghai from developing countries, and Sydney and Tokyo from developed countries. The scope has been restricted to three main themes: examining the policy aims and instruments for poly-centric spatial structuring; the dynamics of employment cluster and sub-center formation; and the commuter trip characteristics associated with the growth of employment sub-centers. Although policy-making directions, and especially patterns of employment locations, and the impacts of decentralized employment on trips, have been found to be different in detail, there are common points amongst these six case cities. The most important trend observed across all the case cities is that the decentralization of employment into both urban and regional sub-centers have been nominated by governments as important policy aims in their master plans in order to dissolve the urban problems arising from the excessive loads in the central city, and to control the increasing commuting distances by providing self-contained centers which are well connected by public transport. Although the decentralization of jobs has been an evident urban pattern both by the results of market-driven forces and implemented policies, the good examples of well designed sub-centers that match with the policy aims are limited. The case-specific results further support these general conclusions

**Bangalore:** In 2007, there is a clear historic core (with a British Imperial residual) and a traditional CBD. There are two IT centers located about 18 to 20 km from the CBD connected by road. There is a ring road that will connect the proposed 5 satellite cities – fully integrated functioning towns. With investment by the Toyota Motor Company of a factory in one of the satellites there is every prospect that substantial employment re-structuring will take place, especially with the public sector-private sector partnerships emerging here, as in other parts of India.

**Jakarta:** In the 1960s (partly stimulated by hosting the 1962 Asian Games), the independent nation building of a former Dutch colony by President Sukarno, and supported by Russian assistance, created a new CBD at Kemayoran some 13 km from the old city of Kota. Modernization of the late 1970s and 1980s created a linear development of jobs connecting both centers – now, collectively, referred to as the new Jakarta CBD. This CBD is still the dominant location for firms and government offices and it attracts most of the trips over the whole region - even from newly developing new towns. This CBD adds to the car kilometers traveled by commuters.

**Istanbul:** The Bosphorus Strait is a natural barrier that has influenced the spatial structure of the city, both on the Asian and on the European side. The historical core of Istanbul has a rich history from Byzantium times; the preservation of this economic and cultural center is a key objective of urban policy that includes a decentralization of employment. The government role in spatial restructuring has been modest. Although the development has been by the private sector, and market-driven, some government assistance has helped the two wing attraction centers to be successful with manufacturing and industry. The bridges, and the emergence of sub-centers, both have helped reduce mean trip times over a period when the city was growing rapidly.

**Shanghai:** From the 1940s the major urban planning strategy aimed at trying to de-centralize the over-crowded population in the central part of the city. Unfortunately, the de-centralization strategy to encourage the people to locate in the satellite towns has not been successful. Recently, the municipal government has put great attention to support the secondary city in the suburbs of Shanghai. According to the plan, the three most important new towns will each have a population of one million.

**Sydney:** As with Shanghai, Sydney has a long planning history dating back to 1948 when it was recognized that the concentration of jobs in the center caused major traffic and transport problems. Spatial plans have consistently encouraged the decentralization of jobs. The urban development process has led to some decentralization of jobs, but not necessarily into the designated centers, and at a rate lagging behind the dispersal of population. Five cities are designated as the major employment nodes under the latest metropolitan strategy. Sydney has an extensive suburban rail network allowing 46 % of commuters to travel to the CBD by rail, but in the other suburban centers on the rail network about 70 % of commuters drive, as in the case of many North American cities.

**Tokyo:** The unique feature of Tokyo, which helps to explain the continued employment centralization, is the high quality, reliable, rail and subway system that extends services throughout the region. The long-standing network has shaped employment densities around rail stations. There are some examples of successful decentralization that has built up employment, although much of this can be attributed to the railway companies building up vertical business that include land and property development. The best example of new town planning by a railway company (Tokyu) is that of Tama New Town, when land, once protected by the green belt (following the London example of the 1944 Foreshaw and Abercrombie Plan), was released for urban development. New towns, with some employment, have been staged development following the railway line.

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