# CHAPTER 1: INTRODUCTION

## 1.1 BACKGROUND

In the general context, this research is about polycentric metropolitan form and a multi-dimensional phenomenon called globalization. In other words, it is about relations between physical form of a specific type of city, the global city, and its functional aspects related to globalization. Hillier (1996, 149) mentions that so far there is a compartmentalization between disciplines concerned with the city, which creates two types of gaps. First gap is a form-function gap. There is a split between planners, who deal with social and economic processes which animate the city; and urban designers, who are concerned with the physical and spatial synthesis in the city.

The second gap is a scale gap. Planning begins with the region and deals with the functional city, but does not get to the urban area. On the other hand, urban design begins with a group of buildings, gets to the urban area, but hesitates to move to the city-scale not to repeat the errors of the past when over-orderly towns meant the whole city, which never became places. For Hiller (1996) we can only understand the city if we see it as a physical and functional whole. This research aims to explain the physical and functional characteristics of the polycentric metropolitan areas under the impact of global forces.

### 1.1.1 Globalization and Global Cities

In the last two decades, globalization has entered every dimension of our lives. The discussions about globalization and its effects intensively take place in the popular and academic media regarding its political, social, and economic dimensions. Effects of globalization are wide spread and pervasive in every day life. The notion of an international style and culture has become a widely accepted reality.

Global cities are under constant transformation. In order to attract global flows and capital and better accommodate them, city governments are continuously searching for growth opportunities in terms of their infrastructure capabilities, office-space and housing capacities, and transportation facilities. This desire for growth has resulted in the drastic expansion of the global cities (Scott, et al. 2001). The built-up area of these cities can hardly be perceived as conforming to traditional city boundaries. This growth aspiration both economically and morphologically has given rise to the new regionalism. Global cities are now perceived as polycentric regions. In the US, this regionalism started with suburbanization and formation of edge cities (Scott, et al. 2001).

Sassen (1995, 72) argues that in global cities, the centrality of the central business districts is under reconstruction. This reconstruction of CBD is different from the agglomeration patterns visible in central business districts of the cities that did not experience global city functions. There are evidences of commercial and office space development in global cities emerging as a decentralized re-concentration of economic activity on the urban periphery (Sassen 1995, 72).

In the US, major office construction is taking place as the rebuilding of the center, whereas in Europe, where urban centers are far more protected, new office space development is taking place outside the old centers (La Defense complex in Paris, Docklands in London), and in Asia there are many satellite office districts emerging outside the city such as Teleport Town in Tokyo (Graham and Marvin 2001). According to Sassen (1995) it is important to analyze if the central business districts have traditional gravitational force in these new patterns (Sassen 1995). In terms of centrality patterns and the formation of global city regions, Sassen (2001b) argues that the dispersal of transnational service industry on a regional scale weakens the core idea of the global city, thus she suggests that global city functions need to be centralized rather than dispersed.

Under the impact of globalization, the built environment and land use planning of global cities have also been transformed. City centers, skylines, waterfront developments, shopping malls, and mixed use centers have become characteristic elements of global cities (Sassen 2001a). Among these developments, high-rise buildings is usually associated most with the transnational business activities with their high-tech communication infrastructure and by being the iconic landmarks of corporate power that symbolizes material accomplishments of commercial enterprises (Dupree 1996).

Until now, the impact of globalization on the land-use patterns of global cities has remained theoretical or when conducted, quantitative analysis focused on individual cities (Audirac and Fitzgerald 2003). This research aims to combine both theoretical explanation and spatial statistical analysis in analyzing the centrality patterns of advanced producer service firm clusters

10 US global cities. High-rise office building clusters have the capacity to define the new centrality patterns by being high-density work spaces and they also lead the formation of ancillary business and residential activities around them. Thus, when we are talking about changing centrality patterns in the land use in global city regions, high-rise office buildings require a special focus.

### 1.1.2 Polycentric Metropolis

In their article “From Metropolis to Polyopolis”, Hall and Pain (2006a) suggests that a new phenomenon is emerging in the most urbanized parts of the world: the polycentric mega-city region. This construct emerged through the extended decentralization from big central cities to adjacent smaller ones. The result is a new form with a “series of separate, but functionally networked towns or cities clustered around one or more larger central cities” (Hall and Pain 2006, 3). There are two underlying mechanisms of this new urban form: globalization and informationalization. Both of them emphasize the new knowledge economy and the division of labor based on services rather than manufacturing. In this regard, office geography and distribution of service employment become important units of analysis in the new polycentric metropolis.

In the US case, decentralization mainly started in 1930s as suburbanization due to improvements in road and rail networks. By 1960s, an uninterrupted polycentric metropolitan region started to be visible in the North East United States, identified by Jean Gottmann (1961) as megalopolis. In 1980s, shift of manufacturing to developing countries and globalization of finance has completely transformed the economic bases of the US cities into a service and high-tech economy. Highly developed information, communication, and transport technologies have accelerated the decentralization process (Castells 1989). Telecommunications compensated for the physical distance. The resulting pattern in contemporary American metropolis is a massive spurt of city building and the evolution of dispersed, polycentric spatial structure (Lang and Knox 2007, 5) identified as the "megapolitans" (Lang and Dhavale 2005).

Megapolitan area is basically a large region that combines at least two or more existing metropolitan areas that are interconnected physically through transportation networks. Megapolitans include nation's largest and most important metropolitan areas. The international airports are located in these regions. Thus, megapolitans are the gateways to the global economy (Lang and Dhavale 2005). Major metropolitan areas of megapolitans also have a polycentric structure in themselves in terms of concentration of business activity. Downtowns are no more the only center of business and commerce.

**1.1.3 Office Geography and Locational Strategies of APS in the New US Metropolis**

Hall and Pain (2006) demonstrates that the most important expression of the new knowledge economy is the emergence of the advanced producer services: a cluster of knowledge and information intensive activities that provide specialized services to other service sectors. APS include activities such as management and administration, marketing, legal services, banking and finance, accounting, insurance, human resources, IT support, and transport and logistics. Sassen (2001) demonstrates that APS constitute the core functions of the global cities. APS firms have special spatial requirements: they need to be in dense agglomeration because they benefit from face to face contact, informal information networks, pool of skilled employees, and high-tech infrastructure found in centralized locations. Major metropolitan areas of the megapolitans, as gateways to the global economy, are the central locations of APS firms. Then, the question is how the APS sectors and firms are distributed in the polycentric US metropolis.

In examining the office sprawl in 13 largest US metropolitan areas, Lang, Sanchez, and LeFurgy (2006) concluded that the office location and employment is highly decentralized. The largest share of office employment with 40% of office employment took place in edgeless cities, places that extend over hundreds of miles of urban space, but yet cannot be perceived as one place. If the office space in the polycentric US metropolis is so scattered and decentralized, how do the APS firms that require dense agglomeration and benefit from central locations is located in decentralized metropolitan areas?

APS firms are found in enclaves of international banking, finance, and business services (Graham and Marvin 2001; McNeill 2005; Newman and Thornley 2005; Sassen 2001b). These enclaves are mega-urban projects in the form of clusters of high-rise buildings. High-rise buildings are mostly found in high-density areas like central cities where space is scarce. However, in recent years we see the development of high rise building clusters as renovation projects of run-down industrial districts or in lower density areas. The aim here is to shift the center of business activity with these mega-urban projects from CBDs to other emerging centers. Logic dictates that high-rise buildings are the preferred locations of APS firms because these buildings define high-density areas where many firms could locate close to each other. In this research, we will explore the centrality patterns of a special type of APS firms, which are transnational APS firms (APS TNCs) through a cluster analysis. The clusters of APS TNCs will be referred as "global business activity nodes".

This study is concerned with the assumption that the contemporary global flows of people, capital, and commodities, which accelerated dramatically in the age of globalization, have significant impact on the land use patterns of global cities. With this assumption, the study further questions whether or not the distribution of transnational advanced producer service firms define a new form of centrality in the US global cities, in which the traditional central business districts and suburban centers differ from each other in terms of spatial clustering patterns and sectoral distributions of transnational advanced producer service firms.

## 1.2 RESEARCH QUESTIONS AND HYPOTHESES

The main research question of this thesis is: "How are transnational advanced producer service firms are organized in the polycentric US metropolis?" To define the polycentric US metropolis, the research employs Lang et al's (Lang, et al. 2006) classification of metropolitan office space, which is comprised of downtowns, secondary downtowns, urban envelopes, edge cities (and corridors), and edgeless cities distinguished according to office space density . To address this main question, this research seeks to answer the following three questions:

1- What are the centrality patterns of the advanced producer service clusters (global business activity nodes) in selected U.S. metropolitan areas with respect to their location[1], size[2], and industry composition[3]?

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[1] Location is defined from the classification of Lang et al (Lang, et al. 2007).
[2] Size is defined through the number of firms.

2- What are the centrality patterns of the high-rise commercial office building clusters in selected U.S. metropolitan areas with respect to their location[4], size[5], and year of construction[6]?

3- Since advanced producer services require dense agglomeration, do company and building clusters follow a similar locational pattern in decentralized metropolitan areas?

With the first sub-question, the research aims to explore whether or not APS TNCs from different sectors have different locational patterns. With the second and third sub-questions, the research aims to explore whether high-rise office buildings are preferred locations of APS TNCs. The units of analysis in this research are company and building clusters and units of observations are APS TNCs and high-rise office buildings. These 3 research questions produce 13 hypotheses:

**Question 1:**

1. In major metropolitan areas of the U.S. megapolitan regions, global advanced producer service firms are highly-clustered.
2. The clusters of APS firms have a centralized locational pattern.
3. The locational patterns of APS firm clusters indicate a polycentric metropolitan form.
4. The knowledge intensive producer APS firms (accounting, finance/banking, insurance, law, management consultancy, design consultancy, advertising and marketing, and real estate) are mostly clustered in primary or secondary downtown-density areas and inside the urban envelope.

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[3] Industry composition is the number of different sectors represented.
[4] Location is defined from the classification of Lang et al (Lang, et al. 2007).
[5] Size is defined through the number of buildings and total number of floors.
[6] Year of construction is defined as the medial year of the construction end date of buildings in the cluster.

5. Distributive APS firms (logistics, IT) are clustered along corridors and edge-city density areas and they are located close to airports.

**Question 2:**

1. In major metropolitan areas of the U.S. megapolitan regions, high-rise office buildings are highly-clustered.
2. The clusters of high-rise office buildings have a centralized location pattern.
3. The locational patterns of high-rise office building clusters indicate a polycentric metropolitan form.
4. Traditional downtowns still have most of the high-rise office space.
5. High-rise office construction accelerated after 1980s, when the impact of globalization intensified.
6. Most of the new construction after 1980s, started to take place in areas outside of traditional downtowns.

**Question 3:**

1. Global advanced producer company clusters and high-rise office building clusters follow a similar locational pattern: High-rise office buildings are the preferred locations of APS firms.
2. High-rise building complexes in high-density areas (primary and secondary downtowns) mostly serve knowledge-intensive producer service firms (accounting, finance/banking, insurance, law, management consultancy, design consultancy, advertising and marketing, and real estate).

## 1.3 CONTRIBUTIONS OF THE RESEARCH

This research contributes to the existing literature in several dimensions. First of all, instead of treating global city as a theoretical construct, the research focuses on the physical space of global cities and identify where globalization is actually being shaped. Secondly, by identifying the high-rise office districts as the preferred locations of the transnational service sector, the research links the network aspect of global cities to individual locations inside these cities.

Nelson (2005) argues that much of the work in agglomeration economies overlooks the importance of availability of office space and she mentions further reserach is needed in that regard. Schwartz (1992, 281) also concludes that most studies in terms of corporate services do not identify the locations within the major national or international centers that are attracting these services. This, research fills the gap in the literature in terms of producer services and their intrametropolitan locations.

## 1.4 OVERVIEW OF THE METHODOLOGY

In describing the centrality patterns of global business activity nodes in decentralized U.S. metropolitan areas, this study utilizes embedded multiple descriptive case study research methodology. To identify company and building clusters, data was analyzed through the Nearest Neighbor Hierarchical Clustering Method in CrimeStat Program. Lang et al.'s office geography (2006) categorization is employed to define the locations of the clusters.

There are four categories in case selection:

1- Metropolitan Area Selection: Based on have high connectivity to the global economy, presence in major metropolitan areas of the megapolitan regions, and presence in the top thirteen largest metropolitan commercial real estate markets researched by Robert Lang (2003). Metropolitan areas that satisfy the first criterion and either of the second or third criterion is included in the reserach, thus the result is 10 metropolitan areas: New York, Chicago, Los Angeles, San Francisco, Boston, Dallas, Houston, Washington, Atlanta, Miami.

2- Selection of Advanced Producer Service Firm Sectors: Ten sectors are identified including accounting, finance/banking, insurance, law, management consultancy, design consultancy, advertising and marketing, and real estate, IT, and logistics.

3- Company Selection: Advanced Producer Service Transnational Corporations: Based on NAICS Codes in Business and Company Resource Center Database by Thompson&Gale.

4- Building Type Selection: Based on EMPORIS database

## 1.5 OVERVIEW OF THE CHAPTERS

Chapter 2 reviews the existing literature in relation to globalization, global cities, advanced producer service firms, and polycentric metropolis. In the first section, emergence of globalization and global city theories by Sassen (2001), Castells (1996), Friedmann (1995), and Taylor (2004) are discussed. The second section focuses decentralization and polycentricity as spatial structures of global cities. In this section, characteristics of APS firms and their locational startegies are dicuseed. This section also defines polycentric metropolis concept and provides a discussion on the development of polycentric urban structure through the arguments of different scholars, including Castells' (1989) Informational City concept. The high-rise office buildings are also introduced in this section. The chapter concludes with a research agenda based on the questions derived from the literature review.

Chapter 3 is the Research Design and Methodology chapter that introduces the reserarch strategy, research questions and hypotheses, case selection and data collection processes, data sources, and specifics of the Nearest Neighbor Hiearchical Spatial Clustering method used to analyze the collected data to identify building and company clusters.

Chapter 4 reports the cluster analysis results in each of the ten cities. The results are recorded according to company clusters, building clusters, and both of them together. Chapter 5 focuses on the polycentric metropolis concept in the US context and offers a discussion based on findings in Chapter 4. The first section discusses the historical development of polycentricity in the US metropolitan areas and explores the regional differences between Sunbelt and former manufacturing belt cities. The second section sectoral and spatial characteristics of global business activity nodes in the ten selected metropolitan areas and offers inter-urban and inter-regional comparisons between Sunbelt and former manufacturing belt cities. Chapter 6 is the Conclusion and it also offers policy implications and further research ideas.

# CHAPTER 2: LITERATURE REVIEW

This chapter will review the existing literature in relation to globalization and its effects on urban environment. Emerging polycentric urban structure of global cities will be the main focus. First of all key concepts of globalization and theories of global cities will be discussed. Debates on internal spatial structure of global cities, locational characteristics of advanced producer service firms, and polycentric metropolis will be provided next. The chapter will be concluded with the discussion on a research agenda to explore American Metropolis based on questions derived from the literature review.

## 2.1 GLOBALIZATION

Globalization is rooted in the economic and technological restructurings that started taking place in the world around 1970s. After World War II, Bretton Woods agreement established an international regime based on US hegemony. Due to the OPEC price increases in 1973 and following financial crisis, this hegemony started to disintegrate. Between 1970s and 1980s, the US transnational corporations and banks became major players in the world economy. The Third World Debt Crisis in 1980s resulted in the reorganization of the financial industry and global dispersion of manufacturing activities (Sassen 2001b). The coinciding developments in information and communication technologies also supported the global dispersion of manufacturing and business activities (Castells 1996). Thus, the world experienced a shift from an international to a more global economy (Knox 1995), which is characterized by decentralization of production, yet integration of capital markets (Sassen 2001b), and increased flows of people, trade, technology, capital, goods, and ideas across borders (Appadurai 1996; Knox 1995).

These economic restructurings also have had dramatic effects on cultural, social, and political realms. Today, globalization cannot be defined solely dependent on economic terms; it should be seen as a general paradigm with economic, cultural, social and political dimensions. Held et al define globalization as “the widening, deepening, and speeding up of world-wide connectedness in all aspects of contemporary social life” (Held et al 199, 2 in Newman and Thornley 2005, 13).

As much as it is a widely accepted phenomenon, globalization is also highly a contested concept. In recent years, globalization has become increasingly the focus of debate between those who argue that globalization promotes social justice, political freedom and overall efficiency in world economic output and those who envision globalization as a manifestation of the exploitative forces of capitalism designed to promote and advance the causes of capital accumulation and concentration. Cochrane and Pain (2000) develops a framework with three perspectives in this regard: hyperglobalists, skeptics (traditionalists), and transformationalists.

Hyperglobalists support the view that globalization is a tangible phenomenon and it demarcates a new era in economic, political, social, and cultural realms. Local differences lessen and the world is becoming more homogenized. Globalization is seen as an inevitable end of human development process (Cochrane and Pain 2000, 22). Hyperglobalists argue that global economy is a fully developed economy that replaced international economy. Global forces are driven by market forces through networks of interdependence and integration, and all agents of the global economy are competitive. These views coincide with neo-liberalist political positions and promote the idea of global free markets (Cochrane and Pain 2000). In the new economy, national borders and national economy is irrelevant, political empires are replaced with corporate empires (McGrew 2000). Its supporters are usually business elites, international financial institutions like Worldbank and IMF (Newman and Thornley 2005, 15). Hyperglobalists also argue that through the increased global flows of people, capital, and ideas; the global society will become "the global village", which is a theory developed by media guru Marshall McLuhan referring to the transcendence of constraints of physical place due to the advanced communication technologies (MacKay 2000, 55; Short, et al. 1996). Place will loose its importance and virtual communication will become dominant. Internet is seen as the leading argument for this approach (MacKay 2000, 55).

Skeptics (traditionalists) believe that globalization is an exaggerated concept or even a myth developed for ideological reasons of capitalist accumulation (Cochrane and Pain 2000, 22). Skeptics advocate that economic globalization is not a new phenomenon, in fact world was more globalized in the late 19$^{th}$ century, when open trade and liberalism were the norms (Newman and Thornley 2005, 15), what we are witnessing is a continuation of world-wide norms of market liberalism. Skeptics argue that the economic activity is still regional more than global (emergence of EU) and nation-states can still cooperate and challenge market forms (Cochrane and Pain 2000, 22). They argue that local and national cultures still remain unchallenged and they will continue to be dominant, unaffected from global flows (MacKay 2000).

Transformationalists reject the duality between hyperglobalists and skeptics and they suggest a third way. They agree that hyperglobalists view is an exaggeration, however they also think that globalization cannot be fully dismissed (Cochrane and Pain 2000, 22). Transformationalists accept that new forms of intense interdependence and integration are changing the international economy, which places constraints on the national economy (McGrew 2000). The current system is another evolutionary process in which closed national and local economies disintegrate into more cosmopolitan societies (Thompson 2000). Globalization of politics implies a reconfiguration of state power. Transformationalists argue that global flows exist, but they are internalized differently by local cultures (MacKay 2000). Robertson is embracing the transformationalists' view by suggesting that globalization can be best understood through the interface of gaining a consciousness of the world as a whole and perception of individual cultural differences (King 1995).

After 1980s, the widely accepted reality by hyperglobalists and transformationalists is that the world economy shifted from an international to a global focus (Knox 1995). International economy is characterized by goods and services traded between nation states by individuals and firms based in different countries, and these exchanges are highly structured by nation states. On the other hand, in the global economy goods and services are produced by oligopolistic web of transnational corporate networks, whose operations are loosely regulated by nation-states. Thus, the new global economy is dependent on less restrictive labor markets, financial deregulation, and privatization (Knox 1995, 1). New global economy is characterized by integration and interdependence between markets based on flows of capital, trade, and FDI (Thompson 2000), constituting a network (Castells 1989). In this new economic order, transnational corporations are the key agents of the global economy.

### 2.1.1 Key Agents of Globalization: TNCs and APS Firms

Castells (1989) argues that the convergence of advanced technology and capitalist logic defines a new techno-economic paradigm, termed as globalization. In the new global economy, transnational corporations (TNCs) appear as key agents due to their wealth creation capacity (Taylor 2004). TNCs are considered as organizations boundless from any national place. They would globally search for locations that will give them the competitive advantage to carry out production with highest efficiency and maximum profit. Their management style and personnel are highly international (Thompson 2000, 103). TNCs constitute highly complex networks and innovative production and management strategies to remain competitive in the market.

TNCs highly utilize the advanced information and communication technologies to locate their operations globally for their profit interests. Castells (1996, 411) argues that TNCs has formed a network in which different production and consumption centers and their ancillary services are linked together. In Castells view, production networks totally operate on a global scale, transcending spaces of places. On the other hand, Dicken (2003) characterizes the global economy as being interconnected localized activity clusters that are embedded in corporate networks. Both scholars agree on the dominance of TNCs on the creation of global production networks. Due to the flexible spatial arrangements of TNCs and advanced technology, global production was reshaped in innovative ways. Mass production is replaced with flexible specialization. This has formed flexible business networks, in which almost all functions of the production chain are subcontracted to smaller firms. However, the final product is always integrated under the brand name of the TNC (Dicken 2003, 262).

Global dispersion of production activities of TNCs, their decentralized structure, and integration of global markets have resulted in the need for centralized management and control functions such as accounting, banking, law, and advertising (Castells 1996). Due to the high complexity of the new TNC, these activities are also outsourced to highly specialized advanced producer service firms (APS) (Sassen 2001b). These APS firms also extended their operations globally in order to serve their clients in specific regions of operation (Taylor 2004). The discussion on APS firms and their locational strategies will further be elaborated in the polycentric metropolis section.

Cross-border operations of manufacturing and APS TNC networks take place basically through capital flows of foreign direct investment (FDI) and international trade, both of them resulting in the integration of different markets (Sassen 2001b; Thompson 2003). FDI is direct investment of one firm in another in order to gain a degree of control over that firm's operations through mergers and acquisitions or branch setting (Dicken 2003, 51), occurring cross-borders. FDI patterns are dominated by core economies, however in the recent years there is a growing FDI trend that occurs from developing economies (especially from East Asia) to core economies. Thus, FDI stays in the core (Dicken 2003, 80). Trade consists of the net balance between exports and imports. Due to the advanced technologies, manufacturing has accelerated which also enhanced the global trade activities between localities. In looking at the trade activities of manufacturing products across Western Europe, Asia, and North America, Dicken (2003, 41) conclude that much of the trade happens within the regions (EU, NAFTA, ASEA). Thus, these regions are recognized as the prime regions of globalization, or better known as the global triad.

Advanced technology and the integrated markets through TNCs are the most distinguishing factors of the global economy. With these characteristics, globalization demarcates a new era. Through the utilization of advanced technology, globalization also has the potential to globally promote social justice, political freedom, and overall efficiency. However, it is important to emphasize that in the current economic and political framework of globalization, dominance and power are still concentrated in the core economies and in transnational firms, which are mostly grounded in these economies. Therefore, globalization in its current form introduces capital accumulation logic in favor of the core economies.

The current economic system can be seen as the ordering of many different flexible business networks under the umbrella of TNCs. These individual networks are then integrated into a larger network of global capitalist system in which the key agents are the individual TNCs (Taylor 2004) and different nation states. The integration of different flexible business networks governed by a larger network of global capitalist system requires spatial identification of the command and control nodes of these networks (Thompson 2003, 205-212), which are cities with important strategic functions.

### 2.1.2 Globalization and Cities

Since the current world system is comprised of nation-states, the issue of geographical configuration (spatiality) is associated with locations within states. However, the basic logic of

TNC, undertaking operations transcending the boundaries of nation-states, contradicts with this state-centric view (Dicken 2003). Actually, the world system was not comprised of states until the treaties in 1648 that formed Westphalia system, which confirmed the territorial states as the building blocks of modern society (Taylor 2004, 15). Until this time, world system was comprised of cities. Cities were the markets for different production, consumption, and trade activities. With the Westphalia system, cities were integrated under national frameworks as regional cities or as capital centers. This declined the autonomy of cities in the international system (Taylor 2004).

Starting from 1980s, with the increased global operations of transnational companies that gave way to the globalization of economic activity, the understanding of the world through national urban systems became less important. Grounding of headquarter functions of these companies in certain cities required a new approach to relations between cities, which led to the world-city literature on theories of global city systems (Taylor 2004). By transcending the boundaries of nation states, TNCs are once again introducing the cities as more autonomous locations for their command and control functions (Castells 1996; Dicken 2003; Sassen 2001b; Taylor 2004). More and more individual cities like London, New York, and Tokyo (Sassen 2001b) are seen as the postindustrial production sites and the center of the world economy rather than their corresponding states. These cities that have agglomerations of command and control functions of the global economy are recognized as global cities (Sassen 2001) or world cities (Friedmann 1995) in literature. From this point on, we will refer to this special category of cities as global cities.

Global economy has been associated with a placeless logic. Yet, the main issue behind the emergence of global cities is related to the locational decisions of transnational corporations in terms of where to locate their command and control functions. This is what Jessop calls as illogics of globalization (Jessop 1999 in Newman and Thornley 2005, 18). Cities have always been integrated into the world economic system. As mentioned above, until the constitution of Westphalia system, cities were the major actors in the international economic system. Abu-Lughod (in Taylor 2004, 8) mentions that during 1250-1350, trading systems of Euroasia became integrated from China to Europe as a common commercial network of production and exchange. Due to the high travel times, in-between cities became exchange centers, thus merchants (firms) were located in these cities. Another example is the Hanseatic League of cities between twelfth and seventeenth centuries, which started as an association of merchants, then in the fourteenth century turned into a community of cities to form a trade blockade (Taylor 2004, 11).

What make the current global city network unique are the opportunities created by the advanced information, communication, and transport technologies. Due to the advances in these technologies, restriction of space is not an issue anymore (Castells 1996). Global cities like New York, London, and Tokyo that are found in different time zones undertake parallel activities related with management and functioning of financial markets (Sassen 2001b), they keep the world economy and the corporations in continuous operation. As Richard Florida argues the world is now a "spiky place", rather than flat (Florida 2004; Florida and Gulden 2005). Thus, the current global city system is a crucial framework for analysis.

**2.1.2.1. Global City Theories:**

Contemporary global city literature highly revolves around the idea that the relations between cities are both competitive and cooperative. Although, the early global city models were highly dependent on the definition of hierarchy based on competitive relations between cities, later the idea of networks and cooperation between cities dominated the field. Although the network models did not eliminate the concept of hierarchy totally, they introduced the logic of networks, in which the cities were seen as essential parts. In this network model, global city phenomenon is not reduced to few cities because the concept of hierarchy is not stable, but subject to dynamics of the network. Thus, in the network model, cities are seen as cooperative and they can be competitive.

Networks are alternative conceptions of analyzing how a range of social activity is organized and governed (Thompson 2003, 29). Networks are initiated as assemblages of diverse components brought together by a certain ordering rule. Networks emerge through direct and indirect interactions between these diverse components (individuals and/or organizations) forming interlinked chains. Networks arrive spontaneously or by deliberate design, but they are not coordinated by any administrative structure. Networks operate on loyalty, selflessness, trust, and reciprocity of its participants. In networks, hierarchy between parts is not important; the important thing is the network as a whole system. The major difference between networks and hierarchies is that networks lead towards a flat organizational structure with a lot of equality between participants, whereas hierarchies lead to a more vertical structure with power concentrated at the top levels. In hierarchy market-driven self interest and competition to achieve that is the priority, whereas in networks the survival of the whole network is important, achieved through cooperation (Thompson 2003).

#### 2.1.2.1.1 Theories of Hierarchy:

Hierarchy theories emerged from ranking the cities through the distribution of city populations within a national urban system (Taylor 2004, 16). In terms of global city theories hierarchy also became an important approach. In this regard, Friedmann's (1986, 1995b) "world city hypothesis" and Sassen's (1991) "global city hypothesis" are two prominent theories.

##### 2.1.2.1.1.1. Friedmann and World City Hypothesis:

Friedmann's World City Hypothesis is about the spatial organization of the new division of labor, concerned with how the new global production system characterized by locational dispersion is going to coincide with the local interests (Friedmann 1995a; Taylor 2004). Friedmann's World City Hypothesis focuses on the agglomeration of globalization related functions in major cities and classifies them according to this agglomeration rather than looking into their in between relations, suggesting a hierarchical world city system structure. The theory outlines seven theses according to the new international division of labor. Taylor (Taylor 2004, 22-23) combines these seven thesis into three general groups: Functional thesis, hierarchical thesis, and global-local thesis.

Functional thesis outlines that structural changes in the city arise from the integration of the city's economy into the world economy and functions assigned to that city. These functions are command and control functions such as headquarter functions, financial center functions, and articulator functions. The most important cities will have all three functions (Taylor 2004, 22).

Hierarchical thesis emerges from the argument that key cities are the basing points of global capital used in the spatial organization of production and markets. The resulting linkages enable the creation of a complex spatial hierarchy based on several variables including: the importance of the city as a financial center, corporate headquarters, international institutions, business services, manufacturing, transportation, and population size (Friedmann 1995b, 319; Taylor 2004). Global-local thesis focuses on internal relations in cities and argues that the dominance of globalization related functions attracted highly-paid managerial elites to the major cities, thus the social structure of these cities became polarized between this group and a large group of low-skilled workers (Taylor 2004, 23).

**2.1.2.1.1.2 Sassen's Global City:**

In her book "Global City: New York, London, and Tokyo" Sassen (1991, 3) argues that the spatial dispersion and global integration have created a strategic role for major cities, giving rise to a new type of city, which she calls "the global city". Other than their history of being centers for international trade and banking, these major cities now function in four other ways: first, as command points in the world economy to control the globally dispersed operations, second, as key locations for finance and for specialized service firms, which have replaced manufacturing activities and became dominant sectors in global cities, third as sites of production and innovation in the specialized service industries, and fourth as markets for the products and innovations produced. Sassen (2001) suggests that globalization needs more than computer screens and information networks to ground its operations and cities provide this space for globalization (Sassen 2001b).

Sassen (1991) identifies London, New York, and Tokyo as the leading examples. In her later framework in 2001 she includes other cities such as Frankfurt and Paris. By characterizing global cities as dense agglomeration sites for the global service industry, it can be argued that Sassen follows Friedmann's model of hierarchy. In her analysis, the data that Sassen bases her analysis on is based on city rankings rather than relational data. This does bring a hierarchical approach to her global city concept in the early version.

Sassen's (1991; 2001b) global city hypothesis focuses on the agglomeration of advanced service industry as the defining function of global cities. According to Sassen the highly complex system of global economy created the need for the centralization of command and control functions in certain places. However, due to this highly complex and dispersed nature of the global production system, the command and control functions of TNCs also became highly complex and require highly specialized operations, thus TNCs started to outsource these functions into advanced producer service firms (APS) operating in finance, accounting, banking, and media services. Due to the global nature of their clients, these firms also started locating globally and became transnationalized (Sassen 1991, 2001b).

Control and command functions are highly depend on information. In order to be close to informal information networks and due to the importance of face to face contacts in the service economy, APS firms started agglomerating in the major cities of the world. This very agglomeration created the global cities. Other than operating as command and control centers for TNCs, these cities became the production and innovation centers for APS firms as well as the markets resulting from this production and innovation (Sassen 2001b).

Global cities are usually established in major world cities that were once as imperial and cultural capitals of the world (London, New York, and Tokyo). The historical, cultural, and social characteristics of these cities also provide lively milieu that support the life styles of the international managerial elite working in the advance service industry. Since the corporations outsource their functions, the headquarters of the corporations are not necessarily located in global cities, although major transnational firms locate their headquarters in these localities. Thus, we can conclude that Sassen's global city hypothesis defines a hierarchical world city system based on the agglomeration of the advanced producer service industry (Sassen 1991, 2001b; Taylor 2004). For Sassen, global city function is almost like a city located within a city; it is limited to the spaces of command and control activities held by the transnational service industry.

**2.1.2.1.2. Theories of Network:**

Theories that utilize the network approach offer a wider perspective in terms of analyzing the urban systems in the era of globalization. In this section, we will focus on three theories: Castells' space of flows, Sassen's revised global city theory, and Taylor's interlocking world-city network.

**2.1.2.1.2.1 Castells' Space of Flows:**

In his The Rise of The Network Society Manuel Castells (1996) introduces the logic of the space of flows as the dominant spatial logic of the new networked, information society. The space of flows is the new social space where the new global economy organizes society according to the concepts of high mobility of capital, information, technology, ideas, and people, which were only made possible due to the advances in the information technology. In the new network society, due to advances in communication and information technologies, the simultaneity of time can be separated from physical contiguity of space (Taylor 2004). There are new alternative material supports of simultaneity other than place, like electronic mediums (Castells, 1996). Thus, the dominant spatial form in the new society is transformed from being spaces of places to spaces of flows (Castells 1996).

Castells (1996, 442-448) demonstrates that this new space is comprised of at least three layers. The first layer is constituted by circuit of electronic exchanges, which is the infrastructure network. The second layer is the space of the social practices that define society, termed as nodes and hubs, where agents operate. The best example for this layer is the cities (Taylor 2004). The third layer is the spatial organization of the economic elite. For Castells (1996) cities are processes embedded in a network of global flows. These networks are supported and constituted by advanced information and communication technologies. Due to the function of the network some cities become nodes where strategically important functions are located (global cities) and some cities become hubs with exchange and management functions. However, although hierarchy exists in the network, it is not stable. As the network evolves, other cities might become nodes, and some nodes might loose their functions. In this regard, he gives the example of emergence of Mexico City, Sao Paulo, and Madrid as global cities. Thus, cities are processes, rather than places, which connect production and consumption centers and their ancillary services into the network (Castells 2000, 422).

Castells (1996) also talks about the hierarchy in the network. For Castells hierarchy exists between cities, but it is not stable and subject to inter-city competition. He gives the example of fluctuations in global real estate markets in 1990s. In the early 1990s, the economic growth in Asian markets has made cities such as Bangkok, Taipei, and Shanghai to become important centers of transnational business activities. These cities experienced boosts in real estate activities and prices. At the same time, the real estate markets in New York, London, and Tokyo went down. However, the Asian financial crisis in the late 1990s reversed this situation. This example illustrates the competition and cooperation between cities in the global city network in the best way.

Castells (1989) argues that global city is also a dual city. In global cities, there is a microflow of unpublic information, to gain that information for time and money reasons speed becomes important. This unpublic information is a cause of the dual structure. Also, global city is a dual city because the presence of highly-paid economic elite restructures the social, cultural, and entertainment activities according to their standards and tastes, which is highly cosmopolitan disconnected from the local culture (Castells 1989). The biggest contribution of Castells to the global city literature is situating the cities into networks, rather than defining a hierarchical structure of the world city system.

**2.1.2.1.2.2. Sassen's revised Global City Theory:**

As mentioned in the previous section, Sassen's global city is a hierarchical framework that privileges certain limited number of cities such as London, New York, and Tokyo as having global city functions. However, in the 2001 edition of her book "Global Cities", Sassen talks about the emergence of cross-border networks in the financial sector that forms new ties between global cities. According to Sassen (2001, 121), the global financial system has reached a high level of complexity that require cross-border networks to overcome the inefficiencies resulting from closed-domestic systems. Sassen (2001, 122) demonstrates that the markets are now connected through "competition, strategic corporation, and hierarchy". In this regard, Sassen (2001) gives examples of consolidation of electronic networks that only connect select markets to form strategic alliances: Global trading alliance of NYSE with Tokyo Stock Exchange and Euronext, alliance formed between London Stock Exchange and Frankfurt's Deutsche Borse, and Paris led Euronext alliance with Brussels and Amsterdam.

**2.1.2.1.2.3. Taylor's Interlocking World City Network:**

Following Castells' space of flows as its basing argument, Taylor (2004) also argues that world cities constitute a network. He further argues that service firms, city governments, service sector institutions, and nation states are primarily responsible for shaping the world city network (Taylor 2004, 58). Among these agencies, Taylor (2004, 59) privileges the advanced producer service firms as key agents due to the facts that these firms are the wealth creating agents of the network and the overall structure of the network is created through the decisions of service locations of the firms.

Taylor's network is an interlocking type of network in which the cities are nodes and the global service firms are sub-nodal actors. Thus, world cities are interlocked through one another through the office networks of advanced producer service firms (Beaverstock, et al. 2001, 16). Since the firms are the key agents in this network, the importance of cities in the global era is not primarily dependent on the promotional activities of city governments; city's importance primarily depends on its links to other cities through business forms. Hence, city competition becomes less important than cooperation between cities (Beaverstock, et al. 2001, 16).

Beaverstock et al. (2001) utilizes Taylor's interlocking network concept to a study comparing London and Frankfurt as financial centers after European Monetary Union. In this study, they found that cooperation between London and Frankfurt is more dominant than competition. Beaverstock et al. interviewed service sector executives in both cities. The result of this study indicates that competition is primarily a size issue. London is a global financial center, whereas Frankfurt is a regional financial center within Europe. Therefore, Frankfurt and London are not even compatible in size and institutional thickness to compete for attracting global firms and other global flows. They are connected to global flows with different intensity. The only existing competition medium is the cultural amenities that support the life style habits of the transnational business class. In this case, London is also seen superior (Beaverstock, et al. 2001). On the other hand cooperation is a stronger trend between London and Frankfurt. Beaverstock et. al (2001) presents that for companies the response to globalization has been to develop global management that integrates multidisciplinary teams from across the world working on the same project. Many firms in London and Frankfurt cooperate through virtual offices. On the other hand, travel between London and Frankfurt has increased. London being the European and global capital market has positive effects in terms of attracting global firms to Europe; this aspect positively affects Frankfurt's business activities. At the same time, London is benefiting from Frankfurt's European business connections (Beaverstock et al 2001).

### 2.1.2.2 Internal Social and Spatial Dynamics of Global Cities:

The major arguments in terms of social structure of world cities lies around the existence of social polarization between the highly-paid transnational business class and Third World migrant populations. Sassen (2001) suggests that the global cities have two major groups of workforce: highly-skilled workers of the advance service industry and the low-skilled workers, who are mostly migrants from Third World countries that are employed in low-paying jobs that support the work conditions and life style needs of the business elite. The high polarization in income structures of these two groups lead to polarization in the global cities. Castells' (1989) dual city argument mentioned in the previous section also indicates this social polarization in global cities.

Social polarization also leads to spatial polarization in the global city landscape. Sassen (1991, 255) argues that since 1980s, the extent of the spatial segmentation has reached to dramatic levels. Gentrification has become a major trend and a problem in global cities. Sassen (2001, 323) argues that although gentrification is not a new concept for the urban landscape, what makes its new form distinctive is that the current gentrification has an ultra-urban context characterized by style, high prices, and a new ideology of consumption. The new consumption is not only restricted to the consumption habits of the elite, which has always existed in large cities. The new consumption has almost become a mass consumption emphasizing a unique design and fashion, which attracts high income people as well as "transient group" such as students who participate in this culture for temporary amount of time (Sassen 2001, 323). The examples of these new landscapes of gentrification can be given as expensive restaurants, boutiques, show rooms, and urban malls, and the extreme case of gated office and residential communities (Newman and Thornley 2005, 26).

In a similar concept Graham and Marvin (2001) examine the social and spatial polarization in global cities through the infrastructure networks. Due to the increased privatization of public infrastructure starting in the 1980s, in power, water, sewage, and communication infrastructure, Graham and Marvin (2001) argue that the higher-income people have now become better connected to the global networks than other groups. They demonstrate that the transnational companies undertaking the development of infrastructure networks tend to exclude lower-income areas from their network, thus they selectively serve the business elite and the zones that have the potential to become occupied by the business elite (Graham and Marvin 2001).

The elite in these privileged zones mostly isolate themselves from the other parts of the population by creating gated office and residential communities (urban citadels) supplied with state of the art surveillance and communication technologies. Their leisure activities take place in enclosed malls inaccessible by public transportation (Graham and Marvin 2001). Graham and Marvin (2001, 223) also argue that "as the infrastructure networks become unbundled, the built spaces of many cities are becoming reboundled". Gigantic complexes of offices, shopping and entertainment malls, housing, hotels and convention centers, airports, and business parks are emerging, which is termed by Knox (1993, 23) as "packaged developments", almost determining an isolated city within the city. Due to these trends, the resulting urban landscape of the global city has now a highly polarized, fragmented, splintering city (Graham and Marvin 2001).

Global cities attract flows of people, capital, technology, and ideas from all over the globe and they are cultural innovation sites for the contemporary society. Global cities have "institutional thickness" meaning they have social, cultural, and institutional capability to support enterprises (Amin and Thrift 1995). On the other hand, global cities are highly polarized due to the vast differences in income levels of different groups. Population scale is not a crucial characteristic for a global city, although due to their massive influence on the global economy, most of the mega-cities are considered in the global city framework. Global city is where the global economy is managed through advanced producer service firms. They are the sites where the global power is concentrated. With a population of 729,000 Amsterdam is considered as a powerful global city, whereas with a population of ten million, Sao Paulo is also in this category. Global cities absorb global flows and they internalize them according to their individual characteristics forming unique urban identities.

## 2.2. SPATIAL STRUCTURE OF GLOBAL CITIES: DECENTRALIZATION AND POLYCENTRICITY

In the previous section, key concepts of globalization are discussed in relation to emergence of new economic order in which TNCs, especially APS firms, are the key agents. The argument was framed around the understanding that these firms are leading to a globally integrated economy. Through the locational strategies of APS TNCs, a special category of cities gained importance as command and control centers, referred to as global cities (Beaverstock, et al. 1999a). In this section, internal spatial structure of global cities will be elaborated with regards to the agglomeration logic of APS TNCs and the emergence of polycentric metropolitan urban form.

### 2.2.1: APS Firms: Emergence and Characteristics

In the previous section, it has been stated that the world economy has experienced a transformation from an international to a more global economy. Theories of Friedmann (1995), Castells (1996), Sassen (2001), and Taylor (2004) has shown us that “informationalization”, which is the shift in advanced economies away from manufacturing towards service production, specifically advanced producer services that handle information, has resulted in some cities to become command and control centers of the global economy (Hall and Pain 2006a). These cities are referred to as global cities.

Halbert et al (2006) demonstrate that despite the flattening impacts of technological improvements in information, communication, and transport technologies (ICT), the world is still a “spiky” place with a limited number of powerful global cities (Florida and Gulden 2005). The internal social and spatial dynamics of these cities including the growing importance of the knowledge economy, need for talented and creative labor force, high-quality urban locations, and organizational networking makes global cities important sites of innovation (Halbert, et al. 2006, 110).

Shift from manufacturing to service economy placed service industry in the center of the new global economy. The most prominent classification of services comes from Singlemann’s work (Bryson, et al. 2004; Stein 2002). Singlemann (1978) classified services into four subgroups: distributive services (communication, trade, transport), (knowledge-intensive) producer services (banking, business services, real estate), social services (education, health, public, non-profit, etc.), and personal services (hotels, restaurants, travel, etc.). Producer services are services that provide direct inputs to other firms (Moulaert and Todtling 1995). Distributive services like IT and logistics also fits this criteria. In studies by Marquand, Hubbard and Nutter, distributive services are also included under producer services (Daniels 1995). In terms of producer services, Schamp (1995) argues that advanced producer services are a special category under producer services and they are distinguished as being highyly knowledge-intensive.

The most important expression of the new global economy and the economic basis of global cities are the APS firms. Advanced producer services are a cluster of activities that provide specialized services, embodying professional knowledge and processing specialized information, to other service sectors. APS firms utilize highly developed information, communication, and transport (ICT) technologies (Stein 2002) and they offer services in areas including: management, accounting, law, information and communication, technology, insurance, finance/banking, advertising, marketing, human resources, design consultancy, logistics, and research and development (Hall and Pain 2006a, 4; Taylor, et al. 2006).

Moulaert et al (1995, 109) demonstrate that until the beginning of the $20^{th}$ century, enterprises relied on financial and distributive services like banking, insurance, accounting, transportation, and trade. In the first quarter of the $20^{th}$ century, the development of national firms increased this reliance even more and added other necessary functions such as business administration services, data processing, marketing, and logistics. In the beginning, these services were provided in-house by the firms themselves. However, the internationalization of the economy after 1970s imposed a great deal of complexity on the organizational structure of transnational corporations.

This complexity brought the impossibility of achieving in-house economies of scale for all services in all regions, which led to the importance of outsourcing some of the command and control related functions to external APS suppliers (Moulaert, et al. 1995, 109). Keeble and Nachum (2001, 6) argue that due to increased international competition, technological change, and the changing needs of organizations in a rapidly changing macro-economic environment reflects the ever-growing demand for APS industry.

Developments in technology and changes in organizational dynamics brought the transition from fordist to post-fordist (flexible) mode of production. In Fordist era, the production systems mainly remained national. APS firms located close to headquarters of the manufacturing firms that they are serving, and they also remained national. The flexible mode of production in post-fordist era is summarized by principles of functional decentralization, functional integration, flexible production systems, automated technology, and market orientation. These principles meant responsiveness and complexity in the production and distribution systems, which further reinforced the information-sensitive nature of the APS firms (Moulaert, et al. 1995,112). Transnational operations of the companies also meant that APS firms will follow their clients, thus an important percentage of these companies also became transnationalized.

Although location near headquarters of the client companies is still an important pull factor, Sassen (2001) argues that advancements in ICT technologies removed this barrier. The company HQs can be located anywhere, but the APS firms need to be located in dense-agglomerations in global cities. Electronic communication and occasional face to face meetings can sustain the relationship of the company and the APS firm. GM is a good example for that. Although the company is located in Detroit, most of its management consultancy and finance operations are handled by APS firms in New York or Chicago (Sassen 2001b). This is the reason that Beaverstock et al (1999a, 450) calls global cities like New York and Chicago as "postindustrial production sites" where innovations in corporate services and finance have an effect on the world economy.

Sassen's global city theory argues that global cities are the main agglomeration nodes for APS firms. APS industry has very specific locational demands. Complexity introduced by the globalization of economic activity made APS industry more sensitive towards agglomeration and face to face contact. Improvements in technology enabled world wide operations, in return command and control functions handled by APS became more sophisticated (Graham 1997b). The next section discusses the characteristics of APS firms in detail.

**2.2.1.1 Characteristics of APS Industry:**

APS firms have specific characteristics, which impact their locational strategies. Knowledge-intensive nature of the APS firms (Todtling, et al. 2006), importance of access to a skilled labor pool (Keeble and Nachum 2001), and the dependency on advanced infrastructure (Castells 1989; Graham 1999) are the most important characteristics highlighted in literature and they will be discussed in this section.

Knowledge has become a key source of competitiveness for advanced regions and nations, indicating a transformation of capitalism towards a "knowledge economy". Knowledge intensive sectors in production and in services have a lead in this respect and they are seen as role models of the future. The innovation process and knowledge exchange together make APS differ from other service sectors (Todtling, et al. 2006, 1035). Information is important for APS firms because they are operating in areas that have great uncertainty. They compete and corporate with other APS firms for information. Information then becomes knowledge through the act of interpretation (Bryson, et al. 2004). Cooperation is important for technology intensive APS firms because it helps to reduce uncertainties, provides access to complementary resources and technologies, and speed up the innovation process in knowledge creation (Todtling, et al. 2006, 1051). Strambach (2002, 221) suggests that the guranteed long-term relationship of APS firms with their customers is associated with their ability to transfer existing knowledge in innovations systems to firm-specific context and application.

There are two types of knowledge: codified and tacit (Bryson, et al. 2004). Codified knowledge is commonly available knowledge, which is codified in a format that makes it easy to transfer between the parties. Manuals, reports, blue-prints are examples of codified knowledge. On the other hand, tacit knowledge is the knowledge that is not codified yet, which makes it difficult to transfer between parties. Tacit knowledge can be hidden in people's heads and actions (Bryson, et al. 2004; Hall 2001). Due to its unstructured nature, tacit knowledge is most difficult to gather, understand, and implement. Tacit knowledge is best transmitted via face-to-face contacts and through frequent interaction (Todtling, et al. 2006). For example, Thrift describes the core of financial activities as "information, expertise, contact", which all require spatial proximity (Thrift 1994, 334).

Todtling et al (2006, 1037) identify two knowledge bases for APS firms: synthetic and analytic. Synthetic knowledge base is created by the application of existing knowledge, low levels of R&D and applies to solving specific problems brought by customers. Learning by doing and interacting, practical skills and tacit knowledge are highly important. Synthetic knowledge base is found in traditional APS firms such as finance, banking, accounting, and insurance. In analytic knowledge base there is a strong reliance on scientific inputs and codified knowledge. Knowledge generation is based on the application of widely shared and understood scientific principles and methods and outcomes tend to be documented in reports, electronic files or patent descriptions. Biotechnology research and information technology are two APS sectors with analytic knowledge base. In sectors where an analytical knowledge base prevails there is much more systematic basic and applied research than in traditional industries. Analytic knowledge base is also shaped by tacit knowledge to a certain extent (Todtling, et al. 2006, 1037). Due to its highly unstructured nature, tacit knowledge is the most important determinant factor in defining the locational strategies of transnational APS firms with either the synthetic or analytic knowledge base. In order to have an access to informal knowledge networks, the logic suggests that these firms need to be located close to each other.

APS firms are highly labor intensive because specialized expertise of the workforce is the main material for their production. Thus, access to skilled labor is a particularly important location consideration for APS firms. Vacancy is more likely to find a match with an unemployed worker when the labor market is larger (Anas, et al. 1998, 1447), global cities supply this large labor pool. Professional skilled labor working and living in global cities are aware of their special status. According to Reszat (2002, 7) they may complain about traffic jams and air pollution, but they enjoy the advantages related to the way of life and the feeling to be a part of a special global city culture.

Robert Reich (1992) argues that there are three different types of work emerging in the new American economy, which also have an affect on division of labor: routine production services, in-person services, and symbolic-analyst services. Routine production services are blue-collar, routine manufacturing and data entering jobs. In-person services depend on catering people such as restaurant and hotel work. Symbolic-analyst services depend on knowledge creation and problem solving. They can be traded internationally. Reich (1992) calls them symbolic because their practice involves solving problems through manipulating symbols or abstract images (Bryson, et al. 2004, 42). Professional skilled labor in APS falls into this category. Problem solving depends on information flowing in global information networks and face-to-face contact with other symbolic analysts. The transnational APS industry feeds on these interactions, which are concentrated in global cities. Thus, professionals working for APS firms benefit to be in global cities and by this way APS firms have an access to the skilled labor pool, which is vital for their operations.

All aspects of development and functioning of global cities and APS firms also depend on advanced telecommunications networks and appropriate urban infrastructures embedded in good transportation. Global cities concentrate the most-communications intensive elements of all economic sectors and transnational activities within small portions of geographical space (Graham 1999, 930; Moulaert and Gallouj 1995, 153).

Advanced producer services in global cities highly depend on sophisticated urban infrastructure (Wernerheim and Sharpe 2005, 181), which increases efficiency and reduces transaction costs by allowing clients to interact with suppliers remotely and in real time (Graham 1999; Todtling, et al. 2006). Talking about the law firms in London, Taylor and Smith (1999) mention that firms have developed intranets as an internal notice board to facilitate rapid delivery of information to their offices worldwide. They also use the latest technology to serve their clients better with electronic document transfer, internet web pages, video conferencing, and 24-hour phone services (Taylor and Smith 1999).

Most of the telecommunication networks are handled by private TNCs (Graham 1997a; Graham and Marvin 2001), these companies selectively serve markets as part of their profit-making strategy. As a result, telecommunications and fast transport infrastructures is not evenly distributed in global cities. They link nodes and city centers together into networks, whilst excluding much of the peripheral spaces. They link global cities into a single virtual marketplace. Cambridge-London and Stockholm-Uppsala corridors and Randstad Holland are examples (Graham 1999; Graham and Marvin 2001). The privatization of telecommunication companies also support the “fortress effect”, or the commercial gated community appearance of many postmodern buildings (Graham 1997b). Telecommunications also bring efficiency to transport networks. Global cities are nodal locations for the largest airports in their regions (Moulaert, et al. 1995); airports have become gateways for the transnational business travelers. In parallel airports are also developed as “abstract spaces”. Thus, telecommunications reinforce the character of global cities as important nodes in the global economy and efficient locational choices for APS firms (Thrift 1996).

Telecommunications networks are actually invisible except for construction stage. Since demonstrating that cities have technological capability to house global operations is an important marketing strategy, efforts have been made to increase the visibility of telecommunications in cities. Large satellite dishes are located near buildings just for cosmetic reasons (Doel and Hubbard 2002). The most challenging part of construction of telecommunications infrastructure in global cities is termed as the "last mile" problem. Getting satellite installations, optic-fibre cables under streets and sidewalks constitute a major construction problem and it is a very expensive operation (Graham 1997b; Graham and Marvin 2001). Buildings that bring together all the high-tech equipment in the construction stage necessary for their occupants become the top choices for global companies.

Producer services have a dependency on built environment. For example, in older times in London, developers used to put up offices for financial institutions, and these institutions were easily moving in and out of those buildings for speculative reasons. Today, requirements of banks have become too specialized and major financial companies design their own buildings with large trading floors and technological capability to handle huge amounts of electronic transactions everyday (Keeble and Nachum 2001).

The above discussion has demonstrated that APS have specific characteristics: most importantly they need to have close relations with associated companies and specialized services for their knowledge base, a high level of accessibility (international airport, junctions of motorways and railways, sophisticated communication facilities), access to a large and diversified labor market, and a wide range of cultural, educational, and consumer facilities (Graham 1997b). The next section will focus on how these specific characteristics of APS industry affecting their locational strategies.

**2.2.1.2 Locational Demands of APS Firms: Agglomeration and Clustering**

Hitz et al (1994, 173) and Keeble and Nachum (2001) determine that general assets generating agglomeration in global cities are transport and communication infrastructure, physical environment, business climate and entrepreneurship resulting in knowledge spillovers, access to labor markets, political and social dynamics, educational system, and cultural and scientific life. The discussion in the previous section has shown us that these are also the important characteristics that APS firms depend on. Thus, APS firms need to be located in dense concentration in global cities to benefit from economies of agglomeration.

Economies of agglomeration is a concept that indicates the average cost savings as a result of more production occurring in a specified geographical area. It might be defined in the intra-firm (internal scale economies) and inter-firm levels (external scale economies). Advantages brought by inter-firm agglomeration are called economies of localization if the context is locational advantages between firms in the same industry. If the context is all industries located in an urban area, it is called economies of urbanization (Anas, et al. 1998). In agglomeration economies, firms are able to share some of their external expenses with other firms in the same locational cluster (Keeble and Nachum 2001).

Porter (1998, 1; 2000, 15) defines clusters as geographic concentrations of interconnected companies and institutions in a particular field that compete but also corporate. Feser's (Feser and Luger 2003, 13) cluster definition focuses on inter-firm linkages and various aspects of common behaviour. Clustering enables producer service establishments to realize labor market economies, minimize transaction costs associated with the production and exchange of their services, and facilitate the exchange of knowledge and information (Nelson 2005, 332). Clusters are more than single industries; they might include suppliers of specialized inputs, providers of specialized infrastructure, governmental organizations, or firms (Porter 1998, 2000). Cluster has become an important unit of analysis in urban geography because this unit of analysis is the best fit to the nature of competition and governmental policies. Clusters have a broader definition than traditional industry agglomerations and they capture important relations in terms of skills, information, marketing, and technology (Porter 2000, 18). Proximity is important in clusters because it reduces the formal and informal costs of matching demand and supply of adequate labor and costs of workers moving between firms in the same area; proximity also enhances competition by increasing peer pressure on employees (Kloosterman and Lambregts 2001, 722)

Maoh and Kanaroglu (2006, 29) demonstrate that where firms locate and eventually cluster give rise to the way commercial and industrial land uses are organized over space, which in turn defines the shape of urban form. Keeble and Nachum (2001) demonstrate that clustering pattern is more evident in globally oriented APS firms located in global cities like London, New York, and Tokyo. Beaverstock et al (1999a, 449) argue that high concentration of APS functions in these cities can be explained by the collection of several factors including potential customers, corporate headquarters of manufacturing and service firms, government departments, non-governmental organizations, and foreign firms.

Porter (1998,4) argues that as global competition decreases traditional comparative advantages and exposes companies to the best rivals from around the world, a growing number of transnational companies are shifting their home bases to more dynamic clusters. APS firms operating only in national or local levels have a more dispersed pattern. Globalization indicates that increasing number of transnational APS firms (APS TNCs) are serving overseas markets, they are foreign-owned, they developed global and local networks with other APS firms and they recruit their staff internationally. For APS TNCs location in a central area of a global city offers important advantages in terms of international air, rail, and telecommunications networks and gives them access to global knowledge (Keeble and Nachum 2001, 12).

Locational pattern of many service firms are often less spatially concentrated than for APS firms. For APS firms, large concentrations of private and public service clients remain important locational attractions (Moulaert, et al. 1995, 107). Face to face, tacit knowledge is a key factor in explaining spatial clustering of APS firms. Firms located in the same cluster can observe their competitors and market trends, they can develop more innovative solutions (Moulaert and Djellal 1995, 107), thus they become part of a "collective learning process" (Keeble and Nachum 2001). Ihlanfeldt (1995) argues that face-to face interaction of APS firms creates "communication economies". Communication economies are related to technological change and they create a unique environment in which "exchange of ideas, augmentation of human capital, and diffusion of technology come from formal and informal face-to-face interactions" (Ihlanfeldt 1995, 129).

Another benefit of clustering is access to skilled labor. When located in clusters, flow of professionals and embodied expertise through the local labor market becomes easier (Todtling, et al. 2006, 1037). Manhattan is the earliest example of this, even after the World Trade Center attacks it is still “the place” for employees of the transnational service sector. After the attacks, Manhattan offices of the Goldman Sachs Company were destroyed and Goldman Sachs wanted to move their office complex to an already existing tower in New Jersey. However, employees resisted wanting to stay in Manhattan, they did not want to loose their location on the hot-spot of global business. In the end, Goldman Sachs has commissioned a $1.8 billion new headquarters near Ground Zero (Economist 2006; Russell 2004).

There is a growing evidence that the rise of multi-locational APS firms corresponds to a multi-dimensional spatial logic, involving intra-and inter-urban as well as intra-regional considerations (Moulaert and Gallouj 1995, 150). Several factors that affect intra-urban agglomeration of APS firms are the quantity, quality, and price of office space, the communications infrastructure and its accessibility, the socio-cultural environment, the proximity to and the interface with complimentary services (Moulaert and Gallouj 1995, 151).

APS firms depend on information and knowledge as key ingredients for their production and they benefit from economies of localization by being in places where there is an ample supply of highly trained specialists and moderately skilled workers, suppliers, and customers (Anas, et al. 1998; Nelson 2005, 332). APS firms also benefit from economies of urbanization in global cities because by being nodes in global economy, these cities provide a fertile environment in terms of cross-industry linkages and flow of information (Anas, et al. 1998; Castells 1996; Sassen 2001b).

Telecommunication requires massive investments and offer significant economies of scale due to high fixed costs and low marginal costs. The main source of demand for telecommunications comes from information-intensive APS industries located in cores of large metropolitan areas. Thus, development of specialized telecommunications networks and firms that benefit from these networks has been concentrated in core areas of large cities, resulting in centralization (Castells 1989; Moulaert and Schachar 1995). Telecommunications development has become an important city marketing strategy (Taylor and Smith 1999, 1861), they provide strong competitive advantages to cities and regions (Short, et al. 1996, 707). Construction of new "urban quarters" designed to provide knowledge-rich entrepreneurs and APS firms with living, work, and entertainment space has become crucial strategies for place promotion. London's Canary Wharf, New York's Battery Park, Paris's La Defense, which are all large agglomerations of APS firms, are examples to this strategy (Daniels and Bobe 1995; Moulaert and Shachar 1995).

Metropolitan areas are the nodes on telecommunication highways that are essential to the operation of the international service economy (Hitz, et al. 1994, 172). Globally connected cities are articulated with innovative architectural and urban design strategies. Fortress like office buildings are one form of these strategies (Daniels and Bobe 1995). Graham (1997a) mentions the myth, which says that as a result of advanced technology, cities will disappear. Urban functions will decentralize in a world where all information will be available to all places and all people. However, Graham (1997a) argues that telecommunications only help the work patterns in cities to become more flexible. They bring together the advantages of the large metropolis. Telecommunications help the development of urban regions rather than traditional compact cities; they provide the advantage of remote control. Information running between electronic networks create the need for face to face interaction for interpretation of this information, which is handled in the command centers of APS firms (Graham 1997a).

To summarize, we can say that the need for face to face contact, proximity to skilled labor pool, the dependency on sophisticated infrastructure in their operations resulted in APS firms to be located in clusters. In traditional monocentric cities, this clustering was taking place in core areas of cities, called central business districts (CBDs). However, as suburbanization became an important trend for people and businesses, there is an increased tendency of APS firms to locate their offices in areas outside of CBDs to cut back from land costs, to be closer to their employees, and to take advantage of the highway transportation (Sasaki 1990). The tendency to be closer to airports and the efficiency brought by advanced telecommunications and transport technologies also supported this decentralization of APS firms (Castells 1989). This new trend is giving way to the development of polycentric metropolitan areas.

### 2.2.2. From Monocentric City to Polycentric Metropolis

This section of the literature review will explain the polycentric metropolitan area concept as a global trend. In doing this, the discussion derives from the locational strategies of APS firms and it engages with the concepts of "Informational City"(Castells 1989) and "polycentric metropolitan areas" (Hall 2001; Hall and Pain 2006b; Scott, et al. 2001).

#### 2.2.2.1 Departure from Monocentric City: Informational City

Anas et al. (1998) argue that at least for two centuries world's cities have been growing and spreading out. However, in the recent decades this process of decentralization has taken a more polycentric form with a number of concentrated employment centers affecting the distribution of both employment and population (Anas, et al. 1998, 1426). The polycentric city concept is a major deviation from the monocentric city model that was influential in explaining the urban structure for two decades since its formulation by William Alonso in 1964 (Anas, et al. 1998, 1434).

Alonso's monocentric city model builds on von Thunen's model of agricultural land use, which suggested that distance from the market would determine the agricultural land use (Johnston, et al. 1994, 672). Johnston et al. (1994, 13) explains the key components of Alonso's monocentric city model as accessibility and its relationship to the transport costs. The simplest form of the model assumes that all journeys from residential to non-residential areas focus on the city center. CBDs have the highest land rents. The land rent decreases as one moves away from CBD. Thus, the further the households live from the city center; they will be able to spend less on land and property, but more on commuting to CBD. Industrial and commercial uses benefit more from central city location than residential use because they achieve large profit margins by being close to their suppliers and customers (Johnston, et al. 1994, 13).

Monocentric model became eroded between 1925 and 1960s. Suburban train stations and trucking has changed the dependency of city economies on the monocentric model. Massive automobile ownership around the world has brought freedom to housing and business locations (Kloosterman and Musterd 2001, 625), resulting in suburbanization of employment and population. First the manufacturing activities moved out of central cities then, population follows to ran away from deteriorating inner city housing, negative neighborhood externalities associated with poor neighborhoods, and racial preferences (Anas, et al. 1998). Retail and services followed people (O'Sullivan 2000). As will be discussed later in Chapter 5, in the US, the magnitude of suburbanization was the highest starting from 1950s. Among Europe and North America, Europe experienced suburbanization much slower. Being much older, Europe's cities started as medieval towns. There is a greater mixture of residences and businesses in the core. Apartment buildings in central cities are more common and public transportation is much more important. However, after 1970s, there has been massive suburbanization and development of subcenters in Europe as well (Anas, et al. 1998).

Suburbanization results in the decentralization of economic and residential activity. Small and medium businesses including retailing agglomerates in locations close to their markets, forming "subcenters" (Anas, et al. 1998), resulting in a polycentric urban structure (Hartshorn and Muller 1989). In recent years, following suburbanization, there has been another significant spatial pattern evolving in urban areas of North America, Europe, and Eastern Asia (Hall and Pain 2006a; Kloosterman and Musterd 2001). Kloosterman and Musterd (2001, 625) explain this as a result of handling of information and production of services replacing manufacturing as the dominant urban economic activity. This shift resulting from the complex restructuring of global economy has made APS firms the key agents of the new global economy. As explained previously, these firms benefit from clustering. (Sassen 1991, 2001b; Taylor 2004). Thus, in the discussions on the polycentric metropolis, the locational strategies of these firms and how they contribute to the polycentric metropolitan area formation are important topics because strong agglomeration needs of these firms introduce a contrary logic to decentralization.

In his influential book “The Informational City”, Manuel Castells (1989) offers a fundamental analysis of how the improvements in information, communication, and transport technologies affected the locational strategies of APS firms and enabled the development of new polycentric urban structure in global cities. Analysis of Castells (1989) reveals that CBDs still have the largest concentrations of APS firms. Castells (1989, 151) demonstrates that the reasons for agglomeration of APS industry in CBDs are importance of face to face contact, existence of a business social milieu with a unique culture, prestigious location, existing office stock, available ancillary services.

Castells (1989) demonstrates that none of these agglomeration factors are new. What is new is that through telecommunications technology, these firms can have remote control access to larger markets located anywhere in the world. Since these companies are highly dependent on advanced telecommunications and benefit from agglomeration economies, CBDs also have the most sophisticated information and communications infrastructure and highest concentration of office buildings equipped with this high-tech infrastructure. This is a two-way process. The more centralized the infrastructure is in CBDs, the more APS firms are attracted to these places. Manhattan might be the best example for that. In Manhattan, in 1958, 35 percent of the jobs were information-intensive industries. In 1982, the rate has increased to 54 percent (Castells 1989, 149). Today, Manhattan is full of “Internet-ready” real estate. The New York Information

Technology Center, a thirty-storey, 400,000 square feet building, sells itself as Manhattan's hottest wired building and the ultimate global connector (Graham and Marvin 2001, 332).

Besides the agglomeration of information-intensive advanced producer services in central areas of global cities, Castells (1989, 153) also demonstrates there is another trend that shapes contemporary urban structure. This process is decentralization of service activities over locations within major metropolitan areas, which is also stimulated by information technologies. In terms of decentralization in metropolitan areas, a new suburbanization, which is purely business led than residential, is taking place (Castells, 1989). This new suburbanization is based on the formation of relatively dense business and commercial subcenters, changing metropolitan areas into a multi-centered organization. This suburbanization movement also transforms the built environment of office space that accelerated towards 1980s (Castells 1989, 156). For example in Manhattan, between 1982 and 1985, 23 million square feet of office space was added, but in the same time frame, Manhattan's office space share in the whole metropolitan area fell from 67 percent to 60 percent. In Los Angeles, in the same time frame, downtown share of newly constructed office space fell from 60 percent to 34 percent (Castells 1989, 156).

Castells (1989) argues that these new suburban office buildings have a different character than the office buildings in CBDs. They might be low-rise, or in major sub-centers there are high-rise buildings surrounded by large parking lots located in a more dispersed pattern. This new geography of commercial buildings is made possible as a result of the developments in the freeway system. For Castells (1989, 158) this decentralization is a hierarchical arrangement. The command and control functions and headquarters still remain in the most central areas like CBDs or major subcenters. Divisional branches prioritize regional operations, thus they can be located in CBDs or in suburban locations close to airports. The peripheral locations houses routine operations and back office spaces that need to maintain their connections with central locations, which is only possible through telecommunications (Castells 1989).

For APS firms, selecting non-CBD location as the main office location depends on various factors: lower land prices and office rents, being more accessible to their workers, and most importantly search for specific labor force including highly-educated women who need more flexible working hours due to their home-making priorities. Castells (1989) gives the example that in San Francisco Bay area, insurance companies highly decentralize to suburbs in spite of the advantages of CBD due to low quality of labor force in the CBD (Castells 1989, 162). Electronic communications technology also gave rise to telecommuting of workers, who are working from their homes and commuting to offices very infrequently (Anas, et al. 1998; Castells 1989, 165).

Castells (1989) main argument is that as a result of new technological developments, a new type of city is emerging which is called the “Informational City”. This new city is mostly emerging in the context of global cities and it is highly characterized by decentralization of business activity, specifically APS firms. Thus, this new urban model is a major deviation from the monocentric model. Decentralization is not completely scattered and distribution of business activity is not functionally undifferentiated. Instead, it is based on formation of subcenters, which are specialized in back-office spaces or branch offices. New directional centers are also making the corporate geography more complicated. Kloosterman an Musterd ( 2001, 626) demonstrate that

CBDs still matter for innovative activities based on face to face contact, however, they are not the only urban cluster of economic activity anymore. They became part of a wider spatial division of labor with other spatial clusterings that takes place near suburban junctions and important motorways. In "Informational City" what is emerging is a simultaneous process of centralization and decentralization of business activity (Castells 1989, 167).

As discussed previously, APS firms benefit from clustering. Thus, decentralization of APS firms does not result in a dispersed pattern, rather these firms cluster in several different locations in metropolitan areas. Keeble and Nachum (2001) identify this trend as selective reagglomeration or geographical clustering. There are many CBD like employment subcenters emerging in suburban areas. Subcenter is defined as an area with a significantly higher employment density than surrounding areas. A subcenter should also be large enough to have a substantial effect on the overall spatial structure of the urban area, leading to local rises in population density, land prices, and housing prices (McMillen and Smith 2003, 322). Subcenters are referred by different names by different authors. Hitz et al (1994) calls these new business district "outer cities" or "business satellites", Soja (1992) calls them "exopoles" and Garreau (1991) calls them edge cities.

In this thesis, we are interested in the locations of transnational advanced producer service firm clusters, which encompass only ten industries including accountancy, advertising and marketing, design consultancy, finance and banking, insurance, IT, law, logistics, management consultancy, and real estate. Thus, we have to introduce a separate terminology for clusters of APS firms in these industries. Clusters of firms in these industries will be referred to as "global business activity nodes". "Global business activity nodes" term is derived from "multifunctional activity centers" used by Hartshorn and Muller (1989) and Gordon and Richardson (1996), which is defined as areas of concentrated business activity that "possess increasingly well-defined labor markets, trade areas, and identities as social centers for their populations". They are suburban downtowns. The next section will explain characteristics of polycentric urban form in detail.

**2.2.2.2 Polycentric Metropolis**

Technological developments had a big impact on urban structure, changing monocentric city into a more dispersed form. Castells (1989) argues that this dispersal is not taking place freely; new economy and urban form are bounded to infrastructure availability and spatial proximity. In this section, we will define polycentric metropolitan area concept and identify its internal spatial logic. In doing this, this part of the literature review engages with the concepts of mega-city regions, megapolitans, intra-urban polycentricity, and functional classification of subcenters in polycentric metropolis.

**2.2.2.2.1 Defining Polycentricity in Different Levels**

Hall and Pain (2006a, 3) demonstrate that a new urban spatial structure, polycentric mega-city regions, is emerging in the most highly urbanized parts of the world through a long process of very extended decentralization from big central cities to smaller ones. This is a new urban form consisting of 10 to 50 physically separate, but functionally networked town and cities clustered around one or more larger cities. The economy of these areas is dependent on information-intensive service industry, mainly advanced producer services.

Champion (2001, 664) demonstrates that there are three ways in which a polycentric metropolis or region can emerge. The first one is the "The Centrifugal Mode". In a monocentric city, continuous growth may result in increasing land rents and accessibility problems to central city. As a result, production and service activities may move to alternative centers, which in time may rival the original CBD. Most of the former manufacturing belt cities are transformed in the contemporary era according to the centrifugal mode. The second way is "The Incorporation Mode". A growing urban center might incorporate smaller centers in the surrounding area. These incorporated centers later may attract population and businesses and secondary centers may emerge around them resulting in a polycentric urban area. The third way is "The Fusion Mode" in which several independent centers might develop linkages and merge. In all these models, strong economic networking between settlements is the key point. Dallas-Ft. Worth and Miami-Ft. Lauderdale metropolitan areas are good examples to polycentric developments formed as a fusion between two independent centers.

Fishman (1990) demonstrates by the end of 1980s, the suburb and central city division started to become obsolete. Growth corridors stretching 50-100 miles brought the end of the monocentric city (Fishman 1990) . These corridors usually ended with an international airport and they included high-tech infrastructure (Batten 1995). Fishman (1990) calls these corridor cities as "New Cities". Contemporary urban structure includes multiple corridor cities, in which cities are functionally interconnected. The best example is Randstad in the Netherlands. This new urban structure is multicentered. Batten (1995) calls the interlinked cities in one region as "network cities".

In identifying the anatomy of the polycentric mega-city regions, Hall et al. (2006) argue that as suburbanization became an important trend, the traditional city boundaries will not be sufficient to understand the new metropolitan geography. People living miles away from a city commute daily to their works and this creates a economically interlinked regions. To overcome this boundary problem in defining metropolitan areas, American urban analysts have come up with Metropolitan Statistical Area (MSA) concept (Hall, et al. 2006), which has 50,000 or more population nucleus concentrated in a county with a central city. Around this central core, there are adjacent suburban communities having a high degree of social and economic integration with that core (U.S. Census Bureau 2000c). European geographers translated the (MSA) concept as functional urban regions (FUR) that has a core defined in terms of employment and density and a ring around the core defined in terms of daily commuting patterns to the core. Contiguous FURs make up mega-city regions (MCRs). MCR concept in Europe also derives from Combined Statistical Metropolitan Area (CMSA) concept in the US (Hall, et al. 2006), which is a grouping of contiguous metropolitan and micropolitan statistical areas according to a certain population criteria (1 million or more) (U.S. Census Bureau 2000a).

European geographers identified eight MCRs: South East England with London being the center, The Randstad in the Netherlands encompassing Amsterdam, The Hague, Rotterdam, and Utrecht, Central Belgium with Brussels as the center, Rhine Ruhr region, The Rhine-Main Region in Germany with Frankfurt as the center, the EMR of Switzerland running between Zurich and Basel, the Paris Region, and Greater Dublin.

American geographers also responded to the MCR concept by identifying ten megapolitan areas. The megapolitan studies are started in Metropolitan Institute of Virginia Tech. Megapolitan area is basically a large region with metropolitan and micropolitan areas that are interconnected physically through transportation networks and constitute a functionally interdependent urban network.

Other specifications in the definition are that megapolitan area combines at least two or more existing metropolitan areas; derives from contiguous metropolitan and micropolitan areas, will have 10,000,000 or more residents by 2040; and constitutes a distinctive cultural and historical identity. These megapolitans encompass only 20% of the US land area, but they have 67% of the total US population, meaning that they have the highest density areas. The basic unit of megapolitans is counties. Megapolitan regions evolve as the spillover of the vastly expanding major metropolitan areas (Lang and Dhavale 2005; Lang and Nelson 2006). As the metropolitan area boundaries is pushed further out, the formation of mega-city regions become inevitable. Major metropolitan areas also have a polycentric structure in themselves in terms of concentration of business activity. These megapolitans include nation's largest and most important metropolitan areas and they define a larger territory than consolidated statistical metropolitan areas. The international airports are located in these regions. Thus, megapolitans are the gateways to the global economy (Lang and Dhavale 2005; Lang and Nelson 2006).

Carbonell and Yaro (2005, 3) demonstrate that between now and 2050, more than half of the US population growth and two thirds of its economic growth will occur in these megapolitan regions. Megapolitans are expected to become the new CMSA definitions of the US Census Bureau by 2010. There are 10 megapolitan regions identified by Lang and Dhavale (2005) with their major metropolitan areas: Northeast with Boston, New York and Washington DC as their major metro areas; Midwest with Chicago, Detroit and Pittsburgh; Gulf Coast with Houston and New Orleans; Piedmont with Atlanta and Charlotte; NorCal with San Francisco; Southland with Los Angeles and Las Vegas; Valley of the Sun with Phoenix; Cascadia with Seattle and Portland; Peninsula with Miami and Tampa; and I-35 Corridor with Dallas and Kansas City.

The core economic competencies of megapolitans identified by Lang (2005) demonstrate that these megapolitan areas mainly specialize in service sector and high-tech employment. Northeast specializes in finance, Piedmont in banking, Southland in entertainment, and Peninsula specializes in tourism. Cascadia, Gulf Coast, I-35 corridor, Nor Cal specialize in high-tech manufacturing, energy, and aerospace industry. Among the megapolitans Midwest is the only one that is dependent on manufacturing (Lang and Dhavale 2005). The major centers of these megapolitans are in cooperation with each other. More investment is being made in high-speed rail, broadband communications, and other infrastructure to establish stronger transport and economic linkages among the major centers of megapolitan regions. The government is developing tools such as the Transportation Infrastructure Innovation Act (TIFIA) to establish stronger connectivity between these regions (Carbonell and Yaro 2005).

From the definitions of MCRs and megapolitans vs FURs and metropolitan areas, we can derive that polycentricity can be defined at two levels: regional and intra-urban (metropolitan) (Kloosterman and Musterd 2001). Regional polycentricity was first captured in Gottmann's seminal work "Megalopolis" (Gottmann 1961) and today it continues with MCRs and megapolitans. Gottmann (1961) identified that in the Northeastern Atlantic seaboard of the United States a new urban structure is emerging. In 1960s, urban landscape between Boston and

Washington DC was comprised of continuous built up areas of manufacturing plants, residential communities, old urban centers, and new suburbs connected with traffic arteries (Gottmann 1961, 5). This tightly interwoven system transcended state boundaries and encompassed many different regions with 37 million people (Gottmann 1961, 7). Decentralization in US metropolis has continued after 1960s. Today American metropolis is characterized by a massive spurt of city building and the evolution of dispersed, polycentric spatial structure (Lang and Knox 2007, 5).

Graham (1997b, 23) argues that advanced telematics linkages tend to facilitate the development of polycentric urban regions through their support for extended complexity. He further suggests that with their polycentric constellations of centers, distributed across large areas, such urban regions are becoming the norm. Polycentric MCRs, CMSAs, and megapolitans define very large geographic areas and they are formed with coming together of FURs in Europe and metropolitan and micropolitan statistical areas in the US, which are also polycentric and include smaller cities and towns. We define intra-urban polycentricity at the MSA level in the context of this thesis. For example, Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Statistical Area is a part of Baltimore-Washington Consolidated Metropolitan Statistical Area in census definition. The CMSA is divided into three metropolitan divisions including Bethesda-Gaithersburg-Frederick, MD Metropolitan Division, Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Division, and Baltimore-Towson, MD MSA. Each metropolitan area is divided into counties and cities are located under counties. Washington DC, Arlington. Alexandria, Bethesda, Tyson's Corner, Baltimore are all considered as cities in this CMSA. According to the definition of Metropolitan Institute of Virginia Tech Washington-Arlington-

Alexandria, DC-VA-MD-WV Metropolitan Statistical Area is a part of Northeast megapolitan region that includes Boston, New York, and Washington its major core cities. In this case, the megapolitan includes the CMSAs. As stated by the Metropolitan Institute, megapolitans are seen as the future definitions of CMSAs. As a conclusion, in this thesis, polycentric metropolis is defined as a metropolitan area including suburbs and commuting hinterland with wide-spread observations of employment sub-centers rivaling the CBD in size (Champion 2001, 663).

#### 2.2.2.2.2. Internal Spatial Logic of Polycentric Metropolitan Areas

Peter Hall (2001, 72; Hall and Pain 2006a) argues that if global cities are defined through external linkages, polycentric global-city regions should be defined in terms of their corresponding internal linkages. These internal linkages are formed with regular commuting of people to their jobs and infrequent business meetings. Face to face contact is important in these internal linkages because professionals need to come together to interpret and exchange information (Hall and Pain 2006a). These meeting places do not have to be in CBDs anymore, they can be scattered. Professionals can meet in suburban offices, or in airport and hotel lounges specifically designed for business meetings. Time-distance constraints are the most important factors in defining the new nodes of global business activity in metropolitan areas (Hall and Pain 2006a; Kloosterman and Lambregts 2001).

In literature, several scholars examined the internal spatial structure of the polycentric metropolitan areas. Hartshorn and Muller (1989) focused on Atlanta, Hitz et al. (1994) examined Zurich, Keil and Ronneberger (1994) described Frankfurt, Gordon and Richardson (1986) explored Frankfurt, and O’hUallachain and Leslie (2007) looked into Phoenix’s development.

Most of these articles focused on subcenter formation through examining employment densities and clustering of service firms.

In Castell's "Informational City", intra-urban polycentricity is seen as clustering of economic activity in suburban centers as well as central business districts. Castells (1989) argue that centralized clusters in metropolitan areas are distinguished according to a functional hierarchy. Hall (2001) describes the resultant urban structure as polycentric and complex. Traditional CBD based on walking distance is still important for old-established informational services like banking and finance, but it is also being supplemented by a secondary CBD and other nodes. Peter Hall (2001) identifies six common types of nodes in the polycentric metropolitan form: traditional downtown centers, newer business centers developing in an old prestigious residential quarter such as Midtown Manhattan, internal edge cities developing in nearby old industrial or warehouse districts such as New York's World Trade Center and Docklands in London, external edge cities located near transportation routes and nodes like airports, outermost edge cities for back office and R&D operations, and specialized sub centers for education, entertainment, and convention activities. In Hall's classification secondary business centers and internal edge cities are carrying the same functions and facilities like CBD. Established businesses remain in CBD, but new companies tend to locate in more recent business districts. Outermost edge cities handle routine operations. Castell's definition of intra-urban polycentricity is more like CBD vs. non-CBD according to APS locations. Thus, Hall (2001) elaborates Castell's intra-urban polycentricity definition by introducing other categories of business nodes that create the polycentric metropolis.

Traditional downtown centers, newer business districts, and internal edge cities are located close to each other within 3 or 4 miles distances. They are connected to each other with high-quality urban public transport such as PATH train linking New Jersey to World Trade Center. Outermost edge city locations extend beyond 20 miles or more from central cities and they are still considered as a functional part of the polycentric metropolis (Hall and Pain 2006a). This polycentric structure of the major metropolitan areas also suggests that these areas have the nations' most important enclaves of splintering urbanism such as logistics zones, back office enclaves, technopoles, and enclaves of international banking, finance, and business services with high-rise office complexes. These enclaves connect the urban economy to global economy (Graham and Marvin 2001).

Graham (1999, 934) argues that there are limits on how far the decentralization of higher-level services can currently go in the polycentric metropolitan areas. CBDs are still in demands for information-intensive APS firms. This is evident through a recent physical restructuring process in CBDs, caused by the new corporate financial architectures with large dealer floors that can accommodate modern electronic systems. By designing buildings with larger footplates for large financial firms the need for face to face contact is tried to be offset. However, financial firms cannot go very far from cores of global cities, they are dependent on the social and cultural environment of CBDs, so even if they move they will be clustered in a subcenter close to CBD. For example, we might see financial firms moving out from Wall Street to a “doughnut ring” around the edge of Manhattan (Longcore and Rees 1996 in Graham 1999, 934). Hitz et al. (1994, 177) argues that firm can optimize their locations within a metropolis by minimizing the costs for rent, transportation, and telecommunications, and by maximizing the efficiency of their spatial structure. They can locate back offices in areas or establish new administrative centers in areas with lower land value. Kloosterman and Lambregts (2001, 723) also argue that infrequent contacts may be maintained over large distances, however to create a viable environment distances from CBDs may increase up to a certain level.

Keil and Ronneberger (1994, 138) conclude that today cities are multicentered, nodal, flexible, and global. Multiple centers result from the global division of labor in the city, nodality results from the hierarchical networking of these different centers, flexibilization refers to the shift from Fordist to Post-Fordist mode of production in the economy, and global explains the connectivity to the global economy. Centralization and decentralization, and concentration and deconcentration, must not be seen as antagonistic poles but as different aspects of one complex regional growth process. What might look like disurbanization from central perspective is, in fact a dramatic increase in density anywhere else in the region (Keil and Ronneberger 1994, 146).

Talking about Frankfurt's development Keil and Ronneberger (1994) demonstrate that commercial and office developments lead to a distinct decentralized reconcentration on the urban periphery. This microgeographic shift from the core to the periphery that occurred has much to do with the locational decisions of the transnational firms which make the urban peripheries the growth centers of the most dynamic industries (Keil and Ronneberger 1994, 142). In Frankfurt, the continued dominance of downtown economy can be seen in the ongoing construction of new office buildings (Keil and Ronneberger 1994, 144). With the growing significance of the airport and other subcenters, real estate markets became more nodal in Frankfurt. The airport and other subcenters became the measure for land use and land prices in the urban agglomeration (Keil and

Ronneberger 1994, 149). Hitz et al. (1994) demonstrate a similar process in Zurich, where emergence of new peripheral business districts gave way to a polycentric city. In the case of Zurich, instead of forming a high-rise inner city skyline, the global economy shifted the growth outwards to peripheral locations.

Today as architects and planners talk about the global city space, discussions seem to converge on specific building types and land uses including high-rise office buildings, waterfront developments, “packaged landscapes”, and fast modes of transportation between these nodes to create efficient access (Beauregard 1991b; Graham and Marvin 2001; Knox 1995; Sassen 2001b). In order to function efficiently and effectively, global flows insert physical channels into cities. These are the “transnational social spaces” that could be found anywhere in the world and thus must have consequences for the senses of space of those who use them (Sklair 2006, 22) . These channels start from transportation hubs like airports, continue with highways, underground, or railroad transportation that leads to centralized areas, which can easily be identified with high-rise office buildings, corporate chain hotels, water-front developments, luxury loft apartments, international chain restaurants, and shopping centers with brand-name stores from all over the world (Graham and Marvin 2001). This is the space where each city is exhibiting its economic and cultural power through glamorous design of its built environment (Newman and Thornley 2005).

Similar to Frankfurt, in the US, as metropolitan areas expanded, construction of buildings that cater to the service economy and global business elites also increased (Scott, et al. 2001). Between 1980 and 1990, a construction boom took place in the US. The new construction was not confined to traditional centers; rather it had a polycentric pattern (Scott, et al. 2001). Beauregard (1991b, 91) captures this process in the built environment as "the high-density central city with its low-density residential suburban ring has been replaced by a multimodal, sprawling built environment with the central city less and less distinguishable from its competitive outer cities".

In this chapter we have seen how changes in global economy and improvements in information, communication, and transport technologies affected metropolitan areas. Monocentric city has been replaced with polycentric urban areas, in which advanced producer services are the key economic agents. Any change in urban structure is always reflected in the built environment. In this case, clustering of service firms in different subcenters resulted in increased densities in these areas, which enabled the development of high-rise office building clusters.

In development of subcenters, like in other parts of the capitalist city, business interests have been the priority (Fainstein 1994). Office buildings in these centers are speculative developments. The main aim of developers is to attract business elites and capital associated with this group for profit (Hall and Hubbard 1998; Kotler, et al. 2002; Philo and Kearns 1993). Thus, creating imaginative urban landscapes that are technologically advanced and that will cater to the demands and life styles of the business elite is the number one priority (Sklair 2006).

In terms of global cities, competition is fiercer because the flow of capital is higher generating higher profits. Thus, what we see in the development of global business activity nodes is flagship high-rise office projects commissioned to famous architects and developed by transnational development firms. Development and current trends of these commercial megastructures best explain the current character of the capitalist economy (Crilley 1993) and they will be discussed in the next section.

### 2.2.3 Architecture of Global Business Activity Nodes: High-Rise Office Buildings

The contemporary era has seen an intense episode of building higher. Due to advanced technology, the sky has really become the limit. With their sheer scales and sizes high-rise buildings are structures with economic and symbolic significance (Howeler 2003). Thus, in this era defined by global flows these buildings contribute to the image of cities as attractive nodes. The density of the human occupation afforded by high-rise buildings is an important element of the modern economy (Mc Neill 2005b, 43). According to McNeill (2002, 325) the attacks on World Trade Center in 2001 clarified the role of world cities as strategic nodes in the global economy and the importance of tall buildings to that economy.

As Domosh (1996) argues, high-rise office buildings were first developed as corporate icons, signifying the inter-firm rivalry in high-density cities like New York and Chicago. In this rivalry, height was the only determining factor; the tallest building symbolized the most powerful firm (King 2004). From the beginning, high-rise office buildings have been associated with corporate power and capitalist interests in cities with considerable economic and political regional influence. In the contemporary era tall office buildings are still important in the discussions over cities as sites of tacit and codified knowledge in the global economy (Amin and Thrift 2002; Mc Neill 2005b, 43). Cities compete for global flows of people and capital (Hall and Hubbard 1998). As discussed previously, state of the art building and infrastructure construction is an important tool in this competition (Graham and Marvin 2001). Due to multiple factors related to global flows, including agglomeration need of the global service sector (Castells 1996; Reszat 2002), specific life-style demands of the global elite (Sklair 2005, 2006), privatization of infrastructure provision (Graham and Marvin 2001), globalizing nature of architecture, engineering, and real-estate firms (Knox and Taylor 2005; Mc Neill 2005a; Olds 2001), and relaxation of planning controls by local governments to attract global businesses (Mc Neill 2002); the current tendency in major world cities is that high-rise building projects are undertaken by the same developers and design firms (Crilley 1993; Olds 2001) and they are created with the same vision: to claim attention in the world of global cities. Thus, in our contemporary global era, the race for individual corporate tall buildings to be the tallest has become a race between clusters of commercial high-rise buildings in world cities to be the most impressive.

#### 2.2.3.1 High-Rise Office Buildings as Corporate Icons

History of high-rise office buildings started in the USA, in two cities: Chicago and New York (Dupree 1996). High-rise office buildings initiated in Chicago around 1870s (Goldberger 1981) due to the fact that Chicago's rapid growth coincided with the development of critical new technologies (Abel 2003). The technological achievements developed in this early era enabled the construction of high-rise buildings including: the steel frame that displaced solid load bearing walls, (Abel 2003), the discovery of the Otis elevator in 1850s (Easterling 2003), and the phone (de Sola Pool 2004). Shortly after Chicago, tall buildings started to appear in New York City. Willis (1995, 7) identifies early tall buildings as "vernaculars of capitalism", meaning that this building type was less designed than evolved due to the specific demands of the economic system.

Differences between high-rise office buildings of Chicago and New York resulted from the different economic contexts of these two cities. Chicago was the center of American business, whereas New York was the center of international trade. Thus, Chicago's architects emphasized American culture and technological innovation with their designs (Willis 1995), whereas New York imported forms from Europe (Goldberger 1981) and they emphasized height (Willis 1995). Domosh (1996, 68) suggests that "New York's skyline was the result of technological achievements, increasing land values, and the requirements office space, but more importantly it served as a symbolic expression of the power of the New York's emerging merchant and entrepreneurial class". According to Domosh, New York's early skyline can be seen as an iconic representation of the social values and economic power of the city's upper and middle income classes (Lees 2001, 55).

#### 2.2.3.2 Contemporary Era: High-Rise Office Building Clusters as Global Icons

Mc Neill (2005b, 46) argues that high-rise buildings have "always played a role in the representational strategies of financial and political elites to endow their city or nation with a projected self-consciousness". According to Nobel (2006, 20) "the old formula high density plus high land values equals high buildings" is not a sufficient framework to explain the current boom in high-rise office building construction, meaning that the development of these buildings is an outcome of political and profit interests rather than a response to the urban dynamics. Tall buildings contribute to human networks by having skilled people in one spot (Russell 2004).

In the traditional land use theory, high-rise building construction is mostly attributed to the lack of available land, high rents, and increased population density. However, when we look at cities like London, Paris, and New York, we see that city governments designate some areas as redevelopment zones for high-rise office construction, and these areas are often developed with semi-private or fully private capital (Graham and Marvin 2001). These redevelopment efforts do not fully result from the office space need in the cities. They are actually powerful image construction projects, an enhanced scale of city promotion efforts (Zukin 1991). For example, when London's Canary Wharf was built in 1990s, most of its office spaces remained empty; the project was considered as a failure. For the development of La Defense in Paris in 1980s, EPAD, the public authority actually had to enforce strict guidelines in terms of available office space and workforce density, to ensure the high-rise development (Sutcliffe 1993). The formation of skyline in these prominent world cities are not spontaneous, they are intentionally created. Thus, high-rise office clusters in global cities result from zoning regulations as well as changes in laws governing urban estate, and they are critical elements of economic strategies intended to pull buildings away from urban centers to outlying areas (Dupree 1996).

As cities seek to capture global markets, there is enhanced competition between major cities of the world in terms of rising in the hierarchical global urban network. This competition is reflected in city governments promoting their cities through urban boosterism or city marketing activities, which is best demonstrated in the infrastructure creation and design of iconic buildings (Sklair 2006) . Reszat (2002) mentions that although cities compete by building infrastructure and enhancing amenities for their central business districts, whether or not these huge sums of investment really make a difference in the long term remains an open question. According to

Reszat (2002) part of the answer lies in examining the way those places are used, managed, and created.

Olds (2001) mentions that more and more TNCs are including real estate in their investment portfolios, thus alone or together with the states, they have played a crucial role in the development of mega urban projects. TNCs develop property, including high-rise office buildings, in both foreign and domestic markets that have growth potential. The scales of these investments are huge. Olds gives the example that in 1994, the New World Development Company invested in China for the development of property totaling 214 million square feet. Transnational firms also provide background support for these mega urban developments, including market analysis and the development of corporate property strategies. Jones Lang LaSalle, DTZ, and CB Richard Ellis are examples of such TNCs (Olds 2001). Through the speculative nature of their transactions, TNCs dealing with real estate, promote high land prices and rental returns. Thus, activities on land conform to the highest-value rather than the best-one. Through the operations of TNCs in the real estate market, urbanization processes in different parts of the world are becoming more and more interdependent (Olds 2001).

This interdependency is evident through a homogenized landscape of high-rise office buildings or other mega-urban projects built in different parts of the world. In this regard, Crilley (1993) offers a very useful analysis of the Canary Wharf in London (completed in 1990s) and New York's World Financial Center (WFC) (completed in 1980s). Both contain tall office buildings and they are developed by the same firm: Canadian Olympia and York (O&Y). Both developments are speculative in nature arising from governmental policies to increase the office space in cities, and both are designed by a group of international architects. In New York, O&Y benefited from a high tax break; in London, Canary Wharf was declared as an Enterprise Zone, allowing little governmental control on the whole development. For quite a while, Canary Wharf was troubled with vacancies. In this regard, Crilley (1993) mentions that, at that time it were possible for O&Y to shift some of its profits from WFC, to the Canary Wharf project (Crilley 1993, 127-139).

The small number of elite architecture, planning, and construction firms that aspire for prestigious commissions in world cities, mostly undertake the flagship developments. Firms established by architects like Norman Foster, Cesar Pelli, Jean Nouvel, Richard Rogers, Santiago Calatrava, and Rem Koolhaas, as well as SOM and Arup Associates are examples of these firms (Olds 2001, 143). Knox and Taylor (2005, 4-5) demonstrate that design and engineering companies follow their clients. For example, the U.S. Company EDAW has stated that its location strategy is a direct response to the global nature of their clients' business. These companies also emphasize that they offer the same standards worldwide in their service with the help of information technology.  EDAW claims to be a "firm without walls" because its offices work together as a seamless whole. For HOK Group, sophisticated technology allows its employees to work as one virtual office.

In order to maximize the security and reliability of electronic information networks that handle large amounts of important data transfer, developments in global city cores, including high-rise office buildings, are provided with their own private high-quality infrastructure built by global telecommunication firms. These high-quality telecommunication networks connect selected group of users and complexes worldwide and bypass others (Graham and Marvin 2001). In this regard, Graham and Marvin (2001, 323) mention the "artificial platform cities" designed by Obayashi real estate firm in Tokyo as an example, which is a high-rise mega-urban project based on raised platforms that support both infrastructure and high-rise mixed use buildings.

Today, Asia is the leading region in terms of the highest buildings. Asia has 538 of the highest 1000 buildings of the world, North America has 357 of them, and Europe has 57 (Emporis 2007). Most of these highest buildings in Asia are designed by European or North American firms such as SOM (Burj Dubai in Dubai), Foster and Partners (HSBC Building in Shanghai), and Cesar Pelli & Associates (Petronas Towers in Kuala Lumpur).

Political leaders of global cities who would like to leave their imprint on urban landscape and attract global flows to their cities are also engaged in a competition through built environment. In this regard, high-rise office building projects are proven to be powerful tools (McNeill 2002). Prime minister Mahathir Mohamad's support in the construction of Petronas Towers in Kula Lumpur, Mayor Ken Livingstone's desire to transform London's skyline with the Livingstone taste, or Sheikh Maktoum's vision to create Dubai as a "highway to the world" are examples (McNeill 2002; Molavi 2007, 100). Petronas Towers, currently world's second tallest buildings completed, after Taipei 101, has proven that politicians of Kula Lumpur can think in global standards, (Nobel 2006, 20). Livingstone has strong commitment to increasing London's office space through high-rises to make sure that competition from other cities such as Frankfurt, Paris, and Berlin will not pose a threat on London's status as the world's premium financial center (Mc Neill 2002).

The competition for height continues stronger than ever between developers of high-rise office buildings. The developers of Burj Tower in Dubai, which is currently the highest building in the world under construction, refused to reveal its height when they were first announcing the building (Krane 2005). Sustainable design of buildings is a growing trend. London is a prime example of that (Abel 2003, 54). Sustainable urban design is also a growing trend in urban design of global cities. In Europe, the tendency is to connect these high-density settlements with existing transportation nodes. London is demonstrating the most innovative example of urban design in terms of high-rise buildings. Mixed-use proposals for Elephant and Castle by Foster and Partners and London Bridge Tower by Renzo Piano utilize existing transportation nodes, encouraging Londoners to give up their cars (Abel 2003, 86-91; Russell 2004).

Asian mega-cities have very high population densities compared to other regions, thus high-rise living is both a necessity and a trend in Asian cities (Abel 2003; Heathcote 2005). As Abel (2003) points out, Hong Kong planners initiated infrastructure-led development in 1972. They built nine new towns, all planned to be self-sufficient with their residential, commercial, and social spaces and connected with mass transit systems to each other and to the center. This new planning initiative was successful. Singapore followed a similar “constellation cities” strategy by building 23 new towns that include high-rise residential areas. This kind of development also protects the open space between settlements, thus limiting urban sprawl (Abel 2003, 101-106; Russell 2004).

The globalizing nature of design and construction firms, desires of local governments to attract global flows, and life-style of the global elite have made tall office buildings important elements of the global economy. The firm that designs the most impressive building has a good chance of receiving other commissions in other world cities and the city that has the most impressive high-rise office quarter has a good chance of attracting more global flows. High-rise office buildings are "premium network spaces" that are combined through infrastructure networks (Graham and Marvin 2001). Less (2001, 53) mention that in a world of rapidly accelerating global flows, architecture is an important way of anchoring identities and constructing a material connection between people and places. Castells (1996, 450) define the architecture of the global era as "the architecture of nudity", which is so pure and neutral that it does not pretend to say anything. It is a challenge for star-architects of Western firms to design a building that will serve the spatial needs of the global economy, yet anchored in local culture.

## 2.3 TOWARDS A RESEARCH AGENDA

Emergence of polycentric metropolis is an outcome of advances in transport, communication, and information technologies. Global economic restructurings that depend on connectivity and APS firms as key agents accelerated the development of polycentric metropolitan areas. New global economy and its urban implications are complex. The shift from manufacturing to service industry changed the division of labor in cities. Advanced producer service firms utilize all aspects of advanced technology to keep their relations with their customers, suppliers, and competitors.

Technology made up for some of the complexities of the new global economy. Electronic communication systems connected agents all around the world. As Graham (1997b) argues advances in telecommunications made agglomeration more important for analyzing and interpreting information. Sassen (1995) argues that globalization needs more than computer screens to ground its operations and cities provide that space. Traditional CBDs of global cities became important locations for APS TNC clusters, meeting places and convention centers, global chain hotels and restaurants, and any other service demanded by global professional elite (Newman and Thornley 2005). This demand is also reflected in the building activity. High-rise office buildings equipped with the state of the art technology and designed by the most famous architects became landmarks of the global economy in global cities.

The discussions on polycentric metropolis have shown us that CBD is not the only center for intense business activity anymore. Technology allowed firms to be free of spatial constraints. As Nelson (2005) argues proximity started to be measured by time rather than distance. However, in case of APS firms, this does not mean random dispersal, rather it is a concentrated decentralization (Castells 1989). In his book "Informational City" Castells (1989) argues that new subcenters can be distinguished according to their functions and industry composition. Headquarters are still located in downtowns. Regional offices might be near airports, branch offices are clustered near their markets in suburbs, and back office spaces can be dispersed in peripheral locations. Concentration is much more important for transnational APS firms due to the information-intensive nature of their operations. Ihlanfeldt (1995, 139) concludes that "information exchange can occur more efficiently in dense urban environments." and higher-order offices such as corporate headquarters and APS firms need central location more than lower-order offices. Then, it becomes important for us to see where transnational APS firms choose to locate in global cities. Are they only clustered in downtowns or do they have a polycentric pattern? Have airports become strong attraction points of concentration? If these firms are distributed in a polycentric pattern then how are these centers located in relation to proximity to downtown and what is their industrial composition? These are all important questions to be answered in this research.

If APS firms cluster in certain areas in metropolitan space, then these areas become hot-spots for real estate investment. Then, clusters of high-rise office buildings developed after 1980s will be visible in these quarters. For high-rise building and APS TNC clusters we use Pivo's (1990) definition of a cluster. Pivo (1990, 459) defines cluster as two or more office buildings separated by one quarter mile or less, which is the maximum walking distance. Distance selection is based on the criteria that the concept of a cluster is intended to be a pedestrian-oriented unit of analysis. Concept of pedestrian-orientation is important for us. As argued by Reszat (2002) APS firms and their employees demand special cultural environments. Buildings are not enough for this. They need special meeting and entertainment facilities, which can only be in a close downtown like setting. Thus, we expect to see APS TNCs clustered in locations where there is clustering of high-rise office buildings in walking distance. Only then, we can say that these places will become incubators where global transnational culture will flourish and add to the character of the global cities they are located in.

For the geographic context of this study, we chose the ten largest office markets of the US, which are also the top global cities in the US identified by Taylor et al. (2002). These cities are:

Atlanta, Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York, San Francisco, and Washington DC. US provide an important context in terms of clustering of APS TNCs, or what we call global business activity nodes because suburbanization and decentralization of business activity has started much earlier in the US than Europe and Asia. In Europe and Asia, cities are traditionally compact whereas in the US, they have expanded in a more decentralized pattern. Thus, if we can show that even in such a context like US cities, APS TNCs cluster in certain areas and there are patterns to this clustering in terms of their functional, physical, and locational, characteristics; then we can reveal the growth anatomy of the new metropolis in the global era. Such research may also provide significant insight to the development of new transportation networks between global business activity nodes and identify hot-spot areas for commercial real estate.

Selection of cities and APS TNCs as well as cluster analysis are explained in detail in the methodology section. The historical and current characteristics of the decentralized US metropolis will be discussed in Chapter 5 together with the discussion of research findings in the studied metropolitan areas. The discussion will identify similarities and differences between locational distribution and characteristics of global business activity nodes and reveal the growth anatomy of the US metropolis.

# CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

This chapter focuses on the formulation of research design through a detailed review of decisions concerning the research methodology, including research questions, hypotheses development, general research strategy, case selection, data collection, and analysis.

## 3.1. RESEARCH QUESTIONS AND HYPOTHESES

The literature review has shown that globalization is playing a role in the formation of polycentric metropolitan areas. The definition of this new polycentric metropolitan form is two-fold. Polycentricity can be defined at the regional scale or it can be defined as the intra-urban polycentricity of metropolitan areas. In his influential book, The Informational City, Castells (1989) talks about globalization and new information and communication technologies that lead to decentralization inside metropolitan areas and the consequent formation of polycentric metropolises. Sassen (1995) talks about the emergence of different patterns of centrality in global cities according to regional contexts and she argues that further research is necessary in this topic.

The literature review has provided a context for the impact of globalization on the global urban network. Different aspects of metropolitan areas are changing, including metropolitan form and land use. Traditional downtown areas are no longer the dominant locations for all types of businesses. The emergence of edge cities and other business centers are the frontiers in analyzing growth patterns in metropolitan areas.

### 3.1.1. Research Questions

The main research question of this thesis is: "How are transnational advanced producer service firms organized in the polycentric US metropolis?" The literature review has outlined the key trends in terms of the relationship between globalization and metropolitan decentralization. In the analytic part, the aim is to explore the trends related to the intra-urban polycentric form of the large decentralized metropolitan areas of the U.S through the locational strategies of main agents of globalization: transnational advanced producer service firms. Locations with high-concentrations of transnational service firms are referred to as "global business activity nodes". Basically, the aim is to understand if these global business activity nodes demonstrate a polycentric pattern inside the selected metropolitan areas and the key aspects of this new polycentric pattern.

To address the main question, the analytic part of this research seeks to answer the following questions:

1- What are the centrality patterns of the advanced producer service clusters (global business activity nodes) in selected U.S. metropolitan areas with respect to their location[7], size[8], and industry composition[9]?
2- What are the centrality patterns of the high-rise commercial office building clusters in selected U.S. metropolitan areas with respect to their location[10], size[11], and year of construction[12]?

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[7] Location is defined from the classification of Lang et al (Lang, et al. 2007).
[8] Size is defined through the number of firms.
[9] Industry composition is the number of different sectors represented.
[10] Location is defined from the classification of Lang et al (Lang, et al. 2007).

3- Since advanced producer services require dense agglomeration, do company and building clusters follow a similar locational pattern in decentralized metropolitan areas?

### 3.1.2. Research Hypotheses

**Question 1:**

6. In major metropolitan areas of the U.S. megapolitan regions, global advanced producer service firms are highly-clustered.
7. The clusters of APS firms have a centralized locational pattern.
8. The locational patterns of APS firm clusters indicate a polycentric metropolitan form.
9. The knowledge producer APS firms (accounting, finance/banking, insurance, law, management consultancy, design consultancy, advertising and marketing, and real estate) are mostly clustered in primary or secondary downtown-density areas and inside the urban envelope.
10. Distributive APS firms (logistics, IT) are clustered along corridors and edge-city density areas and they are located close to airports.

**Question 2:**

7. In major metropolitan areas of the U.S. megapolitan regions, high-rise office buildings are highly-clustered.
8. The clusters of high-rise office buildings have a centralized location pattern.
9. The locational patterns of high-rise office building clusters indicate a polycentric metropolitan form.
10. Traditional downtowns still have most of the high-rise office space.

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[11] Size is defined through the number of buildings and total number of floors.
[12] Year of construction is defined as the medial year of the construction end date of buildings in the cluster.

11. High-rise office construction accelerated after 1980s, when the impact of globalization intensified.
12. Most of the new construction after 1980s, started to take place in areas outside of traditional downtowns.

**Question 3:**

3. Global advanced producer company clusters and high-rise office building clusters follow a similar locational pattern: High-rise office buildings are the preferred locations of APS firms.
4. High-rise building complexes in high-density areas (primary and secondary downtowns) mostly serve knowledge-intensive producer service firms (accounting, finance/banking, insurance, law, management consultancy, design consultancy, advertising and marketing, and real estate).

## 3.2. RESEARCH STRATEGY

The aim of this research is to describe the centrality patterns of "global business activity nodes", which are classified according to their physical and functional characteristics, in metropolitan areas of the United States that have experienced rapid decentralization of business activity. In doing this, research seeks to reveal the locational strategies of APS TNCs from different sectors. In order to arrive at a logical conclusion, it is necessary to search for similarities and/or differences between different metropolitan areas. Thus, comparative research is an appropriate strategy for this study. The units of analysis in this research are company and building clusters and units of observations are APS TNCs and high-rise office buildings.

According to May (1993, 182) comparative research aims "to understand and explain the ways in which different societies and cultures experience and act upon social, economic, and political changes." Comparative research is based on the selection of most-similar or most-different cases (Manheim, et al. 2002), in social science research it is also recognized as multiple-case study method (Yin 2003). A case study is defined as an empirical inquiry that "investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident" (Yin 2003, 13). Case study enquiries deal with complex situations which have more variables of interests than the chosen data points and these enquiries rely on multiple sources of evidence with data converging in triangulating fashion (Yin 2003).

Case studies can examine a single case or multiple cases. Both of these can be considered as variations of the same methodological framework. Multiple case studies are preferred over single case studies simply because examining more cases makes the argument stronger and they allow comparison across different cases. In multiple case study research, every case should serve a purpose within the general research inquiry. Individual cases can be thought of as single experiments (Yin 2003). Each needs to follow a logic of replication. Replication refers to the search for repeating patterns across cases and displaying them as evidence. Each additional case is selected so that it either produces similar results or contrasting results but for predictable reasons. Later, the results of replication procedures are integrated into a theoretical framework that becomes a tool for generalization of new cases (May 1993). This generalization is different from the common sampling logic of other research strategies. In multiple case study research the generalization is made to a proposition not to a population. Replication logic is also recognized as a tool to achieve external validity in the case study (Yin 2003).

Multiple case studies are differentiated according to the number of units of analysis in the study. When there is a single unit of analysis, the study is described as a holistic multiple case study, and when there are two or more units of analysis, the study is described as an embedded multiple case study (Yin 2003). Case studies can be used for exploratory, descriptive, and explanatory purposes. Exploratory case studies may be conducted in the beginning stages of social research. Descriptive case studies are used when the research goal is to describe a phenomenon that might be predictive about certain outcomes. Explanatory case studies may be used for doing causal investigations (Tellis 1997).

The strengths of case-study research design include the potential for examining the cases in their real-life contexts. Also, by the use of multiple data sources and evidence, case study research can explain causal links and generalize the findings to a theory (May 1993; Yin 2003). Case study research design also has weaknesses. Causality may be multi-faceted and complex and may be hard to establish. There is also the potential for over-complication and the challenge of integrating many different data sources in a logical way (Groat and Wang 2002).

In describing the centrality patterns of global business activity nodes in decentralized U.S. metropolitan areas, this study utilizes embedded multiple descriptive case study research methodology. The research is descriptive because it basically describes the impacts of globalization related trends on city space. The research is also embedded because there are two units of analysis: building clusters and company clusters.

Due to the highly complex nature of the subject, studies on globalization and cities mostly remained descriptive, employing qualitative analysis, with a focus on new international division of labor and the presence of TNCs within metropolitan areas. Descriptive analysis is based on explaining trends that affect the formation of global cities as well as land use in global cities. In terms of the future evolution of the trends, and their consequences, this approach might ask questions, but it does not engage in quantitative analysis to answer those questions (Audirac and Fitzgerald 2003).

Descriptive approaches mostly assume that land use, urban growth, form, and inter-urban connectivity are the consequences of complex strategic decisions of private and public corporations pursuing economic growth and profit. Cities are in the center of the local-global nexus of global capitalism (Audirac and Fitzgerald 2003). Thus, this approach explains the policies and business patterns of TNCs, inter-governmental and non-governmental organizations, and other private and public institutions to analyze the existing locational patterns of different functions in global cities. In descriptive approaches, the emergence of edge cities and other suburbanization patterns are explained as new forms of centrality, where different units of TNCs are connected to each other through digital infrastructure networks as well as physical transportation routes (Graham and Marvin 2001; Sassen 1995). At the same time, these new forms of centrality raise the need for the control and coordination of peripheral operations, which in turn increases the need for agglomeration of specialized managerial activities at strategic sites

(Hawley 1986 in Audriac and Fitzgerald 2003). These strategic sites are either found in the central business districts or in sub-centers located in suburban areas (Nechyba and Walsh 2004).

### 3.3. CASE SELECTION

Case studies can be qualitative, quantitative, or can combine both qualitative and quantitative methods (Yin 2003). The selection of individual cases and justification for the selection are vital processes in multiple case study research design (Manheim, et al. 2002; Yin 2003). Yin (2003) mentions that one question that commonly arises in case study research is the number of cases thought to be sufficient for the study. Since case study research does not use the common sampling logic, sample size criteria derived from statistical analysis is not relevant in number of cases selected. In this way, case study research flows a sampling logic similar to qualitative studies (Patton 2002).

Yin (2003, 51) demonstrates that the number of cases selected is up to the researcher's sense of the complexity of the realm of external validity. If the researcher foresees that external conditions will produce variations in the results, the number of cases included should be larger than in a situation where external conditions do not lead to variations in the results. Patton (2002) demonstrates that selection of cases should be according to a conceptually oriented criterion based on their representation of important theoretical constructs and should follow a theory-based, operational, or theoretical sampling strategy.

Manheim et al. (2002) suggest that case selections should be done in a way that the bias is minimized. They propose two strategies: most-similar-systems design and most-different-systems design. Most-similar-systems design focuses on very similar cases to hold the shared characteristics constant, in case of a variation, the shared characteristics are eliminated as possible explanations. On the other hand, most-different-systems design focuses on very different cases. In case of a common characteristic across cases, the differences can be ruled out (Manheim, et al. 2002, 205).

In this research, the aim is to explain the centrality patterns of global business activity nodes in metropolitan areas of the U.S. that have experienced high-decentralization of business activity. By taking U.S cities as case studies, the study employs a most-similar-systems research design in case selection in order to rule out regional differences. The next subsection will explain the metropolitan area selection process, selection of companies, and building type-selection within these metropolitan areas in detail.

### 3.3.1. Metropolitan Area Selection

The decentralization of business activity is an older trend in the U.S. compared to Europe and Asia (Hall and Pain 2006a); the movement of businesses from U.S. downtowns to suburban locations started in the beginning of the twentieth century mainly due to improvements in modes of transportation (Lang 2003). After the 1980s, the globalization of economic activity completely transformed the economic base of the U.S. cities into a service and high-tech economy. Highly developed information, communication, and transport technologies have accelerated the decentralization process dramatically after this period in the U.S. (Castells 1996). Thus, decentralization of business activity is a major historical trend in the U.S. urban system. One of the hypotheses of this research is that global business activity nodes still follow a centralized locational pattern. Thus, testing this hypothesis in the U.S. urban context, where decentralization is a comparatively older historical trend, will make a stronger argument in proving the hypothesis.

#### 3.3.1.1. Metropolitan Area Selection Criterion 1 – Degree of Global Connectivity

Developing a systematic methodology to measure the global connectivity or the global capacity of cities has been an important topic of study in the world cities research. The majority of these studies has been based on ranking cities according to the locational preferences and roles of transnational corporations (Beaverstock, et al. 1999a).

In 1980s, Friedmann and Wolff (1992) and Friedmann (1986) developed the World City Hypothesis, which stated that the spatial articulation of the emerging world system of production and markets is achieved through a global network of cities since these cities are the locations for the headquarters of TNCs (Friedmann 1995a). Towards the end of the 1980s, research direction began to shift towards different flows of people, capital, goods, technology, and ideas. This was followed by the recognition that certain service industries, defined as firms in accounting, advertising, finance, banking, and law, agglomerate in certain cities (Meyer 2003). In 1991, Sassen's book "The Global City," identified global cities as mainly agglomerations of transnational producer service firms with a hierarchical structure, in which London, New York, and Tokyo were located at the top of the hierarchy (Sassen 1991). Thus, Sassen's study used a comparative case study approach to describe the emerging global cities concept.

After this point until the mid 1990s, much of the global cities research constituted either a case study of one city and its attributes (Warf and Erickson, 1996; Lo and Yeung, 1998; Ciccolella and Mignaqui, 2002 in Meyer 2003) or included multiple cities with a focus on one or more variables such as the number of corporate headquarters (Lyons and Salmon 1995). In the mid 1990s, with Castells' (1996, 2000) theory of the space of flows, global cities were started to be seen as constituting a network rather than a hierarchy. Taylor (2004) identified the global city network as an interlocking network with service sector TNCs being the sub-nodal level based on principal components analysis and matrix formation.

In the earlier stages of their work, Taylor, Beaverstock, and Smith (1999a) developed an inventory of world cities based upon their level of advanced producer services. They studied four producer service sectors: accountancy, advertising, banking, and law. Within these sectors, they recorded the geographical presence of major global firms with multi-city, multi-state locations. Their analysis involves three stages. First, they identified the presence of service firms in each city. Second, they aggregated the firm data to identify the global service centers for each sector. They ranked cities as being a prime center, major center, or minor center for each sector. Third, by aggregating the service center results, they identified alpha, beta, and gamma cities. There are 10 alpha, 10 beta, and 35 gamma cities identified globally. Table 3.1. shows the U.S. cities in this category.

**Table 3.1: Global Cities in the United States**

| Category | Cities |
|---|---|
| Alpha World Cities | New York, Chicago, Los Angeles |
| Beta World Cities | San Francisco |
| Gamma World Cities | Boston, Dallas, Houston, Washington, Atlanta, Miami, Minneapolis |

Source: (Beaverstock, et al. 1999a)

Taylor et al.'s work can be seen as the first prominent work that employed quantitative methods in global cities literature to measure the global connectivity of cities through an analysis of firms from different sectors. Ideally, all global producer service firms in every producer service sector should have been analyzed, but data limitations prevented this at the time. Later, Taylor (2004) expanded this analysis by including more cities, more producer service sectors, and more producer service firms.

In his book "World City Network", Taylor (2004) again identifies the global city network according to the locations of service firms with a different methodology. The GaWC group identified 100 transnational producer service firms (called the "GaWC 100") in six producer service sectors: accounting, advertising, finance/banking, insurance, law, and management consultancy. In his study, Taylor (2004) identifies 314 cities. According to the presence of global, regional, national headquarters and local offices of these firms in each city, Taylor (2004) calculates the service level of the city in the global network of cities. In looking at the global connectivity of European cities, Taylor et al. (2006) looked at eight advanced producer service sectors: accountancy, advertising, banking/finance, design consultancy, insurance, law, logistical services, management consultancy/IT.

Taylor's later work identified many other cities as being connected to the global economy. However, cities in his initial alpha, beta, and gamma inventory always remained the top cities in terms of global connectivity. Thus, in this study, U.S. cities in this initial inventory are taken as the main case selection criterion.

**3.3.1.2. Metropolitan Area Selection Criterion 2 – Presence in a Megapolitan Region**

The contemporary American metropolis is facing a massive spurt of city building activity resulting in a dispersed, polycentric spatial structure (Lang and Knox 2007, 5). This polycentric spatial structure led to the "megapolitan regions" concept (Lang and Dhavale 2005). Megapolitans include the nation's largest and most important metropolitan areas. They are the gateways to the global economy. The core economic competencies of megapolitans depend on service sector and high-tech employment (Lang and Dhavale 2005). The major metropolitan areas of the megapolitan regions also have a polycentric structure in themselves in terms of the concentration of business activity. Downtowns are no longer the only center for business and commerce (Lang 2003). This polycentric structure of the major metropolitan areas suggests that these areas define the major connection points to the global economy (Graham and Marvin 2001).

**Table 3.2 Major Metropolitan Areas of the U.S. Megapolitan Regions**

| Megapolitan Region | Major Metropolitan Area | Signature Industry |
|---|---|---|
| Northeast | Boston, New York*, Washington DC | Finance |
| Midwest | Chicago*, Detroit, Pittsburgh | Manufacturing |
| Gulf Coast | Houston*, New Orleans | Energy |
| Piedmont | Atlanta*, Charlotte | Banking |
| NorCal | San Francisco* | High-tech |
| Southland | Los Angeles*, Las Vegas | Entertainment |
| Valley of the Sun | Phoenix* | Home building |
| Cascadia | Seattle*, Portland | Aerospace |
| Peninsula | Miami*, Tampa | Tourism |
| I-35 Corridor | Dallas*, Kansas City | High Tech |

Source: (Lang and Dhavale 2005)
* indicates the largest metro area

In this research the context is the metropolitan areas that have high-connectivity to the global economy. Thus, one criterion for metropolitan area selection is that these metropolitan areas should be among the major metropolitan areas of the megapolitan regions. Table 3.2 outlines the megapolitan regions, their major metropolitan areas, and the signature industry of each megapolitan region.

**3.3.1.3. Metropolitan Area Selection Criterion 3 – Top Commercial Real Estate Markets**

In his book *Edgeless Cities*, Robert E. Lang (2003) identified the top thirteen largest metropolitan commercial real estate markets in the U.S. by using rental office space data from

1979 to 1999. These thirteen markets together contain more than 2.6 billion square feet of office space and 26,000 buildings (Lang 2003, 3). The data for Lang's study came from private companies such as Black's Guide to Office Leasing and Cushman and Wakefield. The analysis inluded leased multi-tenented buildings and included building types that are found in large commercial centers and housed service sector businesses. Small office buildings were excluded. Government offices, hospitals, universities, and offices combined with light manufacturing were also excluded in the study (Lang, et al. 2007).

The thirteen largest metropolitan commercial real estate markets identified by Lang (2003) are: New York, Chicago, Los Angeles, San Francisco, Boston, Dallas, Houston, Washington, Atlanta, Miami, Philadelphia, Denver, Detroit. Since the main focus of the research is global business activity clusters, the selected metropolitan areas should be among the top commercial real estate markets.

#### 3.3.1.4. Result of the Selection

Only metropolitan areas that satisfy all three criteria are included in this study. There are 10 such metropolitan areas: **Atlanta, Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York, San Francisco, and Washington DC.**

### 3.3.2. Company Selection - Advanced Producer Service Transnational Corporations (APS TNCs)

Transnational service industries have become the most dominant economic sector in global cities as well as being a key aspect that derives and generates different global flows in these cities

(Taylor 2004). Since the 1990s, world cities research has mostly included a specific group of service sector firms as key agents of globalization within the transnational service industry: advanced producer services (Beaverstock, et al. 1999a; Sassen 1991, 2001b; Taylor 2004). Hall and Pain (2006a, 4) define advanced producer services (APS) as a cluster of knowledge and information intensive activities that provide specialized services to other service sectors. This study will also focus on advanced producer service firms.

#### 3.3.2.1 Company Selection Criterion 1 – APS Sectors

In terms of the classification of service industry, Singlemann's work is prominent (Bryson, et al. 2004; Stein 2002). Singlemann (1978) classified services into four subgroups: distributive services (communication, trade, transport), producer services (banking, business services, real estate), social services (education, health, public, non-profit, etc.), and personal services (hotels, restaurants, travel, etc.).

In this classification by Singlemann (1978), distributive services and producer services are examined in separate categories, but they share common characteristics. Producer services are defined as services that serve intermediate or business demand rather than consumer demand (Bryson, et al. 2004). Distributive services such as logistics and IT also serve other businesses, and they will be included in the advanced producer service category. This assumption parallels to Taylor's selection of service sectors (Taylor, et al. 2006). The distinction between producer and advanced producer services is vague in the literature. Advanced producer services are basically complex, knowledge-intensive producer services utilizing high-technology in their operations (Moulaert and Todtling 1995).

In his latest analysis of polycentric European regions, Taylor (2006) included accountancy, advertising, banking/finance, design consultancy, insurance, law, logistical services, management consultancy/IT as the principle APS sectors. This study also includes these sectors, with the addition of the real estate industry. Figure 3.1 shows the APS Sectors that will be included in this research.

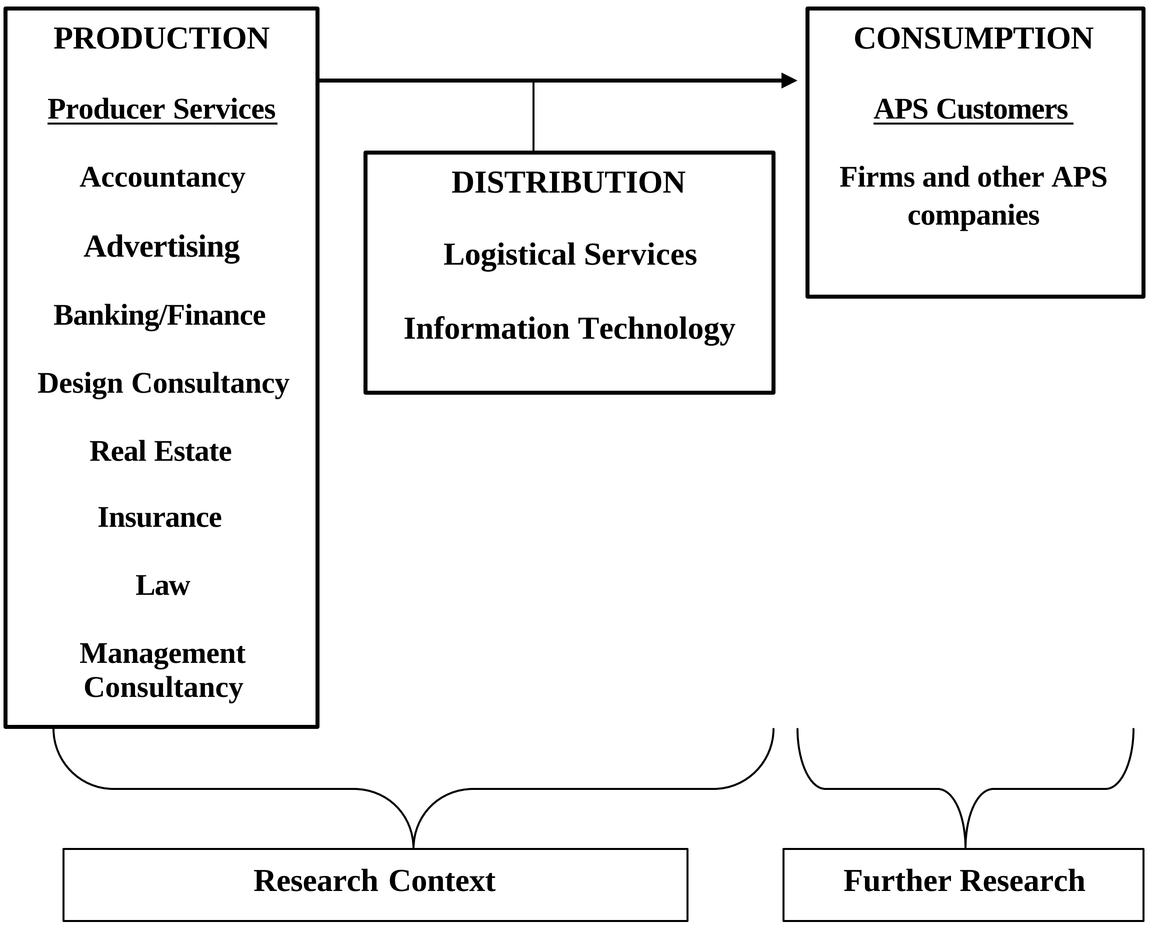



**Figure 3.1: Context of the Research – APS Sectors**

### 3.3.2.2 Company Selection Criterion 2 – Transnational Corporations

As previously mentioned, globalization has been associated with the rapid growth and internationalization of the producer services (Bryson, et al. 2004, 61). Transnational producer service companies are not only the key agents of globalization, but also they advance the globalization process through the impact they have on their client companies. They follow their clients into new international markets and then they support the clients in developing tranansnational operations (Bryson, et al. 2004; Cuadrado Roura, et al. 2002; Taylor 2004). Given their important role in the articulation of the global economy, transnational advanced producer service firms (APS TNCs) will be context of this study.

In defining firms that are global Taylor et al. (2002) argue that a firm is deemed to be pursuing a global locational strategy when it has offices in at least 15 different cities including one or more cities in each of the prime globalization arenas: northern America, western Europe and Pacific Asia. This criteria resulted in the formation of the GaWC 100 list, which included 100 APS TNCs. In the present study, it is important to identify as many companies as possible in order to identify the significant locations for global business activity nodes within metropolitan space. 100 firms will not be sufficient. Thus, in order to obtain more firms with global connections, the 15 cities criterion is reduced 5 cities. Thus, global firms are defined as firms with offices in at least 5 different cities including one or more cities in each of the prime globalization arenas: North America, Western Europe and Pacific Asia.

### 3.3.3. Building Type Selection

As discussed in the literature review, from the beginning, commercial high-rise buildings have been associated with corporate power and capitalist interests in cities with considerable economic and political regional influence. This is transferred to the contemporary era as skyscrapers being central to the debate over cities as sites of tacit and codified knowledge in the global economy (Amin and Thrift 2002; Mc Neill 2005b, 43). Following Graham and Marvin (2001) the research also assumes that high-rise office buildings and skyscrapers are the crucial "connection nodes" to the global networks with their advanced technological infrastructure, thus they are preferred locations of transnational service industry and powerful representations for the impact of globalization on urban structure. Thus, in this study, locational distribution of high-rise commercial building clusters constitute a unit of analysis in terms of understanding the trends in the locational distribution of global business activity nodes within the selected metropolitan areas. The study will explore the increase in the number of commercial buildings and changes in their locations over five time periods. Since globalization started around 1970s and intensified after 1980s, these two years are important threshold points. The study will examine high-rise office buildings constructed before 1970s. Then, buildings in four different time frames will be analyzed: 1970-1980 (the beginnings of globalization), 1980-1990, 1990-2000, 2000-2010 (after globalization).

## 3.4. DATA SOURCES

This section, describes the data sources used in this study for identifying companies and office buildings. All of the data are derived from secondary sources such as different databases and census data.

### 3.4.1. Data Sources for Company Data

Research in world cities literature has utilized various databases and sources. Friedmann's World City Hypothesis mainly depended on the number of headquarters of transnational corporations compiled from secondary sources (Friedmann 1995b). Sassen's (Sassen 1991, 2001b) and

Castells' analysis mostly depended on secondary data from international organizations such as OECD (Financial Market Trends, Statistics on International Transactions), IMF (Balance of Payments and Statistics Yearbook), UNCTAD (World Investment Report). They compiled annual reports on capital and trade (export and import) flows between nation-states. National sources such as Census Databases (e.g.: U.S. Census—Survey of Current Businesses, Japan Statistical Yearbook, UK Census) of different countries, Bank for International Settlements (Annual Reports), and private sources such as Fortune 500, Wall Street Journal and various business and law directories were also utilized in world cities literature.

Relational data between cities was more difficult to gather due to the difficulties in collecting information at that level. Most of the available data identifying global flows of capital, people, and trade of goods were at the national level (Taylor 2004). In terms of relational data, the UN's source called Official Airline Guide in Demographic Yearbook offered flight statistics between cities (Keeling 1995), which was utilized to analyze global flows of people. Also, some authors conducted studies with data from international couriers such as Federal Express to analyze the global flows of goods between cities (Michelson and Wheeler in Castells 2000, 412). In this research, the company data required should identify the service industry that the company belongs to, the exact locations of companies with addresses for geocoding, and the function of the office. The following sub-sections will explain the data sources used in this research to identify the APS TNCs to be studied.

#### 3.4.1.1. Identifying Industries

As discussed in the company selection criteria, the industries identified as producer and distributive service sectors in Singelmann's (1978) classification will be the major framework of study. Thus, there are ten industries:  accountancy, advertising, banking/finance, design consultancy, insurance, IT, law, logistical services, management consultancy, and real estate. All of these sectors are coded in the North American Industry Classification System (NAICS) of the Economic Census. In order to reach the individual companies, it is necessary to find the NAICS codes for the listed sectors.

The NAICS was developed in 1997 to replace the 1987 Standard Industrial Classification (SIC). NAICS is a numeric coding system of all industries including manufacturing and services. It has different levels of coding. It starts with two digit identification of sectors and goes up to six digits identification of very specific industries. NAICS includes 1,170 industries of which 565 are service-based industries (U.S. Census Bureau 2007). As shown in Table 3.3, the ten sectors studied in this research are included under six two-digit industry codes in the NAICS. Appendix A includes all the six digit NAICS codes analyzed in this research. SIC and NAICS codes are highly utilized in many reserach projects that describe industry and company related trends (Feser, et al. 2005).

**Table 3.3 NAICS Codes and APS Industries Studied**

| Two-digit NAICS code for the industry | Industry Description | APS sectors included |
|---|---|---|
| 48-49 | Transportation and Warehousing | Logistics |
| 51 | Information | IT |
| 52 | Finance and Insurance | Finance, Insurance |
| 53 | Real Estate Rental and Leasing | Real Estate |
| 54 | Professional, Scientific, and Technical Services | Accountancy, Legal, Design Consultancy, Advertsing and Marketing, Management Consultancy, IT |
| 55 | Management of Companies and Enterprises | Management Consultancy and Finance |

### 3.4.1.2. Identifying Companies

Companies in this research are identified from the Business and Company Resource Center Database by Thompson & Gale. The Business & Company Resource Center offers business information and company and industry intelligence on thousands of companies. The Business and Company Resource Center brings together company profiles, brand information, rankings, investment reports, company histories, chronologies and periodicals. Companies are listed are ranked according to their global or office sales. There is a search engine that allows the firms to be searched according to their locations, financial data, and SIC and NAICS codes (Gale Group 2003).

The Business & Company Resource Center provides business, company, and industry content in the following areas: periodical articles, news articles, and press releases, detailed information for domestic and international companies and associations, company financials and earning estimates, investment reports, corporate chronologies and company histories, brands and product information, industry and company rankings, market share data, industry overviews, HR law case digests (Gale Group 2003). Thompson and Gale do not reveal their methodology in terms of collecting data, they just provide a list of resources that they use in forming their company list.

In this research, companies are selected from The Business & Company Resource Center database by using the six-digit NAICS codes identified as in Appendix A. Selecting the companies from one source defines a systematic selection process. The limitations of the Business & Company Resource Center database mean that, the companies that they do not include in their database cannot be included in this research. After identifying the two-digit NAICS codes for the industries, the next step is to identify the companies listed under specific six-digit NAICS Codes. For each NAICS code selected, the top 10% of the firms listed are selected. Business and Company Resource Center lists the firms according to their total assets or sales/operating revenue. The six digit NAICS Codes can be found in Appendix A. In the selected top 10 percent of the firms, from the website of each company and their transnational character was identified. The selection criteria of being transnational are as follows:

1- Transnational companies should have branches operated by the company itself in all three regions of the global triad (subsidiaries are not included).
2- They should be headquartered in one of these regions (Asia, Europe, North America).
3- They should have at least 5 offices located globally, with one or more office in each region of the global triad.

After identifying the companies from their websites, the next step was to identify they have offices in the 10 cities studied. Office addresses and office functions are recorded. Office functions are recorded as branch, national headquarter, regional headquarter, or global headquarter. If the office function is not mentioned, they are recorded as branches. The company list with the names of the companies are given in Appendix A. In the end, 614 firms are identified in 10 different industries.

**Table 3.4 Number of Firms in the Selected APS Industries**

| Industry | Number of Firms |
|---|---|
| IT | 189 |
| Finance and Banking | 85 |
| Management Consultancy | 61 |
| Design Consultancy | 57 |
| (Architecture and Engineering) | |
| Advertising and Marketing | 56 |
| Logistics firms | 55 |
| Law | 49 |
| Insurance | 35 |
| Accountancy | 17 |
| Real Estate | 13 |
| TOTAL | 617 |

### 3.4.2. Data Sources for Commercial High-Rise Buildings

In terms of data on office buildings, Lang (2003, 125) mentions that office market data is collected by private parties such as real estate brokers, consulting firms, realty and building associations, and office guide publishers. There is no governmental source that collects office market data. Thus, Lang (2003) demonstrates that given the diversity of sources, no uniform guidelines exist for determining the basic attributes of office markets such as total size, number of floors, etc.

EMPORIS, a database launched in 2004 that has information on most of the high-rise buildings in the world solved the problem of inconsistency and lack of uniform guidelines regarding office market data. EMPORIS defines high-rise buildings as buildings with 12 floors or more or buildings that exceed 35m (110ft). EMPORIS collects information specifically on high-rise buildings regarding where they are located, when they were built, proposed, or demolished, and who has been involved in their construction and management; and connects them into a single database. The EMPORIS Database currently has information on more than 150,000 buildings, 42,500 companies, and 8,000 cities in 206 countries. The city areas identified in EMPORIS are in compliance with the metropolitan area definition of each city (Emporis 2007).

Each city is divided into districts and zones according to the municipal divisions. In each division, the high-rise buildings are identified according to: name, year of end of construction, location (street specific address), status of construction (completed, proposed, approved, under construction, demolished, never built, visionary) structural information (construction type, height, and floor area), number of floors, and main uses (commercial, residential and other uses). Where available, EMPORIS also lists the tenants in the buildings as well as the companies that took place in the construction of the buildings. EMPORIS also provides many images on buildings as well as graphs that demonstrate statistical analysis of the main uses in each city division and the city in general as well as graphs that demonstrate a ranking of the high-rise buildings according to their structural heights in specific cities. According to these criteria listed above, EMPORIS allows users to conduct searches and download the results on Excel spreadsheets (Emporis 2007). In this research, EMPORIS will be used as the primary database to identify building names, number of floors, type of usage, and street address locations of the high-rise buildings. From EMPORIS, all the high-rise office buildings in 10 selected metropolitan areas are identified with their addresses, floor numbers, and end date of construction (year) construction (Emporis 2007).

### 3.5. DATA ANALYSIS

The following section will explain the methods used in anlyzing the spatial company and building data collected.

#### 3.5.1. Spatial Analysis- Identifying Clusters

In this study, the aim is to identify the locational patterns of global business activity nodes. Global business activity nodes are defined as clusters of transnational producer services firms. From the literature we know that these firms mostly prefer to locate in high-density areas in high-rise building clusters. Thus, we test this assumption in the U.S. context by identifying the clusters of commercial high-rise buildings and see if these clusters are in close proximity to the company clusters. The overall aim is to understand how the decentralized metropolitan urban form in the U.S. context is evolving in response to the locational decisions of transnational service firms from different sectors.

Cluster analysis is the fundamental method of analysis in this study. Cluster analysis is generally defined as a "wide variety of techniques used to group entities into homogenous subgroups on the basis of their similarities" (Lorr 1983, 1). Feser and Luger (2003, 12) conclude that cluster analysis is a useful framework for policy-makers to understand the complexity of the regional economies, both in isolation and vis-à-vis the global economy. Cluster analysis can be qualitative or quantitative. Quantitative analysis mostly uses secondary data and objectively identifies clusters, whereas in qualitative analysis, only the knowledge of the expert is communicated (Feser and Luger 2003).

In this research, spatial clusters of companies and buildings will be identified through quantitative methods. Thus, we are engaged in the cluster analysis of point pattern data in other words point pattern analysis. Geographic distributions are clustered as random, regular, or clustered (Haggett, et al. 1977). As Cressie (1991, 586) demonstrates the standard against which spatial point patterns are often compared is a completely spatial random process such as a homogeneous Poisson distribution. In a geographic distribution, spatial clusters occur when features are found in close proximity or when groups of features with similarly high or low values are found together (Mitchell 2005, 148). Thus, the result is local high concentration of events (points) (Diggle 1983), and this distribution exhibits a clear difference than the complete spatial random distribution.

Finding the cluster locations help to uncover the reasons behind that clustering (Mitchell 2005). In a clustered distribution, although clustering of events is obvious, it is important to identify clusters objectively using statistics. We can then derive better conclusions and make better decisions (Meyer 2006; Mitchell 2005). Also, as Cressie (1991, 586) demonstrates, different observers may disagree in terms of the amount of clustering or randomness in a spatial point pattern, thus quantification will solve issues related to this subjectivity.

Gan et al. (2007) demonstrate that clustering problems can be divided into two categories: hard clustering and fuzzy clustering. In hard clustering the data belongs to only one cluster whereas in fuzzy clustering the data can belong to more than one cluster with some probabilities. Hard clustering algorithms are also divided into two: partitional algorithms and hierarchical algorithms (Gan, et al. 2007, 9). Partitional algorithms, frequently called the K-means technique, partition the incidents into a specified number of groupings, usually defined by the user (Levine 2004, 6.2).

As Levine (2004, 6.14) demonstrates hierarchical clustering methods are among the oldest cluster routines. Hierarchical algorithms are also divided into two: divisive and agglomerative algorithms (Lorr 1983). In divisive hierarchical algorithms, the algorithm proceeds from top to bottom. The algorithm starts with one large cluster with all the points in the data set and continues by splitting them into smaller clusters (Gan, et al. 2007). Agglomerative hierarchical algorithms are the most popular clustering techniques (Lorr 1983, 84). They proceed from bottom to top. They are like an inverted tree diagram (dendogram) in which two or more incidents are first grouped on the basis of some criteria (e.g., nearest neighbor, furthest neighbor, average clustering, centroid method, median method, and minimum-variance method) (Levine 2004; Lorr 1983). Then, the pairs are grouped into second-order and higher-order clusters on the basis of the selected criteria. This grouping process continues until either all incidents fall into a single cluster or else the grouping criteria fails at that point. Thus, in the end there is a hierarchy of clusters that can be displayed with a dendogram. (Levine 2004, 6.2).

In agglomerative hierarchical clustering of spatial data, the grouping criterion is usually distance-based. Distance-based methods make use of precise information on the locations of events and have the advantage of not depending on arbitrary choices like counting the number of events occurring in a subset of study region (Cressie 1991, 602). In agglomerative hierarchical clustering Lorr (1983) identifies six distance-based methods: nearest-neighbor, furthest-neighbor, average clustering, centroid cluster, median cluster, and minimum-variance. In furthest neighbor method, the distance between clusters is defined as distance between their most remote pair of entities. In average clustering the distance between two clusters is the average distance between all pairs of entities in the two clusters. In the centroid method, the distance between two clusters is the distance between the cluster centroids. Median method is based on distance between cluster medians (Lorr 1983, 86-90). Among these methods, nearest neighbor method compares the distances between nearest events and distances that would be expected on the basis of chance (complete spatial randomness) (Haggett, et al. 1977; Levine 2004). The distance between two clusters is defined as the distance between their closest members (Lorr 1983).

In this study, hard-clustering methods will be applied because the aim is to assign point locations to only one cluster. Also, the hierarchical clustering is chosen over partitional algorithms because as will be explained later, we are interested in exploring the clustering between locations of buildings and firms that are in walking distance to each other. Thus, distance is the criterion in this study. Nearest neighbor distance will be the grouping criterion since we are interested in the size and the locations of building and company clusters formed by the closest entities. Given this, the Nearest Neighbor Hierarchical Clustering Method as one of the Hot-Spot Analysis

Techniques in CrimeStat program provides a suitable method that meets our criteria as an analytic tool.

### 3.5.1.1 Nearest Neighbor Hierarchical Clustering in CrimeStat Program

Cluster analysis has been an important tool in regional economic analysis (Feser and Luger 2003). This tool is highly utilized in the descriptive analysis of company and industry clusters. By using agglomerative hierarchical clustering algorithm developed by Ward in 1963, Feser (2003) identified knowledge-based occupation clusters in thirty eight US metropolitan areas by comparing 1112 occupations according to 33 variables. The data came from the Occupational Information Network (ONET) database of the US Department of Labor and the clustering algorithm was run in the SAS Software.

Spatial statistics are highly utilized in cluster analysis. Feser et al. (2005, 395) used Getis/Ord local G statistic, which is a measure for spatial concentration, and detailed county-level industry employment data from the US Bureau of Labor Statistics to identify groups of nominally linked industries clustered in particular locations in 1989 and 1997 in the US. O'huallachain and Leslie (2007) used Ripley's K-function, a method used to compare a point pattern distribution with a reference distribution under complete spatial randomness such as a homogenous Poisson process, to detect the clustering patterns of twelve disaggregated advanced producer service sectors in Phoenix, Arizona. Maoh and Kanaroglu (2007) estimate univariate K functions and kernel surfaces to examine the range and shape of firm clustering in the city of Hamilton, Ontario. In his analysis of locational strategies of different industries in eight Canadian cities, Shearmur (2007) developed a measure of spatial autocorrelation and concluded that functions fully characterize the space they occupy: high-order services and FIRE sectors are located in the CBDs and they have high level of spatial autocorrelation indicating interdependence; manufacturing characterizes the outer reaches of metropolitan areas and is also highly autocorrelated. Finally, there are some areas that do not have any specialization.

Also, cluster analysis methods and measures are used to predict subcenter formation (Erickson 1985; McDonald 1987; Sasaki and Mun 1996). In this predictive approach, agglomeration of service industry is explained as a function of the high transportation and opportunity cost of service sector professionals, the availability of labor force and commercial and/or retail space, job/housing ratio, and land use mix. Recent studies also focus on employment density (Anas, et al. 1998; Lee 2007). Edge cities and sub-centers are examples of agglomerations of commercial and retail firms located in suburban areas (Anas, et al. 1998). The data for regression analysis mostly comes from employment data, transportations costs, population and household distribution data found in regular census surveys and in other reports such as US Department of Commerce's County Business Patterns and ZipCode Business Patterns (Glaeser, et al. 2001; Glaeser and Kahn 2001).

In implementing cluster analysis, clustering algorithms and computer software developed in statistics are highly utilized including SAS, CAST, and CrimeStat. In this thesis, Crime Stat is chosen due to its ability to integrate with the ArcGIS software that is used for geocoding firm and building data. CrimeStat is a spatial statistics package that is developed by Ned Levine & Associates to analyze crime incident location data. It is a stand-alone Windows XP Professional program that can inter face with most desktop geographic information systems (GIS). Its purpose is to provide a variety of tools for the spatial analysis of point locations. It is designed to operate with data sets. Although CrimeStat is developed for analyzing crime-incident locations, it can also be used for other types of applications involving point locations, such as the location of arrests, motor vehicle crashes, emergency medical service pick ups, or in this case the locations of firms and buildings (Levine 2004).

In CrimeStat, analyzing concentrations of incidents clustered within a limited geographical area is called the hot-spot analysis. This study utilizes Nearest Neighbor Hierarchical Clustering Technique (Nnh) in Crime Stat. Nearest Neighbor Hierarchical Clustering Technique of CrimeStat is utilized as an analytic tool in various studies. Meyer (2006) used it to identify the the clustering of small and medium sized IT firms in Canada near higher education isntitutions. Elliot (2005) used Nnh clustering technique to identfy the clustering of graphic design firms in Metropolitan Melbourne.

Nnh is a hierarchical clustering routine that clusters points together on the basis of spatially proximity (Levine 2004). Nnh is hierarchical because after identifying the first set of clusters, the routine continues on to grouping the first-order clusters into higher clusters, Nnh shows how the features are clustered at several geographic scales (Mitchell 2005). In the Nnh routine, the user has to define four parameters: threshold distance, probability level, the minimum number of points, and the visual output of the hot spots.

In the threshold distance parameter there are two options: random nearest neighbor distance option calculated by the Nnh routine and the fixed distance option specified by the user. Only points that are closer to one or more other points than the threshold distance are selected for clustering (Levine 2004). The mean random distance is calculated as:

$$\text{Mean Random Distance} = d(ran) = 0.5\ \text{SQRT}\left[\frac{A}{N}\right] \quad \text{(Levine 2004, 6.15)} \ (3.1)$$

A is the study area, N is the number of points. Dividing the area by the number of points gives the average number of points per unit area. The square root is taken to convert this into a linear distance unit. Then, the value is divided by half since the calculation assumes that all distances between points is calculated twice (Mitchell 2005, 155).

Threshold distance option is closely linked with the probability level parameter, where the user specifies a confidence interval around the selected choice of threshold distance. The confidence interval defines a probability for the distance between any pair of points. For a specific one-tailed probability, p, fewer than p% of the incidents would have nearest neighbor distances smaller than this selected threshold distance if the distribution was spatially random. In order to be in a cluster the points must be closer than what would randomly be the case (Levine 2004, 6.16). Higher confidence interval levels, which indicate that a certian percentage of points have distances larger than the threshold distance in a random distribution, will include less features but with a a higher certainity level. The t-value corresponding to this probability level is selected under the assumption that the degrees of freedom are at least 120, which is appropriate for a relatively large sample (Meyer 2006; Mitchell 2005) .

Confidence Interval for Mean Random Distance = Mean Random Distance ± t* SEd(ran)

$$= 0.5\ \text{SQRT}\left[\frac{A}{N}\right] \pm t\left[\frac{0.26136}{\text{SQRT}[N^2/A]}\right] \quad \text{(Levine 2004, 6.15)} \ (3.2)$$

0.26136 is a constant derived from the standard error for a normal curve (Mitchell 2005). Thus, CrimeState uses the principles of normal distribution in defining complete spatial randomness.

The second choice in selecting a threshold distance is to choose a fixed distance (in miles, nautical miles, feet, kilometers, or meters). The main advantage of this method is that the search radius can be exactly specified, which might be useful for comparing the number of clusters for different distributions. However, in this method, the choice of a threshold is subjective, the user has to have a solid justification for the selection. The larger the distance that is selected, the greater the likelihood that clusters will be found by chance. The significance of the clusters can be tested in CrimeStat using a Monte Carlo simulation (Levine 2004, 6.17). In this simulation, the routine assigns N cases randomly to a rectangle with the same area as A, and evaluates the number of clusters according to the defined threshold and minimum point parameters. It repeats this test K times (defined by the user). By running the simulation many times, the user can see the minimum and maximum number of clusters as well as number of clusters at different percentiles (indicates one-tailed error percentage of finding greater number of clusters than by chance) for the particular first-order Nnh (Levine 2004, 6.30). The confidence interval formula of the fixed distance is obtained by substitituting the mean random distance by fixed distance in Formula 3.2.

The minimum number of points is another important parameter in Nnh. The user can specify the minumum number of points that make up a cluster. The dafult is ten points. By decreasing this number, more clusters are produced; by increasing this number, fewer clusters are produced.

This criteria is used to reduce the number of very small clusters in the analysis. If only points are selected based on the threshold distance crietria, there would be so many clusters in the final analysis. To minimize this many very small clusters and reduce the possibility that clusters could be found by chance, the user defines a minimum number restriction. If additional points are to be included in the cluster, then the probability of obtaining the cluster by chance will be less. In the final clustering, Nnh will show clusters that have the minimum number of points and those points will be closer to at least one other point than the specified threshold distance (Levine 2004; Meyer 2006).

The final parameter in the Nnh clustering routine is the visual output of the hot-spots. There are three choices: ellipse, convex hull, or both. A standard deviational ellipse is calculated for each cluster. The user has the option to choose between 1X (the default), 1.5X, and 2X. One standard deviation will cover more than 50% of the cases, one and a half standard deviations will cover more than 90% of the cases, and two standard deviations will cover more than 99% of the cases, although the exact percentage will depend on the distribution. The ellipse is an abstraction, it does not represent the actual cluster. A convex hull is also calculated for each cluster. The convex hull draws a polygon around the points in the cluster. Compared to ellipse, it is the literal definition of the cluster. Both the ellipse and the convex hull can be saved in ArcView ‘.shp’, MapInfo ‘.mif’ or Atlas*GIS ‘.bna’ formats (Levine 2004, 6.18).

### 3.5.1.2. Using Nearest Neighbor Hierarchical Clustering in Identifying Company and Building Clusters

In this section, the specific parameters that will be used in the Nnh routine will be explained. With the help of these parameters Nnh routine identifies the building and company clusters in different metropolitan areas. First of all, it should be mentioned that the methodologies used to identify parameters in both company and building clusters are the same. In order to perform the Nnh clustering routine, point locations of companies and buildings are geocoded and the X, Y coordinates are obtained on Euclidian space. Geocoding was done using an online geocoding server called EZ Locate (www. geocode.com). The street address and number, city, state, and the zip code are enetered and the server gives back the X, Y coordinates that are downloadable into excel format. This data in spreadsheets is then entered into CrimeStat as X,Y coordinates. Before starting the Nnh routine, we also define the unit in CrimeStat. Both in GIS and CrimeStat, projected coordinate system defined in miles is used. Thus, ArcGIS converts the geographic coordinates of point locations into projected coordinate system in miles. The study area for each metropolitan setting also needs to be defined. Area is calculated in square miles from the previously created GIS maps as a total area of the counties.

After defining the X,Y data, coordinate system, and area; the next step is to enter the parameters specific to Nnh. The probability level, which defines the percentage of points with smaller threshold distances in a random distribution, is selected as 5%. This is smaller than the default 10%. (Meyer 2006). In his study to identfy IT firm clusters in Canada, Meyer (2006) used the default 10%. The probability level could go up to 1%, but then identfied clustering gets extremely tight. Elliott's (2005)study uses 1% probability level. In this study, we will use the in between measure of 5%. This probability level indicates that we are 95% confident that less than 5% of the points are closer than the specified threshold distance in a random distribution. Thus, if there is a clustering it becomes highly unlikely that it is due to chance. 5% probability level is also a widely accepted limit in the statistical and scientific research for confidence interval.

The next parameter is the threshold distance. In this study, the aim is to identify the locations of global business activity clusters. We are interested in finding the locations where there is face-to-face contact for transnational businesses, exchange of information between global elite, and transnational material consumption takes place. Thus, we are interested in identifying building and company clusters that have members in close proximity to each other. In this research close proximity is defined as walking distance. Pivo (1990) demonstartes that walking distance is 0.25 miles or less. Thus, this is the maximum threshold distance that will be used in this research. Since the spatial context of each metropolitan area is different, it is likely that threhold distances and minimum number of points per cluster will vary across the selected metropolitan areas. Thus, there is a need for a consistent methodology that will be applied to both companies and buildings across different urban contexts. First of all, we try to find the minimum walking distance that will enable us to have a cluster made up of two points (Pivo 1990). Two points is the very basic definition of a cluster. The first trial starts with 0.01 miles of fixed threshold distance, then the trials continue in 0.01 miles increments until the first clusters are obtained. This distance becomes a boundary distance (d), below this limit there are no other clusters. After finding this boundary distance, we take the next 0.01 mile increment as our fixed threshold distance (d+0.01), taking 0.01 mile more than the boundary distance is relaxing the threshold distance criteria. After many trials this approach proved to be more useful than taking the boundary distance.

The next step is to find a meaningful minimum number of points criteria for buildings and companies. Minimum of two points produces too many clusters with too few members. On the other hand, the trial with minimim of two points identifies the maximum number of clusters at that threshold distance. The Nnh routine also gives the number of points per cluster. The maximum number of points per any cluster indicates the number of trials we will have in order to identify the cut-off value for minimum number of points that will produce different numbers of clusters. For example, mimimum of two points at a specified threshold distance (d+0.01) produced 20 clusters with a minimum of two points and within this twenty clusters there is one cluster with 64 points, which is the largest cluster. Thus, every number between 2 – 64 is tried in the minimum number points criteria in Nnh. Throughut these trials, the number of clusters will remain the same for some values and change in others. For example any trial between minimum of two points to five points produces 20 clusters, any trial between minimum of six points to twelve points produces 10 clusters, any trial between minimum of thirteen points to thirty points produces 5 clusters, any trial between minimum of thrity one points to sixty points produces 2 clusters, and any trial between minimum of sixty one points to sixty four points produces only 1 cluster. Here, our cut-off values are 2 (below that there are no clusters), 5, 12, 30, 60, and 64. We take the upper limit as the cut-off vlaue becuase it indicates a higher certainity level. Thus, these six values are a cluster within themselves (clusters of minimum number of points that result in different number of clusters). Every cluster can be defined by its center. In this case, the center is the median value. In this example, median value will be 45, which will produce 2 clusters. Thus, we identify the minimum number of points in final clustering as this median value.

Sometimes we might have to find a median between two consecutive numbers. For example, 14 minimum points produce 5 clusters and 15 minimum points produce 4 clusters and these two are the two values that we need to calculate our median from. In this case we go with the lower minimum number of points per cluster because half a pont does not exist in reality. The final parameter is the representation of the cluster. In the final maps, clusters will be represented with standar deviational ellipses with two standard deviations. Two standard deviations in our case do not show an exaggerated view becasuse we are dealing with a large area of metropolitan settings.

#### 3.5.1.3. Locations of Clusters within the Metropolitan Areas

After identifying the clusters of buildings and companies, there is a need to define another set of locational criteria that will be used to evaluate the centrality patterns of clusters. This location criteria will be taken from the analysis of Lang et al. (Lang, et al. 2007). Lang et al. (2007) analyzed the office space distribution in 13 largest metropolitan office markets of the US. They produced density maps and developed a classification system of office space density based on these maps. The GIS base maps used in this study are also taken from this study.

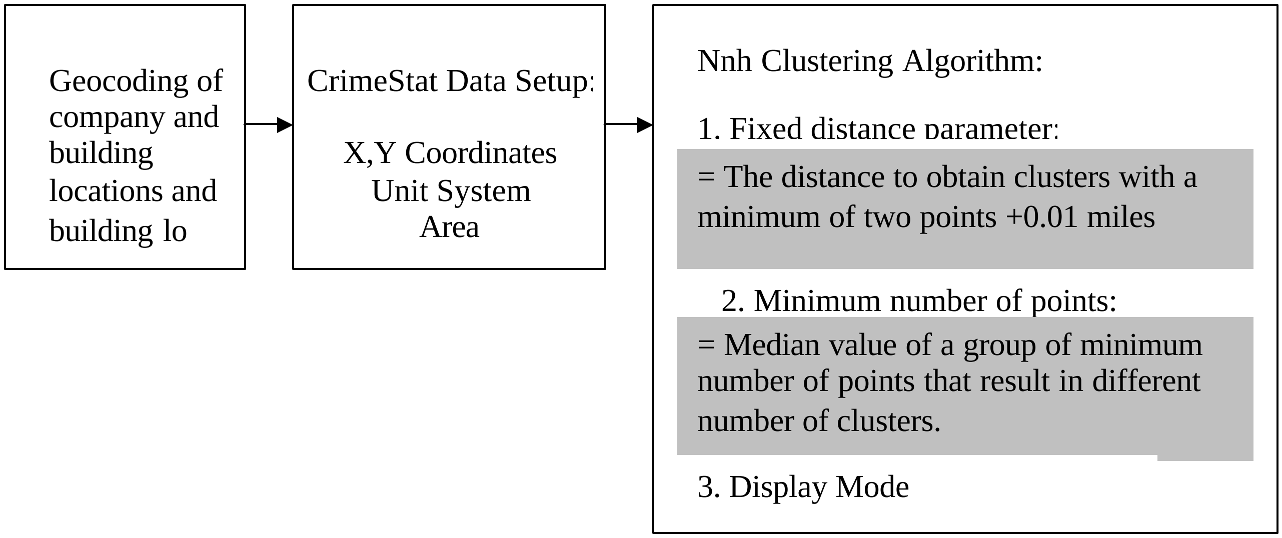



**Figure 3.2: Spatial Analysis Process in Nnh**

The office space data for the study of Lang et al. (2007) came from *Black's Guide to Office Leasing*, a directory of office space (Black's Guide 2005). They surveyed leased multi-tenanted large office buildings exclusively found in large commercial centers and housed businesses such as advertising and finance. The analysis excluded other office facilities such as government offices, warehouses, flex space (offices combined with light manufacturing), hospitals, and universities. Lang et al. (2007) created density maps within a geographic information system (GIS) to identify the clustering of office space in the 13 selected metropolitan areas. To do this, office building locations were first geocoded using street address information obtained from *Black's Guide*. After geocoding the office building data as point locations, density maps were generated for each of the 13 metros. Density maps represent point data as continuous value surfaces which show the distribution of office space such that areas of high concentration (i.e., density) appear as clusters relative to the surrounding metro region. The density maps were then converted to contour maps with isolines of office density delineating office concentrations at predefined thresholds (Lang, et al. 2007, 12). In the analysis the thresholds were as follows (Lang, et al. 2007, 13):

*Primary downtowns* are distinct clusters central to a metro region that have office space densities averaging 7,500,000 s.f. per square mile.

*Secondary downtowns* are office clusters geographically distinct from primary downtowns that have office space densities averaging 3,500,000 s.f. per square mile.

*Edge cities* are office clusters geographically distinct from primary or secondary downtowns averaging office space densities of 2,000,000 s.f. per square mile.

*Urban envelopes* are contiguous to primary downtowns extending outward to edge city office space densities averaging 2,000,000 s.f. per square mile.

*Corridors* are linear clusters usually following major transportation routes (highways or major arterials), averaging edge city office densities, and also being anchored by one or more secondary downtown or edge city. Corridors are seen as a subtype of edge cities.

*Edgeless cities* are the balance of metro regions outside of primary downtowns, secondary downtowns, urban envelopes, edge cities, and corridors. Edgeless cities have office densities averaging approximately 20,000 s.f. per square mile.

Lang et al (2007) also identified the traditional downtown locations in the GIS format. In addition to these locational criteria, this study also takes the locations of major airports in the selected metropolitan areas as important locational criterion.

### 3.5.2. Reporting the Case Study Results

General research strategy in this study is multiple case study research. Yin (2003, 147) demonstrates that "multiple-case studies often contain both the individual case studies and some cross-case chapters". Thus, in reporting the findings of spatial analysis in the next chapter we will follow this pattern.

There are ten cities selected, so there are ten different cases to analyze. In each city, firs analysis will be on companies. General trends such as how many companies had presence in that city, what industries are represented, and how many of these companies are found in clusters will be identified. Then, individual company clusters will be the major focus. We will report how many company clusters there are, where those clusters are located in relation to downtown areas and/or airports, number of companies per cluster, and what industries are represented in those clusters given in percentages. After reporting on individual clusters, there will be a brief conclusion with the trends related to all company clusters. All of the company related analysis will be directed towards evaluating the hypotheses related to research question 1.

The second part of each case study will be on building clusters. We will first identify the general trends such as how many commercial high-rise buildings are included in the analysis in that city and how many of these buildings are found in clusters. Then, we will focus on individual building clusters. Trends such as how many building clusters there are in total, where those clusters are located in relation to downtown areas and/or airports, number of buildings per cluster, total number of floors per cluster, and median year of construction per cluster reported in ten year intervals will be reported. After reporting on individual clusters, there will be a brief conclusion with the trends related to all building clusters. All of the building related analysis will be directed towards evaluating the hypotheses related to research question 2.

The third part of each case study will be a joint analysis of building and company clusters, which will be about evaluating the hypotheses related to research question 3. We will analyze the number of building and company clusters being in close proximity to each other. Also, we will identify which industries tend to locate in the most recent building clusters. After the results for individual cities are reported, the cross-case analysis results will be given in Chapter 5 which is on polycentric American metropolis.

## CHAPTER 4: CASE STUDY RESULTS

This chapter will present the results of the proposed spatial analyses for companies and buildings in ten selected metropolitan statistical areas (MSA). For each MSA, the results of the analyses related to company and building clusters will be explained first. Then, the results related to company and building clusters that intersect with each other will be discussed according to their locations in the MSAs.

### 4.1 METROPOLITAN AREA RESULTS

The results of the spatial analyses will be provided for Atlanta, Boston, Chicago, Dallas, Houston, Los Angeles, Miami, New York, San Francisco, and Washington DC.

#### 4.1.1 Atlanta

Lang et al (2007, 17) identified the office geography of Atlanta as follows: Atlanta has one dense cluster at the core of its central business district determined to be its "downtown." This identified downtown area is indicated with a red circle in the GIS map. 6.7% of Atlanta's office space is located in downtown area. Atlanta also has one urban envelope in which a string of quasi-downtown spaces extend reaching all the way north to Roswell. Atlanta has 38.6% of its office space concentrated in this urban envelope (excluding downtown), which is larger than the urban envelope office space concentration in other metropolitan areas. Lang et al (2007, 18) demonstrates that this is mainly a result of the development pattern that connects the downtown core, Midtown, Buckhead, and Perimeter office agglomerations. Atlanta also has three edge cities identified: Cumberland, Duluth, and North Fulton. Together, these edge cities contain

16.4% of Atlanta's office space. Among these three edge cities, Cumberland has the largest share with 10.3% (Lang, et al. 2007, 31) In Atlanta, 38.4% of the office space is found in edgeless cities. Map 1 demonstrates the findings of Lang et al (2007) in Atlanta.

#### 4.1.1.1 Atlanta Companies

There are 385 APS TNC locations identified in Atlanta Metropolitan Area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.12 miles. The distance to identify clusters was taken as 0.13 miles. The minimum number of points that gave the median number of clusters was 8 and the median number of clusters turned out to be 7. 49% of the companies in Atlanta belong to a cluster. Among the 7 clusters, only two clusters are found in areas with edgeless city densities. Clusters 1, 3, and 4 are found in the urban envelope with their centers in secondary downtown density locations. Cluster 5 is found in Cumberland edge city area. Cluster 2 is the only cluster that has its center in the primary downtown. In Atlanta 5 out of 7 clusters are found in areas that have higher densities than edgeless city density, which proves that most of the company clusters are located in a centralized pattern, yet the multiple locations prove the polycentric structure of the global business activity nodes. All ten industries are represented in Atlanta. Logistics, IT, and real estate are the top three industries in terms of number of companies. Logistics and IT together constitute 47% of all the APS TNCs in Atlanta. Table 4.1 shows the industry composition of Atlanta companies according to the total number of firms.

**Table 4.1: Industries represented in Atlanta APS TNCs.**

| Industries | % of all the firms |
|---|---|
| Accounting | 6.23 |
| Advertising and Marketing | 5.19 |
| Design Consultancy | 7.01 |
| Finance/Banking | 6.75 |
| Insurance | 4.68 |
| IT | 17.40 |
| Law | 1.30 |
| Logistics | 30.91 |
| Management Consultancy | 8.05 |
| Real Estate | 12.47 |
| TOTAL | 100.00 |

**Table 4.2: Number of Companies in Clusters and Percent of Clustering among Industries in Atlanta**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 6 | 2 | 13 | 6 | 3 | 0 | 2 | 12 | 6 | 53 |
| 2 | 10 | 5 | 3 | 7 | 0 | 1 | 4 | 4 | 11 | 2 | 47 |
| 3 | 1 | 2 | 6 | 1 | 4 | 14 | 0 | 4 | 5 | 1 | 38 |
| 4 | 3 | 1 | 1 | 0 | 1 | 2 | 0 | 1 | 1 | 0 | 10 |
| 5 | 1 | 0 | 0 | 0 | 2 | 10 | 0 | 5 | 1 | 0 | 19 |
| 6 | 0 | 1 | 1 | 0 | 1 | 5 | 0 | 2 | 0 | 2 | 12 |
| 7 | 0 | 1 | 0 | 1 | 0 | 6 | 0 | 1 | 0 | 0 | 9 |
| Clustered Comp. | 18 | 16 | 13 | 22 | 14 | 41 | 4 | 19 | 30 | 11 | 188 |
| Total # of Comp. | 24 | 20 | 27 | 26 | 18 | 67 | 5 | 119 | 31 | 48 | 385 |
| % of clustering | 75.00 | 80.00 | 48.15 | 84.62 | 77.78 | 61.19 | 80.00 | 15.97 | 96.77 | 22.92 | 48.83 |

**Table 4.3: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Atlanta**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.66 | 11.32 | 3.77 | 24.53 | 11.32 | 5.66 | 0.00 | 3.77 | 22.64 | 11.32 | 100.00 |
| 2 | 21.28 | 10.64 | 6.38 | 14.89 | 0.00 | 2.13 | 8.51 | 8.51 | 23.40 | 4.26 | 100.00 |
| 3 | 2.63 | 5.26 | 15.79 | 2.63 | 10.53 | 36.84 | 0.00 | 10.53 | 13.16 | 2.63 | 100.00 |
| 4 | 30.00 | 10.00 | 10.00 | 0.00 | 10.00 | 20.00 | 0.00 | 10.00 | 10.00 | 0.00 | 100.00 |
| 5 | 5.26 | 0.00 | 0.00 | 0.00 | 10.53 | 52.63 | 0.00 | 26.32 | 5.26 | 0.00 | 100.00 |
| 6 | 0.00 | 8.33 | 8.33 | 0.00 | 8.33 | 41.67 | 0.00 | 16.67 | 0.00 | 16.67 | 100.00 |
| 7 | 0.00 | 11.11 | 0.00 | 11.11 | 0.00 | 66.67 | 0.00 | 11.11 | 0.00 | 0.00 | 100.00 |

**Table 4.4: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Atlanta**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12.50 | 30.00 | 7.41 | 50.00 | 33.33 | 4.48 | 0.00 | 1.68 | 38.71 | 12.50 |
| 2 | 41.67 | 25.00 | 11.11 | 26.92 | 0.00 | 1.49 | 80.00 | 3.36 | 35.48 | 4.17 |
| 3 | 4.17 | 10.00 | 22.22 | 3.85 | 22.22 | 20.90 | 0.00 | 3.36 | 16.13 | 2.08 |
| 4 | 12.50 | 5.00 | 3.70 | 0.00 | 5.56 | 2.99 | 0.00 | 0.84 | 3.23 | 0.00 |
| 5 | 4.17 | 0.00 | 0.00 | 0.00 | 11.11 | 14.93 | 0.00 | 4.20 | 3.23 | 0.00 |
| 6 | 0.00 | 5.00 | 3.70 | 0.00 | 5.56 | 7.46 | 0.00 | 1.68 | 0.00 | 4.17 |
| 7 | 0.00 | 5.00 | 0.00 | 3.85 | 0.00 | 8.96 | 0.00 | 0.84 | 0.00 | 0.00 |
| Non-clustered | 25.00 | 20.00 | 51.85 | 15.38 | 22.22 | 38.81 | 20.00 | 84.03 | 3.23 | 77.08 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Management Consultancy, Finance/Banking, Law, and Advertising and Marketing are the top three sectors with the highest rate of membership in a cluster. The logistics and real estate are two sectors with the lowest degree of clustering. Table 4.2. summarizes these results.

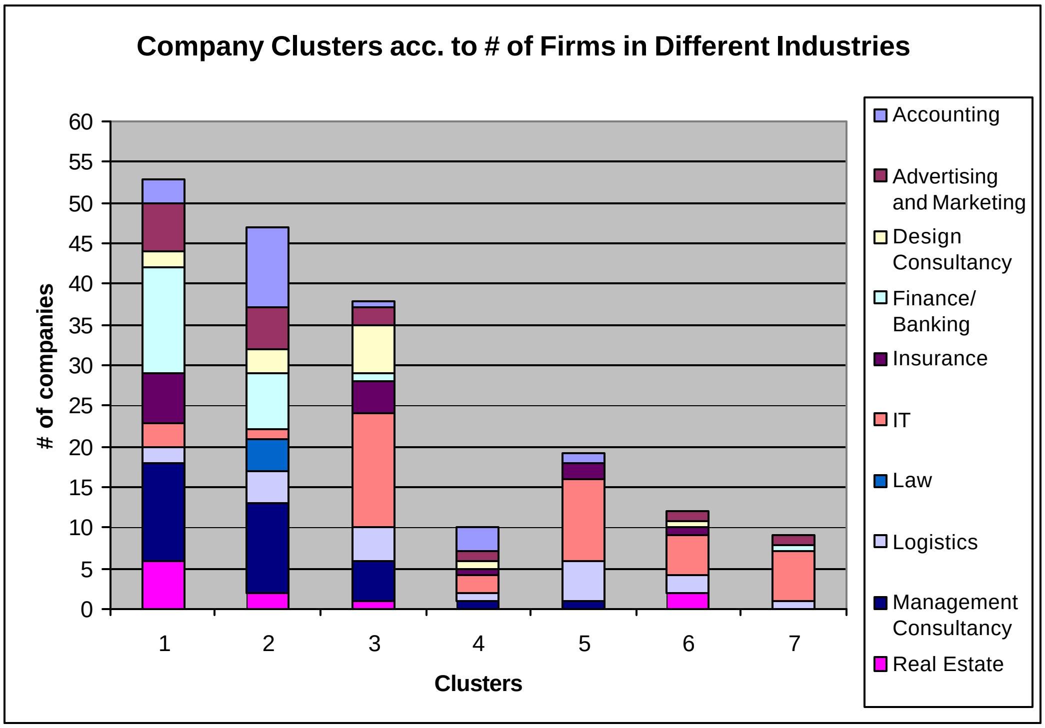



**Figure 4.1: Number of companies in company clusters in Atlanta**

The largest cluster with 53 companies is Cluster 1, which is located in the middle of the urban envelope. The center of this cluster is found in a secondary-downtown density area approximately 5 miles from the center of downtown Atlanta. It is the cluster with the highest number of companies and second densest cluster (Table 4.2). There are 53 firms in total in this cluster, of which 52 are branch locations. All industries except for Law are present. Finance/Banking and Management Consultancy together constitute around 47% of the companies in this cluster (Table 4.3). IT and logistics each have only 2 companies

(Table 4.2). Cluster 1 is the most dominant cluster in four sectors: Advertising and Marketing, Finance/Banking, Insurance, and Management Consultancy. 50% of all the Finance/Banking TNCs identified in Atlanta metropolitan area are found in this cluster. This percentage is 38.71% for Management Consultancy, 33.33% for Insurance, and 30% for Advertising and Marketing firms. This cluster also is the largest cluster in terms of clustered real estate firms with 12.50%. Real estate is a highly decentralized industry in Atlanta. 77.08% of all real estate firms do not belong in a cluster (Table 4.4).

Cluster 2 is located in the downtown Atlanta area. The center of the cluster is in the primary downtown density area. Cluster 2 is the densest cluster and it also is the second largest cluster in terms of number of companies (Table 4.2). There are 47 firms in this cluster, of which 46 are branch locations. All industries except for insurance are present in this cluster. Management Consultancy, Accounting, and Finance/Banking constitute the top industry sectors in the cluster. Management consultancy firms constitute 23.40% of the total number of firms in the cluster; where as accounting constitute 21.28%, and finance/banking firms constitute 14.89% (Table 4.3). This cluster is the only cluster that with the law companies in Atlanta. Transnational law firms is an under represented sector in Atlanta metropolitan area with only 5 firms identified. Cluster 2 is the most dominant cluster in two sectors: Accounting and Law. 80% of all the Law TNCs identified in Atlanta metropolitan area are found in this cluster. This percentage is 41.67% for accounting. Cluster 2 is also the second most dominant cluster in advertising and marketing, finance and banking, and management consultancy. (Table 4.4).

Cluster 3 is located in the northern part of the urban envelope. The center of the cluster is in the secondary downtown density area approximately 11 miles in shortest distance from the center of downtown Atlanta. It is the cluster with the third highest number of companies (Table 4.2). There are 38 firms in total in this cluster, of which 33 are branch locations. This is also the clusters with the highest number of HQ locations. All industries except for Law are present in this cluster. IT is the most dominant sector with 36.84% of all the companies in the cluster followed by Design Consultancy, Management Consultancy, Insurance, and Logistics (Table 4.3). Cluster 3 is the cluster with the highest percentage of already clustered firms in design consultancy and IT. Design consultancy is decentralized with 51.85% of the firms not being in a cluster. 22.22% of the design consultancy firms are found in cluster 3. IT is another decentralized industry with 38.81% of all firms not in a cluster. Cluster 3 has 20.90% of all the IT firms, the largest percentage after non-clustered IT firms. (Table 4.4)

Cluster 4 is also located in the northern part of the urban envelope. The center of the cluster is in the secondary downtown density area approximately 9.5 miles in shortest distance from the center of downtown Atlanta. It is the cluster with the sixth highest number of companies and it is the third densest cluster (Table 4.2). There are 10 firms in total in this cluster, of which 7 are branch locations. This is the cluster with the second highest number of HQ locations. Accounting is the most dominant sector with 3 companies followed by IT with 2 companies. There are no companies from Finance/Banking, Law, and Real Estate sectors in this cluster (Table 4.3).

Cluster 5 is located outside of the urban envelope in Cumberland. The center of the cluster is in the secondary downtown density area approximately 9 miles in shortest distance from the center of downtown Atlanta. It is the cluster with the fourth highest number of companies (Table 4.2). There are 19 firms in total in this cluster, of which 17 are branch locations. All industries except for Law are present in this cluster. IT and Logistics dominate the cluster with 10 and 5 firms consecutively; together they make up around 79% of all the firms in the cluster (table 4.3).

Cluster 6 is located outside of urban envelope between two edge cities of Duluth and North Fulton. The center of the cluster is in an edgeless city density area approximately 20 miles in shortest distance from the center of downtown Atlanta. It is the cluster with the fifth highest number of companies (Table 4.2). There are 12 firms in total in this cluster, all of which are branch locations. IT dominate the cluster with 5 firms. There are two companies each from the Logistics and Real Estate Sectors. There are no firms from Finance/Banking, Accounting, Management Consultancy, and Law sectors (Table 4.2).

Cluster 7 is also located in outside of the urban envelope between two edge cities of Duluth and North Fulton. The center of the cluster is in the edgeless cities density area approximately 23 miles in shortest distance from the center of downtown Atlanta. It is the cluster with the seventh highest number of companies. There are 9 firms in total in this cluster, 8 of which are branch locations. IT firms dominate the cluster with 6 firms (Table 4.2).

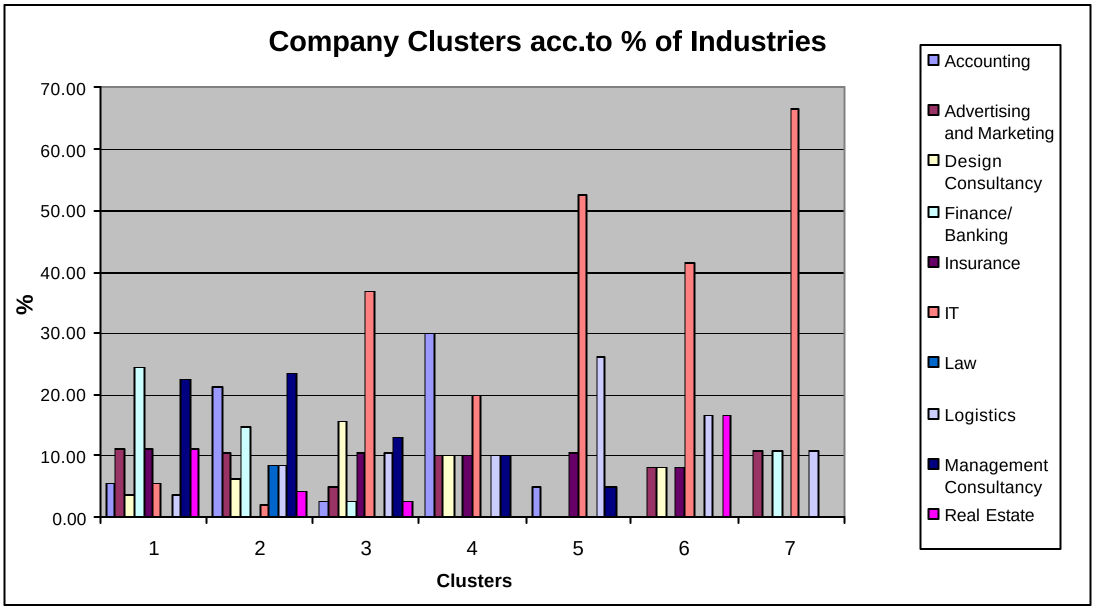



**Figure 4.2: Percent of Industries in Company Clusters in Atlanta**

Urban envelope and downtown together have above 70% of the firms in accounting, advertising and marketing, finance/banking, law, and management consultancy. These industries are mostly found in the same clusters together. Logistics, real estate, and design consultancy are the top three highly decentralized industries in Atlanta. 84.03% of all logistics, 77.08% of all real estate, and 51.85% of all design consultancy firms do not belong in a cluster. IT firms are found in clusters that do not have high percentages of banking/finance, management consultancy, law, and accounting, the IT firms are also clustered in locations far away from traditional downtown. Map 2A show the APS TNC locations and Map 2B demonstrates the company clusters in Atlanta.

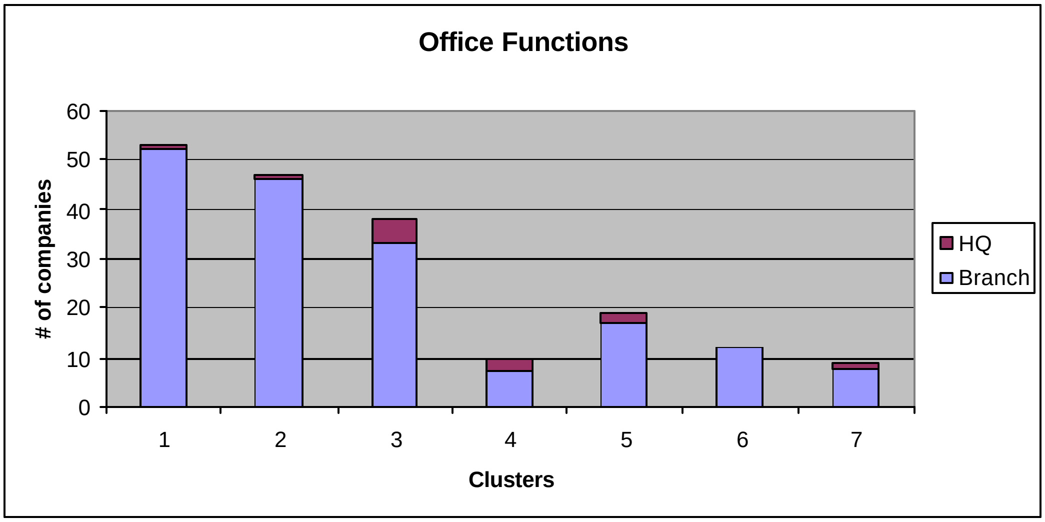



**Figure 4.3: Number of Companies according to Office Functions in Atlanta**

#### 4.1.1.2 Atlanta Buildings

There are 162 building locations in total in Atlanta Metropolitan Area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.25 miles, thus the distance that is used in calculating the clusters is taken as 0.26 miles. The minimum number of points that formed the median number of clusters was 14 and the median number of clusters turned out to be 5. All of the building clusters have mean centers in areas with primary or secondary downtown densities, which prove that these clusters are located in a centralized fashion. 4 of these clusters are found in the urban envelope and one cluster is found in the edgeless city Cumberland.

**Table 4.5: Percent of Buildings according to Year of Construction in Atlanta**

| Years | % of buildings |
|---|---|
| 2000-2010 | 38.27 |
| 1990-2000 | 16.67 |
| 1980-1990 | 24.07 |
| 1970-1980 | 7.41 |
| Pre1970 | 13.58 |
| TOTAL | 100.00 |

**Table 4.6: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Atlanta**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 12 | 5 | 9 | 8 | 19 | 53 |
| 2 | 8 | 1 | 7 | 2 | 0 | 18 |
| 3 | 13 | 3 | 8 | 1 | 1 | 26 |
| 4 | 7 | 5 | 4 | 0 | 0 | 16 |
| 5 | 5 | 4 | 6 | 0 | 0 | 15 |
| Total Clustered Buildings | 45 | 18 | 34 | 11 | 20 | 128 |
| Total Buildings | 62 | 27 | 39 | 12 | 22 | 162 |
| % of clustering | 72.58 | 66.67 | 87.18 | 91.67 | 90.91 | 79.01 |

**Table 4.7: Percent of Buildings in Clusters according to Year of Construction in Atlanta**

| Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 22.64 | 9.43 | 16.98 | 15.09 | 35.85 | 100.00 |
| 2 | 44.44 | 5.56 | 38.89 | 11.11 | 0.00 | 100.00 |
| 3 | 50.00 | 11.54 | 30.77 | 3.85 | 3.85 | 100.00 |
| 4 | 43.75 | 31.25 | 25.00 | 0.00 | 0.00 | 100.00 |
| 5 | 33.33 | 26.67 | 40.00 | 0.00 | 0.00 | 100.00 |

**Table 4.8: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Atlanta**

| Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 19.35 | 18.52 | 23.08 | 66.67 | 86.36 | 32.72 |
| 2 | 12.90 | 3.70 | 17.95 | 16.67 | 0.00 | 11.11 |
| 3 | 20.97 | 11.11 | 20.51 | 8.33 | 4.55 | 16.05 |
| 4 | 11.29 | 18.52 | 10.26 | 0.00 | 0.00 | 9.88 |
| 5 | 8.06 | 14.81 | 15.38 | 0.00 | 0.00 | 9.26 |
| Non-clustered | 27.42 | 33.33 | 12.82 | 8.33 | 9.09 | 20.99 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 79% of all high-rise office buildings in Atlanta were constructed after 1980s.

2000-2010 is the time when 38.27% of all buildings were constructed, which is the highest percentage of building construction in a time interval (Table 4.5). 79% of all buildings in Atlanta belong to a cluster (Table 4.6). The buildings constructed during 1970-1980 have the highest membership to a cluster with 91.67%. Up to the beginning of 1990s, the membership percentage in a cluster remains in the same levels. However, between 1990 and present, the percentage of membership to a cluster significantly drops suggesting decentralization (Table 4.6). The multiple locations of building clusters suggest a polycentric structure. Four clusters in the urban envelope together with downtown has 70% of all the buildings.

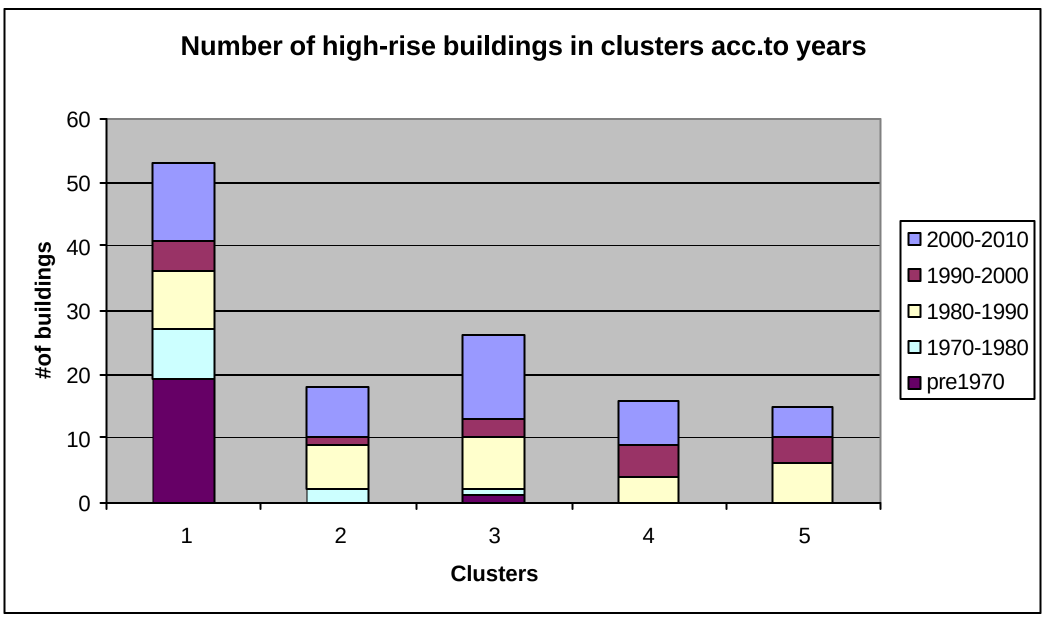



**Figure 4.4: Number of buildings in Building Clusters according to Year of Construction in Atlanta**

Cluster 1 is located in downtown Atlanta, in a primary downtown density area. It is the cluster with the highest number of buildings and the densest cluster in terms of buildings per area. There are 53 buildings in total in this cluster (Table 4.6), which makes up

32.72% of all the high-rise buildings. Around 50% of these buildings are constructed after 1980s, although the highest rate of construction took place before 1970s (Table 4.7). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in pre-1970s. 86.36% of all buildings constructed before 1970s exists in this cluster, making it the oldest cluster. Also, 66.67% of all buildings constructed between 1970 and 1980 exist in cluster 1. Cluster 1 has the highest percentage of clustered buildings constructed between 1980 and 2000, thus although it is the oldest cluster, it still continues to expand (Table 4.8).

Cluster 2 is located inside the urban envelope close to downtown Atlanta. The center of the cluster is in the secondary downtown density area approximately 1.5 miles in shortest distance from the center of downtown Atlanta. It is the cluster with the third highest number of buildings and second densest cluster. There are 18 buildings in this cluster (Table 4.6). 44.44% of the buildings in this cluster are constructed after 2000 and around 90% of the buildings are constructed after 1980s (Table 4.7.). Cluster 3 is found in the middle of the urban envelope, in a secondary downtown density area, 5.5 miles away in shortest distance from the center of downtown Atlanta. It is the cluster with the second highest number of buildings and third densest cluster (Table 4.6). 92% of all the buildings in this cluster are constructed after 1980s. 50% of the buildings in this cluster are constructed or scheduled to be constructed during 2000-2010 (Table 4.7). This makes cluster 3 the most dominant cluster in terms of having the highest percentage of clustered buildings in 2000-2010 (Table 4.8).

Cluster 4 is located in the northern part of the urban envelope, in a primary downtown density area, 11 miles away from the center of downtown. There are 16 buildings in this cluster and all of them were constructed after 1980s (Table 4.6) and the time interval that the highest percentage of construction took place was 2000-2010 (Table 4.7). This cluster has the highest percentage of clustered buildings (18.52%) constructed in 1990-2000 interval (Table 4.8).

Cluster 5 is the only cluster that is in an edge city. It is found in Cumberland, in a secondary downtown density area, 8.6 miles away from downtown. There are fifteen buildings in this cluster (Table 4.6), all of which were constructed after 1980s (Table 4.7). Cluster 4 and Cluster 5 are the two most recent building clusters in Atlanta, since both of them started after 1980s, later than other clusters. Map 3A shows the high-rise office buildings and Map 3B demonstrate the building clusters in Atlanta.

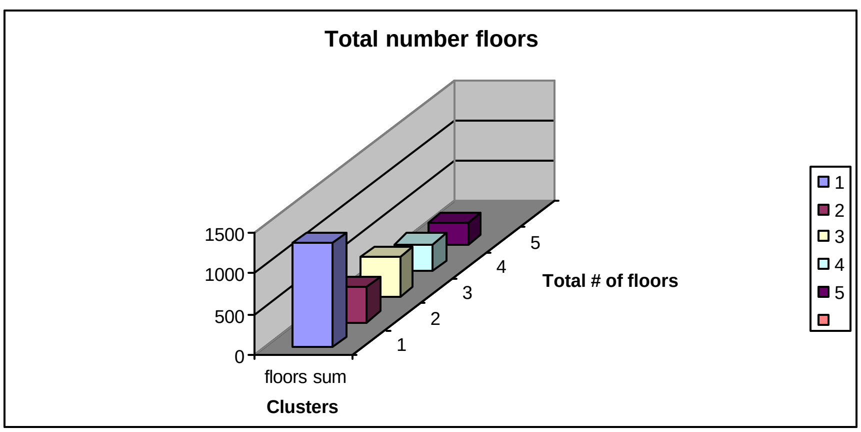



**Figure 4.5: Total Number of floors in Atlanta Building Clusters**

#### 4.1.1.3 Atlanta Company-Building Analysis

All the building clusters intersect with at least one company cluster. Company clusters 6 and 7 are the only two clusters that do not intersect with a high-rise building cluster. The highest building cluster in terms of total number of floors is also the oldest building cluster found in downtown Atlanta, which is Building Cluster 1 (Figure 4.3). In downtown Atlanta there is one company cluster and two building clusters. Company Cluster 2 intersects with Building Clusters 1&2. Company cluster 2 is the densest and second largest company cluster with all the industries except for insurance. In this cluster IT and real estate remain underrepresented with only two clusters. Building cluster 1 is also the densest and largest building cluster. This is the oldest building cluster in Atlanta. Building Cluster 2 remains like an extension of the Building Cluster 1 built in more recent years. It can be concluded that highly decentralized industries such as logistics, real estate, design consultancy, and IT are underrepresented in downtown Atlanta. On the other hand accounting and law has a strong presence followed by advertising and marketing, finance/banking, and management consultancy; and these industries prefer high-rise building districts.

Company Cluster 1 intersects with the Building Cluster 3 in the middle of the urban envelope. The centers of these two clusters are almost found in the same location. This location is similar to downtown in terms of the existing industries and the character of high-rises, but it is more recently developed. 92 % of all the buildings in this cluster are built after 1980s. Building cluster 3 is the second highest building cluster in terms of number of floors. This location is the most important location for advertising and marketing, finance/banking, insurance, and management consultancy firms. But, similar to downtown location IT and logistics remain underrepresented.

Company Cluster 3 and 4 are found in the northern part of the urban envelope. Together these two clusters have 62% of the headquarter functions that are found in clusters. The location of this cluster has a central location in the middle of the company clusters. Having a high concentration of headquarter functions in this location suggests a change in centrality patterns of headquarter functions, downtowns may no more be the most important headquarter places. In both of these sectors IT is the most dominant sector. Cluster 3 is also an important cluster for design consultancy. It is important to note that this is a very recent cluster, all buildings are constructed after 1980s. Thus, IT and design consultancy may be locating in more recent building complexes located away from downtowns and traditional producer services. Company Cluster 5 and Building Cluster 5 are found in the edge city of Cumberland and they intersect with each other. Company cluster 5 is highly dominated by logistics and IT. The company cluster 5 is also developed after 1980s. Thus, this cluster grew on IT and logistics.

These findings suggest that in Atlanta majority of the APS TNCs choose to locate in high-density areas and high-rise buildings are their preferred locations especially for Finance/Banking, Advertising and Marketing, Management Consultancy, Law, Insurance, and Accounting. Logistics and real estate are highly decentralized and not found in high-rise locations. IT is rather clustered than dispersed and these firms are found in more recent high-rise districts, which are located away from traditional downtown. Design consultancy follows a similar pattern with IT firms. Map 4 shows Atlanta company and building clusters together.

### 4.1.2. Boston

Boston has one urban envelope, and two edge cities identified by Lang et al (2007). The downtown is found in the core of the urban envelope identified by the red circle in Map 5. 38.7% of all the office space lies inside the downtown area, and 4.6% of all the office space lies inside the urban envelope. The urban envelope of Boston includes Boston, Cambridge, and Brookline (excluding Boston downtown). Boston also has two edge cities. Together these edge cities contain 6.7% of Boston's office space. The larger edge city is found in Waltham and the smaller edge city identified on the map is found in the Burlington area. 50.1% of all office space in Boston is scattered in edgeless cities (Lang, et al. 2007). Map 5 demonstrates the findings of Lang et al (2007) in Boston.

#### 4.1.2.1 Boston Companies

There are 376 APS TNC locations identified in Boston Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.08 miles. The distance to identify clusters was taken as 0.09 miles. The minimum number of points that gave the median number of clusters was 6 and the median number of clusters turned out to be 9. 52.66% of the companies in Boston belong to a cluster. Among the 9 clusters, only two clusters (clusters 6 and 9) are found in areas with edgeless city densities. Clusters 1, 2, 3, 4, and 5 are found inside downtown area. Cluster 7 is found inside the urban envelope and Cluster 8 is found in Waltham edge city area.

In Boston 7 out of 9 clusters are found in areas that have higher densities than edgeless city density, which proves that most of the company clusters are located in a centralized pattern, yet the multiple locations prove the polycentric structure of the global business activity nodes. All ten industries are represented in Boston. Logistics, IT, and management consultancy are the top three industries in terms of number of companies. IT and logistics together they constitute almost 47.61% of all firms in Boston. Table 4.9 shows the industry composition of Boston companies according to the total number of firms. Law, Finance/Banking, and Advertising and Marketing are the top three sectors with the highest rate of membership in a cluster. The logistics, real estate and IT are the top three sectors with the lowest degree of clustering. Table 4.10 summarizes these results.

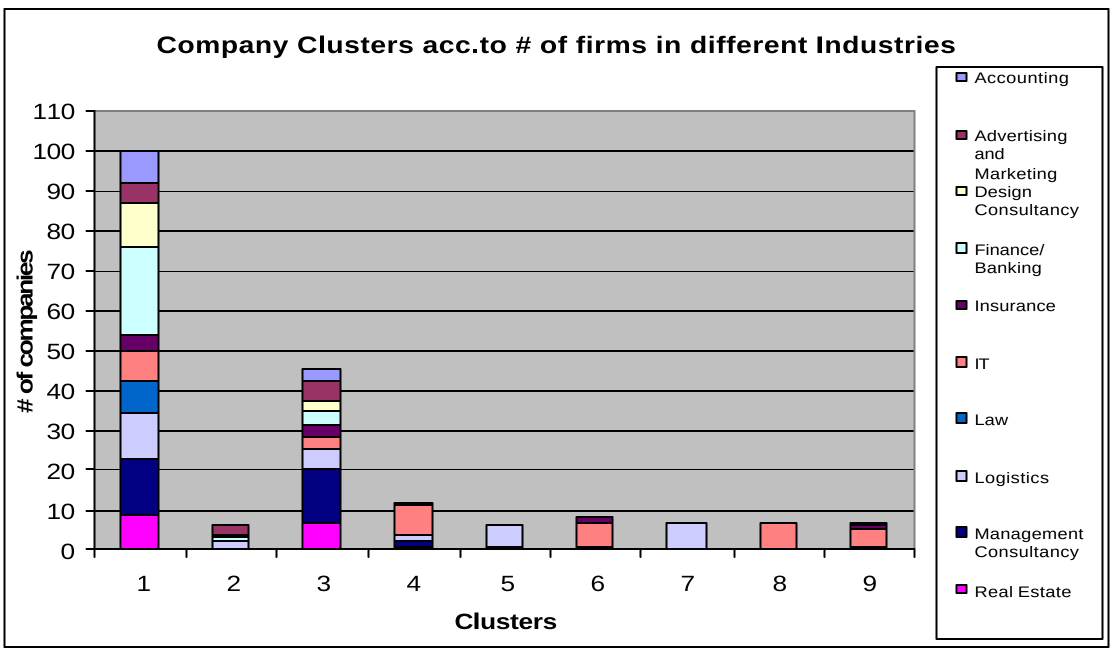



**Figure 4.6: Number of companies in company clusters in Boston**

**Table 4.9: Industries represented in Boston APS TNCs.**

| Industries | % of all firms |
|---|---|
| **Accounting** | 5.05 |
| **Advertising and Marketing** | 4.26 |
| **Design Consultancy** | 5.59 |
| **Finance/Banking** | 8.78 |
| **Insurance** | 3.72 |
| **IT** | 19.95 |
| **Law** | 2.39 |
| **Logistics** | 27.66 |
| **Management Consultancy** | 11.44 |
| **Real Estate** | 11.17 |
| TOTAL | 100.00 |

**Table 4.10: Number of Companies in Clusters and Percent of Clustering among Industries in Boston**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 5 | 11 | 22 | 4 | 8 | 8 | 11 | 14 | 9 | 100 |
| 2 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 6 |
| 3 | 3 | 5 | 2 | 4 | 3 | 3 | 0 | 5 | 13 | 7 | 45 |
| 4 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 2 | 1 | 1 | 12 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 6 |
| 6 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 1 | 0 | 0 | 8 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 7 |
| 8 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 7 |
| 9 | 0 | 0 | 1 | 0 | 1 | 4 | 0 | 1 | 0 | 0 | 7 |
| **Clustered Companies** | 12 | 12 | 15 | 27 | 9 | 35 | 8 | 34 | 28 | 18 | 198 |
| **Total Companies** | 19 | 16 | 21 | 33 | 14 | 75 | 9 | 104 | 43 | 42 | 376 |
| **% of clustering** | 63.16 | 75.00 | 71.43 | 81.82 | 64.29 | 46.67 | 88.89 | 32.69 | 65.12 | 42.86 | 52.66 |

**Table 4.11: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Boston**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.00 | 5.00 | 11.00 | 22.00 | 4.00 | 8.00 | 8.00 | 11.00 | 14.00 | 9.00 | 100.00 |
| 2 | 0.00 | 33.33 | 16.67 | 16.67 | 0.00 | 0.00 | 0.00 | 33.33 | 0.00 | 0.00 | 100.00 |
| 3 | 6.67 | 11.11 | 4.44 | 8.89 | 6.67 | 6.67 | 0.00 | 11.11 | 28.89 | 15.56 | 100.00 |
| 4 | 8.33 | 0.00 | 0.00 | 0.00 | 0.00 | 58.33 | 0.00 | 16.67 | 8.33 | 8.33 | 100.00 |
| 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.33 | 0.00 | 16.67 | 100.00 |
| 6 | 0.00 | 0.00 | 0.00 | 0.00 | 12.50 | 75.00 | 0.00 | 12.50 | 0.00 | 0.00 | 100.00 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 100.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| 9 | 0.00 | 0.00 | 14.29 | 0.00 | 14.29 | 57.14 | 0.00 | 14.29 | 0.00 | 0.00 | 100.00 |

**Table 4.12: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Boston**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 42.11 | 31.25 | 52.38 | 66.67 | 28.57 | 10.67 | 88.89 | 10.58 | 32.56 | 21.43 |
| 2 | 0.00 | 12.50 | 4.76 | 3.03 | 0.00 | 0.00 | 0.00 | 1.92 | 0.00 | 0.00 |
| 3 | 15.79 | 31.25 | 9.52 | 12.12 | 21.43 | 4.00 | 0.00 | 4.81 | 30.23 | 16.67 |
| 4 | 5.26 | 0.00 | 0.00 | 0.00 | 0.00 | 9.33 | 0.00 | 1.92 | 2.33 | 2.38 |
| 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.81 | 0.00 | 2.38 |
| 6 | 0.00 | 0.00 | 0.00 | 0.00 | 7.14 | 8.00 | 0.00 | 0.96 | 0.00 | 0.00 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.73 | 0.00 | 0.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.33 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0.00 | 0.00 | 4.76 | 0.00 | 7.14 | 5.33 | 0.00 | 0.96 | 0.00 | 0.00 |
| Non-clustered | 36.84 | 25.00 | 28.57 | 18.18 | 35.71 | 53.33 | 11.11 | 67.31 | 34.88 | 57.14 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The largest cluster with 100 companies is Cluster 1, which is located in the middle of downtown Boston in a primary-downtown density area. It is also the densest cluster (Table 4.10). There are 100 firms in total in this cluster, of which 95 are branch locations. This is the cluster with the second highest number of HQ locations. All industries are present, it is the most diverse[13] cluster. Finance/Banking, Management Consultancy, Logistics, and Design Consultancy constitute top three sectors in the cluster. Together they make up constitute around 58% of the companies in this cluster (Table 4.11). Advertising and Marketing and Insurance have the least number of firms in this cluster (Table 4.10). Cluster 1 is the most dominant cluster in five sectors: Accounting, Advertising and Marketing, Design Consultancy, Finance/Banking, and Law. 88.89% of all the law TNCs identified in Boston metropolitan area are found in this cluster. This percentage is 66.67% for finance and banking, 52.38% for Design Consultancy, 42.11% for accounting, and 31.25% for advertising and marketing firms. This cluster also is the largest cluster in terms of clustered insurance, IT, logistics, management consultancy, and real estate firms (Table 4.12).

Cluster 2 is also located in the downtown Boston. The center of the cluster is between the primary and secondary downtown density areas. There are only 6 firms in this cluster, all of which are branch locations (Table 4.10). Advertising and marketing and logistics each have two firms; design consultancy and finance/banking each have one firm (Table 4.10). Cluster 3 is located in downtown Boston next to Cluster 1. It is the second largest and second densest cluster. The center of the cluster is in the primary downtown density area (Table 4.10). There are 45

[13] Diverse cluster refers to company clusters with firms from many different sectors, mainly dominated by knowledge-intensive producer service firms.

firms in total in this cluster, of which 39 are branch locations. This is the clusters with the highest number of HQ locations. All industries except for law are present in this cluster. Management Consultancy is the most dominant sector with 28.89% of all the companies in the cluster followed by real estate, logistics, and advertising and marketing (Table 4.11). These four sectors constitute 66.67% of all the firms in this cluster. Cluster 3 is located in downtown Boston and it is the most dominant cluster in advertising and marketing together with cluster 1. It is also the second most dominant cluster in terms of clustered firms in accounting, design consultancy, finance/banking, insurance, management consultancy, and real estate (Table 4.12).

Cluster 4 is also located in the northern part of downtown Boston. The center of the cluster is in the secondary downtown density area. It is the cluster with the fourth highest number of companies and it is the third densest cluster (Table 4.10). There are 12 firms in total in this cluster, of which 10 are branch locations. IT is the most dominant sector in this cluster with 7 firms. Cluster 4 is second most dominant in terms of clustered IT firms (Table 4.12). There are no companies from advertising and marketing, design consultancy, finance/banking, insurance, and law (Table 4.11). Cluster 5 is located in the southern part of downtown Boston next to Cluster 2. The center of the cluster is in the secondary downtown density area. There are 6 firms in total in this cluster, all of which are branch locations (Table 4.10). Only logistics and real estate firms are present in this cluster. Logistics dominate the cluster with 5 firms, which is 83.33% of all the companies in the cluster (Table 4.11).

Cluster 6 is located outside of the urban envelope in an edgeless city density area approximately 17 miles in shortest distance from the center of downtown Boston. It is the cluster with the fourth highest number of companies. There are 8 firms in total in this cluster, all of which are branch locations. IT dominate the cluster with 6 firms. There is one company each from logistics and insurance sectors (Table 4.10), which makes up 75% of the cluster. This cluster is the third most dominant cluster in terms of clustered IT firms (Table 4.12). Cluster 7 is located in the fringe of the urban envelope. The center of the cluster is in the edgeless cities density area approximately 3 miles in shortest distance from the center of downtown Boston. There are 7 firms in this cluster all of which are logistics firms (Table 4.10). It is the second most dominant cluster in terms of clustered logistics firms (Table 4.12).

Cluster 8 is located in the edge city of Waltham, approximately 11.6 miles from downtown Boston. The cluster has 7 firms all of which are from the IT sector (Table 4.10), which makes it the second largest cluster in terms of clustered IT firms (Table 4.12). Cluster 9 is located in an edgeless city density area with 7 firms. Like cluster 8, cluster 9 is an IT dominated cluster. 4 out of 7 firms are IT firms. There is one firm each from logistics, finance/banking, and design consultancy (Table 4.10).

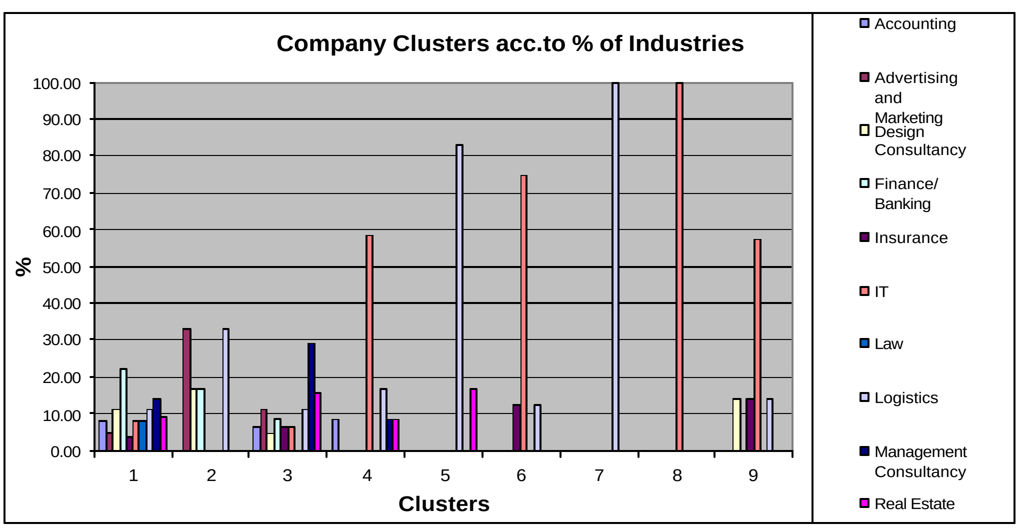



**Figure 4.7: Percent of Industries in Company Clusters in Boston**

In terms of Boston companies, the most striking conclusion is many specialized clusters on IT and logistics. Map 6A shows the APS TNC locations and Map 6B demonstrate the company clusters in Boston. Company clusters 1, 2, and 3 make up the diversified company clusters with knowledge-intensive producer services. On the other hand, company clusters 4, 6, 8, and 9 are specialized in IT. Company clusters 5 and 7 are specialized clusters in logistics. Logistics clusters 5 and 7 are located in close proximity to Boston Logan International Airport. IT clusters (except for cluster 4) are mostly located in low density areas away from downtown Boston. Headquarter functions in Boston are most dominant in the clusters 1 and 3, which are the most diversified clusters with the most number of companies (Figure 4.8).

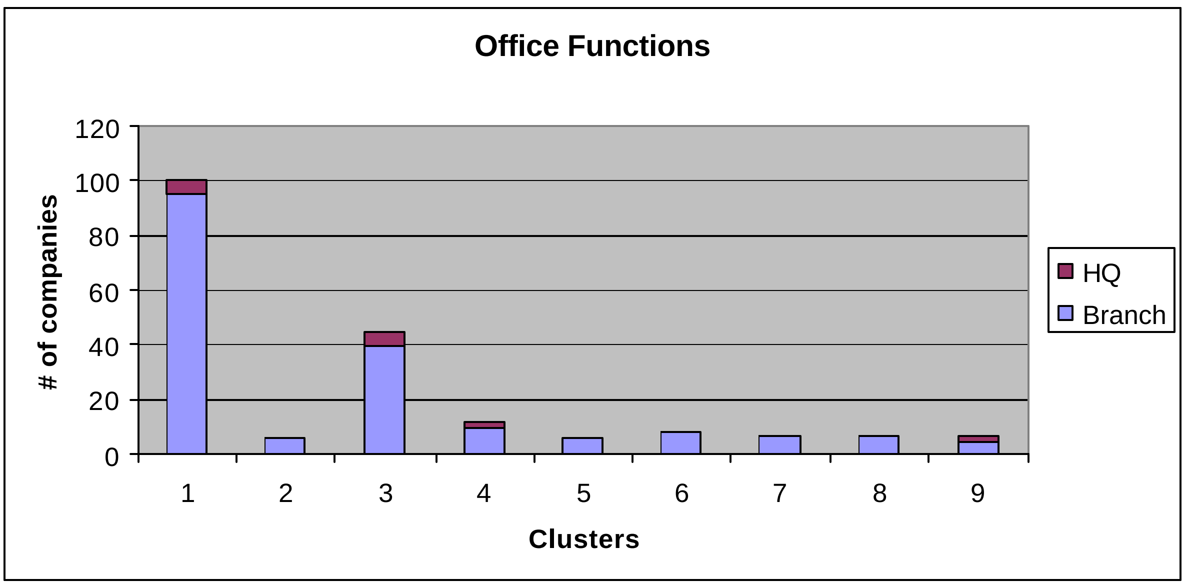



**Figure 4.8: Number of Companies according to Office Functions in Boston**

#### 4.1.2.2 Boston Buildings

There are 136 high-rise building locations identified in total in Boston Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.21 miles, thus the distance that is used in calculating the clusters is taken as 0.22 miles. The minimum number of points that formed the median number of clusters was 4 and the median number of clusters turned out to be 3. Two of these building clusters are located in downtown Boston and have mean centers in the primary downtown density location, which prove that these clusters are located in a centralized fashion. Map 7A shows the high-rise office building locations and Map 7B demonstrate the building clusters in Boston.

**Table 4.13: Percent of Buildings according to Year of Construction in Boston**

| Years | % of buildings |
|---|---|
| 2000-2010 | 11.76 |
| 1990-2000 | 7.35 |
| 1980-1990 | 23.53 |
| 1970-1980 | 16.18 |
| pre1970 | 41.18 |
| TOTAL | 100.00 |

**Table 4.14: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Boston**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 11 | 9 | 30 | 16 | 50 | 116 |
| 2 | 3 | 0 | 0 | 0 | 2 | 5 |
| 3 | 0 | 0 | 0 | 3 | 2 | 5 |
| Total Clustered Buildings | 14 | 9 | 30 | 19 | 54 | 126 |
| Total Buildings | 16 | 10 | 32 | 22 | 56 | 136 |
| % of clustering | 87.50 | 90.00 | 93.75 | 86.36 | 96.43 | 92.65 |

**Table 4.15: Percent of Buildings in Clusters according to Year of Construction in Boston**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | Pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 9.48 | 7.76 | 25.86 | 13.79 | 43.10 | 100 |
| 2 | 60 | 0 | 0 | 0 | 40 | 100 |
| 3 | 0 | 0 | 0 | 60 | 40 | 100 |

**Table 4.16: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Boston**

| Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 68.75 | 90.00 | 93.75 | 72.73 | 89.29 | 85.29 |
| 2 | 18.75 | 0.00 | 0.00 | 0.00 | 3.57 | 3.68 |
| 3 | 0.00 | 0.00 | 0.00 | 13.64 | 3.57 | 3.68 |
| Non-clustered | 12.50 | 10.00 | 6.25 | 13.64 | 3.57 | 7.35 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 42.64% of all high-rise office buildings in Boston were constructed after 1980s. 41.18% of these buildings were constructed before 1970s, which is the highest percentage of building construction in a time interval (Table 4.13). 92.65% of all buildings in Boston belong to a cluster (Table 4.14). The buildings constructed during 1970-1980 have the highest membership to a cluster with 91.67%. Membership percentage in a cluster did not fluctuate much throughout the years, although a big gap occurred between pre1970s and 1970-1980 intervals (Table 4.14). The multiple locations of building clusters suggest a polycentric structure. Downtown Boston has 85.29% of all the high-rise buildings.

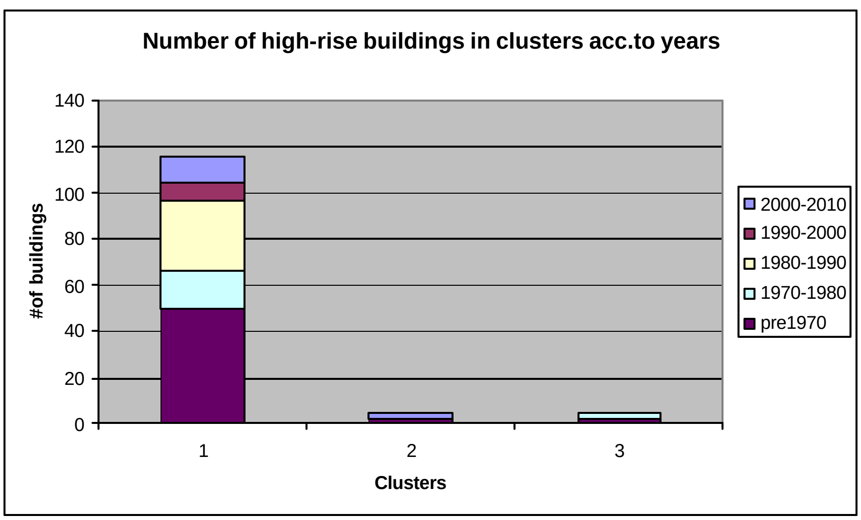



**Figure 4.9: Number of buildings in Building Clusters according to Year of Construction in Boston**

Cluster 1 is located in downtown Boston in a primary downtown density area. It is the cluster with the highest number of buildings and the densest cluster in terms of buildings per area. There are 100 buildings in total in this cluster (Table 4.14), which makes up 85.29% of all the high-rise buildings. Around 43.10% of these buildings are constructed after 1980s, although the highest rate of construction took place before 1970s (Table 4.15). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in all years. It is the oldest cluster, but it still continues to expand (Table 4.15). With 100 buildings, Cluster 1 can be named as the only building cluster in Boston.

Cluster 2 is also located in downtown Boston. The center of the cluster is in the primary downtown density area. It is the second densest cluster. There are 5 buildings in this cluster (Table 4.14). 3 buildings are constructed after 2000 and 40% of the buildings are constructed before 1970s (Table 4.15). Cluster 2 is located next to Cluster 1 and it might indicate the new expansion of Cluster 1. Cluster 3 is found in an edgeless city density area, 38 miles away in shortest distance from the center of downtown Boston. It is the third densest cluster and has 5 buildings which are all built before 1980s (Table 4.14)

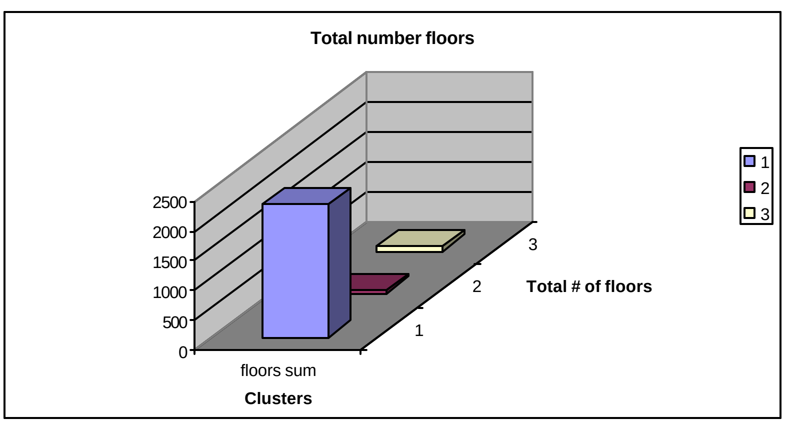



**Figure 4.10: Total Number of floors in Boston Building Clusters**

#### 4.1.2.3 Boston Company-Building Analysis

In Boston, building clusters 1 and 2 intersect with company clusters 1, 2, and 3 in the core of downtown area. Company clusters 4, 5, 6, 7, 8, and 9 do not intersect with any building clusters. This outcome indicates that logistics and IT are found in specialized clusters, high-rise building clusters are not the preferred locations for these industries in Boston. They locate in low-rise, low-density business nodes. Other knowledge-intensive producer services prefer to locate in high-rise districts. The highest building cluster in terms of total number of floors is also the oldest building cluster found in downtown Boston, which is building cluster 1 (Figure 4.11), most of the high-rise buildings in this cluster are also found in company cluster 1, which is the most diversified and largest company cluster in Boston. Map 8 shows Boston company and building clusters together.

### 4.1.3. Chicago

Chicago has one urban envelope and four edge cities identified by Lang et al (2007). The downtown is found in the core of the urban envelope identified by the red circle in Map 9. The downtown Chicago still dominates the metropolitan area. Chicago has one of the biggest downtowns together with New York and compared to other cities these two cities have the largest share of their regional space located in central business districts (Lang et al., 2007). 49.2% of all the office space of Chicago lies inside the downtown area, and 0.8% of all the office space lies inside the urban envelope. Chicago also has four edge cities. Together these edge cities contain 10.7% of Chicago's office space. The largest edge city Schaumburg has 4.4% of the office space. O'Hare has 2.6%, Naperville has 2%, and Oakbrook has 1.7% of all the office space in Chicago. 39.4% of all office space in Chicago is scattered in edgeless cities (Lang, et al. 2007). Map 9 demonstrates the findings of Lang et al (2007) in Chicago.

#### 4.1.3.1 Chicago Companies

There are 519 APS TNC locations identified in Chicago Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.08 miles. The distance to identify clusters was taken as 0.09 miles. The minimum number of points that gave the median number of clusters was 7 and the median number of clusters turned out to be 9. 66.67% of the companies in Chicago belong to a cluster (Table 4.18). 5 out of the 9 clusters are found in areas with edgeless city densities (Clusters 3, 5, 7, 8, and 9). Clusters 2, 4, and 6 are found in edge cities. Cluster 1 is the only cluster located in the downtown area.

In Chicago only 4 clusters are found in areas that have higher densities than edgeless city density, which proves that most of the company clusters are located in a decentralized pattern, yet the multiple locations prove the polycentric structure of the global business activity nodes. All ten industries are represented in Chicago (Table 4.17). Logistics, IT, and real estate are the top three industries in terms of number of companies. IT and logistics together constitute almost 45.28 % of all firms in Chicago. Table 4.17 shows the industry composition of Chicago companies according to the total number of firms. Law, Advertising and Marketing, and Insurance are the top three sectors with the highest rate of membership in a cluster. The real estate, logistics, and accounting are the top three sectors with the lowest degree of clustering. Table 4.18 summarizes these results.

### Table 4.17: Industries represented in Chicago APS TNCs.

| Industries | % of all firms |
|---|---|
| Accounting | 4.43 |
| Advertising and Marketing | 6.74 |
| Design Consultancy | 5.78 |
| Finance/Banking | 8.67 |
| Insurance | 6.74 |
| IT | 17.53 |
| Law | 2.50 |
| Logistics | 27.75 |
| Management Consultancy | 9.25 |
| Real Estate | 10.60 |
| TOTAL | 100.00 |

### Table 4.18: Number of Companies in Clusters and Percent of Clustering among Industries in Chicago

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 14 | 31 | 18 | 33 | 24 | 30 | 13 | 34 | 35 | 9 | 241 |
| **2** | 0 | 1 | 1 | 1 | 5 | 13 | 0 | 0 | 0 | 2 | 23 |
| **3** | 1 | 0 | 3 | 2 | 0 | 9 | 0 | 2 | 2 | 4 | 23 |
| **4** | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 4 | 1 | 0 | 7 |
| **5** | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 13 | 0 | 0 | 16 |
| **6** | 2 | 0 | 0 | 1 | 1 | 2 | 0 | 5 | 0 | 1 | 12 |
| **7** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 1 | 7 |
| **8** | 0 | 0 | 1 | 0 | 0 | 5 | 0 | 3 | 0 | 0 | 9 |
| **9** | 0 | 0 | 0 | 1 | 1 | 5 | 0 | 0 | 1 | 0 | 8 |
| **Clustered Companies** | 17 | 32 | 24 | 38 | 31 | 68 | 13 | 67 | 39 | 17 | 346 |
| **Total Companies** | 23 | **35** | 30 | 45 | 35 | 91 | 13 | 144 | 48 | 55 | 519 |
| **% of clustering** | 73.91 | 91.43 | 80.00 | 84.44 | 88.57 | 74.73 | 100.00 | 46.53 | 81.25 | 30.91 | 66.67 |

**Table 4.19: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Chicago**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5.81 | 12.86 | 7.47 | 13.69 | 9.96 | 12.45 | 5.39 | 14.11 | 14.52 | 3.73 | 100.00 |
| 2 | 0.00 | 4.35 | 4.35 | 4.35 | 21.74 | 56.52 | 0.00 | 0.00 | 0.00 | 8.70 | 100.00 |
| 3 | 4.35 | 0.00 | 13.04 | 8.70 | 0.00 | 39.13 | 0.00 | 8.70 | 8.70 | 17.39 | 100.00 |
| 4 | 0.00 | 0.00 | 14.29 | 0.00 | 0.00 | 14.29 | 0.00 | 57.14 | 14.29 | 0.00 | 100.00 |
| 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.75 | 0.00 | 81.25 | 0.00 | 0.00 | 100.00 |
| 6 | 16.67 | 0.00 | 0.00 | 8.33 | 8.33 | 16.67 | 0.00 | 41.67 | 0.00 | 8.33 | 100.00 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 85.71 | 0.00 | 14.29 | 100.00 |
| 8 | 0.00 | 0.00 | 11.11 | 0.00 | 0.00 | 55.56 | 0.00 | 33.33 | 0.00 | 0.00 | 100.00 |
| 9 | 0.00 | 0.00 | 0.00 | 12.50 | 12.50 | 62.50 | 0.00 | 0.00 | 12.50 | 0.00 | 100.00 |

**Table 4.20: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Chicago**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 60.87 | 88.57 | 60.00 | 73.33 | 68.57 | 32.97 | 100.00 | 23.61 | 72.92 | 16.36 |
| 2 | 0.00 | 2.86 | 3.33 | 2.22 | 14.29 | 14.29 | 0.00 | 0.00 | 0.00 | 3.64 |
| 3 | 4.35 | 0.00 | 10.00 | 4.44 | 0.00 | 9.89 | 0.00 | 1.39 | 4.17 | 7.27 |
| 4 | 0.00 | 0.00 | 3.33 | 0.00 | 0.00 | 1.10 | 0.00 | 2.78 | 2.08 | 0.00 |
| 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.30 | 0.00 | 9.03 | 0.00 | 0.00 |
| 6 | 8.70 | 0.00 | 0.00 | 2.22 | 2.86 | 2.20 | 0.00 | 3.47 | 0.00 | 1.82 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.17 | 0.00 | 1.82 |
| 8 | 0.00 | 0.00 | 3.33 | 0.00 | 0.00 | 5.49 | 0.00 | 2.08 | 0.00 | 0.00 |
| 9 | 0.00 | 0.00 | 0.00 | 2.22 | 2.86 | 5.49 | 0.00 | 0.00 | 2.08 | 0.00 |
| Non-clustered | 26.09 | 8.57 | 20.00 | 15.56 | 11.43 | 25.27 | 0.00 | 53.47 | 18.75 | 69.09 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

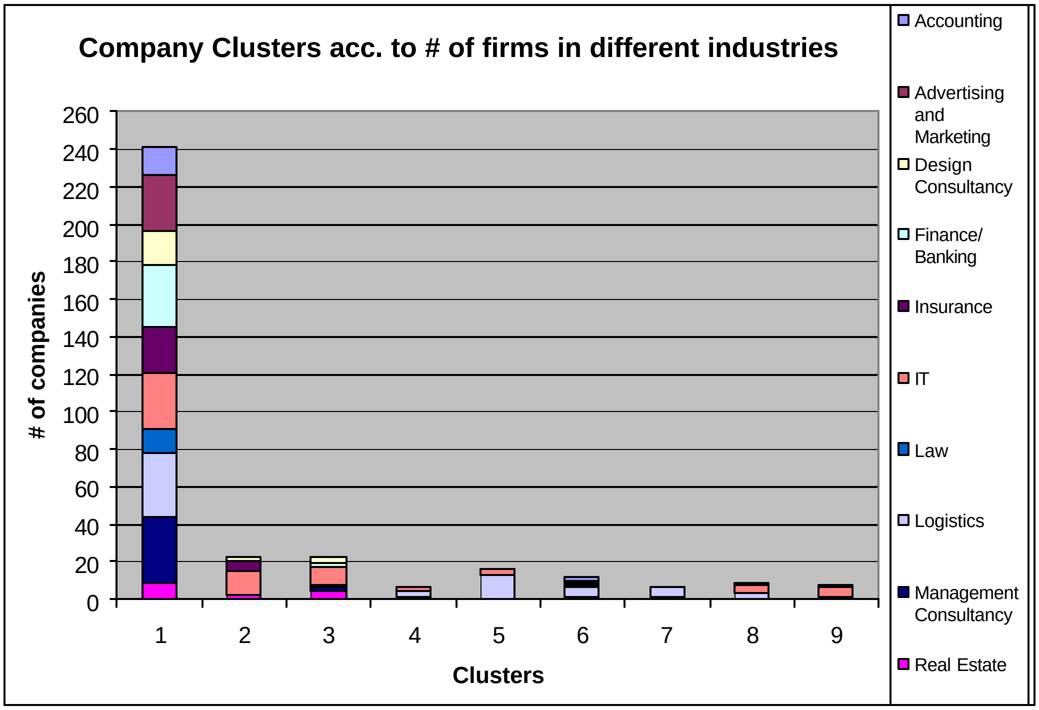



**Figure 4.11: Number of companies in company clusters in Chicago**

The largest cluster with 241 companies is Cluster 1, which is located in the middle of downtown Chicago in a primary-downtown density area. It is also the densest cluster (Table 4.18) and have 16.36% of all TNCs (Table 4.20). There are 241 firms in total in this cluster, of which 218 are branch locations. This is the cluster with the highest number of HQ locations. All industries are present, thus it is the most diverse cluster. Management consultancy, logistics, and finance/banking constitute top three sectors in the cluster. Together they make up constitute around 42.32% of the companies in this cluster (Table 4.19). Real estate, law, and accounting have the least number of firms in this cluster (Table 4.18). Cluster 1 is the most dominant cluster in all the sectors except for logistics, logistics is highly decentralized. However, this cluster is also the most dominant cluster in terms of clustered logistics firms. 100% of all the law TNCs identified in Chicago metropolitan area are found in this cluster. This percentage is 88.57% for advertising and marketing and 73.33% for finance and banking (Table 4.20).

Cluster 2 is the second largest cluster and it is also located in the edge city of Schaumburg in an edge city density area, 23 miles away from downtown Chicago in shortest distance. There are 23 firms in this cluster, of which 20 are branch locations (Table 4.18). IT, insurance, and real estate dominate this cluster with 13, 5, and 2 firms consecutively. This cluster is the second most dominant cluster in terms of clustered IT and insurance firms (Table 4.20). Cluster 3 is located in an edgeless city density area close to O'Hare edge city, 13 miles away from downtown Chicago and 2.5 miles away from Chicago O'Hare International Airport in shortest distance. It is also the second largest and the third densest cluster. There are 23 firms in total in this cluster, of which 21 are branch locations (Table 4.18). IT, real estate, and design consultancy are the most dominant sectors in the cluster. IT is the number one sector with 9 firms, which make up 39.13% of the cluster (Table 4.19). Cluster 3 is also the second most dominant cluster in terms of clustered firms in design consultancy, management consultancy, and real estate (Table 4.20).

Cluster 4 is located in the edge city of O'Hare 14.5 miles away from downtown. The cluster includes Chicago O'Hare International Airport. The center of the cluster is in the edge city density area. There are 7 firms in the cluster, of which 6 are branch locations. There are 4 logistics firms (Table 4.18). IT and logistics together make up 71.43% of all the firms in the cluster (Table 4.19). Cluster 3 and 4 intersect, thus they might be defining a larger cluster in which IT and logistics would be the most dominant sectors (Map 10A and Map10B). Cluster 5 is located in an edgeless city density area between edge cities of O'Hare and Schaumburg. It is located 18 miles from downtown Chicago and 4 miles from Chicago O'Hare International Airport. There are 16 firms in this cluster of which 13 are logistics firms (Table 4.18). Logistics make up 81.25% of all the firms in this cluster (Table 4.19). Cluster 5 is the second most dominant cluster in terms of clustered logistics firms (Table 4.20). The other three companies in the cluster are IT firms, no other industry is represented (Table 4.18).

Cluster 6 is located in Naperville in an edge city density area approximately 16 miles in shortest distance from the center of downtown Chicago. There are 12 firms in total in this cluster, all of which are branch locations. Logistics dominate the cluster with 5 firms. IT and accounting each has 2 firms. (Table 4.18). IT and logistics make up 58.34% of all the firms in this cluster. Cluster 6 is the second most dominant cluster in terms of clustered accounting firms (Table 4.20). Cluster 7 is located on the fringe of the urban envelope. The center of the cluster is in the edgeless cities density area approximately 4 miles in shortest distance from the center of downtown Chicago. There are 7 firms in this cluster of which 6 are logistics firms (Table 4.18). Cluster 6 and 7 are located 9.5 miles and 12 miles from Chicago O'Hare International Airport. Clusters 4, 5, 6, and 7 grew on logistics due to their proximity to the airport.

Cluster 8 is located near the edge city of Oakbrook, approximately 25 miles from downtown Chicago and 5.5 miles away from Oakbrook. The cluster has 9 firms. IT dominates the cluster with 5 firms followed by logistics which has 3 firms, there is only 1 design consultancy firm in the cluster (Table 4.18). IT and logistics together make up 88.89% of all the firms in the cluster. (Table 4.19). Cluster 9 is located in an edgeless city density area with 7 firms. Like cluster 8, cluster 9 is an IT dominated cluster. 4 out of 7 firms are IT firms. There is one firm each from logistics, finance/banking, and design consultancy (Table 4.10).

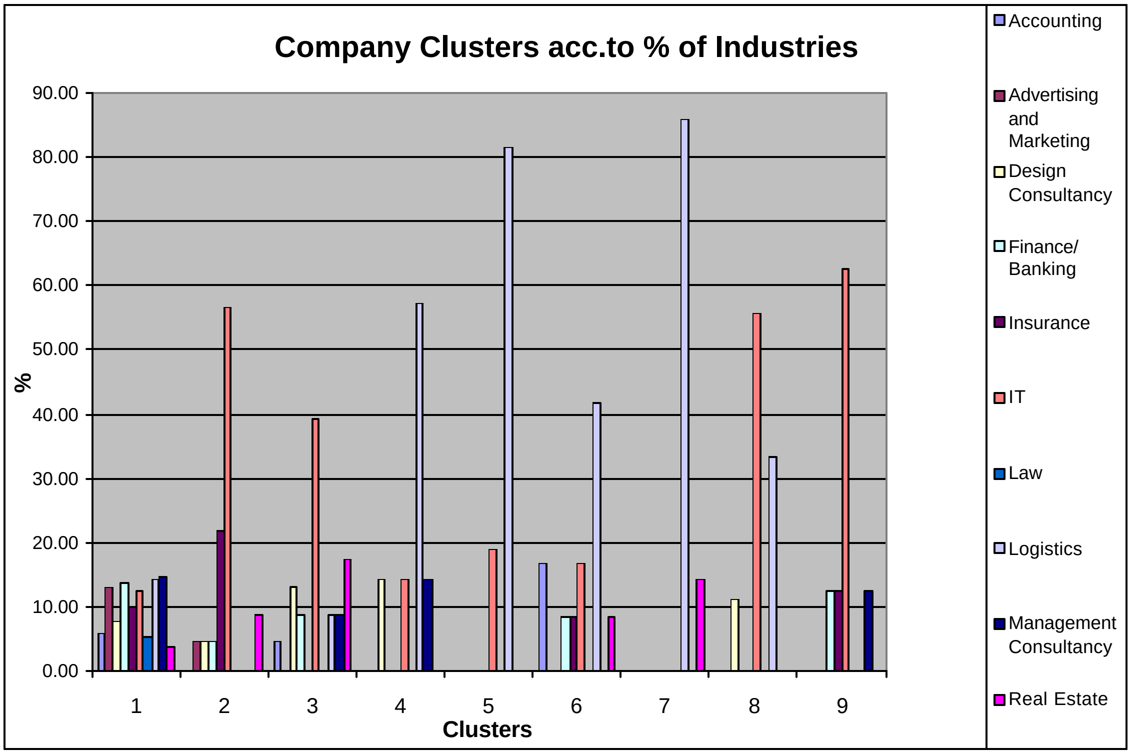



**Figure 4.12: Percent of Industries in Company Clusters in Chicago**

Urban envelope and downtown together have above 60% of the firms in accounting, advertising and marketing, design consultancy, finance/banking, insurance, law, and management consultancy. These industries are concentrated in the same cluster in the downtown area. The rest of the company clusters are founded on IT and logistics. IT and logistics firms are found in clusters that do not have high percentages of other producer services and they are located away from downtown in edge city density or edgeless city density areas. Logistics dominated clusters mostly evolved around Chicago O'Hare International Airport.  Map 10A shows the APS TNC locations and Map 10B demonstrates the company clusters in Chicago.

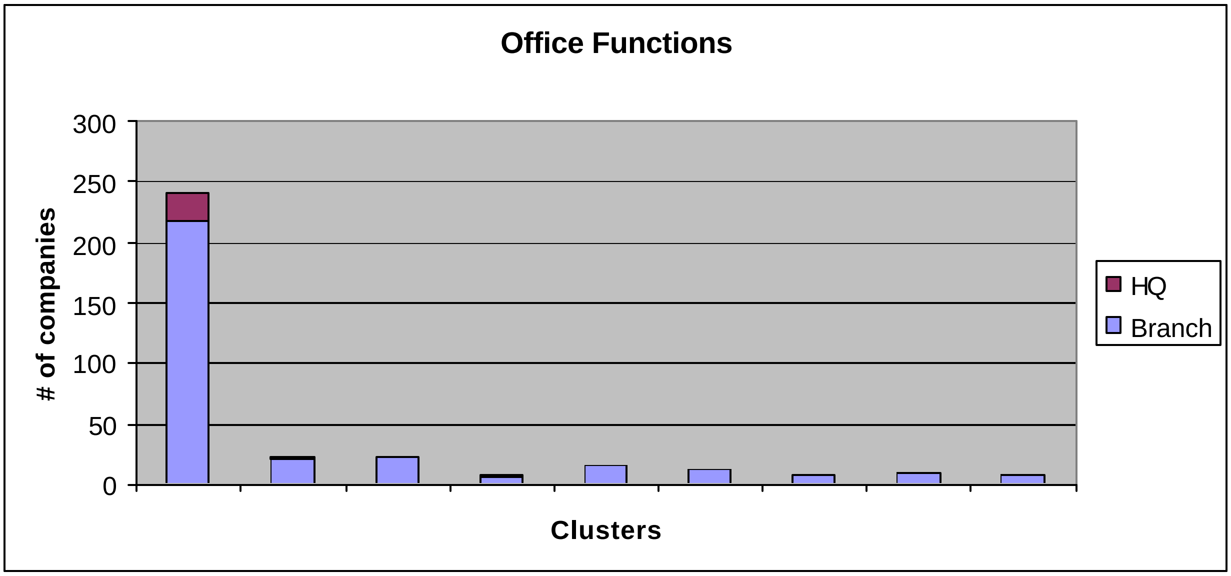



**Figure 4.13: Number of Companies according to Office Functions in Chicago**

### 4.1.3.2 Chicago Buildings

There are 277 high-rise building locations identified in total in Chicago Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.14 miles, thus the distance that is used in calculating the clusters is taken as 0.15 miles. The minimum number of points that formed the median number of clusters was 4 and the median number of clusters turned out to be 3. Two of these clusters are located in an area that has a higher density than edgeless city density, thus the clusters are located in a centralized fashion. Map 11A and Map 11B demonstrates the office buildings and clusters in Chicago.

**Table 4.21: Percent of Buildings according to Year of Construction in Chicago**

| Years | % of buildings |
|---|---|
| **2000-2010** | 11.55 |
| **1990-2000** | 7.94 |
| **1980-1990** | 21.30 |
| **1970-1980** | 13.00 |
| **pre1970** | 46.21 |
| TOTAL | 100.00 |

**Table 4.22: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Chicago**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 29 | 16 | 38 | 27 | 119 | 229 |
| 2 | 2 | 3 | 3 | 0 | 0 | 8 |
| 3 | 0 | 0 | 5 | 0 | 0 | 5 |
| Total Clustered Buildings | 31 | 19 | 46 | 27 | 119 | 242 |
| Total Buildings | 32 | 22 | 59 | 36 | 128 | 277 |
| % of clustering | 96.88 | 86.36 | 77.97 | 75.00 | 92.97 | 87.36 |

**Table 4.23: Percent of Buildings in Clusters according to Year of Construction in Chicago**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 12.66 | 6.99 | 16.59 | 11.79 | 51.97 | 100.00 |
| 2 | 25.00 | 37.50 | 37.50 | 0.00 | 0.00 | 100.00 |
| 3 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 100.00 |

**Table 4.24: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Chicago**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 90.63 | 72.73 | 64.41 | 75.00 | 92.97 | 82.67 |
| 2 | 6.25 | 13.64 | 5.08 | 0.00 | 0.00 | 2.89 |
| 3 | 0.00 | 0.00 | 8.47 | 0.00 | 0.00 | 1.81 |
| Non-clustered | 3.13 | 13.64 | 22.03 | 25.00 | 7.03 | 12.64 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 68.07% of all high-rise office buildings in Chicago were constructed after 1980s. 46.21% of these buildings were constructed before 1970s, which is the highest percentage of building construction in a time interval (Table 4.21). 87.36% of all buildings in Chicago belong to a cluster (Table 4.22). The percent of clustering declined between pre1970s to 1990s from

92.97% to 77.97% suggesting decentralization. After 1990s, the percentage of membership in a cluster increased reaching its peak between 2000-2010 as 96.88%. (Table 4.22). The multiple locations of building clusters suggest a polycentric structure. Downtown Chicago has 82.67% of all the high-rise buildings.

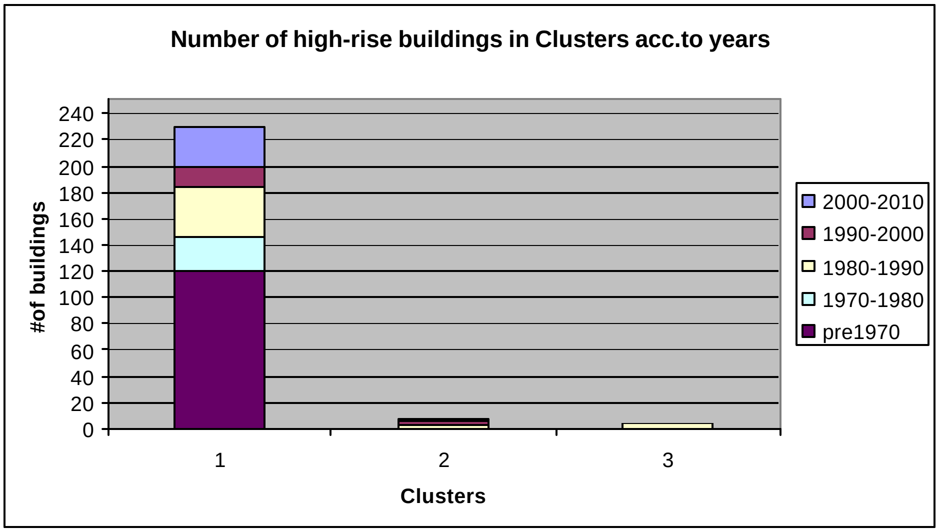



**Figure 4.14: Number of buildings in Building Clusters according to Year of Construction in Chicago**

Cluster 1 is located in downtown Chicago. It is the cluster with the highest number of buildings and the densest cluster in terms of buildings per area. There are 229 buildings in total in this cluster (Table 4.22), which makes up 82.67% of all the high-rise buildings (Table 4.24). Around 48.03% of these buildings are constructed after 1980s, although the highest rate of construction took place before 1970s (Table 4.23). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in all years. It is the oldest cluster, but it still continues to expand (Table 4.15). Between 2000-2010 90.63% of all the 32 buildings constructed in Chicago was in this cluster.

Cluster 2 is located in Schaumburg edge city, 23.5 miles away from downtown.  It is the third densest cluster. There are 8 buildings in this cluster, all of them are constructed after 1980s (Table 4.22). Cluster 3 is found in an edgeless city density area, 38 miles away in shortest distance from the center of downtown Chicago. It is the second densest cluster and has 5 buildings which are all built between 1980-1990 (Table 4.22). Cluster 3 is located 2 miles away from Chicago O’Hare International Airport in shortest distance.

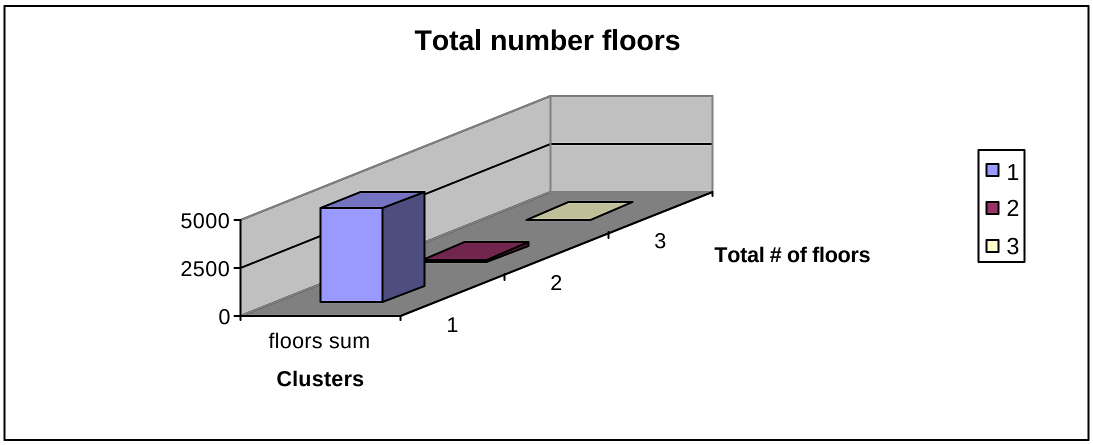



**Figure 4.15: Total Number of floors in Chicago Building Clusters**

### 4.1.3.3 Chicago Company-Building Analysis

In Chicago, all building clusters intersect with at least one company cluster. Company clusters 5, 6, 7, 8, and 9, which are predominantly IT and logistics clusters do not intersect with any building clusters. This outcome indicates that logistics and IT are found in specialized clusters and high-rise buildings are not their preferred locations. They locate in low-rise, low-density business nodes. Other knowledge-intensive producer services prefer to locate in high-rise districts. Map 12 shows Chicago company and building clusters together. The highest building cluster in terms of total number of floors is also the oldest building cluster found in downtown Chicago, which is building cluster 1 (Figure 4.19). Building cluster one collides with company cluster 1, which is the densest and most diversified company cluster. The high percentage of company and building presence in this location proves the dominance of Chicago downtown as a global business activity node in the region. The building cluster in this area has always attracted more construction (Figure 4.20).

Schaumburg is another area that building cluster 2 and company cluster 2 collides with one another. Company cluster is IT dominated with 13 firms although insurance also has a strong presence with 5 firms. The building cluster 2 is developed after 1980s. Major expansion occurred between 1980-2000. This shows that although it is not a general trend, IT clusters may take place in recently developed high-rise locations. O'Hare is another location that IT and logistics dominated company clusters 3 and 4 intersect with building clusters 3. Building cluster 3 is the smallest cluster with 5 buildings and all of its buildings are developed between 1980-1990, there was no expansion in this cluster afterwards. Map 12 illustrates the company and building clusters in Chicago.

#### 4.1.4. Dallas

Dallas has one downtown area and two secondary downtown areas: Ft. Worth and Oaklawn. The downtown, indicated with a red circle in the GIS map, consists of 20.6% of all the office space. Ft. Worth is located 31 miles away from downtown Dallas and has 3.7% of all the office space. Oaklawn is located 4.2 miles away from downtown Dallas and has 2.7% of all the office space. There are three edge cities identified in Dallas metropolitan area: Irving/Las Colinas, LBJ

Freeway/Corridor, and North Dallas Corridor that connects downtown and LBJ Freeway/Corridor. North Dallas Corridor has nearly 22 percent of the total office space in Dallas. Corridors are commonly supported by highways or other important transportation features (Lang et al. 2007, 18). Irving/Las Colinas is located 11.5 miles away from downtown Dallas and has 7.4% of all office space clustered whereas LBJ Freeway is located 10.2 miles away from downtown and has 9.9% of all the office space in Dallas metropolitan area. In Dallas, 33.9% of the office space is found in edgeless cities (Lang et al. 2007). Map 13 demonstrates the findings of Lang et al (2007) in Dallas.

#### 4.1.4.1. Dallas Companies

There are 376 APS TNC locations identified in Dallas metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.12 miles. The distance to identify clusters was taken as 0.13 miles. The minimum number of points that gave the median number of clusters was 9 and the median number of clusters turned out to be 8. 47.87% of the companies in Dallas belong to a cluster. Among the 8 clusters, only two clusters are found in areas with edgeless city densities which prove that most of the company clusters are located in a centralized pattern, yet the multiple locations prove the polycentric structure of the global business activity nodes. Cluster 1 is found in downtown, clusters 2 and 8 are found in LBJ Freeway/Corridor, clusters 3 and 5 are found in Irving/Las Colinas, and Cluster 4 is found in Ft. Worth.

**Table 4.25: Industries represented in Dallas APS TNCs**

| Industries | % of all firms |
|---|---|
| Accounting | 6.12 |
| Advertising and Marketing | 0.00 |
| Design Consultancy | 10.11 |
| Finance/Banking | 5.05 |
| Insurance | 4.79 |
| IT | 16.49 |
| Law | 3.19 |
| Logistics | 38.30 |
| Management Consultancy | 8.24 |
| Real Estate | 7.71 |
| TOTAL | 100.00 |

**Table 4.26: Number of Companies in Clusters and Percent of Clustering among Industries in Dallas**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 0 | 11 | 8 | 8 | 4 | 12 | 7 | 12 | 2 | 72 |
| 2 | 2 | 0 | 4 | 3 | 2 | 10 | 0 | 6 | 4 | 3 | 34 |
| 3 | 2 | **0** | 0 | 0 | 0 | 7 | 0 | 5 | 3 | 0 | 17 |
| 4 | 7 | **0** | 2 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 15 |
| 5 | 0 | **0** | 1 | 1 | 0 | 6 | 0 | 1 | 2 | 1 | 12 |
| 6 | 0 | **0** | 0 | 1 | 0 | 0 | 0 | 9 | 0 | 0 | 10 |
| 7 | 0 | **0** | 0 | 2 | 0 | 7 | 0 | 1 | 0 | 0 | 10 |
| 8 | 1 | **0** | 2 | 1 | 2 | 0 | 0 | 1 | 3 | 0 | 10 |
| Clustered Companies | 20 | 0 | 20 | 17 | 13 | 35 | 12 | 30 | 26 | 7 | 180 |
| Total Companies | 23 | **0** | 38 | 19 | 18 | 62 | 12 | 144 | 31 | 29 | 376 |
| % of clustering | 86.96 | 0.00 | 52.63 | 89.47 | 72.22 | 56.45 | 100.00 | 20.83 | 83.87 | 24.14 | 47.87 |

**Table 4.27: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Dallas**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11.11 | 0.00 | 15.28 | 11.11 | 11.11 | 5.56 | 16.67 | 9.72 | 16.67 | 2.78 | 100.00 |
| 2 | 5.88 | 0.00 | 11.76 | 8.82 | 5.88 | 29.41 | 0.00 | 17.65 | 11.76 | 8.82 | 100.00 |
| 3 | 11.76 | 0.00 | 0.00 | 0.00 | 0.00 | 41.18 | 0.00 | 29.41 | 17.65 | 0.00 | 100.00 |
| 4 | 46.67 | 0.00 | 13.33 | 6.67 | 6.67 | 6.67 | 0.00 | 0.00 | 13.33 | 6.67 | 100.00 |
| 5 | 0.00 | 0.00 | 8.33 | 8.33 | 0.00 | 50.00 | 0.00 | 8.33 | 16.67 | 8.33 | 100.00 |
| 6 | 0.00 | 0.00 | 0.00 | 10.00 | 0.00 | 0.00 | 0.00 | 90.00 | 0.00 | 0.00 | 100.00 |
| 7 | 0.00 | 0.00 | 0.00 | 20.00 | 0.00 | 70.00 | 0.00 | 10.00 | 0.00 | 0.00 | 100.00 |
| 8 | 10.00 | 0.00 | 20.00 | 10.00 | 20.00 | 0.00 | 0.00 | 10.00 | 30.00 | 0.00 | 100.00 |

**Table 4.28: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Dallas**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 34.78 | 0.00 | 28.95 | 42.11 | 44.44 | 6.45 | 100.00 | 4.86 | 38.71 | 6.90 |
| 2 | 8.70 | 0.00 | 10.53 | 15.79 | 11.11 | 16.13 | 0.00 | 4.17 | 12.90 | 10.34 |
| 3 | 8.70 | 0.00 | 0.00 | 0.00 | 0.00 | 11.29 | 0.00 | 3.47 | 9.68 | 0.00 |
| 4 | 30.43 | 0.00 | 5.26 | 5.26 | 5.56 | 1.61 | 0.00 | 0.00 | 6.45 | 3.45 |
| 5 | 0.00 | 0.00 | 2.63 | 5.26 | 0.00 | 9.68 | 0.00 | 0.69 | 6.45 | 3.45 |
| 6 | 0.00 | 0.00 | 0.00 | 5.26 | 0.00 | 0.00 | 0.00 | 6.25 | 0.00 | 0.00 |
| 7 | 0.00 | 0.00 | 0.00 | 10.53 | 0.00 | 11.29 | 0.00 | 0.69 | 0.00 | 0.00 |
| 8 | 4.35 | 0.00 | 5.26 | 5.26 | 11.11 | 0.00 | 0.00 | 0.69 | 9.68 | 0.00 |
| Non-clustered | 13.04 | 100.00 | 47.37 | 10.53 | 27.78 | 43.55 | 0.00 | 79.17 | 16.13 | 75.86 |

There are no transnational advertising and marketing firms identified in Dallas. Logistics, IT, and design consultancy are the top three industries in terms of number of companies. Logistics and IT together constitute 54.79% of all the APS TNCs in Dallas. Table 4.25 shows the industry composition of Dallas. Map 14A shows the APS TNC locations and Map 14B illustrates the company clusters in Dallas.

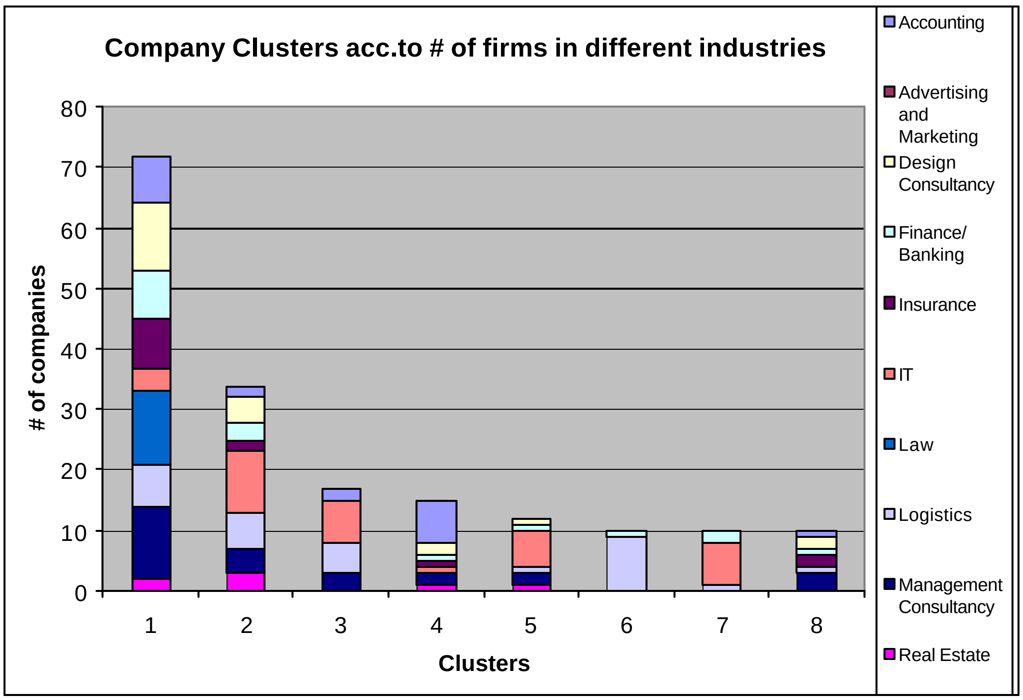



**Figure 4.16: Number of companies in company clusters in Dallas**

The largest cluster with 72 companies is Cluster 1, which is located in downtown Dallas. The center of this cluster is found in a primary-downtown density area. It is the cluster with the highest number of companies and second densest cluster (Table 4.26). There are 72 firms in total in this cluster, of which 70 are branch locations. All industries except for advertising and marketing are present, thus this is the most diversified cluster in Dallas. Management consultancy, design consultancy, and law are the top three sectors in this cluster, together they constitute around 48.62% of the companies in this cluster (Table 4.27). Real estate, IT, and logistics are the three sectors with the lowest number of companies (Table 4.26). Cluster 1 is the most dominant cluster in five sectors: accounting, finance/banking, insurance, law, and management consultancy. All law TNCs and 44.44% of all the insurance companies are found in this cluster. This percentage is 42.11% for Finance/Banking, 38.71% for management consultancy, and 34.78% for accounting firms. This cluster also is the largest cluster in terms of clustered design consultancy firms with 28.95%. Logistics and real estate are highly decentralized in Dallas. 79.17% of all logistics firms and 75.86% of all real estate firms do not belong in a cluster (Table 4.28).

Cluster 2 is located in LBJ Freeway/Corridor. The center of the cluster is in the secondary downtown density area, 10.6 miles away from downtown. Cluster 2 is the second largest cluster in terms of number of companies (Table 4.26). There are 34 firms in this cluster, all of which are branch locations. All industries except for advertising and marketing and law are present in this cluster. IT, logistics, management consultancy and design consultancy are the top three sectors. IT and logistics together make up 47.06% of all the companies in the cluster (Table 4.27). Cluster 2 is the most dominant cluster in terms of clustered IT and real estate firms with 16.13% of IT companies, 10.34% of real estate companies (Table 4.28).

Cluster 3 is located in Irving/Las Colinas edge city. The center of the cluster is in the edge city density area approximately 12 miles in shortest distance from the center of downtown Dallas and 3 miles away from Dallas/Ft. Worth International Airport. It is the cluster with the third highest number of companies (Table 4.26). There are 17 firms in total in this cluster, of which 15 are branch locations. Only four industries are present in this cluster: accounting, IT, logistics, and management consultancy. IT is the most dominant sector with 41.18% of all the companies in the cluster followed by logistics with 29.41% (Table 4.27). This cluster is the second most dominant cluster in terms of clustered IT firms. 11.29% of all IT companies are found in this cluster. Cluster 3 is the cluster with the highest percentage of already clustered firms in design consultancy and IT (Table 4.28).

Cluster 4 is located in the secondary downtown of Ft. Worth. The center of the cluster is in an edge city density area approximately 32 miles in shortest distance from the center of downtown Dallas. It is the cluster with the fourth highest number of companies and it is the densest cluster (Table 4.26). There are 15 firms in total in this cluster, of which are branch locations. Accounting is the most dominant sector with 7 companies followed by management consultancy and design consultancy with 2 companies from each. Accounting makes up 46.67% of the cluster (Table 4.27). The cluster is the second most dominant cluster in terms of accounting TNCs. There are no companies from advertising and marketing, law, and logistics sectors in this cluster (Table 4.28).

Cluster 5 is located in Irving/Las Colinas edge city. The center of the cluster is in an edge city density area approximately 9.6 miles in shortest distance from the center of downtown Dallas and 4.8 miles away from Dallas/ Ft. Worth International Airport. It is the cluster with the fifth highest number of companies (Table 4.26). There are 12 firms in total in this cluster, of which 11 are branch locations. IT dominates the cluster with 6 firms, which make up 50% of all companies in the cluster (Table 4.27). Management consultancy has two firms and design consultancy, finance/banking, logistics, and real estate each have one firm. This cluster is the third most dominant cluster in terms of clustered IT firms (Table 4.28). Cluster 6 is located in an edgeless city density area approximately 18 miles in shortest distance from the center of downtown Dallas, 6.5 miles from Irving/Las Colinas and 4.5 miles away from Dallas/ Ft. Worth International Airport. There are 10 firms in total in this cluster, all of which are branch locations (Table 4.26). 90% of the firms belong to logistics (Table 4.27). This cluster is the most dominant cluster in terms of clustered logistics firms (Table 4.28).

Cluster 7 is also located in an edgeless cities density area approximately 20 miles north of downtown Dallas and 10 miles north of LBJ Freeway Corridor. There are 10 firms in total in this cluster, 8 of which are branch locations. IT dominate the cluster with 7 firms (Table 4.26), which makes this cluster the second most dominant cluster in terms of clustered IT firms (Table 4.28). Cluster 8 is located in LBJ Freeway Corridor edge city area in a secondary downtown density location. There are 10 firms in the cluster. IT, real estate, law, and advertising and marketing have no firms in Cluster 8 (Table 4.26).

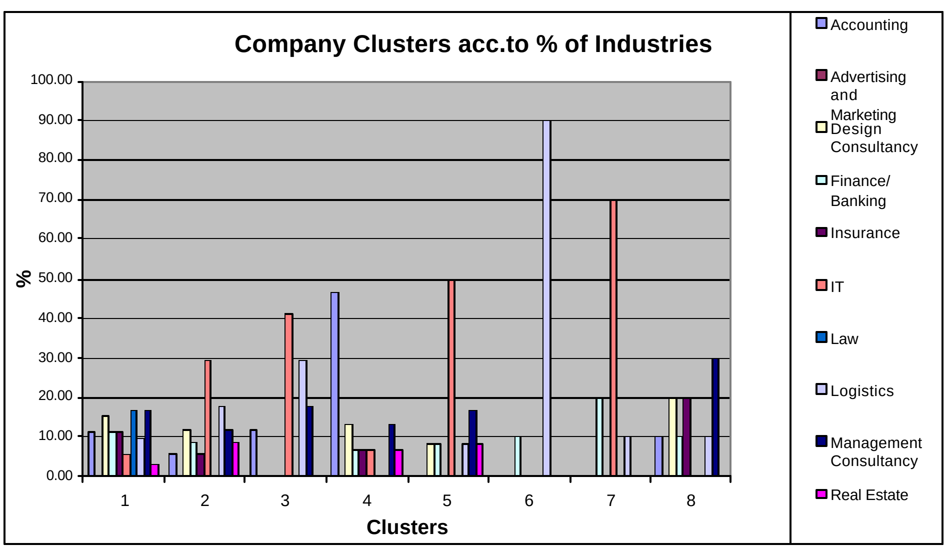



**Figure 4.17: Percent of Industries in Company Clusters in Dallas**

In Dallas, all industries except for law are clustered in various locations within the metropolitan area. Logistics and real estate are the most decentralized industries in Dallas. 79.17% of all logistics and 75.86% of all real estate firms do not belong in a cluster. IT firms are found in clusters that are located far away from traditional downtown area. In Dallas, IT firms are found in diversified clusters. Map 14 demonstrates the company clusters in Dallas.

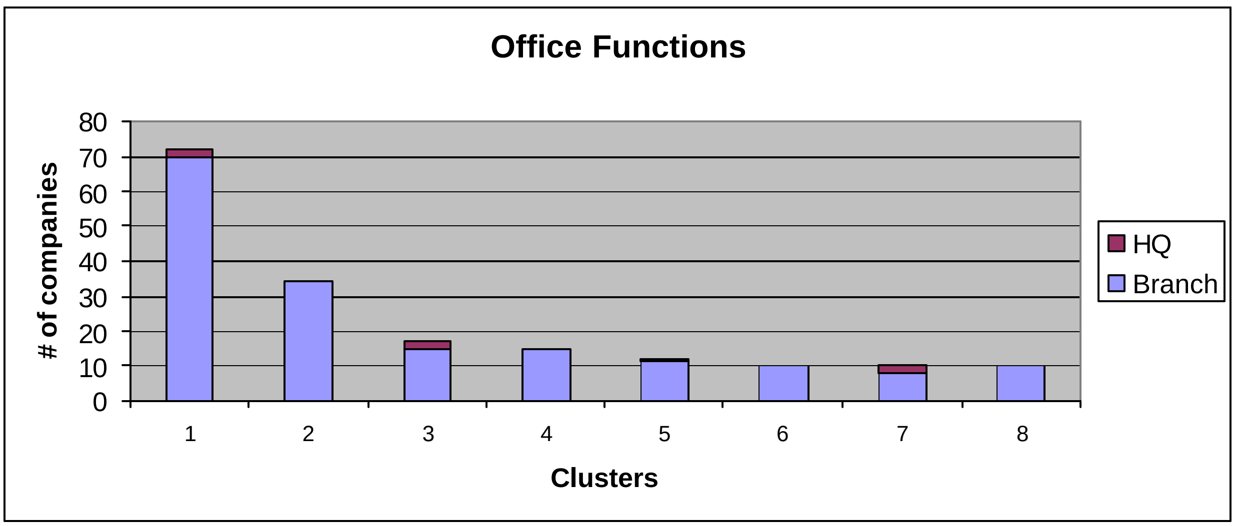



**Figure 4.18: Number of Companies according to Office Functions in Dallas**

#### 4.1.4.2 Dallas Buildings

There are 213 high-rise building locations identified in total in Dallas Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.20 miles, thus the distance that is used in calculating the clusters is taken as 0.21 miles. The minimum number of points that formed the median number of clusters was 9 and the median number of clusters turned out to be 7. All clusters are located in areas that have higher density than edgeless city density, thus the clusters are located in a centralized way.

**Table 4.29: Percent of Buildings according to Year of Construction in Dallas**

| Years | % of buildings |
|---|---|
| 2000-2010 | 10.33 |
| 1990-2000 | 7.51 |
| 1980-1990 | 50.23 |
| 1970-1980 | 11.74 |
| Pre1970 | 20.19 |
| TOTAL | 100.00 |

**Table 4.30: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Dallas**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 7 | 4 | 27 | 6 | 20 | 64 |
| 2 | 6 | 4 | 10 | 2 | 0 | 22 |
| 3 | 2 | 0 | 3 | 2 | 13 | 20 |
| 4 | 2 | 2 | 5 | 1 | 0 | 10 |
| 5 | 1 | 0 | 11 | 1 | 0 | 13 |
| 6 | 2 | 0 | 9 | 1 | 0 | 12 |
| 7 | 0 | 2 | 6 | 2 | 0 | 10 |
| Total Clustered Buildings | 20 | 12 | 71 | 15 | 33 | 151 |
| Total Buildings | 22 | 16 | 107 | 25 | 43 | 213 |
| % of clustering | 90.91 | 75.00 | 66.36 | 60.00 | 76.74 | 70.89 |

**Table 4.31: Percent of Buildings in Clusters according to Year of Construction in Dallas**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 10.94 | 6.25 | 42.19 | 9.38 | 31.25 | 100.00 |
| 2 | 27.27 | 18.18 | 45.45 | 9.09 | 0.00 | 100.00 |
| 3 | 10.00 | 0.00 | 15.00 | 10.00 | 65.00 | 100.00 |
| 4 | 20.00 | 20.00 | 50.00 | 10.00 | 0.00 | 100.00 |
| 5 | 7.69 | 0.00 | 84.62 | 7.69 | 0.00 | 100.00 |
| 6 | 16.67 | 0.00 | 75.00 | 8.33 | 0.00 | 100.00 |
| 7 | 0.00 | 20.00 | 60.00 | 20.00 | 0.00 | 100.00 |

**Table 4.32: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Dallas**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 31.82 | 25.00 | 25.23 | 24.00 | 46.51 | 30.05 |
| 2 | 27.27 | 25.00 | 9.35 | 8.00 | 0.00 | 10.33 |
| 3 | 9.09 | 0.00 | 2.80 | 8.00 | 30.23 | 9.39 |
| 4 | 9.09 | 12.50 | 4.67 | 4.00 | 0.00 | 4.69 |
| 5 | 4.55 | 0.00 | 10.28 | 4.00 | 0.00 | 6.10 |
| 6 | 9.09 | 0.00 | 8.41 | 4.00 | 0.00 | 5.63 |
| 7 | 0.00 | 12.50 | 5.61 | 8.00 | 0.00 | 4.69 |
| Non-clustered | 9.09 | 25.00 | 33.64 | 40.00 | 23.26 | 29.11 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 41% of all high-rise office buildings in Dallas were constructed after 1980s. 50.23% of these buildings were constructed between 1980 and 1990, which is the highest percentage of building construction in a time interval (Table 4.29). 70.89% of all buildings in Dallas belong to a cluster (Table 4.30). The percentage of clustering was 76.74% before 1970. Between 1970 and 1980, the clustering percentage decreased down to 60%. After 1980s, the degree of clustering increased reaching its peak between 2000 and 2010 with 90.91% (Table 4.30). The multiple locations of building clusters suggest a polycentric structure.

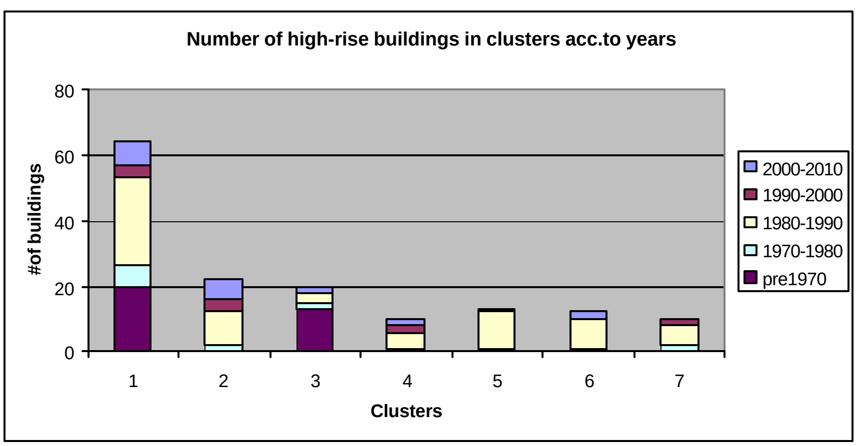



**Figure 4.19: Number of buildings in Building Clusters according to Year of Construction in Dallas**

Cluster 1 is located in downtown Dallas, in a primary downtown density area. It is the cluster with the highest number of buildings and the third densest cluster in terms of buildings per area. There are 64 buildings in total in this cluster (Table 4.30), which makes up 30.05% of all the high-rise buildings (Table 4.32). Around 60% of these buildings are constructed after 1980s, the highest rate of construction took place between 1980 and 1990 (Table 4.31). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in pre-1970s and between 1990 and 2010. 46.51% of all buildings constructed before 1970s exists in this cluster, making it the oldest cluster. Although it is the oldest cluster, the high rate of construction between 1990 and 2010 proves that it still continues to expand. Cluster 1 is also the most dominant cluster in terms of clustered high-rise buildings between 1970 and 1990 (Table 4.32).

Cluster 2 is located inside the LBJ Freeway/Corridor in a secondary downtown density area. The center of the cluster is approximately 10 miles in shortest distance from the center of downtown Dallas. It is the cluster with the second highest number of buildings. There are 22 buildings in this cluster (Table 4.30). 90.01% of the buildings in this cluster are constructed after 1980s and around 42.19% of the buildings are constructed between 1980 and 1990 (Table 4.31). Similar to Cluster 1, Cluster 2 is the most dominant cluster in terms of high-rise building construction between 1990 and 2000 and it is the second most dominant cluster between 2000 and 2010.

Cluster 3 is found in the secondary downtown of Ft. Worth in an edge city density area. The center of the cluster is 31 miles in shortest distance from the center of downtown Dallas. It is the cluster with the third highest number of buildings and second densest cluster (Table 4.30). 65% of all the buildings in this cluster are constructed before 1980 (Table 4.31), which makes cluster

3 the second most dominant cluster in terms of having the highest percentage of high-rise buildings built before 1970s (Table 4.8).

Cluster 4 is located in the northern part of LBJ Freeway/Corridor, in a secondary downtown density area, 10.5 miles away from the center of downtown. The cluster looks like an extension of Cluster 2. There are 10 buildings in this cluster; there are no buildings from pre 1970 (Table 4.30) and 90% of all the buildings were constructed after 1980s (Table 4.31). The time interval that the highest percentage of construction took place was between 1980 and 1990 (Table 4.31). This cluster is the second most dominant cluster in terms of high-rise building construction between 1990 and 2000 (Table 4.32).

Cluster 5 is located on the fringe of the edge city of Irving/Las Colinas in an edge city density area. It is 9.2 miles away from downtown Dallas. There are 13 buildings in this cluster, of which 11 were constructed between 1980 and 1990 (Table 4.30), which makes Cluster 5 the second most dominant cluster in terms of clustered high rise buildings in that year (Table 4.32). Cluster 5 is also the closest building cluster to Dallas/Ft. Worth International Airport with 4.7 miles. Cluster 6 is located on the fringe of LBJ Freeway/Corridor in a secondary downtown density area. There are 12 buildings in this cluster and 9 of these buildings were constructed between 1980 and 1990. Cluster 7 is the only cluster located in North Dallas/Corridor. There are 10 buildings and 6 of them were constructed between 1980 and 1990 (Table 4.30). Map 15A shows the high-rise office buildings and Map 15B demonstrates the building clusters in Dallas.

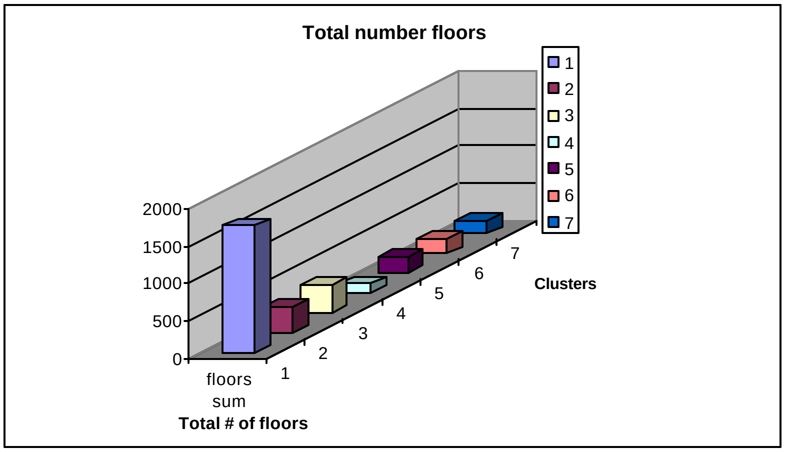



**Figure 4.20: Total Number of floors in Dallas Building Clusters**

### 4.1.4.3 Dallas Company-Building Analysis

In Dallas, 6 out of 7 building clusters intersect with one company cluster. Building cluster 7, located in North Dallas/Corridor does not intersect with a company cluster. Company clusters 3, 6, and 7 do not intersect with a high-rise building cluster. There are four locations that building and company clusters intersect with each other: downtown Dallas, secondary downtown of Ft. Worth, edge city of LBJ Freeway/Corridor, and edge city of Irving/Las Colinas.

In downtown Dallas, building cluster 1 intersects with the company cluster 1. Building cluster 1 is the highest building cluster in terms of total number of floors and it is also the oldest building cluster (Figure 4.20). However, although it is the oldest, this cluster continued to expand in all years, thus it is a hot-spot location for commercial high-rise buildings. Building cluster 1 intersects with company cluster 1, which is the densest and most diversified cluster. Although IT, logistics, and real estate are underrepresented, company cluster 1 is the most dominant cluster in accounting, finance/banking, insurance, law, and management consultancy. This also proves the high-rise location tendency of these sectors.

In the edge city of LBJ Freeway/Corridor, building clusters 2 and 4 intersect with company cluster 2; building cluster 6 intersects with company cluster 8. Both building cluster 2 and 4 are developed after 1980s, the most of the buildings in both clusters were constructed between 1980 and 1990. Thus, these are more recent clusters compared to cluster 1. Company cluster 2 is the second largest company cluster and also it is the second most diversified cluster. In this cluster IT and logistics are the top dominant industries, which prove that whenever clustered, the distributive services are found in recently developed high-rise districts. Building cluster 6 is also a recent building cluster mostly developed between 1980 and 1990. Company cluster 8 intersects with this cluster, all the knowledge-intensive producer services except for law and real estate are present in this cluster. There are no IT firms and only one logistics firm in this company cluster.

In the edge city of Irving/Las Colinas, building cluster 5 intersects with company cluster 5. Building cluster 5 is developed between 1980s and 1990. Company cluster 5 is an IT dominated cluster which proves the locational tendency of IT firms as being away from downtown in recent high-rise building clusters. In secondary downtown of Ft. Worth, building cluster 3 intersects with company cluster 4. Building cluster 3 is an older cluster. 65% of the buildings are constructed before 1980s. Company cluster 4 is dominated by accounting firms. IT only has one company and logistics has no firms in this cluster. These findings suggest that in Dallas more than half of the APS TNCs are decentralized. High-rise buildings are preferred locations of the clustered firms in Accounting, Design Consultancy, Finance/Banking, Insurance, Law, and, Management Consultancy. More than 55% of the IT firms are clustered and they are found in high-rise districts far away from downtown areas.  Map 16 shows Dallas company and building clusters together.

### 4.1.5 Houston

Houston has one downtown, one urban envelope, and three edge cities: Post Oak, Greenspoint, and Katy Freeway Corridor. Houston has the greatest proportion of office space in edge city densities and locations, with all of the office space falling within Harris County. The downtown, indicated with a red circle in the GIS map, consists of 22.8% of all the office space. Urban envelope has 3.3% of all the office space. Three edge cities together has 39.3% of the office space in Houston. Post Oak is located 5.3 miles away from downtown and it has 22.4% of office space, Greenspoint is located 13 miles away from downtown and it consists of 11.5% of the office space, and finally the Katy Freeway Corridor is located 11.2 miles away from downtown and it has 5.4% of all the office space in Houston metropolitan area. In Houston, 34.7% of the office space is found in edgeless cities (Lang et al. 2007). Map 17 demonstrates the findings of Lang et al (2007) in Houston.

#### 4.1.5.1. Houston Companies

There are 360 APS TNC locations identified in Houston metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.12 miles. The distance to identify clusters was taken as 0.13 miles. The minimum number of points that gave the median number of clusters was 7 and the median number of clusters turned out to be 7. 45% of the companies in Houston belong to a cluster. Among the 7 clusters, only two clusters are found in areas with edgeless city density, which proves that most of the company clusters are located in a centralized pattern. The multiple locations of clusters prove the polycentric structure of the global business activity nodes. Cluster 1 is found in downtown, clusters 2, 3, and 5 are found in Post Oak, cluster 4 is located in Katy Freeway Corridor. All industries are represented in Houston. Logistics, IT, and design consultancy are the top three industries in terms of number of companies. Logistics and IT make up 51.11% of all the APS TNCs (Table 4.33).

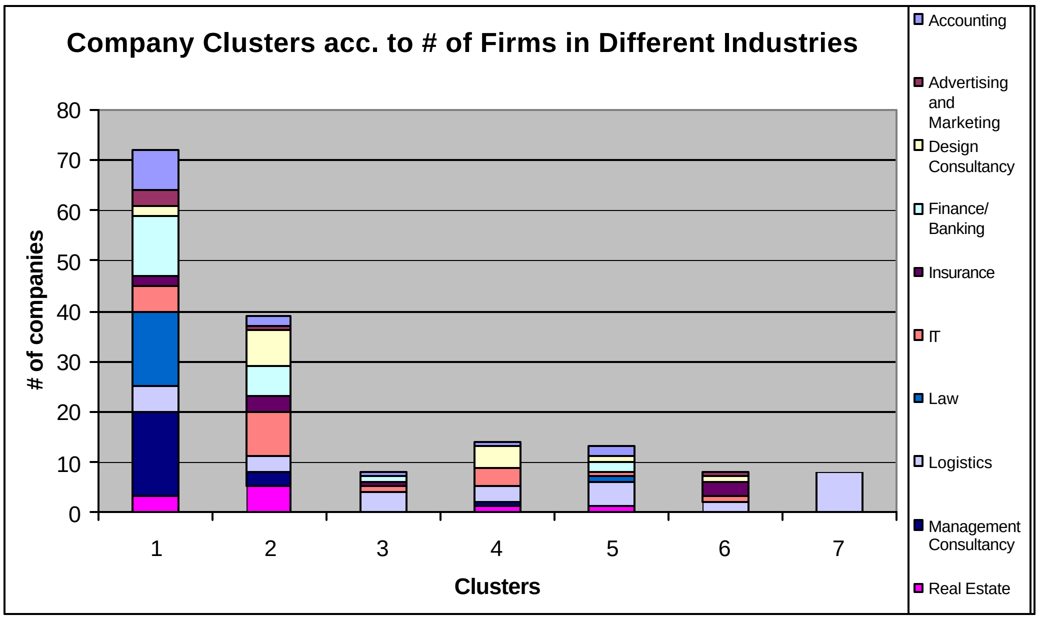



**Figure 4.21: Number of companies in company clusters in Houston**

Accounting, insurance, and law are the top three sectors with the highest rate of membership in a cluster. All of the firms in these industries are found in clusters. The logistics, real estate, and design consultancy are three sectors with the lowest degree of clustering. Table 4.34 summarizes these results. Map 18A and Map18B show Houston APS TNCs and company clusters.

## Table 4.33: Industries represented in Houston APS TNCs

| Industries | % of all firms |
|---|---|
| Accounting | 3.89 |
| Advertising and Marketing | 1.94 |
| Design Consultancy | 11.67 |
| Finance/Banking | 6.94 |
| Insurance | 2.50 |
| IT | 12.78 |
| Law | 4.44 |
| Logistics | 38.33 |
| Management Consultancy | 7.50 |
| Real Estate | 10.00 |
| TOTAL | 100.00 |

## Table 4.34: Number of Companies in Clusters and Percent of Clustering among Industries in Houston

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 3 | 2 | 12 | 2 | 5 | 15 | 5 | 17 | 3 | 72 |
| 2 | 2 | 1 | 7 | 6 | 3 | 9 | 0 | 3 | 3 | 5 | 39 |
| 3 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 4 | 0 | 0 | 8 |
| 4 | 1 | 0 | 4 | 0 | 0 | 4 | 0 | 3 | 1 | 1 | 14 |
| 5 | 2 | 0 | 1 | 2 | 0 | 1 | 1 | 5 | 0 | 1 | 13 |
| 6 | 0 | 1 | 1 | 0 | 3 | 1 | 0 | 2 | 0 | 0 | 8 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 8 |
| Total Clustered Companies | 14 | 5 | 15 | 21 | 9 | 21 | 16 | 30 | 21 | 10 | 162 |
| Total Companies | 14 | 7 | 42 | 25 | 9 | 46 | 16 | 138 | 27 | 36 | 360 |
| % of clustering | 100.00 | 71.43 | 35.71 | 84.00 | 100.00 | 45.65 | 100.00 | 21.74 | 77.78 | 27.78 | 45.00 |

**Table 4.35: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Houston**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11.11 | 4.17 | 2.78 | 16.67 | 2.78 | 6.94 | 20.83 | 6.94 | 23.61 | 4.17 | 100.00 |
| 2 | 5.13 | 2.56 | 17.95 | 15.38 | 7.69 | 23.08 | 0.00 | 7.69 | 7.69 | 12.82 | 100.00 |
| 3 | 12.50 | 0.00 | 0.00 | 12.50 | 12.50 | 12.50 | 0.00 | 50.00 | 0.00 | 0.00 | 100.00 |
| 4 | 7.14 | 0.00 | 28.57 | 0.00 | 0.00 | 28.57 | 0.00 | 21.43 | 7.14 | 7.14 | 100.00 |
| 5 | 15.38 | 0.00 | 7.69 | 15.38 | 0.00 | 7.69 | 7.69 | 38.46 | 0.00 | 7.69 | 100.00 |
| 6 | 0.00 | 12.50 | 12.50 | 0.00 | 37.50 | 12.50 | 0.00 | 25.00 | 0.00 | 0.00 | 100.00 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 100.00 |

**Table 4.36: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Houston**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 57.14 | 42.86 | 4.76 | 48.00 | 22.22 | 10.87 | 93.75 | 3.62 | 62.96 | 8.33 |
| 2 | 14.29 | 14.29 | 16.67 | 24.00 | 33.33 | 19.57 | 0.00 | 2.17 | 11.11 | 13.89 |
| 3 | 7.14 | 0.00 | 0.00 | 4.00 | 11.11 | 2.17 | 0.00 | 2.90 | 0.00 | 0.00 |
| 4 | 7.14 | 0.00 | 9.52 | 0.00 | 0.00 | 8.70 | 0.00 | 2.17 | 3.70 | 2.78 |
| 5 | 14.29 | 0.00 | 2.38 | 8.00 | 0.00 | 2.17 | 6.25 | 3.62 | 0.00 | 2.78 |
| 6 | 0.00 | 14.29 | 2.38 | 0.00 | 33.33 | 2.17 | 0.00 | 1.45 | 0.00 | 0.00 |
| 7 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.80 | 0.00 | 0.00 |
| Non-clustered | 0.00 | 28.57 | 64.29 | 16.00 | 0.00 | 54.35 | 0.00 | 78.26 | 22.22 | 72.22 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The largest cluster with 72 companies is Cluster 1 located in downtown Houston in a primary downtown density area. It is the densest cluster (Table 4.34). There are 72 firms in total in this cluster, of which 68 are branch locations. All industries are present. Management Consultancy, Law, and Finance/Banking and together constitute 61.11% of the companies in this cluster (Table 4.35). IT and logistics each have only 5 companies (Table 4.34). Cluster 1 is the most dominant cluster in five sectors: Accounting, Advertising and Marketing, Finance/Banking, Law, and Management Consultancy. 93.75% of all the Law TNCs identified in Houston metropolitan area are found in this cluster. This percentage is 62.96% for management consultancy, 57.14% for accounting, 48% for finance/banking, and 42.86% for advertising and marketing firms. and 30% for Advertising and Marketing firms (Table 4.36).

Cluster 2 is located in the center of Post Oak edge city area in a secondary downtown density location, 5.8 miles away from downtown Houston. Cluster 2 is the densest cluster and it also is the second largest cluster in terms of number of companies. There are 39 firms in this cluster, of which 38 are branch locations. All industries except for law are present in this cluster. IT, design consultancy, and finance/banking constitute the top industry sectors in the cluster (Table 4.34). IT firms constitute 23.08% of all the companies in the cluster, design consultancy constitutes 17.95%, and finance/banking constitutes 15.38% (Table 4.35). Cluster 2 is the most dominant cluster in insurance. 33.33% of all insurance firms in Houston are found in this cluster. Cluster 2 is also the most dominant in terms of clustered firms in design consultancy and IT (Table 4.36). Cluster 3 is also located in the Post Oak edge city area in a secondary downtown density location, 7 miles away from downtown Houston, next to Cluster 2. There are only 8 firms in this cluster, of which 4 of them are from logistics. All firms are branch offices. Accounting, finance/banking, IT, and insurance each have one firm (Table 4.34).

Cluster 4 is located in the Katy Freeway Corridor, 12.4 miles away from downtown Houston in an edge city density location. It is the cluster with the third highest number of companies. There are 14 firms in total in this cluster, all of which are branch locations. IT and design consultancy each has 4 firms followed by logistics with 3 firms. Management consultancy, real estate, and accounting each have one firm in this cluster (Table 4.34). Cluster 5 is located in the Post Oak edge city area in a secondary downtown density location, 4.3 miles away from downtown Houston. It is the third densest cluster. There are 13 firms in total in this cluster. The most dominant is the logistics sector with 5 companies. Accounting and finance/banking each has two companies. Other than cluster 1, cluster 5 is the only cluster with law firms. There is one law TNC in this cluster (Table 4.34). Post Oak edge city area that includes clusters 2, 3, and 5 is specialized in IT and logistics.

Cluster 6 is located in an edgeless city density location, 10.5 miles away from downtown Houston in shortest distance. There are 8 firms in this cluster, all of which are branch locations. Insurance and logistics firms together constitute 62.50% of all the firms in the cluster (Table 4.35). Insurance dominate the cluster with 3 firms, followed by logistics with 2 firms. There is only one company each from advertising and marketing, design consultancy, and IT (Table 4.34). Cluster 7 is the only cluster located close to the Houston Intercontinental Airport. It is located 3.7 miles away from the airport and 12.7 miles away from downtown Houston. The cluster is located in an edgeless city density area. There are 8 companies, all of which are from logistics (table 4.34).

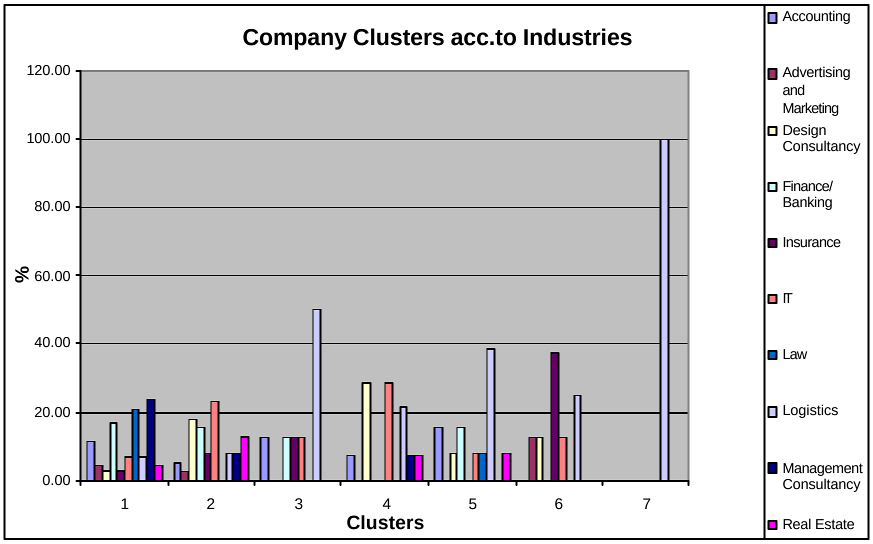



**Figure 4.22: Percent of Industries in Company Clusters in Houston**

IT and logistics together make up half of all the APS TNCs in Houston. In Houston, there is only one specialized cluster that has only logistics companies. There are no IT specialized clusters. This is different from the other cities identified so far. Half of the clustered IT companies are in the Post Oak edge city area. Design consultancy is more decentralized than IT, which is also different than other cities identified so far. Downtown is still the most diversified and most dominant cluster in knowledge intensive producer services.

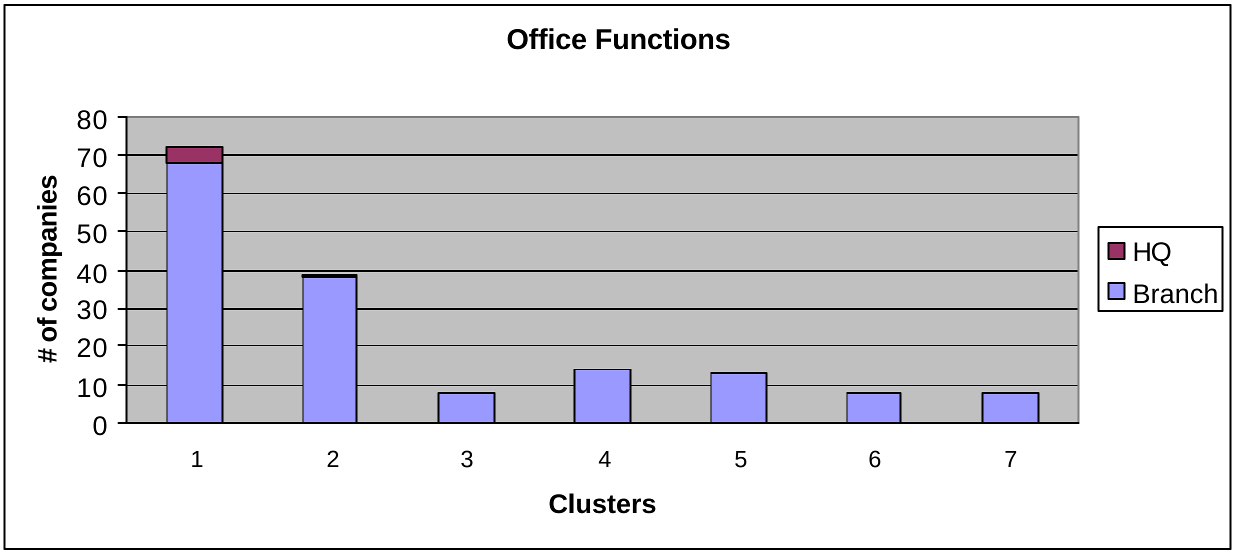



**Figure 4.23: Number of Companies according to Office Functions in Houston**

### 4.1.5.2 Houston Buildings

There are 207 high-rise building locations identified in total in Houston metropolitan area (Table 4.37). In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.21 miles, thus the distance that is used in calculating the clusters is taken as 0.22 miles. The minimum number of points that formed the median number of clusters was 8 and the median number of clusters turned out to be 7. Only one cluster is located in an area with an edgeless city density, which proves that the clusters are located in a centralized way. Multiple locations of the clusters demonstrate the polycentric pattern of building clusters. Cluster 1 is located in downtown Houston in a primary downtown area. Clusters 2 and 3 are located in the edge city of Post Oak in a secondary downtown density area. Clusters 4 and 6 are located in Katy Freeway-Corridor in an edge city density location. Cluster 5 is located in Greenspoint in an edge city density location. Cluster 7 is the only cluster located in an edgeless density city area.

**Table 4.37: Percent of Buildings according to Year of Construction in Houston**

| Years | % of buildings |
|---|---|
| 2000-2010 | 12.08 |
| 1990-2000 | 4.35 |
| 1980-1990 | 45.41 |
| 1970-1980 | 19.32 |
| pre1970 | 18.84 |
| TOTAL | 100.00 |

**Table 4.38: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Houston**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 7 | 2 | 17 | 14 | 30 | 70 |
| 2 | 1 | 2 | 22 | 14 | 1 | 40 |
| 3 | 0 | 0 | 10 | 6 | 1 | 17 |
| 4 | 5 | 1 | 4 | 0 | 3 | 13 |
| 5 | 0 | 1 | 10 | 0 | 0 | 11 |
| 6 | 3 | 0 | 6 | 0 | 0 | 9 |
| 7 | 3 | 1 | 5 | 0 | 0 | 9 |
| Total Clustered Buildings | 19 | 7 | 74 | 34 | 35 | 169 |
| Total Buildings | 25 | 9 | 94 | 40 | 39 | 207 |
| % of clustering | 76.00 | 77.78 | 78.72 | 85.00 | 89.74 | 81.64 |

**Table 4.39: Percent of Buildings in Clusters according to Year of Construction in Houston**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 10.00 | 2.86 | 24.29 | 20.00 | 42.86 | 100.00 |
| 2 | 2.50 | 5.00 | 55.00 | 35.00 | 2.50 | 100.00 |
| 3 | 0.00 | 0.00 | 58.82 | 35.29 | 5.88 | 100.00 |
| 4 | 38.46 | 7.69 | 30.77 | 0.00 | 23.08 | 100.00 |
| 5 | 0.00 | 9.09 | 90.91 | 0.00 | 0.00 | 100.00 |
| 6 | 33.33 | 0.00 | 66.67 | 0.00 | 0.00 | 100.00 |
| 7 | 33.33 | 11.11 | 55.56 | 0.00 | 0.00 | 100.00 |

**Table 4.40: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Houston**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 28.00 | 22.22 | 18.09 | 35.00 | 76.92 | 33.82 |
| 2 | 4.00 | 22.22 | 23.40 | 35.00 | 2.56 | 19.32 |
| 3 | 0.00 | 0.00 | 10.64 | 15.00 | 2.56 | 8.21 |
| 4 | 20.00 | 11.11 | 4.26 | 0.00 | 7.69 | 6.28 |
| 5 | 0.00 | 11.11 | 10.64 | 0.00 | 0.00 | 5.31 |
| 6 | 12.00 | 0.00 | 6.38 | 0.00 | 0.00 | 4.35 |
| 7 | 12.00 | 11.11 | 5.32 | 0.00 | 0.00 | 4.35 |
| Non-clustered | 24.00 | 22.22 | 21.28 | 15.00 | 10.26 | 18.36 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 62% of all high-rise office buildings in Houston were constructed after 1980s. Major expansion took place between 1980 and 1990, when 45.41% of the high-rise buildings were constructed, which is the highest percentage of building construction in a time interval (Table 4.37). 81.64% of all buildings in Houston belong to a cluster (Table 4.38). The buildings constructed before 1970 have the highest membership percentage to a cluster with 89.74%. After 1970, this percentage declined, reaching 76% for 2000-2010 interval, suggesting decentralization (Table 4.38). Map 19A and Map 19B show Houston high-rise office buildings and clusters.

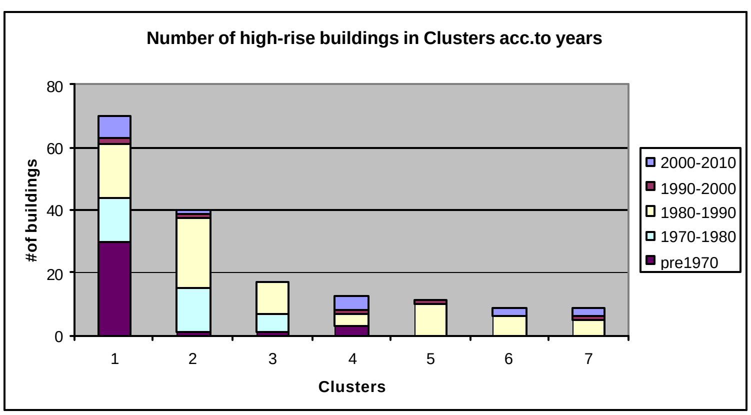



**Figure 4.24: Number of buildings in Building Clusters according to Year of Construction in Houston**

Cluster 1 is located in downtown Houston, in a primary downtown density area. It is the cluster with the highest number of buildings and the densest cluster in terms of buildings per area. There are 70 buildings in total in this cluster (Table 4.38), which makes up 33.82% of all the high-rise buildings (Table 4.40). Around 60% of these buildings are constructed after 1970s, although the highest rate of construction took place between before 1970s; 42.86% of all high-rise buildings constructed were in this cluster, making cluster 1 the oldest cluster (Table 4.39). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in pre-1970s, between1970 and 1980, and between 1990 and 2010. Although it is the oldest cluster, the high rate of construction between 1990 and 2010 proves that it still continues to expand (Table 4.40).

Cluster 2 is located in the edge city of Post Oak in a secondary downtown density location, 6 miles away from downtown Houston. It is the cluster with the second highest number of buildings and second densest cluster. There are 22 buildings in this cluster (Table 4.38). 62.50% of the buildings in this cluster are constructed after 1980s and around 55% of the buildings are constructed between 1980 and 1990 (Table 4.39). Cluster 2 is the most dominant cluster in terms of high-rise building construction between 1970 and 1990 (Table 4.40). Cluster 3 is also located in the edge city of Post Oak in a secondary downtown density location, 4 miles away from downtown Houston. It is the cluster with the third highest number of buildings (Table 4.38). 41.18% of all the buildings in this cluster are constructed before 1980 (Table 4.39). Major expansion took place between 1980 and 1990, when 58.82% of all buildings in this cluster were constructed. There were no buildings added after 1990 in this cluster (Table 4.39). Cluster 3 has 8.21% of all the buildings in Houston (Table 4.40).

Cluster 4 is located on the fringe of Katy Freeway Corridor, in an edge city density area, 4 miles away from the center of downtown. There are 13 buildings in this cluster; and there are no buildings from pre 1970 (Table 4.38). 90% of all the buildings were constructed after 1980s. The time interval that the highest percentage of construction took place is between 1980 and 1990 (Table 4.39). This cluster is the second most dominant cluster in terms of high-rise building construction between 1990 and 2000 (Table 4.40). Cluster 5 is located in the edge city of Greenspoint in an edge city density area. The cluster is 13 miles away from downtown and 4.2 miles away from the Houston Intercontinental Airport. There are 11 buildings in this cluster, of which 10 were constructed between 1980 and 1990 (Table 4.38). There is no building construction before 1980s.

Cluster 6 is located in Katy Freeway Corridor in an edge city density area. There are 9 buildings in this cluster and 6 of these buildings were constructed between 1980 and 1990. 3 of the buildings were constructed between 2000 and 2010 (Table 4.38). Cluster 7 is the only building cluster located in an edgeless city density area, 15.5 miles away from downtown. There are 9 buildings and 5 of them were constructed between 1980 and 1990. 3 of the buildings were constructed between 2000 and 2010 (Table 4.30). Map 19 demonstrates the building clusters in Houston.

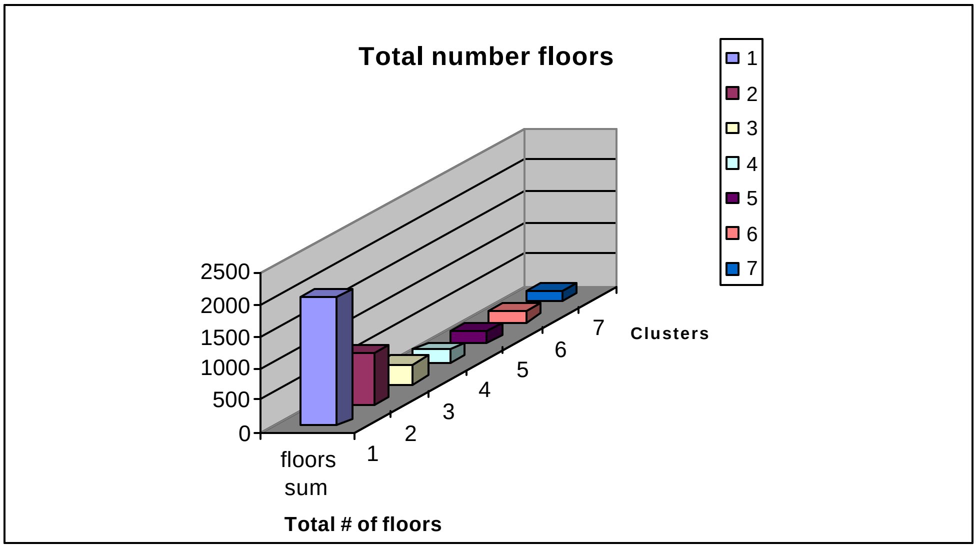



**Figure 4.25: Total Number of floors in Houston Building Clusters**

### 4.1.5.3 Houston Company-Building Analysis

In Houston, 4 out of 7 building clusters intersect with at least one company cluster. All building clusters that intersect with a company cluster are located in the urban envelope or urban corridor. There are three locations that building and company clusters intersect with each other: downtown Houston, edge city of Post Oak, and Katy Freeway Corridor.

In downtown Houston, building cluster 1 intersects with the company cluster 1. Building cluster 1 is the highest building cluster in terms of total number of floors and it is also the oldest building cluster (Figure 4.25). Although it is the oldest, this cluster continued to expand in all years, thus it is a hot-spot location for commercial high-rise buildings. Building cluster 1 intersects with company cluster 1, which is the densest and most diversified cluster. Although real estate, design consultancy, and logistics are underrepresented, company cluster 1 is the most dominant cluster in accounting, advertising and marketing, finance/banking, law, and management consultancy. This also proves the high-rise location tendency of these sectors.

In Post Oak, building cluster 2 intersects with company clusters 2 and 3; also building cluster 3 intersects with company cluster 5. Company cluster 2 is dominated by IT, design consultancy, finance/banking firms and company cluster 3 mostly contains logistics firms. Building cluster 2 is the second largest and second tallest building cluster (Figure 4.25). This cluster expanded between 1970 and 1990. Thus, building cluster 2 is the second major location for high-rise buildings. Finding IT and logistics dominated company clusters intersecting with a rather older building cluster is a different trend than other cities studied so far. Also, in Post Oak, building cluster 3 intersects with company cluster 5 Company cluster 5 is dominated by logistics. Building cluster 3 is mainly developed between 1980 and 1990 and did not expand after 1990s. Again, in this location we see a distributive service sector being located in a rather older high-rise building district.

Another building and company cluster intersection takes place inside the Katy Freeway Corridor. Building cluster 6 intersects with company cluster 4. In company cluster 4, IT and logistics firms form 50% of the cluster. Design consultancy also has a major presence with 3 firms. Building cluster 6 developed between 1980 and 1990, it is a recent building cluster. This cluster is also under current development. This trend follows the national trend of distributive services being located in recent high rise clusters located away from downtown areas. Map 20 shows Houston company and building clusters together.

### 4.1.6 Los Angeles

Los Angeles has one downtown, three secondary downtowns, five edge cities including one urban corridor with an edge city density. Secondary downtowns are found in West LA/Beverly Hills/Santa Monica, Glendale, and Pasadena. In terms of secondary downtown office space, Los Angeles has a significantly greater proportion than does the other metros. This is due to the substantial office space clusters in West Los Angeles and near the John Wayne airport areas (Lang et al., 2007). Five edge cities are: John Wayne Airport/Southcoast, Woodland Hills, Sherman Oaks, Southbay/LAX, and Santa Ana. There is one urban corridor in Los Angeles, which is the Wilshire/ Santa Monica Boulevard Corridor. This corridor surrounds downtown Los Angeles and West LA/Beverly Hills/Santa Monica secondary downtown. Lang et al (2007) includes the urban corridor in the edge cities since it has edge city density space.

The downtown, indicated with a red circle in the GIS map, consists of 16.1% of all the office space. West LA/Beverly Hills/Santa Monica is located 9.5 miles away from downtown and it has 10% of all the office space, Glendale and Pasadena has 1.8% of all the office space. Glendale is located 7.2 miles away from downtown and Pasadena is located 9.5 miles away from downtown. Edge cities in total have 24.3% of all the office space. John Wayne Airport/Southcoast and Santa Ana are the only two locations located in Orange County. John Wayne Airport/Southcoast is located 35 miles away from downtown and it has 4.7% of all the office space, Santa Ana is located 30 miles away from downtown and it has 3% of all the office space. Woodland Hills is located 21 miles away from downtown and it has 2.5% of the office space. Sherman Oaks is located 14 miles away from downtown and it has 1.7% of all the office space. Southbay/LAXis located south of urban corridor, 10 miles away from downtown and it has 3.7% of all the office space. In Los Angeles, 46% of the office space is found in edgeless cities (Lang et al. 2007). Map 21 demonstrates the findings of Lang et al (2007) in Los Angeles.

#### 4.1.6.1. Los Angeles Companies

There are 632 APS TNC locations identified in Los Angeles metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.05 miles. The distance to identify clusters was taken as 0.06 miles. The minimum number of points that gave the median number of clusters was 9 and the median number of clusters turned out to be 11. 43.04% of the companies in Los Angeles belong to a cluster. Among the 11 clusters, only 2 clusters are found in areas with edgeless city density, which proves that most of the company clusters are located in a centralized pattern. The multiple locations of clusters prove the polycentric structure of the global business activity nodes.

Cluster 1 is found in downtown; clusters 5, 3, and 9 are found in West LA/Beverly Hills/Santa Monica; cluster 2, 4, and 6 are found in John Wayne Airport/Southcoast; cluster 7 is found in Southbay/LAX; cluster 8 is found in Pasadena; clusters 10 and 11 are found in edgeless city locations. All industries are represented in Los Angeles. Logistics, IT, and real estate are the top three industries in terms of number of companies. Logistics and IT together make up 45.26% of all the APS TNCs (Table 4.41). Map 22A shows the APS TNC locations and Map 22B illustrates the company clusters identified in Los Angeles.

### Table 4.41: Industries represented in Los Angeles APS TNCs

| Industries | % of all firms |
|---|---|
| Accounting | 5.06 |
| Advertising and Marketing | 5.70 |
| Design Consultancy | 7.28 |
| Finance/Banking | 8.39 |
| Insurance | 4.27 |
| IT | 15.35 |
| Law | 5.70 |
| Logistics | 29.91 |
| Management Consultancy | 7.44 |
| Real Estate | 10.92 |
| TOTAL | 100.00 |

### Table 4.42: Number of Companies in Clusters and Percent of Clustering among Industries in Los Angeles

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 4 | 9 | 18 | 9 | 3 | 21 | 11 | 14 | 3 | 99 |
| 2 | 7 | 1 | 1 | 3 | 4 | 17 | 4 | 0 | 6 | 1 | 44 |
| 3 | 2 | **0** | 0 | 8 | 0 | 2 | 5 | 2 | 5 | 3 | 27 |
| 4 | 0 | **0** | 1 | 0 | 1 | 6 | 0 | 0 | 1 | 0 | 9 |
| 5 | 1 | **1** | 4 | 4 | 0 | 0 | 0 | 3 | 3 | 0 | 16 |
| 6 | 3 | **0** | 2 | 0 | 0 | 5 | 2 | 1 | 3 | 0 | 16 |
| 7 | 0 | **3** | 1 | 0 | 0 | 7 | 0 | 2 | 1 | 0 | 14 |
| 8 | 2 | **0** | 1 | 1 | 2 | 2 | 0 | 3 | 1 | 2 | 14 |
| 9 | 1 | **0** | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 5 | 11 |
| 10 | 1 | **3** | 1 | 1 | 0 | 5 | 1 | 0 | 0 | 0 | 12 |
| 11 | 0 | **2** | 2 | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 10 |
| Total Clustered Companies | 24 | 14 | 22 | 38 | 16 | 48 | 33 | 28 | 34 | 15 | 272 |
| Total Companies | 32 | **36** | 46 | 53 | 27 | 97 | 36 | 189 | 47 | 69 | 632 |
| % of clustering | 75.00 | 38.89 | 47.83 | 71.70 | 59.26 | 49.48 | 91.67 | 14.81 | 72.34 | 21.74 | 43.04 |

**Table 4.43: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Los Angeles**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.07 | 4.04 | 9.09 | 18.18 | 9.09 | 3.03 | 21.21 | 11.11 | 14.14 | 3.03 | 100.00 |
| 2 | 15.91 | 2.27 | 2.27 | 6.82 | 9.09 | 38.64 | 9.09 | 0.00 | 13.64 | 2.27 | 100.00 |
| 3 | 7.41 | 0.00 | 0.00 | 29.63 | 0.00 | 7.41 | 18.52 | 7.41 | 18.52 | 11.11 | 100.00 |
| 4 | 0.00 | 0.00 | 11.11 | 0.00 | 11.11 | 66.67 | 0.00 | 0.00 | 11.11 | 0.00 | 100.00 |
| 5 | 6.25 | 6.25 | 25.00 | 25.00 | 0.00 | 0.00 | 0.00 | 18.75 | 18.75 | 0.00 | 100.00 |
| 6 | 18.75 | 0.00 | 12.50 | 0.00 | 0.00 | 31.25 | 12.50 | 6.25 | 18.75 | 0.00 | 100.00 |
| 7 | 0.00 | 21.43 | 7.14 | 0.00 | 0.00 | 50.00 | 0.00 | 14.29 | 7.14 | 0.00 | 100.00 |
| 8 | 14.29 | 0.00 | 7.14 | 7.14 | 14.29 | 14.29 | 0.00 | 21.43 | 7.14 | 14.29 | 100.00 |
| 9 | 9.09 | 0.00 | 0.00 | 27.27 | 0.00 | 0.00 | 0.00 | 18.18 | 0.00 | 45.45 | 100.00 |
| 10 | 8.33 | 25.00 | 8.33 | 8.33 | 0.00 | 41.67 | 8.33 | 0.00 | 0.00 | 0.00 | 100.00 |
| 11 | 0.00 | 20.00 | 20.00 | 0.00 | 0.00 | 10.00 | 0.00 | 40.00 | 0.00 | 10.00 | 100.00 |

**Table 4.44: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Los Angeles**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 21.88 | 11.11 | 19.57 | 33.96 | 33.33 | 3.09 | 58.33 | 5.82 | 29.79 | 4.35 |
| 2 | 21.88 | 2.78 | 2.17 | 5.66 | 14.81 | 17.53 | 11.11 | 0.00 | 12.77 | 1.45 |
| 3 | 6.25 | 0.00 | 0.00 | 15.09 | 0.00 | 2.06 | 13.89 | 1.06 | 10.64 | 4.35 |
| 4 | 0.00 | 0.00 | 2.17 | 0.00 | 3.70 | 6.19 | 0.00 | 0.00 | 2.13 | 0.00 |
| 5 | 3.13 | 2.78 | 8.70 | 7.55 | 0.00 | 0.00 | 0.00 | 1.59 | 6.38 | 0.00 |
| 6 | 9.38 | 0.00 | 4.35 | 0.00 | 0.00 | 5.15 | 5.56 | 0.53 | 6.38 | 0.00 |
| 7 | 0.00 | 8.33 | 2.17 | 0.00 | 0.00 | 7.22 | 0.00 | 1.06 | 2.13 | 0.00 |
| 8 | 6.25 | 0.00 | 2.17 | 1.89 | 7.41 | 2.06 | 0.00 | 1.59 | 2.13 | 2.90 |
| 9 | 3.13 | 0.00 | 0.00 | 5.66 | 0.00 | 0.00 | 0.00 | 1.06 | 0.00 | 7.25 |
| 10 | 3.13 | 8.33 | 2.17 | 1.89 | 0.00 | 5.15 | 2.78 | 0.00 | 0.00 | 0.00 |
| 11 | 0.00 | 5.56 | 4.35 | 0.00 | 0.00 | 1.03 | 0.00 | 2.12 | 0.00 | 1.45 |
| Non-clustered | 25.00 | 61.11 | 52.17 | 28.30 | 40.74 | 50.52 | 8.33 | 85.19 | 27.66 | 78.26 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

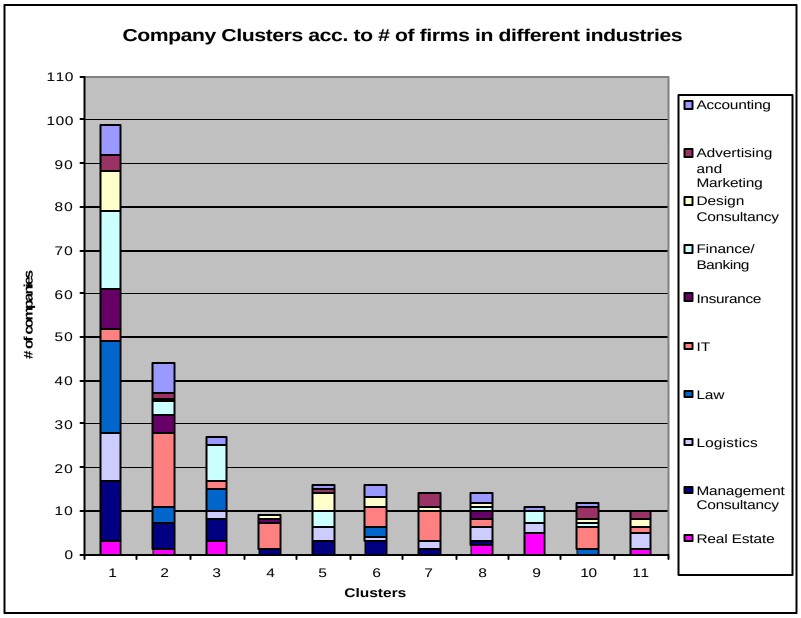



**Figure 4.26: Number of companies in company clusters in Los Angeles**

The largest cluster with 99 companies is Cluster 1, which is located in downtown Los Angeles. The center of this cluster is found in a primary-downtown density area. It is the cluster with the highest number of companies and the densest cluster (Table 4.42). There are 99 firms in total in this cluster, of which 94 are branch locations. All industries are present; this is the most diversified cluster in Los Angeles. Law, finance/banking, and management consultancy are the top three sectors in this cluster, together they constitute around 53.53% of the companies in this cluster (Table 4.43). Advertising and marketing, real estate, and IT are the three sectors with the lowest number of companies (Table 4.42). Cluster 1 is the most dominant cluster in three sectors: finance/banking, law, and management consultancy. 33.96% of all finance/banking companies, 58.33% of all law firms, and 29.79% of all management consultancy companies are found in this cluster. Cluster 1 is also the most dominant cluster in terms of clustered firms in accounting, advertising and marketing, insurance, and logistics (Table 4.44). Logistics and real estate are highly decentralized in Los Angeles. 85.19% of all logistics firms and 78.26% of all real estate firms do not belong in a cluster. Advertising and marketing, design consultancy, and IT is also moderately decentralized. More than 50% of these firms do not belong in a cluster (Table 4.44).

Cluster 2 is located in the edge city of John Wayne Airport/Southcoast in a secondary downtown density location, 35 miles away from downtown Los Angeles. The center of the cluster is located 0.8 miles away from John Wayne Airport. It is the cluster with the second highest number of companies (Table 4.42). There are 44 firms in this cluster, all of which are branch locations. All industries except for logistics are present in this cluster. IT, accounting, and management consultancy are the top three sectors (Table 4.43). Cluster 2 is the most dominant cluster in terms of clustered IT and accounting firms with 17.53% of IT companies, 21.88% of all accounting companies in this cluster (Table 4.44).

Cluster 3 is located in the secondary downtown of West LA/Beverly Hills/Santa Monica. The center of the cluster is in the secondary downtown density area approximately 9.4 miles in shortest distance from the center of downtown Los Angeles. It is the cluster with the third highest number of companies and second densest cluster. There are 27 firms in total in this cluster, of which 26 are branch locations. There are no firms from advertising and marketing, design consultancy, and insurance (Table 4.42). Finance/banking, law, and management consultancy are the most dominant firms in the cluster. 29.63% of all the firms are from finance/banking, law and management consultancy has 18.52% of all the firms. Real estate, accounting, and IT have the least number of firms (Table 4.43). This cluster is the second most dominant cluster in terms of law firms. 13.89% of all the law firms are found in this cluster. This cluster is also the second most dominant cluster in terms of clustered real estate and finance/banking companies (Table 4.44).

Cluster 4 is located in the edge city of John Wayne Airport/Southcoast in a secondary downtown density location, 35 miles away from downtown Los Angeles. The center of the cluster is located 1.7 miles away from John Wayne Airport. There are 9 firms in total in this cluster, all of which are branch locations. IT is the most dominant sector with 6 companies. Management consultancy, insurance, and design consultancy each has one company (Table 4.42). Cluster 5 is located in the secondary downtown of West LA/Beverly Hills/Santa Monica. The center of the cluster is in the secondary downtown density area approximately 10.5 miles in shortest distance from the center of downtown Los Angeles. It is the cluster with the fourth highest number of companies and third densest cluster. There are 16 firms in total in this cluster, all of which are branch locations (Table 4.42). Design consultancy and finance/banking firms make up 50% of all the firms in this cluster (Table 4.43). Cluster 5 is the second most dominant cluster in terms of clustered design consultancy firms (Table 4.44).

Cluster 6 is located in the edge city of John Wayne Airport/Southcoast in an edge city density location, 33 miles away from downtown Los Angeles. The center of the cluster is located 1.3 miles away from John Wayne Airport. There are 16 firms in the cluster, 14 of which are branch locations. It is the cluster with third highest number of companies (Table 4.42). IT dominates the cluster with 5 firms. Management consultancy and accounting each has 3 firms. This is the second most dominant cluster in terms of clustered accounting firms (Table 4.44). Cluster 7 is located in the edge city of Southbay/LAX in an edge city density area approximately 12 miles away from downtown Los Angeles. There are 14 firms in total in this cluster, 13 of which are branch locations. IT dominate the cluster with 7 firms (Table 4.42), which makes this cluster the second most dominant cluster in terms of clustered IT firms (Table 4.44). Advertising and marketing has 3 firms and logistics has 2 firms in this cluster (Table 4.42).

Cluster 8 is located in the secondary downtown of Pasadena in an edge city density area, approximately 9.5 miles north east of downtown. There are 14 firms in this cluster, all of which are branch locations. Logistics has the most firms, there are 3 logistics firms. Real estate, IT, insurance, and accounting each have 2 firms and design consultancy, finance/banking, and management consultancy each have one firm (Table 4.42). Cluster 9 is located in the secondary downtown of West LA/Beverly Hills/Santa Monica. The center of the cluster is in the secondary downtown density area approximately 8 miles in shortest distance from the center of downtown Los Angeles. There are 11 firms in this cluster, all of which are branch locations. Real estate dominates the cluster with 5 firm, followed by finance and banking with 3 firms, and logistics with two firms. There are no IT firms in this cluster (Table 4.42).

Cluster 10 is located in Orange County in an edgeless city density area, 40 miles away from downtown Los Angeles.  There are 12 firms in total in this cluster, all of which are branch locations. IT dominate the cluster with 5 firms, followed by advertising and marketing with 3 firms. There are no firms from insurance, logistics, management consultancy, and real estate (Table 4.42). Cluster 11 is located in Los Angeles County in an edgeless city density area, 12 miles southwest of downtown Los Angeles.  There are 10 firms in total in this cluster, 9 of which are branch locations. IT dominates the cluster with 5 firms, followed by advertising and marketing with 3 firms. The cluster is 3.5 miles away from Los Angeles International Airport. Logistics dominate the cluster with 4 firms followed by advertising and marketing and design consultancy (Table 4.42).

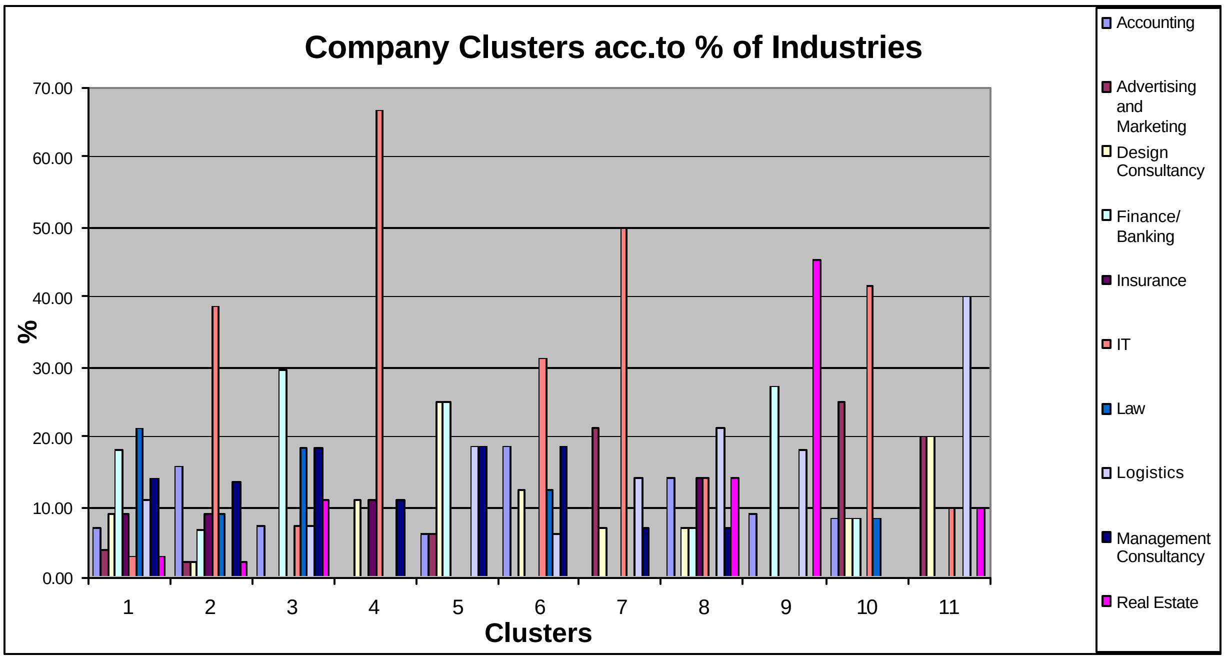



**Figure 4.27: Percent of Industries in Company Clusters in Los Angeles**

In Los Angeles, cluster 1 in downtown is a major location for all knowledge intensive producer services except for real estate. Cluster 2 in the John Wayne Airport edge city is a major location for accounting, insurance, and management consultancy. However, IT has the priority in this cluster. The downtown of Orange County is John Wayne Airport edge city in terms of number of firms and their diversity. IT firms are again found in clusters that are located far away from traditional downtown areas. Map 22 demonstrates the company clusters in Los Angeles.

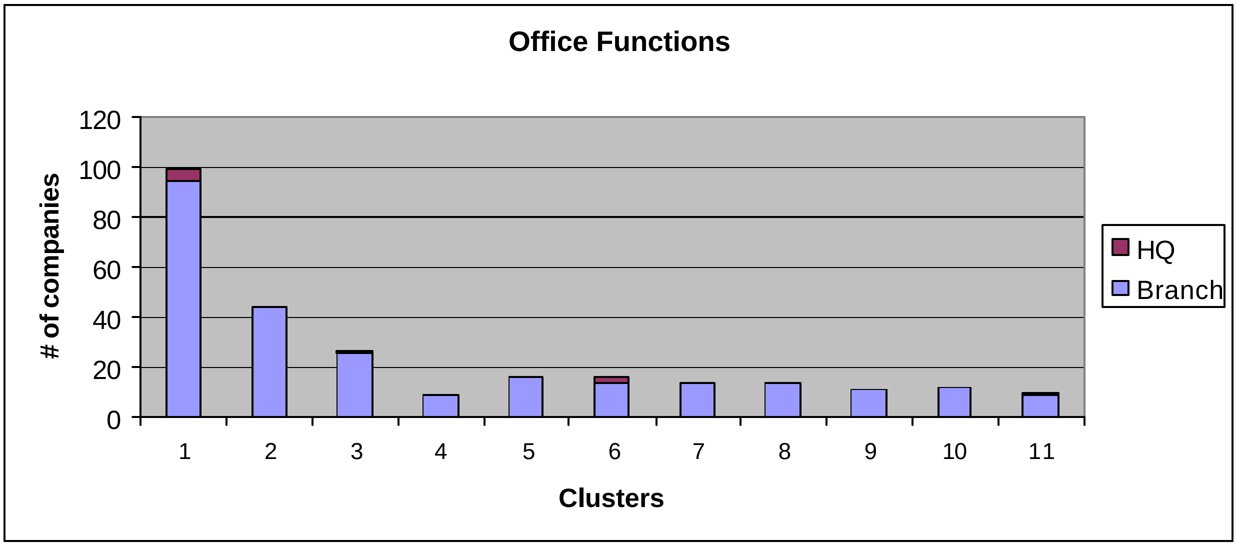



**Figure 4.28: Number of Companies according to Office Functions in Los Angeles**

### 4.1.6.2 Los Angeles Buildings

There are 384 high-rise building locations identified in total in Los Angeles Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.08 miles, thus the distance that is used in calculating the clusters is taken as 0.09 miles. The minimum number of points that formed the median number of clusters was 10 and the median number of clusters turned out to be 8. 7 out of 8 clusters are located in areas that have higher density than edgeless city density, thus the clusters are located in a centralized way.

**Table 4.45: Percent of Buildings according to Year of Construction in Los Angeles**

| Years | % of buildings |
|---|---|
| **2000-2010** | 7.81 |
| **1990-2000** | 9.90 |
| **1980-1990** | 27.60 |
| **1970-1980** | 17.19 |
| **pre1970** | 37.50 |
| **TOTAL** | 100.00 |

**Table 4.46: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Los Angeles**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 1 | 10 | 19 | 10 | 76 | 116 |
| 2 | 0 | 0 | 3 | 6 | 13 | 22 |
| 3 | 2 | 1 | 4 | 8 | 5 | 20 |
| 4 | 8 | 9 | 1 | 0 | 0 | 18 |
| 5 | 0 | 1 | 8 | 4 | 4 | 17 |
| 6 | 1 | 1 | 5 | 2 | 5 | 14 |
| 7 | 0 | 0 | 2 | 4 | 6 | 12 |
| 8 | 0 | 4 | 5 | 2 | 0 | 11 |
| Total Clustered Buildings | 12 | 26 | 47 | 36 | 109 | 230 |
| Total Buildings | 30 | 38 | 106 | 66 | 144 | 384 |
| % of clustering | 40.00 | 68.42 | 44.34 | 54.55 | 75.69 | 59.90 |

**Table 4.47: Percent of Buildings in Clusters according to Year of Construction in Los Angeles**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 0.86 | 8.62 | 16.38 | 8.62 | 65.52 | 100.00 |
| 2 | 0.00 | 0.00 | 13.64 | 27.27 | 59.09 | 100.00 |
| 3 | 10.00 | 5.00 | 20.00 | 40.00 | 25.00 | 100.00 |
| 4 | 44.44 | 50.00 | 5.56 | 0.00 | 0.00 | 100.00 |
| 5 | 0.00 | 5.88 | 47.06 | 23.53 | 23.53 | 100.00 |
| 6 | 7.14 | 7.14 | 35.71 | 14.29 | 35.71 | 100.00 |
| 7 | 0.00 | 0.00 | 16.67 | 33.33 | 50.00 | 100.00 |
| 8 | 0.00 | 36.36 | 45.45 | 18.18 | 0.00 | 100.00 |

**Table 4.48: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Los Angeles**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 3.33 | 26.32 | 17.92 | 15.15 | 52.78 | 30.21 |
| 2 | 0.00 | 0.00 | 2.83 | 9.09 | 9.03 | 5.73 |
| 3 | 6.67 | 2.63 | 3.77 | 12.12 | 3.47 | 5.21 |
| 4 | 26.67 | 23.68 | 0.94 | 0.00 | 0.00 | 4.69 |
| 5 | 0.00 | 2.63 | 7.55 | 6.06 | 2.78 | 4.43 |
| 6 | 3.33 | 2.63 | 4.72 | 3.03 | 3.47 | 3.65 |
| 7 | 0.00 | 0.00 | 1.89 | 6.06 | 4.17 | 3.13 |
| 8 | 0.00 | 10.53 | 4.72 | 3.03 | 0.00 | 2.86 |
| Non-clustered | 60.00 | 31.58 | 55.66 | 45.45 | 24.31 | 40.10 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 45.31% of all high-rise office buildings in Los Angeles were constructed after 1980s. 37.50% of these buildings were constructed before 1970, which is the highest percentage of building construction in a time interval (Table 4.45). 59.90% of all buildings in Los Angeles belong to a cluster (Table 4.46). The percentage of clustering was 75.69% before 1970. Between 1970 and 1980, the clustering percentage decreased down to 54.55%. Between 1980 and 1990, the clustering percentage decreased down to 44.34%. Although there was an increase in 1990s, the clustering percentage became 40% in 2000s, suggesting decentralization (Table 4.46). The multiple locations of building clusters suggest a polycentric structure. Map 23A shows the high-rise office building locations and Map23B demonstrates the building clusters in Los Angeles.

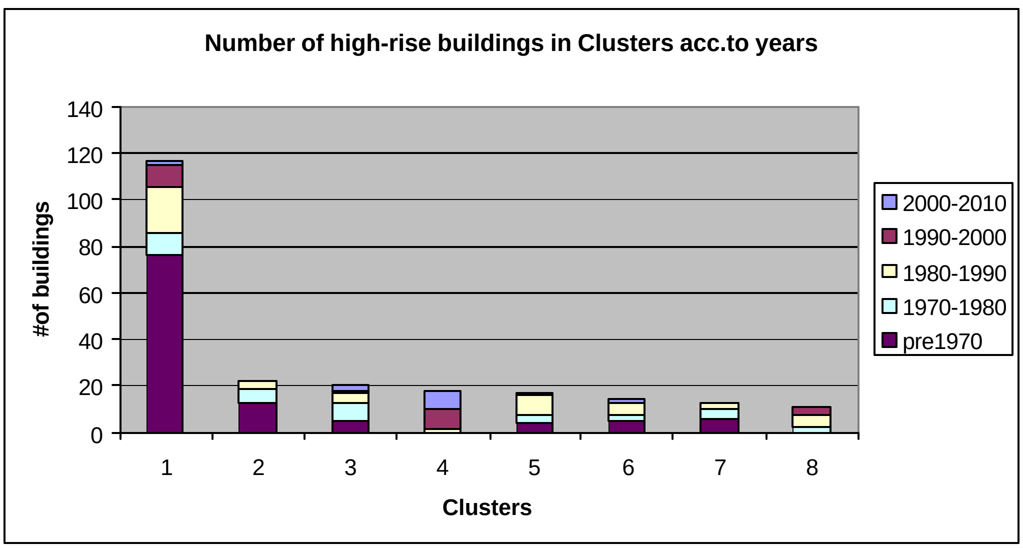



**Figure 4.29: Number of buildings in Building Clusters according to Year of Construction in Los Angeles**

Cluster 1 is located in downtown Los Angeles, in a primary downtown density area. It is the cluster with the highest number of buildings and the third densest cluster in terms of buildings per area. There are 116 buildings in total in this cluster (Table 4.46), which makes up 30.21% of all the high-rise buildings (Table 4.48). 25.86% of these buildings are constructed after 1980s. The highest rate of construction took place before 1970s (Table 4.47). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in pre-1970s. It is also the most dominant cluster between 1970 and 2000 in terms of clustered buildings (Table 4.48). 52.78% of all buildings constructed before 1970s exists in this cluster, making it the oldest cluster. Although it is the oldest cluster, the high rate of construction between 1990 and 2000 proves that it expanded in later times.

Cluster 2 is located inside the Wilshire/ Santa Monica Boulevard Corridor in a secondary downtown density location 2.7 miles away from downtown Los Angeles. It is the cluster with the second highest number of buildings and the densest cluster. There are 22 buildings in this cluster (Table 4.46). 86.36% of the buildings in this cluster are constructed before 1980s and 59.09% of the buildings are constructed before 1970 (Table 4.47). Cluster 3 is located in the secondary downtown of West LA/Beverly Hills/Santa Monica. The center of the cluster is in the secondary downtown density area approximately 9.2 miles in shortest distance from the center of downtown Los Angeles. It is the cluster with the third highest number of buildings (Table 4.46). 65% of all the buildings in this cluster are constructed before 1980 (Table 4.47), which makes cluster 3 the second most dominant cluster in terms of having the highest percentage of high-rise buildings built between 1970 and 1980 (Table 4.48).

Cluster 4 is located in the edge city of John Wayne Airport/ Southcoast, in a secondary downtown density area, 34.5 miles away from the center of downtown. There are 18 buildings in this cluster; there are no buildings built before 1980s, which makes this cluster the most recent building cluster (Table 4.47); 94.44% of all the buildings were constructed between 1990 and 2010 (Table 4.47). This cluster is the second most dominant cluster in terms of clustered high-rise building construction between 1990 and 2010 (Table 4.48). Cluster 5 is located in the secondary downtown of West LA/Beverly Hills/Santa Monica. The center of the cluster is in the secondary downtown density area approximately 11 miles in shortest distance from the center of downtown Los Angeles. There are 17 buildings in this cluster, of which 8 were constructed between 1980 and 1990 (Table 4.46), which makes Cluster 5 the second most dominant cluster in terms of clustered high rise buildings in that year (Table 4.48).

Cluster 6 is located in the edgeless city density area, 20 miles away from downtown. There are 14 buildings in this cluster and half of them were constructed after 1980s (Table 4.47). Cluster 7 is located inside the Wilshire/ Santa Monica Boulevard Corridor in an edge city density location 6 miles away from downtown Los Angeles. There are 12 buildings and 10 of them were constructed before 1980. There was no construction after 1990 (Table 4.46). Cluster 8 is located in the secondary downtown of Glendale in an edge city density location 7 miles away from downtown. There are 11 firms in this cluster, all of them were constructed between 1970 and 2000 (Table 4.46). Highest construction rate took place between 1980 and 1990 (Table 4.47).

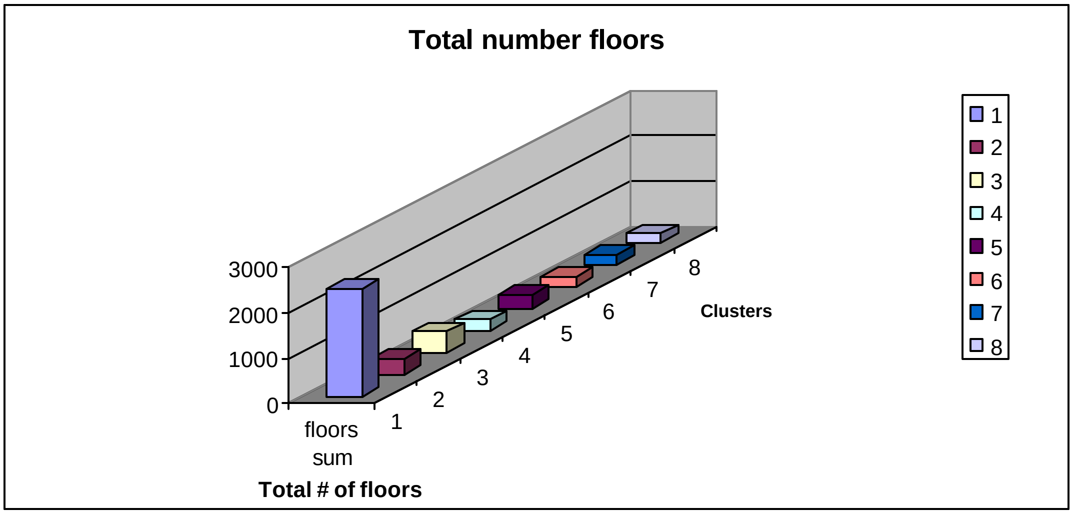



**Figure 4.30: Total Number of floors in Los Angeles Building Clusters**

### 4.1.6.3 Los Angeles Company-Building Analysis

In Los Angeles, 4 out of 8 building clusters intersect with four company cluster. All building clusters that intersect with a company cluster are located in primary and secondary downtown density areas. There are three locations that building and company clusters intersect with each other: downtown Los Angeles, secondary downtown of West LA/Beverly Hills/Santa Monica, and edge city of John Wayne Airport/Southcoast. Map 24 shows the company-building analysis of Los Angeles.

In downtown Los Angeles, building cluster 1 intersects with the company cluster 1. Building cluster 1 is the highest building cluster in terms of total number of floors and it is also the oldest building cluster (Figure 4.30). Although it is the oldest, this cluster continued to expand in all years, thus it is a hot-spot location for commercial high-rise buildings. Building cluster 1 intersects with company cluster 1, which is the densest and most diversified cluster. Company cluster 1 is the most dominant cluster in finance/banking, law, and management consultancy.

Law and design consultancy are other important sectors in company cluster 1. These findings demonstrate the high-rise location tendency of these sectors.

In West LA/Beverly Hills/Santa Monica secondary downtown, building cluster 3 intersects with company cluster 3; also building cluster 5 intersects with company cluster 5. Finance/banking, law, and management consultancy are the sectors with the most number of firms in company cluster 3. Building cluster 3 has 65% of all its buildings constructed before 1980. The main expansion in this cluster occurred between 1970 and 1980 when 40% of the buildings were constructed. This location represents a similar composition to downtown in terms of the industry content and the high-rise location tendency of the sectors. Design consultancy, management consultancy, finance/banking, and logistics are the most important sectors in company cluster 5. Building cluster 5 started before 1970s, but the main expansion took place between 1980 and 1990. The industry composition of this location is again similar to downtown, but the buildings make it a more recent cluster.

Another building and company cluster intersection takes place inside the John Wayne Airport/Southcoast edge city. Building cluster 4 intersects with company cluster 2. The function of downtown in Los Angeles County is taken by John Wayne Airport edge city in the Orange County. This became a central location for the company clusters. Company clusters 2, 4, and 6 are located here and they are all dominated by IT firms. IT does not have a major presence in Los Angeles County except for company cluster 7, which is located in an edgeless city area. Building cluster 4 intersects with only company cluster 2. Building cluster 4 is the most recent high-rise building cluster in Los Angeles metropolitan area; its central location also proves that John Wayne Airport edge city became a recent and important global business activity node.

### 4.1.7 Miami

Miami has one downtown, one secondary downtown of Ft. Lauderdale and four edge cities: Coral Gables, Lauderdale Lakes, Boca Raton, and West Palm Beach. Downtown is located in the area including Brickell Avenue and Biscayne Boulevard. Miami has the smallest downtown area compared to other metropolitan areas in terms of share of metropolitan office space. Ft. Lauderdale, located 26 miles away from downtown, has 5% of all the office space. Edge cities in total contain 22.9 % of all the office space in Miami. Coral Gables has 8.7% of all the office space. Lauderdale Lakes, located 30 miles away from downtown Miami and 5 miles away from Ft. Lauderdale, has 5.2% of all the office space, Boca Raton located 44 miles away from downtown Miami and 18 miles away from Ft. Lauderdale has, 4.4% of all the office space. Finally, West Palm Beach is located 67 miles away from downtown Miami and it consists of 4.7% of all the office space. Miami is the leader in edgeless city office space among the selected ten metro regions in terms of percentage. Miami has 72.1% of all its office space scattered in edgeless city density areas (Lang et al. 2007). Map 25 demonstrates the findings of Lang et al (2007) in Miami.

#### 4.1.7.1. Miami Companies

There are 320 APS TNC locations identified in Miami metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.10 miles. The distance to identify clusters was taken as 0.11 miles. The minimum number of points that gave the median number of clusters was 6 and the median number of clusters turned out to be 6. 39.06% of the companies in Miami belong to a cluster (Table 4.50). Among the 6 clusters, only one cluster is found in and edgeless city density area. The multiple locations of clusters prove the polycentric structure of the global business activity nodes. Cluster 1 is found in downtown, clusters 2, 3, and 5 are found in Coral Gables, cluster 4 is located in Ft. Lauderdale and Cluster 6 is located in West Palm Beach in an edgeless city density location. All industries are represented in Miami. Logistics, IT, and real estate are the top three industries in terms of number of companies. Logistics and IT make up 43.13% of all the APS TNCs (Table 4.49).

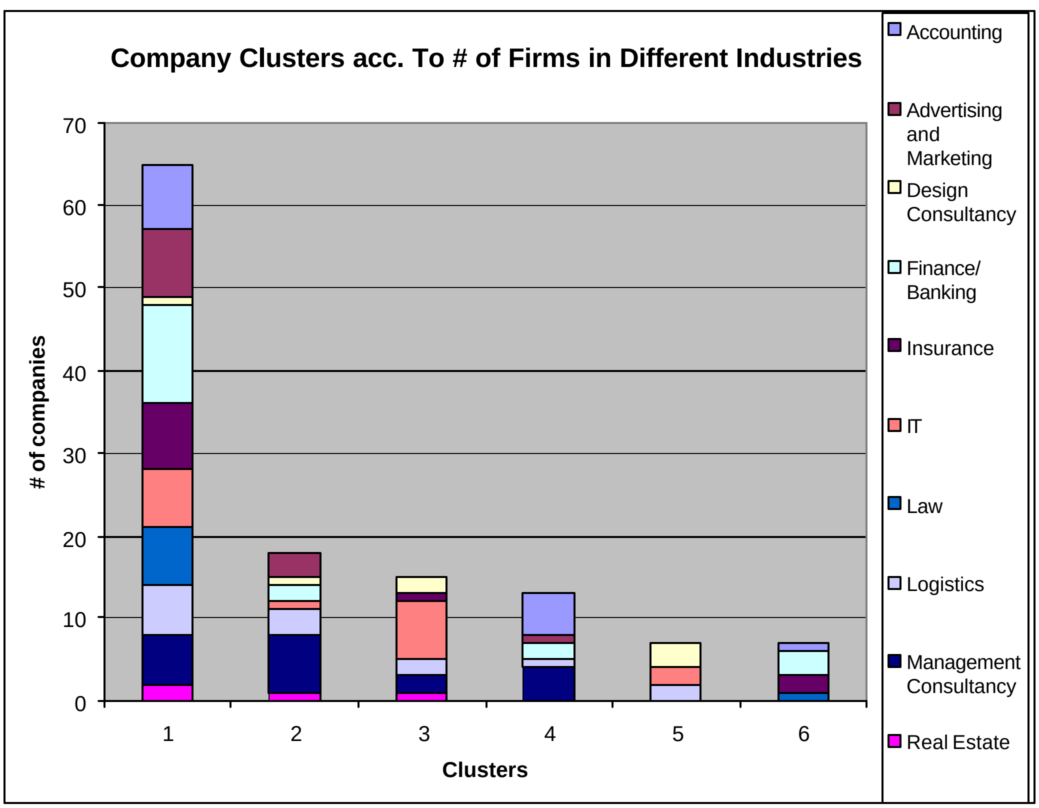



**Figure 4.31: Number of companies in company clusters in Miami**

Table 4.49: Industries represented in Miami APS TNCs

| Industries | % of all firms |
|---|---|
| Accounting | 7.81 |
| Advertising and Marketing | 4.38 |
| Design Consultancy | 9.06 |
| Finance/Banking | 8.44 |
| Insurance | 6.56 |
| IT | 10.94 |
| Law | 2.50 |
| Logistics | 32.19 |
| Management Consultancy | 7.81 |
| Real Estate | 10.31 |
| TOTAL | 100.00 |

Table 4.50: Number of Companies in Clusters and Percent of Clustering among Industries in Miami

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 8 | 1 | 12 | 8 | 7 | 7 | 6 | 6 | 2 | 65 |
| 2 | 0 | 3 | 1 | 2 | 0 | 1 | 0 | 3 | 7 | 1 | 18 |
| 3 | 0 | 0 | 2 | 0 | 1 | 7 | 0 | 2 | 2 | 1 | 15 |
| 4 | 5 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 4 | 0 | 13 |
| 5 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 7 |
| 6 | 1 | 0 | 0 | 3 | 2 | 0 | 1 | 0 | 0 | 0 | 7 |
| Total Clustered Companies | 14 | 12 | 7 | 19 | 11 | 17 | 8 | 14 | 19 | 4 | 125 |
| Total Companies | 25 | 14 | 29 | 27 | 21 | 35 | 8 | 103 | 25 | 33 | 320 |
| % of clustering | 56.00 | 85.71 | 24.14 | 70.37 | 52.38 | 48.57 | 100.00 | 13.59 | 76.00 | 12.12 | 39.06 |

**Table 4.51: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Miami**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12.31 | 12.31 | 1.54 | 18.46 | 12.31 | 10.77 | 10.77 | 9.23 | 9.23 | 3.08 | 100.00 |
| 2 | 0.00 | 16.67 | 5.56 | 11.11 | 0.00 | 5.56 | 0.00 | 16.67 | 38.89 | 5.56 | 100.00 |
| 3 | 0.00 | 0.00 | 13.33 | 0.00 | 6.67 | 46.67 | 0.00 | 13.33 | 13.33 | 6.67 | 100.00 |
| 4 | 38.46 | 7.69 | 0.00 | 15.38 | 0.00 | 0.00 | 0.00 | 7.69 | 30.77 | 0.00 | 100.00 |
| 5 | 0.00 | 0.00 | 42.86 | 0.00 | 0.00 | 28.57 | 0.00 | 28.57 | 0.00 | 0.00 | 100.00 |
| 6 | 14.29 | 0.00 | 0.00 | 42.86 | 28.57 | 0.00 | 14.29 | 0.00 | 0.00 | 0.00 | 100.00 |

**Table 4.52: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Miami**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 32.00 | 57.14 | 3.45 | 44.44 | 38.10 | 20.00 | 87.50 | 5.83 | 24.00 | 6.06 |
| 2 | 0.00 | 21.43 | 3.45 | 7.41 | 0.00 | 2.86 | 0.00 | 2.91 | 28.00 | 3.03 |
| 3 | 0.00 | 0.00 | 6.90 | 0.00 | 4.76 | 20.00 | 0.00 | 1.94 | 8.00 | 3.03 |
| 4 | 20.00 | 7.14 | 0.00 | 7.41 | 0.00 | 0.00 | 0.00 | 0.97 | 16.00 | 0.00 |
| 5 | 0.00 | 0.00 | 10.34 | 0.00 | 0.00 | 5.71 | 0.00 | 1.94 | 0.00 | 0.00 |
| 6 | 4.00 | 0.00 | 0.00 | 11.11 | 9.52 | 0.00 | 12.50 | 0.00 | 0.00 | 0.00 |
| Non-clustered | 44.00 | 14.29 | 75.86 | 29.63 | 47.62 | 51.43 | 0.00 | 86.41 | 24.00 | 87.88 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Law, advertising and marketing, and management consultancy are the top three sectors with the highest rate of membership in a cluster. Real estate, logistics, and design consultancy are the three sectors with the lowest degree of clustering. Table 4.50 summarizes these results. Map 26A shows the APS TNCs and Map 26B demonstrates Miami company clusters.

The largest cluster with 65 companies is Cluster 1 is located in downtown Miami, 5 miles away from Miami International Airport. This cluster includes part of Brickell Avenue and Biscayne Boulevard, which is a major business activity location in Miami metropolitan region. It is also the densest cluster (Table 4.50). There are 65 firms in total in this cluster, of which 61 are branch locations. All industries are present, thus it is the most diversified cluster in Miami. Design consultancy and real estate are underrepresented with 1 and 2 firms consecutively. Finance/banking dominates the cluster with 12 firms (Table 4.50). Cluster 1 is the most dominant cluster in terms of advertising and marketing, finance/banking, and law. 87.50% of all the law firms in Miami metropolitan area are found in this cluster. This percentage is 57.14% for advertising and marketing and 44.44% in finance/banking. Cluster 1 is also the most dominant cluster in terms of clustered firms in accounting, insurance, IT, logistics, and real estate (Table 4.52).

Cluster 2 is located in Coral Gables in an edge city density location, 2.7 miles away from Miami International Airport. Cluster 2 is the second largest cluster in terms of number of companies. There are 18 firms in this cluster, all of which are branch locations. Accounting, insurance, and law are not present. Management consultancy is the most dominant industry with 38.89% followed by logistics and advertising and marketing. Cluster 2 is the most dominant cluster in

Miami in terms of management consultancy firms (Table 4.52). Cluster 3 is also located in Coral Gables an edge city density location, 1.7 miles away from Miami International Airport. There are 15 firms in this cluster, of which 14 of them are branch locations. IT dominates the cluster with 7 firms (table 4.50). Together with cluster 1, this cluster is the most dominant cluster in terms of clustered IT firms (Table 4.52).

Cluster 4 is located in the secondary downtown of Ft. Lauderdale, 25 miles away from downtown Miami in an edge city density area. It is the cluster with the fourth highest number of companies and third densest cluster in Miami. There are 13 firms in total in this cluster, 12 of which are branch locations. Accounting, management consultancy, and finance/banking are the top three sectors with 5, 4, and 2 firms consecutively. There are no IT firms and only one logistics firm (Table 4.50). This cluster is the second most dominant cluster in terms of clustered accounting firms (Table 4.52).

Cluster 5 is located on the fringe of edge city of Coral Gables. The center of the cluster is in an edge city area, 3 miles away from Miami International Airport. There are 7 firms in total in this cluster. Design consultancy, IT, and logistics are the only industries present in this cluster. The most dominant industry is design consultancy with sector with 3 firms. IT and logistics each has two companies (Table 4.50). This cluster is the most dominant cluster in terms of clustered design consultancy firms (Table 4.52). Cluster 6 is located in an edge city density location, 1.6 miles away from West Palm Beach edge city and 67 miles away from downtown Miami. It is the second densest cluster. There are 7 firms in this cluster, all of which are branch locations.

Finance/banking, insurance, law, and accounting are the existing sectors. This company cluster is the only company cluster with a law TNC except for cluster 1 (Table 4.50).

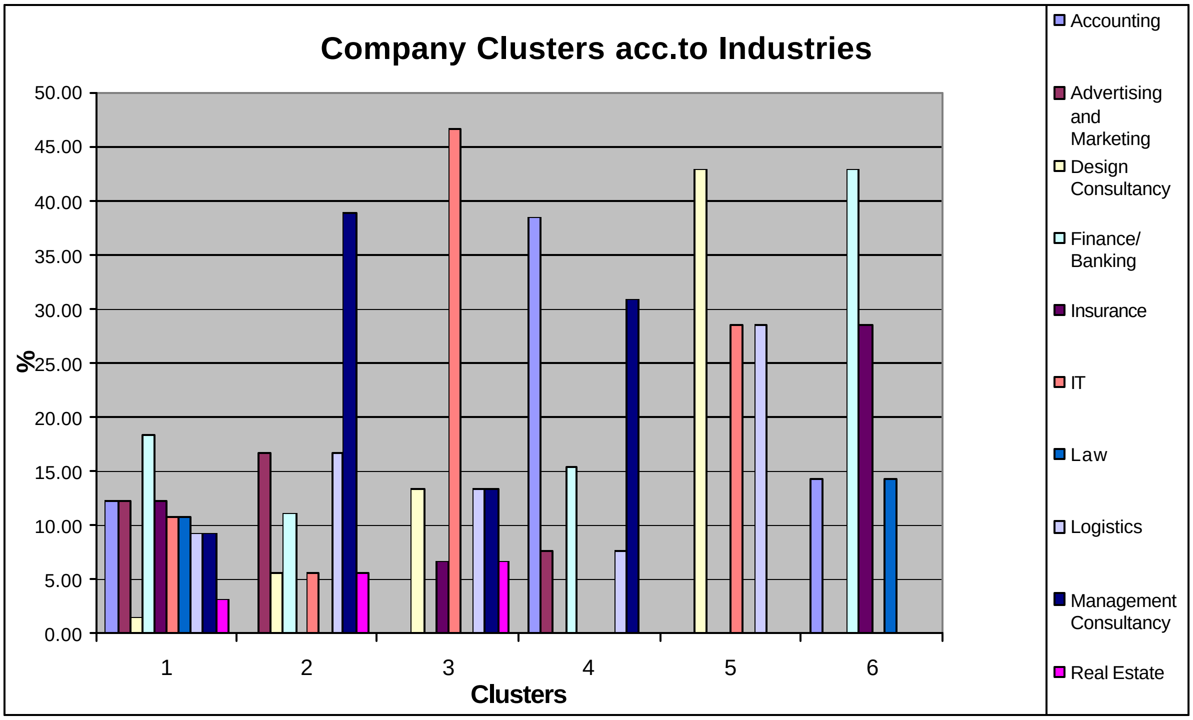



**Figure 4.32: Percent of Industries in Company Clusters in Miami**

IT, logistics, and real estate together make up half of all the APS TNCs in Miami. In Miami, there are two clusters that are specialized in management consultancy and IT, however there is no single industry dominated cluster. Design consultancy is more decentralized than IT, which is a similar trend with Houston.

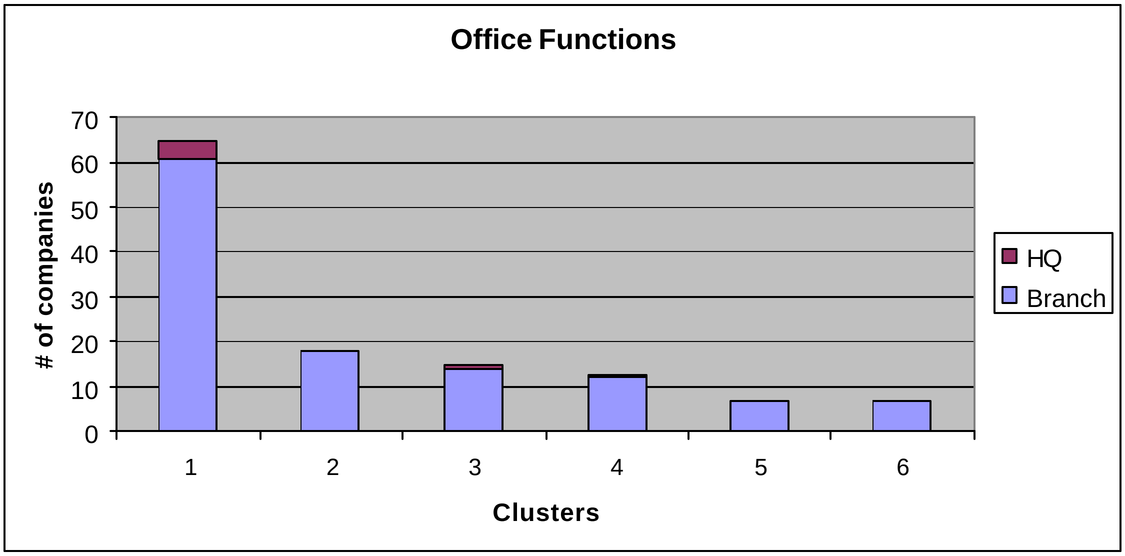



**Figure 4.33: Number of Companies according to Office Functions in Miami**

#### 4.1.7.2 Miami Buildings

There are 128 building locations in total in Miami Metropolitan Area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.25 miles, thus the distance that is used in calculating the clusters is taken as 0.26 miles. The minimum number of points that formed the median number of clusters was 10 and the median number of clusters turned out to be 4. Three of the building clusters have mean centers in areas with edge city densities, which prove that these clusters are located in a centralized fashion. Miami does not have any primary or secondary downtown density locations due to the high degree of dispersal of office space. Three of the building clusters are found in downtown, Ft. Lauderdale, and West Palm Beach. One building cluster is found near ocean front in Brickell Avenue and Biscayne Boulevard.

**Table 4.53: Percent of Buildings according to Year of Construction in Miami**

| Years | % of buildings |
|---|---|
| 2000-2010 | 23.44 |
| 1990-2000 | 14.84 |
| 1980-1990 | 34.38 |
| 1970-1980 | 9.38 |
| Pre1970 | 17.97 |
| TOTAL | 100.00 |

**Table 4.54: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Miami**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 11 | 0 | 18 | 5 | 17 | 51 |
| 2 | 3 | 5 | 7 | 5 | 0 | 20 |
| 3 | 4 | 5 | 5 | 1 | 0 | 15 |
| 4 | 1 | 3 | 5 | 0 | 2 | 11 |
| Total Clustered Buildings | 19 | 13 | 35 | 11 | 19 | 97 |
| Total Buildings | 30 | 19 | 44 | 12 | 23 | 128 |
| % of clustering | 63.33 | 68.42 | 79.55 | 91.67 | 82.61 | 75.78 |

**Table 4.55: Percent of Buildings in Clusters according to Year of Construction in Miami**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 21.57 | 0.00 | 35.29 | 9.80 | 33.33 | 100.00 |
| 2 | 15.00 | 25.00 | 35.00 | 25.00 | 0.00 | 100.00 |
| 3 | 26.67 | 33.33 | 33.33 | 6.67 | 0.00 | 100.00 |
| 4 | 9.09 | 27.27 | 45.45 | 0.00 | 18.18 | 100.00 |

**Table 4.56: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Miami**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 36.67 | 0.00 | 40.91 | 41.67 | 73.91 | 39.84 |
| 2 | 10.00 | 26.32 | 15.91 | 41.67 | 0.00 | 15.63 |
| 3 | 13.33 | 26.32 | 11.36 | 8.33 | 0.00 | 11.72 |
| 4 | 3.33 | 15.79 | 11.36 | 0.00 | 8.70 | 8.59 |
| Non-clustered | 36.67 | 31.58 | 20.45 | 8.33 | 17.39 | 24.22 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 72.65% of all high-rise office buildings in Miami were constructed after 1980s. 1980-1990 and 2000-2010 are the two time intervals with the highest rate of construction. 34.38% of all high-rise buildings were built between 1980 and 1990. 23.44% of the buildings were built or scheduled to be built between 2000 and 2010 (Table 4.53). 75.78% of all buildings in Miami belong to a cluster (Table 4.54). The buildings constructed during 1970-1980 have the highest membership to a cluster with 91.67%. The rate of membership to a cluster declined steadily reaching 63.33% between 2000 and 2010. This decline suggests decentralization (Table 4.54). The multiple locations of building clusters suggest a polycentric structure.

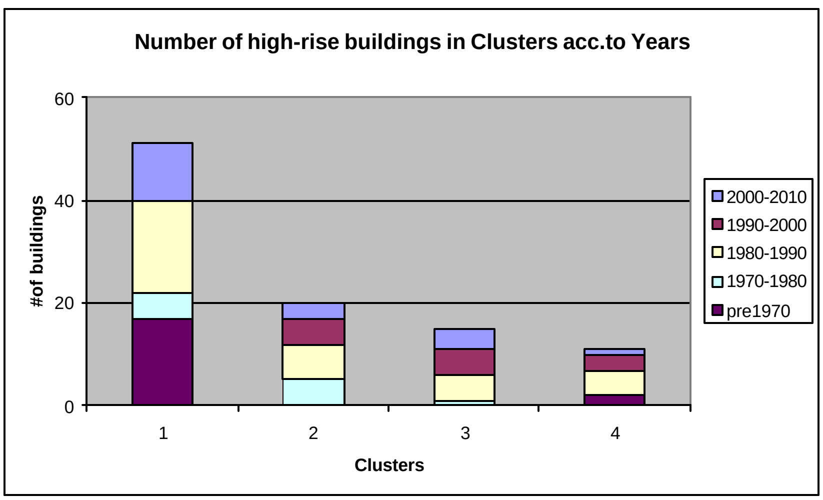



**Figure 4.34: Number of buildings in Building Clusters according to Year of Construction in Miami**

Cluster 1 is located in downtown between Brickell Avenue and Biscayne Boulevard. It is the cluster with the highest number of buildings and the second densest cluster in terms of buildings per area. There are 51 buildings in total in this cluster (Table 4.54), which makes up 39.84% of all the high-rise buildings. Around 43% of these buildings are constructed after 1980s, although the highest rate of construction took place between 1980 and 1990 (Table 4.55). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in all year intervals except for 1990-2000. 73.91% of all buildings constructed before 1970s exists in this cluster, making it the oldest cluster. Also, 41.67% of all buildings constructed between 1970 and 1980 exist in cluster 1. This percentage is 40.91% between 1980 and 1990 and 36.67% between 2000-2010. Although, this is the oldest cluster, it still continues to expand. There are no buildings constructed between 1990 and 2000 (Table 4.56).

Cluster 2 is located in the secondary downtown area in the city of Coral Gables. The center of the cluster is in an edge city density area. It is the cluster with the second highest number of buildings and the third densest cluster. There are 20 buildings in this cluster (Table 4.54). Development started in 1970s in this cluster. 25% of the buildings are constructed between 1970 and 1980. The highest rate of building construction took place between 1980 and 1990. 35% of the building construction took place in this time interval (Table 4.55). This cluster is the most dominant cluster in terms of high-rise building construction between 1970 and 1980 (Table 4.56).

Cluster 3 is located in Ft. Lauderdale in an edge city density location, 3.5 miles away from Ft. Lauderdale/Hollywood International Airport. It is the cluster with the third highest number of buildings and the densest cluster (Table 4.54). Development of the cluster started in the early 1980s and it still continues, making this a hot-spot location for high-rise buildings (Table 4.55). Cluster 3 is the most dominant cluster in terms of high-rise buildings in 1990-2000 time interval and second most dominant cluster in 2000-2010 time interval (Table 4.56). Cluster 4 is located in

West Palm Beach, in an edge city density area, 67 miles away from the center of downtown. There are 11 buildings in this cluster (Table 4.54). The highest percentage of construction took place between 1980 and 1990 (Table 4.55). Map 27A shows the high-rise office buildings and Map 27B demonstrates the building clusters in Miami.

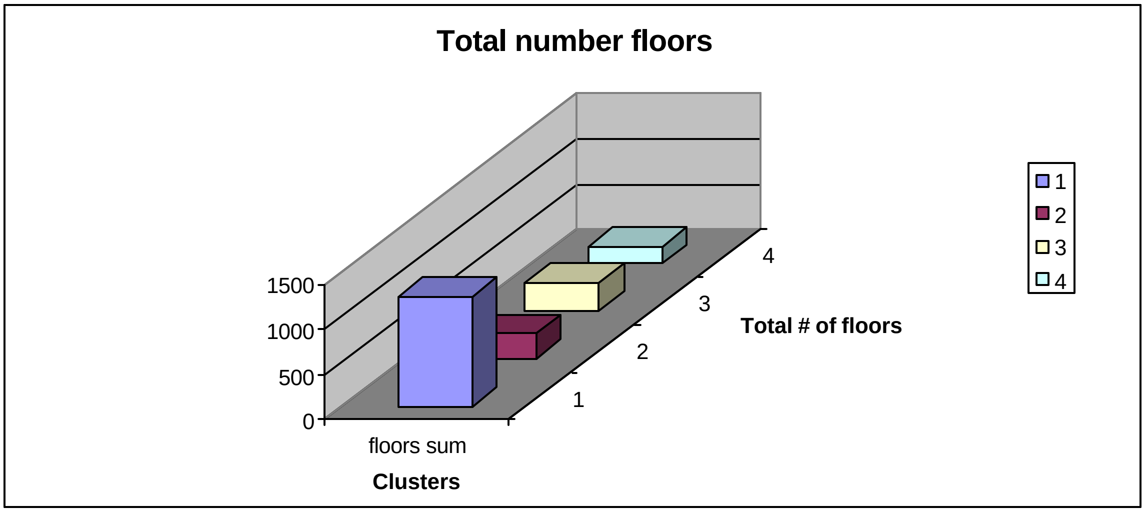



**Figure 4.35: Total Number of floors in Miami Building Clusters**

#### 4.1.7.3 Miami Company-Building Analysis

Each building cluster intersects with one company cluster. Company clusters 3 and 5 do not intersect with a high-rise building cluster. The highest building cluster in terms of total number of floors is also the oldest building cluster found in downtown between Biscayne Boulevard and Brickell Avenue, which is building cluster 1 (Figure 4.35). Building cluster 1 intersects with company cluster 1. Together these two clusters define the major location in terms of knowledge-intensive producer services. This location is currently under rapid development. Many commercial and residential high-rise buildings are being added. In Coral Gables, building cluster 2 intersects with company cluster 2 in the city of Coral Gables. Company cluster 2 is dominated by management consultancy and this location developed in 1980s after globalization became an important trend.

In Ft. Lauderdale, building cluster 3 intersects with company cluster 4. Company cluster 4 is dominated by accounting, management consultancy, and finance/banking. Building cluster 3 that intersects with company cluster 4 also developed after 1980s. In West Palm Beach, building cluster 4 intersects with company cluster 6. Company cluster 6 includes a diverse group of knowledge intensive producer services. Main development took place after 1980s in this cluster. In Miami, before 1980s, most high-rise development took place in building cluster 1. After 1980s, three more clusters evolved contributing to the internal polycentricity of the global business activity nodes.

### 4.1.8 New York

New York has one downtown, three secondary downtowns, and six edge cities. Downtown is located in Manhattan. Secondary downtowns are: Jersey City, Brooklyn, and Newark. Edge cities are: White Plains, Morristown/Parisppany, Tinton Falls, Metro Park, I-78/I-287, and Melville. Downtown area is Manhattan, which has the largest share of office space with 54.5% of all the office space in New York metropolitan area being located in Manhattan. Downtown is very dominant in New York and it has the largest area compared to other cities. Secondary downtown of Jersey City is located 2 miles west of Manhattan and it has 2.9% of all the office space. Brooklyn is located 2 miles south east of Manhattan and it has 1.9% of all the office space. Newark is located 9 miles west of Manhattan and it consists of 2.1% of all the office space. Newark is in close proximity to Newark International Airport. Downtowns all together have 61.4% of all the office space in New York metropolitan region. This is the largest proportion of downtown office space compared to other regions, which is not surprising given the importance of New York as an international, financial center and the location for many corporate headquarters. New York also is the largest in terms of total office space and demonstrates a polycentric regional model totaling over 600 million square feet of office space (Lang et al. 2007).

Six edge cities in total have 6.3% of all the office space. White Plains is located 27 miles away from downtown area and it has 1.5% of all the office space. Morristown/Parisppany is located 24 miles away from downtown and it has 1.6% of the office space. Tinton Falls is located 29 miles away from Manhattan and it has 0.8% of the office space. Metropark is located 22 miles south of downtown and it has 0.7% of all the office space. I-78/I-287 is located 34 miles away from downtown Manhattan and it has 0.9% of the office space. Melville is located 32 miles east of Manhattan and it consist of 0.7% of all the office space in New York metropolitan region (Lang et al. 2007). 32.3% of all office space in New York is located in edgeless city density areas. Map 29 demonstrates the findings of Lang et al (2007) in New York.

#### 4.1.8.1 New York Companies

There are 1021 APS TNC locations identified in New York metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.04 miles. The distance to identify clusters was taken as 0.05 miles. The minimum number of points that gave the median number of clusters was 9 and the median number of clusters turned out to be 11. 65.62% of the companies in New York belong to a cluster. Among the 11 clusters, only 2 clusters are found in areas with edgeless city density, which proves that most of the company clusters are located in a centralized pattern. The multiple locations of clusters prove the polycentric structure of the global business activity nodes.

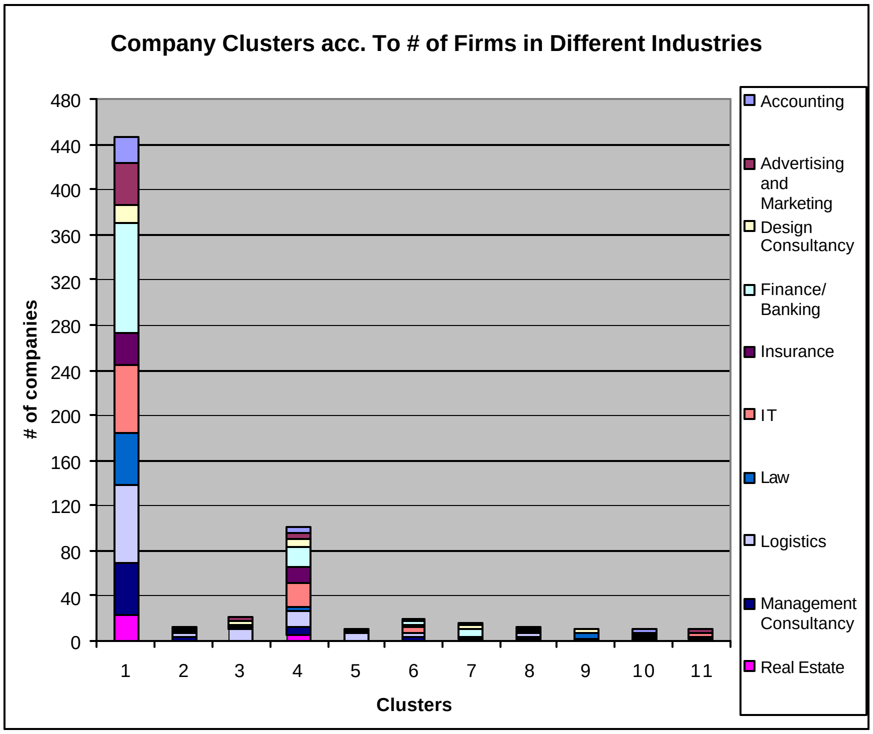



**Figure 4.36: Number of companies in company clusters in New York**

Clusters 1, 2, 3, 4, and 5 is found in Manhattan; clusters 6 is found in Jersey City. Cluster 7 is found near Metropark in an edgeless city density location. Cluster 8 is found near Morristown/Parisppany in an edgeless city density area. Cluster 9 is located in Newark. Cluster 10 is located in Melville and Cluster 11 is located in White Plains. All industries are represented in New York. Logistics, IT, and finance/banking are the top three industries in terms of number of companies. Logistics and IT together make up 39.76% of all the APS TNCs (Table 4.57). Map 30A and Map 30B illustrate the APS TNCs and company clusters identified in New York.

**Table 4.57: Industries represented in New York APS TNCs**

| Industries | % of clustering |
|---|---|
| Accounting | 4.80 |
| Advertising and Marketing | 6.37 |
| Design Consultancy | 5.29 |
| Finance/Banking | 14.40 |
| Insurance | 7.05 |
| IT | 15.96 |
| Law | 5.68 |
| Logistics | 23.80 |
| Management Consultancy | 9.40 |
| Real Estate | 7.25 |
| TOTAL | 100.00 |

**Table 4.58: Number of Companies in Clusters and Percent of Clustering among Industries in New York**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22 | 38 | 16 | 96 | 29 | 60 | 46 | 70 | 46 | 23 | 446 |
| 2 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 5 | 2 | 1 | 12 |
| 3 | 0 | 5 | 4 | 1 | 1 | 1 | 0 | 9 | 0 | 1 | 22 |
| 4 | 6 | 5 | 6 | 18 | 14 | 22 | 3 | 15 | 7 | 5 | 101 |
| 5 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 7 | 0 | 1 | 10 |
| 6 | 2 | 0 | 0 | 5 | 1 | 5 | 0 | 4 | 2 | 1 | 20 |
| 7 | 2 | 0 | 3 | 7 | 0 | 0 | 2 | 1 | 0 | 1 | 16 |
| 8 | 1 | 1 | 0 | 1 | 0 | 3 | 0 | 2 | 2 | 2 | 12 |
| 9 | 0 | 0 | 3 | 0 | 1 | 1 | 4 | 1 | 1 | 0 | 11 |
| 10 | 3 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 0 | 10 |
| 11 | 0 | 2 | 0 | 2 | 0 | 3 | 1 | 1 | 0 | 1 | 10 |
| Total Clustered Companies | 36 | 54 | 33 | 133 | 48 | 97 | 56 | 115 | 62 | 36 | 670 |
| Total Companies | 49 | 65 | 54 | 147 | 72 | 163 | 58 | 243 | 96 | 74 | 1021 |
| % clustering | 73.47 | 83.08 | 61.11 | 90.48 | 66.67 | 59.51 | 96.55 | 47.33 | 64.58 | 48.65 | 65.62 |

**Table 4.59: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in New York**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.93 | 8.52 | 3.59 | 21.52 | 6.50 | 13.45 | 10.31 | 15.70 | 10.31 | 5.16 | 100.00 |
| 2 | 0.00 | 8.33 | 0.00 | 8.33 | 8.33 | 8.33 | 0.00 | 41.67 | 16.67 | 8.33 | 100.00 |
| 3 | 0.00 | 22.73 | 18.18 | 4.55 | 4.55 | 4.55 | 0.00 | 40.91 | 0.00 | 4.55 | 100.00 |
| 4 | 5.94 | 4.95 | 5.94 | 17.82 | 13.86 | 21.78 | 2.97 | 14.85 | 6.93 | 4.95 | 100.00 |
| 5 | 0.00 | 10.00 | 0.00 | 10.00 | 0.00 | 0.00 | 0.00 | 70.00 | 0.00 | 10.00 | 100.00 |
| 6 | 10.00 | 0.00 | 0.00 | 25.00 | 5.00 | 25.00 | 0.00 | 20.00 | 10.00 | 5.00 | 100.00 |
| 7 | 12.50 | 0.00 | 18.75 | 43.75 | 0.00 | 0.00 | 12.50 | 6.25 | 0.00 | 6.25 | 100.00 |
| 8 | 8.33 | 8.33 | 0.00 | 8.33 | 0.00 | 25.00 | 0.00 | 16.67 | 16.67 | 16.67 | 100.00 |
| 9 | 0.00 | 0.00 | 27.27 | 0.00 | 9.09 | 9.09 | 36.36 | 9.09 | 9.09 | 0.00 | 100.00 |
| 10 | 30.00 | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 0.00 | 0.00 | 20.00 | 0.00 | 100.00 |
| 11 | 0.00 | 20.00 | 0.00 | 20.00 | 0.00 | 30.00 | 10.00 | 10.00 | 0.00 | 10.00 | 100.00 |

**Table 4.60: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in New York**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 44.90 | 58.46 | 29.63 | 65.31 | 40.28 | 36.81 | 79.31 | 28.81 | 47.92 | 31.08 |
| 2 | 0.00 | 1.54 | 0.00 | 0.68 | 1.39 | 0.61 | 0.00 | 2.06 | 2.08 | 1.35 |
| 3 | 0.00 | 7.69 | 7.41 | 0.68 | 1.39 | 0.61 | 0.00 | 3.70 | 0.00 | 1.35 |
| 4 | 12.24 | 7.69 | 11.11 | 12.24 | 19.44 | 13.50 | 5.17 | 6.17 | 7.29 | 6.76 |
| 5 | 0.00 | 1.54 | 0.00 | 0.68 | 0.00 | 0.00 | 0.00 | 2.88 | 0.00 | 1.35 |
| 6 | 4.08 | 0.00 | 0.00 | 3.40 | 1.39 | 3.07 | 0.00 | 1.65 | 2.08 | 1.35 |
| 7 | 4.08 | 0.00 | 5.56 | 4.76 | 0.00 | 0.00 | 3.45 | 0.41 | 0.00 | 1.35 |
| 8 | 2.04 | 1.54 | 0.00 | 0.68 | 0.00 | 1.84 | 0.00 | 0.82 | 2.08 | 2.70 |
| 9 | 0.00 | 0.00 | 5.56 | 0.00 | 1.39 | 0.61 | 6.90 | 0.41 | 1.04 | 0.00 |
| 10 | 6.12 | 1.54 | 1.85 | 0.68 | 1.39 | 0.61 | 0.00 | 0.00 | 2.08 | 0.00 |
| 11 | 0.00 | 3.08 | 0.00 | 1.36 | 0.00 | 1.84 | 1.72 | 0.41 | 0.00 | 1.35 |
| Non-clustered | 26.53 | 16.92 | 38.89 | 9.52 | 33.33 | 40.49 | 3.45 | 52.67 | 35.42 | 51.35 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Law, Finance/Banking, and Advertising and Marketing are the top three sectors with the highest rate of membership in a cluster. The logistics and real estate are two sectors with the lowest degree of clustering, although compared to other cities they have high degree of clustering (above 47%). Table 4.58 summarizes these results.

The largest cluster with 446 companies is Cluster 1, which is located in upper Manhattan. It is the cluster with the highest number of companies and the densest cluster (Table 4.58). There are 446 firms in total in this cluster, of which 356 are branch locations. This is the cluster with the highest number of headquarters in all the selected cities. All industries are present; this is the most diversified cluster in New York together with cluster 4. Finance/banking, logistics, and IT are the top three sectors in this cluster, together they constitute around 50.67% of the companies in this cluster (Table 4.59). Real estate, accounting, and design consultancy are the three sectors with the lowest number of companies (Table 4.58). Cluster 1 is the most dominant cluster in six sectors: accounting, advertising and marketing, finance/banking, insurance, law, and management consultancy. 79.31% of all the law firms, 65.31% of all finance/banking companies, 58.33% of all law firms, and 58.46% of all advertising and marketing companies, 47.92% of all management consultancy firms, 44.90% of all accounting companies, and 40.28% of all insurance companies are found in this cluster. Cluster 1 is also the most dominant cluster in terms of clustered firms in design consultancy, IT, logistics, and real estate (Table 4.60).

Cluster 2 is also located in upper Manhattan next to cluster 1. There are 12 firms in this cluster, 10 of which are branch locations. Logistics dominate the cluster with 5 firms. There are no firms from accounting, design consultancy and law (Table 4.58). Cluster 3 is located in midtown

Manhattan. It is the cluster with the third highest number of companies. There are 22 firms in total in this cluster, 18 of which are branch locations. Logistics dominate the cluster with 9 firms. Advertising and marketing has 5 firms and design consultancy has 4 firms. There are no firms from management consultancy, law, and accounting (Table 4.58). Cluster 3 is the second most dominant cluster in terms of clustered firms in advertising and marketing and design consultancy (Table 4.60). Clusters 1, 2, and 3 are approximately 6 miles away from La Guardia International Airport.

Cluster 4 is located in lower Manhattan; in a secondary downtown density location. It is the cluster with the second highest number of companies and the second densest cluster. There are 101 firms in total in this cluster, 78 of which are branch locations. This is also the cluster with the second highest number of headquarters in New York (Table 4.58). IT, finance/banking, and logistics are the top three sectors in terms of number of companies. Together they make up 54.45% of this cluster (Table 4.59). All industries are present in this cluster. Cluster 4 is the second most dominant cluster in terms of finance/banking companies. It is also the second most dominant cluster in terms of clustered firms in all other industries (Table 4.60). Cluster 5 is located in midtown Manhattan. There are 10 firms in this cluster and 7 of these firms are logistics firms. There is one firm each from advertising and marketing, finance/banking, and real estate (Table 4.58).

Cluster 6 is located in Jersey City, in a secondary downtown density area, 2 miles away from downtown Manhattan. There are 20 firms in the cluster, 17 of which are branch locations (Table 4.58). Finance/banking, IT, and logistics are the top three industries. Finance/banking and IT each has 25% of the firms and logistics have 20% of the firms in this cluster (Table 4.59). Cluster 7 is located in an edgeless city density area 2 miles away from Metropark edge city and approximately 20 miles away from downtown Manhattan. It is the third densest cluster. There are 16 firms in this cluster, 15 of which are branch locations. Finance/banking dominates the cluster with 7 firms followed by design consultancy and accounting. There are no IT firms in this cluster and there is only one logistics firm (Table 4.58).

Cluster 8 is located in an edgeless city density area, 2.8 miles away from Morristown/Parisppany edge city and approximately 25 miles away from downtown Manhattan. There are 12 firms in this cluster, 10 of which are branch locations. IT has 3 firms followed by logistics, management consultancy and real estate with 2 firms each (Table 4.58). Cluster 9 is located in the secondary downtown of Newark in a secondary downtown density area. The cluster is located 3 miles away from Newark International Airport and 9 miles away from downtown Manhattan. There are 11 firms in this cluster, 10 of which are branch locations. Law and design consultancy dominate the cluster with 4 and 3 firms each consecutively (Table 4.58). Cluster 9 is the second most dominant cluster in law (Table 4.60).

Cluster 10 is located in the edge city of Melville, in an edge city density location, approximately 32 miles away from downtown Manhattan in shortest distance. There are 10 firms in total in this cluster, all of which are branch locations. Accounting and management consultancy together make up half of the firms in the cluster (Table 4.59). There are no logistics firms and only one IT firm in the cluster (Table 4.58). Cluster 10 is located in the edge city of White Plains, in an edge city density location, approximately 25 miles north of downtown Manhattan. There are 10 firms in total in this cluster, 9 of which are branch locations. IT dominates the cluster with 3 firms, followed by advertising and marketing and finance/banking. Each of these sectors have 2 firms in this cluster (Table 4.58).

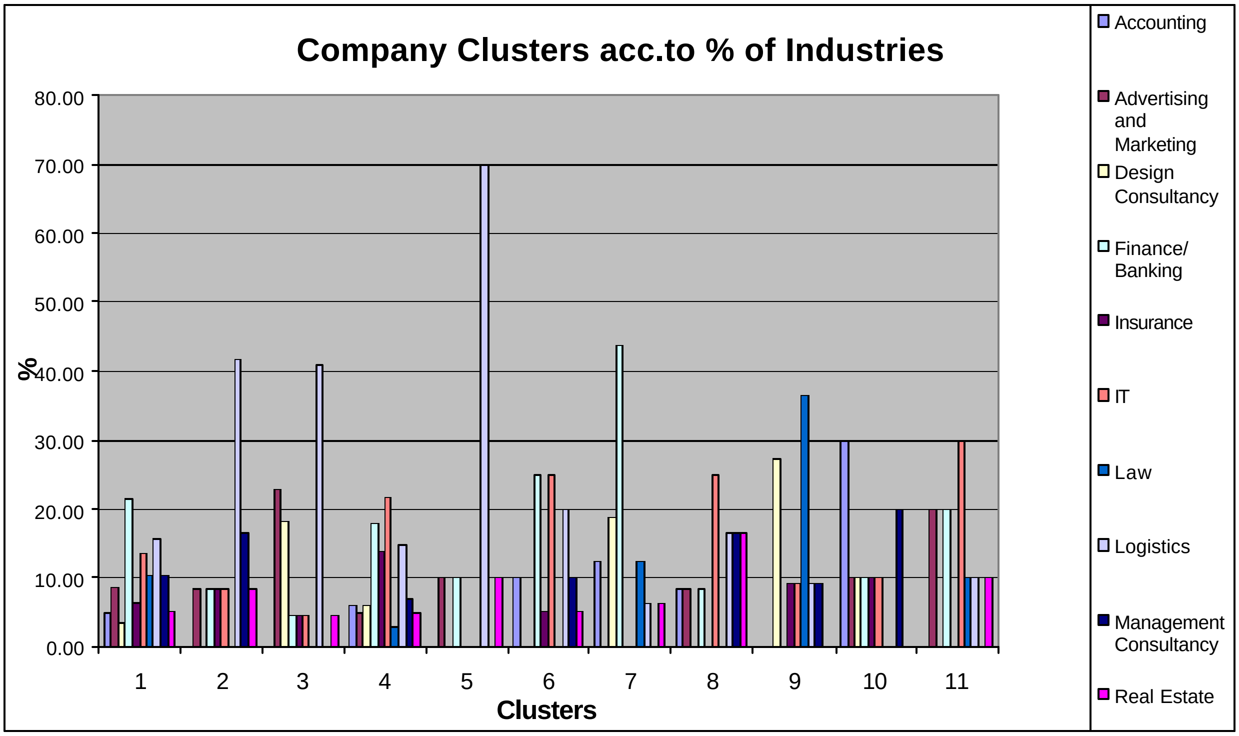



**Figure 4.37: Percent of Industries in Company Clusters in New York**

New York is similar to Chicago in the sense that both of these cities have very dominant downtowns. 88% of the clustered firms in New York are clustered in downtown area. Similar to Chicago, majority of the clustered IT and logistics companies in New York are also found in downtown. In New York, all industries have high degree of clustering. This is a different trend than other cities where real estate, logistics, and sometimes IT is highly decentralized. Although there are 3 international airports in New York, logistics companies do not form a walking distance cluster around these airports. Instead, they are scattered around the airports. In New

York, there is no single IT cluster. Almost all the clustered IT companies are found in downtown.

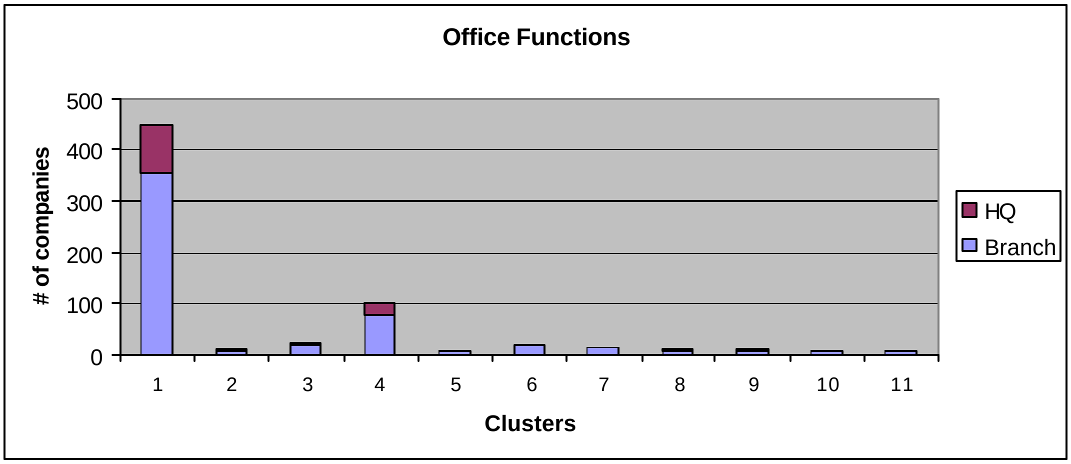



**Figure 4.38: Number of Companies according to Office Functions in New York**

### 4.1.8.2 New York Buildings

There are 1309 high-rise building locations identified in total in New York Metropolitan Area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.03 miles, thus the distance that is used in calculating the clusters is taken as 0.04 miles. The minimum number of points that formed the median number of clusters was 12 and the median number of clusters turned out to be 11. 10 out of 11 clusters are located in areas that have higher density than edgeless city density, thus the clusters are located in a centralized way.

**Table 4.61: Percent of Buildings according to Year of Construction in New York**

| Years | % of buildings |
|---|---|
| 2000-2010 | 5.73 |
| 1990-2000 | 2.98 |
| 1980-1990 | 9.70 |
| 1970-1980 | 6.65 |
| pre1970 | 74.94 |
| TOTAL | 100.00 |

**Table 4.62: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of New York**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 19 | 19 | 51 | 40 | 495 | 624 |
| 2 | 0 | 0 | 0 | 2 | 133 | 135 |
| 3 | 0 | 1 | 9 | 4 | 31 | 45 |
| 4 | 5 | 4 | 23 | 14 | 150 | 196 |
| 5 | 1 | 0 | 0 | 0 | 24 | 25 |
| 6 | 0 | 0 | 1 | 1 | 12 | 14 |
| 7 | 1 | 1 | 3 | 3 | 20 | 28 |
| 8 | 5 | 1 | 4 | 3 | 27 | 40 |
| 9 | 14 | 4 | 4 | 1 | 3 | 26 |
| 10 | 4 | 3 | 6 | 3 | 0 | 16 |
| 11 | 1 | 0 | 5 | 5 | 2 | 13 |
| Total Clustered Buildings | 50 | 33 | 106 | 76 | 897 | 1162 |
| Total Buildings | 75 | 39 | 127 | 87 | 981 | 1309 |
| % of clustering | 66.67 | 84.62 | 83.46 | 87.36 | 91.44 | 88.77 |

**Table 4.63: Percent of Buildings in Clusters according to Year of Construction in New York**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 3.04 | 3.04 | 8.17 | 6.41 | 79.33 | 100.00 |
| 2 | 0.00 | 0.00 | 0.00 | 1.48 | 98.52 | 100.00 |
| 3 | 0.00 | 2.22 | 20.00 | 8.89 | 68.89 | 100.00 |
| 4 | 2.55 | 2.04 | 11.73 | 7.14 | 76.53 | 100.00 |
| 5 | 4.00 | 0.00 | 0.00 | 0.00 | 96.00 | 100.00 |
| 6 | 0.00 | 0.00 | 7.14 | 7.14 | 85.71 | 100.00 |
| 7 | 3.57 | 3.57 | 10.71 | 10.71 | 71.43 | 100.00 |
| 8 | 12.50 | 2.50 | 10.00 | 7.50 | 67.50 | 100.00 |
| 9 | 53.85 | 15.38 | 15.38 | 3.85 | 11.54 | 100.00 |
| 10 | 25.00 | 18.75 | 37.50 | 18.75 | 0.00 | 100.00 |
| 11 | 7.69 | 0.00 | 38.46 | 38.46 | 15.38 | 100.00 |

**Table 4.64: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in New York**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 25.33 | 48.72 | 40.16 | 45.98 | 50.46 | 47.67 |
| 2 | 0.00 | 0.00 | 0.00 | 2.30 | 13.56 | 10.31 |
| 3 | 0.00 | 2.56 | 7.09 | 4.60 | 3.16 | 3.44 |
| 4 | 6.67 | 10.26 | 18.11 | 16.09 | 15.29 | 14.97 |
| 5 | 1.33 | 0.00 | 0.00 | 0.00 | 2.45 | 1.91 |
| 6 | 0.00 | 0.00 | 0.79 | 1.15 | 1.22 | 1.07 |
| 7 | 1.33 | 2.56 | 2.36 | 3.45 | 2.04 | 2.14 |
| 8 | 6.67 | 2.56 | 3.15 | 3.45 | 2.75 | 3.06 |
| 9 | 18.67 | 10.26 | 3.15 | 1.15 | 0.31 | 1.99 |
| 10 | 5.33 | 7.69 | 4.72 | 3.45 | 0.00 | 1.22 |
| 11 | 1.33 | 0.00 | 3.94 | 5.75 | 0.20 | 0.99 |
| Non-clustered | 33.33 | 15.38 | 16.54 | 12.64 | 8.56 | 11.23 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

18.41% of all high-rise office buildings in New York were constructed after 1980s. 75% of commercial high-rise buildings in New York are constructed before 1970s. After 1970s, the majority of the expansion took place between 1980 and 1990, when 10% of the buildings were constructed (Table 4.61). 88.77% of all buildings in New York belong to a cluster (Table 4.62). Pre 1970s had the highest percentage of clustering with 91.44%. Up to 2000, the clustering percentage remained in the same level, in the mid eight percent Between 2000 and 2010, the clustering percentage dropped down to 66.67% suggesting sharp decentralization (Table 4.62). The multiple locations of building clusters suggest a polycentric structure. Map 31A shows the high-rise office buildings and Map31B demonstrates the building clusters in New York.

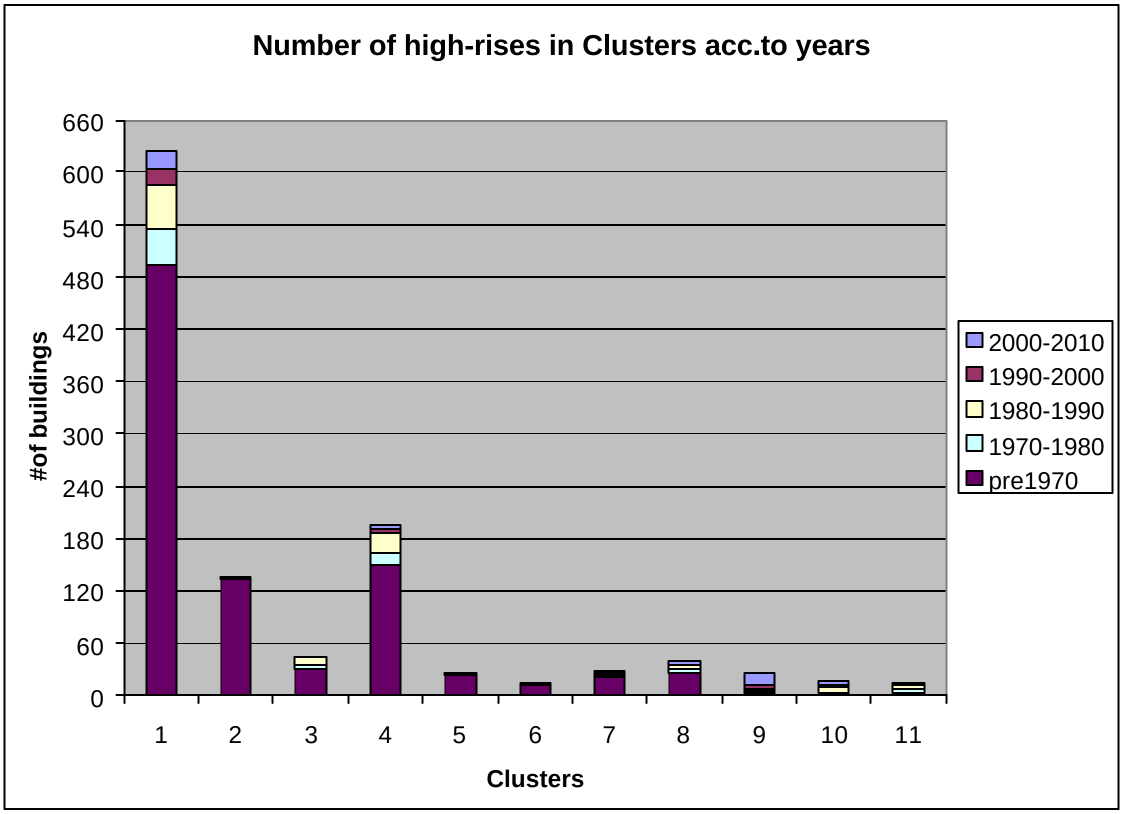



**Figure 4.39: Number of buildings in Building Clusters according to Year of Construction in New York**

Cluster 1 is located in upper Manhattan. It is the cluster with the highest number of buildings and the second densest cluster in terms of buildings per area. There are 624 buildings in total in this cluster (Table 4.61), which makes up 47.67% of all the high-rise buildings (Table 4.62). Only 14.26% of these buildings are constructed after 1980s. The highest rate of construction took place before 1970s (Table 4.63). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in all year intervals up to 2000. Between 2000 and 2010 non-clustered building percentage exceeded the buildings in cluster 1. However, Cluster 1 remained as the most dominant cluster in terms of clustered high-rise buildings (Table 4.64). This cluster is the oldest cluster in New York. However, it continued to expand in all the years, the increase of number of buildings were much more than in other clusters in every year.

Cluster 2 is located in upper Manhattan south of cluster 1. It is the cluster with the second highest number of buildings. There are 135 firms in Cluster 2 (Table 4.62), which makes around 10% of all the commercial high-rise buildings in New York. All the buildings in this cluster are constructed before 1980; there was no expansion afterwards (Table 4.63). Cluster 3 is also located in upper Manhattan, north of cluster 1. There are 45 buildings in this cluster. 68.89% of all the buildings in this cluster are constructed before 1970 (Table 4.63). Cluster 3 is the second most dominant building cluster in terms of clustered buildings built between 1980 and 1990. The development of the cluster slowed down after 1990 (Table 4.62).

Cluster 4 is located in lower Manhattan (midtown and downtown). It is the cluster with the second highest number of companies and the second densest cluster. There are 196 buildings in this cluster. 83.67% of the buildings were built before 1980 (Table 4.63). This cluster is the second most dominant cluster in high-rise building construction up to 2000 (Table 4.64). Cluster 5 is located in midtown Manhattan in an edge city density area. It is the densest cluster. There are 25 buildings in this cluster, of which 24 were constructed before 1970 (Table 4.62). Cluster 6 is also located in midtown Manhattan in an edge city density area. There are 14 buildings in this cluster and 12 of them were constructed before 1970. There was no expansion after 1990 (Table 4.62).

Cluster 7 is located in the secondary downtown of Brooklyn, in a secondary downtown density location, 1.5 miles away from downtown Manhattan. There are 28 high-rise commercial buildings in this cluster and 20 of them were constructed before 1970. The development of the cluster slowed down after 1990 (Table 4.62).Cluster 8 is located in Newark, in a secondary downtown density location, approximately 9 miles away from downtown. Cluster 8 is also located 2.5 miles away from Newark International Airport. There are 40 buildings in this cluster. 27 of the buildings were constructed before 1970. This cluster is the third dominant cluster in terms of clustered high-rise buildings between 2000 and 2010, which indicates that it is under current expansion (Table 4.64).

Cluster 9 is located in Jersey City, 1.5 miles west of downtown in a secondary downtown density location. There are 26 buildings in this cluster, 53.85% of the buildings were constructed between 2000 and 2010, which makes this cluster the most recent in New York metropolitan area (Table 4.63). Cluster 9 became the second most dominant cluster in terms of clustered high-rise buildings between 1990 and 2010 (Table 4.64). Cluster 10 is the only cluster located in edgeless city density location in the city of Stamford, 35 miles away from downtown. There are 16 buildings in this cluster. Building construction started after 1970s (Table 4.62). The highest rate of building construction took place between 1980 and 1990, when 37.50% of the buildings were constructed. 25% of all the buildings in this cluster are constructed or scheduled to be constructed between 2000 and 2010 (Table 4.63). Cluster 11 is located in the edge city of White Plains, 26 miles away from downtown Manhattan. There are 13 buildings in this cluster. 10 of these buildings were developed between 1970 and 1990 (Table 4.62).

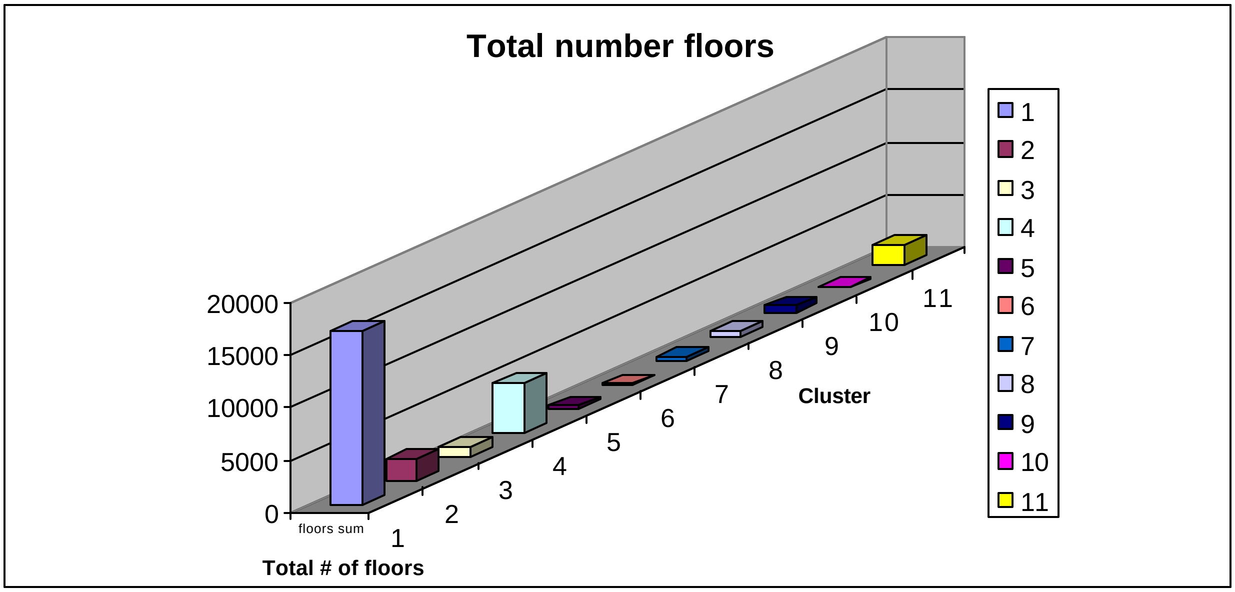



**Figure 4.40: Total Number of floors in New York Building Clusters**

### 4.1.8.3 New York Company-Building Analysis

In New York Metropolitan area, there are 5 locations that company and building clusters intersect with each other. Two of them are in Manhattan and three of them are separately located in Jersey City, Newark, and White Plains.

In upper Manhattan building clusters 1, 2, and 3 intersect with company clusters 1,2,3, and 5. Company clusters in this location define the most diversified global business activity node, which is the major location for companies from all industries. Finance/banking, IT, and logistics are the top three industries. This is the heart of New York's global businesses. It is also the location with the most headquarter locations. Building clusters 1, 2, and 3 together define the oldest high-rise building locations. This is also the location with the largest amount of high-rise office space (Figure 4.40). Thus, upper Manhattan is the most well-established global business activity node in New York metropolitan area. The second major location for global business activity node is in lower Manhattan. Building Clusters 4, 5, and 6 intersect with company clusters 4 and 5. Company clusters 4 and 5 together define the second most diversified cluster in New York. Similar to upper Manhattan, IT, logistics, and finance/banking are the top three industries in terms of number of companies. Building clusters 4, 5, and 6 together define the second oldest building cluster. The industry composition and the concentration of high-rise buildings demonstrate that Manhattan is a hot-spot location as a global business activity node. As we mentioned, New York and Chicago are the two metropolitan areas with dominant downtowns. Downtowns have the majority of the office space. Similarly, in New York, they also contain the majority of the APS TNCs in every sector. Thus, high-rise Manhattan is the preferred location for APS TNCs in New York.

Secondary downtown of Jersey City is another location where a building and company cluster intersects. In Jersey City building cluster 9 intersects with the company cluster 6. As explained above, building cluster 9 is the most recently developing business cluster in New York. Company cluster 6 has a similar industry composition to Manhattan. Finance/banking, IT, and logistics are the top three sectors. It might be seen as the extension to Manhattan or the expansion of New York's downtown. In Newark, building cluster 8 intersects with company cluster 9. This location is close to Newark International Airport. However, no logistics companies are found in company cluster 9, they are scattered around the airport. Building cluster 8 is established before 1970s, but it is a cluster that is under current expansion. In the near future, together with the building cluster 8, the company cluster 9 might grow on logistics.
In White Plains, building cluster 11 intersects with company cluster 11. Company cluster 11 is the smallest company cluster dominated by IT, finance/banking, and advertising and marketing

firms. Building cluster 11 mainly developed between 1970 and 1990. It is also the smallest building cluster. The joint location of these clusters may define an important future location for a global business activity node in the polycentric New York metropolitan area.

#### 4.1.9 San Francisco

San Francisco has one downtown, one urban envelope, one secondary downtown of Oakland, and four edge cities identified by Lang et al: Fremont, Pleasanton, San Ramon, and Walnut Creek. Downtown area is indicated with a red circle on the map and it has the largest share of office space with 39.2%. Secondary downtown of Oakland is located 7.5 miles east of downtown and it has 6.7% of all the office space. Urban envelope surrounds and it only has 0.3% of all the office space. Downtowns all together have 46.3% of all the office space in San Francisco metropolitan area. Four edge cities in total have 14.4% of all the office space. Walnut Creek is located 21 miles away from downtown area and it has 3.1% of all the office space. San Ramon is located 25 miles away from downtown and it consists of 3.5% of all the office space. Pleasanton is located 29 miles away from downtown and it has 3.7% of all the office space in San Francisco. Fremont is located 30 miles away from downtown and it has 4.1% of all the office space on San Francisco. 39.4% of all office space in San Francisco is located in edgeless city density areas (Lang et al. 2007). Map 33 demonstrates the findings of Lang et al (2007) in San Francisco.

##### 4.1.9.1 San Francisco Companies

There are 551 APS TNC locations identified in San Francisco metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.05 miles. The distance to identify clusters was taken as 0.06 miles. The minimum number of points

**Table 4.65: Industries represented in San Francisco APS TNCs**

| Industries | % of all firms |
|---|---|
| Accounting | 5.44 |
| Advertising and Marketing | 5.81 |
| Design Consultancy | 7.44 |
| Finance/Banking | 8.17 |
| Insurance | 5.08 |
| IT | 23.59 |
| Law | 7.26 |
| Logistics | 22.87 |
| Management Consultancy | 9.80 |
| Real Estate | 4.54 |
| TOTAL | 100.00 |

**Table 4.66: Number of Companies in Clusters and Percent of Clustering among Industries in San Francisco**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 14 | 22 | 18 | 25 | 14 | 24 | 19 | 26 | 28 | 5 | 195 |
| 2 | 4 | 0 | 0 | 1 | 0 | 5 | 11 | 2 | 4 | 0 | 27 |
| 3 | 1 | 0 | 9 | 0 | 1 | 6 | 0 | 6 | 2 | 2 | 27 |
| 4 | 0 | 0 | 2 | 0 | 3 | 13 | 0 | 0 | 1 | 0 | 19 |
| 5 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 12 | 0 | 0 | 17 |
| 6 | 9 | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 17 |
| 7 | 0 | 0 | 3 | 4 | 4 | 2 | 0 | 1 | 2 | 1 | 17 |
| 8 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 3 | 0 | 15 |
| 9 | 0 | 1 | 0 | 1 | 2 | 4 | 0 | 2 | 2 | 1 | 13 |
| Total Clustered Companies | 28 | 24 | 35 | 32 | 25 | 71 | 31 | 49 | 43 | 9 | 347 |
| Total Companies | 30 | 32 | 41 | 45 | 28 | 130 | 40 | 126 | 54 | 25 | 551 |
| % of clustering | 93.33 | 75.00 | 85.37 | 71.11 | 89.29 | 54.62 | 77.50 | 38.89 | 79.63 | 36.00 | 62.98 |

**Table 4.67: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in San Francisco**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.18 | 11.28 | 9.23 | 12.82 | 7.18 | 12.31 | 9.74 | 13.33 | 14.36 | 2.56 | 100.00 |
| 2 | 14.81 | 0.00 | 0.00 | 3.70 | 0.00 | 18.52 | 40.74 | 7.41 | 14.81 | 0.00 | 100.00 |
| 3 | 3.70 | 0.00 | 33.33 | 0.00 | 3.70 | 22.22 | 0.00 | 22.22 | 7.41 | 7.41 | 100.00 |
| 4 | 0.00 | 0.00 | 10.53 | 0.00 | 15.79 | 68.42 | 0.00 | 0.00 | 5.26 | 0.00 | 100.00 |
| 5 | 0.00 | 5.88 | 5.88 | 0.00 | 0.00 | 17.65 | 0.00 | 70.59 | 0.00 | 0.00 | 100.00 |
| 6 | 52.94 | 0.00 | 11.76 | 5.88 | 5.88 | 11.76 | 5.88 | 0.00 | 5.88 | 0.00 | 100.00 |
| 7 | 0.00 | 0.00 | 17.65 | 23.53 | 23.53 | 11.76 | 0.00 | 5.88 | 11.76 | 5.88 | 100.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 80.00 | 0.00 | 0.00 | 20.00 | 0.00 | 100.00 |
| 9 | 0.00 | 7.69 | 0.00 | 7.69 | 15.38 | 30.77 | 0.00 | 15.38 | 15.38 | 7.69 | 100.00 |

**Table 4.68: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in San Francisco**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 46.67 | 68.75 | 43.90 | 55.56 | 50.00 | 18.46 | 47.50 | 20.63 | 51.85 | 20.00 |
| 2 | 13.33 | 0.00 | 0.00 | 2.22 | 0.00 | 3.85 | 27.50 | 1.59 | 7.41 | 0.00 |
| 3 | 3.33 | 0.00 | 21.95 | 0.00 | 3.57 | 4.62 | 0.00 | 4.76 | 3.70 | 8.00 |
| 4 | 0.00 | 0.00 | 4.88 | 0.00 | 10.71 | 10.00 | 0.00 | 0.00 | 1.85 | 0.00 |
| 5 | 0.00 | 3.13 | 2.44 | 0.00 | 0.00 | 2.31 | 0.00 | 9.52 | 0.00 | 0.00 |
| 6 | 30.00 | 0.00 | 4.88 | 2.22 | 3.57 | 1.54 | 2.50 | 0.00 | 1.85 | 0.00 |
| 7 | 0.00 | 0.00 | 7.32 | 8.89 | 14.29 | 1.54 | 0.00 | 0.79 | 3.70 | 4.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.23 | 0.00 | 0.00 | 5.56 | 0.00 |
| 9 | 0.00 | 3.13 | 0.00 | 2.22 | 7.14 | 3.08 | 0.00 | 1.59 | 3.70 | 4.00 |
| Non-clustered | 6.67 | 25.00 | 14.63 | 28.89 | 10.71 | 45.38 | 22.50 | 61.11 | 20.37 | 64.00 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

that gave the median number of clusters was 12 and the median number of clusters turned out to be 9. 52.66% of the companies in San Francisco belong to a cluster. Among the 9 clusters 6 clusters are found in areas that have greater density than edgeless city density. Although not identified by Lang et al (2007) because it is part of CMSA rather than MSA, Silicon Valley will be analyzed in this chapter due to the importance of the location for IT industry. The multiple locations of clusters prove the polycentric structure of the global business activity nodes.

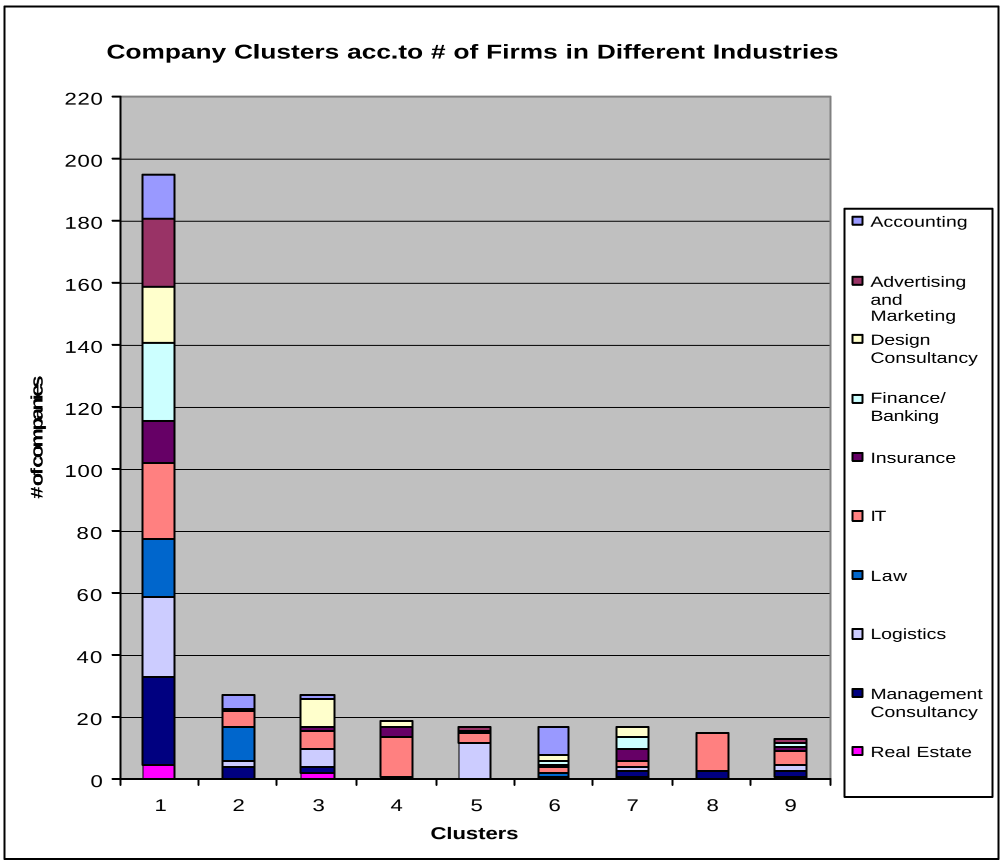



**Figure 4.41: Number of companies in company clusters in San Francisco**

Cluster 1 is found in downtown. Cluster 3 is found in the secondary downtown of Oakland. Cluster 7 is found in the edge city of Walnut Creek. Clusters 2, 5, and 9 are scattered in edgeless city density locations. Clusters 4, 6, and 8 are located in Silicon Valley Area, which is not included in the study by Lang et al (2007). The close proximity of company clusters in this area indicates a secondary downtown density formation. All industries are represented in San Francisco. IT, logistics, and management consultancy are the top three industries in terms of number of companies. Logistics and IT together make up 46.46% of all the APS TNCs (Table 4.65). Map 34A shows the APS TNC locations and Map 34B illustrates the company clusters identified in San Francisco. Accounting, insurance, and design consultancy are the top three sectors with the highest rate of membership in a cluster. The logistics and real estate are two sectors with the lowest degree of clustering. Table 4.66 summarizes these results.

The largest cluster with 99 companies is Cluster 1, which is located in downtown San Francisco. The center of this cluster is found in a primary-downtown density area. It is the cluster with the highest number of companies and the densest cluster (Table 4.66). There are 195 firms in total in this cluster, of which 182 are branch locations. All industries are present; this is the most diversified cluster in San Francisco. Management consultancy, logistics, and finance/banking are the top three sectors in this cluster, together they constitute around 40.51% of the companies in this cluster (Table 4.67). Real estate, accounting, and insurance are the three sectors with the lowest number of companies (Table 4.66). Cluster 1 is the most dominant cluster in all the sectors except for IT, logistics, and real estate; which are the top three decentralized industries. 61.11% of all logistics firms, 64% of all real estate firms, and 45.38% of all IT firms do not belong in a cluster. Although percentage of non-clustered firms is higher than in any other cluster, cluster 1 is also the most dominant clustered in terms of clustered firms in IT, logistics, and real estate. (Table 4.68).

Cluster 2 is located in Palo Alto in an edgeless density city area, 29 miles away from downtown San Francisco. It is the cluster with the second highest number of companies and the third densest cluster (Table 4.66). There are 27 firms in this cluster, 26 of which are branch locations. Law, IT, accounting, and management consultancy dominate this cluster. Law is the most dominant industry. 40.74% of all companies belong to law (Table 4.67), which makes Cluster 2 the second most dominant company cluster in terms of law firms (Table 4.68). Cluster 3 is located in the secondary downtown of Oakland. The center of the cluster is in the secondary downtown density area approximately 7.7 miles in shortest distance from the center of downtown San Francisco. It is the cluster with the second highest number of companies and the third densest cluster. There are 27 firms in total in this cluster, of which 26 are branch locations (Table 4.66). Design consultancy, IT, and logistics are the most dominant firms in the cluster. 33.33% of all the firms are from design consultancy, IT and logistics each has 22.22% of all the firms (Table 4.67). This cluster is the second most dominant cluster in terms of design consultancy. 21.95% of all the design consultancy are found in this cluster (Table 4.68).

Cluster 4 is located in Silicon Valley, San Jose, in Orange County, 39 miles away from downtown San Francisco. San Jose International Airport is also located in the borders of Cluster 4. There are1 9 firms in total in this cluster, 17 of which are branch locations. IT is the most dominant sector with 13 companies (Table 4.66). This cluster is the second most dominant cluster in insurance and also the second most dominant in terms of clustered IT firms (Table 4.68). Cluster 5 is located in an edgeless city area south of downtown. The cluster is located 8.8 miles away from downtown San Francisco and 4.5 miles away from San Francisco International

Airport. There are 17 firms in this cluster and 12 of them belong to logistics and 3 of them belong to IT (Table 4.66). Given the close proximity of the airport, the number of logistics companies is an expected outcome. Cluster 5 is the second most dominant cluster in terms of clustered logistics firms (Table 4.68).

Cluster 6 is also located in Silicon Valley, San Jose area, 42 miles away from downtown San Francisco. There are 17 firms in the cluster, 15 of which are branch locations. It is the second densest cluster (Table 4.66). Accounting dominates the cluster with 9 firms (Table 4.67). Cluster 6 is the second most dominant cluster in terms of accounting firms (Table 4.68). The presence of accounting suggests that this cluster has the control functions, we will consider Cluster 6 as a secondary downtown. Cluster 7 is located in the edge city of Walnut Creek in an edge city density area approximately 21 miles away from downtown San Francisco. There are 17 firms in total in this cluster, all of which are branch locations. Insurance, finance/banking, and design consultancy are the top 3 sectors with the most firms (Table 4.67). Cluster 7 is the second most dominant cluster in terms of insurance firms (Table 4.68).

Cluster 8 is located in Silicon Valley, San Jose, 3 miles away from San Jose International Airport and 37 miles away from downtown. There are 15 firms in this cluster, 13 of which are branch locations. 12 of the 15 firms are IT firms (Table 4.66). This is the third dominant cluster in terms of IT firms (Table 4.68). Cluster 9 is located in an edgeless city density area 17 miles away from downtown. There are 13 firms in this cluster, 12 of which are branch locations. There are 4 IT firms and 2 firms each from logistics, management consultancy, and insurance (Table 4.66).

In San Francisco, 6 out of 9 clusters are found in edgeless city density areas. Cluster 1 in downtown is a major location for all knowledge intensive producer services. Law firms in other cities are mostly concentrated in one cluster. However, in San Francisco Cluster 2 is also a major location for law firms. Clusters 4, 6, and 8 in Silicon Valley are located very close to each other. Clusters 4 and 8 are specialized in IT. On the other hand, Cluster 6 is specialized in accounting. More than half of the firms in this very dense cluster belong to accounting.

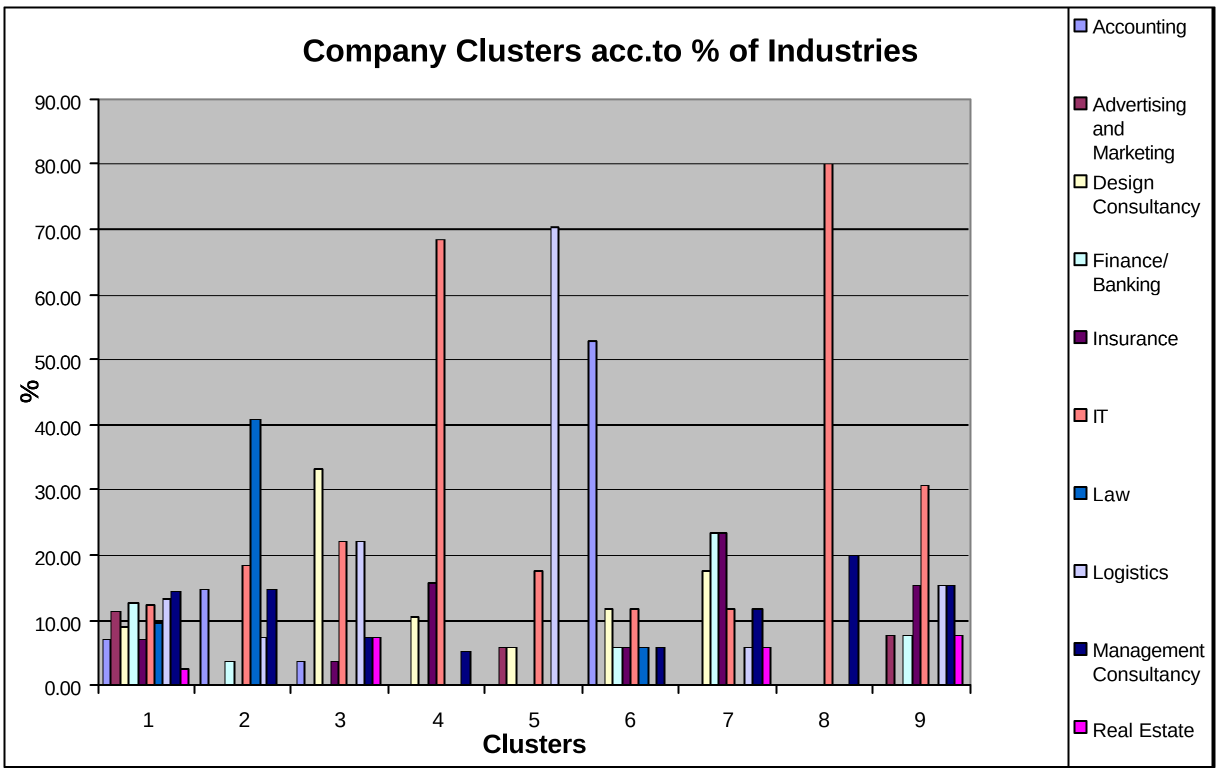



**Figure 4.42: Percent of Industries in Company Clusters in San Francisco**

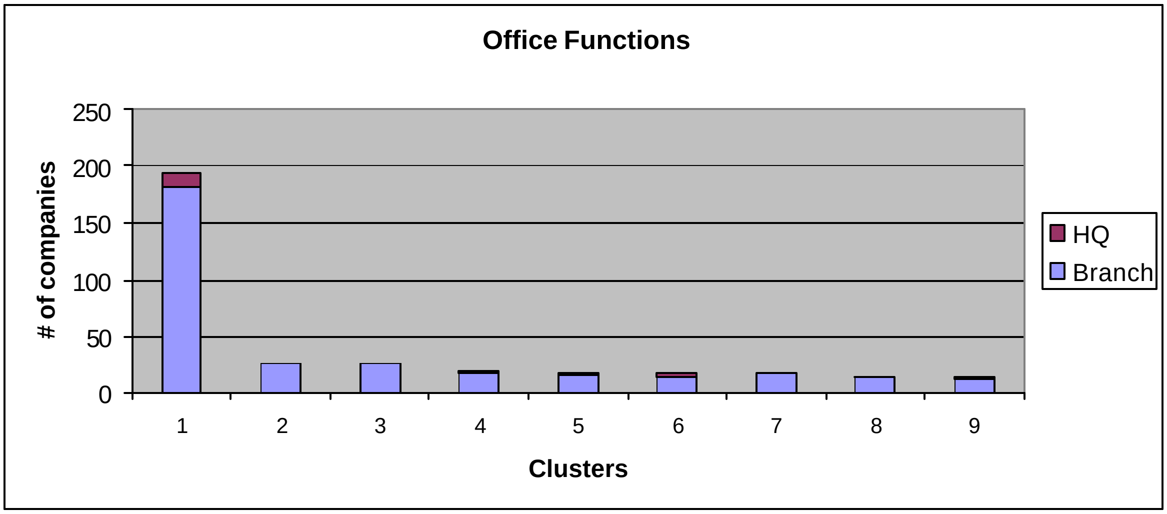



**Figure 4.43: Number of Companies according to Office Functions in San Francisco**

#### 4.1.9.2 San Francisco Buildings

There are 278 building locations in total in San Francisco Metropolitan Area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.25 miles, thus the distance that is used in calculating the clusters is taken as 0.26 miles. The minimum number of points that formed the median number of clusters was 27 and the median number of clusters turned out to be 3. Only one of the three building clusters have mean centers in areas with edgeless city density, which prove that these clusters are located in a centralized fashion. First building cluster is found in downtown; second one is located in Oakland. The third cluster is located in Silicon Valley. As stated before, since Silicon Valley is part of CMSA rather than MSA, it will not be included in the discussion of findings section. Map 35A shows the high-rise office building locations and Map 35B illustrates the high-rise office building clusters in San Francisco.

**Table 4.69: Percent of Buildings according to Year of Construction in San Francisco**

| Years | % of buildings |
|---|---|
| 2000-2010 | 12.23 |
| 1990-2000 | 6.83 |
| 1980-1990 | 23.38 |
| 1970-1980 | 14.39 |
| pre1970 | 43.17 |
| TOTAL | 100.00 |

**Table 4.70: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of San Francisco**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 13 | 7 | 41 | 26 | 93 | 180 |
| 2 | 6 | 8 | 6 | 3 | 16 | 39 |
| 3 | 6 | 3 | 9 | 5 | 5 | 28 |
| Total Clustered Buildings | 25 | 18 | 56 | 34 | 114 | 247 |
| Total Buildings in that year | 34 | 19 | 65 | 40 | 120 | 278 |
| % clustering | 73.53 | 94.74 | 86.15 | 85.00 | 95.00 | 88.85 |

**Table 4.71: Percent of Buildings in Clusters according to Year of Construction in San Francisco**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 7.22 | 3.89 | 22.78 | 14.44 | 51.67 | 100.00 |
| 2 | 15.38 | 20.51 | 15.38 | 7.69 | 41.03 | 100.00 |
| 3 | 21.43 | 10.71 | 32.14 | 17.86 | 17.86 | 100.00 |

**Table 4.72: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in San Francisco**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 38.24 | 36.84 | 63.08 | 65.00 | 77.50 | 64.75 |
| 2 | 17.65 | 42.11 | 9.23 | 7.50 | 13.33 | 14.03 |
| 3 | 17.65 | 15.79 | 13.85 | 12.50 | 4.17 | 10.07 |
| Non-clustered | 26.47 | 5.26 | 13.85 | 15.00 | 5.00 | 11.15 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Around 42.44% of all high-rise office buildings in San Francisco were constructed after 1980s. Pre 1970s and 1980-1990 are the two time intervals with the highest rate of construction. 43.17% of the buildings were built before 1970s. 23.38% of all high-rise buildings were built between 1980 and 1990 (Table 4.69). 88.85% of all buildings in San Francisco belong to a cluster (Table 4.70). The buildings constructed before 1970s have the highest membership to a cluster with 95%. Although the rate of membership to a cluster stayed between 80%-90%, it declined dramatically in 2000s reaching to 73% suggesting decentralization (Table 4.71). The multiple locations of building clusters suggest a polycentric structure.

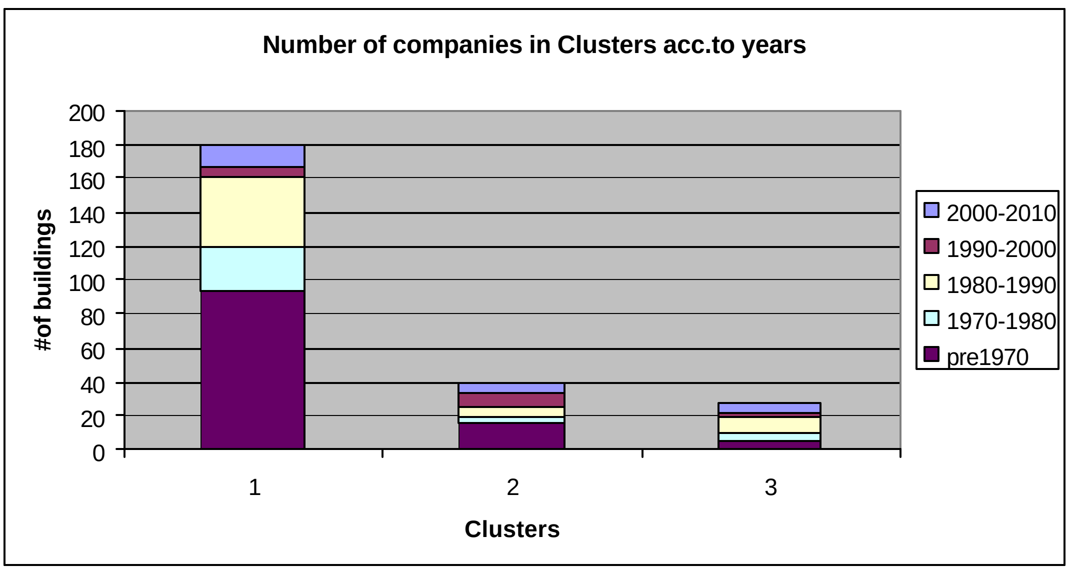



**Figure 4.44: Number of buildings in Building Clusters according to Year of Construction in San Francisco**

Cluster 1 is located in downtown San Francisco in a primary density area. It is the cluster with the highest number of buildings and the densest cluster in terms of buildings per area. There are 180 buildings in total in this cluster (Table 4.70), which makes up 64.75% of all the high-rise buildings. Around 34% of these buildings are constructed after 1980s, although the highest rate of construction took place before 1970 (Table 4.71). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in all year intervals. 77.50% of all buildings constructed before 1970s exists in this cluster, making it the oldest cluster. Also, 65% of all buildings constructed between 1970 and 1980 exist in cluster 1. This percentage is 63.80% between 1980 and 1990, 36.84% between 1990-2000, and 38.24% between 2000-2010. Although, Cluster 1 is the oldest cluster, it still continues to expand (Table 4.72).

Cluster 2 is located in the secondary downtown of Oakland. The center of the cluster is in a secondary downtown density area, located 8 miles away from downtown San Francisco. It is the cluster with the second highest number of buildings and the second densest cluster. There are 39 buildings in this cluster (Table 4.70). 41.03% of all buildings were constructed before 1970s. 51.27% of the buildings were constructed after 1980s (Table 4.71). This cluster is the second most dominant cluster in terms of high-rise building construction before 1970 and between 1990 and 2000. It is also the second most dominant building cluster in terms of clustered high-rise buildings constructed between 2000 and 2010 (Table 4.72).

Cluster 3 is located in Silicon Valley, San Jose in an edgeless city density location, 42 miles away from downtown and 3.4 miles away from San Jose International Airport. It is the cluster with the third highest number of buildings and the third densest cluster (Table 4.70). There are 28 buildings in this cluster (Table 4.70). 64.28% of the buildings were constructed after 1980s (Table 4.71), thus it is the most recent building cluster.

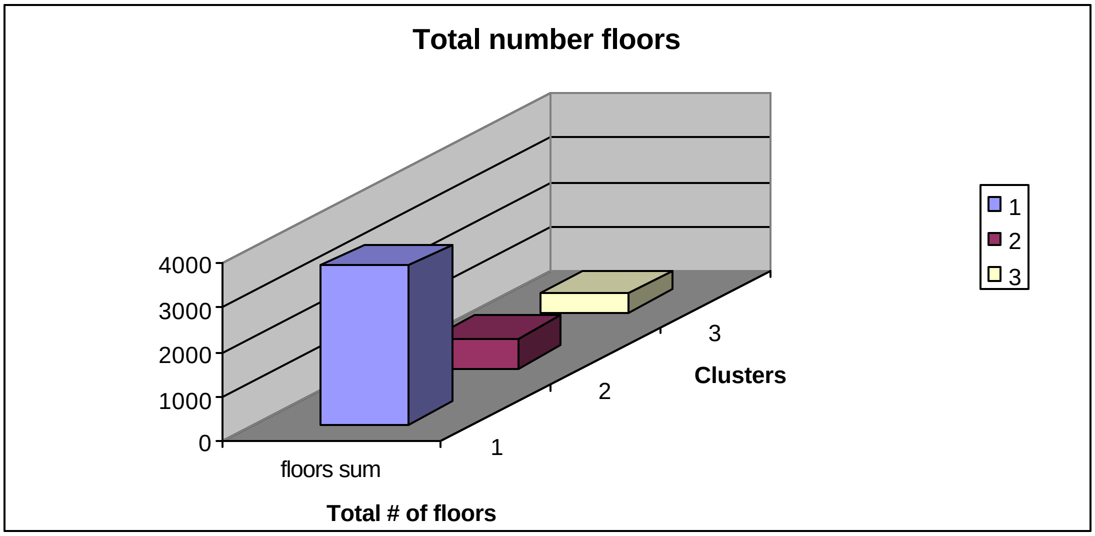



**Figure 4.45: Total Number of floors in San Francisco Building Clusters**

#### 4.1.9.3 San Francisco Company-Building Analysis

In San Francisco, each building cluster intersects with one company cluster. Company clusters 2, 4, 5, 7, 8, and 9 do not intersect with a high-rise building cluster. The highest building cluster in terms of total number of floors is also the oldest building cluster found in downtown, which is building cluster 1 (Figure 4.45). Building cluster 1 intersects with company cluster 1. Company cluster 1 is the largest and most diversified cluster in San Francisco. Together these building and company clusters in downtown define the major location in terms of APS TNC locations. In Oakland, building cluster 2 intersects with company cluster 3. Company cluster 3 is dominated by design consultancy, IT, and logistics. The building cluster 2 that intersects with the company cluster in Oakland is under rapid development after 1990s. Especially, between 1990 and 2000, it is the cluster with the highest number of buildings constructed.

In Silicon Valley San Jose, building cluster 3 intersects with company cluster 6. Silicon Valley is the global destination for IT firms. Clusters 4 and 8 around Cluster 6 are both dominated by IT.

However, company cluster 6, which is a very small and dense cluster, is dominated by accounting firms. In San Jose/Silicon Valley area it is the only cluster that intersects with a high-rise building cluster. Thus, this location might expand to become a secondary downtown in San Jose.

**4.1.10 Washington DC**

Washington DC has one downtown, one secondary downtown of Silver Spring, one urban envelope around Alexandria/Arlington, and eight edge cities: Tyson's Corner, Herndon/Reston, Chantilly/Dulles, Gaithersburg, Leesburg, Fairfax Center, I-270 Corridor, and Rt. 28 Corridor. The downtown, indicated with a red circle in the GIS map, consists of 22.7% of all the office space. The secondary downtown of Silver Spring is located 7.5 miles away from downtown and it has 1.5% of all the office space. Urban envelope has 18.4% of all the office space, which is the second largest urban envelope after Atlanta. Washington DC urban envelope encompasses much of the District, and extends into Arlington and Alexandria, VA. Old Town Alexandria, which has seen a recent construction boom near the Eisenhower Avenue station on the Washington Metro, also forms part of DC's urban envelope (Lang et al., 2007, 18).Together downtown locations have 41.1% of all the office space (Lang et al., 2007).

Edge cities in total have 34.8% of all the office space. Tyson's corner is the largest edge city. It is located 10 miles west of downtown and it has 6.3% of all the office space. Herndon/Reston is located 17 miles away from downtown and 5 miles away from Dulles International Airport and it contains 4.8% of all the office space. Chantilly/Dulles is located south of Herndon/Reston 5 miles from Dulles International Airport and 21 miles from downtown and it has 4.1% of the office space. Herndon/Reston and Chantilly/Dulles is surrounded by Rt.28 corridor which has an edge city density and contains 4.6% of all the office space. These three locations together near Dulles Airport contain 15% of all the office space in Washington DC. Gaithersburg edge city has 2.9% of the office space. It is located 16 miles north of downtown. Gaithersburg is surrounded by I-270 Corridor, which has 6.9% of all the office space. Together these two locations contain 9.7% of all the office space in Washington DC. Leesburg is located 26 miles north west of downtown and it has 3.1% of all the office space. Fairfax Center is located 17 miles away from downtown and it contains 2% of all the office space in Washington DC. Washington, DC has the smallest share of edgeless office space with 24%. This is an evidence to the clustered nature of office development in the area (Lang et al., 2007). Map 37 demonstrates the findings of Lang et al (2007) in Washington DC.

**4.1.10.1 Washington DC Companies**

There are 627 APS TNC locations identified in Washington DC metropolitan area. In the NNHS analysis, minimum distance between two points in a 5% confidence interval is calculated as 0.06 miles. The distance to identify clusters was taken as 0.07 miles. The minimum number of points that gave the median number of clusters was 10 and the median number of clusters turned out to be 10. 48.08% of the companies in Washington DC belong to a cluster. Among the 10 clusters, no clusters are found in areas with edgeless city density, centralized location pattern of the clusters. The multiple locations of clusters prove the polycentric structure of the global business activity nodes.

Clusters 1, 2, and 5 are found in downtown; clusters 6, 8, and 10 are found within the urban envelope. Cluster 3 is found in Mc Lean in Tysons Corner in a secondary downtown density location. Cluster 4 is found in Baltimore. Cluster 7 is found in an edge city density area in Bethesda, which is in I-270 corridor. Cluster 9 is found in Herndon/Reston edge city in a secondary downtown density location. All industries are represented in Washington DC. IT, logistics, and management consultancy are the top three industries in terms of number of companies. Logistics and IT together make up 48.73% of all the APS TNCs. Insurance, advertising and marketing and real estate are the industries with the least number of firms (Table 4.73). Map 38A shows the APS TNC locations and Map 38B illustrates the company clusters identified in Washington DC.

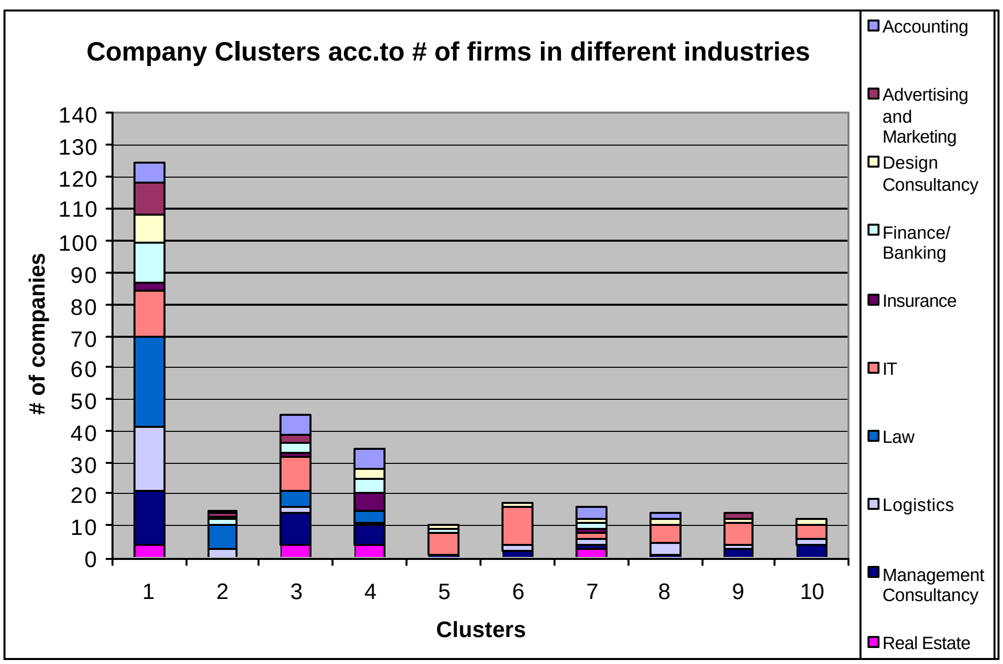



**Figure 4.46: Number of companies in company clusters in Washington DC**

**Table 4.73: Industries represented in Washington DC APS TNCs**

| Industries | % of all firms |
|---|---|
| Accounting | 6.07 |
| Advertising and Marketing | 3.19 |
| Design Consultancy | 8.31 |
| Finance/Banking | 4.63 |
| Insurance | 3.51 |
| IT | 27.64 |
| Law | 9.11 |
| Logistics | 21.09 |
| Management Consultancy | 11.98 |
| Real Estate | 4.47 |
| TOTAL | 100.00 |

**Table 4.74: Number of Companies in Clusters and Percent of Clustering among Industries in Washington DC**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 10 | 9 | 12 | 3 | 14 | 29 | 20 | 17 | 4 | 124 |
| 2 | 1 | 1 | 1 | 2 | 0 | 0 | 7 | 3 | 0 | 0 | 15 |
| 3 | 6 | 3 | 0 | 3 | 1 | 11 | 5 | 2 | 10 | 4 | 45 |
| 4 | 6 | 0 | 3 | 5 | 5 | 0 | 4 | 1 | 6 | 4 | 34 |
| 5 | 0 | 0 | 1 | 1 | 0 | 7 | 0 | 0 | 1 | 0 | 10 |
| 6 | 0 | 0 | 1 | 0 | 0 | 12 | 0 | 2 | 2 | 0 | 17 |
| 7 | 4 | 0 | 1 | 2 | 1 | 2 | 0 | 2 | 1 | 3 | 16 |
| 8 | 2 | 0 | 2 | 0 | 0 | 5 | 0 | 4 | 1 | 0 | 14 |
| 9 | 0 | 2 | 1 | 0 | 0 | 7 | 0 | 1 | 3 | 0 | 14 |
| 10 | 0 | 0 | 2 | 0 | 0 | 4 | 0 | 2 | 4 | 0 | 12 |
| Total Clustered Companies | 25 | 16 | 21 | 25 | 10 | 62 | 45 | 37 | 45 | 15 | 301 |
| Total Companies | 38 | 20 | 52 | 29 | 22 | 173 | 57 | 132 | 75 | 28 | 626 |
| % of clustering | 65.79 | 80.00 | 40.38 | 86.21 | 45.45 | 35.84 | 78.95 | 28.03 | 60.00 | 53.57 | 48.08 |

**Table 4.75: Percent of Industries Represented in Clusters according to Total Number of Firms in Clusters in Washington DC**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.84 | 8.06 | 7.26 | 9.68 | 2.42 | 11.29 | 23.39 | 16.13 | 13.71 | 3.23 | 100.00 |
| 2 | 6.67 | 6.67 | 6.67 | 13.33 | 0.00 | 0.00 | 46.67 | 20.00 | 0.00 | 0.00 | 100.00 |
| 3 | 13.33 | 6.67 | 0.00 | 6.67 | 2.22 | 24.44 | 11.11 | 4.44 | 22.22 | 8.89 | 100.00 |
| 4 | 17.65 | 0.00 | 8.82 | 14.71 | 14.71 | 0.00 | 11.76 | 2.94 | 17.65 | 11.76 | 100.00 |
| 5 | 0.00 | 0.00 | 10.00 | 10.00 | 0.00 | 70.00 | 0.00 | 0.00 | 10.00 | 0.00 | 100.00 |
| 6 | 0.00 | 0.00 | 5.88 | 0.00 | 0.00 | 70.59 | 0.00 | 11.76 | 11.76 | 0.00 | 100.00 |
| 7 | 25.00 | 0.00 | 6.25 | 12.50 | 6.25 | 12.50 | 0.00 | 12.50 | 6.25 | 18.75 | 100.00 |
| 8 | 14.29 | 0.00 | 14.29 | 0.00 | 0.00 | 35.71 | 0.00 | 28.57 | 7.14 | 0.00 | 100.00 |
| 9 | 0.00 | 14.29 | 7.14 | 0.00 | 0.00 | 50.00 | 0.00 | 7.14 | 21.43 | 0.00 | 100.00 |
| 10 | 0.00 | 0.00 | 16.67 | 0.00 | 0.00 | 33.33 | 0.00 | 16.67 | 33.33 | 0.00 | 100.00 |

**Table 4.76: Percent of Industries Represented in Clusters according to Total Number of Firms in Industries in Washington DC**

| Company Clusters | Accounting | Advertising and Marketing | Design Consultancy | Finance/ Banking | Insurance | IT | Law | Logistics | Management Consultancy | Real Estate |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.79 | 50.00 | 17.31 | 41.38 | 13.64 | 8.09 | 50.88 | 15.15 | 22.67 | 14.29 |
| 2 | 2.63 | 5.00 | 1.92 | 6.90 | 0.00 | 0.00 | 12.28 | 2.27 | 0.00 | 0.00 |
| 3 | 15.79 | 15.00 | 0.00 | 10.34 | 4.55 | 6.36 | 8.77 | 1.52 | 13.33 | 14.29 |
| 4 | 15.79 | 0.00 | 5.77 | 17.24 | 22.73 | 0.00 | 7.02 | 0.76 | 8.00 | 14.29 |
| 5 | 0.00 | 0.00 | 1.92 | 3.45 | 0.00 | 4.05 | 0.00 | 0.00 | 1.33 | 0.00 |
| 6 | 0.00 | 0.00 | 1.92 | 0.00 | 0.00 | 6.94 | 0.00 | 1.52 | 2.67 | 0.00 |
| 7 | 10.53 | 0.00 | 1.92 | 6.90 | 4.55 | 1.16 | 0.00 | 1.52 | 1.33 | 10.71 |
| 8 | 5.26 | 0.00 | 3.85 | 0.00 | 0.00 | 2.89 | 0.00 | 3.03 | 1.33 | 0.00 |
| 9 | 0.00 | 10.00 | 1.92 | 0.00 | 0.00 | 4.05 | 0.00 | 0.76 | 4.00 | 0.00 |
| 10 | 0.00 | 0.00 | 3.85 | 0.00 | 0.00 | 2.31 | 0.00 | 1.52 | 5.33 | 0.00 |
| Non-clustered | 34.21 | 20.00 | 59.62 | 13.79 | 54.55 | 64.16 | 21.05 | 71.97 | 40.00 | 46.43 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The largest cluster with 124 companies is Cluster 1, which is located in downtown Washington DC. The center of this cluster is found in a primary-downtown density area. It is the cluster with the highest number of companies and the densest cluster (Table 4.74). There are 124 firms in total in this cluster, of which 119 are branch locations. All industries are present; this is the most diversified cluster in Washington DC. Law, logistics, and management consultancy are the top three sectors in this cluster; together they constitute around 53.23% of the companies in this cluster (Table 4.75). Insurance, real estate, and accounting are the three sectors with the lowest number of companies (Table 4.74). Cluster 1 is the most dominant cluster in three sectors: advertising and marketing, finance/banking, and law. 50% of all advertising and marketing companies, 41.38% of all finance/banking firms, and 50.88% of all law companies are found in this cluster. Cluster 1 is also the most dominant cluster in terms of clustered firms in accounting, design consultancy, IT, logistics, management consultancy, and real estate (Table 4.76). Logistics and IT are highly decentralized in Washington DC. 71.97% of all logistics firms and 64.16% of all IT firms do not belong in a cluster. Design consultancy and insurance are also moderately decentralized. More than 50% of these firms do not belong in a cluster (Table 4.74).

Cluster 2 is also located in downtown Washington DC. It is the fourth densest cluster. There are 15 firms in this cluster, 14 of which are branch locations. There are no companies from insurance, IT, management consultancy, and real estate (Table 4.74). Cluster 2 is law dominated. 46.67% of the firms are legal firms (Table 4.75), which makes cluster 2 the second most dominant cluster in terms of clustered law firms (Table 4.76).

Cluster 3 is located in McLean in the edge city of Tysons Corner. The center of the cluster is in the secondary downtown density area approximately 11 miles in shortest distance from the center of downtown Washington DC. It is the cluster with the second highest number of companies. There are 45 firms in total in this cluster, 43 of which are branch locations. There are no firms from design consultancy (Table 4.74). IT, management consultancy, and accounting are the most dominant firms in the cluster. 24.44% of all the firms are from IT, 22.22% of the firms are from management consultancy, and 13.33% of the firms are from accounting (Table 4.75). Logistics, insurance, and advertising and marketing have the least number of firms (Table 4.74). This cluster is most dominant in terms of clustered accounting and real estate firms. It is also the second most dominant cluster in terms of clustered firms in advertising and marketing and management consultancy (Table 4.76).

Cluster 4 is located in Baltimore, Maryland. The center of the cluster is located 35 miles away from downtown and 8 miles away from Baltimore Washington International Airport. It is the cluster with the third highest number of companies and the second densest cluster (Table 4.74). There are 34 firms in total in this cluster, 32 of which are branch locations. Management consultancy, accounting, insurance, and finance and banking are the most dominant sectors. Together they make up 65% of the companies in the cluster. There are no firms from advertising and marketing and law. Logistics has only one company (Table 4.75). Cluster 4 is the second most dominant cluster in terms of finance/banking firms after Cluster 1 in downtown Washington DC. 17.24% of all the finance/banking firms are found in this cluster. Cluster 4 is also the most dominant cluster in terms of clustered firms in insurance, accounting, and real estate (Table 4.76). Although Baltimore is included in CMSA rather than MSA, due to its intense economic links with Washington DC MSA, it is included in this analysis

Cluster 5 is located in downtown Washington DC in a primary downtown area. There are 10 firms in total in this cluster, all of which are branch locations (Table 4.74). Cluster 5 is IT dominated (Table 4.74). 70% of all the firms are from IT (Table 4.75). Together clusters 1, 2, and 5 define the clusters in downtown DC. Together these three clusters contain over 60% of companies in advertising and marketing, finance/banking, law, and logistics.

Cluster 6 is located in Arlington, VA in a secondary downtown density location within the urban envelope, 3 miles away from downtown Washington DC. The center of the cluster is located 0.7 miles away from Ronald Reagan National Airport. There are 17 firms in the cluster, all of which are branch locations. IT dominates the cluster with 12 firms (Table 4.74). Management consultancy and logistics each has 4 firms. Cluster 6 is the second most dominant cluster in terms of clustered IT firms (Table 4.76).

Cluster 7 is located in I-270 Corridor in Bethesda, MD; in an edge city density location. The center of the cluster is located approximately 7 miles away from downtown

Washington DC. It is the third densest cluster. There are 16 firms in total in this cluster, all of which are branch locations. Accounting dominates the cluster with 4 firms. Finance/banking, IT, and logistics each have 2 firms (Table 4.74). Cluster 7 is the second most dominant cluster in terms of clustered companies in accounting and real estate (Table 4.76).

Cluster 8 is located in the urban envelope, in Alexandria, VA, in an edge city density area, approximately 6.5 miles south of downtown. There are 14 firms in this cluster, 13 of which are branch locations. IT has the most firms with 5 companies. The second dominant industry is logistics with 4 firms (Table 4.74). Cluster 9 is located in the edge city of Herndon/Reston. The center of the cluster is in the secondary downtown density area approximately 17.5 miles in shortest distance from the center of downtown Washington DC and 5 miles away from Dulles International Airport. There are 14 firms in this cluster, 13 of which are branch locations. IT dominates the cluster with 7 firms, followed by management consultancy with 3 firms (Table 4.74). Cluster 10 is also located in Arlington, VA, inside the urban envelope. The center of the cluster is located in a secondary downtown density area, 4.5 miles away from downtown Washington DC. There are 12 firms in total in this cluster, 11 of which are branch locations. IT and management consultancy dominate the cluster with 4 firms each (Table 4.74).

In Washington DC, there are no company clusters in edgeless city density area. This shows that APS TNC firm clusters in Washington DC are more centralized than in other cities. Cluster 1 in downtown is a major location for all knowledge intensive producer services. Urban corridor is very dominant in Washington DC. 3 of the 10 company clusters are located here. Urban envelope is also a hot spot location in terms of IT dominated clusters. There are many logistics companies around Dulles International Airport. However, they are dispersed and no logistics clusters are identified in this area. Map 38A shows the APS TNC locations and Map 38B demonstrates the company clusters in Washington DC.

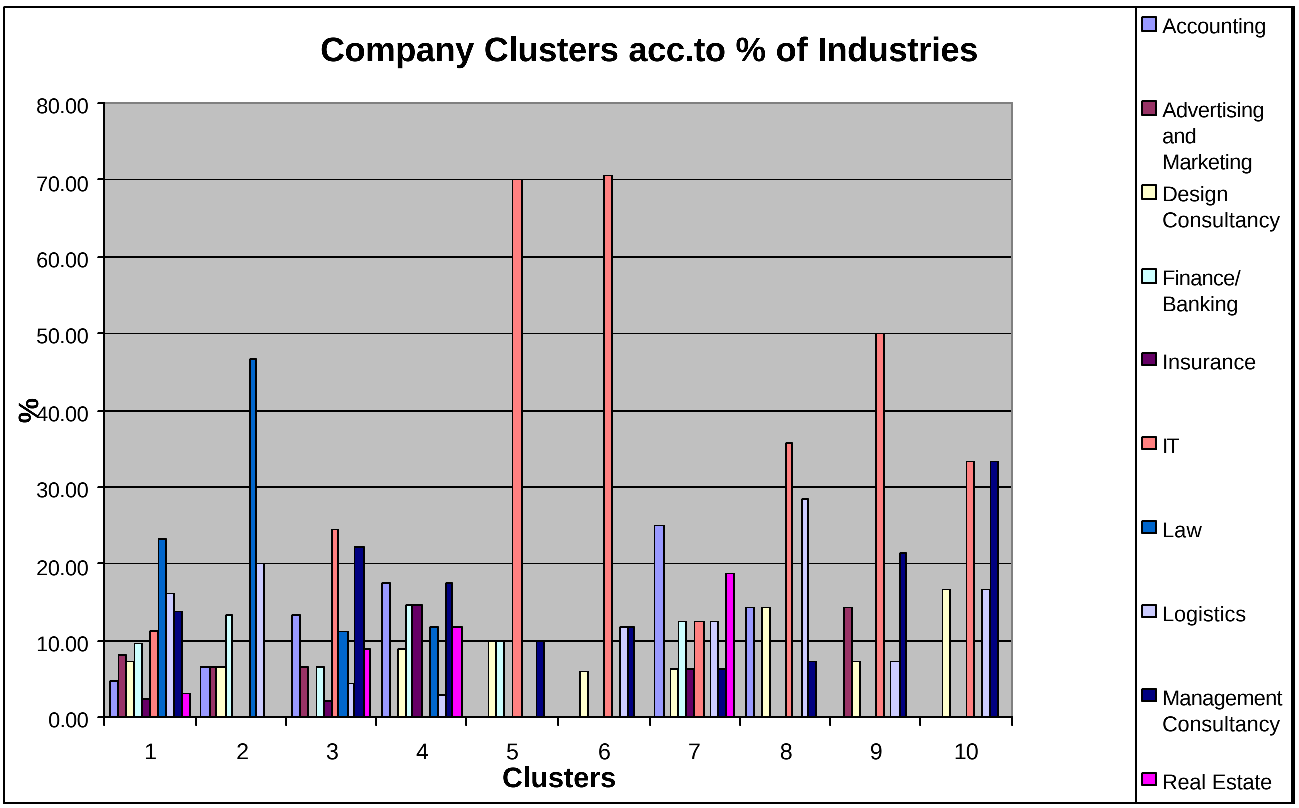



**Figure 4.47: Percent of Industries in Company Clusters in Washington DC**

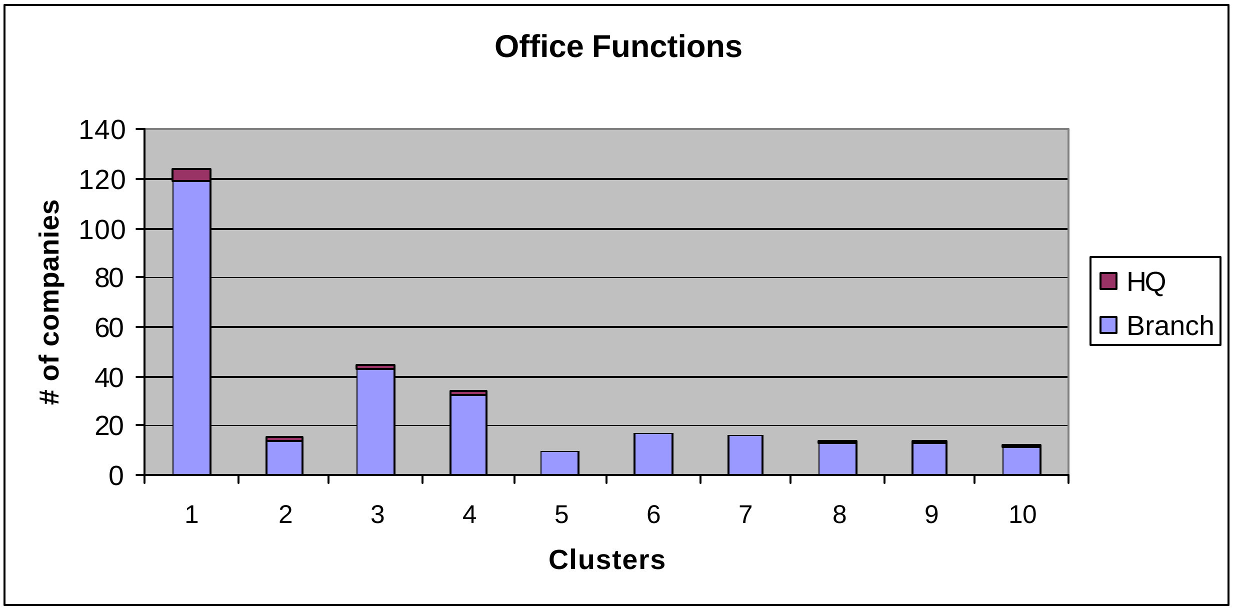



**Figure 4.48: Number of Companies according to Office Functions in Washington DC**

#### 4.1.10.2 Washington DC Buildings

There are 703 high-rise building locations identified in total in Washington DC metropolitan area. In the NNHS analysis, minimum distance between two points at a 5% confidence interval is calculated as 0.06 miles, thus the distance that is used in calculating the clusters is taken as 0.07 miles. The minimum number of points that formed the median number of clusters was 16 and the median number of clusters turned out to be 8. All of the clusters are located in areas that have higher density than edgeless city density, thus the clusters are located in a centralized way.

**Table 4.77: Percent of Buildings according to Year of Construction in Washington DC**

| Years | % of buildings |
|---|---|
| 2000-2010 | 18.78 |
| 1990-2000 | 15.08 |
| 1980-1990 | 29.87 |
| 1970-1980 | 10.81 |
| pre1970 | 25.46 |
| TOTAL | 100.00 |

**Table 4.78: Number of Buildings and Degree of Clustering in High-Rise Building Clusters of Washington DC**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 45 | 50 | 81 | 27 | 77 | 280 |
| 2 | 15 | 4 | 4 | 0 | 2 | 25 |
| 3 | 6 | 3 | 34 | 11 | 30 | 84 |
| 4 | 2 | 4 | 33 | 17 | 20 | 76 |
| 5 | 7 | 10 | 7 | 7 | 34 | 65 |
| 6 | 11 | 5 | 8 | 0 | 4 | 28 |
| 7 | 1 | 6 | 7 | 2 | 1 | 17 |
| 8 | 4 | 12 | 1 | 0 | 0 | 17 |
| Total Clustered Buildings | 91 | 94 | 175 | 64 | 168 | 592 |
| Total Buildings | 132 | 106 | 210 | 76 | 179 | 703 |
| % of clustering | 68.94 | 88.68 | 83.33 | 84.21 | 93.85 | 84.21 |

**Table 4.79: Percent of Buildings in Clusters according to Year of Construction in Washington DC**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 16.07 | 17.86 | 28.93 | 9.64 | 27.50 | 100.00 |
| 2 | 60.00 | 16.00 | 16.00 | 0.00 | 8.00 | 100.00 |
| 3 | 7.14 | 3.57 | 40.48 | 13.10 | 35.71 | 100.00 |
| 4 | 2.63 | 5.26 | 43.42 | 22.37 | 26.32 | 100.00 |
| 5 | 10.77 | 15.38 | 10.77 | 10.77 | 52.31 | 100.00 |
| 6 | 39.29 | 17.86 | 28.57 | 0.00 | 14.29 | 100.00 |
| 7 | 5.88 | 35.29 | 41.18 | 11.76 | 5.88 | 100.00 |
| 8 | 23.53 | 70.59 | 5.88 | 0.00 | 0.00 | 100.00 |

**Table 4.80: Percent of Buildings in Clusters according to Total Number of Buildings Built in the Same Time Interval in Washington DC**

| Building Clusters | 2000-2010 | 1990-2000 | 1980-1990 | 1970-1980 | Pre1970 | TOTAL |
|---|---|---|---|---|---|---|
| 1 | 34.09 | 47.17 | 38.57 | 35.53 | 43.02 | 39.83 |
| 2 | 11.36 | 3.77 | 1.90 | 0.00 | 1.12 | 3.56 |
| 3 | 4.55 | 2.83 | 16.19 | 14.47 | 16.76 | 11.95 |
| 4 | 1.52 | 3.77 | 15.71 | 22.37 | 11.17 | 10.81 |
| 5 | 5.30 | 9.43 | 3.33 | 9.21 | 18.99 | 9.25 |
| 6 | 8.33 | 4.72 | 3.81 | 0.00 | 2.23 | 3.98 |
| 7 | 0.76 | 5.66 | 3.33 | 2.63 | 0.56 | 2.42 |
| 8 | 3.03 | 11.32 | 0.48 | 0.00 | 0.00 | 2.42 |
| Non-clustered | 31.06 | 11.32 | 16.67 | 15.79 | 6.15 | 15.79 |
| TOTAL | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

63.73% of all high-rise office buildings in Washington DC were constructed after 1980s. 29.87% of these buildings were constructed between 1980 and 1990, which is the highest percentage of building construction in a time interval (Table 4.77). 84.21% of all buildings in Washington DC belong to a cluster (Table 4.78). The percentage of clustering was 93.85% before 1970. Between 1970 and 2000, the clustering percentage stayed around mid 80%. Between 2000 and 2010, the clustering percentage decreased down to 68.94%, suggesting decentralization (Table 4.78). The multiple locations of building clusters suggest a polycentric structure. Map 39a and Map 39b demonstrate the building clusters in Washington DC.

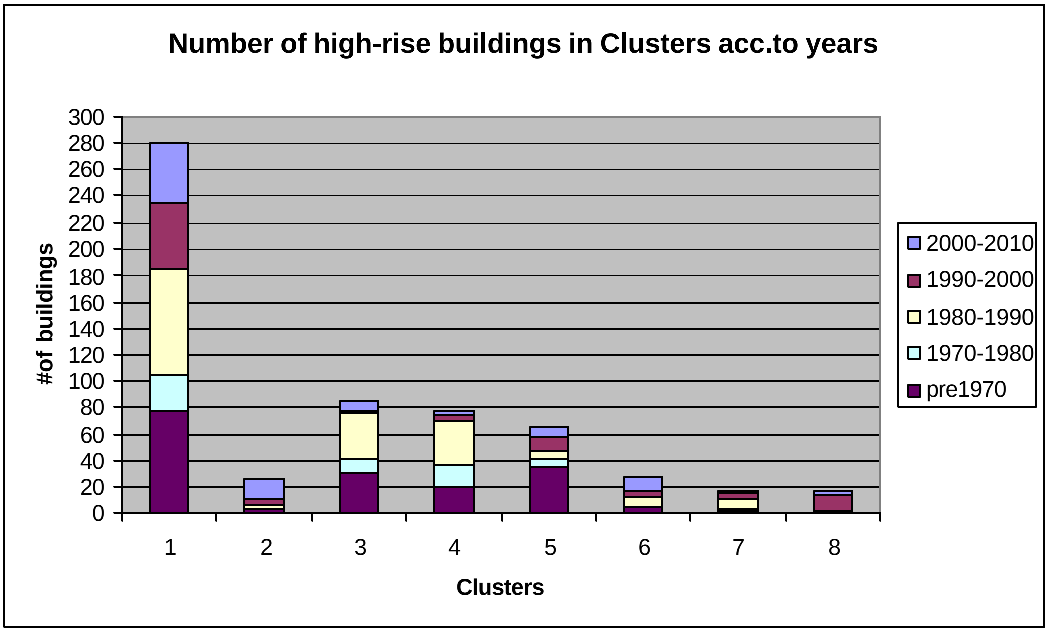



**Figure 4.49: Number of buildings in Building Clusters according to Year of Construction in Washington DC**

Cluster 1 is located in downtown Washington DC, in a primary downtown density area. It is the cluster with the highest number of buildings and the densest cluster in terms of buildings per area. There are 280 high-rise buildings in this cluster (Table 4.78), which makes up 39.83% of all the high-rise buildings (Table 4.80). 62.86% of the buildings in this cluster are constructed after 1980s. The highest rate of construction took place before 1970 (Table 4.79). Cluster 1 is the most dominant cluster in terms of high-rise office building construction in all year intervals (Table 4.80). 43.02% of all buildings constructed before 1970s exists in this cluster, making it the oldest cluster. Although it is the oldest cluster, the high rate of construction between 1970 and 2010 proves that the cluster continued to expand.

Cluster 2 is located on the fringe of downtown in a secondary downtown density location. There are 25 buildings in this cluster (Table 4.78). 94% of the buildings in this cluster are constructed after 1980.60% of the buildings are constructed between 2000 and 2010 (Table 4.78). Thus, cluster 2 is the most recent cluster in Washington DC. This is different than in other cities because mostly downtowns do not have the most recent building clusters. Cluster 2 is the second most dominant cluster in terms of clustered buildings constructed between 2000 and 2010 (Table 4.80). Cluster 3 is located in the urban envelope in Arlington, VA. The center of the cluster is in the secondary downtown density area approximately 2.5 miles in shortest distance from the center of downtown Washington DC. It is the cluster with the second highest number of buildings and the second densest cluster (Table 4.78). 51.19% of all the buildings in this cluster are constructed after 1980 (Table 4.79). The highest construction took place between 1980 and 1990, which makes cluster 3 the second most dominant cluster in terms of having the highest percentage of clustered high-rise buildings built between 1980 and 1990 (Table 4.80).

Cluster 4 is also located in Arlington inside the urban envelope. The center of the cluster is located in a secondary downtown density area, 3.2 miles away from the center of downtown. Ronal Reagan National Airport is located within the boundaries of cluster 4. It is the cluster with the third highest number of buildings and also it is the third densest cluster. There are 76 buildings in this cluster (Table 4.78). 48.69% of the clusters are built before 1980. 43.42% of the buildings are constructed between 1980 and 1990. The building construction slowed down after 1990 (Table 4.79). This cluster is the second most dominant cluster in terms of high-rise building construction between 1970 and 1980

(Table 4.80). Cluster 5 is located in Baltimore. The center of the cluster is approximately 35 miles in shortest distance from the center of downtown Washington DC. There are 65 buildings in this cluster, of which 52.31% were constructed before 1970 (Table 4.79).

Cluster 6 is located in Arlington inside the urban envelope. The center of the cluster is located in a secondary downtown density area, 4.5 miles away from downtown. There are 28 buildings in this cluster and 24 of them were constructed after 1980s (Table 4.78). The highest construction rate took place between 2000 and 2010 (Table 4.79). Cluster 7 is located in the secondary downtown of Silver Spring in an edge city density location 6.6 miles away from downtown Washington DC. There are 17 buildings and 14 of them were constructed after 1980. 76.47% of the buildings were constructed between 1980 and 2000 (Table 4.79). Cluster 8 is located in the Herndon/Reston edge city area, in a secondary downtown density location, 17.5 miles away from downtown. There was no construction before 1980 in this cluster (Table 4.78). There are 17 firms in this cluster, 12 of them were constructed between 1990 and 2000 (Table 4.78).

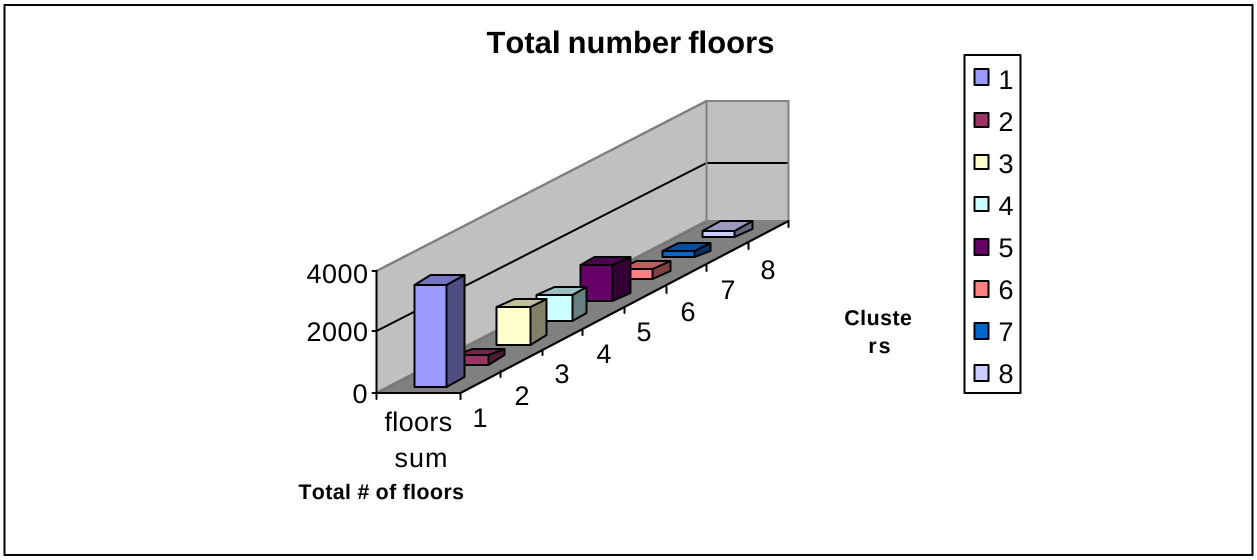



**Figure 4.50: Total Number of floors in Washington DC Building Clusters**

There are also two more clusters that the NNHS analysis did not identify with minimum number of 16 points per cluster. They are located in Tysons Corner and in Bethesda inside the I-270 corridor. These two locations are important global business activity nodes and it is important to note that they also have high-rise building clusters. Bethesda cluster has 15 buildings and Tysons Corner cluster has 12 buildings.

#### 4.1.10.3 Washington DC Company-Building Analysis

In Washington DC, building and company clusters intersect at four different locations: downtown Washington DC, inside the urban envelope in Arlington, in Bethesda inside Rt. 28 corridor, in Tysons Corner edge city, in Herndon/Reston edge city, and in Baltimore. Map 40 shows the company-building analysis of Washington DC. In downtown Washington DC, building clusters 1 and 2 intersect with the company clusters 1, 2, and 5. Building cluster 1 is the highest building cluster in terms of total number of floors and it is also the oldest building cluster (Figure 4.50). Although it is the oldest, this cluster continued to expand in all years. Building cluster 2 is the most recent building cluster. Thus, downtown is the hot-spot location for recent high-rise building construction. Company clusters 1, 2, and 5 define the largest cluster in terms of all knowledge intensive producer services as well as distributive services. Thus, downtown Washington DC is the most active global business activity node.

In Arlington, inside the urban envelope company cluster 6 intersects with building cluster 4 and company cluster 10 intersects with building cluster 6. IT dominates company cluster 6. 12 out of 17 firms are from IT sector. Building cluster 4 is a relatively older building cluster. Around 35% of the buildings in this cluster are built before 1970, the cluster mainly expanded between 1980 and 1990. More than 40% of the buildings are constructed during this time interval. This might be due to attraction of IT firms to the area. 50% of the companies in company cluster 10 belong to distributive services. Management and design consultancy constitute the other half. Building cluster 6 mainly developed after 1980s. The highest rate of construction is between 2000 and 2010. In near future company cluster 10 might attract more firms from distributive services.

In Herndon/Reston edge city company cluster 9 intersects with building cluster 8. 50% of the buildings in company cluster 9 belong to IT firms. Building cluster 8 developed after 1980 and the highest rate of construction took place between 1990 and 2000. Similar to other cities, in Washington DC, IT companies are locating in recently developed high-rise building clusters. In Baltimore, MD; company cluster 4 intersects with building cluster 5.

Together these two clusters define downtown Baltimore. The industry composition is diverse and the building cluster defines a well-established location mainly founded before 1970. Building cluster 5 is the second highest building cluster in Washington DC metropolitan area (Figure 4.50). In Bethesda inside Rt.28 corridor and in Tysons Corner company clusters 7 and 3 intersect with two building clusters. Both of these building clusters are fairly diverse and in terms of industry composition they are similar to traditional downtowns.

This chapter identified the case study results of individual metropolitan areas. Next chapter will focus on the polycentric American metropolis through a discussion of these findings including cross-case analyses of companies and buildings. In cross-case analyses, differences and similarities between metropolitan areas and their regions will be the main focus.

# CHAPTER 5: POLYCENTRICITY AND GLOBAL BUSINESS ACTIVITY NODES IN THE NEW US METROPOLIS

This chapter continues from where Chapter 2: Literature Review left and discusses polycentric metropolitan areas in the US context. The discussion will be organized around the evolution of polycentric US metropolis and the locational strategies of APS TNCs. First part will describe the historical and contemporary trends that shaped the evolution of polycentric urban structure and office geography in the metropolitan areas of the US. The second part will discuss the characteristics and locational strategies of global business activity nodes in the selected metropolitan areas through the case study results provided in Chapter 4.

## 5.1 POLYCENTRIC US METROPOLIS

This section will describe the evolution of polycentric US metropolis and its office geography as an outcome of new global economic order and developments in information, communication, and transport technologies.

### 5.1.1 From Monocentric City to Polycentric US Metropolis

Anas et al (1998) argue that the spatial structure of modern US cities was shaped by advances in transport and communication. Before the industrial era, most cities were dependent on to harbors, rivers, and canals due to the scale economies provided by the decreasing costs when freight processing took place in one port. In the industrial era railroads became more important means of transportation. Proximity to railway stations rather than harbors became crucial for scale economies. At that time, intra-urban freight transport was held by horse and wagon, which was inefficient. After 1850s, telegraph accelerated the flow of information between cities, but it was too costly to change the intra-urban communication system. These conditions led to the development of one dominant central business district (CBD) in American cities, which was divided into different districts of manufacturing and service activities surrounded by residential zones (Anas, et al. 1998, 1428). In this monocentric city model, competition for land and ecological processes of congregation and segregation played the most important roles for identifying land use patterns (Lang and Knox 2007).

The electric street car trolley in 1850 enabled upper and middle income people to move further out of central city locations between 1850 and 1900 forming streetcar suburbs. Later, subways contributed to this growth pattern. Advances in building technology around 1870s, enabled the construction of high-rise office buildings in CBDs (Abel 2003), which was supported by the discovery of the Otis elevator (Easterling 2003). By the end of $19^{th}$ century American cities were both growing upwards and outwards.

In the beginning of the $20^{th}$ century, the internal combustion engine and telephone brought new changes to urban structure. Horse and wagon was replaced by small truck and the messenger was replaced by the telephone. Thus, businesses could move out of the center to take advantage of the lower land costs. Around 1910, the discovery of automobile opened up a new era by offering more speed, privacy, and convenience than mass transit (Anas, et al. 1998, 1430). Offices started move further out to new and less congested business centers called "uptowns". Manufacturing could easily locate in flat factory buildings established in peripheral areas. Around the new factory locations, satellite cities were formed (Lang 2003, 9). However, in the early and mid 20$^{th}$ century manufacturing was still bounded to rail terminals and harbors in urban core and monocentric city was seen as the essential structure of cities. "Concentric Zone Hypothesis" of Ernest Burgess (1925), which states that cities expand outwards around CBDs in five concentric zones, shows that cities had monocentric, CBD dominated character. Alonso also suggested a similar structure which states that cost of land decreases as one moves away from the center. Due to scale economies and high land costs, mostly commercial and industrial activities located in the concentrated CBD (O'Sullivan 2000).

#### 5.1.1.1 Emergence of Polycentric Structure

After World War II, this dependency on the monocentric model and concentric growth assumption of cities started to disintegrate with suburban railway terminals, declining cost of inter-city trucking, construction of the new highway system in 1956, and affordable mortgage loans by government to fulfill the classic suburban dream of people who returned from overseas. The population increase in the baby boom period also contributed to this expansion of the US cities. Manufacturing left central cities and central cities became service oriented (Anas, et al. 1998, 1430; Macionis and Parrillo 2004; Morrill 2006).  Residential developments started to take place on city fringes from where people commuted to their work in CBDs via automobile. In 1945, Harris and

Ullman developed the "Multiple Nuclei Theory", which stated that urban land use is developed around several nuclei and larger the city, more specialized the nuclei (Harris and Ullman 1945). This decentralization was very much evident in the urban landscape. By 1960s, evidences of an uninterrupted polycentric metropolitan region were visible in the North East United States (Lang and Knox 2007), identified by Jean Gottmann (1961) as megalopolis.

In late 1960s and early 1970s, deindustrialization and shift of manufacturing to mainly low-cost developing countries have started a new decentralization pattern in the US (Sassen 2001b). The old city centers of the manufacturing belt were decaying. What is left of industry relocated in the Sunbelt states in more recent and high-tech plants located in close proximity to the new highway system outside of central Sunbelt cities. Employees followed firms due to more favorable living and working conditions in region (Castells 1989; Macionis and Parrillo 2004). The population remaining in central cities of the manufacturing belt moved out to suburban areas as a result of the decaying infrastructure, high taxes, and low quality of life in central cities (Macionis and Parrillo 2004). Retail businesses followed residents, new shopping malls started to be built in suburbs. In this relocation of retail activity, accessibility was the main concern, thus highway junctions and corridors developed as hot-spot commercial locations. Soon, these locations attracted office-parks that cater to small sales and back-office functions. Large corporations remained in central cities between 1960 and 1970 (Hartshorn and Muller 1989).

This urban restructuring in 1960s was best captured by "urban realms" model of John Vance. In 1964, by looking at the metropolitan change in the San Francisco Bay Area, John Vance (1964) argued that large metropolises like San Francisco, Los Angeles, and New York became so large and decentralized that they can only be characterized by semi-autonomous regions, or "urban realms" (Lang and Knox 2007; Vance 1964). Vance proposed an urban structure model, which suggested the emergence of large, economically diversified activity centers in the suburbs. These activity centers are mixed-use providing all necessary services and goods for the population living in the periphery. In a way they can be seen as suburban downtowns. Thus, the whole metropolis is divided into large and independent urban realms, which have their own identities (Hartshorn and Muller 1989; Vance 1977). The ties between realms are similar to those between cities. There is a well-defined, systemic relationship operating between realms. Only a small number of the population will have reasons to cross the boundary of their realms, the central city as the dominant core will decline and suburban downtowns will be rivals to the traditional CBD (Vance 1977, 353). As realms get more equal, core-periphery relationship weakens. As Lang and Knox (2007) mention, a good example to urban realms theory is Los Angels and Orange Counties. Both counties have specific economic and cultural identities and they contribute to the regions economic growth. However, their economic basis are different, they have a symbiotic relationship.

Between 1970 and 1980, suburbanization of business and residential activity continued and the shift from a monocentric to polycentric urban structure started to become more and more evident. By the end of 1980s, in the US the percentage of the metropolitan population in central cities dropped from 64 percent in 1948 to 39 percent in 1990. The percentage of manufacturing employment dropped from 67 percent to 45 percent. The greatest decline took place in trade and service employment. Wholesaling employment dropped from 92 percent to 49 percent, retail employment dropped from 75 percent to 48 percent, and the service employment dropped from 85 percent to 52 percent (O'Sullivan 2000, 267).

In 1983, Pierce Lewis (1983) captured this polycentric structure with the term “galactic metropolis”, which is a large metropolitan region with interconnected urban centers, sub-centers, and small satellites. By mid 1970s, office corridors with high-rise buildings started to form along freeways. Boston’s Route 128 and Silicon Valley in San Jose developed as high-tech clusters. Large malls established close to suburbs attracted large office complexes for large companies (Hartshorn and Muller 1989), which became important economic centers. Garreau (1991) conceptualized these centers as “edge cities”.

Edge city concept was mentioned in the literature review as being synonymous to subcenters. Edge cities are usually found in highway junctions and they are characterized by large concentrations of office and retail space. These places have more jobs than bedrooms, they are perceived by the population as one place and these places were nothing like a city before 1960s (Ding and Bingham 2000; Garreau 1991). Tyson’s Corner in Washington DC metropolitan area and Perimeter Center in Atlanta are examples of edge cities. The most prestigious edge cities were formed close to most affluent residential suburbs. The profile of the residents had an impact on the large companies and headquarters willing to locate in these newly developing places to be close to their employees (Hartshorn and Muller 1989).

#### 5.1.1.2 New US Metropolis in the Contemporary Era

Knox (2008) demonstrates that the new economic order, which started in 1960s and reached to a maturity stage in 1990s had a drastic effect on the formation of polycentric urban structure in the US cities. This "new economic order is based on digital technologies and featuring economic and cultural globalization, the international division of labor, international finance, supranationalism, and cosmopolitanism" (Knox 2008). Service employment in the US increased from 8.7 million in 1956 to 27.3 million in 1988 (O'hUallachain and Reid 1991). The internationalization of economic geography has weakened the control of both big government and big labor. As a result of the new communication technologies employees could work from their home and telecommute to their work (Castells 1996; Knox 2008) . New high-tech industries have relocated away from city centers where the aging built environment is not well-suited to their needs, to suburbs where there are new buildings with flexible layout and ready wired access to digital telecommunications networks. The households also relocated as a result of this flexible spatial logic of the corporations (Knox 2008).

In the end of 1980s, new high-rise offices designed by the most famous architects and equipped with high-tech infrastructure indicated that there is a rivalry between edge cities and traditional downtowns (Hartshorn and Muller 1989). After 1980s, central cities of the

US resisted this decline by investments in new sports arenas, arts complexes, and high-rise office towers. CBDs had the advantage of having the best metropolitan accessibility and already existing office stock (Morrill 2006, 157). These strategies paid off after 1990s, when the CBD populations started to increase with the moving of young professionals, empty nesters, and immigrants (Macionis and Parrillo 2004).

During 1990s and onwards suburbs experienced an even higher increase in population and jobs than the central cities. Revitalized cores had most of the advanced producer services and the suburbs had most of the retail, wholesale, and manufacturing jobs (Morrill 2006, 159). Much of the new growth took place as low-density exurban sprawl even surpassing suburbs. Fishman (1987) suggests that exurban areas are organized around technoburbs, which is a peripheral zone that has emerged as a self-sufficient unit. They have shopping malls, industrial parks, campus-like office complexes, hospitals, and housing along its highway growth corridors. All these elements are randomly scattered around a region and in time they may form a city without deliberate design. By the end of 1990s, the new US metropolis was characterized by an intense geographical differentiation, economic development, cultural transformation, and sprawl (Knox 2008).

The resulting pattern in contemporary American metropolis by the beginning of 20th century is a "massive spurt of city building and the evolution of dispersed, polycentric spatial structure" (Lang and Knox 2007, 5), which "have grown so decentralized that they had become an assembly of economically and culturally semi-autonomous sub-regions or urban realms" (Lang and Knox 2007, 6). In 1950s, fifty seven percent of MSA residents and seventy percent of MSA jobs were located in central cities. By 1995, only thirty seven percent of the residents and forty five percent of MSA jobs were located in central cities (Ihlanfeldt 1995, 125). By 2000, sixty percent of the jobs in American metropolitan areas were located in suburbs (Knox 2008).

Deyan Sudjic (1992) used the term “100-mile city” to explain this massive decentralization. According to Sudjic (1992) the contemporary city is an assembly of mega-developments located so far away from each other that one can hardly capture the urban territory. LA school theorists suggests that the new metropolis has a chaotic structure (Hackworth 2005). By taking Los Angeles as a case study, Edward Soja (2000) argues that future of urbanism is decentralized, socially and economically segregated metropolis with a fragmented power structure. According to Michael Dear (Dear 2001, 2003) global-local nexus deepened the social polarization and the contemporary urban landscape has become compartmentalized according to power structures. Sprawl results in disputes of political representation, which then leads to socially and economically polarized and chaotic metropolis. In this metropolis periphery now controls the urban core (Hackworth 2005).

Ihlanfeldt (1995) demonstrates that rapid decentralization of jobs and people and development of subcenters (edge cities) have started debates on the importance of central city in the regional economy. These debates are revolving around competition or cooperation between subcenters and CBDs. Scholars like Hartshorn and Muller (1989), Garreau (1991), and Muller (1981) argue that in the US metropolis, there is a competition between subcenters and CBDs. The maturing edge cities will become as important as CBDs. On the other hand, as discussed in the literature review chapter, Castells (1989) proposes a symbiotic relationship between edge cities and CBDs. Through his typology of the emerging business centers with different functions, Peter Hall (2001) also proposes cooperation between subcenters and CBDs rather than competition.

According to Ihlanfeldt (1995) CBDs and subcenters are interdependent. The metropolitan areas are usually recognized from outside by their central cities. If central cities experience a decline, this will affect the economic and demographic conditions of the subcenters. Central cities also have a unique sense of place, which is valued in the whole region. Knox (2008) similarly argues that traditional CBDs will always be important settings for advanced business services, but edge cities, newer business centers, back-office spaces, and specialized subcenters will become complimentary to downtowns in forming the new US metropolis.

### 5.1.2 Regional Differences in the Polycentric Urban Structure of the US

The shift in the economic base of the US cities from manufacturing to service based economy has introduced a decentralized spatial logic for industrial location. Castells (1989, 152) argues that this decentralization needs to be examined in three levels: between regions, from metropolitan to non-metropolitan areas, and suburbanization within the metropolitan areas. Suburbanization of industrial location was examined in the previous section. In this section, regional decentralization of industrial activity in the US will be the focus.

Deindustrialization in 1960s, led to the economic decline of the manufacturing belt cities in the US. In these cities energy costs were getting higher, tax breaks were not as favorable as they used to be, union pay scales made labor very costly, and the aging plant buildings did not meet the demands of the new high-tech industries (Macionis and Parrillo 2004). On the other hand, cities of the south and south west, were anxious to attract more capital and industry. Sunbelt is the name given to the part of the US below the 37$^{th}$ parallel (Rice and Bernard 1983). City governments in this region offered enough land for new high-tech plants with proximity to new highway system, favorable tax break, and less unionized labor force. The warm weather added to the "good business climate" of the Sunbelt cities. People living in manufacturing belt cities also started to move to Sunbelt due to employment opportunities and lower living costs (Clark and Roche 1984; Macionis and Parrillo 2004; Rice and Bernard 1983). Thus, after 1960s, cities of Sunbelt experienced rapid increase in population and businesses. Frey (2003) demonstrates that between 1995-2000, the top ten migration magnets in the US were all from cities in the Sunbelt . Phoenix, Atlanta, Las Vegas, Dallas-Ft. Worth, Austin, Tampa, Orlando, Denver, Charlotte, and Raleigh make the top of the most popular cities that people migrate.

Growth of Sunbelt cities is best demonstrated by statistics of population and land area. Between 1950 and 1990, population of Los Angeles increased by 77 percent, Dallas increased by 1.32 times, Houston increased by 1.73 times, and Phoenix increased by 8.2 times in population. On the other hand, in the same time frame New York City experienced 7.2 percent decline, Chicago experienced 23 percent decline, Detroit experienced 27 percent population decline, and Boston experienced 28 percent decline in population. Between 1950 and 1990, the land area of Los Angeles increased by 2 percent, Dallas grew twice; Houston grew 2.4 times, and Phoenix increased by 23.5 times. In this interval, New York's land area decreased 2 percent, Detroit decreased by 0.6 percent. Chicago's land area increased by 9.5 percent and Boston's land area increased only by 1.2 percent (derived from Gibson 1998).

Average population per square mile declined in all the cities except for Los Angeles suggesting decentralization. The extent of this decentralization between 1950 and 1990 is much bigger in Sunbelt than in former manufacturing belt cities. Population density in Phoenix in 1990 was cut down to one third of what it was in 1950, which means the land area growth was much higher than the population growth. Population density in Dallas was cut down by 1.5 times. Only in Los Angeles the population density increased meaning that the population growth was at a higher rate than the land area increase. New York experienced only 8 percent population density decline whereas Chicago and Boston experienced around 30 percent decline, which is still lower than the decrease in Sunbelt cities (derived from Gibson 1998).

### 5.1.3 Office Geography in the New US Metropolis

Regional and metropolitan decentralization are the processes that define the New US Metropolis. Knox (2008) and Lang (2003) argue that the key element of the polycentric New US Metropolis is office employment. Office space is an important variable in understanding metropolitan restructuring because it provides the settings where a large percentage of job growth takes place. Tracking the office space identifies hot-spot locations of metropolitan growth and provide important insight to urban sprawl and transportation policies (Lang, et al. 2007). Central cities are loosing their office space to suburbs. In 1979, 74 percent of office space was found in central cities; by 1999 this percentage has declined to 58 percent. During these years, office space of suburbs increased by 16 percent (Lang 2000). Pivo (1990, 457) argues that it is important to reveal the pattern of office development within suburban areas through comparative analysis.

The literature on the distribution of office space in the US cities mostly analyzes the office space according to edge city vs. CBD model (Pivo 1990). Edge cities or suburban centers are seen as major attraction nodes for attract most urban jobs and services that are relocating in suburbs (Garreau 1991). Other scholars such as Berry (1970) and Cervero (1986) identified highway corridors as being important low-density growth locations for metropolitan office space. Office space is also found randomly scattered between suburban clusters and corridors. Pivo (1990, 458) used the term scatteration to describe low density office development spread across urban fabric without any particular focal points (Pivo 1990, 458). Pivo (1990) concludes that no suburb appeals to one locational type; rather they are combinations of suburban centers, corridors, and scatteration.

Lang (2003) has demonstrated that edge cities are not the principal nodes in terms of suburban office space, actually edge cities capture a modest share of non-CBD office space. In their study of 13 largest metropolitan office markets Lang, Sanchez, and LeFurgy (2006) has shown that out of the 3 billion square feet of office space analyzed edge cities have around 14 percent of the office space and downtowns have 33 percent share. 40 percent of the office space is found in what Lang (2003) terms as edgeless cities, which is a smaller scale and dispersed commercial form (Lang, et al. 2006). The rest of the office space falls into secondary downtowns, urban envelopes, and corridors, whose density measures were identified in the methodology section. Lang et al. (2007) argues that the dominance of edgeless cities in office space means that office development in New Metropolis is no longer categorized as being nodal, rather there is a post-polycentric office geography evolving in the US metropolitan areas. Lang's office space categorization is important because it goes beyond the suburbs vs. CBD model and identifies six different categories including downtown, secondary downtown, urban envelope, edge city, corridor, and edgeless cities.

Downtowns are the original Central Business Districts (CBD), which lie at the center of the region. Secondary downtowns are formed in the streetcar and early auto era and they support some pedestrian presence. Secondary downtowns are less dense version of primary downtowns. Urban envelopes ring downtowns in cases where office density gradually declines outward from a detectable cluster. Not all metropolitan areas have urban envelopes (Lang, et al. 2007, 8). For edge cities, Lang (2003) uses Garreau's (1991) definition and define edge cities as non-CBD clusters with as much as 5 million square feet of office space. Edge cities are denser relative to their suburban surroundings. The number of edge cities varies according to metropolitan areas. Larger office markets contain more edge cities. Edge city corridors are defined as linear clusters usually following major transportation routes (highways or major arterials), averaging edge city office densities, and also being anchored by one or more secondary downtown or edge city. Similar to urban envelopes not all cities have edge city corridors (Lang, et al. 2007, 10).

Edgeless cities lack a boundary and they scatter over large amount of urban space. They have the basic elements of a city but are structured in a way that few would recognize them as a city. They might be located on the fringe of the metropolitan area or between edge cities and they have low density compared to edge cities (Lang, et al. 2007, 11). The growth of edgeless cities is related with increased individual mobility and highway system and it is an important trend in the US (Lee 2007). Gordon and Richardson (1996) reveal that in Los Angeles, the share of total employment in “activity centers” had decreased from 20 to 12 percent between 1970 and 1990, these numbers do not even suggest a polycentric form.

In this study, Lang’s (2003; 2007) office geography will be used as the basis of identifying the locational strategies of APS TNCs in ten US metropolitan areas. Lang’s classification is selected as a basis to explore the distribution of global business activity nodes due to its detailed typology of metropolitan office space.

## 5.2 GLOBAL BUSINESS ACTIVITY NODES IN THE NEW METROPOLIS

This section will offer a discussion on the differences and similarities of locational distribution of APS TNC and high-rise office building clusters in ten metro areas grouped according to Sunbelt vs. former manufacturing belt regions. The discussion in this section derives from the case study results in Chapter 4.

### 5.2.1 Locational Distribution and Sector Components of APS TNC Clusters in Polycentric US Metropolis

Locational strategies of advanced producer service firms were explained in Chapter 2. These firms highly benefit from clustering in urban space. Schwartz (1992, 279) mention that APS industry has been one of the largest sources of national employment growth after 1970s. In this study we deal with a special category of APS firms, which is the transnational APS firm (APS TNCs).

Sassen's (2001) global cities theory is based on the assumption that complexity of global economy also brought complexity in corporate functions. Command and control functions of transnational corporations are outsourced to specialized advanced producer service firms. These firms operate in global partnerships and they follow their clients in international markets. This indicates increased city to city transactions and formation of a transnational urban system. Thus, APS TNCs have become the key sector of the global economy and the new transnational urban system (Sassen 2001b).

As discussed in the literature review, Friedmann (1995b) also includes the advanced producer services in defining the complex spatial hierarchy of world cities. Cities with high numbers of APS TNCs rise in the global hierarchy. In Castells' (1996) space of flows theory, APS TNCs are seen as agents operating on the second layer of nodes and hubs defining global linkages. They highly utilize the high-tech infrastructure and according to their operations these firms also influence the spatial distribution of the economic elite. Urban glamour zones like hotels, restaurants, shopping malls, high rise office buildings, and airport lounges are organized according to the consumption demands of this class, which are highly mobile and have strong ties to the global business culture (Newman and Thornley 2005). Taylor's interlocking world city network model also recognizes APS TNCs as the key elements of globalization.

APS TNCs benefit from clustering. All the locational demands that we discussed in Chapter 2 for APS firms are also valid for their transnational counterparts. APS TNCs are highly information dependent and knowledge intensive. APS TNCs' clients are mostly other transnational firms (Olds 2001). Being in close proximity increases collaboration opportunities of APS firms with their client companies. Large metropolitan area location is important for APS TNCs. These centers can offer the amenities and lifestyles demanded by the highly-paid personnel employed in APS TNCs (Olds 2001; Reszat 2002). A comparison between Frankfurt and London by Beaverstock et al. (2001) has demonstrated that the rich urban culture in London is an important location decision for firms because their employees prefer to live in such a place. APS TNCs depend on global telecommunications systems. Following Graham (1997a; 1997b), we can argue that this dependency is also an important factor in agglomeration of these firms.

Most of the studies in locational analysis of advanced producer services do not distinguish transnational firms from others (Nelson 2005; O'hUallachain and Leslie 2007; O'hUallachain and Reid 1991; Schwartz 1992). However, when we look at global cities like New York, Paris, and London, we see that city governments are marketing their cities through clusters of high-rise office buildings mostly rented by global producer service companies. Thus, one can argue that clustering is even more important for transnational APS firms due to corporate image, access to information, and social and cultural advantages of urban glamour zones for employees (Reszat 2002). Also, transnational service firms are important revenue generators for global cities. 20 percent of international trade comes from producer service firms (Warf 1996).

Due to these reasons it is important to see how APS TNCs are clustered in the polycentric metropolis. In this thesis, clusters of APS TNC firm clusters are defined as global business activity nodes. Next, we will explore the commonalities and/or differences among the locational distribution of global business activity nodes according to cities and regions.

#### 5.2.1.1 Discussion of Case Study Findings: Cross-City and Cross-Regional Perspectives

In order to understand the locational strategies of APS TNC firm clusters we asked the following research question: "What are the centrality patterns of the advanced producer service clusters (global business activity nodes) in selected U.S. metropolitan areas with respect to their location[14], size[15], and industry composition[16]?" Chapter 4 identified the centrality patterns of individual company clusters. In this part we will offer a cross-city and cross-regional discussion of these results. The NNHS analysis results for all cities are given in Table 5.1.

**Table 5.1: NNHS Analysis Results for All Cities**

| Cities | # of APS TNCs | # of clustered APS TNCs | % of clustering | NNHS distance | NNHS minimum points per cluster |
|---|---|---|---|---|---|
| Atlanta | 385 | 188 | 48.83% | 0.12 | 8 |
| Boston | 376 | 198 | 52.66% | 0.08 | 6 |
| Chicago | 519 | 346 | 66.67% | 0.08 | 7 |
| Dallas | 376 | 180 | 47.87% | 0.12 | 9 |
| Houston | 360 | 162 | 45.00% | 0.12 | 7 |
| Los Angeles | 632 | 272 | 43.04% | 0.05 | 9 |
| Miami | 320 | 125 | 39.06% | 0.1 | 6 |
| New York | 1021 | 670 | 65.62% | 0.04 | 9 |
| San Francisco | 551 | 347 | 62.98% | 0.05 | 12 |
| Washington DC | 626 | 301 | 48.08% | 0.06 | 10 |

In total, 5166 locations are geocoded for 617 firms. The NNHS distance turned out to be the least in New York, suggesting the close locations of the companies especially in Manhattan. Atlanta, Dallas, and Houston had the highest minimum walking distance suggesting firms in these cities are located more far apart. Highest clustering of firms took place in Chicago followed by New York. These two metropolitan areas also have the largest downtowns in square feet of office space (Lang, et al. 2007). Miami had the

14 Location is defined from the classification of Lang et al (Lang, et al. 2007).
15 Size is defined through the number of firms.
16 Industry composition is the number of different sectors represented.

lowest clustering percentage of APS TNCs, followed by Los Angeles and Houston, which suggests that these cities have the most decentralized location patterns for APS TNCs. The Sunbelt cities, except for San Francisco, have lower clustering rates than manufacturing belt cities. The first hypothesis was that in all the metropolitan areas firms would be highly clustered. However, with highest clustering percentage of 66.67 percent and lowest clustering percentage of 39.06 percent we cannot conclude that there is high clustering especially in Sunbelt cities (Table 5.1). Thus, decentralization is a general trend for all APS TNCs in all cities.

**Table 5.2: Number of Company Clusters in Different Density Locations**

| Cities | # of clusters in downtown | # of clusters in urban envelope | # of clusters in secondary downtown | # of clusters in edge cities | # of clusters in edgeless cities | TOTAL |
|---|---|---|---|---|---|---|
| Atlanta | 1 | 3 | 0 | 1 | 2 | 7 |
| Boston | 5 | 1 | 0 | 1 | 2 | 9 |
| Chicago | 1 | 1 | 0 | 4 | 3 | 9 |
| Dallas | 1 | 0 | 1 | 4 | 2 | 8 |
| Houston | 1 | 0 | 0 | 4 | 2 | 7 |
| Los Angeles | 1 | 0 | 4 | 4 | 2 | 11 |
| Miami | 1 | 0 | 1 | 3 | 1 | 6 |
| New York | 5 | 0 | 2 | 2 | 2 | 11 |
| San Francisco | 1 | 0 | 4 | 1 | 3 | 9 |
| Washington DC | 3 | 3 | 1 | 3 | 0 | 10 |

The second hypothesis was that the clusters of APS firms will have a centralized location pattern. In terms of centralized location, we mean that clusters will mostly be located in areas with higher than edgeless city density. The distribution of the number of clusters according to Lang’s office geography is given in Table 5.2. In all the metropolitan areas, most of the company clusters are located in areas with densities higher than edgeless city density, which proves that company clusters are located in a centralized pattern. In all cities, NNHS analysis identified multiple company clusters with companies in walking distance to each other that demonstrate the polycentric locational pattern of global business activity nodes which proves the third hypothesis (Table 5.2).

The fourth and fifth hypotheses about APS TNC clusters are related to their sectoral components. To test these hypotheses, we first examine the percentages on the total number of firms clustered according to different density areas. This will help us to identify the general company clustering pattern in cities and identify regional trends. Then, we will discuss the clustering trends for different sectors in ten cities with the help of Chapter 4 results. As will be highlighted in the discussion, there are important differences between former manufacturing belt and Sunbelt cities.

**Table 5.3: Percentages of Companies Clustered in Different Density Locations**

| Cities | % of firms clustered in downtown | % of firms clustered in downtown +urban envelope | % of firms clustered in secondary downtown | % of firms clustered in edge cities | % of firms in clustered in edgeless cities | Non-clustered firms |
|---|---|---|---|---|---|---|
| Atlanta | 12.21% | 38.44% | 0.00% | 4.94% | 5.45% | 51.17% |
| Boston | 44.95% | 46.81% | 0.00% | 1.86% | 3.99% | 47.34% |
| Chicago | 46.44% | 47.78% | 0.00% | 12.52% | 6.36% | 33.33% |
| Dallas | 19.15% | 19.15% | 3.99% | 19.41% | 5.32% | 52.13% |
| Houston | 20.00% | 20.00% | 0.00% | 20.56% | 4.44% | 55.00% |
| Los Angeles | 15.66% | 15.66% | 10.76% | 13.13% | 3.48% | 56.96% |
| Miami | 20.31% | 20.31% | 4.06% | 12.50% | 2.19% | 60.94% |
| New York | 57.88% | 57.88% | 3.04% | 1.96% | 2.74% | 34.38% |
| San Francisco | 35.39% | 35.39% | 7.99% | 9.26% | 10.34% | 37.02% |
| Washington DC | 23.80% | 30.67% | 5.43% | 11.98% | 0.00% | 51.92% |

Table 5.3 shows the number of companies distributed according to different density locations. In New York, Boston, Chicago, and San Francisco majority of the APS TNCs are found in clusters in downtown areas. Boston, Chicago, and New York have 45 percent or more of the companies clustered in downtown locations, which is a significant share. In Miami, Washington DC, and Los Angeles, although downtowns contain the largest percentage of clustered firms, high decentralization pattern of APS TNCs prevent these downtowns to be classified as dominant. Los Angeles downtown has 15.66 percent of the firms, Miami downtown has 20.31 percent, and Washington DC has 23.80 percent (Table 5.3).

Atlanta has the lowest percentage of APS TNCs clustered in its downtown. In Atlanta, 26.23 percent of the APS TNCs are found inside 3 other clusters in its urban envelope. Lang (2007) demonstrates that among the studied cities, Atlanta has the largest urban envelope. Boston, Chicago, and Washington DC also have small number of APS TNCs clustered in their urban envelopes. Dallas, Miami, Los Angeles, New York, and San Francisco do not have urban envelopes. In the case of New York, the secondary downtowns of Jersey City and Brooklyn are in very close proximity around Manhattan. Although they are identified in a different category, these spaces can be seen as urban envelope like extensions (Table 5.3). Thus, we can say that expansion of APS TNC clusters in urban envelopes is more of a characteristic pattern for former manufacturing belt cities than Sunbelt cities.

Los Angeles has 10.76 percent of its APS TNCs clustered in secondary downtown locations, followed by San Francisco with 7.99 percent. All Sunbelt cities have secondary downtowns except for Houston. On the other hand, Boston and Chicago do not have secondary downtowns. Dallas, Houston, and Los Angeles have the highest percentage of firms clustered in edge cities. In these three cities, edge cities rival downtowns in terms of total number of APS TNCs. San Francisco has the largest percentage of APS TNCs clustered in its edgeless city areas followed by Chicago (Table 5.2).

As we see from the findings in Table 5.3, in former manufacturing belt cities APS TNCs are highly clustered in traditional downtown areas. In Sunbelt cities, we see a more decentralized pattern. In Los Angeles, San Francisco, and Miami, geography plays an important role in this decentralization pattern (Lang, et al. 2007). Secondary downtowns are more common in Sunbelt cities. Total number of APS TNCs clustered in edge cities of Sunbelt is almost equal to number of companies clustered in downtowns, which is not the case in former manufacturing belt cities. Sunbelt cities also demonstrate APS TNC clusters in office corridors; which is different than manufacturing belt cities except for Washington DC. These corridors are formed along highways and anchored by an edge city or secondary downtown.

**5.2.1.1.1 Sectoral Components of APS TNC Clusters**

If there is a difference in the clustering patterns of APS TNCs between manufacturing belt and Sunbelt, this differentiation would also be evident in the sectoral distribution of companies inside the metropolitan areas. Table 5.4 shows the top three most and least clustered sectors according to the metro areas.

**Table 5.4: Most and least clustered industries in metropolitan areas**

| Cities | Most clustered industries | Least clustered industries |
|---|---|---|
| Atlanta | Management consultancy, finance/banking, advertising and marketing, law | Logistics, real estate, design consultancy (48.15%) |
| Boston | Law, finance/banking, advertising and marketing | Logistics, real estate, IT (46.67%) |
| Chicago | Law, advertising and marketing, finance/banking | Real estate, logistics, accounting (73.91%) |
| Dallas | Law, finance/banking, accounting | Real estate, logistics, IT (56.45% ) |
| Houston | Law, insurance, accounting | Logistics, real estate, design consultancy (35.71%) |
| Los Angeles | Law, accounting, management consultancy | Logistics, real estate, advertising and marketing (38.89%) |
| Miami | Law, advertising and marketing, management consultancy | Real estate, logistics, design consultancy (24.14%) |
| New York | Law, finance/banking, advertising and marketing | Logistics, real estate, IT (59.51%) |
| San Francisco | Accounting, insurance, design consultancy | Real estate, logistics, IT (54.62%) |
| Washington DC | Finance/banking, advertising and marketing, law | Logistics, IT, design consultancy (40.38%) |

In terms of most clustered industries law firms are at the top of the hierarchy. Beaverstock et al (1999b) argue that law has special characteristics that differentiate it from other APS sectors. It is fragmented according to regional and state traditions, thus it is highly in need of local expertise and information intensive. Face-to-face contact need of clients and lawyers also play a key role in the tight clustering of law firms.

After law, advertising and marketing is the second most clustered industry, which is in the top three most clustered industries in 6 metropolitan areas including all east coast cities of Atlanta, Boston, Miami, New York, and Washington DC and Chicago (Table 5.4). Finance/banking is among the top three most clustered industries in 6 cities including Atlanta, Boston, Chicago, Dallas, New York, and Washington DC. All former manufacturing belt cities have these three sectors among their most clustered ones. Accounting is highly clustered in Sunbelt cities including Los Angeles, San Francisco, Dallas, and Houston (Table 5.4). Management consultancy is listed among the top 3 most clustered sectors in Atlanta, Los Angeles, and Miami. Although the clustering percentages do not reflect the number of firms, they do reflect which industries are more utilizing the agglomeration economies in cities (Table 5.4).

Logistics is the most decentralized industry; it is in the list of top three most decentralized industries in all the selected metropolitan areas. Real estate follows logistics in terms of being the second most decentralized industry. Decentralized pattern of logistics and real estate show that these sectors are local consumer market oriented. IT is the third most decentralized industry in Boston, Dallas, New York, San Francisco, and Washington DC. However, in all of these cities except for Washington DC, IT clustering is above 45%, which is still high compared to other decentralized industries (Table 5.4).

***Former Manufacturing Belt Cities:***

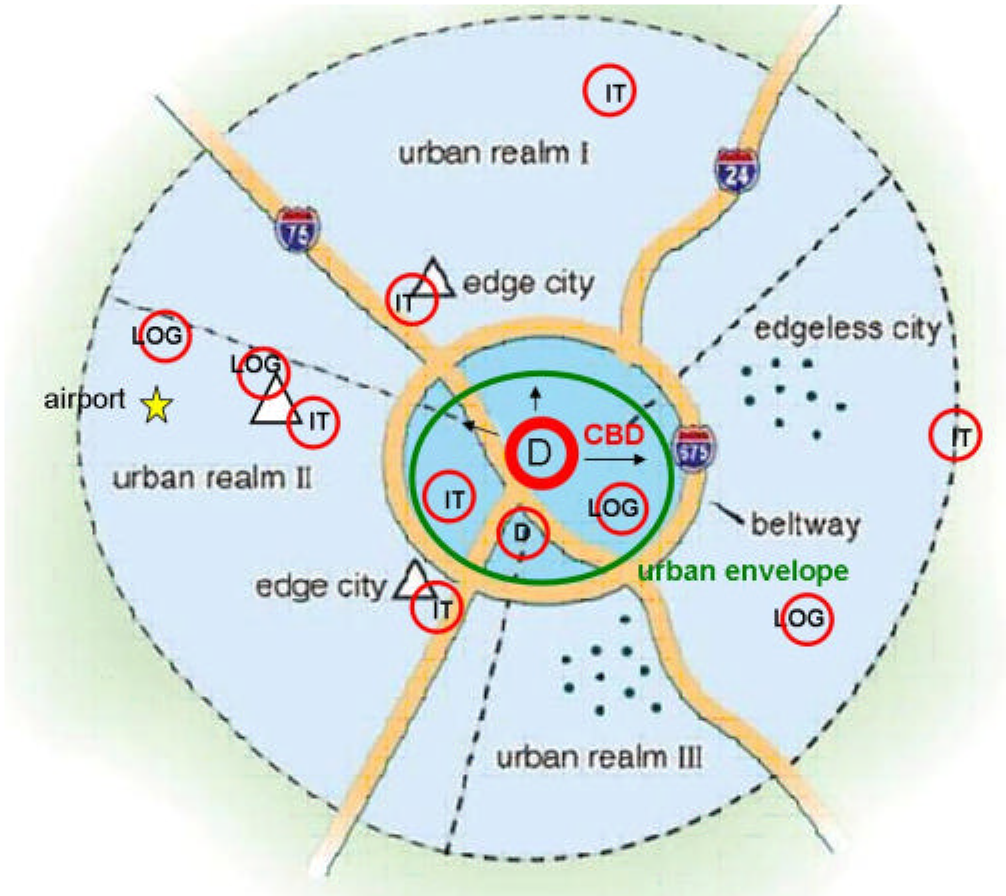
Appendix C includes sectoral distribution of clustered APS TNCs in different density areas in ten metros. These statistics prove the dominance of downtowns in all sectors for former manufacturing belt cities. In Boston, accounting, advertising and marketing, design consultancy, finance/banking, law and management consultancy have more than 63 percent of all their firms clustered in downtown. Downtown Chicago is the focus of much of the region's business trade (Lang, et al. 2006, 22) and its business cluster includes 100 percent of transnational law firms, 88.57 percent of advertising and marketing companies, and 73.33 percent of finance/banking. In New York, except for logistics and real estate, APS TNCs have overwhelming majority of their firms clustered in Manhattan (Appendix C). Although Washington DC looks like an outlier, the three clusters inside its urban envelope fits with this expansion trend.

With 46.73 percent of all 336 regional and/or global headquarter locations; New York is the global capital in the US. Among the cities studied, New York metro area has the most number of APS TNCs in every sector except for IT. In total number of IT firms, Washington DC exceeds New York. Lang et al. (2006) characterizes Washington DC as a mature polycentric metropolis. Although downtown is still a dominant location for most sectors, for clustered firms in accounting, insurance, and IT, secondary downtowns and edge cities have exceeded downtowns' share in Washington DC (Appendix C).

In former manufacturing belt cities traditional downtowns are still the most dominant locations for all APS TNCs. Especially in Boston and Chicago, there are no other clusters outside of downtowns that contain these sectors. In 2003, Lang's classification consisted of primary and secondary downtowns, edge cities and edgeless cities. In revisiting this study in 2006, Lang et al. also included a third category called urban envelopes, which is contiguous to downtowns and extending to edge city density areas. As shown in Chapter 4, in Boston, Chicago, and Washington DC, urban envelopes have diversified clusters as well as IT and logistics dominated clusters (Appendix C). Thus, we can say that expansion in APS TNC locations took place from downtowns towards urban envelopes.

Except for Boston, edge cities in Chicago, New York, and Washington DC have company clusters including firms from different sectors. In terms of number of firms, IT and logistics have the majority in edge cities. Out of the 9 total APS TNC clusters in edge cities in the four cities only 2 are not dominated by IT or logistics. Edgeless city clusters are less diversified than edge cities, but again IT and logistics are dominant. Out of the 7 company clusters, only one of them is not dominated by IT or logistics.

Edge cities and edgeless cities in former manufacturing belt have predominantly attracted IT or logistics dominated clusters. International airports have become the major attraction points especially for logistics dominated clusters. Except for Washington DC, we do not see urban corridors in the former manufacturing belt cities. Figure 5.1 gives a schematic representation of locational distribution of APS TNC clusters in former manufacturing belt cities. These findings verify our fourth hypothesis, which stated that knowledge-intensive producer services are clustered in primary or secondary downtowns. Fifth hypothesis stated that distributive services are clustered in edge city areas and/or close to airports. IT and logistics are found in downtown clusters with more intensity than they are found in edge city clusters (Appendix C). However, in edge city and edgeless city density areas, we observe the development of specialized or dominantly IT clustering. Logistics is highly decentralized in manufacturing belt cities. If clustered, logistics companies mostly cluster near airports or they are found in the same cluster with IT companies.




D=Diversified cluster, IT=Information Technology dominated cluster LOG=Logistics dominated cluster

**Figure 5.1: APS TNC Clustering in Former Manufacturing Belt Cities**

In the literature review, we mentioned Champion's (2001) typology of three models of polycentric metropolitan area formation. One can argue that former manufacturing belt cities fit to the centrifugal mode in which continuous growth results in increasing land rents and accessibility problems in a monocentric city, consequently production and service activities move to alternative centers. The formation of urban envelopes might be resulting from the high-tech infrastructure need of APS firms provided by newer buildings, thus firms move to more recently developing areas, but they still remain close to downtowns.

***Sunbelt Cities:***

In Sunbelt cities of Dallas, Houston, Los Angeles, Miami, and San Francisco downtowns still capture a large proportion of APS TNC firms. However, different from manufacturing belt cities, they are not the most dominant locations. In most sectors, Sunbelt downtowns share similar percentages of clustered APS TNCs with edge cities and secondary downtowns (Appendix C). This is much different from the former manufacturing belt cities, where company clusters in edge cities have significantly lower proportions of APS TNCs than downtowns. For example, although Boston and Dallas have very close total number of companies, Boston's edge city cluster capture 1.86 percent of the total companies whereas four edge city clusters in Dallas capture 19.41 percent (Table 5.3). The large number of edge cities and company clusters show that APS TNCs are more decentralized in Dallas than they are in Boston. Thus, in Dallas, edge cities are major locations for APS TNCs. In Houston, number of firms in edge cities is higher than the number firms in downtown (Table 5.3). Edge cities of the Sunbelt are more diversified than edge cities of the manufacturing belt.

Lang et al. (2006) mention that Los Angeles is a complex region where decentralization is stronger than in other metro areas due to the well-established highway network. Although Los Angeles is a decentralized, sprawling metropolis, due to geographic constraints it cannot expand much, thus clustering of economic activity is an important trend. The high number of APS TNC clusters is an outcome of the fragmented geography of Los Angeles. Between 1950 and 1990, the land area of Los Angeles increased by only 2 percent, one of the lowest in Sunbelt and its population density increased in contrast to other Sunbelt cities (derived from Gibson 1998).

Compared to other cities, Los Angeles has the least dominant downtown in knowledge intensive APS firms. Clusters in secondary downtowns and edge cities rival Los Angeles in terms of number of clustered APS TNCs in many sectors. In accounting, edge city clusters contain 31.25 percent of the firms, downtown cluster contains 21.88 percent, and secondary downtown clusters contain 18.75 percent. In advertising and marketing downtown and edge city clusters contain the same number of firms. In management consultancy, edge city clusters are catching up with the downtown cluster. Law is the only sector that is still highly clustered in downtown Los Angeles, but even with a percentage of 58.33, it is behind than Washington DC (63.16%), and New York (84.48%).

Lang et al (2006) mention that similar to Los Angeles, San Francisco's geography made up of mountains and the bay area, led to the development of a polycentric city from the beginning. In San Francisco, except for logistics and real estate, all other sectors have more firms in clusters than non-clustered ones. Downtown has the most dominant in all sectors except for IT. Number of APS TNCs in IT industry clustered in edge cities exceed the IT firms clustered in downtown. Miami's office development is characterized by edgeless cities with few centers. Among the studied metro areas, Miami has the least number of APS TNC clusters and most percentage of companies that do not belong in a cluster (Table 5.1). Miami's downtown cluster is most dominant in design consultancy, insurance, law, and management consultancy. In accounting and advertising and marketing edge city clusters have a similar share with downtown in number of APS TNCs. (Appendix C).

In Atlanta, downtown has left its place to a large urban envelope that is dominant in all the sectors. Downtown Atlanta is the most dominant in accounting firms. 41.67 percent of all accounting firms are found clustered in this location. Around 60 percent of management consultancy and insurance firms; 53 percent of finance/banking firms and 45 percent of advertising and marketing firms are found inside the urban envelope. Although the majority of the APS TNCs are located in the urban envelope, Atlanta is still different from former manufacturing belt cities, which experienced growth through urban envelopes, but still protects dominant downtowns. In Atlanta, downtown is less visible compared to urban envelope. Thus, more than expansion, this trend in Atlanta can be defined as a major decentralization of APS TNC activity (Appendix C).

Secondary downtowns of Sunbelt cities have diversified clusters or clusters dominated by one knowledge intensive producer service sector rather than being IT or logistics dominated. For example, secondary downtown of Ft. Worth captures an important share of accounting firms and small shares of other knowledge-intensive APS TNCs from different sectors in its company cluster. In Los Angeles, four secondary downtowns contain almost as much finance/banking companies as downtown. In Miami, Ft.

Lauderdale secondary downtown has almost equal number of firms in finance/banking with downtown Miami. Ft. Lauderdale secondary downtown cluster is the second most diversified cluster and besides finance, it is an important location for accounting, design consultancy, law, and management consultancy firms (Appendix C). In San Francisco, Oakland secondary downtown is the second most diversified cluster and it is dominated by design consultancy firms. As stated in the findings section, although Silicon Valley is in the CMSA rather than MSA, it is included due to its economic links with San Francisco Metropolitan Area. The other secondary downtown in San Francisco is found in Silicon Valley and it is dominated by accounting companies.

Edge cities of Sunbelt cities have important shares of knowledge-intensive producer services, but their most dominant sectors are IT and logistics. Out of the 16 edge city APS TNC clusters in Sunbelt cities, only 3 clusters were either diversified or dominated by other firms. 13 clusters were IT or logistics dominated. The number of IT and logistics companies in Sunbelt edge cities outnumber that of manufacturing belt cities. For example, Chicago and San Francisco have around 90 IT firms in total. San Francisco edge cities contain around 36 percent of these companies, whereas Chicago edge cities contain 27 percent (Appendix C), even though Chicago has more edge city clusters than San Francisco.

Edgeless city clusters of Sunbelt are also important locations for logistics and IT firms. Out of the 11 edgeless city density APS TNC clusters in 6 Sunbelt cities, only 3 is not dominated by IT or logistics. Interestingly in San Francisco, there is one edgeless city density cluster, which is dominated by law firms. Law is an industry that is highly clustered in primary or secondary downtowns. Finding a cluster which is dominated by law firms in an edgeless city density area is different from other cities. One explanation can be that along I-280 corridor is developing in a more high-density manner. Also, due to the gravitational pull of Silicon Valley's economy, San Francisco might be developing specialized APS TNC clusters along I-280.

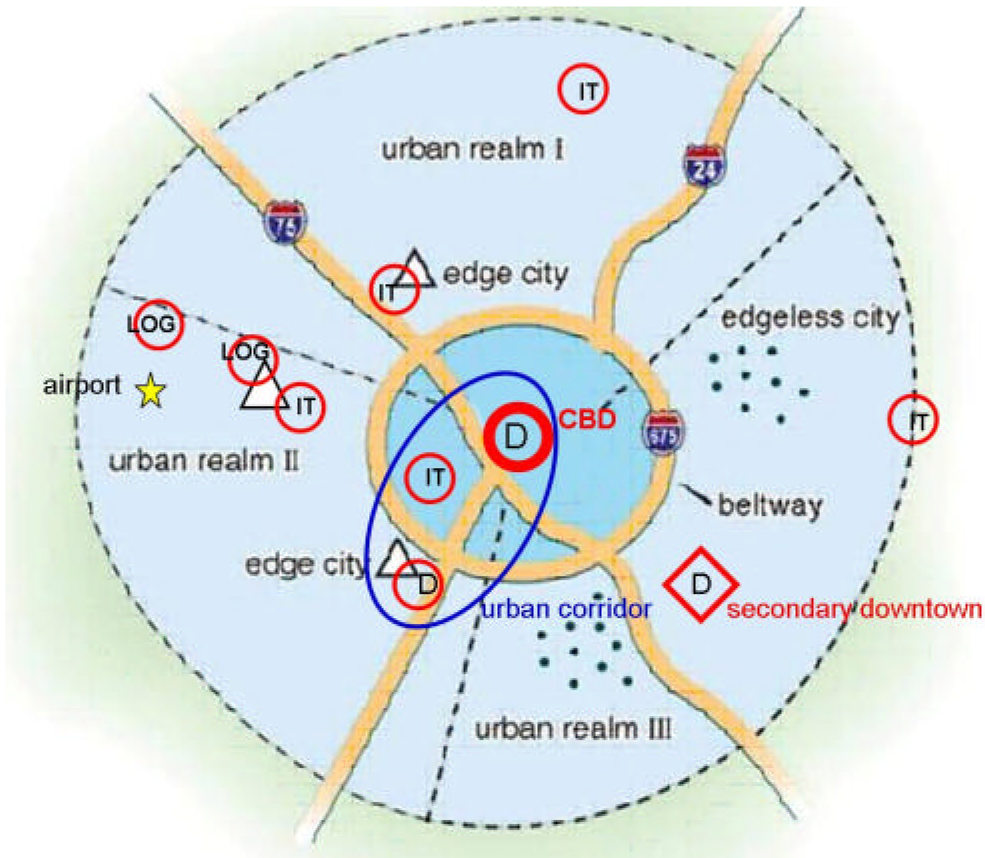
These findings in Sunbelt cities suggest that, although downtowns are still important locations for knowledge intensive APS TNCs, they are not the most dominant ones. Many firms have located in diversified secondary downtowns or edge cities. Secondary downtowns are not a characteristic trend in former manufacturing belt cities like they are in Sunbelt cities. As shown, Dallas, Houston and Los Angeles all have urban corridors. Most of these corridors start close to downtown; they follow freeways and they are anchored by an edge city. I-280 in San Francisco might define an important urban corridor for APS TNC locations in the near future. It already has three APS TNC clusters including the second and the third largest ones in terms of number of firms. Thus, in Sunbelt cities expansion of APS TNC locations takes place through urban corridors, edge cities, and secondary downtowns.

On the other hand, Sunbelt cities do not have any APS TNCs clustered in urban envelopes except for Atlanta. Dallas, Los Angeles, Miami do not have urban envelopes. These findings suggest that locational distribution of APS TNCs are more decentralized in Sunbelt cities compared to manufacturing belt.

This regional differentiation between Sunbelt cities and former manufacturing belt cities indicate that the global business activity node formation in CBDs and subcenters followed different patterns in these two regions. Through their analysis, Gober and Behr (1982, 383) conclude that central cities in the old manufacturing belt differ from their suburbs on the basis of high service employment and low income per capita. On the other hand, in Sunbelt cities, traditional central city-suburban economic relationships are not present; Sunbelt cities have more polycentric employment patterns. Younger populations and higher automobile ownership separate Sunbelt suburbs from central cities. Gober and Behr (1982) also conclude that recentness in development, rapid growth, low density, and decentralized urban structure are characteristics that are more representative of Sunbelt cities.

Table 5.3 shows that Sunbelt cities have more number of APS TNCs clustered in edge cities than in manufacturing belt cities. These edge cities have significant share of knowledge-intensive TNCs clustered, sometimes rivaling downtown in total number of firms. Thus, edge cities of Sunbelt are more diversified than edge cities in manufacturing belt. Yet, IT and logistics firms outnumber other clustered firms in edge cities. In both regions, international airports have become the major attraction points especially for logistics dominated clusters.

Figure 5.2 gives a schematic representation of locational distribution of APS TNC clusters in Sunbelt cities. Our fourth hypothesis stated that knowledge-intensive producer services are clustered in primary or secondary downtowns. This is true in Sunbelt cities, but they are also clustered in edge city density areas. The fifth hypothesis was that distributive services are clustered in edge city areas and/or close to airports, which is a valid statement for IT firms in Sunbelt cities. Logistics is highly decentralized in Sunbelt and it is only in clusters close to airports, mostly together with IT firms.




D=Diversified cluster, IT=Information Technology dominated cluster LOG=Logistics dominated cluster

**Figure 5.2: APS TNC Clustering in Sunbelt Cities**

According to Champion's (2001) typology, one can argue that Sunbelt cities have two processes of polycentric city formation. The first way is "The Incorporation Mode" in which a growing urban center might incorporate smaller centers in the surrounding area. Atlanta's urban envelope was formed in this way having three focal points in its urban envelope. The second way is "The Fusion Mode" in which several independent centers develop linkages and merge. This model is more valid for Dallas, Miami, Los Angeles, and San Francisco in which secondary downtowns capture a significant number of clustered APS TNCs.

#### 5.2.1.1.2 Common Trends among Regions

Our findings suggest that CBD is still the major location for APS TNC firms in all sectors. They still serve as management and administrative hubs of the global economy (O'hUallachain and Leslie 2007). Benefits of CBD location are greater for some sectors like finance than any other industries. As Lee (2007) demonstrates the strong CBD agglomerations of New York and Boston can be associated with their strong industrial base in the finance and business services sectors (Lee 2007, 511). On the other hand, sectors with a mixture of corporate and consumer markets, such as insurance, real estate, and accounting may be more dispersed (Nelson 2005; O'hUallachain and Leslie 2007). Insurance and accounting is moderately decentralized especially in Sunbelt cities and Washington DC. In Houston more than 40 percent of insurance and accounting firms are clustered in edge city density areas. In Miami and Los Angeles more than 30 percent of accounting firms and around 20 percent of insurance firms are clustered in edge city density areas (Appendix C).

In both regions, individual non-CBD clusters are mostly dominated by IT and/or logistics firms. IT is a highly growing industry in the US. In 1992, gross domestic income from IT jobs for the whole US was 371,080 million dollars (U.S. Census Bureau 2000b). In 2000 this increased to 814,727 million dollars. After 2005, IT jobs are predicted to grow three times faster than total employment in the United States, and this productivity wave is expected to exceed that in the 1990s. Lower cost of inputs boosts economic activity, investment and, eventually, job creation in the IT industry (World Investment Report 2004, 207).

Rees (2007) mention that most cities with a large 25 to 44 year old demographic cohort are home to a particularly large number of information technology workers. Of the 21 US cities with the greatest percentage of residents between the ages of 25 to 44 years old, 15 also rank among the top 20 cities for IT employment and half of these cities 20 cities are located in the Sunbelt region. Thus, the major growth in IT industry is expected in the Sunbelt region. Castells (1989) demonstrates that between 1980 and 1985, information related jobs accounted fro 77.8 percent of all new US jobs and 71.6 percent of these new IT jobs were located in the Sunbelt region (Castells 1989).

Although IT is recognized as a paperless industry, face-to-face contact between IT suppliers and customer APS firms is necessary for joint development and co-production of end products (Moulaert and Djellal 1995). Advanced producer service industry and other high-tech production highly depend on IT services. Thus, growth in IT consultancy firms in one area might attract other transnational companies. In that way, IT dominated APS TNC clusters might indicate the future growth locations of major business centers in the studied metropolitan areas.

Hackworth (2005) suggest that it is important to identify whether contemporary urban form is dominated by the periphery or whether the center still has a gravitational pull on the economic activity. In case of APS TNCs, what we observe is that although center still has the gravitational pull, subcenters are increasingly gaining importance either as diverse clusters or specialized subcenters of IT and logistics. Castells (1989) argued that command and control functions will stay in CBDs and suburbs will attract back office spaces or activities that target local consumer markets. However, the polycentric locational distribution of APS TNCs proves that New Metropolis is growing in a more complex way where centers are identified according to their industrial mix rather than command and control vs. routine functions.

### 5.2.2 Locational Distribution and Characteristics of High-Rise Office Building Clusters in the Polycentric US Metropolis: Cross-City and Cross-Regional Analysis

Nelson (2005, 339) suggests that the availability of the office space is one of the most important determinants of the location decisions of the advanced producer service firms, and it has been overlooked in the literature on producer services and intrametropolitan location. Beauregard (1994) and Schwartz (1992) demonstrate that the growth in APS industry after 1970s, has been integral to the downtown construction boom of the 1980s in the US (Schwartz 1992), which was unparalleled in the postwar era. The building boom of 1980s was mostly due to demand created by the accelerated shift of manufacturing activity towards business services and the resulting increase in highly paid professionals (Beauregard 1994, 721). Agglomeration in one place, prestige and image concerns, and dependency on high-tech infrastructure make high-rise office buildings important locational destinations for APS TNC firms (Sklair 2006).

**Table 5.5: NNHS Analysis Results for All Cities**

| Cities | # of high-rise office buildings | # of clustered high-rise office buildings | % of clustering | NNHS distance | NNHS minimum points per cluster |
|---|---|---|---|---|---|
| Atlanta | 162 | 128 | 79.01% | 0.25 | 14 |
| Boston | 136 | 126 | 92.35% | 0.21 | 4 |
| Chicago | 277 | 242 | 87.36% | 0.14 | 4 |
| Dallas | 213 | 151 | 70.89% | 0.20 | 9 |
| Houston | 207 | 169 | 81.64% | 0.21 | 8 |
| Los Angeles | 384 | 230 | 59.60% | 0.08 | 10 |
| Miami | 128 | 97 | 75.08% | 0.25 | 10 |
| New York | 1309 | 1162 | 88.77% | 0.03 | 12 |
| San Francisco | 278 | 247 | 88.85% | 0.25 | 27 |
| Washington DC | 703 | 592 | 84.21% | 0.06 | 16 |

In order to find out the locational distribution and characteristics of high-rise office building clusters, we asked the following question: "What are the centrality patterns of the high-rise commercial office building clusters in selected US metropolitan areas with respect to their location[17], size[18], and year of construction[19]?" Chapter 2 highlighted the significance of signature high-rise office projects in the economic and cultural development of global cities. Chapter 4 highlighted the characteristics of individual

[17] Location is defined from the classification of Lang et al (Lang, et al. 2007).
[18] Size is defined through the number of buildings and total number of floors.
[19] Year of construction of the cluster is defined as the median year of the construction end date for buildings in the cluster.

building clusters in selected cities. In this section, general locational distribution trends and characteristics of high-rise office building clusters will be discussed through cross-city analysis.

In total, 3797 high-rise office building locations are geocoded in 10 cities. The NNHS distance turned out to be the least in New York, suggesting the close locations of the buildings especially in Manhattan. Atlanta and Miami had the highest minimum walking distance suggesting buildings in these cities are located more far apart. Highest clustering of buildings took place in Boston followed by New York. Los Angeles has significantly lower clustering percentage of APS TNCs with 59.60 percent, suggesting decentralization in high-rise office building locations. The Sunbelt cities, except for San Francisco, have lower clustering rates than the manufacturing belt cities. The first hypothesis was that in all the metropolitan areas buildings would be highly clustered. Except for Los Angeles, all other cities have 70 percent or higher clustering that goes up to 92.35 percent. Thus, we can conclude that there is high clustering in all the cities and buildings in former manufacturing belt are more clustered than those of Sunbelt (Table 5.5).

**Figure 5.3: Manhattan High-Rise Office Buildings**

**Figure 5.4: Downtown Chicago**

**Table 5.6: Number of Building Clusters in Different Density Locations**

| Cities | # of building clusters in downtown | # of clusters in urban envelope | # of building clusters in secondary downtown | # of building clusters in edge cities | # of building clusters in edgeless cities | TOTAL |
|---|---|---|---|---|---|---|
| Atlanta | 1 | 3 | 0 | 1 | 0 | 5 |
| Boston | 2 | 0 | 0 | 0 | 1 | 3 |
| Chicago | 1 | 0 | 0 | 1 | 1 | 3 |
| Dallas | 1 | 0 | 1 | 5 | 0 | 7 |
| Houston | 1 | 0 | 0 | 5 | 1 | 7 |
| Los Angeles | 1 | 0 | 4 | 2 | 1 | 8 |
| Miami | 1 | 0 | 0 | 3 | 0 | 4 |
| New York | 6 | 0 | 3 | 1 | 1 | 11 |
| San Francisco | 1 | 0 | 1 | 0 | 1 | 3 |
| Washington DC | 2 | 4 | 1 | 1 | 0 | 8 |

The second hypothesis was that building clusters will have a centralized location pattern in all the cities, which means that clusters will mostly be located in areas with higher than edgeless city density. The distribution of the number of buildings clusters according to Lang's office geography is given in Table 5.6. In all the metropolitan areas, most of the building clusters are located in areas with densities higher than edgeless city density, which proves that building clusters are located in a centralized pattern. Atlanta, Miami, and Washington DC do not have any building clusters in edgeless density areas. In all cities, NNHS analysis identified multiple building clusters with buildings in walking distance to each other. This shows the polycentric locational pattern of building clusters which proves the third hypothesis (Table 5.6).

**Figure 5.5: Downtown Washington DC**

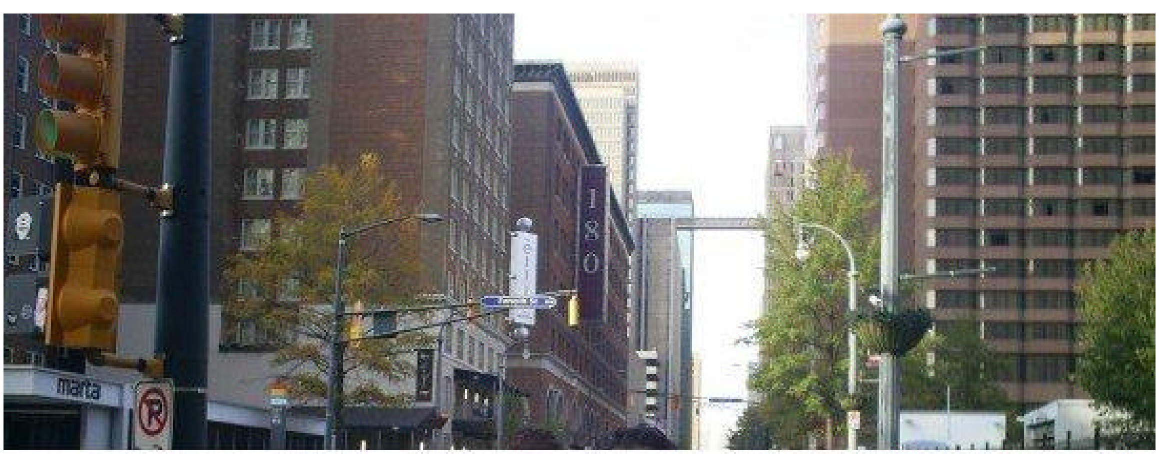



**Figure 5.6: Atlanta High-Rise Office Buildings**

**Table 5.7: Percentages of Buildings Clustered in Different Density Locations**

| Cities | % of buildings clustered in downtown | % of buildings clustered in downtown +UE | % of buildings clustered in secondary downtown | % of buildings clustered in edge cities | % of buildings in clustered in edgeless cities | TOTAL clustering | % of Non-clustered buildings |
|---|---|---|---|---|---|---|---|
| **Atlanta** | 43.83% | 69.75% | 0.00% | 9.26% | 0.00% | 79.01% | 20.99% |
| **Boston** | 88.97% | 88.97% | 0.00% | 0.00% | 3.68% | 92.65% | 7.35% |
| **Chicago** | 82.67% | 82.67% | 0.00% | 2.89% | 1.81% | 87.36% | 12.64% |
| **Dallas** | 30.05% | 30.05% | 9.39% | 31.46% | 0.00% | 70.90% | 29.11% |
| **Houston** | 33.82% | 33.82% | 0.00% | 43.48% | 4.35% | 81.65% | 18.36% |
| **Los Angeles** | 30.21% | 30.21% | 18.23% | 7.81% | 3.65% | 59.90% | 40.10% |
| **Miami** | 39.84% | 39.84% | 11.72% | 24.22% | 0.00% | 75.78% | 24.22% |
| **New York** | 79.37% | 79.37% | 7.18% | 0.99% | 1.22% | 88.77% | 11.23% |
| **San Francisco** | 64.75% | 64.75% | 14.03% | 0.00% | 10.07% | 88.85% | 11.15% |
| **Washington DC** | 43.39% | 72.55% | 9.25% | 2.42% | 0.00% | 84.21% | 15.79% |

The fourth hypothesis states that traditional downtowns still contain majority of the high-rise office buildings. As Table 5.7 shows, in Boston, Chicago, and New York, downtown clusters contain around 80 percent or more of the high-rise office buildings. San Francisco follows these cities with 64.75 percent. Clustered office buildings in downtowns of other Sunbelt cities, Los Angeles, Dallas, Houston, and Miami are between 30 percent and 40 percent, which is much less than the number of buildings clustered in downtowns of former manufacturing belt cities. Atlanta and Washington DC downtowns both have around 44 percent of the high-rise office buildings in clusters, which is still the highest in these cities (Table 5.7). Also, it is only in those two cities that have building clusters in their urban envelopes. Downtowns and urban envelopes together have 70 percent of the clustered firms in Atlanta and Washington DC (Table 5.7).

In Dallas and Houston, edge city clusters have more clustered high-rise buildings than downtowns. In Los Angeles, number of non-clustered buildings exceeds the clustered ones. In terms of distribution of buildings and building clusters, Los Angeles is much decentralized; it has the highest number of non-CBD building clusters (Table 5.6). Dallas, Houston, and Los Angeles are the three cities where downtowns do not contain the majority of the office space. Miami's CBD office space share is also not very much higher than its edgeless city office space.

We can say that downtowns of former manufacturing belt cities still have most of the high-rise office space. On the other hand, high-rise office space in Sunbelt cities is distributed among downtowns, edge cities, and secondary downtowns. Only San Francisco has a significant share of high-rise buildings clustered in edgeless density area. Due to the durability of built environment, spatial development patterns in urban places are path dependent (Giuliano 2005 in Lee 2007). Thus, New York, Boston, and Chicago with large and older CBDs were less subject to decentralization, while Los Angeles and San Francisco developed in a more decentralized and polycentric way (Lee 2007,511).

Among the selected cities New York is the oldest in high-rise construction. Among its 1309 high rise office buildings, around 75 percent of them were built before 1970s. New York is followed by Chicago. Around 47 percent of Chicago's 277 high-rise office buildings were built before 1970s. Up to this day, these two cities are considered as the laboratories of the skyscraper design (Domosh 1996). San Francisco, Boston, and Los Angeles follow New York and Chicago. Although 1970-1980 period was slower than pre

1970s, all cities added new high-rise office buildings. For Miami, Atlanta, and Washington DC, 1970-1980 period has been the slowest one (Appendix D).

**Figure 5.7: Downtown Dallas**

US experienced a building construction boom between 1980 and 1990. Beauregard (1991a, 715) mentions that the value of new construction, in constant dollars, invested each year between 1980 and 1989 was 22 percent higher than it had been in the 1970s, and 56 percent greater than during the 1960s. Half of America's rental inventory went up during 1980s (Hughes, et al. 1992). Beauregard (1991a, 723) demonstrates that 1980s construction boom was more fueled by the investment and other commercial construction than residential and industrial. This construction boom mostly affected Sunbelt cities. In Atlanta, Dallas, Houston, Miami, and Washington DC most of their high-rise building construction took place during this boom. Houston and Dallas had the highest percentage increases in this period. Around 50 percent of high-rise office buildings in Dallas and around 45 percent of office buildings in Houston were constructed during this period. In all other cities, except for Atlanta, 1980-1990 construction boom meant the addition of highest number of buildings after the pre-1970 period (Appendix D).

**Figure 5.8: Downtown Houston**

After the construction boom, in 1990s, high-rise office building construction was the slowest in 7 of 10 metropolitan areas. Boston, Chicago, New York, Dallas, Houston, Los Angeles, and San Francisco had their slowest construction rate between 1990 and 2000. After 2000, the high-rise office construction started to take off again. Almost 39 percent of Atlanta's and 23 percent of Miami's high-rise buildings are constructed or under development until 2010. The fifth hypothesis suggested that high-rise office construction accelerated after 1980s. As it is mentioned in the beginning of this section, 1980s building boom is highly related with the global economic restructurings. Increase in services meant more office space and there was sufficient demand from the high-paid professionals. Real estate trends move in cycles. Our findings show that, after 1990s, the growth in high-rise office buildings could not be sustained in that level, although after

2000, there is another increase downtown high-rise office space largely due to the come-back to central cities by young professionals and high-income groups (Knox and McCarthy 2005).

**Figure 5.9: Downtown Los Angeles**

Before 1970s, 7 out of 10 cities had overwhelming majority of their buildings in downtown clusters. Boston, Chicago, New York, and Atlanta had more than 85 percent of the high-rise office buildings clustered in their downtown areas. Miami and Houston had more than 73 percent of their pre 1970 high-rise buildings clustered in downtown. Washington DC downtown, together with its urban envelope has around 70 percent of the high rise buildings built before 1970. In Los Angeles and Dallas, primary downtown clusters contain 53 percent and 46 percent of all buildings consecutively. In these two cities, secondary downtowns also experienced construction growth in high-rise office buildings. Thus, we can say that before 1970, downtowns were the hot-spot locations for high-rise office construction (Appendix D).

During 1970 and 1980, the differences between manufacturing belt and Sunbelt cities started to become more evident. In this time frame, other than Dallas, Houston, Los Angeles, and Miami; other downtown clusters continue to stay dominant, although their shares declined, suggesting decentralization. In Dallas, Houston, Los Angeles, and Miami the share of downtown clusters declined more than half. The edge cities and secondary downtowns became more dominant than downtowns in terms of number of buildings they have in their clusters. For example out of the 40 new buildings added between 1970 and 1980 in Houston 20 of them were in clusters located in edge cities and 14 of them were located in downtown clusters (Appendix D).

**Figure 5.10: San Francisco High-Rise Office Buildings**


**Figure 5.11: Boston High-Rise Office Buildings**

During the construction boom, the downtown clusters of former manufacturing belt cities received most of the buildings. Washington DC and Atlanta experienced an increase in number of clustered buildings both their downtowns and urban envelopes. In Houston and Dallas, edge city building clusters received much more office buildings than downtowns. For example, in Houston edge city building clusters attracted 55 percent of the total construction between 1980 and 1990, whereas downtown clusters attracted only around 19 percent. In Los Angeles, primary and secondary downtowns received equal number of buildings (Appendix D). Beauregard (1994, 719) explains that Houston's phenomenal growth resulted from the potential profit expectation of investors and easy to obtain financing. Many high-rise office buildings were built, exceeding the real demand, which later resulted in vacancies and bankruptcies.

Between 1990 and 2000, in former manufacturing belt cities, downtown clusters attracted majority of the building construction. On the other hand, in Sunbelt cities, except for Atlanta, we see a general trend of majority of new buildings being built in secondary downtowns (Los Angeles and San Francisco) or in edge city density areas (Dallas, Houston, Miami).

**Figure 5.12: Downtown Miami**

In the contemporary 2000-2010 period, Boston, Chicago, and Washington DC had most of the growth in their downtowns. In Boston and Chicago, except for the buildings constructed in downtown clusters, there were no other building additions in other density areas. New York and Atlanta had equal growth in their traditional downtown areas and secondary downtowns. Dallas, Houston, and Los Angeles experienced the major growth in their edge city clusters. Contemporary growth in Miami and San Francisco also takes place in traditional downtown areas, although secondary downtown clusters, edge city density and edgeless city density clusters also attract considerable amount of new construction. For example, In San Francisco, downtown clusters has around 38 percent of the firms constructed between 2000 and 2010, secondary downtown of Oakland attracted around 18 percent (Appendix D).

The sixth hypothesis assumed that most of the new construction after 1980s takes place outside of downtowns. However, our results have shown that this is not the case for all metropolitan areas, especially in former manufacturing belt cities. Only in Houston, Dallas, and Los Angeles, edge city and secondary downtown building clusters attracted majority of the buildings after 1980s. Traditional manufacturing belt cities always have had dominant downtowns, which attracted most of the new building construction.

**5.2.3 Merging Company Clusters and Building Clusters: Cross-City Analysis**

In this section, we will combine the results from individual company and building clusters to answer the third research question: “Since advanced producer services require dense agglomeration, do company and building clusters follow a similar locational pattern in decentralized metropolitan areas?” Table 5.8 gives the number of company clusters that intersect with at least one high-rise office building cluster.

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**Table 5.8: Number of APS TNC Clusters that Intersect with at least one High-Rise Building Cluster**

| Cities | # of APS TNC clusters in downtown | intersecting with building clusters | # of APS TNC clusters in urban envelope | intersecting with building clusters | # of APS TNC clusters in secondary downtown | intersecting with building clusters | # of APS TNC clusters in edge cities | intersecting with building clusters | # of APS TNC clusters in edgeless cities | intersecting with building clusters | TOTAL # of APS TNC Clusters |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlanta | 1 | 1 | 3 | 3 | 0 | 0 | 1 | 1 | 1 | 0 | 7 |
| Boston | 5 | 4 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 9 |
| Chicago | 1 | 1 | 1 | 0 | 0 | 0 | 4 | 3 | 3 | 0 | 9 |
| Dallas | 1 | 1 | 0 | 0 | 1 | 1 | 4 | 3 | 2 | 0 | 8 |
| Houston | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 4 | 2 | 0 | 7 |
| Los Angeles | 1 | 1 | 0 | 0 | 4 | 2 | 4 | 1 | 2 | 0 | 11 |
| Miami | 1 | 1 | 0 | 0 | 1 | 1 | 3 | 2 | 1 | 0 | 6 |
| New York | 5 | 5 | 0 | 0 | 2 | 2 | 2 | 1 | 2 | 0 | 11 |
| San Francisco | 1 | 1 | 0 | 0 | 4 | 2 | 1 | 0 | 3 | 0 | 9 |
| Washington DC | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 1 | 0 | 0 | 10 |
| Total | 20 | 19 | 8 | 5 | 13 | 9 | 27 | 16 | 19 | 0 | 87 |
| % of intersecting | | 95.00% | | 62.50% | | 69.23% | | 59.26% | | 0.00% | |

Among the 87 company clusters, 48 of them intersect with at least one building cluster, which is around 55 percent. Of 59 high-rise building clusters, 46 of them intersect with at least one company cluster, which is around 78 percent. This difference results from some of the company clusters in selected metro areas such as in Atlanta and New York intersecting with more than one building cluster.

None of the edgeless city company clusters intersects with a building cluster. Thus, APS TNCs clustered in edgeless city density areas in all the cities are mostly locating in low-rise buildings and company and building clusters do not follow the same locational pattern. There are 19 edgeless city density building clusters in total (Table 5.7). 10 of these clusters are IT dominated; 5 of them, in Chicago, Dallas, Houston, Los Angeles, and San Francisco are close to airports and logistics dominated; and the final 4 are dominated by knowledge-intensive producer firms (Chapter 4). Knowledge-intensive service oriented clusters are located away from downtowns, close to an edge city area. Most probably these clusters are in areas that are waiting to become edge cities in the near future. Company cluster 8 close to Morristown/Parsippany in New York and the company cluster 9 between downtown San Francisco and Silicon Valley are examples.

All downtown company clusters, except for IT dominated Cluster 4 in Boston; intersect with at least one high-rise office building cluster. In downtowns, company and building clusters follow the same locational pattern. The diverse mix of companies from different sectors and the unique agglomeration economies offered by downtowns make them attractive locations for APS TNCs, thus downtowns are high-density, high-rise locations. Recent construction boom in US downtowns after 2000 prove that they will be attractive locations for all sectors, but mostly for knowledge-intensive producer services.

Among the 13 company clusters located in secondary downtowns, 9 of them intersect with at least one building cluster. In Dallas, Miami, New York, and Washington DC, there are 5 secondary downtown area clusters. They are all dominated by knowledge-intensive producer service firms and they intersect with at least one building cluster. In San Francisco, two diversified secondary downtown clusters intersect with building clusters and the other two IT dominated company clusters do not intersect with any high-rise office building cluster. In Los Angeles, all secondary downtown density building clusters are diversified, but only two intersect with building clusters. The trend here is that, secondary downtowns mostly have diverse company clusters and building clusters in secondary downtowns follow similar locational patterns with APS TNC clusters that have diverse mix of sectors.

In urban envelopes of the selected metros, there are 8 clusters in total, of which 5 of them intersect with a high-rise office building cluster. Among the 5 clusters, 3 of them are dominated by IT and/or logistics firms. In the urban envelopes of Boston, Chicago, and Washington DC there is one distributive service cluster each (IT and/or logistics) that do not intersect with a building cluster. Thus, in urban envelopes 2 of the diverse clusters are found in high-rise areas and half of the 6 IT/logistics clusters locate near high-rises. In urban envelopes, percentage wise, building clusters follow the locational pattern of diverse clusters more than IT and/or logistics dominated ones, although the results are vague and more-company specific research is necessary to prove this argument.

Edge cities have 27 company clusters in total. Out of these 27 company clusters, 16 of them intersect with at least one building cluster, among which 12 are logistics and/or IT dominated. 4 buildings clusters have a diverse mix. 7 IT and/or logistics dominated clusters and 4 diverse clusters do not intersect with a building cluster. In total there are 19 IT/logistics clusters in edge cities. In edge cities, building clusters follow a similar locational strategy with IT and/or logistics clusters more than they do with diverse clusters. Unlike edgeless density areas and secondary downtown clusters, IT and logistics dominated clusters mostly locate in high-rise locations in edge city density areas. Edge city cluster trends in terms of company and building clusters together do not show a regional variation.

Downtowns of American cities have always been important economic centers. Historically, high-rise buildings and skyscrapers of American downtowns have always been the major elements of what distinguish American cities from other world cities and define their identity. In the current global era, downtowns are still major global business activity nodes. However, as our findings demonstrate, especially in Sunbelt cities this dominance of downtowns is being compromised by the increase in global companies and emerging high-rise office buildings in other subcenters. Sunbelt cities are truly growing as “urban realms”. More and more, downtowns are becoming one of the high-rise clusters. In manufacturing belt, they are still visible as the places where global economy functions and manifests itself through the built environment.

# CHAPTER 6: CONCLUSION AND FURTHER RESEARCH

This chapter will summarize the main arguments in the thesis and explain the policy implications of research findings as well as further research ideas.

## 6.1: CONCLUSION

This research explored the locational distribution of transnational advanced producer service firms (APS TNCs) in the polycentric US metropolis in relation to their spatial and sectoral characteristics. In doing this, the research first examined the impact of globalization on cities and the development of global cities concept. Through the theories of Castells (1996), Sassen (2001), Friedmann (1995), and Taylor (2004) in defining global cities, the research identified the APS TNCs as the key agents of the global economy. Due to their specific characteristics, APS TNCs highly benefit from agglomeration economies; they are located in high-rise, high-density areas. However, the polycentric metropolitan areas are characterized by decentralization, suburbanization, and low-density sprawl. Thus, the research mainly focused on this duality and examined the clustering patterns of APS TNC firms. APS TNC clusters are referred as global business activity nodes.

High-rise high-density locations introduced two other parameters: High-rise office buildings and areas with different density of commercial activity. For different density locations, the research employed Lang et al's (2007) category of downtowns, secondary downtowns, urban envelopes, edge cities, and edgeless cities. For high-rise locations, clusters of high-rise buildings are taken as the basis. The research identified in which density areas the global business activity nodes are located in and whether they are found in close proximity with the high-rise building clusters. In examining the locational distributions of APS TNCs and high-rise buildings, the research employed nearest neighbor hierarchical cluster analysis in CrimeStat, as an analytic tool. According to the discussion of case study results based on cluster analysis of APS TNC locations and high-rise office building locations, the research demonstrated that there are regional differences between Sunbelt and former manufacturing belt cities. The specific research questions and related hypotheses were answered in the discussion section. Here we provide the summary of results.

Both regions demonstrate polycentric pattern of company and building clusters which are centralized. Buildings turned out to be more clustered than APS firms. In former manufacturing belt cities downtowns and urban envelopes are dominant centers for all sectors including distributive services. Companies in downtowns and urban envelopes mostly locate in high-rise office buildings. Downtowns of manufacturing belt are older than Sunbelt downtowns and most of their buildings were constructed before 1970s. 1980-1990 construction boom was the second most important time interval in terms of increase in high-rise office building construction. In all the ten year intervals after 1970, overwhelming majority of the new construction took place in downtowns. After 1990s, in Washington DC and New York, construction increased in non-CBD areas where there are diverse company clusters. However, these areas such as Tysons Corner and Jersey City are not located far from the downtown areas. As discussed in the literature review, Graham (1999) argues that there are limits to decentralization of APS firms especially in sectors like finance, where agglomeration economies and infrastructure are highly important. The close locations of high-rise diverse company clusters to downtowns prove that in former manufacturing belt cities this limit is drawn around downtowns.

In manufacturing belt cities, as the office densities fall, the sectoral component of company clusters change and they become dominated by IT and logistics. In edge cities, more than half of the IT and logistics dominated clusters locate in high-rise areas. Airports attract logistics dominated company clusters, but they do not attract high-rise office building clusters in their close vicinity. For former manufacturing belt cities, we can say that the high-rise building expansion mainly occurs in a more monocentric way, in downtown and urban envelopes.

In Sunbelt cities, downtowns are important agglomeration centers for knowledge intensive producer service sectors, but they are not the only ones. There are many clusters in secondary downtowns and edge cities that are dominated by knowledge-intensive producer sectors. In some cases like San Francisco, even edgeless cities attract specialized law or accounting clusters. The number of firms from finance, advertising and marketing, and management consultancy clustered in edge cities rival those in downtowns. Consumer market-oriented firms in accounting and insurance have higher presence in edge cities or in secondary downtowns. Majority of the IT and logistics firms are clustered in edge and edgeless city density areas. Although edge cities have a diverse mix of sectors, IT and logistics companies outnumber other firms in individual edge city clusters. Airports attract logistics dominated clusters, but not high-rise building clusters. APS TNC geography is much more decentralized in Sunbelt cities than in former manufacturing belt cities.

Construction boom between 1980 and 1990 was the time when the Sunbelt cities experienced the most increase in their high-rise office building construction. In Houston and Dallas, in all the years, edge city clusters had higher number of buildings added than downtown clusters. In Los Angeles, secondary downtown building clusters received much of the building construction. Miami's downtown is going through another construction boom in the current period, but high-rise office building construction in its edge cities and secondary downtown are also ongoing. San Francisco's high-rise buildings were confined to downtown and Oakland area due to government regulations, which has been changed recently. Similar to APS TNC geography, high-rise building geography is also decentralized in Sunbelt cities. In Sunbelt cities, main global business activity node is not downtown; rather it is a combination of many clusters in other density areas. Thus, for all sectors, Sunbelt cities represent a better case of what Castells (1989) calls decentralized centralization. In Sunbelt cities, expansion of high-rise buildings occurs in a more polycentric way.

In both regions, IT and logistics dominate the edge city and edgeless city company clusters. Further research is necessary to further examine how these firms differ from the others in the same sector that locate in downtown areas. Differences between Sunbelt and manufacturing belt cities suggest that in manufacturing belt cities imprint of global culture and economy is mostly evident in downtowns, whereas in Sunbelt cities, other subcenters are becoming more visible as quarters of globalization. Gordon and Richardson (1996, 292) explain that even though after 1980s, there was important revitalization efforts in downtown Los Angeles, people and businesses preferred to stay in other subcenters. Thus, new high rise office buildings had high vacancy rates, night life became nonexistent, and apartment buildings stayed empty. In explaining Atlanta's suburban developments Hartshorn and Muller (1989) mention about the Galleria project, which is a mixed-use, retail-hotel-office complex, constructed in Waverly, inside Atlanta's urban envelope. This project was the first large-scale commercial project that was undertaken by a national firm, Trammel Crow, and it marks an important milestone in the rise of suburban commercial centers. Shortly after the construction, high-rise office projects surrounded the Galleria (Hartshorn and Muller 1989).

The most important aspect of global business activity nodes is that they provide focal points for the reorganization of social, cultural, spatial, and economic aspects of global cities. Global business activity nodes are not only clusters of buildings and companies. They are spaces where global economy and culture provide a unique sense of place (Sklair 2005). As we learned from Sassen (2001), Castells (1996), Taylor (2004), and Hall and Pain (2006a) advanced producer service firms are the key agents of global cities and global business activity nodes. APS firms have specific characteristics, which impact their locational strategies (Bryson, et al. 2004; Daniels 1995; Graham 2001; Strambach 2002) . As elaborated in the literature review, knowledge-intensive nature of the APS firms (Todtling, et al. 2006), importance of access to a skilled labor pool (Keeble and Nachum 2001), and the dependency on advanced infrastructure (Castells 1989; Graham 1999) are the most important characteristics that lead to agglomeration in global cities (Sassen 2001).

As different scholars argued (Beaverstock, et al. 2001; Castells 1996; Reszat 2002; Sassen 2001b), life-style demand of the global elite working for APS TNC firms, or what Richard Florida (2004) calls symbolic analysts, is an important element in the internal spatial organization of global business activity nodes. Mostly, these spaces are found in traditional downtowns, or in subcenters that have appropriate facilities of providing certain socio-cultural environment (Newman and Thornley 2005). Luxury malls, state of the art office buildings with high-tech infrastructure, restaurants, hotels, and conference centers (Graham and Marvin 2001) are all parts of what define a global business activity node.

In fact, this fits with how Porter (2000, 15) defined clusters: geographic concentrations of interconnected companies, service providers, suppliers, and associated institutions that compete and cooperate; providing competitive advantage to metropolitan, national, and regional economies. In this study, in defining the clusters, we took walking distance as our distance criterion. We derived this from Pivo's (1990) definition of a cluster. Working with walking distances in the cluster analysis enabled us to identify the locations where face-to-face interaction is likely to take place and where we are likely to find other cultural facilities related to global flows.

In terms of built environment of global business activity nodes, high-rise office clusters have an important role in the forming their unique global identity. As we learned from Domosh (1996), McNeill (2005), and Sklair (2006) these buildings have symbolic importance that conveys the global-city image and they also attract transnational business activities. Secondly, high-rise office building clusters bring dense population to the area and they impose the formation of different types of economies around them including hotels, residences, shopping and recreation, and different types of retail activities. Thus, they shift the center of gravity to their area of location (Howeler 2003; Russell 2004). High-rise office buildings first emerged in New York and Chicago in the 19$^{th}$ century as a result of the economic significance of these two cities (Domosh 1996). Up to 1970s, in most cities they remained in downtowns. After 1970s, decentralization of economic activity and the development of polycentric metropolitan areas led to the appearance of these buildings in subcenters.

Polycentricity is not a concept that evolved with globalization. As we learned from Anas et al. (1998) starting from the beginning of the 20$^{th}$ century, with the developments in transportation technology, people started to locate in places other than congested downtowns. Businesses also located their manufacturing activities in the peripheries. In the postwar period, due to government regulations and increase in population, suburbanization became a major trend in the US cities. Globalization of economic activity coincided with the technological improvements in information and communications technologies and this started a new pattern of polycentric urban development after 1980s (Hartshorn and Muller 1989).

The difference of this new pattern was its geographic scale. Vastly decentralized regions became a unit of analysis in analyzing urban structure. Due to these technologies, most firms could locate anywhere, but as Castells (1989) argued in his book, Informational City, certain activities like advanced producer services that are highly dependent on face to face contact and agglomeration, stayed concentrated in downtowns or in suburban centers, leading to "decentralized centralization of economic activity" (Castells 1989; Keil and Ronneberger 1994). Concentration mainly increases economic productivity and performance by intensifying creativity (Scott, et al. 2001).

Other than being the focal points of organization of urban structure, global business activity nodes also facilitate the connection between their urban and regional economies and the global economy (Castells 1989; Scott, et al. 2001). Thus, for these two reasons it is important to map the current geography of global business activity nodes and explore their physical characteristics in the polycentric US metropolis, which were the main tasks in this thesis.

Since global networks place considerable spatial and functional demand on global cities, how the administrators of these cities deal with the pressures of globalization in the political and planning realms is a key question. In this regard, the regulation of land use in global cities becomes a fundamental component in the development of polycentric metropolitan areas. Through their analysis of twenty global cities in North America, Europe, and South-East Asia, Newman and Thornley (2005) conclude that land use is specific to particular places and falls within the control of local, regional, and national political organizations. Thus, land use and zoning regulations in different global cities should differ according to the local historical, cultural, traditional characteristics. Newman and Thornley (2005) also demonstrate that convergence is not the defining framework for globalization; rather particularities arising from local history and culture play an important role in shaping the city politics.

Do suburban centers rival downtowns? As the research identified, downtowns still have an important share of APS TNCs in all the metropolitan areas. Ihlanfeldt (1995) demonstrates that downtowns and suburban centers are interdependent because downtowns still define the identity of metropolitan areas in regions. With their current industry mix, office stock and unique sense of place, downtowns still offer a powerful image as nodes of global connectivity. Thus, we conclude that the relationship between downtowns and suburban centers is cooperation rather than competition.

### 6.2 FURTHER RESEARCH AND POLICY IMPLICATIONS

In this research we identified the two-dimensional and three-dimensional geography of global business activity nodes as well as their sectoral components. Connection of these global business activity nodes to aiports and other business centers is crucial. Thus, the research offers a useful analysis for policies related to inter and intra metropolitan transportation. The research also identified the growth trends in high-rise office building construction. These growth trends need to be examined carefully by poliy makers and analysts in developing smart growth policies. In this reserach hot- spot areas for commercial real estate are mapped. This will allow the researchers or business sector to make better judgement for the real estate locations. Finally, the study identified the locations of IT clusters. As we learned from Meyer (2006) IT clusters can be connected to education facilities like universities. Thus, this research may provide important insight to educational instituions that would like to establish links with the IT industry.

This study did not provide details on whether suburban clusters are dependent on downtowns in terms of business relations. Schwartz's (1992) analysis in Los Angeles, New York, and Chicago prove that suburban–based companies are dependent on central-cities. For future reserach, one direction would be to do a survey study with a portion of the firms included in this study and explore their inter-firm linkages in the metropolitan areas as well as their preferences in terms of intrametropolitan locations. Another research direction will be to tie this research with Peter Taylor's (Taylor 2004) global service value index and identify the global service values of each cluster, then tie them into a global network with other clusters in other cities.

The third further research direction would be to apply the same methodology to European and Asian cities and identify the two and three dimensional geography of APS TNCs in these regions to offer comparisons between the three regions of the global triad. Fourthly, we can concnetrate on different global business activity nodes in selected cities and identify their social and cultural aspects. We can also examine which other businesses are located in these clusters and how they are linked with the APS TNCs. Global hotel and restaurant chains, shopping malls, and mixed use complexes might be the focal points in this regard. Final further research direction would be to examine the policy decisions behind the development of high-rise office buildings and identify the responses of local governments to arguments related to decentralization and concentration of economic activity.

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