Chapter 19
Logistics-Intensive Clusters: Global Competitiveness and Regional Growth

Yossi Sheffi

Abstract Logistics intensive clusters are agglomerations of several types of firms and operations: (1) firms providing logistics services, such as 3PLs, transportation, warehousing and forwarders, (2) the logistics operations of industrial firms, such as the distribution operations of retailers, manufacturers (in many cases after-market parts) and distributors and (3) the operations of companies for whom logistics is a large part of their business. Such logistics clusters also include firms that service logistics companies, such as truck maintenance operations, software providers, specialized law firms, international financial services providers, etc. Logistics clusters exhibit many of the same advantages that general industrial clusters (such as Silicon Valley, Hollywood, or Wall Street) do: increase in productivity due to shared resources and availability of suppliers; improved human networks, including knowledge sharing; tacit communications and understanding; high trust level among companies in the cluster; availability of specialized labor pool as well as educational and training facilities; and knowledge creation centers, such as universities, consulting firms, and think tanks. Logistics clusters, however, exhibit other characteristics which make them unique in terms of cluster formation and their contribution to economic growth. Logistics operations may locate in a logistics cluster due to the cluster's role in supporting economies of scope (mainly for direct operations transport modes) and economies of density (mainly for consolidated transportation modes); their provision of spill-over capacity for warehousing and transportation; and the ability to cooperate between providers when dealing with demand fluctuations. Such clusters provide a range of employment opportunities—from moving boxes to executive, IT and other professional jobs, and they diversify the economic base since they support many

Y. Sheffi (✉)
Elisha Gray II Professor of Engineering Systems, Professor, Civil and Environmental Engineering, MIT, Director, MIT Engineering Systems Division, Director, Center for Transportation and Logistics, MIT, 77 Massachusetts Avenue, Cambridge, MA 02139, USA
e-mail: sheffi@mit.edu

J. H. Bookbinder (ed.), *Handbook of Global Logistics*, International Series in Operations Research & Management Science 181, DOI: 10.1007/978-1-4419-6132-7_19,

other industries, such as manufacturing as well as a range of "mini-clusters." This chapter describes such clusters, based on primary research in several large logistics clusters around the world, interviews with dozens of executives in retail, manufacturing and distribution organizations; with transportation and logistics service providers; with infrastructure operators; with public and private development agencies; and with real estate developers.

19.1 Industrial Clusters

It has long been observed that industries tend to be geographically "clustered." Well known examples of clusters include the concentration of information technology firms in Silicon Valley, California and their counterparts along Route 128 outside Boston, Massachusetts; film studios in Hollywood; wineries in Napa and Sonoma valleys in California; finance and investment banking in Wall Street and around Manhattan, New York City; fashion products in Northern Italy; computer products in Taipei, etc.

In addition, certain corporate functions tend to be clustered. Examples include biotechnology research and development centers in Cambridge, Massachusetts; garments and shoes design in Milan; corporate innovation centers in Silicon Valley; corporate planning and marketing in Zurich and Geneva, etc.

This agglomeration of firms, or corporate functions, that draw economic advantages from their geographic proximity to others in the same industry or stage of value addition is a phenomenon that was originally observed and explained by the British economist Alfred Marshall (1920) in his classic work "Principles of Economics". Marshall hypothesized that the development of industrial complexes implies the existence of positive externalities of co-location. He attributed such externalities to three main forces: (1) knowledge sharing and spillover among the co-located firms; (2) development of specialized and efficient supplier base, and (3) development of local labor pools with specialized skills (see also Peneder 1997).

Michael Porter (1998) expanded on this hypothesis in a landmark paper, providing a detailed framework for cluster analysis, as well as many more examples of clusters in various industries. His paper focuses on the competitive advantages and the increased innovation offered by clusters. He suggests that clusters affect competition by (1) increasing the productivity of the co-located companies, (2) increasing the pace of innovation, and (3) stimulating the formation of new businesses.

Most of the economic literature deals with regional and supra-regional industrial clusters, some of which even span several countries, such as the life science companies in Medicon Valley (extending from Eastern Denmark to Western

Sweden[1]) and the US automotive industry spanning several Midwestern states. A similar phenomenon, however, exists also among retailers on a micro-scale of certain streets or city blocks. Thus, when hairdressers in Boston talk about working on "The Street," they do not mean Wall Street, but rather Newberry Street in the Back Bay of Boston, which is home to dozens of women's beauty salons. There are 25 Italian restaurants on Mulberry Street in Lower Manhattan, in the two block stretch between Broome and Hester Streets.[2] Most British newspapers are located on Fleet Street in London; and six out of the seven concrete plants in Singapore are located in the Port of Jurong, even though the Port of Singapore is significantly larger.

Obviously, many of the economic reasons for clustering used in the literature to explain the advantage and role of clusters do not apply to such "sub clusters," agglomerated along a single street or around a few blocks area. Neither the work force, nor the suppliers' base, nor the customers are located in the vicinity of such clusters. So why aren't they spread all over the urban area in locations where inexpensive real estate and parking would be more available? In reality, some are—there are hundreds of Italian restaurants in Manhattan and many are the only ones on their block; and there are many beauty salons in Boston located in suburbs and shopping malls with few competitors within walking distance. Yet the phenomenon of sub-clusters is evident.

The two major types of inter-firm relationships which contribute to the success of clusters can be defined as "vertical" and "horizontal."

Vertical relationships are links between trading partners. The ultimate examples of vertical clusters are those created by a single "channel master," such as "Toyota City" or the cluster of aviation suppliers servicing Boeing in Everett, Washington. As an example of the wider economic effect of such a channel master, consider Shain's (2009) description of the impact of the BMW plant in Greer, South Carolina. It employs 5,000 workers, yet it supports over 23,000 jobs in the state, as many suppliers decided to co-locate around Greer.

Horizontal relationships are between firms at the same stage of production, such as automobile manufacturing plants in Detroit, Michigan, or film studios in Hollywood, California. Such firms both compete with each other and cooperate along dimensions that benefit them. Horizontal relationships also exit between functions in firms of the same or different industries. Thus, HR, legal, procurement, finance, and supply chain management functions may collaborate across companies and industries.

Clusters grow due to "positive feedback" or "reciprocal reinforcement" forces. As more companies of a certain type (or certain corporate functions) move in, more suppliers and customers move in, making the cluster even more attractive.

---

[1] See the chapter on "Logistics in the Oresund Region of Scandinavia" by Gammelgaard and Kinra in this volume.

[2] Naturally, consumer behavior drives, in part, such retail clusters as they minimize search costs while allowing a variety of options.

Furthermore, as the cluster grows, its influence with government grows, affecting more infrastructure investments as well as advantageous regulations, attracting—again—even more companies.

Naturally, most clusters include both vertical and horizontal types of relationships. Thus, Detroit and its vicinity is composed of not only many automotive plants but also a legion of suppliers and sub-suppliers' plants, as well as educational institutions and a large employee pool. Similarly, Hollywood includes major studios but also a myriad of technical and artistic suppliers, as well as the professional human resources necessary to bring films to life.

19.2 Why Clusters?

In many ways, the existence of such clusters today is surprising. While there are many well-documented examples of clusters in ancient times,[3] it is not intuitive to associate clusters with economic success in today's global economy. In many ways, Tom Friedman's (2005) best seller "The World Is Flat" popularized the ideas that today's efficient processes, supported by advanced communications technologies mean, as earlier authors argue, "The End of Geography" (O'Brien 1992) and "The Death of Distance" (Cairncross 1997).Yet—despite such trends—over half the world's population now live in urban areas, as reported by the UN Population Fund (2007) and that portion is increasing. Commensurate with this trend, Sassen (2001) showed that the economic leadership of mega cities, which are obvious clusters of economic activity, has become more pronounced.[4]

Similarly, data show that industries do tend to cluster; raising the question of why this phenomenon takes place given today's advanced abilities. The answer to this question is that industrial clusters embody certain advantages:

- *Trust*. Clusters include, by and large, people with similar backgrounds, language, culture, religion and customs. It is thus easier to develop trust, among organizations and people, leading to lower transactions costs between firms whether they are trading partners or horizontal collaborators/competitors. In most cases this trust is based on relationships forged outside the work environment. Thus, Hollywood, Wall Street and Silicon Valley are famous for their deal making ability, based on deal participants' reputation and familiarity, giving them a competitive advantage over outsiders.

[3] Examples include the Incense Route along the Horn of Africa, carpet-weaving in North–West Persia, glass-blowing in Phoenicia, the obsidian industry of Teotihuacán, Mexico—the pre-Aztec culture that introduced the world to chocolate—all of which were keys to economic growth.

[4] Naturally, urbanization economics which include also the benefits of concentration of diverse economic activities is somewhat different from the cluster economics which is focused on similar and related industries in the same region. Yet the issues are closely connected.

- *Tacit knowledge exchange*. As systems and services become more complex, much of the knowledge associated with their development and operations cannot be codified in an email attachment sent to a supplier. Such tacit knowledge exchange supports discussions over specifications with a supplier; exchanging benchmarking information with a competitor; or supporting a customer—all made easier, faster, less expensive and more effective when conducted within a cluster—using face-to-face and chance meetings. A related phenomenon is knowledge spillover, which as Rodrı'guez-Posea and Crescenzi (2008) argue "the process of knowledge accumulation gives rise to spillovers that could benefit a whole set of potential (intended or unintended) beneficiaries." Much of this knowledge exchange takes place informally, between programmers, traders, technicians, and growers—depending on the type of cluster involved.
- *Collaboration*. The concentration of firms in the same industry, with their similar needs and concerns, gives natural rise to joint activities. These include lobbying for the provision of infrastructure, regulatory relief, incentives, and other government largesse; development of and participation in organizations dedicated to the cluster development, such as chambers of commerce; developing cluster-focused procurement strategies, leading to lower costs and higher quality for all members; engaging in cluster-specific marketing and branding activities; etc.
- *Research and education*. The strength of engineering and computer science in Stanford University and bio-technology and engineering at MIT mean that companies located in Silicon Valley and "Bio-Cambridge" have access to state of the art research and have a steady supply of educated employees, while faculty and students can work in their laboratories on real problems using actual data. Such symbiotic relationships between university and industry clusters are not limited to the information technology or bio-technology industry. Thus, Sonoma Valley supports the Wine Business Institute in Sonoma State University, while the nearby University of California, Davis offers, arguably, the leading program in the US for viticulture and enology.
- *Supply base*. As mentioned by Marshall almost 100 years ago, clusters attract suppliers who see advantages in locating next to their customers. Even in today's environment, the opportunity for unstructured and chance interaction with customers, the opportunities to learn where their business is heading and the opportunities to forge strong, trusting and collaborative relationships with customers is very important when firms make location decisions.

Given all these advantages, one can ask why firms in a cluster don't end up acquiring each other to form larger enterprises if closeness is so advantageous. Of course, to some extent this takes place in an active merger and acquisition environment. Yet, in many ways a cluster may be an optimal balance between the complexity and bureaucracy that hamper innovation in large enterprises, and the lack of scale that holds back smaller firms. In Porter's (1998) words "A cluster

allows each member to benefit *as if* it had greater scale or *as if* it had joined with others formally—without requiring it to sacrifice its flexibility".[5]

19.3 Logistics Clusters

The focus of this chapter is on a particular type of cluster—a cluster of firms with logistics-intensive operations. This includes mainly three types of companies: (1) logistics services providers, such as transportation carriers, warehousemen, forwarders, third party logistics companies (3PLs),[6] customs brokers, and specialized consulting and IT providers, (2) companies with logistics-intensive operations, and (3) the logistics operations of industrial firms, such as the distribution operations of retailers, and after-market parts suppliers.

19.3.1 Examples of Logistics Clusters

There are, literally, thousands of logistics clusters around the world. They are known as "Logistics Villages" in Germany, "Distribution Parks" in Japan, "Logistics Platforms" in Spain and various other names around the world. This section describes some of the largest and most visible logistics clusters, including Memphis, Tennessee; Zaragoza, Spain; Rotterdam in Holland; the Singapore Port area; the Panama Canal Zone; and Alliance in Fort Worth, Texas.

Note that one can define and analyze logistics clusters in several scales. For example, one can view the entire area in the triangle Rotterdam (Holland)-Antwerp (Belgium)-Duisberg (Germany) as a single logistics cluster, covering the two large port complexes and the German rail hub.[7] Or, one can look at the "Dutch Logistics Corridor" stretching from Rotterdam to the German border. This corridor includes, naturally, the port of Rotterdam with its terminals and concentration of logistics service providers; Brabant with its focus on sustainable logistics; Breda, along the main highways connecting the hinterlands of Amsterdam, Rotterdam and Antwerp; and Fresh Park Venlo on the German border, which includes over 70 companies providing trading, transport, warehousing and value

[5] In some cases, leader firms in the cluster discourage mergers in order to foster competition among suppliers. For example, the major chemical plants in Rotterdam encourage competition among industrial gas suppliers (de Langen, 2011, "private communication").

[6] In this chapter the term 3rd Party Logistics ("3PL") is used interchangeably with Logistics Service Provider("LSP") and Integrated Logistics Provider ("ILP") to mean a company offering an array of logistics services, such as transportation, warehousing, custom brokerage, forwarding, return management, part distribution, etc.

[7] Unfortunately, however, trade and economic data can usually be obtained only by province, municipality, state, or country.

added services dealing with fresh products (de Langen 2010). Each of these provinces is, at the same time, a local logistics cluster, comprising several *logistics parks*. Such parks can be classified into two types: (1) managed logistics parks—which are developed and managed by real estate developers, local governments or public authorities, providing a range of value added services—in fact, port authorities are logistics parks according to this definition, and (2) unmanaged agglomeration of logistics facilities. In many cases such facilities operate in the vicinity of managed parks due to the availability of logistics infrastructure.

19.3.1.1 Singapore

The modern history of Singapore dates to 1819 when Sir Thomas Raffles established a British port on the island with the express intent of developing free trade (Josey 1980) and loosen existing Dutch trading monopolies at the time. In 1965 Singapore was separated from Malaysia and lost its hinterland. In order to compete, Singapore redoubled its focus on trade and developed a re-export-oriented manufacturing economy, requiring efficient port operations, continuing Singapore's role as *entrepôt* for Southeast Asia (about 85 % of the containers that come to Port of Singapore never enter the country and over half of the remaining material leaves Singapore as re-export). It is a hub for global corporations, or their subsidiaries, importing raw materials and transforming them into world exports (Choy 2009).

To fulfill this need, first and foremost Singapore developed into a world-class transshipment port, later establishing itself as a world-leading container port. This was naturally followed by the move of logistics-intensive industries into Singapore, transforming it to a regional as well as a global warehousing and distribution center. In parallel, Singapore developed oil port facilities to cater to the needs of oil companies in South East Asia. It is important to note that Singapore development in general, and its logistics and trade in particular, rest upon a virtually corruption-free environment, an educated and motivated workforce, and well-established legal and financial business frameworks. Singapore was rated #2 in the World Bank's (2009) International Logistics Performance Index and #1 in the World Economic Forum's The Global Enabling Trade Index (Lawrence Drzeniek and Moavenzadeh 2009).

At the same time, the Singaporean Port Authority (PSA) kept investing in automation, leading to continuous optimization of port services, reducing time and cost to its tenants. Hand in hand with this policy, the PSA and the government made sure that port services were competitively priced and regulations were simplified and streamlined.

As a result of these policies and investments, Singapore was the world's busiest container port in terms of total shipping containers according to the American Association of Port Authorities (2009), until it was overtaken by the port of Shanghai in 2010. Singapore is still the world's busiest transshipment port, handling one fifth of the world's container transshipment throughput (PSA 2010), as well as handling half of the world's annual supply of crude oil. It is serviced by

200 shipping lines, sailing to and from 600 ports worldwide. The port boasts the fastest customs clearing process in the world.

While the Port of Singapore is a logistics park, including many terminal operators in its midst, there is another, smaller port in Singapore -Jurong. Furthermore, the Air Logistics Park of Singapore (ALPS), on the premises of Changi Airport, houses many logistics operators. Thus, the entire nation-island of Singapore can be considered a logistics cluster as many operators and various logistics services providers, including forwarders, customs agents, and information technology providers, are located in the city itself.

19.3.1.2 Rotterdam, the Netherlands

A coalition of Dutch businesses coined the slogan "Holland is Logistics" to increase awareness to the importance of this sector to the Dutch economy. Like Singapore, re-exports constitute a large fraction of total Dutch export—in this case close to 50 %. It is worthwhile to point out, that Holland has been a trading hub for centuries. Notably, the Dutch East India Company (VOC) was the first multinational in the world, operating hundreds of vessels throughout Asia and between Asia and Europe in the 16th century and beyond. In fact, in 1770, Holland's re-export share was 70 % of all exports. Today, free trade policies (aided by the creation of the European Union), an educated and multilingual work force, and a sophisticated financial transactions capability support the Dutch trading tradition, creating several strong logistics clusters throughout Holland. Holland is ranked 4th in the World Bank's International Logistics Performance Index (2009).

Rotterdam is the busiest container port in Europe.[8] In addition to several large terminal operators, the port encompasses three logistics parks ("distriparks"): Eemhaven, Maasvlkte, and Botlek. While the logistics service providers in Botlek specialize in chemicals, Eemhaven and Maasvlkte[9] are located next to large container terminals (among others, the ECT Home terminal at Eemhaven and the ECT Delta terminal at Maasvlakte). The land of Eemhaven is owned by the Albrandswaard municipality, while the land owner of Maasvlkte is the Port of Rotterdam, which manages all three distriparks. These distriparks are connected to the European hinterland by highways, rail, inland waterways and short sea shipping,[10] allowing for efficient distribution of shipments from Rotterdam to Europe. A dedicated freight rail line is used to move containers directly from the Rotterdam port to Duisburg, which is a rail hub in Germany close to the Dutch border.

[8] Followed by Antwerp and Hamburg (based on 2008 figures). For comparison, however, note that in 2008 the Port of Singapore handled more TEUs than these three ports combined.

[9] The Port of Rotterdam is reclaiming more land for the development of the next phase of Maasvlkte, which will more than double its capacity.

[10] Inland waterways include river transport, while short sea shipping refers to sea-borne freight movement in the same continent.

19.3.1.3 Zaragoza, Spain

The city of Zaragoza is the capital of Aragón. It is the fifth largest city in Spain, located strategically almost equidistant from Spain's four largest cities: Madrid, Barcelona, Valencia and Bilbao, as well as the industrial concentration in Toulouse, France. The logistics cluster in Zaragoza presents a very special case since it was newly conceived and constructed from the ground up, despite not being close to a port, a large city or a main airport. It operates, however, as an inland port,[11] connecting the Mediterranean ports of Barcelona, Tarragona and Valencia, to the Atlantic ports of Bilbao, Gijon, and Aviles y Sines (in Portugal). It is connected to the European rail freight network through a direct rail link to Barcelona.

The logistics park in Zaragoza, PLAZA (Platforma Logistica de Zaragoza) was conceived by the Government of Aragón in the early 2000s in response to the need to diversify the region's economic base away from its reliance on the big Opel plant in the area. The park was built on a green field site, literally from scratch, with investments in high speed roads, rail intermodal facilities, an expanded airport, and supporting services, connecting Zaragoza efficiently to the entire Iberian Peninsula and the rest of Europe.

PLAZA is the largest (and newest) logistics park in Europe (Cambra-Fierro and Ruiz-Benitez 2009); it encompasses more than 12 million square meters (130 million square feet) focused on transportation, distribution and logistics-intensive operations. It provides companies in PLAZA and the surrounding areas with state-of-the-art logistics and, particularly, intermodal services. While it is clear that the Government of Aragón took a significant gamble in developing PLAZA at such a size, deliberately eschewing plans for gradual development, the gamble paid off handsomely.[12] Today, leading companies, including the likes of Inditex, Imaginarium, Porcelanosa, Decathlon, TDN, DHL Express, Acciona Infraestructuras, Memory Set, Caladero and many others moved into the park and established distribution operations there (http://www.plazalogistica.com/index.aspx). As PLAZA grew, new services catering to trucking, as well as shopping and hotels were developed in the park.

The Aragón logistics cluster, however, is more extensive than just PLAZA, large as it is. The Aragón Government has developed other, specialized logistics parks in the vicinity of PLAZA. These include PLATEA in Truel, with a railroad access to the Valencia port; PLHUS in Huesca with connections to the Bilbao and Barcelona ports; and PL FRAGA in Fraga. Private developers also built

[11] An inland port is a location away from a seaport, typically connected to the port by a rail line, where many port operations (customs, bonded warehousing, intermodal operations and distribution infrastructure) can occur. Such inland ports are sited on inexpensive real estate and away from urban areas to avoid the negative externalities of noise, congestion and pollution associated with large scale freight transportation activities.

[12] The huge scale of investment in PLAZA was likely used, in part, to deter the development of competing logistics parks elsewhere in Spain.

specialized logistics parks, including Mercazaragoza, with a focus on agribusiness logistics; PTR Zaragoza, focusing on recycling; CTZ, specializing in automotive logistics; and TMZ, the Zaragoza Maritime Terminal (which is an inland port).

19.3.1.4 Memphis, Tennessee

Folklore suggests that when Fred Smith, the legendary founder of FedEx, proposed a reliable overnight delivery service in a computer information age in a paper at Yale's management School, he got a 'C' grade. The professor wrote: "The concept is interesting and well-formed but in order to get better than 'C' the idea must be feasible…" The paper became the idea for FedEx (for years, the sample package displayed in the company's print advertisements featured a return address at Yale University).

Memphis is the largest cargo airport in the world, handling 3.7 million metric tons of cargo in 2009,[13] largely due to the FedEx operations there (Credeur 2010). FedEx handled an average of over 3.5 million packages every day in 2008, while delivering almost as many in its ground operations segment. The air service offered by FedEx attracted a score of companies who compete based on time-sensitive logistics to Memphis. For example, Mallory Alexander International handles the logistics for 1-800-FLOWERS. It receives flowers from growers in the US, Europe and Latin America into its temperature-controlled warehouse in Memphis. It processes customer orders until 8:00 pm and then picks, packs, and ships more than 100,000 orders a year. These orders can be delivered the next morning anywhere in the US. Flextronics, the US contract manufacturing company headquartered in Singapore, repairs 5,000 laptops every night shipping them to customers for next day delivery; Thomson Technicolor ships 1.2 million DVDs per day from its Memphis location (representing half of all the DVDs purchased in the US), and Advanced Toxicology runs 5,000 lab tests a night for next day delivery of results throughout the US.

The airport-related economic growth generated what Kasarda (2009) has termed an "Aerotropolis." The term refers to a concentration of aviation-intensive businesses around a major airport, creating a new urban form including "shopping malls, office buildings, hotels, hospitals, an international business center, conference and exhibition spaces, warehouses and even a residential community" (Mihm 2006, p. 32). Examples of Aerotropolis developments include Schiphol in Holland, Hong Kong's Chek Lap Kok, Beijing Capital Airport City, Dubai World Central, London's Heathrow, and Suvarnabhumi in Bangkok. Memphis airport supports over 220,000 jobs (over a third of the total area employment).

Memphis, however, is much more than an Aerotropolis built around FedEx services, as a staff report in the trade magazine Inbound Logistics (2008) demonstrates. It is an important trucking hub where interstate highways I-40 and

[13] Hong Kong, the #2 cargo airport, handled 3.35 million tons in 2009.

I-55 intersect and, in the future, I-69 (the "NAFTA Highway") will go through. All major US truck lines operate significant terminals in the Memphis area and it is home to 400 trucking companies, making it possible to ship goods from Memphis by truck to 152 US markets overnight and reach most of the US population with second day service. Memphis is also an important Rail hub: The Canadian National Railway connects Memphis with the Gulf Coast, Chicago, and all of Canada. The Burlington Northern Santa Fe and the Union Pacific connect Memphis with most large cities west of the Mississippi, including the major Pacific ports; and CSX and the Norfolk Southern connect Memphis to most of the Midwest and East Coast cities and ports, as the interactive graphics page put up by the Intermodal Freight Transportation Institute of the University of Memphis (IFTI 2010) demonstrates. Finally, Memphis is the 4th largest inland port in the US and the 2nd largest port on the Mississippi River, handling over 19 million tons annually (Schmitt 2009). These other transportation and logistics options were an important factor in attracting heavy industry to Memphis, such as the Nucor steel plant, which opened in 2008.

19.3.1.5 Panama

The concept of a canal through the Central American Isthmus dates back to the early 16th century. The United States completed the construction in 1914, cutting the sailing distance between New York and San Francisco from 14,000 miles, to go around Cape Horn, to 5,900 miles through the Panama Canal.

On December 31st, 1999 the canal was transferred to Panamanian authority and is now managed by the Autoridad del Canal de Panamá (ACP). In the years since the transfer the ACP has managed the canal independently and professionally. Transit times were cut, fees were set based on market segmentation, more services and accompanying fees were offered. This led to the canal traffic volume more than doubling between 2000 and 2008, reaching 300 million tons per year, while revenue reached over $2 Billion a year.

The largest ships that can fit in the canal are called "Panamax." Panamax container ships can carry up to 4,500 TEU.[14] Many ocean carriers today operate bigger "Post Panamax" vessels that can carry well over 5,000 TEU—in fact, the largest ship operating in 2010, the *Emma Maersk*, can carry 15,200 TEU. In 2007 the ACP embarked on an expansion of the canal aimed at doubling its capacity and allowing it to handle Post Panamax vessels. The project is set to finish in 2014, to mark the 100th anniversary of the opening of the original canal.

In conjunction with the expansion of the canal, the Panamanian Government is investing in the development of several logistics parks, transforming Panama to a significant logistics cluster. In addition to investment in port operations on both sides of the canal (Panama City on the Pacific side and the Port of Colon on the

[14] Container ships capacity is measured in TEU-s—Twenty foot-Equivalent Unit (containers come in 20 and 40 ft length).

Atlantic side), the government is investing in the development of Panama Pacifico Industrial and Logistics Park on the Pacific side of the canal.

19.3.1.6 Alliance*Texas

Alliance*Texas is a development by Hillwood, which is a Perot company. The company built and opened the first dedicated cargo airport in the US in 1989 as part of a 17,000 acre development. In 2010, the development featured the Alliance Global Logistics Hub offering inland transportation option via BNSF's Alliance Intermodal facility, two Class I rail lines and connecting Interstate highways. Naturally, the logistics park is in the middle of the Dallas-Fort Worth metro area, with its 6.6 million inhabitants, as well as many millions more within a 250 miles radius—including communities from Oklahoma City to Houston and San Antonio.

The development attracted over 220 companies, creating sub-clusters of such industries as Automotive (Hyundai, Audi, GM, Ford, Bridgestone, Firestone, Tucker Rocky, Enkei, and others); Electronics (e.g. LG Electronics, Texas Instruments, AT&T, Motorola), Health care (e.g. such as Amerisource Bergen, Cardinal Health, Galderma, HCA, Patterson Dental Supplies, US Oncology, Teleflex), and a consumer goods sub-cluster (with Behr, Coca Cola, General Mills, Kraft, Lego, Michaels, Nestle). Some of these companies are running their own logistics operations at Alliance but many others are supported by the services of 3PLs operating in the park, including AmeriCold, BNSF Logistics, Ceva, DSC Logistics, Exel Logistics, KFS, PT, Ryder, Trans-Trade, and UPS.

19.3.2 Classification

One can classify the myriad logistics parks around the world in various ways but these classifications rarely produce mutually exclusive types. Some possible classification schemes can be based on the following factors:

- Modal orientation:
  - Air logistics parks, such as Memphis Airport; Alliance Airport in Fort Worth, Texas; Hong Kong International Airport; Schiphol Airport in The Netherlands; Frankfurt Main Airport; and Changi Airport in Singapore.
  - Port logistics parks, such as Rotterdam in The Netherlands; Elizabeth, New Jersey; Los Angeles-Long Beach area; Singapore Port; Dubai Maritime City; etc.
  - Rail logistics parks, such as BNSF Logistics ParkLogistics Park-Chicago; and the Union Pacific in Dallas. These are built around large intermodal facilities.
  - Trucking is the ultimate distribution mode used by parks dominated by other modes of transport. "Pure" trucking logistics hubs usually serve urban areas or supplement industrial clusters dominated by various industries. Free-standing trucking parks typically serve a short radius of about 100 miles.

The modal orientation generally implies a level of service orientation which is attractive to certain companies. Thus, air logistics parks will tend to attract companies dealing with time-sensitive, high value items; port logistics parks attract enterprises dealing with the large volumes moved by maritime transport and rail, while parks anchored in rail transportation will attract companies dealing with bulk and commodities.

Note that many logistics parks serve as mode-transfer nodes in the global supply chain. Thus ports serve to move freight between ships and rail and/or trucks; airports move freight to/from airplanes from/to trucks; rail intermodal facilities exchange containerized freight between trains and trucks, etc.

- Scope-based classification:
  - International—such as most port and airport-based logistics parks. Other parks, however, also handle significant international freight as globalization means that freight moving in any country may be originated or destined overseas. Specifically, inland ports serve as distribution hubs for containerized international shipments.
  - Regional—handling regional distribution needs, such as the role of the Zaragoza Logistics Park Logistics Park, PLAZA in the Iberian Peninsula and Southwest France, or Greater Richmond Logistics cluster in Virginia, serving the East Coast distribution needs of its tenants.
  - Urban distribution parks are typically set up outside large urban areas to manage the pickup and delivery of goods in and out of the urban area. Such logistics clusters exist and are adjacent to almost all majors cities, such as New York, or, on a much smaller scale, Lyon Logistics, a wholesale and agri-food distribution center.
- Functional classification:
  - Customs and taxation-advantaged places, including:

Foreign Trade Zones (also known as Free Trade Zones)—are areas with special customs procedures. Items that are imported and then re-exported through such locations are not subject to duty.

Bonded logistics parks—include a set of warehouses where imported goods can be stored without duties paid until they are released into the country. Many logistics parks may have a bonded warehousing area within the park—typically near ports and airports.

Export Processing Zones—these are specific areas or sometimes even "virtual zones" that provide a set of export subsidies offered by the government to exporting industries.[15]

[15] The World Trade Organization takes a dim view of such export subsidies, and is working with members countries to phase then out.

– Single commodity logistics parks—specialize in particular commodities, such as food, electronics, chemicals, etc. Such logistics parks support the relevant industry cluster.
– Special services logistics parks—such as those specializing in temperature-controlled storage and distribution; bulk commodity distribution (such as grains, chemicals, and liquids); or hazardous material handling.

19.3.3 Logistics Clusters Around the World

Yu et al. (2005) developed a classification of logistics parks in China, which includes some of the largest such clusters in the world, as shown in Table 19.1.[16]

None of these parks could be described as a "pure" modal or functional park. Thus, port and air parks usually have other transportation modal connections, and multimodal parks simply have no dominant mode. Industrial parks are home to manufacturing industries that rely on a logistics infrastructure for the supply of raw materials and parts, and for the distribution of the finished product. To this table one can add Chinese single commodity/single industry logistics parks, such as the following:

- Agriculture logistics parks—such as Lilijang LP; Nanning Jinqiao LP; Shouguang Agricultural Products LP; and others
- Chemical logistics parks—such as Sinopec LP in Shantou; the Yangtze River International *Chemical* Industrial Park; Nanjing Chemical Industrial Park Logistic Center; etc.
- Pharmaceuticals logistics parks—such as Jingyitang Mediine LP; *Rencheng* Pharmaceutical Logistics Park; etc.

Many other single commodity/single industry logistics parks support clusters in China for automotive, bulk commodities, oil, and other industries. (See also the chapter by Chen and Lee on "Logistics in China," in this book.)

Boile et al. (2009) review 55 "freight villages," 18 intermodal industrial parks and five industrial parks in Europe, North America and Asia. The list of the logistics clusters they review is given in Table 19.2.[17]

[16] The table includes a few updates added by the present author as several large logistics parks were opened since the original article was published. In addition, several new logistics parks are under construction. For example, the multi-modal Jinxia Logistics Park in the north of Changsha City which will sport integration of highway, rail, water and air traffic. It will be China's largest logistics park. Construction started at the end of 2009.

[17] The table is based on organizations that participated in this EU research project and is focused on managed logistics parks. It misses, however, many of the large European clusters, such as Duisberg and Hamburg.

Table 19.1 Classification of Chinese Logistics Parks (based on Yu et al. 2005)

Type	Conditions	Main function	Cases
Port logistics park (PLP)	Port	International and domestic distribution	Shenzhen Yantian, Guangzhou Huangpu, Nansha, Shanghai Waigaoqiao LP, Dalian Dahushan Island International LP, Qingdao Qianwan, Wuxi Jiangyin Changjiang, Ningbo Beilun, Zhenjiang, Lianyungang, Suzhou, Nantong PLP
Air logistics park (ALP)	Airport	Air express logistics	Beijing Tianzu, Shanghai Pudong, Tianjin ALP, Guangzhou Baiyun, Shenzhen Baoan, Nanjing ALP, Hong Kong ALP
Multimodal logistics park (LP)	Road hub, Railway hub, Intermodal facilities	Multimodal transport, Distribution	Beijing Liangxiang LP, Majuqiao LP, Ningbo Mingzhou LP, Tianjin Nanjiang Bulk LP, Wuhan Road Hub LP, Zhengzhou Baizhuang LP
Industrial logistics park	Economic development district, industrial district	Manufacturing logistics service	Tianjin Economic developing industrial LP, Wuhan Donghu Guanshan LP, Yizheng petrochemical LP, Suzhou Zhongxin industrial LP
Bonded logistics	Bonded zone	Bonded logistics	Tianjin Bonded International Logistics Operation Zone, Qingdao Bonded LP, Guangzhou Airport Bonded Logistics Center, Dalian Bonded LP, Qianhai Bay Bonded Port
City distribution	Existing warehouses near cities	Urban distribution	Shenzhen Sungag-Qingshuihe LP, Wuhan Duoluokou Distribution LP, Dalian Laogangqu city LP

(continued)

Table 19.1 (continued)

Type	Conditions	Main function	Cases
Integrated logistics park (ILP)	Central location vis-a-vis transport network, market etc	Regional or urban logistics service	Shanghai North-west ILP, Beijing Logistics Port, Nanjing Wangjiawan ILP, Xuzhou Huaihai ILP, Wuxi North-west ILP, Shenzhen Pinghu Logistics Base, Changzhou Xinqu ILP, Suzhou Weiting ILP

19.3.4 Lobbying

Logistics clusters enjoy many, if not all, of the characteristics and advantages of other industrial clusters. Like other clusters, they support joint activities by the cluster's residents. Thus, the Memphis Chamber of Commerce is encouraging more companies to locate their logistics-intensive activities in the Memphis area; the business friendly government of Panama, which came to power in 2009, listed logistics development as one of its four development pillars; the PLAZA organization has been lobbying the Government of Aragón and the central government of Spain for more infrastructure investment; the Port of Rotterdam works together with and on behalf of the terminal operators and the companies in its various logistics parks, lobbying the government of Holland to invest in infrastructure—mainly in the hinterland to alleviate port congestion—and to promote Holland as the logistics and distribution capital of Europe; and Hillwood continues to lobby the Dallas, Fort Worth and other area governments, as well as the Texas Government, to invest in infrastructure. In fact, Hillwood worked closely to remove many hurdles for the construction of Highway 170, connecting the park to the East–West Highway 114 and North–South Interstate 35 W. In addition, all these representative bodies continue to lobby their respective national governments to simplify and ease the bureaucracy and paperwork associated with international trade.

To this end, it is instructive to note the burden of such bureaucracy: Hausman et al. (2005) write that while a typical export transaction requires only a single signature in Germany and only two in Australia, Austria, and Canada, a similar transaction requires 42 approval signatures in the Democratic Republic of Congo, 40 in Azerbaijan, 39 in Nigeria, and 33 in Mali. It is no wonder that Germany leads the world in the World Bank's Logistics Performance Index. In addition to the quality of its infrastructure and services, one of the important dimensions along which countries are scored, is the efficiency of the clearance process by border control agencies.

Table 19.2 Boile et al. list of reviewed logistics clusters

Europe	
Denmark	Denmarks Transport Center, Hoeje-Taastrup Transport Center, Nordic Transport Center, Skandinavisk Transport Center, Taulov Transport Center
France	Rungis-Sogaris
Germany	GVZ-Dresden, GVZ-Bremen NW, GVZ Weil am Rhein, GVZ Nuremberg, GVZ Frankfurt/Oder (ettc), GVZ Osnabruck, GVZ Herne-Emscher, GVZ Kiel, GVZ Kassel, GVZ Hamburg, GVZ Bremen SW, GVZ Rostock, GVZ Koblenz
Greece	Promachon S.A
Hungary	Budapest Intermodal Logistics Center
Italy	Interporto di Bologna, Interporto Marche, Interporto di Novara, Interporto Quadrante Europa, Interporto di Padova, Interporto di Parma, Interporto Rivalta Scrivia, Interporto di Rovigo, Interporto di Torino, Interporto di Venezia, Interporto di Verona
Portugal	Terminal Multimodal Do Vale Do Tejo S.A
Spain	Bilkakobo-Aparcabisa, Centro de Transportes Aduana de Burgos, Centro de Transportes de Coslada, Centro de Transportes de Irun, Centro de Transportes de Madrid, Centro de Transporte de Vitoria, ZAL Port de Barcelona, Zona Franca de Barcelona, ZAL Gran Europa, Centro De Transportes de Benavente, Cimalsa, Ciudad del Transporte de Pamplona, Ciudad del Transporte de Zaragoza, Platforma Logistica de Zaragoza
Ukraine	Liski-Ukrainian State Centre of Transport Service
United Kingdom	DIRFT Logistics Park, Key point: Swindon's premier logistics park, Kingmoor Park, Port of Tyne, Wakefield Europort, Birch Coppice business park
Asia	
Singapore	Keppel Distripark, Pasir Panjiang Distripark, Anexandra Distripark
China	ATL Logistic Center Hong Kong, Beijing Airport Logistics Park, Shenzhen Pinghu Logistics, Husihai Integrated Logistics Park Shanghai North-West ILP, Nanjing Wangjiawan ILP, Tradeport Hong Kong
Korea	Gwangyang Port Distripark, Busan New Port Distripark, Gamcheon Distripark
Taiwan	Far Glory FTZ, Taisugar Logistics Park
Malaysia	Northport Distripark-Port Klang
North America	
US	CenterPoint development in Joliet IL, Alliance TX, Pureland Industrial Complex NJ, Raritan Center NJ, Heller Industrial Park NJ, Hunts Point NY, Winter Haven FL, Mesquite Intermodal Facility/Skyline Business Park TX, Guild's Lake Industrial Sanctuary, Oregon, Dallas Intermodal Terminal/Dallas Logistics Hub TX, Rickenbacker Intermodal Facility OH, California Integrated Logistics Center Shafter CA, Salt Lake City Intermodal Facility UT, Cumberland Valley Business Park PA
Canada	Atlantic Gateway-Halifax Logistics Park

19.3.5 Education and Research

One of the important characteristics and success factors for any cluster is the availability of knowledge creating and education facilities. Some of the leading logistics clusters have invested in specialized university facilities in support of their logistics mission, upgrading their capabilities through partnership with international centers of excellence. Examples include the following:

- *Singapore*. Over the last decade, Singapore's government invested heavily in education and research, both developing its own institutions and through partnering with leading universities. Thus, Nanyang Technical University (NTU) and The National University of Singapore (NUS) partnered with leading universities in multiple scientific and engineering fields, as well as in management education. The various logistics-related higher learning partnerships in Singapore include The Logistics Institute Asia–Pacific, involving Nanyang Technical University and Georgia Institute of Technology, and the MIT-Singapore transportation initiative which is part of the Singapore-MIT Alliance for Research and Technology (SMART). In addition, the *Institut des Sciences Economiques* awards logistics degrees on its Singapore campus, as do several local universities including the School of Business Logistics in Chennai and the Singapore Institute of Purchasing and Material Management.
- *Zaragoza*, *Spain*. Zaragoza has partnered with the MIT Center for Transportation and Logistics to develop the Zaragoza Logistics Center (ZLC). The ZLC offers international masters and PhD degrees as well as a master's degree in Spanish, aimed at upgrading capabilities of the local work force. The ZLC is situated at the middle of PLAZA, ensuring that students and faculty interact effectively with the 300 + companies in the park.
- *Memphis*. The University of Memphis Fogelman College of Business and Economics offers a degree in Logistics and Supply Chain Management. The university works with local businesses to customize courses and programs to business needs.
- *Holland*. Holland has several strong university programs in logistics and supply chain management. However, in line with the country's emphasis on logistics, it established in 2010 The Dutch Institute for Advanced Logistics (Dinalog). Dinalog's mission is to coordinate the Dutch Research and Development Program for Logistics and Supply Chain Management. Dinalog is envisioned as the (physical and virtual) place where the private sector will cooperate with Universities on tackling logistics challenges and developing technology and processes to enhance the country's efficiency. Dinalog is a cornerstone in the Dutch ambition to propel Holland, by 2020, to a leadership position in controlling flows of goods passing through Europe.
- *Alliance*, *Texas*. Hillwood and the companies in the park interact with and support in many ways several of the institutions offering logistics education in the area. These include Texas Christian University (TCU) offering undergraduate major and MBA concentration in logistics; and University of North Texas

(UNT) offering an MBA with logistics concentration as well as internship with Alliance companies. Alliance itself offers logistics "Associate" and "Technician" training, in addition to on-site training for forklift certification, manufacturing processes, OSHA, quality management, and more.

19.4 Operational Advantages of Logistics Clusters

While many of the advantages of industrial clusters can be found in logistics clusters, such clusters have several unique characteristics which reinforce the cluster's formation and its advantages. These can be classified into two categories: operational advantages related to transportation and advantages related to sharing of assets among companies. Both types of advantages add significantly to the reciprocal reinforcing feedback mechanism which makes the cluster more attractive as it grows, leading to further growth.

19.4.1 Transportation Advantages of Logistics Clusters

The transportation advantages of logistics parks include economics of scope, scale, density and frequency of transportation services in and out of a logistics cluster.

19.4.1.1 Economies of Scope in Transportation

The cost of transportation can be divided along many dimensions. One of the most important is the direct transportation cost vs. the cost of repositioning vehicles. To understand the issue, note that freight flows are not symmetric—for example, there are many more truckloads of freight going from the US industrial Midwest to Florida than loads available to carry from Florida Northbound. Thus, once a truck has delivered its freight in Florida, it will most likely move back (at least part way) empty to a place where it can be loaded again. Naturally, trucking companies collect revenues only for loaded moves and consequently movements into areas where little freight originates will be expensive, since the carrier has to take into account its next empty repositioning move.

Many (though not all) logistics clusters act as transshipment points where the inbound and outbound flows are balanced.[18] Consequently, carriers—be they truck

[18] In other cases trade flows dominate and the flows are not balanced. For example, while freight flows in and out of Singapore Port are fairly balanced, Shanghai is dominated by outbound flows. Note, however, that Shanghai-bound containers have to be repositioned and thus the container flow is balanced.

lines, railroads, airlines, or ocean carriers will charge lower rates for carrying freight in and out of a logistics cluster—since they are not likely to move empty out of there once delivering a load, and not likely to move empty into a logistics park in order to carry a load out of there.

As more companies locate in the park, carriers are more likely to find follow-on loads, leading to lower transportation costs, making the cluster even more attractive to logistics operators.

19.4.1.2 Economies of Scale

The cost of moving a transportation conveyance is almost independent of its load. Equipment amortization and operator wages do not change at all, while fuel consumption and equipment wear and tear are affected only marginally. Consequently, it is advantageous to move the conveyance always loaded at capacity or close to it. When moving in and out of a logistics cluster, where many firms manage bidirectional flows, the likelihood of filling in conveyances is higher than otherwise, leading, again, to lower transportation costs.

In addition, as the volume of freight in and out of the cluster grows, transportation carriers can start using larger and larger conveyances. Since the cost of operating a transportation conveyance does not grow linearly with the size of the vehicle, it costs less to operate a larger vehicle, on a per unit capacity basis, than a smaller vehicle. This is evident by ocean carriers' move to larger and larger ships (resulting in the need to expand the Panama Canal); the use of double stacking and very long trains by railroads; the use of 53′ trailers and double and triple combinations by motor carriers; and the use of large cargo planes by freight airlines. As the size of the logistics cluster grows, this phenomenon generates another positive feedback, since when carriers can use larger conveyances they can reduce their rates, making the cluster more attractive to more companies, increasing the size of the cluster and making it even more attractive to carriers and shippers.

A further advantage of locations where there is a large concentration of freight is that more direct conveyance movements can be operated. For example, LTL movements out of a cluster can utilize more direct movements, bypassing terminals with fully loaded trailers and reducing handling costs (as well as improving service and reducing handling errors and damage to shipments). This phenomenon grows with increasing freight volumes, creating, again, a positive feedback loop.

19.4.1.3 Economies of Density

While in many cases, companies will send a full conveyance directly from origin to destination, this is not always so and thus transportation companies may consolidate a group of less-than-conveyance-loads into a single conveyance load. In some cases, such a load may move directly to a destination but, more often, into

a consolidating terminal. In such a terminal the full loads will be built and sent to a destination terminal, where the load will be "broken" and the individual shipments delivered to the specific consignees. Such deliveries will follow a delivery/pickup route in which a truck will conduct a multiple-stop tour at specific shipper locations.

When these pickup/delivery tours are conducted within a logistics cluster, they become more efficient as the cluster grows, since the distances between pickup (or delivery) locations are short. This increases the efficiency of the "last mile" which is usually the most expensive one, allowing motor carriers to charge less for serving the logistics cluster, attracting more companies to the park, increasing further the efficiency of the transportation service.

19.4.1.4 Economies of Frequency

One of the most important factors in providing service by transportation companies is the frequency of departures and arrivals. Such frequency will naturally increase with increased volumes going in and out of the cluster. This is especially important when filling ocean containers since many manufacturing companies will park a container next to their facility and fill it up with shipments destined to a specific place; naturally, sending it to a cluster, the container can be filled with shipments to multiple locations within the cluster. Also, outbound from a cluster, resident companies can cooperate in sending full containers, or a third party logistics company or a carrier can park a container in a cluster, getting it filled up quickly and sending it, thereby increasing frequency without incurring the cost of sending partially-filled containers just to keep the frequency up.

For ocean containers, such frequency increase can mean weeks' worth of reduction in transit time, enhancing the attractiveness of the cluster as the number of firms in it grows.

19.4.2 Operational Advantages of Resource Sharing

In addition to the transportation advantages, logistics clusters offer their members other advantages rooted in their ability to share assets, serve customers better and allow for better adjustment to business volume.

19.4.2.1 Shared Assets

When the daily UPS flights out of Singapore to its Asian hub are full, UPS does not ask its customers to wait 24 h until the next departure. Instead, it can utilize the DHL, FedEx or Kuehne & Nagel airlift capacity to move the package. Having all

companies located within the Airport Logistics Park of Singapore (ALPS), makes it easy to arrange for such shipments.

Similarly, warehouse capacity can be used for short periods when one company is running temporarily out of space and another has space to lease. As additional logistics providers join a logistics cluster, these opportunities rise, making the cluster even more valuable to other logistics-intensive operations.

In many logistics parks, a single 3PL may serve multiple customers and thus it can share management, administration, forklifts, and processes across its local customer base. In some cases, customers of a single 3PL provider share the same physical facility and even the same sorting lines, as is the case, for example, with UPS Supply Chain Solutions logistics campus in Louisville, Kentucky.

19.4.2.2 Serving Customers When Providers Change

Logistics is an ultimate global business and the multinationals that operate logistics networks operate on a global scale and serve, in many cases, multinational customers. Such customers routinely move their business from one logistics provider to another, impacting the way their shipments are collected, routed, delivered, tracked and paid for, throughout the world.

When a company changes logistics providers, the new provider has to get up to speed very quickly on the shipper's processes, get familiar with their facilities, hours of operation, personnel, and various special requirements. When the logistics services providers are located next to each other, it is easier for them to coordinate the changes and provide the customer with a smooth transition. The uninitiated may be surprised that the "losing" company will support the change. The reason is that it is understood among all concerned that such changes happen all the time, and the "loser" may be the "winner" next time around. Thus, the logistics providers make sure that above all, the customer gets good service. Naturally, it is another reason for shippers to locate within the logistics cluster, where the presence of multiple logistics providers eases transitions from one to another.

19.4.2.3 Expansion Capabilities

As mentioned above, the flows over a logistics network are not predictable in many cases. The reason is that most strategic changes a company makes, such as spinning off a division; acquisition of other companies; entering new markets; launching new products; or offering new services, manifest themselves immediately in the product flows and the need for storage space. When a company locates its warehousing facilities in a logistics cluster, whether it owns its facilities or uses a public warehouse space, there will be other facilities in the area when there is a need for more space, and its own space may be easier to lease to others if its storage needs contract.

Thus, a location within a cluster gives companies flexibility that can be used when the business expands or contracts. Such flexibility obviates the immediate need to move to a new location, which may be costly due to the need to change the network.

19.4.2.4 Shared Workforce

While companies operating distribution centers may not always share resources directly in a horizontal collaboration, they do it through their 3PL or another external body. Thus, for example, Exel operates multiple customer distribution centers in and around the Alliance Logistics Park north of Fort Worth, Texas. As customer needs fluctuate Exel moves its trained warehouse workers from one facility to the next. Similarly, ATC, in the same park, uses local temporary staffing agencies to move workers not only between its own facilities and customers, but, in fact, to share the pool of trained workers with other 3PLs in the area.

19.5 Conditions Unique to Development of Logistics Clusters

Many economists and other observers argue that government has little or no role in cluster formation. This is especially pronounced in analyzing high technology clusters (Wadhwa 2010) and in the large number of analyses of the most examined cluster of all—Silicon Valley (see, for example, Graham 2006). Others, such as Cortright (2006) and Markusen et al. (1991) take a more nuanced view of the Silicon Valley cluster, acknowledging the role of government, through its early defense spending in the region, the role of higher education institutions (Rogers and Larsen 1984), and the role of individual leadership (Krugman 1991), in addition to the culture and entrepreneurial spirit of people in the area.

Most logistics clusters are developed by a development agent. In many cases, this development agent is the (regional or national) government. In many more of the recent clusters, it is a public–private partnership, a quasi government authority (such as a port authority). But within a logistics cluster, there are likely to be one or several logistics parks, which were developed privately. Unlike many other clusters (such as Silicon Valley, Hollywood, Bio-Cambridge, or Wall Street), logistics parks are typically actively managed by the real estate developer. Furthermore, whether government plays a direct role or not, government regulations and policies play a crucial part in any logistics cluster's operation and success.

An important element in the development of logistics clusters is the natural environment, comprising mainly (but not only) their central geographical location. Thus, many logistics clusters have been a trade junction throughout history.

19.5.1 Natural Conditions and History

Dependency on the natural environment is not unique to logistics clusters. Clearly, agriculturally-based clusters, such as the wine clusters in Napa and Sonoma Valley in California, the coffee growing clusters in Colombia or the banana growing clusters in Ecuador and Costa Rica also depend on natural conditions. For logistics clusters, geography is particularly relevant since it implies a central node in a transportation network with easy accessibility to major trading locations. Other natural conditions, however, also sometimes come into play.

19.5.1.1 Singapore

Singapore is strategically located in a central point on the most important inter-Asian trade lanes; between Japan, China and Korea to the East, Australia to the South and India, as well as the Middle East and all of Europe (through the Suez Canal) to the West. Thus, the Port of Singapore is a natural transshipment location and it is no wonder that Sir Raffles established a port there. The Singapore Port Authority turned the port into one of the most modern and efficient facilities in the world, creating world class maritime infrastructure. It is augmented by the top notch Changi Airport, serving 80 international airlines with 4,500 flights a week to 60 countries, processing 1.9 million tons of cargo annually.

19.5.1.2 Holland

The Dutch Golden Age, during the 17th century, was based on trade with the rest of Europe. The Dutch controlled the North Sea and the Baltics and continuously challenged the English for the Southern trading routes. At that time Amsterdam became the main clearinghouse of bills of exchange as well as a thriving trade center. The Dutch East India Company, founded in 1602 to carry out colonial activities in Asia, was the first multinational corporation and the first to issue stock. This trading culture carries through today with the importance of logistics in Holland, anchored at the Port of Rotterdam.

Rotterdam lies on the Northeast side of the English Channel, which is a major shipping lane. Its main geographical advantage, however, is its location on the estuary of the rivers Rhine and Maas, leading to efficient and inland vessel connections deep into Germany and the heart of Europe. In addition, Holland is a flat country, where transportation operations over land are not faced with natural obstacles and thus distribution networks can be laid out optimally. Building on these advantages, the Port of Rotterdam is now connected to the rest of Europe via five transportation modes: road, rail, pipeline, coastal shipping and inland shipping, The Betuwe Route is the new, 160 km long, freight-dedicated rail line that links Rotterdam directly with Germany. Since trucking is still the major

distribution mode, the corridor between Rotterdam and Venlo became, in effect, a logistics-intensive cluster.

19.5.1.3 Zaragoza

Zaragoza was named after Caesar Augustus, who established it in 14 BC as a military outpost and a logistics center. Its importance continued to grow, becoming a central node in the expansion of trade and with it Roman culture. The Muslims conquered Zaragoza in 714, using it also as a logistical base for their excursions into Northwestern Spain and Southern France.

Today Zaragoza is the fifth largest city in Spain with some 700,000 people in the metropolitan area. It lies almost equi-distant to the four largest cities in Spain: Madrid, Barcelona, Valencia and Bilbao. Although far from the sea, at the crossroads between multiple cities, Zaragoza is a natural distribution hub for the Iberian Peninsula and Southwest France, including the industrial region of Toulouse.

The Government of Aragón has capitalized on this location, in addition to leveraging the existence of an old US Air Force base built to support bomb-laden B-52 bombers during the cold war. As such the runway could easily handle the heaviest cargo plane, such as the Boeing 747 freighter and the Antonov An-225. As the park was being built, the Spanish Government completed the high speed rail line connecting Zaragoza to Madrid and Barcelona, thereby increasing the capacity of the existing railway to carry freight. A state-of-the-art intermodal facility, combined with modern freeway connections, completes the physical connectivity. In addition, PLAZA provided a fiber-optic backbone, redundant energy supply and other attractive factors for companies locating in the park. Interestingly, Zaragoza's central in-land location changed one perceived disadvantage of PLAZA—the lack of a seaport—into an advantage, by developing a dry port between the Mediterranean Spanish ports of Barcelona, Tarragona, and Valencia, and the Atlantic ports in Santander, Bilbao and Pasajes. The Government of Aragón astutely noted that while at most major seaports, land was scarce, Zaragoza had no shortage of square meters, thereby building in a cost advantage without which it would have been difficult to compete. As an aside, note that such 'inland ports' logistics clusters have been developed around the world, including Virginia Inland Port, which was the first one in the US.

19.5.1.4 Memphis

From its beginning Memphis' location and the river-based transportation system made it an important trading location, based, for the most part, on cotton trading. In fact, the cotton trade tied Memphis to Northern industry, so much so that many in Memphis did not want to secede from the Union at the beginning of the Civil War.[19]

[19] Unfortunately, Memphis also has a sordid past as a hub of the slave trade.

But Memphis became an important node in the modern global supply chains when FedEx moved in. Some of the most important reasons FedEx decided to start operations in the Memphis Airport were the city's central location, central time zone,[20] and the good aviation weather Memphis enjoys throughout the year, allowing FedEx to keep its on-time delivery promise. Memphis is far enough South to be out of the Snow Belt compared to Chicago, Pittsburgh, and other Northern airports, and it is further east from "tornado alley," the region of frequent summer thunderstorms and tornados of Texas, Oklahoma, Kansas, and Nebraska.

Once FedEx moved in and grew, Memphis became a natural location for industries which relied on FedEx for deliveries throughout the US and the world. The excellent railroad, highway and river connections added to Memphis' attractiveness for rail, truck and barge shippers, making a natural distribution hub.

19.5.1.5 Panama

As a Spanish colony from 1501 on, Panama was a major hub of trading and commerce between the North and South, as well as serving as a major trading route between the Atlantic and Pacific islands. In 1513, Spanish traveler Vasco Nunez de Balboa explored the jungle of Panama and discovered a route across Panama to the Pacific Ocean. This route allowed the movement of gold and other treasures from the South American colonies to Spain. In fact, as early as 1532, the Spanish began thinking about digging an all-water route across the Americas, but concluded that it was too difficult and focused on a land route, which was dubbed Camino Real. Gold from Peru was brought to Panama City by ship, transported across the isthmus by slaves and mules along the Camino Real to Portobelo, a port city in the Atlantic, and then by ship to Spain. This trade route became also an important target of pirates such as Francis Drake (between 1572 and 1595) and a century later, Henry Morgan (between 1668 and 1674). The California Gold Rush, which began in 1848, renewed the interest in crossing the Panama Isthmus, as this was the most efficient road from California to the US East Coast. The demand allowed for the construction of the Panama Railroad, which opened in 1855 and followed pretty much the line of the present canal. It cut the crossing time for passengers from several days to one hour; freight, however, still had to be unloaded at one end and loaded at the other, giving the impetus to the construction of the Panama Canal.

The main trading routes using the Panama Canal today are between the Eastern coast of the US and Asia as well as the West Coast of South and Central America;

[20] While Western population centers are further away from Memphis than Eastern ones, the two hour difference, while going westbound, allows FedEx two extra hours to complete its service commitment in the morning. Thus, for example, a flight departing Memphis to New York at 1:00 AM will land around 4:30 local time after about two and half hours of flight. The same flight departing to Portland, Oregon will land at about 4:30 local time after about five and half hours in the air.

between Europe and the West Coasts of the US, Central America, South America, and Asia; and US inter-coastal.

Today, the Panama Canal is in the midst of a significant expansion, slated for completion in 2014,[21] which would allow most Post Panama vessels to use the canal. To complement the expansion, the Panamanian Government is in the process of investing in expanded port facilities and logistics parks.

19.5.2 Government and Regulations

In general, many industrial clusters include and/or are in close contact with government-related entities associated with the type of cluster under consideration. For a logistics cluster this is achieved through local trade associations, export support offices, chambers of commerce offices, etc.

Much of the infrastructure investment exemplified above is financed and advanced by local and central governments, especially in the initial stages of development, unlike other industrial clusters, where government investment increases as the cluster grows and its ability to influence government investment grows.

One of the most important contributions that government can make is not to meddle in the management of the logistics cluster. This is especially the case when the cluster has developed around one facility. In both Singapore and Panama, the government controls the authority that runs the facility—the Port of Singapore (PSA) and the Panama Canal Authority (ACP)—yet both are managed very much like private corporations. In fact, in each case, it is the respective governments' "hands off" policies, that have contributed to the economic success of the two regions. Both the MPA and the ACP are profitable. Similarly, PLAZA in Aragón was established as an independent authority, empowered to act in the best interest of the logistics park—and has been very successful, as is the case with the Memphis Airport Authority. While the Dutch logistics parks are privately managed, in 2004 the Port of Rotterdam was re-organized as a private corporation with public accountability in order to create a "business-driven structure" (see the Port of Rotterdam Annual report 2005). Naturally, there is little concern when the developer and manager of a logistics park is a private corporation to begin with, such as CenterPoint's management of the Joliet Logistics Park outside Chicago, or Hillwood's management of the Alliance Logistics Park outside Fort Worth.

There are five free trade zones in Singapore—four cater to seaborne freight and are adjacent to the port, and one caters to airborne cargo and is located at Changi Airport. All five are focused on facilitating *entrepôt* trade and certain repacking, sorting and reconditioning of goods. As with other free trade zones, transshipped and re-exported goods are exempt from the goods and services tax (GST),

[21] At the 100th anniversary of the completion of the original canal.

and customs and duties are deferred on importation of goods to the FTZ. Other incentives for facilitating entrepôt trade within the FTZs also apply. In addition, the Government of Singapore also signed many bilateral free trade agreements, notably with the US, EU, Japan, India, Korea and Australia.

The Government of The Netherlands has long recognized the importance of the logistics sector to the Dutch economy. To this end, Holland offers customs bonded warehousing, deferring the value added tax until the goods are distributed throughout the European Union, and avoiding it altogether for goods that are destined outside the EU. Holland also offers other VAT deferment mechanisms, as well as a relatively low corporate income tax. In addition, Dutch Customs is highly automated, allowing Dutch distribution centers to operate 24/7. The Holland International Distribution Council represents and promotes the logistics sector in Holland.

Memphis is home to two free trade zones and multiple sub-zones with bonded warehouses available throughout Memphis. The logistics and distribution functions are promoted through the International Division at the Greater Memphis Chamber of Commerce.

The Government of Panama has some of the most business-friendly regulations. Its 1948 Off Shore Company Law allows corporations to establish themselves in Panama and keep ownership and bank dealings secret. This made Panama the leading country for ship registry as well as an important international banking center.[22] The Colon Free Trade Zone was established in 1948 and allows companies to move materials and goods in and out of the Colon FTZ without paying any taxes,[23] known as Panama's Custom Suspense Regime. Panama also set a structure of Export Processing Zones, which can be located anywhere and enjoy no tax for any exports.[24] Panama also encourages corporations to set up headquarters in Panama, with a special law giving tax advantages to the companies and its executives (Law 41 for headquarters), as well as to companies located in the City of Knowledge and in the Panama Pacifico Logistics Park, built on the abandoned American Howard Military Base.

The Alliance-Texas development offers all foreign trade zone advantages, including the elimination of export duty, reduced customs paperwork, no duty on value added in the FTZ, high security status, and the ability to pay on either components or finished products produced in the FTZ, whichever is lower. Alliance also offers complete inventory tax exemption for 175 days, and an on-site

[22] The secrecy was weakened when Panama became a signatory to the 2004 Basel II Accord issued by the Basel committee on Banking Supervision.

[23] The Colon FTZ is not compatible with WTO rules since it allows no tax for any export nor on dealings between companies in Panama, amounting to export subsidies. Panama joined the WTO in 1995 and has been tweaking its laws to get into compliance since. The Colon FTZ has been arguing that it provides services, not manufacturing, and thus needs to wait until the WTO will come up with service rules.

[24] The Export Processing Zones scheme is also incompatible with WTO rules, and Panama is in the process of changing some of its rules to comply with the WTO.

US customs and central examination station to streamline administrative processes even further.

19.5.3 Horizontal Collaboration

The supply chain management literature is awash in articles and reports about "collaboration." The majority of these are concerned with collaboration or "partnerships" between trading partners, also referred to as vertical collaboration. Logistics clusters, however, offer companies located in the cluster the opportunity for operational horizontal collaboration– in this case between, say, the distribution operations of shippers (such as retailers, manufacturers and distributors) who locate their distribution centers in the cluster.

Academics, consultants and think tanks have exalted the virtues of such collaboration since in principle it can lead to clear improvements in costs, customer service, and sustainability. For example, Doherty and Hoyle (2009) argue in a World Economic Forum report that optimized transport networks are one of the keys to reduce carbon-based emissions. To support its recommendation, it points out that 24 % of the truck vehicle miles in the EU are empty, and the average utilization of the "full" vehicles is only 57 %. Naturally, much of this can be due to structural imbalance of freight flows, but the authors argue that a third of this inefficiency can be reduced with optimized transportation movements. Since companies can only ship what their customers demand, horizontal collaboration is almost the only approach that can lead to increased utilization without sacrificing service.

Cruijssen et al. (2007) report that in 1993, eight competing medium-sized Dutch producers of sweets and candy agreed to cooperate on transportation deliveries. A logistics service provider was contracted to consolidate and deliver the shipments from these eight companies to 250 retail distribution centers, resulting in reduced costs and improved customer service levels. This cooperation, called Zoetwaren Distributie Nederland (ZDN: Dutch Sweets Distribution) still exists today.

Kees Verwij (2009) reports on several horizontal collaboration activities across the Benelux countries. One of his examples is a joint manufacturing consolidation center between Kimberly-Clark and Unilever for combined deliveries to retail centers, leading to increased service levels and reduced costs.

(Haex, 2010, private communication), of Buck Consultants in The Nederland's, reports on dozens of vertical and horizontal collaborations, including a joint warehousing and distribution operation for Pirelli and Continental Tires, operated by Ewals (a 3PL). van der Meer (2003) reports on the collaboration between four LTL carriers specializing in building materials (Brothers Transport, Vink Internatioal transport, Kluitmans Transport and Twello Verheul), resulting in over 10 % reduction in vehicle-km traveled and 30 % improvement in load factors.

In the late 1990s and early 2000, several cities in Germany launched projects to reduce urban truck traffic. For example, the ISOLDE project in Nuremberg aimed at consolidating urban deliveries of parcel and LTL in "freight villages" ("Gueterverkehrszentrum GVZ") located outside the core urban area. Similar projects were launched around the same time in Heidelberg and Freiburg, as well as Berlin, Duisburg and Frankfurt. Several of these projects included disposal of recyclable material using the trucks going back to the depots.

Unfortunately, these success stories, in Holland, Germany and elsewhere, are few and far between, and many of them have been abandoned.[25] The high tech boom of the 1990s saw many attempts to use the Internet to achieve horizontal collaboration, focusing on collaborative procurement consortia, such as Covisint in the automotive industry and the World Wide Retail Exchange (WWRE). Thousands of procurement sites and digital exchanges tried to connect buyers with sellers in every industry—most, however, failed or changed the business model. The transportation market was no different. Many entrepreneurs developed digital exchanges in every segment and mode of the transportation market, hoping to more efficiently match shippers and carriers. The idea was that carriers would benefit from reduced empty miles and higher utilization, while shippers would benefit from competition between carriers leading to reduced transportation prices. Most of these attempts failed—usually due to carriers' refusal to participate in these online auctions. Using a somewhat different business model, current examples of such exchanges include Manhattan Associates Inc.' Express Bid® application and Open Bid Inc.'s thrice-a-day trucking auction service.

The emphasis during the first decade of the 21st century on global warming and the reduction of carbon footprint has added an extra impetus to the business imperatives of costs and service, yet most businesses do not collaborate with others on logistics-related operations.

Note that in all the collaborations mentioned above, and many others, there is a third party involved. So while digital exchanges can be seen as collaborative efforts (one shipper's head haul is another's back haul), the exchange operator manages the transactions, sets the rules of engagement, executes the financial settlements, and generates reports and analysis. All the above mentioned Dutch examples include a logistics provider to manage the collaborative operation. The German city logistics examples were mandated by local government and thus had to take place as a condition for doing business. Thus, it seems that collaboration can be either mandated or involve a third party.

The companies in Alliance-Texas Logistics Park can be used as an example of the myriad types of collaboration that take place in many logistics clusters. They include space, equipment and worker sharing, but these collaborations are typically neither initiated nor managed by the shippers themselves, but rather operate through the logistics service providers. The approaches to cooperation are

[25] In a 2010 presentation at the MSOM conference in Haifa, Israel, Ton de Kok claimed that all horizontal collaborations in The Netherland since 1990 failed.

basically ways in which the logistics suppliers utilize their own resources to provide effective service to their customers. Thus, some of them, such as Ryder and UPS Logistics, provide multi-customer distribution centers, where the space allocation is dynamic and the equipment and workforce are basically shared; others, such as Exel, who operates a dedicated facility for each of its customers, moving their work force from facility to facility when the businesses demand it.

Furthermore, the logistics service providers collaborate with each other, even though they are fierce competitors. Again, they do it through their suppliers—the specialized human resource firms that serve them. All the logistics service providers have unpredictable needs for workers. For example, winning a contract may require several hundred trained workers in short order. Staffing companies like Staff mark, Adecco, Spherion, and others serve this logistics market and in many cases collaborate on locating, recruiting and moving workers to satisfy the needs of the 3PLs.

19.6 Impact of Logistics Clusters

In many cases, when governments (either local or national) look to cluster strategies for economic development, they fix their sights on the "sexy" ones—investing resources in developing the "Silicon Pyramid" in Egypt, Japan's "Science City" in Tsukuba, the Iberian Nanotechnology Laboratory in Portugal, or a film industry in Alaska. Yet logistics clusters provide just as many advantages, and in many cases even more benefits. The agglomeration of companies with logistics-intensive operations in a given location, not only provides these companies with certain competitive advantages, but they also contribute significantly to the economic growth in the regions where they are located, despite logistics rarely being associated with "high technology." The regional economic returns from logistics clusters are rooted in the following factors:

19.6.1 Job Creation

Logistics clusters typically create a large number of jobs. The traditional criticism, that logistics jobs involve "moving boxes" at minimum wage, is an outdated view of the industry. In addition to low-level manual jobs (sorting or hand-picking), the industry includes the following:

Part time jobs—while some warehouse and distribution center jobs involve sorting, loading and unloading, these jobs are usually filled by part time workers for whom such jobs are a stepping stone to another career. Thus, at UPS, the third largest employer in the US with about 465,000 employees in 2010, many of the part time jobs are filled by students and, consequently, UPS' benefit package includes not only medical and retirement benefits but also tuition assistance.[26]

[26] About half of UPS employees are working in these part-time jobs.

- Professional jobs—many other jobs in the industry involve the operations of machinery, ranging from trucks to forklifts, as well as airplanes, trains, and ships, and even sophisticated robotics equipment, such as that used in the Zara distribution center in Zaragoza, Spain.
- Information technology jobs—it may be difficult for those not familiar with the industry to realize how sophisticated are the information technology applications used in supply chain management. Naturally, the need to control millions of parts and finished products, moving throughout the globe, in real time, from sub-suppliers, to suppliers, to manufacturers, distributors and retailers; using all modes of transportation plus an array of brokers, custom agents, and port operators; and as well as the associated contracts' provisions and financial settlements requirements; and endless array of multiple government regulations, security requirements, reporting standards and tax regimes; require an immense information technology infrastructure. In addition, however, supply chain operations have to be optimized in order to balance customer service and costs, in a very uncertain and volatile demand environment. Consequently, companies are spending significant amounts of money on specialized supply chain software applications. In fact, at one point, UPS was spending four times as much on information technology annually as it was spending on buying trucks, raising the question whether it is really a trucking company or an information technology company.
- Executive jobs—as in every other industry, there are many managerial and executive jobs associated with logistics operations.

19.6.2 Advanced Operations and More Jobs

Logistics clusters encourage the development of new and advanced logistics offerings. These include the provision of consulting, planning, network design and information technology services. Naturally, those result in not only more jobs tied to logistics operations but also high paying jobs. For example, YCH Global Logistics started as a transportation company in 1955 in Singapore by Yap Chwee Hock. In 1977 it changed from passenger to cargo transportation under the leadership of Robert Yap, Yap Chwee Hock's son, and became a leading cargo transportation carrier for the Port of Singapore. In the early 1980s it added warehouse leasing, warehouse management and freight forwarding services, and later integrated and added services to become a full service 3PL. In 1992 it opened YCH "DistriPark," as part of the logistics cluster on the intersection of the Kayang Paya Lebar expressway and the Pan Island Expressway in Singapore. In the 1990s the company built a network of distribution centers in logistics clusters around Asia and, at the same time, developed a suite of supply chain management software applications focusing on manufacturing logistics, return management and

consumer goods distribution. Today the company offers both logistics execution services and supply chain management consulting/solutions services, with offices in 12 Asian countries. The sophistication of the software drove YCH in the 2000s to set its IT function as a standalone subsidiary, Y3 Technologies, developing and supplying IT application to the logistics industry.

And UPS does not only develop software to optimize its own vast global network. A subsidiary—UPS Supply Chain Solutions—offers shippers consulting, planning, supply chain management and IT services including visibility, tracking and tracing, trade compliance, network design, and more. This subsidiary of UPS has over $6 Billion in sales, employing thousands of high level professionals.

Other directions which logistics service providers have been branching into include light manufacturing and late customization/postponement efforts (see, for example, Sheffi 2005).

Hewlett-Packard reported one of the most-cited success stories of postponement (Lee et al. 1993). It used to distribute six printer models and 23 different country configurations, resulting in 138 versions of the finished printers. To cut down inventory carrying costs and improve service, HP redesigned both the printers and its supply chain. Using a pan-European forecast, it started shipping generic printers to its European distribution center in Holland. As the printers arrive in Holland, an easily accessible side panel in the shipping carton lets HP configure printers for each country once the local demand is known. Logistics clusters are ideal locations for such added-value operations, bringing even more jobs into the local economy.

On a more fundamental level, logistics clusters can be viewed as advanced infrastructure. They serve as the means by which manufacturing industries can move material and finished goods in and out of their plants. For example, both Nucor and Cargill operate large manufacturing plants in Memphis, in large part due to the extensive rail and barge connections available there. Thus, logistics clusters can foster the creation of manufacturing jobs as well.

19.6.3 Diversification

A logistics cluster creates an efficient "infrastructure" for other "sub clusters" of various industries that require strong logistics services. This leads to the seeding of industry clusters and their development, due to the positive feedback mechanisms mentioned above: attracting suppliers, other service providers, being able to lobby as a group, the exchange of tacit knowledge, the ability to consummate "deals" more easily, etc.

For example, Medtronic—a leading US medical devices company, operates a distribution center in Memphis, TN. It chose Memphis because of the ability to ship overnight throughout the US, while tendering shipments very late. Furthermore, Memphis is also a hub for Delta Airlines, which also figures in Medtronic's strategy.

To understand Medtronic's distribution business, consider for example their sale of spinal kits, used by hospitals for spinal procedures. The kit can cost more than $100,000 and hospitals cannot afford to stock them until needed. Furthermore, in any operation, only a small part of the kit is actually used. So when an operation is scheduled for Thursday afternoon say in Boston, Medtronic can put a kit on the FedEx flight on Wednesday night, arriving in Boston Thursday morning and available to the surgeons immediately. After the operation, the unused part of the kit is sent back to Memphis to be cleaned, refurbished, and ready for the next spinal procedure anywhere in the US. Furthermore, when even higher shipping speed is needed, as in the case of an emergency operation following an accident, Medtronic uses a "Next Flight Out" (NFO), involving a Medtronic employee placing the package with the crew of the next flight from Memphis to Boston (there are several flights a day), and a Boston hospital employee will pick up the package at the Delta counter in Boston, rushing it to the operating theatre.

Medtronic is working actively with the Memphis Chamber of Commerce to attract other medical device companies to Memphis. They understand that the presence of a cluster of competitors will attract suppliers and other specialty service providers, creating a positive feedback loop that will benefit all the members of such a medical devices cluster.

Another example is the fashion design cluster in Amsterdam. Having creative talent alone in Amsterdam would not have enabled it to become a fashion design center. Since manufacturing is centered in South East Asia, and mainly China, designers have to be in constant communication with the factories to evaluate apparel color, textures and "feel." To this end, Schiphol airport is the hub of KLM airlines (as well as a few smaller airlines), with nonstop flights to over 260 airports in 91 countries. Furthermore, the logistics cluster around Schiphol includes over 200 logistics services providers. Thus, test fabric swatches can be flown from Hangzhou to Amsterdam, arriving on the same day, ready for a transcontinental design session. This allows factories in Hangzhou to use design shops in Amsterdam, each enjoying cluster advantages of its own industry, while relying on the Schiphol connectivity.

In addition to the fashion cluster, the Schiphol Area Development Company (SADC) is working to seed and develop several other clusters in perishables (based on Holland's logistics prowess in flower distribution); life sciences (again, based on the airport's large number of direct connections), high technology (which also requires fast connectivity), and aerospace, which is a natural cluster for this large airport.

19.6.4 Measuring the Impact

Very few logistics parks or clusters measure their own economic impact. An exception is the Alliance-Texas Logistics Park in Fort Worth, Texas. Alliance has documented with great care the total of all investments—public and private—that

Table 19.3 Investments by regional authorities (figures provided to the author by Alliance-Texas)

Authority	Investment ($)
City of Fort Worth	39,151,482
City of Haslet	597,823
City of Raonoke	3,706,000
Tarrant County	23,172,538
Denton County	2,025,000
Keller ISD	87,366,854
Northwest IAS	14,076,745

went into the park, and the results of these investments (some of the data mentioned in this section can be found on line[27]). For example, the investment by the various regional public authorities was as in Table 19.3.

Figure 19.1 depicts the taxes paid by Alliance companies to the same cities, counties and independent school districts.

By 2008 the average rate of return for the public sector was 11 %. Assuming that the park will continue to grow at the rate it was growing in the last decade, the average rate of return will reach 19 %.

In addition to the direct taxes paid back to these public authorities, Alliance estimated the total economic impact from 1990 to 2008 at $36.4 Billion. This should be compared to a total of $7.1 Billion capital which was in place by 2008, $6.7 of it from private sources and a total of $387 million from public sources (including the State of Texas and the Federal Government, besides the local authorities). A total of 28,000 jobs were created in the park (in addition to the 1,710 construction jobs). The development also led to the creation of 63,388 indirect jobs. In total, 31.2 million sq ft of distribution space was developed by 2008, as well as 7,154 homes, 288 apartments and 200 hotel rooms. The development also planted 36,166 trees.

The impact of the Zaragoza logistics park, PLAZA, was not measured directly but since it was the main investment of Aragón's Government between 2002 and 2008, some performance indicators of Aragón's economy can be used as a (very rough) proxy for the impact of PLAZA. For example, between 2002 and 2008, unemployment in Aragón was only a little over half of the average unemployment in Spain; the index of industrial production rose from 2003 to 2008 by 86.7 % in Aragón, while increasing only by 82.8 % in Spain as a whole; the total ton-miles transported to and from Aragón increased by 58 % from 2002 to 2007; and the number of commercial trucks registered in Argon during this period increased from 7,529 to 19,557.

[27] See, for example, http://www.alliancetexas.com/Research/AllianceTexasFacts/EconomicImpact/tabid/202/Default.aspx. Others are available in various Alliance-Texas publications.

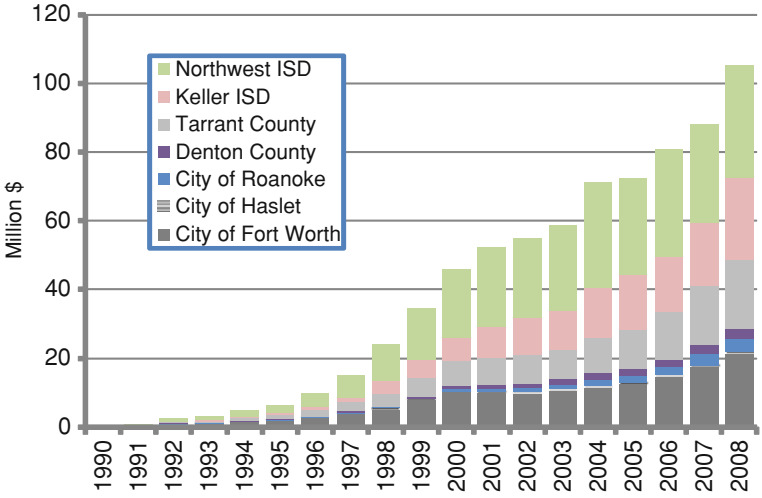

Fig. 19.1 Taxes Paid 1990–2008 (figures provided to the author by Alliance-Texas)

19.7 Conclusions

While the literature dealing with industrial clusters focuses disproportionally on high technology, knowledge-based clusters, this chapter argues and demonstrates that logistics-intensive clusters should occupy an important place in the mind of regional and national governments interested in economic development. These clusters exhibit many of the advantages of all industrial clusters in terms of creating trusting relationships among companies, leading to tacit knowledge exchange among individuals and strong collaborative culture and joint activities to benefit all cluster companies, in addition to attracting suppliers, including knowledge suppliers in terms of research and educational institutions. Such elements help create the positive feedback where more companies in any industrial cluster enhance the benefits and the impact of these elements, attracting even more companies.

Logistics clusters exhibit the same type of advantages (not always to the same extent, though), but they also exhibit other advantages. The main two are (1) the process of positive feedback in the development of a logistics cluster may be stronger than in many other clusters due to the economies of scope, scale, density and frequency involved in the provision of transportation services, and (2) the opportunity to share resources in the face of fluctuating demand for workers, equipment and warehouse space.

As described in this chapter, logistics clusters are typically developed in a geographical hub of transportation; they typically require significant investment in terms of infrastructure; and they require favorable government regulations, such as free trade zones, bonded warehouses and other tax relief.

Most importantly, however, logistics clusters generate a large number of jobs. While many of these jobs are relatively low-paying ones, these jobs serve a large fraction of the population. Logistics services, however, involve global movements of information and cash, in support of the movement of physical goods. Consequently, logistics clusters generate a significant number of higher-paying information technology and banking-related jobs, in addition to managerial and executive jobs (See also Sheffi 2012).

References

American Association of Port Authorities (2009) World port rankings 2008. Retrieved from http://aapa.files.cms-plus.com/Statistics/WORLD%20PORT%20RANKINGS%2020081.pdf

Boile M, Theofanis S, Strauss-Wieder A (2009) Feasibility of freight villages in the NYMTC region: Task 3-Description of how typical freight villages work (2009) Rutgers Center for Advanced Infrastructure and Transportation. (http://www.nymtc.org/project/freight_planning/frtvillage/FrtVillage_files/Task_3_Report_April_2009F2.pdf)

Cairncross R (1997) The death of distance. Harvard Business School Press, Cambridge

Cambra-Fierro J, Ruiz-Benitez R (2009) Advantages of intermodal logistics platforms: insights from a Spanish platform. Supply Chain Manage Int J 14(6):418–421

Choy KM (2009) Trade cycles in the re-export economy: the case of Singapore. WP 2009/05 Economic Growth Center, Division of Economics, Nanyang Technological University, Singapore.

Cortright J (2006) Making sense of clusters: regional competitiveness and economic development. A discussion paper prepared for The Brooking Institution Metropolitan Policy Program

Credeur MJ (2010) FedEx's home airport widens cargo gap over Hong Kong (Update1). *Bloomberg*. Retrieved from http://www.bloomberg.com/apps/news?pid=20601080&sid=aE20.tadEAV4

Cruijssen F, Dullaert W, Fleuren H (2007) Horizontal cooperation in transport and logistics: a literature review. Transp J 22–39

de Langen P (2010) Transport, logistics and the region. Inaugural lecture, Eindhoven University of Technology

de Langen P (2011) Private communication

Doherty S, Hoyle S (2009) Supply chain decarbonization: the role of logistics and transportation in reducing supply chain carbon emission. World Economic Forum

Friedman T (2005) The world is flat: a brief history of the twenty-first century. Farrar, Straus, and Giroux, New York

Graham P (2006) How to be silicon valley. Retrieved from http://www.paulgraham.com/siliconvalley.html

Haex P (2010) Private communication

Hausmann W, Lee H, Subramanian U (2005) Global logistics indicators, supply chain metrics, and bilateral trade patters. World Bank Policy Research Working Paper No. 3773

Inbound Logistics (2008) Memphis: North America's logistics center. Retrieved from http://www.inboundlogistics.com/articles/features/1008_feature04.shtml

IFTY (2010) http://umdrive.memphis.edu/haklim/public/final_the3rd.swf

Josey A (1980) Singapore. Its Past, Present, and Future. Andre Deutsch Ltd

Kasarda J (2009) Airport Cities. Urban Land

Krugman P (1991) Geography and trade. MIT Press, Cambridge

Lawrence R, Drzeniek Hanouz M, Moavenzadeh J (eds) (2009). The global enabling trade report 2009. World Economic Forum, Geneva, Switzerland

Lee H, Corey B, Brent C (1993) Hewlett-Packard gains control of inventory and service through design for localization. Interfaces, July–August 1993, pp 1–11

Markusen A, Hall P, Campbell S, Deitrick S (1991) The Rise of the Gunbelt: The Military Remapping of Industrial America. Oxford University Press, New York
Marshall A (1920) Principles of Economics. Macmillan, London
Mihm S (2006) The 6th annual year in ideas: the Aerotropolis. New York Times Magazine. pp 31–71
O'Brien R (1992) Global financial integration: the end of grography. Royal Institute of International Affairs, London
Peneder M (1997) Creating a coherent design for cluster analysis and related policies, Paper presented at the *OECD Workshop on Cluster Analysis and Cluster Based Policies*, Amsterdam
Port of Rotterdam Annual Report (2005) Retrieved from http://www.portofrotterdam.com/en/Port-authority/finance/Documents/Annual%20report%202005.pdf
Porter M (1998) Clusters and the new economics of competition. Harvard Business Review
PSA (2010) Retrieved from http://www.singaporepsa.com
Rodríguez-Posea A, Crescenzi R (2008) Mountains in a flat world: why proximity still matters for the Location of economic activity. Camb J Reg Econ Soc 1(3):371–388
Rogers EM, Larsen JK (1984) Silicon valley fever: growth of high technology culture. Basic Books, New York
Sassen S (2001) The Global City, 2nd. Princeton University Press, Princeton
Schmitt T (2009) America's Aerotropolis. Special Presentation to the Brookings Institution
Shain A (2009) Boeing jobs: suppliers likely to relocate. The Post and Courier.
Sheffi Y (2005) Maxing the gain: the key is delaying the point of "Differentiation." Chief Executive Magazine
Sheffi Y (2012) Logistics clusters: Delivering value and driving growth, MIT Press
United Nations Population Fund (2007) State of the World's Population. Retrieved from http://www.unfpa.org/swp/2007/english/introduction.html
van der Meer T (2003) Concurrenten gaan Deelladingen Bundelen in project Distribouw (Competitors participate together in cargo project distribouw). LogistiekKrant 16(3):3
Verweij K (2009) TNO. Presentation at the 7th 3PL Summit. Brussels, Belgium
Wadhwa V (2010) Top-down tech clusters often lack key ingredients. Bloomber Business Week. Retrieved from http://www.businessweek.com/technology/content/may2010/tc2010053_047892.htm
World Bank (2009) International logistics performance index. Retrieved from http://info.worldbank.org/etools/tradesurvey/mode1b.asp
Yu W, DingW, LiuK (2005) The planning, building and developing of logistics parks in China: review of theory and practice. Chin USA Bus Rev 4(3):73–78