

INFRASTRUCTURE

Infrastructure Needs for New Jersey's Regional Innovation Clusters

Not only does infrastructure perform necessary services for individuals, firms, and communities, but it also establishes a certain quality of life that attracts the people and firms to communities. Due to these important roles, our roads, sewers, and other public facilities play a powerful role in guiding the State's physical and economic growth.

The New Jersey State Planning Commission takes a comprehensive view of the infrastructure conditions necessary to spur cluster development. "The preferred location for RICs is at or in close proximity to assets such as commuter transit hubs, freight lines, nautical ports, airports, higher education facilities and existing corporate campuses where adequate infrastructure exists. Studies have documented that high-technology businesses, research and development firms, and corporate headquarters rely on "knowledge" or "talent" workers who strongly consider quality of life, and recreational resources in particular, when making employment decisions" (State Planning Commission, 2011).

The following research describes the ways in which the various types of infrastructure impact the development of regional innovation clusters, with an emphasis on New Jersey's unique assets and the industries.



Transportation

Transportation infrastructure has an important relationship with industry clusters due to the inherent transport cost savings derived from clustering. The adequate capacity and proper maintenance of both passenger and freight transportation networks is essential for the movement of people and goods in all industries. By investing in transportation infrastructure, New Jersey and its localities can attract workers and firms to foster industry cluster development.

Traditional theory states that as firms cluster to form agglomeration economies, they benefit from lower transport costs that facilitate an easier exchange of goods, people, and ideas. Interestingly, however, the cost of moving goods has greatly declined over time but industries still exhibit the desire to cluster. This is due in part to the steadily rising cost of moving people. Industry clusters allow for greater labor market pooling in which employees have access to more jobs, and employers have access to more workers. Furthermore, research shows that service industries who must deliver face-to-face services to customers concentrate in more urban areas, while manufacturing tends to concentrate in more rural areas as their goods are cheaper to deliver (Glaeser, 2010).

Thus, the accessibility and efficiency of transportation facilities is important for businesses to transport their workers, customers, and goods. For example, a new road could decrease travel time with a connection to a hub within a transport network, while a well-designed street could drive more foot traffic to businesses. The travel costs of moving goods is also important for the many modern businesses relying on “just-in-time” delivery, in which product inventory is constantly in circulation to avoid warehousing costs. An efficient transportation system is necessary for firms that practice “just-in-time” to distribute products to markets in the most economical manner (Hague, Hague & Breitbach, 2011).

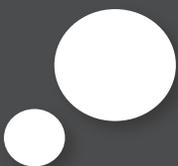
While transportation is a key concern for almost every business, New Jersey’s various industries certainly have different transportation needs. As a densely populated state with a large number of retail and service establishments, New Jersey exhibits a significant demand

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for products that rely on freight transportation. For example, businesses in the advanced manufacturing industry rely on steady shipments of raw materials. Corporate offices may require special pick-up/delivery of time-sensitive materials. New Jersey is also home to a manufacturing industry that produces goods moved by freight on major highways and rail lines. Freight requirements also vary depending on the type of manufacturing activity, as some firms rely on bulk deliveries of raw materials and others bring in smaller, more varied shipments before sending out finished goods. The demand for freight transport, on behalf of both consumers and producers, changes as New Jersey's economy changes over time. Therefore, it is important that we continue to analyze the trends in the freight industry, as put forth in the New Jersey Comprehensive Statewide Freight Plan, when developing economic development strategies (Parsons Brinckerhoff Quade & Douglas, Inc., 2007). The South Jersey Freight Transportation and Economic Development Assessment, prepared in 2010 by Parsons Brinckerhoff for the NJDOT, is an excellent example of efforts to make vital connections between transportation and New Jersey's economy (NJDOT, 2010).

In addition to freight needs of the State's industry clusters, there are also transportation considerations for the movement of workers and customers. For example, many firms in the healthcare, life sciences, finance, and technology industries employing members of the "creative class" rely on public transit for employees to reach the workplace. These types of workers were found to be positively associated with the percentage of people that take public transit, walk, or bike to work (Florida, 2011). Based on these trends, clusters employing creative class workers in New Jersey might benefit from public transport investment.

Transportation networks are also vital to New Jersey's tourism industry, and some suggest that there is still room for improvement. For example, industry leaders at the 2011 Governor's Conference on Tourism suggested that the lack of transportation options from New York City to Atlantic City discourage many from visiting (Fletcher, 2011). The seasonal ACES train, a train that took passengers from New York City to Atlantic City via Philadelphia, was suspended in March 2012 after a three year trial. The initiative was ultimately unprofitable, but the train did boast around 90% ridership in summer months signaling a demand for this type of transportation



(Wittkowski, 2012).

Moreover, research has shown that public transportation can play a significant role in fostering the development of industry clusters. As mentioned above, reduced travel time is an important factor for agglomeration economies. An improvement in public transport can lower transport costs, thereby increasing connectivity between firms and workers and increasing firm productivity. This occurs as a larger labor pool within commuting distance allows for more employees to access jobs, and there is better job matching and less worker turnover. Public transport improvements could also encourage a more economically productive use of land through higher occupancy and denser development. If these positive effects of agglomeration are to occur, development regulations should allow densification around public transport facilities (Chatman).

Finally, the conditions and capacity of our transportation networks have direct economic impacts on businesses. Deteriorated conditions damage vehicles and increase operating costs for trucks, cars, and rail vehicles. Additionally, transportation facilities in poor condition may lead to greater miles traveled and time wasted, as routes are unusable or congested. Such costs reduce the productivity and competitiveness of New Jersey businesses. For example, a truck traveling on deficient pavement could face higher operating costs, lower safe travel speeds, detours due to weight restrictions, and even damaged goods. Moreover, deficiencies in capacity result in congestion and stop-and-go conditions that generate additional travel time, higher operating costs, and unpredictable business operations. In the Mid-Atlantic region, such pavement deficiencies affect 44% of vehicle miles traveled and capacity deficient routes affect 23% of vehicle miles traveled. As a state in the more urbanized Mid-Atlantic region, New Jersey is also more susceptible to the costs of congestion and deficient transit than other areas of the country (Economic Development Research Group, 2011).

Transportation - The New Jersey Context

Every worker and customer must arrive at their destination, whether by personal or public transportation. New Jersey is quite unique in that 10.6% of its population uses public

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transportation to commute to work, according to 2010 American Community Survey 5-year estimates. Moreover, about 12% of households do not have access to a vehicle (U.S. Census Bureau, 2010). Many of New Jersey's industries could benefit from locating near public transportation facilities in order to reach these segments of the population.

Without doubt, New Jersey has an extensive freight transportation network that plays a significant role in our economy. For example, the State Strategic Plan cites that we hold the world's 3rd largest port, in addition to a number of ports along the Delaware River with growth potential. An estimated 620 million tons of freight valued at over \$850 billion pass through such ports each year. Furthermore, our regional air network represents almost 25% of all U.S. International air cargo (State Planning Commission, 2011). The Army Corps of Engineers Waterborne Statistics Center estimates that in 2010 the Port of New York and New Jersey ranked third among the top 50 water ports by tonnage at 139.2 million short tons. The Paulsboro, New Jersey port ranks 40 on this list, with 17.5 million short tons (Mindy, Bailey & William, 2011). According to the Association of American Railroads 2010 data, the top commodity by weight terminating in New Jersey by rail shipment was chemicals, while intermodal shipments were the top rail shipments originating in the state (Mindy, Bailey & William, 2011).

As mentioned above, the success of many of New Jersey's industries is dependant on the condition and capacity of our transportation network. While slightly dated, the 2007 Report Card for New Jersey's Infrastructure highlights major trends in the state's transportation network that are still relevant into 2013. Aviation received a grade "D," considering the size and air traffic control capacities of airports, largely Newark Airport, to handle greater volumes of service and newer, larger airliners. New Jersey's roads received a "D" due to our high levels of pavement deficiency, congestion, and old roadway drainage systems. Bridges also received a "D" based on the condition of bridges. Finally, Ports and Navigable Waterways received a grade "C", with South Jersey lacking in capital investment on their waterways and rail, and North Jersey exhibiting issues with the channel depth, bridge clearance, and intermodal connectors. It is important to note that the recent Port Authority effort to raise the Bayonne Bridge will significantly enhance the capacity of North Jersey's ports which will coincide with the expansion of the Panama Canal



(ASCE New Jersey Section, 2007).

The issues associated with New Jersey's transportation network are reflected in more current data as well. According to the National Air Traffic Controllers Association, Newark Airport exhibited the most delayed arrivals with 33.75% of flights delayed and the second most delayed departures of all major U.S. airports in September 2011 with 23.05% of flights delayed (National Air Traffic Controllers Association, 2011). Recent reports from the Federal Highway Administration Highway Statistics on the 2009 pavement condition of the State's interstates, other principal arterials, rural minor arterials, and the National Highway System use the International Roughness Index. Of these roads, it is estimated that only 45% had acceptable or good ride quality. According to the 2011 National Bridge Inventory, 10.1% of road bridges are structurally deficient, signifying that they are either closed, restricted to light vehicles, or require immediate rehab to remain open. New Jersey's road bridge conditions are worse in terms of lane widths, load carrying capacities, clearances, and approach roadway alignments, with 25.1% being functionally obsolete and no longer meeting the criteria for the system of which the bridge is a part (Mindy, Bailey & William, 2011).

The destruction from Superstorm Sandy confronted state transportation agencies with the challenge of restoring service as quickly as possible to return the region's transportation commuting capacity. Immediately after the storm, the Port Authority of New York and New Jersey worked quickly to restore container terminals to accommodate shipping. PATH train service returned gradually as well with the most effort focused on the Hoboken Terminal. NJTransit's North Jersey Coast Line and the Montclair-Boonton Line were damaged by falling trees, washout, and other debris from the storm. Additionally, NJTransit and Amtrak worked together to remove water from the underground Hudson River train tunnels. Many alternative transportation options were developed for commuters including trans-Hudson ferry access and expanded NJTransit Bus routes. For approximately about a week after the storm a gasoline shortage severely limited vehicular travel as well.

This unique and unprecedented event has caused officials to realize the vulnerabilities

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of the state's transportation infrastructure. Moving forward, efforts will need to be made to make the system more resilient. For example, when the Kearny rail yards flooded a significant portion of NJTransit's rolling stock was damaged. The implausibility of moving the rail yard and maintenance facility will require installation of key resiliency infrastructure to mitigate damage from a future storm. Other resiliency projects will be required to protect transportation infrastructure along the Jersey Shore and in urban areas such as Hoboken and Jersey City.



Water and Sewer Infrastructure

It is important that communities understand the water needs and desires of businesses to effectively promote economic development. Businesses commonly take a community's water and wastewater into account when involved in site selection. Industrial firms evaluate the capacity of wastewater facilities to decide whether or not they treat on-site or use a community facility. Both the availability and quality of water are also considerations in the site selection process. Some firms even look to utilize different "types" of water to increase efficiency, such as using reclaimed water for irrigation and cooling (Bruns, 2008).

There are a number of highly water-intensive and water-dependant industries that use both publicly and self-supplied water. Automobile manufacturing, biotechnology/ pharmaceuticals, and electronics are considered to be the most dependant on a clean, reliable water supply in the U.S. economy. On the other hand, certain industries are more water-intensive. These include agriculture, mining, and power generation (which mostly self-supply) and manufacturing sectors such as paint & coating manufacturing, alkalies & chlorine manufacturing, paperboard mills, and food processing (which mostly use public water infrastructure) (Economic Development Research Group, 2011). Therefore, water and wastewater is a particularly important infrastructure consideration for New Jersey's life sciences, manufacturing, and tourism industries.

As the majority of water infrastructure resides out of sight underground, conditions often go unnoticed. The consequences of ignoring old and degraded pipes should not be overlooked, however, as they can cause disruptions in service, slowed emergency response, damages to other types of infrastructure, and unsanitary conditions. Businesses and households with undependable water delivery and inadequate water treatment face costs associated with higher water rates, moving, purchasing/operating equipment, and medical issues (Economic Development Research Group, 2011).

While water and sewer infrastructure is widely recognized as a fundamental component of economic development, the development of such infrastructure can have large impacts on

WATER AND SEWER

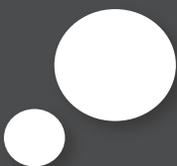
communities, especially those under growth pressures. Entities responsible for the provision of water and sanitation can face overloading, maintenance issues, and collapse without an adequate tax base. It is recommended that a life-cycle cost approach be used when financing infrastructure to ensure that the system is sustainable (Hague, Hague & Breitbach, 2011).

Water and Sewer Infrastructure - The New Jersey Context

The make-up of New Jersey's water infrastructure varies greatly by scale and ownership. As of late 2010, there are 31 investor-owned water utilities that serve over 40% of NJ's businesses and households. There are also 620 public community water supply systems, 75% of which serve less than 3,000 accounts. Finally, there are more than 260 community wastewater systems, 60% of which are publicly owned. On the other hand, stormwater infrastructure is not operated as a utility operation at all, but is managed by local and county public works departments (NJ Clean Water Council, 2010).

While New Jersey has a competitive advantage over much drier states in the West and South, New Jersey has many older cities and towns with drinking water infrastructure systems that are aged and prone to failure. The majority of the water distribution piping dating from the late 1800's through the late 1960's is cast-iron with a life of about 120 years and in need of replacement. Different types of piping from the 1920's and the post WWII boom have average life spans of 100 and 75 years respectively. Similarly, the majority of the sewerage collection systems in Jersey were put in over 70 years ago, while expected useful life of pipe is just 50 years. The quality of pipes may be prolonged past this 50 year mark, however maintenance neglect is common. It is important to note that age is not the only factor in the degradation of piping, as temperature, corrosion, and hydraulic surges are all factors (ASCE New Jersey Section, 2007).

In 2007, the American Society of Civil Engineers released a report card for New Jersey's infrastructure that highlighted the fact that critical repairs are needed for our existing infrastructure. The wastewater utilities received a grade of "D" and drinking water utilities were given a "C". Subsequently, the New Jersey Clean Water Council put forth a number of recommendations in 2010 that suggest infrastructure should be maintained at the lowest life-



cycle cost in order to avoid wasting resources/money and maintain a viable economy. That is, utilities should implement asset-management principles and standardized approaches to utility accounting, as well as receive sufficient institutional support (“Recommendations for water,” 2010).

There are also considerable concerns related to New Jersey’s wastewater systems due to a large number of combined sewer and wastewater systems throughout the state. Such systems, which were constructed in early cities to transport sewage, industrial wastewater, and rainwater runoff in the same pipes, pose serious environmental and public health risks when water is discharged into water bodies during periods of heavy rain. In addition to health concerns, combined sewer overflows (CSOs) also create financial burdens related to cleanup expenses, lost tourism revenue, emergency repairs, lost productivity, and medical costs. New Jersey has 20 permit holders for CSOs and 254 outfalls (U.S. Environmental Protection Agency, 2011). Combined sewer overflows and dilapidated pipes that result in the discharge of raw sewage are of particular concern for the tourism industry. Pollution often occurs in older urban areas near bodies of water, as well as coastal areas. A polluted shore environment is simply detrimental to the Jersey Shore tourism industry (NJDEP Division of Water Quality, 2012).

Finally, the effects of severe weather and other climate change impacts on water and sewer infrastructure should not be underestimated. It is estimated that Superstorm Sandy damaged over 100 facilities that supply drinking water and treat sewage in the New Jersey. This translates to about \$2.6 billion to repair systems and make them more resilient. The rebuilding needs are only exacerbated by the fact that the state’s water and sewer infrastructure was already in poor condition, as evidenced in the above discussion. Not only do the impacts cause disruptions in daily life, there are considerable health concerns. For example, the Passaic Valley Sewerage Commission, which is the fifth-largest wastewater plan in the country, suffered from flooding that resulted in millions of gallons of sewage dumped into waterways (Johnson, 2013). Tackling these issues will not be an easy task, as current funding levels are insufficient.

The U.S. EPA features an initiative known as “Climate Ready Water Utilities,” which

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provides a number of valuable resources to help utility owners and operators adapt to the impacts of climate change. According to the initiative's Adaptation Guide for Water Utilities, the northeast region of the U.S. should expect temperature rise, shifts in precipitation patterns, and altered hydrologic cycles as a result of climate change. As such, they suggest that water utilities should incorporate climate adaptation plans into their long-range planning efforts. These plans can incorporate sustainability aspects such as energy management and green infrastructure into their adaptation strategies. Therefore, it is imperative that the state's water utilities work to both rebuild damaged and decayed infrastructure in the short term and adopt climate adaptation measures for the long term.



Power Infrastructure

The electricity system is made up of three basic components that vary by age, capacity, and condition: generation facilities, high-voltage transmission lines, and local distribution systems. The sufficiency and reliability of this system depend on the age, capacity, and spatial pattern of the infrastructure. The age of equipment is often related to reduced power quality and availability, while equipment capacity is also associated with bottlenecks in the electricity grid that cause brownouts and blackouts (Economic Development Research Group, 2011). Electricity transmission congestion is a notable issue for the State, as New Jersey lies directly within a Critical Congestion Area designated by the U.S. Department of Energy that runs from south of Washington D.C. to north of New York City (U.S. Department of Energy, 2009).

Reduced reliability of electricity supply due to equipment failures, voltage surges, irregular power quality, and blackouts/brownouts can have several negative economic effects. These effects include damaged electronic equipment, spoilage of food and items kept in controlled conditions, unproductive time for workers, and costs related to backup and monitoring/conditioning equipment. By failing to invest in electricity infrastructure, such effects could negatively impact the development of New Jersey's industry clusters. For example, a 2004 study by the U.S. Department of Energy Office of Science national laboratory found that industrial firms lost around \$2,000 to \$5,000 and commercial firms lost around \$700 to \$1,300 per power interruption. In addition to costs related by electricity interruption, there are also economic impacts related to higher electric costs, costs associated with unreliability, and more expensive industrial processes. Such expenses translate to reduced competitiveness and job loss. Because electricity is generated, transmitted, and distributed by private companies under public oversight, investment in electricity infrastructure cannot be accomplished by purely increasing public expenditure. In addition to public policy, private investments rely on the private capital loan and bond markets and perceptions of economic risk. Nevertheless, public policies can regulate the pace, siting, and nature of electricity infrastructure investment (Economic Development Research Group, 2011).

While most industries depend on electricity, there are certain sectors that are more dependent on a reliable source of electricity. Industries that use higher than average portion of their revenue for electricity include (in descending order) primary metals, non-metal minerals, paper, accommodation & food, education, chemical products, agriculture & forestry, food & beverage manufacturing, wood products, plastics, mining, textiles and apparel, leasing, printing, petroleum & coal products, and fabricated metals (Economic Development Research Group, 2011). Within the technology industry, data center facilities have specific power infrastructure concerns. The number of data centers is growing rapidly in New Jersey, which has doubled to almost 40 since 2005. These facilities need high quantities of power for constant operation and back up. For example, the world's largest data center was opened last year in Edison, NJ, and can support enough electricity to power about 80,000 homes (Portlock, 2011). The emergence of a "Green Economy" cluster also prompts some power infrastructure concerns as solar power facilities become increasingly common. With large solar and wind energy facilities on the horizon, it will be necessary for infrastructure to have the capacity to accommodate these new power sources.

Power Infrastructure - The New Jersey Context

There are four energy distribution companies that span different areas of the State, including Atlantic City Electric Company in South Jersey, Jersey Central Power and Light and Public Service Electric and Gas Company in North/Central Jersey, and Rockland Electric Company serving a small portion of North Jersey. All of these companies are controlled by PJM, a regional transmission organization that coordinates the flow, reliability, and security of the electric power system ("New Jersey energy," 2011). In late 2011, the State adopted an Energy Master Plan (EMP) that sets forth a number of initiatives to expand in-state electricity resources, promote cost-effective renewable resources and conservation/energy efficiency programs, and support the development of innovative energy technologies. The theme of economic development is woven into the EMP, highlighting the various benefits businesses may receive from the implementation of the stated goals ("New Jersey energy," 2011).

The commercial and industrial sector uses 65% of overall electric power in New Jersey.



Because energy costs are the second greatest expense for most New Jersey businesses, reducing energy costs would directly contribute to business success. Moreover, our electricity prices are relatively high compared to other states, which may discourage certain industries from locating in New Jersey. In addition to reducing energy cost for existing industries, the EMP also recognizes the potential for new business creation in the emerging renewable energy industry. The State Strategic Plan identifies the “Green Economy” as an emerging industry cluster. As such, collaboration between universities, research institutions, and businesses is key to spurring innovation and developing this industry cluster (“New Jersey energy,” 2011).

The 2007 Report Card for New Jersey’s Infrastructure assigned the state a “C+” energy grade which was above the national average. Our diversified energy sources, commitment to and exploration of new energy sources, and PJM’s investment in transmission position New Jersey as a leader in energy infrastructure (ASCE New Jersey Section, 2007). Under new circumstances, New Jersey has the opportunity to be a leader in the context of a post Superstorm Sandy power system.

On 9:00AM on October 31, 2012, two days after Superstorm Sandy made landfall 2,040,195 or 51% of customers were without power in New Jersey. Salem Unit 1, a 1,174 megawatt nuclear generation facility was manually shut down safely on October 30th due to four of the station’s six circulating water pumps being no longer available due to weather impacts. Petroleum and natural gas refineries in Port Reading and Linden were such down as well (Hurricane Sandy Situation Report #6). The impacts of flooding damaged substations and high winds led to trees falling on transmission lines. With the lack of power gas stations were unable to pump gasoline, further exacerbating the impact to transportation. Immediately after the storm passed energy companies mobilized a massive multi-state force of technicians, workers and equipment to begin repairs to the severely damaged power infrastructure.

To move forward and mitigate the impacts of future storms it will take a combination of common sense initiatives and strategic investment into our power delivery system. First, substations in areas venerable to flooding should be raised above the flood plain. Next, at facilities such as hospitals, other healthcare institutions and community centers on site power generation

should be examined. For transportation infrastructure such as gas stations, having generator hook up ports installed into the site will allow for easy connection of emergency generators. Finally, underground power lines in new developments will reduce exposure to falling trees while regular tree grooming will help maintain existing lines. Ultimately, without power the economy cannot function. The state should place priority in the technology that exists to improve the power system and make it less open to future storm impacts.



Telecommunications Infrastructure

Broadband access is an increasingly important economic consideration for individuals, businesses, and communities. For example, 62% of workers in the US depend on the Internet for their occupation. Businesses can use the internet to improve their operating process and access new, larger markets. The Internet is also a valuable workforce development tool, allowing individuals to learn new skills and find employment. Finally, communities can attract new industries and workers through the development of telecommunications infrastructure. Therefore, the National Broadband Plan recommends the development of broadband programs that support entrepreneurship and small/medium businesses, deliver job training and placement services, promote telework, and enable local/regional economic development. A great example of such recommendations that represent the spirit of this report is recommendation 13.8, that “The federal government should develop regional and community broadband benchmarks for use as a central component within economic development planning and programs” (“National broadband plan,” 2010).

In addition to helping firms operate on a daily basis, technology also plays a great role in the development of industry clusters. Put simply, technology enables innovation. Fast and dependable broadband and wireless allow various industries to use digital tools that propel them forward with a competitive edge. This includes the opportunity for healthcare institutions to share x-rays and other digital images, as well as practice “telemedicine.” Educational institutions also benefit from the ability to better engage students distance learning and real-time assessment. More generally, better technology such as video conferencing allows for better communication and opportunities for collaboration (West, 2011).

Telecommunications also enable the tourism industry to provide innovative smartphone maps and mobile-friendly websites to help guide visitors to new activities and experiences. For example, Asbury Park is considered a leader in its development of an interactive phone application that helps tourists explore the city. Industry leaders suggest that these technologies are becoming increasingly important ways to stay competitive in tourism (Fletcher, 2011).

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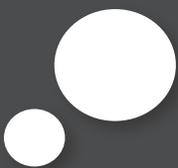
The technology industry is especially impacted by the quality and availability of broadband access. For example, a 2003 study found that cities with greater telecommunications capacity are more likely to have positive growth in the high-tech industry (Hackler). In his article in the *Journal of Urban Technology*, Wieman accurately illustrates the importance of telecommunications infrastructure when he states “Broadband information infrastructure is now as important to a growing array of high-tech firms as railroads were to nineteenth-century steel and textiles mills” (1998).

Telecommunications - The New Jersey Context

Not only are telecommunications an essential feature of our economy and daily life, they are also critical in emergency situations. We rely on this infrastructure to call 911, get in touch with family and friends, obtain news, and so on. This was painfully clear for New Jersey during the events of Superstorm Sandy. Telecommunications infrastructure suffered substantial impacts as a result of Superstorm Sandy, with one of every four cell towers out of service in the 10 state region affected by the storm according to the FCC. Moreover, there is a vital relationship between telecommunications and power infrastructure, as we rely on electricity to power the antenna towers, central offices, individual devices, and other equipment necessary for the function of the network. Therefore, as the state lost power during Superstorm Sandy, telecommunications suffered as well (Beeson).

Similar to all other types of infrastructure, the telecommunications industry must pursue greater resiliency in the face of severe weather events and other climate change effects. The Federal Communications Commission held a series of field hearings in the months following the storm to discuss failures of the telecommunications system and explore ways to increase resiliency. Some suggested that infrastructure be hardened to protect from flooding and ensure that there is sufficient back-up power at cell tower sites. Other ideas include co-locating towers with each other to create redundancy in the system and greater cooperation among mobile carriers (Beeson).

Overall, New Jersey is a national leader in broadband access (State Planning Commission, 2011). Broadband is provided through DSL, cable, fiber, or wireless systems by various providers.



As of December 2011, the majority of New Jersey's population (64.3%) had access to 3 wireline providers, while 74.1% had access to 4 wireless providers. Moreover, 58.2% of the population had access to fiber technology, while DSL, cable, and wireless were available to 93.9%, 95.1%, and 99.8% respectively. Broadband speeds also tend to vary by type of user. For example, homes tended to have the highest speeds, followed by medium/large businesses, schools/libraries/community centers, and small businesses (NTIA, 2011).

Finally, The National Telecommunications and Information Administration's State Broadband Data and Development Grant Program recently funded the New Jersey Office of Information Technology to map the availability and utilization of broadband in New Jersey. The mapping efforts will allow the state to better understand the current and future demand for broadband. For the purposes of this report, fiber-optic service areas from this broadband mapping initiative were mapped to depict the latest fast and reliable technology sought by broadband users.

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Corporate Parks, Centers, and other Industrial Facilities

Science and technology parks have become an integral part of industry clusters, especially for the technology, life science, and advanced manufacturing industries. These parks assist in the development of industry clusters in many ways due to their ability to bring together firms that foster creativity and innovation. In spurring innovation, they can further jump start the economy by cultivating and attracting talent and creating new jobs. Successful science and technology parks tend to have a specialized management team, value-added services, quality facilities, efforts for new business creation and business attraction, networks, and positive effects on the surrounding geography (Bellavista & Sanz, 2009). Some of the major science and technology parks in New Jersey include the University Heights Science Park, Technology Center of New Jersey, South Jersey Technology Park, and the Waterfront Technology Center at Camden.

Warehousing and distribution centers are common sights clustered at highway interchanges, ports, and airports in New Jersey. Many of the facilities function as “value-added warehouses,” in which employees assemble, customize, and/or prepare products before shipping to their final destination. The 2007 Comprehensive Statewide Freight Plan states that such facilities are “the intersection of the freight transportation system and economic development.” These facilities, which naturally tend to cluster due to their logistical needs, are often the site of the state’s transportation, logistics, and warehousing industry cluster, as well as many firms involved in manufacturing processes. Many of New Jersey’s companies benefit from operating within one of the five foreign trade zones located across the state. Within these zones, products that are processed and re-exported receive duty-free treatment (State of New Jersey). According to the Statewide Freight Plan, warehouse and distribution centers tend to take three forms in the state, either as 500,000+ square foot facilities that serve the northeast and national markets, 100,000-500,000 square foot facilities that serve the regional market or those that must be on-site or adjacent to ports and airports. In New Jersey, the Port of Newark/Elizabeth is significant, as products can be shipped in from overseas and prepared in the state’s warehouse and distribution centers. Exit 8A on the New Jersey Turnpike is considered the “epicenter” of distribution center activity, while exit 7A is also developing as a prominent center. Issues facing the development and

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success of these centers include truck traffic, competition with I-78 and I-80 sites in Pennsylvania, and a shortage of suitable land area (Parsons Brinckerhoff Quade & Douglas, Inc., 2007).

“Freight villages” are becoming an increasing popular framework for fostering clusters of logistics, warehousing, and distribution facilities and other support activities. The Delaware Valley Regional Planning Commission Long-Range Vision for Freight promotes the development of freight villages as a means to enhance the link between freight transportation and land use. A typical freight village would be located around a highway interchange and/or intermodal facilities and include light manufacturing, warehouse/distribution, and office, retail, and hotels that support the industry. Pureland Industrial Complex in Swedesboro, NJ is a shining example of a freight village with over 15 million square feet of facilities adjacent to a highway and served by rail (DVRPC, 2010).



Higher Education Institutions

Both community colleges and universities have a vital role to play in New Jersey's Regional Innovation Clusters. Universities impact their local economies in three major ways. Traditionally, they generate jobs and wealth through purchasing and procurement, and enhance human capital through education. Most importantly, however, universities are often central components of industry clusters because they produce research that fuels innovation. This occurs during the process of "technology transfer," in which the results of basic and applied research are used in the commercialization of products, services, or processes. This includes patenting, licensing, research consortia, technical assistance programs, spin-off business, start-up incubators, research parks, venture-capital funds, consultant services, and other less formal interactions between the university and the industry.

In a report produced by Carnegie Mellon University for the U.S. Department of Commerce Economic Development Administration, the authors suggest that universities with high engagement, a strong base of research and development, and alignment with the greater region are more likely to successfully contribute to industry cluster development. It is also important to note that the nature and organization of a specific cluster affects the ability of a university to make significant impacts. For example, the de-concentration of production and a general resistance to accepting new technology and innovations could negatively impact a university's ability to contribute to an industry cluster (Paytas, Gradeck, & Andrews, 2004).

While universities are the primary producers of innovative research, community colleges play a more localized workforce and economic development role. They serve as workforce intermediaries to assist in the job-matching process, improve the quality of the labor supply, and enhance the capacity of employers (Velluzzi, 2010). For example, in a study of four community colleges, Rosenfeld (2000) found that colleges embedded within a cluster had the social resources to incorporate cluster influenced curricula, match students to jobs, and further the development of the cluster by supplying trained labor.

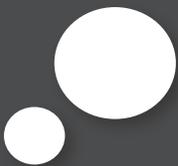
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Research shows that certain industries benefit greatly from university programs and partnerships, including technology, life sciences, and advanced manufacturing. For example, a 2011 report from the Brookings-Rockefeller Project on State and Metropolitan Innovation suggests that states should actively promote the advanced manufacturing industry by creating research and education centers to develop new, relevant technologies, as well as provide education to assist businesses in applying such technologies (Halper & Wiel).

Higher Education Institutions- The New Jersey Context

The Draft State Strategic Plan states that New Jersey is in the top ten states for bachelor degree attainment for people ages 25-44, as well as 6th in the country for residents holding an advanced degree (State Planning Commission, 2011). It should be noted that although New Jersey's workforce is well-educated, these numbers should not overshadow the significant "brain drain" that New Jersey experiences. According to the National Center for Education Statistics Fall 2010 data, New Jersey has the 6th lowest ratio of in-state students to residents enrolled in any state (.65) compared to all other states, which means New Jersey is losing the opportunity to educate its own residents in state. Moreover, 34,995 students migrated out of state, while only 5,451 migrated into New Jersey, representing a net out-migration of -29,544 students (U.S. Department of Education, 2011). Coupled with the high amount of unmet demand is a low capacity to serve college-bound students. For example, New Jersey ranks 46th in the nation in public four-year college/university enrollment per capita (New Jersey Association of State Colleges and Universities, 2012). These trends indicate that there is a significant gap between the real and potential enrollment in New Jersey's colleges and universities. By investing in New Jersey's educational institutions, we could retain more of our bright students and fuel innovation for our industry clusters.

Moreover, further development of research institutes, training programs, etc. in colleges and universities tailored to industry cluster needs would be beneficial to New Jersey's economic development efforts. For example, the New Jersey Advanced Manufacturing Institute at the Rutgers University School of Engineering seeks to foster business partnerships, attract investment, and do research and development for the advanced manufacturing industry. Another



example is the Stem Cell Institute of New Jersey out of the UMDNJ-Robert Wood Johnson Medical School and Rutgers, which benefits the state's life sciences industry by engaging in research, training, and clinical studies to attract pharmaceutical and biotechnology companies. Finally, the pending merger of Rutgers University and UMDNJ presents an opportunity for New Jersey to have greater capacity to attract more research grants and corporate partnerships for the healthcare industry. The merger, which is set for July 1, 2013, will also allow the state to provide greater educational opportunities and attract more talent.

HIGHER EDUCATION



Hospitals

Like colleges and universities, hospitals often serve as community anchor institutions that employ residents and generate significant economic activity through local spending. It should be noted, however, that hospitals are not a panacea for ailing economies. Rather, significant opportunities exist when hospitals and other healthcare institutions work within industry clusters that involve higher education institutions, businesses, and economic development efforts. This is especially true within the healthcare and life sciences industry. In order to sustain these clusters, it is imperative that the greater community fosters conditions in which workforce development is prioritized, there is a high quality of life, and significant opportunity for entrepreneurs. State and local governments can play a major role in encouraging such conditions. For example, the Indiana Department of Commerce designated central Indianapolis as a Certified Technology Park, qualifying the area to receive state funding for location incentives and infrastructure improvements. The BioCrossroads Initiative has now developed a successful life sciences center made up of hospitals, medical device companies, drug manufacturers, and research labs in the Indianapolis area (Krohe, 2012).

Hospitals - The New Jersey Context

Containing around 34% of all healthcare employment, hospitals are clearly a key component of New Jersey's healthcare cluster. As such, general medical and surgical hospitals represent the largest type of healthcare employer (Ehert, 2011). Hospitals contribute to the healthcare cluster by teaching future medical professionals and supporting smaller businesses that provide support products and services. Hospitals are also particularly important to New Jersey's life science cluster because they often conduct research and clinical trials that assist pharmaceutical and biotechnology companies. For more on the role in hospitals in the Life Sciences industry refer to the Route 1 Corridor case study.



Institutions for Collaboration

While physical infrastructure, government regulation, companies, and universities are recognized as basic components that affect business competitiveness and industry cluster development, there are other types of entities that play an integral role as well. Michael Porter identified such organizations as “institutions for collaboration,” which include chambers of commerce, industry and professional organizations, quality centers, think tanks, technology transfer organizations, university alumni associations, and more. By fostering relationships, doing shared activities, and setting standards, institutions for collaboration can affect productivity and competitiveness. Porter suggests that as the number of institutions for collaboration is increasing, the knowledge and skills of competition are increasing as well (Porter, 2003).

Institutions for Collaboration - The New Jersey Context

New Jersey has an abundance of institutions for collaboration dedicated to the advancement of New Jersey’s industries. There are chambers of commerce on the statewide, regional, and local level. Statewide chambers include the New Jersey Chamber of Commerce, Statewide Hispanic Chamber of Commerce of New Jersey, African American Chamber of Commerce of NJ, NJ Chinese American Chamber of Commerce, and the Asian Indian Chamber of Commerce. There are also a large number of associations that focus on certain trades and professions in New Jersey. Each of the state’s industry clusters can benefit from trade organizations including the HealthCare Institute of New Jersey, New Jersey Hospital Association, the New Jersey Bankers Association, BioNJ, the New Jersey Technology Council, the New Jersey Tooling and Manufacturing Association, Material Handling Society of New Jersey, and the New Jersey Motor Truck Association.

New Jersey’s Department of Labor and Workforce Development has recently introduced a number of Talent Networks that focus on the six industry clusters put forth in the Draft State Strategic Plan. The Talent Networks are a shining example of Michael Porter’s Institutions for Collaboration in that they bring together a number of partners for workforce development in

their respective industries. They consist of colleges and universities, workforce investment boards, trade associations, chambers of commerce, funding groups, employers, and others. Together, these companies and organizations can make a powerful difference in the advancement of their industries.



Quality of life infrastructure

Many well-established industry cluster theories are based in the idea that firms cluster to reap benefits of efficiency, knowledge spillovers, and face-to-face contact. Many experts are now expanding such theories to include a firm's desire to access a talented workforce concentrated in a particular place. To this end, there are clear arguments that human capital is a major driver of regional economic growth because businesses cluster to benefit from common labor pools.

In an expansion of this concept, Richard Florida identifies the “creative class” as a specific type of worker that seeks to locate in places with a certain quality of life. The creative class includes super-creative people that create useful new forms or designs such as scientists, engineers, artists, architects, professors, writers, analysts, and others; and creative professionals that work in knowledge-based fields such as technology, finance, healthcare, law, and business. His research shows that these highly-educated workers look for inclusive and diverse places when deciding where to live, thereby attracting firms and driving economic growth in those regions. These places offer high-quality experiences and an inclusive atmosphere in which creative people can flourish. The theory, he asserts, is that innovation and growth are correlated to the three T's, or technology, talent, and tolerance (Florida, 2003).

Such “human capital” and “creative capital” theories of economic development establish a case for promoting an attractive quality of life in places that want to attract workers and firms. In addition to attracting workers, quality of life is also important to firms for other business reasons. Companies often have to pay higher salaries as a form of “disamenity compensation” in places with lower quality of life in order to attract employees. Moreover, quality of life is also a consideration for companies looking to retain employees and avoid recruitment costs (Compton, 2007).

Quality of Life - The New Jersey Context

The Draft State Strategic Plan recognizes that although New Jersey boasts an ideal location, abundant recreational opportunities, preserved landscapes, and rich culture and

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history, the state is also home to underperforming urban centers that hurt our ability to compete economically. Nevertheless, the Plan highlights the growing preference toward more walkable, mixed-use, and urban communities with transportation options and access to recreation and other amenities that make for better quality of life. To achieve such places, New Jersey's transit hubs can be developed and redeveloped as desirable places to live and recreate, as well as promote economic activity. Moreover, preservation and park development is highlighted as a viable means to increase quality of life infrastructure by encouraging both denser development and open space for healthier lifestyles (State Planning Commission, 2011).

The availability of open space and recreational opportunities has been recognized as a major attractor of businesses and workers, particularly for footloose companies and highly educated employees. For example, Richard Florida found that high-technology workers chose environmental quality as the most important factor in their location decisions (Crompton, 2007). The most recent New Jersey Statewide Comprehensive Outdoor Recreation Plan (SCORP) released in 2008 highlights the State's commitment to open space preservation. Goal 2 of the SCORP, "To provide close to home park and recreation opportunities for residents statewide and promote the development of parks in New Jersey's urban and suburban centers to support revitalization efforts," would directly support the development of quality of life infrastructure for industry clusters (New Jersey Department of Environmental Protection, 2007). Using funds from the Garden State Preservation Trust, Land and Water Conservation Fund, Forest Legacy Program, Pinelands Section 502 Program and other sources, the NJDEP Green Acres Program has preserved almost 640,000 acres of open space. However, as of 2013, Green Acres funding has run dry and no new sources of funding have been identified. While New Jersey is considered a leader in open space preservation, the 2007 Report Card for New Jersey's Infrastructure assigned a grade of "C-" to the state's public parks and recreation due to development pressures and unmet funding (ASCE New Jersey Section, 2007).

New Jersey's open space can also serve as an important type of infrastructure for the tourism industry. Eco-tourism is an increasingly popular type of travel that features resources such as the Pinelands. Nevertheless, a disconnect remains between our natural resources and



availability of tourist facilities such as hotels and restaurants. For example, the Pinelands have 20 million people living within 60 miles of his boundaries, presenting quite a market for ecotourism activities (Fletcher, 2011). While communities certainly benefit from the economic activity associated with the tourism industry, there are also impacts on local infrastructure that should be considered. For example, the State Heritage Tourism Plan suggests that communities should “Understand carrying capacity for heritage sites and towns so that visitation does not negatively impact resources or infrastructure.” Moreover, the plan puts forth a strategy to develop heritage products and infrastructure such as building a strong network of historic sites, supporting the Wayfinding Master Plan, and developing a historical marker program. Such initiatives would enhance the quality of life in New Jersey and contribute to a healthy tourism industry (State Heritage Tourism Plan).

In addition to parks and recreational opportunities, housing costs are a major consideration for places looking to foster industry cluster growth. New Jersey, notorious for its high housing costs, faces competition with states that have more affordable housing such as Virginia, North Carolina, and Georgia. Such places have succeeded at attracting knowledge-based jobs and talented workers in recent years. Moreover, New Jersey also faces an outmigration of population as workers seek cheaper housing elsewhere (Hughes, 2007). In fact, the state ranks as the 3rd most expensive state in the latest National Low Income Housing Coalition report *Out of Reach* (2012). For example, the report shows that a worker would have to earn \$25.04 an hour to afford a 2 bedroom fair market rent apartment.

Finally, arts and cultural amenities can be considered a type of “quality of life infrastructure” that attracts workers and firms to communities. New Jersey’s latest Arts Plan recognizes the community and economic development value of the arts, stating that “A strong cultural landscape in New Jersey attracts both businesses and a highly skilled and creative workforce.” For example, the plan seeks to “grow thriving and vibrant communities” by aligning with public policies that encourage innovation and the creative economy, promoting inclusion, connecting with the business community, promoting cultural tourism, and doing further research on the impact of the arts (“Arts plan New Jersey,” 2008). Future research and mapping of New

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Jersey cultural amenities would help inform further analysis on quality of life infrastructure and the development of industry clusters in New Jersey.

