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# The Need for Enhanced Physical Infrastructure in the United States

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Claremont McKenna College

The Need for Enhanced Physical Infrastructure in the United States

Submitted to  
Professor William Ascher

by  
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for  
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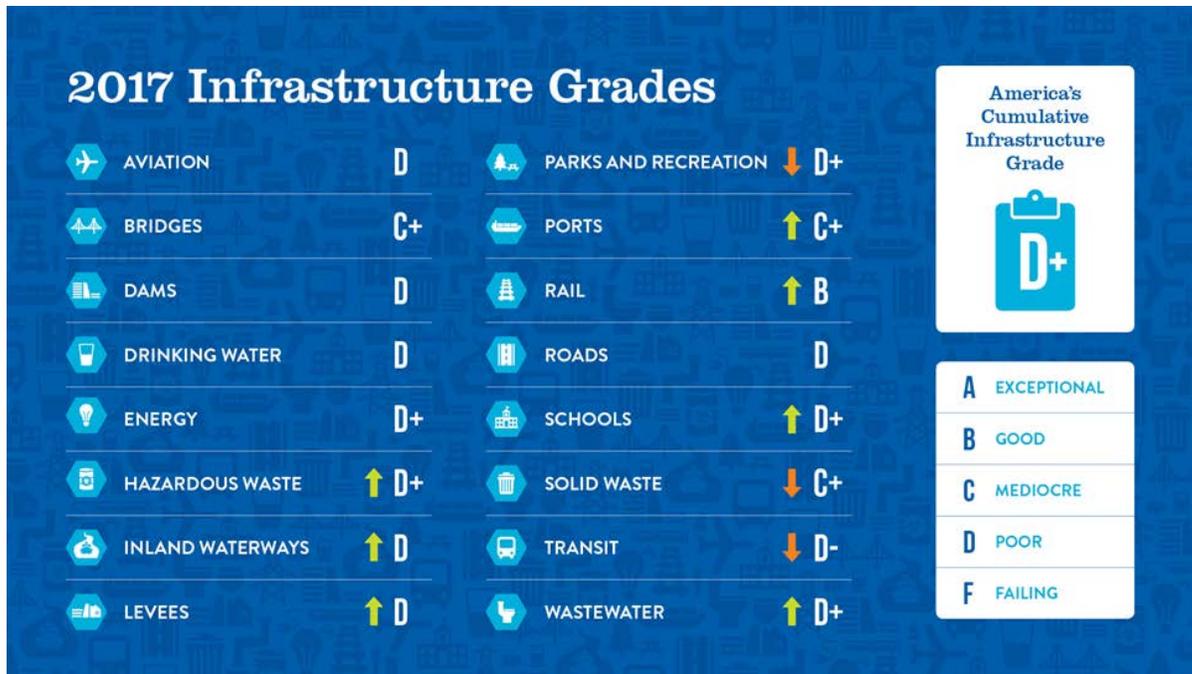
## **Chapter 1: Problem Orientation**

### **Introduction**

In 2016, the United States had the world's largest GDP and was the world's second largest importer of goods (United States Census Bureau 2016). Moreover, the United States was also ranked third in the world for Purchasing Power Parity and had the fourth largest labor force (Central Intelligence Agency 2017). The country has access to limitless resources and occupies a strategic and exceptionally powerful role on the international stage. Despite these strong advantages, the United States has failed to adequately invest in the country's physical infrastructure.

The U.S is ranked thirteenth overall in road quality and twelfth in Quality of Overall Infrastructure (World Economic Forum 2016, 357). In 2017, the American Society of Civil Engineers (2017) (ASCE) gave the United States a rating of D+, based on its analysis of issues such as the quality of transit, roads, inner waterways, ports, aviation, rail, and bridges. ASCE (2017) estimates that the additional necessary investment to raise each of these grades to at least a B by the year 2020 would be \$2.06 trillion USD. The organization asserts that “[i]nfrastructure is also critical for long-term economic growth, increasing GDP, employment, household income, and exports,” but also emphasizes that “the reverse is also true – without prioritizing our nation’s infrastructure needs, deteriorating conditions can become a drag on the economy” (ASCE 2013).

Figure 1.0: The United States' Infrastructure Grades for 2017 (ASCE 2017)



The current state of American infrastructure is lacking and thoroughly undeveloped. According to the National Economic Council and the Council of Economic Advisors (2014), “there are more than 4 million miles of road, 600,000 bridges, and 3,000 transit providers in the United States. And yet, over the past 20 years, total federal, state, and local investment in transportation has fallen as a share of GDP – while population, congestion, and maintenance backlogs have increased.” A stunning 65 percent of all major American roads are in bad conditions and 25 percent of bridges require repair in order to just keep up with today’s traffic (National Economic Council and the President’s Council of Economic Advisers 2014).

Kearney, Hershbein, and Nantz (2015) outlined key figures in the debate over the necessity for investments in our national infrastructure and transportation networks:

The facts make it clear that the state of public financing for transportation infrastructure warrants serious attention. Federal spending as a share of GDP has fallen and the federal Highway Trust Fund (HTF)—the designated source of revenue for spending on our nation’s highways—is about to run out of money. The primary source of funding for the HTF is the federal gas tax, but that tax has not been raised since 1993. Of course, state and local governments also play an active role in both the funding and building of infrastructure projects.

### **The Costs of Poor Infrastructure**

The National Economic Council and the Council of Economic Advisors (2014) estimate that Americans spent 5.5 billion hours in traffic every year, which creates a cost of \$120 billion in lost fuel and time. Inadequate investments in infrastructure also lead to serious safety concerns, contributing to the more than 33,000 traffic fatalities in 2014. These crashes severely affect on the United States’ economy as well, “costing the United States’ economy \$230 billion each year” (ASCE 2013). American businesses also take on additional costs in freight transportation due to the state of American infrastructure, with some estimates even as high as \$27 billion a year (National Economic Council and the President’s Council of Economic Advisers 2014). These costs are transferred to the consumer in delayed shipping times and higher prices. ASCE (2016) predicts that if preventative and necessary investment measures are not taken, between 2016 and 2025, American household stand to lose up to \$3,400 each year in disposable income and the economy could lose \$4 trillion in GDP and 2.5 million jobs.

Since a consensus clearly exists on the extent to which the United States is lacking when it comes to investing in infrastructure and improving national transportation systems and networks, why has the United States not taken active and steady steps to resolve these problems? Perhaps it is because the costs of these infrastructural inadequacies are less obvious, despite the effects they have on everyday Americans. The social costs of insufficient infrastructure and underdeveloped transportation networks are harder to measure, but equally striking. Motor vehicle crashes disproportionately affect rural America, creating additional stress on underdeveloped areas of the country. Many in this country long for functional public transportation system, but for those unable to afford cars, the tolls and dysfunction of public transport is a very real and taxing problem. White (2016) notes that “access to just about everything associated with upward mobility and economic progress—jobs, quality food, and goods (at reasonable prices), healthcare, and schooling—relies on the ability to get around in an efficient way, and for an affordable price.”

Investing in infrastructure has direct impacts on economic growth. This is not only because it brings more Americans into the economic fold, by allowing for access to well-paying jobs and opportunity, but because it creates jobs and economic incentives for businesses to disperse into less populated areas. The United States has historically used focusing on infrastructure as a means to promote economic growth. This can be observed when examining both the pre-Civil War era and measures of President Franklin D. Roosevelt’s New Deal. Currently, the United States’ transportation networks have kept pace with neither the country’s economic demands nor growth.

The National Economic Council and the Council of Economic Advisors (2014) understand the economic advantages to investing in infrastructure. They outline the specific ways in which the current state of transportation networks in the United States is failing. They assert the inherent importance of a well-functioning, robust transportation network in the United States:

A well-performing transportation network allows businesses to manage inventories and transport goods more cheaply, access a variety of suppliers and markets for their products, and get employees reliably to work. American families benefit too: as consumers, from lower priced goods, and as workers, by gaining better access to jobs. An efficient transportation network also enables firms and people to locate near one another, so that they can benefit from shared access to inputs of production... This is all the more vital as regional economies with interdependent urban, suburban and rural areas relying on each other for innovation, employment, and growth become more important in manufacturing, energy, tourism, technology, and other US industries.

Additionally, the report provides concrete evidence on how the United States is falling behind other developed nations, further highlighting the need for increased investment to ensure an effective, well maintained, and strong transportation system. The National Economic Council and Council of Economic Advisors (2014, 4) also note the social benefits to investing in transportation infrastructure, acknowledging that investment can “benefit businesses and consumers alike through shorter and more reliable travel times, resulting in direct and indirect benefits that ripple throughout the

economy.” Citizens of the United States rely on infrastructure for everything from clean drinking water and stable flows of electricity to low transportation costs of goods.

Investing in physical infrastructure is a strong example of an inclusionary policy that can revitalize underserved communities by more efficiently connecting them with other urban areas, thus generating more economic growth. Kodrzycki and Muñoz (2015) further emphasize the argument for long term infrastructure investment. The authors explain: “The strongest influences on the relative fortunes of U.S central cities in the second half of the twentieth century were their locations and economic histories – in other words, predetermined attributes.” This supports the argument that physical location often precludes cities from economic growth and therefore, increasing access to different locations would ease these tensions. In examining cities that were able to recover, dubbed “positive-turnaround cities,” Kodrzycki and Muñoz find that cities that are able to create partnerships between the public and private sectors focused on long term goals, such as “investing in public transportation and improving safety perception” were much more likely to see effective and substantial recoveries. Therefore, the strategic importance of investing in infrastructure and transportation networks can not only be used to grow the economy, but can be used as a tool to specifically aid communities in distress.

### **The Opportunities in Infrastructure Investment**

As the United States prepares to adapt and capitalize on new technologies and innovations to expand and grow our economy, there is another strong argument to be made for investing in American infrastructure and transportation systems. Looking forward, major executives at both Lyft and Uber have heightened the possibilities created by the introduction of self-driving cars. Once heralded as an unlikely and utopian

technology, self-driving technology now promises to change the way American society views transportation – and the main method of transportation – within the next decade. Zimmer (2016) notes the how “[m]ost of us have grown up in cities built around the automobile,” but implores his readers to imagine “what our world could look like if we found a way to take most of these cars off the road. It would be a world with less traffic and less pollution. A world where we need less parking—where streets can be narrowed and sidewalks widened. It’s a world where we can construct new housing and small businesses on parking lots across the country—or turn them into green spaces and parks. That’s a world built around people, not cars.” Zimmer’s vision of the world is an admirable one and one that, if carefully and intentionally implemented alongside the massive reforms that need to occur in American infrastructure, could create economic returns for this country.

If these changes are to take place, however, the United States will need to intentionally increase investment in physical infrastructure in order to meet the country’s growing needs. Actually investing in infrastructure is complicated and involves making tradeoffs between different policy goals, bound by complex limitations. These tradeoffs will be explored in this thesis. In particular, I will be examining the tradeoffs between short termism and long term benefits, funding mechanisms and sources, and distributional fairness as it relates to public private partnerships. Balancing these considerations, along the need for both mass transit and solutions for individual car owners, can be extraordinarily tricky. But if policy makers are cognizant of these obstacles and can find success in hybrid policies, then the United States stands to see substantial benefits for its citizens in both economic growth and opportunity.

## **Chapter 2: Trends and Background**

### **The Rise of American Infrastructure**

During different eras, the United States has relied on investment in infrastructure to drive economic growth and encourage economic activity. As the National Economic Council and Council of Economic Advisors note, “investments by previous generations of Americans – from the Erie Canal in 1807, to the Transcontinental Railroad in 1869, to the Interstate Highway System in the 1950s and 1960s – were instrumental in putting the country on a path for sustained economic growth, productivity increases, an unrivalled national market for good and services, and international competitiveness” (National Economic Council and the President’s Council of Economic Advisers 2014, 2). Historical events and trends in the United States help explain the current state of infrastructure and can serve provide useful context for policy makers who determined to forge a productive path forward.

The first notable historical push for investment in infrastructure, with the specific emphasis on spurring economic growth, was in the post-Great Depression era, fueled by President Franklin Delano Roosevelt’s New Deal Program, specifically the Public Works Administration (PWA) and the Works Progress Administration (WPA). While the programs are often criticized for their inefficiencies and their inability to return the country to pre-Depression levels of spending and financial stability, together, they were responsible for over 480 airports, 78,000 bridges, and almost 40,00 public buildings (Smith 2009, 2). What made the programs highly distinctive, however, was that funds were spent in 3,068 out of the then 3,071 counties in the country (Smith 2009, 2). This meant that these efforts included bridging counties together: in some cases, through

thousands of miles of highway construction. In investing in public works programs, President Roosevelt and his administration focused on both relief and many believed that “thanks to federally funded public works the nation was moving again, money was being pumped into the economy, and people were going back to work” (Smith 2009, 8). While most agree that the United States wartime production effort was what eventually pulled the nation out of the Depression, the long-lasting infrastructure improvements made by the PWA and WPA allowed for higher rates of efficiency and productivity for years to come.

The second major push for increased infrastructure investment came after World War II. President Eisenhower had become acutely aware of the need for improved infrastructure and a better-connected country. He had seen the German “Autobahn” – the highway system in Germany. The autobahn had provided Germans with strategic advantages during the war but also allowed the Allied troops to swiftly move into Germany and eventually win the war. President Eisenhower was determined to create an equivalent American system of interstate highways and in the mid-1950s, upwards of 60 million motor vehicles had been registered in the United States, further emphasizing the need for new roads (Petroski 2016, 48). Under President Eisenhower, the Federal-Aid Highway Act was passed in 1956.

The Federal-Aid Highway Act of 1956 was an expansion of previous acts, such as the Federal Aid Road Act of 1916, which allowed for the matching of state funds for infrastructure purposes. Under the Federal-Aid Highway Act of 1956, \$25 billion was allocated to the construction of a “National System of Interstate and Defense Highways”. This project was expected to take 12 years and pushed the federal share of costs to 90

percent. Additionally, the project “expedited the process of acquiring rights-of-way, established standards for such physical features as lane and median width, and set a completion date of 1972” (Petroski 2016, 48). Finally, the Federal-Aid Highway Act of 1956 established the Federal Highway Trust Fund. The Federal Highway Trust Fund is increased through a federal tax on fuel. The original act was partly financed through the Department of Defense budget for the year, emphasizing Eisenhower’s belief that an efficient and highly interconnected transportation system was essential to the security of the United States. It might be hard to imagine military vehicles traversing the now familiar interstate system, but during the 1950s, the thought of warfare at home was a tangible fear. The original interstate system was thought to be crucial for the movement of military resources, personal, and materials. According to Lasswell’s garrison state hypothesis (1941), this heightened awareness of national security increased national deference to institutions such as the government and, in this way, worked to sway public support of the project.

### **The Fall of American Infrastructure**

After the Federal-Aid Highway Act of 1956, federal spending continued to increase. However, by the late 1950s and early 1960s, the cracks in the nation’s infrastructure process were already starting to show. In 1959, President Eisenhower approved an updated version of the Federal Aid High Way Act that increased the gas tax by 1 cent, introduced after budget shortages just 3 years after the original bill was approved. President Eisenhower, concerned about the long-term stability of the project, ordered a study on the effectivity of the Interstate program, to “delineate Federal responsibility, versus State and local responsibility, in financing, planning, and supervising the highway

program; and determine way of improving coordination between planning for Federal-aid highways and State-local planning, especially urban planning” (Federal Highway Administration). In the same year, Speaker of the House Sam Rayburn created a Special Subcommittee on the Federal-Aid Highway Program to “investigate allegations of corruption,” starting in Oklahoma, where State employees were facing allegations of “double billing, improper wage practices, loose handling of public borrow pits, waste in material flow, falsification of test samples, and gross laxity” (Federal Highway Administration).

In the 1980s, it had become clear that there were systemic problems with American infrastructure. In 1988, Governor Bill Clinton of Arkansas exclaimed, “Our infrastructure is just barely adequate to support our current level of economic activity, and our current rate of infrastructure improvement and investment falls vastly short of tomorrow’s needs” (Petroski 2016, 14). In 1981, Choate and Walter released a report titled, “America in Ruins: Beyond the Public Works Pork Barrel,” which drew public attention to the issue at large and was eventually received front-page coverage by the *New York Times*. In the report, Choate and Walter make an economic case for capital investments in infrastructure to counteract cyclical financial distress and explained that public facilities in America were decaying at a rate that was faster than they were being maintained. Choate and Walter condemned the lack of spending in the 1970s, explaining that they “undermined efforts to revitalize the economy and (threatened), in hundreds of communities, the continuation of such basic services as fire protection, public transportation, and water supplies” (Petroski 2016, 15).

The American Society of Civil Engineers (ASCE) had also begun to pay careful attention to the state of infrastructure in the United States and issued its first “Report Card for America’s Infrastructure” in 1998. This report has changed over the years but has been updated often enough that it may be used as a measure of progress over the last twenty years. The main changes have been to include different categories as they became relevant and to remove categories that became redundant or unnecessary over time. For example, in 2005, ASCE released a Report Card that included the category, “Security,” as it was the first grade report released since the 9/11 attacks. However, this category was later removed in 2009, as engineers had “begun to look at security in the context of infrastructures overall resilience – or the ability to withstand and recover from both natural and man-made hazards” (Petroski 2016, 23). Some additional categories, however, have become permanent additions to the report, such as levees – added after Hurricane Katrina caused unmeasurable damage in New Orleans. The introduction of other categories, such as Rail in 2005, have been added to clarify subsections of other categories. While commuter rail transit may be broken out from the Transit category before 2005, the introduction of its own category allows Rail to include facets such as freight railroad industry.

Figure 2.0. Infrastructure Report Card 1998 – 2017 (ASCE)

Category	ASCE 1998	ASCE 2001	ASCE 2005	ASCE 2009	ASCE 2013	ASCE 2017
Roads	D-	D+	D	D-	D	D
Bridges	C-	C	C	C	C+	C+
Transit	C	C-	D+	D	D	D-
Aviation	C-	D	D+	D	D	D
Dams	D	D	D	D	D	D
Drinking Water	D	D	D-	D-	D	D
Wastewater	D+	D	D-	D-	D	D+
Solid Waste	C-	C+	C+	C+	B-	C+
Hazardous Waste	D-	D+	D	D	D	D+
Schools	F	D-	D	D	D	D+
Inland Waterways		D-	D-	D-	D-	D
Energy		D+	D	D+	D+	D+
Public Parks & Recreation			C-	C-	C-	D+
Rail			C-	C-	C+	B
Levees				D-	D-	D
Ports					C	C+
Average Grade	D	D+	D	D	D+	D+

The American Society of Civil Engineers was founded in 1852 and is the oldest national engineering organization in the United States. Its members include “150,000 civil engineers in private practice, government, industry, and academia who are dedicated to advancing the science and profession of civil engineering” (ASCE 2017). ASCE assigns the grades in its report card based on a variety of different factors: capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation. ASCE scores each category of the Report Card in the context of demand for that infrastructure – for example, the United States might have an objectively more extensive transit network than it did in 1998, but the number of people who require transit services is also disproportionately higher than it was in 1998. While some might argue that ASCE has an incentive to skew perceptions of necessary investment such that its members would benefit if investment was raised, ASCE extensively details its sources. The sources include major government offices, such as the Congressional Budget Office, the U.S. Department of Transportation, and the Environmental Protection Agency, who all rely on their own measures of investment. The country’s infrastructure needs are hard to measure for a variety of reasons, but the data presented by ASCE displays important and notable trends.

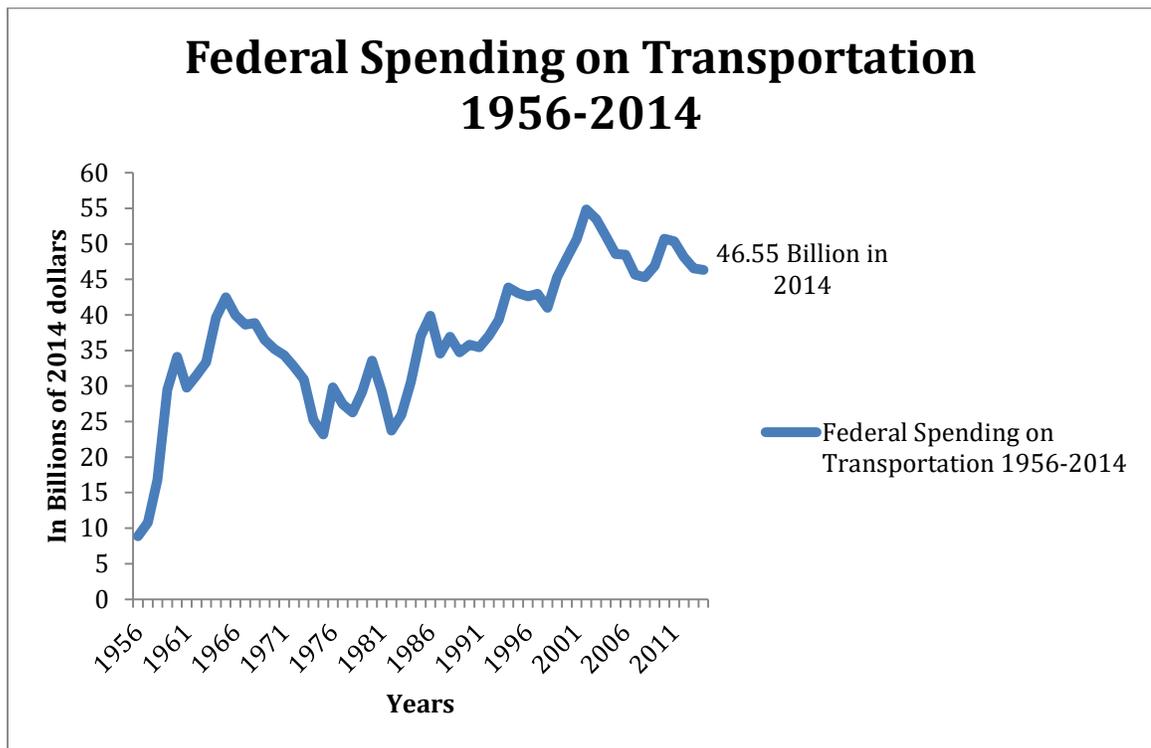
The trends indicated through the progression of grades in ASCE’s Infrastructure Report Card are abysmal to say the least. Only seven categories out of sixteen showed any signs of improvement between 2013 and 2017. Moreover, only nine categories showed improvement from between when they were first recorded and 2017. Among these nine categories, the largest jump was from a C- to a B in Rail, which coincidentally was highest grade in 2017. The categories that declined from 1998 to 2017 are Bridges,

Aviation, and Public Parks & Recreation. In 2017 Petroski rightfully observed “even the casual observer, seeing...virtually all infrastructure categories receiving the mediocre and poor grades in the C and D range since the late 1990s, cannot help but wonder why our nation has not redoubled its efforts to improve our roads and bridges” (Petroski 2016, 25).

In 2009, the American Recovery and Reinvestment Act (ARRA) was passed. ARRA had a variety of purposes, among which was long-term economic investment in infrastructure, with \$105.3 billion going to this end (Congressional Budget Office 2014). Some of these transportation projects were financed in the form of Transportation Investment Generating Economic Recovery (TIGER) grants, which allow for local and state applications for funds for projects that “have a significant impact on the Nation, a region, or metropolitan area” (United States Department of Transportation 2017). However, federal funding of infrastructure has struggled to keep up with the country’s transportation needs. The last federal bill to be passed authorizing funding for infrastructure was the Fixing America’s Surface Transportation Act in 2015. The bill sets aside an average of \$56.2 billion per year for highway and transit programs over the course of 2016-2020. The FAST Act has been criticized for “barely keep[ing] up with inflation over this period of time,” thus meaning that the “overall federal transportation funding level is close to flat” (ASCE 2016, 12). In inflation adjusted terms, the percent change from 2008 to 2013 in funds available to States from the Federal Highway Trust Fund is -10.9 percent. When adjusted to be a per capita basis, the percent change in highway funding from 2008 to 2013 is -7.3 percent (The Associated Press 2013). In 2014, inflation-adjusted federal spending on highways was 23 percent of what it was in

2002 (ASCE 2016, 13). While at the state and local level funding for road maintenance has been stable (inflation adjusted), the level of capital investment (new infrastructure projects) has declined by 30 percent since 2002 (ASCE 2016, 13). In 2014, the Congressional Budget Office released a report detailing Public Spending on Transportation and Water Infrastructure from 1956-2014 and broke down the various spending into greater detail. Spending on new capital was comprised of 43 percent of total funds spent, while operations and maintenance was 57 percent (Congressional Budget Office 2014, 1).

*Figure 2.1: Federal Spending on Transportation 1956-2014, in 2014 dollars (Congressional Budget Office 2015).*



The federal tax on fuel, which goes to the Federal Highway Trust Fund, is currently set at 18.4 cents per gallon. Over the course of the Federal Highway Trust

Fund's history, it has seen both surpluses and shortages. However, many believe that the Federal Highway Trust Fund is problematic, as there is currently no mechanism to index the gas tax to inflation or the amount that people are using the interstate system.

Additionally, as cars become increasing fuel efficient and many transition to electric cars, the amount of fuel that is consumed in the United States will reduce substantially. Sales of electric vehicles increased by 37 percent in the United States in 2016. Despite the overall market share of electric vehicles is still low, many believe this market will continue to grow (Forbes 2017). From 2010 to 2016, twenty-three states increased their state gas taxes (thus increasing their state funding for highways), which has helped counteract the overall federal reduction in investment (ASCE 2016, 13). In 2014, Secretary Anthony Foxx, then Secretary of Transportation, noted that there was "still no long-term certainty" regarding the future of the funding of the Federal Highway Trust Fund.

### **Alternative Funding Routes**

As the United States continues to struggle with sustainable ways to fund infrastructure expenditures, there are two other sources of funding to which people can turn. The first is publicly owned toll roads. Public toll roads sound promising in theory, as the premise is that the revenues earned from the tolls could be used to pay off the expenditures on that specific highway project and eventually be reduced, and ultimately removed. However, in practice, many projects require continued expensive maintenance and are therefore are often difficult to completely "pay off." This reality is often ignored by politicians and by city planners who are optimistic about new projects, as it is unpleasant and does not appeal to those who are used to not paying tolls on the existing roads. Additionally, once

tolls are established, if they start to provide revenue to the state beyond what the original costs and current upkeep costs are, then it is in the state's best interest to put that revenue towards other infrastructure projects that it is looking to finance.

The second noteworthy source of funding is through public private partnerships (PPP). Many believe that the private sector acts as a catalyst to make systems more efficient and streamlined because actors in the private sectors often have one straightforward motivator as opposed to the multitude of aims of the public sector. Public private partnerships can be defined as, "a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility, and remuneration is linked to performance" (World Bank Group 2015). There are many factors to consider when contemplating whether PPPs can be a useful tool for improving infrastructure in the United States. If it can be assumed that the chief incentive of a private sector organization is to generate profit, what are the costs that are passed on to the "user" – in this case citizens of the United States? Additionally, the profit incentive may lead to skewed coverage of infrastructure projects, as private companies might only be interested in higher income, more profitable areas of infrastructure rather than areas that are struggling financially and could benefit from improved infrastructure. However, the profit incentive for private corporations can also lead them to put up significant amounts of financing for initial investments in projects, thus reducing the burden on government institutions to provide capital up front.

## **Chapter 3: Conditioning Factors**

### **Public Perception**

While investment in infrastructure is crucial for the United States, inefficient infrastructure projects end up being unnecessarily costly and negatively affect public perception of infrastructure projects. There are many examples of such projects in the United States: Boston's Big Dig, San Francisco's Bay Bridge, the new Woodrow Wilson Bridge in Washington D.C. (Flyvbjerg 2005). Flyvbjerg (2013) accounts for the approval of such projects as due to inaccurate cost-benefit analyses, as well as inaccurate environmental impact assessments. Many advocate for the increase for "shovel ready projects," but these – meant to describe projects that are for all intents and purposes ready to go with the exception of adequate funding – are hard to define and often still are subject to red tape. Petroski (2016, 142) notes shovel ready projects "may be politically and economically expedient, but it is not necessarily going to result in any models of engineering sense and architectural sensibility. It is true that there is much to repair and replace in our aging infrastructure, but haste makes waste, and function without form does not uplift the soul."

When infrastructure projects experience failures, in the form of delays, additional costs, and major disruptions, public perception of infrastructure projects is negatively affected. Throughout the twentieth century, infrastructure projects have been notorious for corruption, fraud, and waste. The expected inefficiency of infrastructure projects often hides corruption: when people come to expect variances between budgeted estimates and actual expenditures, fraud is easier to disguise. In the case of the San Francisco – Oakland Bay Bridge, the preparatory process of repairing the bridge after the 1998 Loma

Prieta Earthquake was tedious and extremely lengthy. The California Department of Transportation (Caltrans) went through a series of proposals, which increased in both complexity and price with every passing year and it was not until 2013 that the newly renovated bridge was completed. By the end of the process, Caltrans was undergoing a thorough investigation for allowing taxpayer dollars to fund what its executives knew was “substandard” work and actively working to hide the dysfunctions from public light. The report led to public scrutiny of both Caltrans and the process by which infrastructure projects are approved and awarded. After such disastrous projects, it truly is “no wonder that the voting public, and by extension their representatives in Congress, lack enthusiasm for raising taxes to fund infrastructure projects they might see as throwing good money after bad” (Petroski 2016, 180).

### **Proactive Infrastructure**

Infrastructure does serve an important role in keeping American citizens safe during unforeseen natural disasters. If infrastructure is not maintained properly and structurally strong, then cities will take experiences longer times to full recovery. One example of this can be seen through examining New Orleans and the levee failures it faced when Hurricane Katrina hit in 2005. After multiple studies and investigations, it was found that the city’s defense infrastructure, flood walls and levees, were poorly lacking in design and construction. If the United States Army Corp of Engineers had invested more time and consideration in building these original structures, then perhaps New Orleans might not have suffered the catastrophic losses that it did. Other examples of infrastructure failures include the I-35W Mississippi River Bridge in Minneapolis, the I-5 Skagit River Bridge in Washington, and the San Francisco –Oakland Bay Bridge in 1989.

Infrastructure must be built with consideration for risk and “how infrastructure is built to withstand (those risks) at a landscape level” (Miller 2017). In the event that the risks are impossible to predict accurately, then the United States should consider “safe-to-fail” designs which might not be fool proof, but do not make the problem worse either (Miller 2017).

### **Political Costs and Benefits**

Another obstacle many politicians must overcome for the United States to invest in infrastructure projects is political “short termism.” Infrastructure projects, and especially megaprojects, as defined by Flyvbjerg as costing one billion dollars or more, can often be complex, operate across functional and organizational boundaries, and take much longer than originally expected. Flyvbjerg argues that this is partially due to an oversimplification of costs during the planning stage – companies that compete for large project bids have incentives to be selective in how they measure costs, knowing that in order to be chosen, they must keep costs within what they deem to be an acceptable range, regardless of the true total cost (Flyvbjerg 2014). Additionally, “cost plus contracts,” which allow for construction companies to be fully reimbursed for the expenses they incur and then a set amount of profit, do very little to incentivize construction companies to keep costs low and delays short. Since these infrastructure projects are often multiyear affairs with high initial capital outlays, policy makers, whose terms range from two to six years, might not see as much political gain in focusing on infrastructure policy. Additionally, policy makers might have other priorities that they deem more crucial than infrastructure investment. Many in the public sector face constraints of time, money, and support from other funding sources and often these

constraints force tradeoffs among various goals. Without financial support from the federal government, for example, the majority of major state and local infrastructure projects are no longer feasible. Often, in highly contested campaigns, candidates feel pressured to change their positions on issues based on the public perception and pander to what they think is most likely to get them elected, even if they have access to or knowledge of information that is contrary to those beliefs (Chipman 2016). Yet, if policy makers can see political gain in investing in infrastructure, then they will be inclined to work on these projects.

In order for infrastructure projects to be proposed and funded by policy makers, the public must view these projects and investments favorably. Because public support hinges on whether the perceived benefits of infrastructure projects outweigh the perceived costs of the project, proponents of new initiatives must clarify the tradeoffs between costs and benefits. While benefits might include shorter commute times, safer routes, and many other positive changes in the long run, the immediate costs are obvious, and problems of disruption are often highly visible. Poor management often leads to delays and cost overruns. Insofar as citizens have short time horizons, anti-development sentiment can arise. When groups from different areas have opposing beliefs about proposed projects, due to differences in perceived costs, it leads to obvious social tension over the project. Often residents believe that the proposed project should take place, but in a way that does not affect them as much or as directly. Some have termed this phenomenon “Not in My Back Yard” or “NIMBY-ism.” The costs of infrastructure projects must be carefully considered – especially in cases where the groups who bear the costs are not the groups who benefit from the projects.

In Los Angeles, there has been a tangible rise in NIMBY sentiment, with regard to proposed light rails, high density housing, and other typical community improvement measures. In some cases, affluent neighborhoods rally against proposed changes because although changes might improve access for others, the affluent areas might bear the brunt of cost. For example, many in Beverly Hills opposed the proposed Metro Purple Line expansion, which would connect the traditionally high income Westside of Los Angeles with Downtown. Los Angeles County Metropolitan Transportation Authority (Metro) claims that the project is expected to “reduce reliance on automobiles, roadway congestion and deterioration, and reduce travel times” (Los Angeles County Metropolitan Transportation Authority 2015). Beverly Hills residents had claimed the main fault with the proposed expansion is that the plans involved tunneling under Beverly Hills High, which they believe to be a safety threat. The school commissioned two reports on the projects, one of which, found that “the tunnel is therefore not likely to directly impact the campus facilities (as we understand their current use)” (Shannon & Wilson Inc. 2012). This finding is contrary to what residents claimed to be true. Additionally, Beverly Hill High School leaders were strong advocates of moving one of the proposed stations to a location in Santa Monica, but Metro officials refused because of concerns over a fault line close to that location. In this example, Beverly Hill residents believed that the imposed costs of construction on Wilshire Boulevard and perceived costs to Beverly Hills outweighed the benefit of the expanded Purple Line for their own neighborhood and therefore aggressively lobbied against the new project. After multiple lawsuits and a long winded battle, Metro received \$1.6 billion in Federal grants to move forward with the project and aims to have parts of the project completed by 2024. Many in Los Angeles

have expressed frustration with Beverly Hill's NIMBY behavior noting, "rich neighborhoods waging expensive battles against public transit in L.A. remains a questionable and disturbing endeavor" (Broverman 2017).

It is worth noting that often public opinions of these projects can shift. While neighborhoods might originally oppose infrastructure projects on the basis of its costs, later the weight of various benefits might change. For example, while a group of people might originally oppose the expansion of public transportation, deeming it unnecessary, traffic might grow to be so unbearable that alternative transit options provide previously unproductive benefits. Alternatively, environmental concerns could rise to be more pertinent, thus increasing the need for mass transit options.

### **Public Private Partnerships: Build, Operate, Transfer**

If the public sector is unable to fund and effectively execute infrastructure projects, then in order to maintain and keep up with the United States' infrastructure needs, they will have to look to private investment. One model of a public private partnership (PPP) policy makers could investigate and encourage is the "Build, Operate, and Transfer" (BOT) model. The BOT model might also involve other functions such as design or ownership. Under the BOT model, private companies work with the government to obtain any rights they might need, build infrastructure projects from start to finish, operate the project and receive revenues from the project until a pre-determined date, after which they transfer ownership to the government. In some cases, the revenues are "obtained from user fees (as in toll roads) or from payments by the government's procuring authority" (Engel and Fischer and Galetovic 2010, 41). There are many different variations of BOT projects as they are highly dependent on the "the fiscal, legal,

and physical pond the (private actor) swims in” and can be “different from day to day, country to country, and projects,” but if successful, they provide a good model for what mutual beneficial PPPs can look like (Walker and Smith 1995, 24).

Under successful PPPs, there are aligned incentives for both public and private sector actors and BOT projects work to ensure such alignment. Private investment can provide the initial capital outlays for projects, which is a highly significant obstacle for otherwise entirely publicly funded projects to overcome. BOTS allow policy makers to move forward with projects “without immediately raising taxes, tolls, or public debt” (Petroski 2016, 269). Private actors will be willing to take on initial costs because the initial amount would still be less than “projections of revenue throughout the lifetime of the agreement, which might run for fifty years or more,” thus creating a positive net present value for the private actor (Petroski 2016, 264). The public sector would eventually gain ownership of the project, in some cases with the private actor still responsible for upkeep and maintenance of the project. This is symbolic on multiple fronts because the only major cost that the public sector has incurred is giving the private actor the rights to use the land and the permits for building, etc. Thus, it can appear that the government is gaining “something for nothing,” as the private actor has built a public works project and transfers it over without an exchange cost. This sort of transfer reinforces the idea that infrastructure projects are intended to be public works projects and should eventually be property of government entities.

Complexity of infrastructure projects is often exacerbated by interactions of the many groups that are involved with projects. Such groups involve designers, contractors, construction companies, various insurance companies, and regulatory agencies. These

groups might have different interests in the project's long-term success and durability. For example, unless the designers and their construction counterparts work closely together, actual projects might deviate from their original proposed structure, in order to minimize or alter a timeline in the face of costly delays. In BOTs, the incentives for ensuring long-term success and durability are high – since the private actor will be responsible for the upkeep for the length of the contract. In an effort to fight moral hazard, the private financing entities “disburse funds only gradually as project stages are completed” (Engel and Fischer and Galetovic 2010, 45). When construction and operation considerations are taken into account together, it “forces investors to internalize operation and maintenance costs and generates incentives to design the project so that it minimizes life cycle costs. But perhaps even more importantly, when builders are responsible for enforceable service standards, they have an incentive to consider them when designing the project” (Engel and Fischer and Galetovic 2010, 41).

BOT projects can also pose certain difficulties for policy makers. Because citizens will not often be able to distinguish projects that are run by the public sector or the private sector, if BOT projects hit obstacles and start to impose excessive costs on citizens, they will, in turn, incorrectly retaliate against policy makers. Alternatively, this could benefit policy makers by attributing successes of all infrastructure projects to the public sector. To minimize public backlash, policy makers should work to ensure that there are proper incentives for private actors to perform to predetermined standards. Of course, private actors are already incentivized by on-time revenue payments.

The effectiveness of BOT projects also leads some to criticize the public sector for not being able to undertake the same projects itself. One factor is that the cost of raising

capital for private actors is much higher than it would be for governments. Some refer to this as the “PPP premium.” This is because private project finance interest rates are likely to be much higher than the interest rates that the government pays. However, some believe that the government is an anomaly in that the government will often be considered “low risk” and therefore is privy to misleading interest rates that do not accurately reflect the risk actually incurred in infrastructure projects. Another criticism is that any benefit gained by the government by avoiding initial capital outlays is negated by the relinquishment of future user fee revenues that it hands over to the private actor (Engel and Fischer and Galetovic 2010, 65). However, since the scarcity of public funds for initial capital outlays is one of the major hurdles to whether infrastructure projects move forward at all, the benefits of having a private actor take on this responsibility are multiplied. Additionally, the Secretary of Transportation can authorize “Private Activity Bonds” (PABs), which are bonds that are “issued by a conduit on behalf of a private entity for highway and freight transfer projects,” which allows for the private actors to benefit from the lower interest rates typically allowed for a tax-exempt municipal bond (Federal Highway Administration).

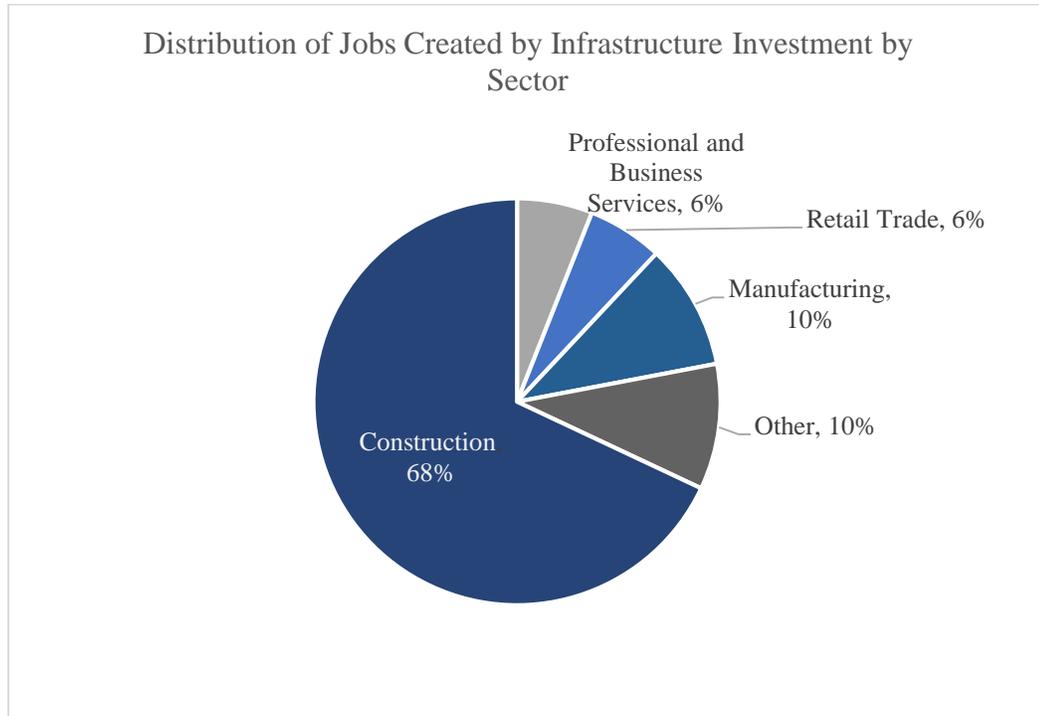
If policy makers look to BOT projects to serve the United States’ infrastructure needs, then policy makers should ensure that they are approaching negotiations from a position of strength rather than desperation. In some cases, if policy makers see the urgent need for new infrastructure, but are severely limited in their funds then, “a potential partnership with private investors can appear to be a godsend” (Petroski 2016, 269). In negotiating these contracts, however, obviously both sides are aiming to benefit. When policy makers come to the table desperate for a solution, they are more likely to

agree to terms that might be beneficial in the short term, but detrimental in the long run. For example, in 2009, Chicago entered into an agreement with an infrastructure investment fund backed by Morgan Stanley, in which the fund would gain control of the thirty-six thousand metered parking spots in the city for 75 years, in exchange for an upfront fee of \$1.2 billion. The initial influx of cash was quite welcome to the city, which was facing a budget deficit, but half a year later, “a report revealed that, according to an estimate made by the city’s inspector general, had Chicago retained control of the meters and operate them itself, it could have realized almost 1 billion more than it would get over the course of the lease” (Petroski 2016, 265).

While PPPs and BOTs provide a unique opportunity for policy makers to bypass traditional public sector inefficiency and hurdles, it remains the ultimate responsibility of the government to be able to fund and create infrastructure for all its citizens. BOT projects are attractive to private actors because of the user-generated revenue they can create in, for example, privately-operated toll roads. Therefore, private actors are unlikely to be interested in projects located in lower income areas that are unlikely to generate such revenues. However, these areas might require heavy maintenance on existing infrastructure or new projects most urgently. The government has a duty to provide for all its citizens equally and fairly. If policy makers are heavily dependent on BOTs, some areas will benefit more than others, and it remains the government’s job to balance out these inequities out by being able to fund infrastructure projects themselves. As previously discussed, however, the government is currently struggling to fund infrastructure projects to adequately meet the public’s needs. The current funding mechanism for the Federal Highway System is the Federal Highway Trust Fund, which

has been unable to keep up with current infrastructure needs. This funding mechanism, therefore, is in dire need of updates and reform. If policy makers are able to increase government spending on infrastructure to meet demonstrated public needs, then overall government expenditures will increase, often improving economic performance. Keynes argued that increased government expenditures would have multiplier effects on GDP, due to an increase in aggregate demand. While some argue over the merits of Keynes' argument and the size of the multiplier itself, the potential for short-term benefits of increased investment in infrastructure need to be considered. These can be seen through increased employment rates, especially in the wake of the 2008 housing crash and the widespread unemployment of construction workers that followed. Additionally, spending on infrastructure creates jobs in manufacturing, retail, and professional and business services. This is because increased infrastructure investment requires a myriad of skills and resources, such as “grading and paving equipment, gasoline or diesel to run the machines, smaller hand tools of all sorts, raw inputs of cement, gravel, and asphalt, surveyors to map the site, engineers and site managers, and even accountants to keep track of costs” (Council of Economic Advisors 2014). Additionally, new infrastructure often connects areas and create new centers of economic activity.

Figure 3.0: Distribution of Job Growth by Sector (Council of Economic Advisors (2014) analysis of Bureau of Economic Analysis and Bureau of Labor Statistics (2012))



In a polarized and partisan era of politics, it is hard to find common ground among policy makers. With parties disagreeing on a wide range of emotionally charged issues, including immigration, foreign policy, and social issues, it is clear why infrastructure and transportation policy has fallen by the wayside. The issue is not flashy and understandably does not garner the same sort of media coverage or electorate attention as other issues on the national spotlight. The problems with infrastructure might not be highly contentious, but they do affect the everyday American on a significant and consistent basis. If policy makers can find a way to gain public support and make substantial changes to the current status quo, then the United States stands to see substantial and tangible both economic and social benefits.

## **Chapter 4: Projections**

The United States' infrastructure is deficient in a myriad of ways: faulty bridges, deteriorating roads, inefficient routing, and inaccurate and costly construction processes. The current state of infrastructure poses seemingly endless challenges, but they also provide a unique opportunity. Recent advances in technology present the ability not just to build new infrastructure, but to build smarter infrastructure. These changes allow for advances that could reduce maintenance costs, system inefficiencies, and increase safety measures. In addition to the opportunity that these technological advances present, the fact that the United States has such a high need for infrastructure investment provides an opportunity to fundamentally redesign urban areas in a way that is more productive and beneficial for society.

### **Changes in Cars**

There are two kinds of technical advancements that are important to note: ones that will change cars and, in turn, change the way people drive and affect their infrastructure needs and ones that change the way that infrastructure is built. Technologically advanced cars are already hitting the market and becoming available to mass consumers. These advances can take many forms from beeping noises that alert the driver, whose car is too close to another car, to complete automation and self-driving technology. One innovation is "connectivity zones" for cars, wireless networks within certain a radius around each car. Cars would be fitted with computers and would connect to this wireless network. Once part of the connectivity zone, each car's location would be uploaded and thus, all cars within the connectivity zone could interact with respect to other cars' locations in relation to their own. This could be particularly impactful, especially when scaled up and

adopted by all cars on the road. This can be used when cars are on the highway, for example, to ensure that all cars in a certain area are traveling at the same speed for maximum efficiency. When one car abruptly slows down, the following cars are instantly alerted and can alter their speed to avoid any collisions. This connectivity is also useful in an urban setting, where awareness of other vehicular behavior is paramount. For example:

if all vehicles in the vicinity of an upcoming intersection were part of the wireless network, the computer in a car approaching the intersection could know whether there would be cross traffic. If so, the driver would be alerted to approach with caution or stop, and perhaps even have a bright electronic stop sign displayed on a navigation screen...If the intersection is anticipated to be clear, no warning would appear and the car would not even have to slow down (Petroski 2016, 275).

If all vehicles were equipped with this system, cities would have lower costs of enforcing speed limits, maintaining roadway signs, and fewer traffic related casualties.

Additionally, citizens would experience immeasurable improvements in road safety and countless hours saved in traffic.

### **Changes in Infrastructure**

Technological advances that affect the way that infrastructure is constructed will also significantly benefit American infrastructure. One example is new types of “self-healing” asphalt that are being tested in the Netherlands and China (Chen 2017). If these inventions work as expected, initial capital outlays for road projects would be higher but the long-term savings would be monumental for the United States. Another innovation

that could provide sizeable benefits is in sensors that monitor structural strength, in the form of:

pieces of smart infrastructure that in essence monitor themselves and alert engineers and others when they are in need of attention. A roadway can be embedded with sensors that detect snow and ice conditions, signaling when road crews should be dispatched. Bridges can be fitted not only with sensors but also with devices controlled by the sensors. Thus, when ice begins to develop on a bridge surface the sensors that detect it can also trigger a system embedded in the curb or guardrail that sprays anti-icing solution over the pavement without human intervention (Petroski 2016, 273).

Additionally, sensors and devices, akin to those that “tell a smartphone or tablet which way is up,” could be incorporated into bridge designs that would signal to performance monitors when usage or unplanned events lead to structural deficiencies, during routine passes over the bridge by “computer – and sensor – filled trucks” (Petroski 2016, 273). The introduction of such technology can have substantial cost-reduction effects: decreasing the necessity of expensive exploratory measures, decreasing the likelihood of bridge failures, and identifying causes of deficiencies. If maintenance crews know exactly how the bridge is failing, then repair times are reduced and overall efficiency of the maintenance process is increased.

In South Carolina, for example, at least eight bridges have been fitted with girder sensors, for \$50,000 per bridge. In 2014, these had already created cost savings for the taxpayer of up to \$5 million (Chieppo 2014). In addition to cost related benefits, South

Carolina Department of Transportation (SCDOT) has found the sensors to create other efficiencies. For example, sensors are able to accurately measure wind speed, which “allows SCDOT to know when to close a bridge without, for example, having to send an employee to site during an approaching hurricane” (Chieppo 2014). Furthermore, agencies can set up alerts if the bridges are facing certain conditions, such as drivers who are driving vehicles above weight or height limits. In these cases, they can penalize those drivers who might be causing the most harm to the structure in the forms of tickets and fees, thus creating incentives to avoid risky behavior.

### **Data and Apps**

In addition to technology advancements that should eventually be built into both vehicles and infrastructure, specific actions that are made possible by technological advancements can be implemented currently at minimal cost. StreetBump, a mobile application developed by the City of Boston’s Mayor’s Office of New Urban Mechanics, allows volunteers to collect road condition data while traveling their normal routines. The phone’s built in accelerometer “detects bumps, and software distinguishes a bump due to hitting a pothole from one due to riding over a manhole or speed bump” Petroski 2016, 275). At the end of the trip, the data is collated with GPS locations and an alert is sent to the city’s road maintenance department. In this way, potholes can be specially targeted and repaired in a much more efficient manner. This sort of data crowd sourcing has increasingly touted as a mechanism to measure infrastructure needs and growth. Placemeter, a startup based in New York, pays users “up to \$50 a month for street views captured via old smartphones” (Jaffe 2014). The company then analyzes the footage from people’s windows and turns it into data. These data are sold to companies for advertising

purposes and to make cities more efficient and functional places. Policy makers could also use these data to “detect the use of benches or near misses at intersections – and generally evaluation (and perhaps improve) public projects more quickly than they might otherwise” (Jaffe 2014). Kansas City recently built a light rail line along which city officials installed “computer-equipped sensors on streetlights,” which are able to “gather information about traffic and available street parking along the corridor” (Totty 2017). They have even made the data publicly available, in order for citizens to find open parking spots and identify areas with heavy traffic (Totty 2017). The sensor can also automatically dim if no one is around, and in this way conserve energy. Bob Bennet, the Chief Innovation Officer of Kansas City, says that their goal is to “improve their efficiency of service and ascertain what services we ought to be providing” (Totty 2017).

As society gains familiarity with technological advancements like machine learning, humanized big data and the growth of cloud services, and the internet of things, it is likely that our transportation systems will be built smarter and more efficiently (Totty 2017). This amplifies the imperative to invest in our systems now, since “whether our roads and bridges can actually evolve to such an idyllic state in the foreseeable future will depend upon how well we care for them in the interim... Almost every dollar budgeted for roads and bridges, whether at the federal, state, or local level, will have to be earmarked for repair and replacement work just to restore the status quo ante rather than advance the technology and apply it broadly” (Petroski 2016, 278). A precondition for being able to make the most of these advancements is not having urgent deficiencies and repairs to crowd out any new or technologically motivated investments.

### **The Effects of Investing in Infrastructure on American Cities**

The need for more productive physical infrastructure in the United States creates an opportunity for civil engineers, city planners, and other policy makers to also fundamentally reimagine what cities and urban areas look like. Currently, American cities are characterized by wide streets and large parking lots and structures. They are built around the country's reliance on cars. As the automobile became more affordable and common place in the United States, roads became increasingly relevant and important in major cities. In some cases, this change had immediate effects on communities: "...city planners wanted to make it as easy as possible for drivers to access metropolitan areas. That often meant building highways straight through the centers of our most vibrant cities. Neighborhoods were literally split in half, and many never recovered" (Zimmer 2016). This is additionally reflected in just how much space is taken up by parking lots, with some lower estimates being up to 3,590 square miles – greater than the combined areas of Delaware and Rhode Island (Kimmelman 2012). Technological advancement can decrease the country's dependence on automobiles – and that can have tangible and discernable effects on what American cities can look like.

With the introduction and normalization of self-driving cars, American car ownership could dramatically decrease. The average car owner in America is spending around \$8,500 annually on car ownership, based on estimates of 15,000 miles driven annually (AAA 2017). Collectively, "Americans spend more than \$2 trillion every year on car ownership – more money than (Americans) spend on food" (Zimmer 2016). With the rise of ride-share technology (and trends of urbanization), fewer people are buying cars than before. Some do not bother learning how to drive – the number of 18 year olds who have their driver's licenses is down 20 percent from 1983 to 2017(Sivak, Schoettle

2016). The downward trend is consistent across all other ages as well, except for those older than 50 (Sivak, Schoettle 2016). Some estimates even have Millennials as 29 percent less likely to purchase cars (Cortright 2015).

Without lower rates of individual ownership of cars, cities will look be palpably different. This change has already started to take root and can be seen around the world, in addition to the United States. In New York City, Mayor Bloomberg has worked to convert spaces traditionally reserved for cars or parking to public or community areas. In addition to building community, these transitions have secondary benefits for the areas they are located. For example, the “parking lot below the Manhattan Bridge, is now a plaza where New Yorkers go to eat lunch and spend time with friends. Just five years after reclaiming this space from cars, retail sales in the surrounding area increased 172%” (Sadik-Khan and Solomonow 2017, 254). This presents an important opportunity to policy makers in the United States. There is a need to invest in productive physical infrastructure – but can they do this while designing cities that meet citizen’s need for infrastructure, but also other needs as well?

One technological advancement that could have extreme effects on the way that American cities look is self-driving technology, and, with it, the automation of parking and parking lots. When self-driving technology becomes fully street legal – and it will, by many estimations, far sooner than often believed – then the need for parking lots will potentially be greatly diminished. This is because when passengers reach their destination, they could choose to rent out the services of their fully capable and self-driving vehicles, instead of, by default, parking their vehicle for the duration that they will be staying at their destination. As of 2013, the average automobile is parked for

around 95% of the time (Barter 2013). Of course, there will be a need for parking lots, but with the car to car connectivity zones discussed previously, parking lots could be made far more efficient and automated. They could be underground and more compact without needing to account for human error.

Some infrastructure improvements will happen slowly – cities are unlikely to retrofit their bridges, roads, and cities without compelling inadequacies and adequate funding. But as routine maintenance is performed, hopefully over time, cities will start to opt for technologically savvy solutions to the problems they have been experiencing for decades. Others have lofty plans to build entirely new cities from scratch – and use them as a model to learn about what works and what does not. This begs the question: How can policy makers be sure that the technology that they might pay millions to install now will not be over shadowed by advances made tomorrow?

This dilemma will likely continue. It is a challenging and complex problem to solve, but there are two paths that policy makers can take to alleviate the effects. First, policy makers can determine what areas are of most concern to them. Then, policy makers should follow advancements that are in the most urgent areas. For example, if a state has a lot of waterways and spends a large portion of its budget on bridge maintenance, it could prioritize incorporating technological advancements that would allow it to reduce maintenance costs and build structures that are more physically durable. Alternatively, if a state is characterized by large urban centers, policy makers could look at technological advancements that reduce congestion, streamline traffic, and making parking more efficient. After explicitly outlining their priorities, policy makers should decide on specific measurable outcomes and then confer with independent experts

to determine what sorts of advancements would meet these goals. In this way, policy experts continue to make progress within pre-determined guidelines on what is “good enough,” rather than being directionless and overwhelmed by choices. These priorities and guidelines should be periodically updated and reviewed, in order to ensure that they stay relevant. Additionally, in the face of ever evolving technology, outcomes that were previously thought to be unachievable might become more plausible.

Another path policy makers can take is through using technology that allows for periodic updates. Since many advances would be accomplished through computerizing everyday devices when improvements are made to that technology, the cars could download those improvements. These updates will be of the utmost importance, especially with regard to self-driving cars and automated vehicular processes, as engineers continue to improve the systems based on the influx of data that will come with mass use. By adopting technology with open architecture, policy makers can ensure that their systems and infrastructure will stay up to date and will continually improve.

The secondary effects from investing in infrastructure are remarkable and should remind policy makers and citizens why investing in infrastructure poses such a crucial opportunity. Technological advances also provide a compelling reason to start now. By funding and solving the country’s most urgent infrastructure needs now, policy makers set the stage for more durable, efficient, and technologically advanced infrastructure later. And by phasing in those technological advancements where feasible now, policy makers reduce the need for increased infrastructure later.

## **Chapter 5: Recommendations and Concluding Thoughts**

As outlined in previous chapters, the costs and opportunities associated with infrastructure investment are numerous. They are well documented, notable, and urgent. Many agree that the United States needs to invest a significant amount in order to bring infrastructure to an acceptable level. However, policy makers face major obstacles in trying to strengthen physical infrastructure in the United States. These obstacles are mostly in the form of tradeoffs and limitations. The tradeoffs and limitations are intricate and pose a challenge for policy makers, who must balance the United States' infrastructure needs alongside many other needs. In order to create good policies, policy makers must balance these tradeoffs and carefully consider the effects they can have on implemented policies. Understanding the tradeoffs involved with constructing effective infrastructure policy is also valuable for policy makers because it allows them to clarify their problem definitions. More specific and nuanced problem definitions allow policy makers to craft effective and detailed solutions, rather than broad, one-size-fits-all policies.

### **Tradeoffs**

One tradeoff policy makers must carefully consider is the targeting of funding. First, policy makers must decide what types of projects take precedence – should new capital expenditures be prioritized over maintenance and upkeep of older infrastructure? How should policy makers value the utility that created by new roads, when there is barely enough available funding for the upkeep of already constructed roads? From here, policy makers might struggle to determine how these funds should be raised in the first place. Many state and local projects are unlikely to be completed without some federal

assistance. But should federal taxes be spent on projects that do not benefit all taxpayers? For example, if a mass transit project is planned in an urban area, what benefits are created for taxpayers who live in rural areas far from the city? The alternative to using federal funding would be to specifically pass all upfront costs to the users of the system in, for example, the form of increased ticket prices or toll roads. These users, however, might not be able to afford these excessive costs.

This dilemma is central to the next major tradeoff that policy makers face when considering investing in infrastructure, which revolves around distributional justice. How can policy makers ensure that every citizens' infrastructure needs are met? PPPs and BOTs create a compelling opportunity for policy makers, by allowing private entities to finance, build, and operate infrastructure projects and receive revenues from the project, before eventually transferring ownership to the government. These projects are important for policy makers to consider because they essentially remove the need for initial capital expenditures for government entities, which is one of the largest hurdles potential projects face. However, as discussed in Chapter 3, revenue streams are essential to incentivizing private actors to put up the initial costs of the problem. Low-income areas, which will likely be unable to generate these revenue streams, are unlikely to appeal to private entities as areas for possible infrastructure investment. This is a problem because low-income areas are often the areas that have the most urgent infrastructure needs. How should policy makers utilize BOT projects, while ensuring that the utility created by those projects benefits all citizens fairly?

Another component of distributional justice is the tradeoff between investment in mass transit, in lieu of infrastructure investments in roads and bridges that would benefit

individual drivers more. Since policy makers are limited by both federal and sub-national budgets, they need to prioritize certain projects over others. Investing in mass transit is important, as it reduces congestion, harmful environmental effects, and allows citizens more choice and flexibility. However, it is complex to introduce comprehensive mass transit systems to already developed cities. For example, if a mature city wants to introduce an underground transit system, it would have to incur extreme costs and likely face many regulatory hurdles along the way. Investing in mass transit also prioritizes the needs of citizens who live in areas that can easily access the system. And while infrastructure investments in roads and bridges are important, they prioritize the needs of those who can afford cars and further emphasize the pervasive idea that car ownership is paramount in the United States.

In addition to distributional fairness, another tradeoff that policy makers face is balancing short term costs with long-term benefits. This is especially relevant when considering public perception and support for projects. Most infrastructure projects are lengthy and are characterized by delays and costly overruns. Therefore, these projects, which might lead to substantial improvements for the community, are often hard to digest, as people tend to have short time horizons and are usually fixated on the costs incurred upfront. Additionally, policy makers face challenges regarding the timing of capital outlays. There are myriad ways that a given proposal for an infrastructure project could be improved and developed further. Some of these additions might substantially reduce the cost of maintenance further down the line. So should policy makers spend more money now to reduce costs later and build American infrastructure to last? Or should policy makers delay the costs and gain more support for less expensive projects

now? Policy makers often issue bonds in an effort to generate capital for investment in infrastructure projects as well. The government is responsible for paying the bonds off at the end of their terms. In this way, policy makers often delay the costs of investing in infrastructure. But if policy makers prioritize balanced budgets, then during the terms of the bond, the government must find a way to raise that capital and the interest that has accrued. Policy makers also face the dilemma of balancing short-term costs with long term benefits when examining potential BOT projects. When government actors agree to BOT projects, they forgo revenue streams generated by the project in the future for a fixed number of years.

If policy makers have a detailed understanding of these nuanced tradeoffs and limitations, then they will be able to craft accurate problem definitions. Geva-May (1997, 2) explains how complicated this can be: “First, a problem situation implies a discrepancy between needs and wants, or between expectations and possibilities; some problems may infer more than one cause for the problem. Second, clients tend to present ‘symptoms’ or troubling alternatives rather than formulate the overall problem in a coherent analytic way that allows a follow-up examination.” Appropriate definitions are paramount for policy makers to be able to create functional solutions to complex policy problems. For example, if the problem definition is simply “The United States is facing serious deficiencies in the country’s infrastructure,” then the solution might be so simple as, “The United States should invest in the country’s infrastructure and solve those deficiencies.” However, as outlined above, that is an oversimplified response and does very little in terms of developing equitable, durable, and robust policies that meet citizens’ needs.

## **Recommendations**

What should policy makers do in face of such challenging tradeoffs? It is likely that policy makers will find the most success in the hybridizations of different options. For example, rather than considering BOT projects as the be-all and end-all to solve the United States' infrastructure crisis, policy makers should only consider engaging in BOT projects in parts of the country that can afford them. At the same time, policy makers should focus on reforming the Highway Trust Fund, by indexing the tax it imposes to gas prices. This would generate funds for publicly-funded infrastructure investment, where BOTs are not feasible.

Additionally, it is of the utmost importance that policy makers engage and educate the public regarding these nuanced challenges surrounding the urgent need for increased infrastructure investment. While a poll conducted in 2017 showed that 79 percent approve of increased infrastructure spending, these sentiments are not reflected in voting results. It is important for the public to reconcile that those same projects might impose costs on citizens in the short term (Agiesta 2017). Without public support, it is unlikely that policy makers will be able to be as effective and accomplish as much as possible. Policy makers can invoke certain appeal principles, in order to effectively engage the public and build public support (Lasswell 1932). This education can come in the form of explicitly outlined policy priorities or in town halls held to explain proposed projects to the public. When citizens feel they have been included in the policy process, it is more likely that they will support proposed infrastructure projects.

## **Final Thoughts**

Infrastructure investment is a challenging topic to take on because the tradeoffs that policy makers need to consider are elaborate. It can be daunting to create solutions and the pursuit of perfect policies is endless. But the difficulty inherent in policy process is matched by the opportunity that infrastructure presents. The current inadequate infrastructure of the United States affects most Americans on a daily basis and, if policy makers can raise enough public support, policy makers can affect real change in the United States, especially through technologically advanced and exciting new innovations in infrastructure. As Petroski (2016, 278) notes, “Neither voters nor elected officials should be satisfied with or tolerate the mediocre to poor infrastructure that we are told our nation now possesses. In fact, we should be embarrassed. We as a nation should want our public works to be better than they are.” Petroski is right – while the United States succeeds by many different measures on a global scale, the country is failing its citizens at home by not adequately investing in infrastructure.

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