Improving Sustainable Development in Lima Through Public Transportation Investment

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Introduction

Every day citizens of Lima travel across the city for work or personal reasons, like people all over the world. Yet they face more obstacles in their daily travels, with a good portion of their time wasted sitting on overcrowded, unregulated, dangerous buses in traffic. Thus, the average person in Lima spends four hours a day commuting to and from work. This inhibits citizens living in lower-income areas from accessing potential jobs in wealthier parts of the city and damages the health of all citizens by polluting the air. By reducing the productivity of Lima’s population, the inefficient transportation limits Peru’s overall growth potential.

An increase in public transportation infrastructure is crucial to Lima’s and Peru’s continued growth and sustainable development since few public transportation options exist because of the rapid growth of the city. Over the past decade, Peru had one of the highest GDP growth rates in Latin America, averaging 5.9 percent per year, with a large percentage of that growth coming from Lima, the capital city, where over one-third of Peru’s population lives (Peru Overview…). For high growth rates to continue in the coming years, however, Lima needs to decrease its income inequality, which has seen little improvement over the same period. Public transportation investment can help reduce income inequality by allowing lower-income citizens access to better-paying jobs across the city. The election of President Pedro Pablo Kuczynski in June 2017 put Peru on this path. One of Kuczynski’s priorities is an increase in infrastructure investment to help close the significant infrastructure gap, providing hope for a brighter future for Lima and Peru.

My purpose in this article is to analyze the transportation system within Lima and to offer recommendations that will allow for sustainable and inclusive growth. I begin by examining the development of Lima into Peru’s
capital city and its rapid population growth over the past century. The development pattern led to the current socio-spatial inequality. Next, I detail the current transportation in Lima with a focus on how the historical socioeconomic income distribution has led to deregulated and informal transportation with long transit times and dangerous levels of pollution. Lima currently has limited public transportation options, consisting of only one main bus corridor and one operating metro line. The existing metro line can integrate with future metro lines, some of which are currently under construction. When combined, the metro lines will create a more complete public transportation network across Lima. I conclude by analyzing the current metro line project and the plans for moving forward with a recommendation for how to best proceed with continued public transportation investment.

Background

Lima’s Development from 1535 to 1908

Founded in 1535 by the Spanish conquistador Francisco Pizarro, the city of Lima grew in bursts, with alternating periods of expansion and destruction from its founding through the twentieth century. Lima was established on the banks of the Rímac River near the coast of Peru. This provided fresh water for the city and a central location through which gold and silver could be routed, allowing for the initial growth of the city. At the same time, the port of Callao was formed directly west of the city center of Lima on the Pacific Ocean. The central district of Lima is still in its original location on the river and sits 13 km from the ocean. The layout of the original town followed traditional Spanish guidelines, with central plazas and streets in an east-west, north-south grid pattern, bringing organization to the city. In the late 1600s the boundaries were clearly defined by a defensive wall built around the city. However, the city interior became less organized as diagonal streets cut across the grid and racially segregated neighborhoods appeared. Unfortunately, most of the early development was destroyed in 1746 when an earthquake hit Lima, and a tsunami struck the nearby port of Callao. By 1796 the population stood at around 50,000 people in an area surrounded by the still-standing wall (Oliver-Smith, p. 263). Lima’s population remained constant for the next century as diseases such as malaria and dysentery were rampant due to poor sanitation. The wall was demolished and a plan for development was created in the 1860s, but growth was halted when the Chilean navy bombed and then occupied Lima during the War of the Pacific (1879–1883).

The most recent period of Lima’s growth began with reconstruction of the city center following the war with Chile and is still continuing today. Following the war, Peru borrowed money from Britain to rebuild, in exchange for British control over all Peruvian mineral resources. Under British influence, rail systems were built for industrial purposes with a focus on linking center city Lima to other coastal settlements and to the Andes Mountains in the West. Electrical grids and sanitation systems were constructed and basic public services provided, including schools, hospitals, and police and fire departments. Despite the modernization of the urban centers, agriculture production was stagnating and economic inequality was growing in rural areas. The declining quality of life pushed people out of rural areas toward Lima and resulted in mass migration to Lima.

Development from 1908 to the Present

The migration that followed can be broken down into three stages: 1908–1940, 1940–1960, and 1960–present. During the first stage, the annual urban population growth rate jumped from 2.5 to 6.1 percent from 1920 to 1930 (Oliver-Smith, p. 266). This was an increase from approximately 6,000 people per year to almost 23,000 people per year. Most of the people were wealthy elites who settled in dense suburbs closer to the coast and expanded beyond the city footprint established over the past 300 years. The second stage, from 1940 to 1960, saw the continued expansion of the city into peripheral areas as the population growth rate climbed to upwards of nine percent annually (Oliver-Smith, p. 267). The area from the old city center of Lima all the way to
Callao became fully urbanized, with migrants of a lower socio-economic class. Lima entered the third and current stage of growth around 1960. By 1984 Lima had grown to 6 million people, equal to the entire population of Peru in 1940 (Oliver-Smith, p. 267). This later group of migrants were primarily low income and settled even further out on the city periphery. This wave of migration was most significant because a large portion of it was in the form of “land invasions,” in which large groups of migrants moved during the night onto property to which they did not have rights.

Communities were built quickly and forced the government into a difficult decision of either forcibly removing the squatters or allowing them to remain. The city of Lima allowed the migration and added legitimacy by granting land titles and formally recognizing community charters. The quickly constructed settlements developed into pueblos jóvenes (young towns) as the buildings became permanent. This process continued on available land on the city periphery, and more pueblos jóvenes arose farther from the city center. The informal migration led to widespread urban sprawl as the city limits expanded into hills unfit for houses and lacking public services such as water and electricity. This latest migration was significantly different from the previous waves of migration in which the communities were planned and infrastructure built along with the houses.

Social/Economic Inequality in Lima

The high rate of population growth led to a lack of available services in the outer parts of the metropolitan area and a lack of infrastructure and transportation throughout the city. As illustrated in Figure 1, the central districts, circled on the map, have very few poor people while the outer districts have large numbers of people living in poverty. In the wealthier districts, over 98 percent of people have incomes in the top quintile. Yet in the poorest districts, the darkest areas on the map, poverty rates are upwards of 26 percent (“Planos Estratificados...”). In total, there are 1.3 million people considered poor by World Bank standards in the Lima metropolitan region and another 1.7 million considered vulnerable (“International Bank...,” p. 2). The outer districts, which have the most poverty, consist largely of the pueblos jóvenes in deteriorated areas without public services.

The location of the pueblos jóvenes on the periphery of Lima creates transportation issues for the people living there and reinforces the economic inequalities within Lima. The average age within the pueblos jóvenes is lower than the average age in Lima, representing a key demographic for growth. Growth and the country's future are dependent on the education of the youth and their access to formal employment. Although there may be jobs in the informal sector within the pueblos jóvenes, most better-paying formal sector jobs are located around the city center in the wealthier districts (“International Bank...,” p. 81). Jobs within the formal sector have significantly higher wages and higher productivity per hour of labor. In addition to formal jobs, most education, health care, and other services are located in the urban centers. Access to these services for everyone is necessary for the development and growth of Lima, and requires efficient transportation throughout the entire city.

Transportation in Lima

The current transportation system is holding back economic growth by creating excessive travel times that reduce productive hours of work and by emitting pollution that adversely affects public health. Every day Limean residents make approximately 22.3 million trips. About half of these trips are made on largely unregulated, private, mass transit vehicles. One-quarter of all trips include personal vehicles, and the rest are made on non-motorized transportation or public transportation.

The unregulated private vehicles include jitneys (also known as combis), which have a capacity of approximately 12 people; microbuses, which have a capacity of approximately 24 people; and larger standard buses, which have a capacity of approximately 60 people. There are approximately 31,000 vehicles among the three types on more than 560 routes around the city. The stops of each bus route are communicated by painting the
stops on the exterior of the bus. The small size of the jitneys and microbuses leads to constant overcrowding, and most of these vehicles are old and therefore emit significant levels of pollution. Despite these inefficiencies, these three private modes account for 98 percent of the miles traveled using mass transportation. The jitneys account for 48 percent of vehicle miles traveled per day on mass transportation, microbuses account for 39 percent, and standard buses account for 11 percent (“International Bank…”).

The trips in personal vehicles, which make up one-quarter of all trips, include personal autos and taxis and are accounted for primarily by wealthier citizens. Cars and motorcycles carrying only single occupants add significantly to the number of vehicles on the road—a single bus carrying 60 people could eliminate 30 cars if each car has two passengers.

**Transportation Issues**

The existing transportation modes within Lima, especially informal public transportation, result in congestion and safety issues and place a greater burden on the poor. The informal mass transportation on gridlocked streets is inefficient with regard to travel time largely due to traffic and the number of stops. Based on surveys of average travel times from 2012, the standard buses take the longest with an average travel time of 47 minutes. This is followed by the microbuses, with an average travel time of
40 minutes ("International Bank..."). These times are longer than private vehicle trips and formal public transportation, placing a greater time and cost burden on the poor who rely heavily on informal public transportation. The longer travel times reduce the number of jobs that are within commuting distance as well as the quality of life by decreasing the amount of time spent with family. This is especially true for the poor communities because they are primarily located on the outskirts of Lima and the formal, higher-paying jobs are concentrated in the central districts of Lima ("International Bank..."). According to Antonio Brack, a former environmental minister in Peru, “Traffic congestion makes the average commute in Lima over an hour each way and costs more than $1 billion a year in lost output and health problems caused by pollution” ("The Train Leaves...").

In addition to monetary and time costs, the current transportation infrastructure poses a significant health risk for the citizens of Lima. For children aged 5 to 14, the leading cause of death is traffic accidents (Fraser, p. 543). This is due to unsafe transportation both on the roads and roadsides, with large numbers of vehicles on the roads because of the insufficient infrastructure to allow for alternative transportation options. In addition to the cost and physical safety issues, current transportation modes present serious environmental and health concerns due to pollution. Most transportation modes release carbon dioxide and soot into the air, polluting the environment and creating health concerns for the citizens of any metropolitan area. However, citizens in the Lima metropolitan region are especially susceptible to pollution because of the aging private vehicles used for mass transportation and Lima’s geography: the prevailing winds off the Pacific Ocean push the pollution inland where it is held by the hills and mountains. One common measurement of air pollution is the amount of particulate matter under 2.5 microns in diameter (PM 2.5) per cubic meter. The particulate matter is made up of sulfates, nitrates, black carbon, and other matter from the burning of fossil fuels. The World Health Organization’s guideline value for clean air is a maximum of 10 micrograms of PM 2.5 per cubic meter. Based on its study of Lima, the World Health Organization found average levels between 38 and 63 micrograms per cubic meter ("Ambient [Outdoor] Air Pollution..."). This was the worst level of pollution found among Latin America cities. According to the Consorcio de Investigación Económica y Social (CIES), a research agency organization in Peru, this high level of pollution has caused over 5,000 deaths from 2007 to 2011 (Joly, p. 1). In addition, and more commonly, pollution can also cause or aggravate asthma and other health problems. The International Study on Asthma and Allergies in Childhood found asthma symptoms in 26 percent of children in Peru, which was the highest of all Latin America countries (Mallol et al., p. 441).

CIES also found that 80 percent of the air pollution in Lima is directly attributable to public transportation, with the old age of the vehicles adding to the increased pollution. As Susan Villaran, the former mayor of Lima, said, “52 percent of Lima’s buses and combis are over 20 years old” (quoted in Joly, p. 2). Studies have shown a direct correlation between heavy traffic in Lima and adverse health effects. One study found that children ages 13 to 15 living within 100 meters of a heavily trafficked avenue are twice as likely to display asthma symptoms (Baumann et al., p. 875). Another study found that the prevalence of asthma in children ages six to seven and 13 to 14 is significantly related to the traffic flow density (Carbajal-Arroyo et al., p. 197). Together these studies show a pattern of dangerous health effects associated with the high traffic density and the modes of transportation currently in use in Lima. These consequences of congestion and pollution led government agencies to begin implementing public mass transportation around 15 years ago, but still further expansion is necessary.

**Current Public Transportation Initiatives**

To help alleviate the many issues associated with transportation in Lima, the municipality of Lima began operating two public mass-transit systems within the past 10 to 15 years and has plans to implement more. In 2012 a rapid bus transit system known as El Metropolitano began accepting riders. It
includes 26 km of a bus rapid transit line along one main north-south corridor as well as a north and south feeder bus network that operates on local roads. The bus rapid transit line has separated lanes down the middle of highways reserved for buses and has stations for on-and-off boarding. The line contains 35 intermediate stations, a central underground station, and a north and south terminal for transfers. The stations are elevated platforms that require payment of fares before entering. Approximately 300 buses operate on the core line with more on the feeder bus networks. All buses run on natural gas and have a capacity of 40 to 80 people (Instituto Metropolitano Protransporte de Lima). The system is heavily utilized with 700,000 trips made daily on the Metropolitano. Taking the Metropolitano reduces travel time by over 25 percent from end to end and at 33 minutes has significantly lower average travel time than other transportation modes (“International Bank…,” p. 3). While the bus rapid transit line only runs on one main corridor, it runs through 12 districts and provides access to 18 districts when the feeder networks are considered. The feeder bus networks allow the Metropolitano to be more accessible to the periphery districts and help increase public transportation options for the poor.

In addition to the Metropolitano bus network, Lima is in the process of implementing an electric train mass transit system. The process began in 1986 when Metro Line 1, which is currently the only operational line, was authorized. The Autoridad Autonoma del Sistema Eléctrico de Transporte Masivo de Lima el Callao (AATE…) was created to plan, coordinate, implement, and supervise the project. Design and construction went on for three years, during which 9 km of the planned 22 km of track was built using $200 million. However, claims of corruption halted progress in 1989. Construction did not begin again until 2006 when Alan Garcia returned to the presidency for a second non-continuous term. Peru then took out a $300 million loan from the Andean Development Corporation to finish construction on the planned 22 km of track. In early 2012, the 22 km of track began passenger service with great success. In fact, rider demand was so high that the Peruvian government funded an extension of 12.4 km with 10 additional stations. This addition cost $900 million for the fully elevated extension, and it opened for operation in July 2014. Line 1 was completed with 26 stations spanning 34.4 km of elevated track. According to a study from 2015, the average weekday ridership is around 450,000 passengers and exceeds capacity at peak periods (“Lima Metro, Peru…”). Ridership is expected to increase to 665,000 passengers per day by 2017 (“Lima Metro, Peru…”). In 2012 the 22-km stretch of Line 1 had an average travel time of 23.5 minutes, which was significantly less than other modes of transportation (“International Bank…,” p. 82). Line 1 has been a success with respect to ridership, but its current impact is still somewhat limited due to the lack of interconnectivity and lack of multiple routes.

With part of Line 1 completed and an expansion planned for in 2012, President Garcia in December 2010 signed Supreme Decree No. 59-2010-MTC. The decree approved and laid out five metro lines with defined stops for each line and put the Ministry of Transport and Communications (MTC) in charge of the use, operations, maintenance, and concessions. The plan included Line 1 as constructed and four other lines spread out in different directions, allowing the metro system to serve the periphery and core of Lima. They will all be connected at a central station where transfers can be made. See Figure 2 for the layout of the five lines in the Lima metropolitan region.

Line 2 and a portion of Line 4 are currently under construction as the Metro Line 2 project. The project includes 27.2 km of track for Line 2 oriented along an east-west axis and 7.7 km of track for Line 4 from the Lima Airport to Line 2. The entire route will be underground with 35 stations, which span the route from Callao into eastern Lima. The decision to put it underground was partially due to the already congested corridors through which it runs, making it difficult to obtain the necessary land for an above-ground system but significantly increasing costs. Most of the tunnels will each contain two tracks, and initially there will be 34 train cars operating on Line 2 and seven on Line 4, with increases planned over the years.
to meet growing demand ("Line 2 and Avenida Faucet...").

In early 2013, a public bid was released for the concession for the Line 2 project in the form of a design–finance–build–operate–transfer contract, establishing it as the largest infrastructure project in Peru’s history, with a cost of $5.37 billion. This is a public-private partnership (P3) in which the project is partly financed by the government of Peru as well as by the contractor. The contractor is responsible for a portion of the funding, in this case $1.6 billion, and is then fully responsible for all aspects of the project, including the design, construction, railcars, and operation before transferring the infrastructure back to the government at a specified date. Since the contractor’s revenue is partially based on the ridership and continued operation of the project, he has the incentive to keep costs low and to complete the project on time. Ultimately, a multinational consortium, Nuevo Metro de Lima, won the bidding as the only consortium to submit a bid. In all, the Nuevo Metro de Lima consists of six companies from several countries, including Spain and Italy, and a smaller partner from Peru. The consortium began construction on the rail tunnels shortly after the project was awarded in 2014 with a scheduled operational date of June 2019 (Quigley).

**Analysis of Current Plans**

The Inter-American Development Bank recognized that the project was high risk...
at the onset when it approved financing for the construction (“International Bank….,” p. vii). The large scale of the project adds to the challenge of managing costs and finishing the project on time. Questions concerning the cost and profitability of the project for a private contractor should have surfaced initially when only one of the three companies that participated in the pre-investment study submitted bids for the concession, with the other two contractors citing cost as their reason to not submit a bid. The bid received was above what the MTC had projected for the cost; yet it met the requirements, allowing the process to continue with only the one bid received. The MTC had significant motivation to underprice the project initially to get it approved, and the private evaluation of cost may be an early indicator that it did just that. Generally, after a project is approved and a bid accepted, there are likely to be changes to the contract, often increasing the cost and/or extending the deadline. In Peru, from 1999 to mid-2016 there were 17 changes in just four concessions for either rail or metro systems (OECD, p. 83). The current contract is structured such that the state is responsible for most cost overruns during construction, leaving the contractor with little incentive to keep costs low during construction. The problems have already become obvious after a comptroller investigation in August 2016 showed increases in costs of $156 million (Post). While this is a minor cost increase compared to the value of the total project, the cost increase is nonetheless worrisome. The contractor has been using slower and more expensive tunneling methods instead of tunnel boring machines and has already delayed the opening of the first section up to 15 months. As Vice President Martin Vízcarra pointed out, it is concerning that the five-year project is less than ten percent complete after two years (Post). The early performance of the project has seen many of the risks come to fruition and is troublesome for the project from a financial and timeline perspective.

Yet, if the Line 2 project is completed successfully, it will provide significant benefits to the riders and the surrounding communities. Travel times between many destinations along the route will be reduced by as much as 70 percent compared to driving, making travel easier and quicker for citizens of Lima (“International Bank….,” p. 84). For the estimated 360,000 daily riders in 2020, this will free up large amounts of time, reducing their two- to three-hour commutes and helping improve their quality of life. The effect will be especially noticeable for people who can take advantage of the connection with Line 1 and fully utilize the feeder network. In addition, it will begin to help with the pollution in Lima by taking many cars off the road. Estimates from the project feasibility study based on the lower-level demand scenario show greenhouse gas emissions from vehicles will decrease by 30,000 to 50,000 metric tons per year of CO₂ equivalent (“International Bank….,” p. 16). To put that into perspective, 30,000 metric tons of CO₂ is equivalent to the burning of 3.4 million gallons of gasoline. These are appreciable results and constitute significant progress toward meeting the goals desired from mass transportation.

Although the implementation of the Line 2 project is making progress, once completed it will be insufficient to fully resolve Lima’s transportation issues, making continued investment necessary. One of the main issues is whether it will be able to better serve the poorest communities. The Metropolitano and metro lines have reduced fares for certain portions of the population, thereby serving poorer citizens. Yet the Line 2 project focuses mainly on serving the wealthier communities of Lima because the chosen route runs through wealthy areas in the city center and accesses the airport rather than running to the periphery of the city. Even with the forecasted demand, the reduction in daily automobile trips will be insufficient if Lima’s population and car ownership continue to grow at the current rate. Based on the 2007 census, the population of the affected districts was 2.53 million and had an average annual growth rate of 2.93 percent since the 1993 census (“Line 2 and Avenida Faucet….”). If growth continues at this rate, from 2015 to 2020 the districts would see a population growth of 494,000, which is a greater increase than the additional transportation capacity provided
by the Line 2 project. Since this project is currently the only major public transportation project in the metropolitan area, it is clear the current initiatives are insufficient to resolve the transportation issues within Lima. To provide the economic development necessary and achieve the goals of public transportation infrastructure, Lima needs to invest more resources and to do it more efficiently.

**Recommendations for the Future**

Moving forward, Peru can take advantage of learning from the Line 2 project and other large transportation projects in Latin America. Lima could benefit from placing portions of the metro above ground on the outskirts of the city, just as Mexico City did, due to the lower population density and lower level of formal development, which allow for more above-ground construction. Placing the metro above ground would cut costs and allow for more kilometers of track to be built. It is also essential to ensure smooth integration with the bus network for the transportation system to be effective, especially in the early stages where the metro covers only certain parts of the city. This requires multiple integrated stations where passengers can transfer seamlessly. For example, the Metro Line 4 in São Paulo, Brazil, a city of comparable size at 12 million people, is integrated with municipal and inter-municipal buses at all the stations along the route (São Paulo...). This allows extended access into the periphery of the city, making the transportation system more effective at serving the poor. Similar interconnectivity in Lima would require more formal bus routes. Currently there is only one express corridor and only a few formal routes on the periphery of the city, which are not enough to cover the city. Most of the mass transit vehicles operate on the informal network, which prevents integration with the metro and a complete system of transportation. Although the metro is already a tremendous undertaking, it would be a missed opportunity not to implement a broader formal bus network and integrate the two systems.

In addition to improving its physical infrastructure, Peru can continue to improve how it implements large infrastructure projects. The use of a P3 allows for foreign expertise on completing large projects to be brought in. This model has been successful in other Latin American countries and allows for the influx of additional financing as well. When run successfully, a P3 can increase the accountability of the private contractor, increase the efficiency of operations, and deliver better service. Yet for a P3 to be successful, it requires strong regulatory commissions, close supervision, and stiff penalties to be built into the contract. At the same time the country must provide assurance of long-term stability in governing bodies, public policy, and support of infrastructure projects. Peru’s recent history of successful elections and improvement in its business and political climate have brought about an influx of foreign investment, and it is important for this to continue. Having a specialized government agency for private investment—ProInversión—also aids the process and allows professionals within Peru to become more experienced with managing P3 concessions. By strengthening that investment agency and by committing to long-term stability and infrastructure development, Peru can take advantage of P3s to continue to build its infrastructure and work toward sustainable development amid the continued growth of Lima.
REFERENCES


