

Socioeconomic and Ecological Impacts of Urban Rail Transportation

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The Status of Public Transit

Urban public transportation in the United States is in a state of failure. Operational networks are too small, timetables are inconvenient, and infrastructure is outdated and crumbling. These factors combine to cause many to take more pollutive forms of transportation, such as cars and buses, to locations where many travel to. Additionally, many who are more dependent on public transit, such as those in less advantageous socioeconomic situations, are underserved by existing infrastructure (House of Commons, 2013). This lack of service hampers the ability of city residents to find a job, increase their level of wealth, and improve their social mobility. Improving the accessibility to reliable transit should be a priority of city planners, however it is imperative that these networks are in fact a net benefit. In order to improve the current state of urban rail transportation in the United States, a series of studies examining economics, social, and public health factors of existing systems were examined. These studies were examined using the framework of technological determinism. This method was chosen due to its ability to correlate people's actions relative to the state of the art of a given technology. Through studying the impacts of transportation in cities, the following research question was answered: how does the implementation of an urban rail transit network impact the socioeconomic and ecological status of a city and its residents?

Research Question and Methods

In order to answer the research question listed above, it must be broken down into smaller components and examined on a smaller scale. The first aspect of the research question is the implementation of transit systems. This is concerned with the locations that transit systems serve, the frequency of service, and the capacity of the service offered. These elements are the three

primary ones that determine the success of transit networks, and will serve as independent variables in this study. The socioeconomic component of this study is concerned with how people's lifestyle and financial situations are impacted by their accessibility to rail transit. Data, such as employment rates, median income, commute time, and workplace productivity, was collected in order to investigate this. The resources that were used included various studies, reports, and statistics gathered from municipalities, transit companies, advisory bodies, and advocacy groups. These sources were found through searching for specific keywords, such as commuter rail and rail transit, in reliable databases. The ecological factor of the research question is concerned primarily with pollution in and around cities. Air, water, and soil pollution were all considered, in addition to the impact of this pollution on local ecosystems and human health. Similar sources were used to gather ecological data, namely reports from government bodies and advocacy groups. Additional sources included scholarly journals and papers comparing rail transit to other modes of transportation. The statistics gathered from all of these sources were compiled to make comparisons between different cities, and different locations within the same cities. On a large scale, cities with high usage rates of public transit relative to car transit were compared to see how this difference impacts socioeconomics and pollution. On the small scale, portions of cities with poor transit infrastructure were contrasted to those with ample access to it, with the same metrics considered.

Review of Literature

An urban rail transportation system, for the purpose of this paper, is defined as any network of rail-based vehicles used to transport people between locations within a single metropolitan area. Examples of vehicles include suburban commuter trains, trams, metros, trolleys, and any other light or heavy rail vehicle. The benefits provided to a society by a

successful rail transportation network are numerous. First, it enables people to have a more convenient way of moving from point to point. Trains do not suffer from the congestion and stress often encountered when driving, and provide a more pleasant overall experience (Time, 2014). Second, taking public transit increases productivity. Riders are able to work or prepare for their day on their journeys, as they are not occupied by having to drive a car. Employees are also less mentally fatigued after taking the train when compared to a rush-hour commute (Wener & Evans, 2011), therefore being more effective at work. A third benefit is that of residential cost savings. Commuters travelling from suburbs into cities benefit greatly from taking the train. The costs of parking, gasoline, and automotive maintenance incurred by driving are far higher than rail fare. Commuters can save up to \$10,230 by opting to use transit instead of cars (Department of Transportation, 2020). Finally, rail transportation is a far cleaner form of transportation than the automobile. As urban areas can often feature high levels of atmospheric pollutants, cutting down on these in any way possible is a benefit, particularly for individuals travelling alone. These commuters can reduce their carbon footprint by 75% through taking the train, as shown in the figure below (BBC, 2019). Using more rail transportation aids in combating climate change, both on a local and global level.

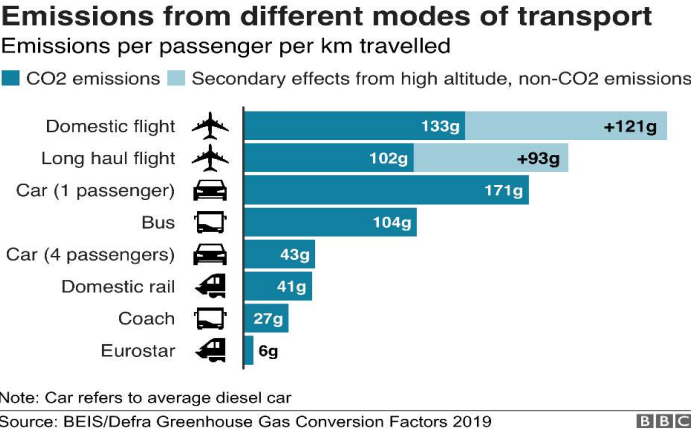


Figure 1: Emissions produced per kilometer travelled on different modes of transport (BBC, 2019)

These are all benefits that are experienced with a well-developed public transit network. Without a sufficient system in a city, many negative effects are felt by those living there. Social mobility is hampered, as people have a more difficult time accessing jobs outside of their immediate surroundings (House of Commons, 2013). The stresses and time costs from vehicular commuting also decrease worker productivity, which decreases economic output or both companies and localities. Pollution levels are also increased with more people driving rather than taking the train.

The Impacts of Technological Determinism

The primary method of analysis used to conduct research was the theory of technological determinism, a major concept in the field of Science, Technology and Society (STS). Technological determinism is the idea that “societal development is shaped by technology rather than the other way around; the course of history itself is driven by technology” (Seabrook, 2019). This theory was initially put forward by Thorstein Veblen in his 1899 book *The Theory of the Leisure Class*. Veblen’s main point was that items are a mark of social status. This theory has changed since its inception, as the Marxist revolutionary fervor which led to its inception has died down. The most prevalent modern proponent of technological determinism is Merritt Roe Smith of the Massachusetts Institute of Technology. His research on this topic is mostly on the history of technology innovation and social change. This definition of technological determinism is very applicable to the analysis of urban rail networks, as seen in the claim that people use less rail transit because they find the current state of the technology inadequate to suit their needs (Smith, 1994).

Another STS theory that is referenced is technological momentum. This theory, proposed by technology historian Thomas P. Hughes, states that society is both shaped by and shaping of

technology (Hughes, 2004). These theories can assist in looking at the societal changes that rail network implementation and development produces.

Avenues for Improvement

Based on the sources that were gathered, a clear, positive correlation between urban rail transportation and improvements in human lifestyle is shown. Pollution levels in cities fall as investments in rail transit are made. Employee health is improved due to less stressful commutes and overall personal productivity simultaneously increases. Additionally, interurban social mobility improves, along with an increase in residential and commercial property values near transit lines (Yu, Pang & Zhang, 2018). These benefits are more clearly found with more developed and robust transit systems, but even the smallest degree of mass transit aids in improving overall city quality. Rail transit technology enables these improvements to be realized, emblematic of the framework of technological determinism.

As mass transit entrenches itself further in a city, its residents see a growing quality of life alongside its growth. The ability to get from point to point is made much easier for all of the people living in a city, as well as those living around it. Tram and metro systems facilitate the rapid movement of individuals within the nucleus of metropole, decreasing the dependence on automobiles and busses that provide less convenient, more expensive, and more pollutive methods of short travel. Commuter rail systems assist with bringing suburban residents into downtown offices and entertainment venues, spurring on the local economy. Regional rail also further aids in the reduction of polluting traffic, as cars will drive shorter distances to local stations, and leave their polluting vehicles further from the center of population. Technological determinism is supported by this trend, as locals will experience all of these benefits as effective public transit systems will generate these improvements.

Additionally, the synthesis of these different modes of rail transit, the tram, metro, and commuter rail, enables a city's public transportation system to work more harmoniously. This seamless integration means that pollutive forms of transit can be cut out from a journey almost entirely, leaving personal vehicles in the suburbs, and making transfers from train, to metro, and even to tramways a clean and easy process. Timetables that are organized to promote intermodality produce this effect more reliably, and reduce stress on the transit system as a whole. This benefit works in two ways, as it makes the required size of the vehicle fleet smaller, and makes the vehicles that are in use more effective. Railway fleets are be up to 25% smaller compared to nonintegrated systems, and will be able to transport at least 33% more passengers (Chun, Anderson & Paik). As a result of successful timetabling, maintenance burdens are lower and greater passenger and economic benefit is derived, as commuting is easier. Further benefits arise to make network expansion more viable, as lower operating costs leave more revenue available for the construction of more track, the purchase of new rights-of-way (the space that the railway occupies), and more modern rolling stock. This cost reduction represents a self-sustaining cycle, and should good timetabling be maintained with system expansion, further expansion and growth will occur. The result of this cycle is a prime example of technological momentum at work. People's ridership of a system is justified by the system functioning well, and proper utilization of the technology will result in the behavior of the populace changing to further integrate the technology into their lives.

Another realm that public transit improves urban life in is that of personal costs. Having to travel to work downtown in major cities, such as Los Angeles, New York, and San Francisco is extremely expensive. Employees have to pay a variety of costs, both financial and personal. Financial expenses result from fuel, parking, tolls, and vehicle wear-and-tear. Personal outlays

incurred include time consumption, self-stress, and health ramifications. A majority of these costs are be avoided through the proper usage and implementation of rail transit systems. While the non-zero cost of rail fare does exist, purchasing journeys in bulk enables for individual trip prices to drop. This results in immediate personal travel expenses to drop below their original level and save the commuter money. Again, efficacious application of rail transit technology will deterministically result in this financial recuperation.

Further savings are also made in the personal realm, as an individual's health can be improved greatly by avoiding automobile commuting. Rush hour travel is a major contributor to the degradation of a person's health as stress increases and time is spent in a polluted atmosphere (American Heart Association, 2015). Riding transit to work is associated with a lower risk of high blood pressure, diabetes, and being overweight. Moreover, accidents are more likely to occur in stressed traffic, leading to unnecessary injuries. These are largely avoided by traveling by train, as the problem is not experienced in the first place. Once on a train, stress drops significantly, as the employee is not responsible for driving their vehicle. Also, the air around train tracks is better than on a congested highway, preserving health. Distracted driving is also reduced, as those responsible are doing their distracting activities in environments that do not require such immediate attention. Lives are saved by taking cars off the road. Phone calls can be made, meeting notes can be reviewed, and breakfast can all be eaten in the comfort of a train. Reduced driving stress also serves a second benefit, as commuters are also more productive at their jobs, as they have had a more relaxing journey to prepare.

Additional benefits from the usage of public transit are gained in the environmental realm. As mentioned above, automobiles and busses are polluting forms of transportation. As nearly all forms of urban rail transit are operate using electric power, the pollution generating

vehicles are largely removed from the transit equation (Fröidh, Kottenhoff & Andersson, 2014). Even though the power needed to provide catenary electricity might not be the cleanest in its generation, many power plants are not located in the center of cities. An example of clean power generation for electric transit is through the use of hydroelectric generators at Safe Harbor Dam, providing the electricity for a significant portion of the Mid-Atlantic United States. This impacts the commuter systems of SEPTA, NJ Transit, and MARC, serving the areas of Philadelphia, New Jersey, and Maryland, respectively. A total of 200 Gigawatt hours are produced at this dam over the course of a calendar year, making up over a third of all electricity consumed by rail vehicles from Boston to Washington (Eitzmann et al., 1997). As more people across the world begin to value the environment and its conservation, more people will be willing to take public transit, even if the financial costs break even. The long-term sustainability of the environment is a factor many people consider when making purchases, and the decision made to use electric transit, rather than petrochemical powered vehicles is just another example of this (Chester & Cano, 2016). The technology in place, in this case clean electric trains, has impacted the decisions of its riders to further support the rail network, showing technological determinism at work.

The final major significance that rail transit offers is in social mobility. Access to transit greatly improves an individual's job prospects, and as such increases their standard of living by giving them more money in their pocket. If somebody is unable to own a car or have access to other forms of transit, their ability to obtain high-paying and competitive jobs is severely curtailed. However, with rail networks traveling through lower income towns and neighborhoods, an individual who would otherwise have a difficult time obtaining better employment now has access to employment places along the transportation network. Rail transit

enables the rapid transportation of people from less affluent residential areas to more corporate and commercial ones, and assist with economic growth and poverty alleviation. As rail fare is far less expensive than purchasing and operating a car from a low-income perspective, this presents an attractive opportunity for people (Knowles, Ferbrache & Nikitas, 2020).

Conclusion

Urban rail transportation serves a very useful purpose in modern cities. It assists in making transit easier for all commuters. Personal costs incurred while commuting are wholly decreased. Human health is also improved through the elimination of a largely stressful gauntlet from the life of a commuter. Pollution in cities also drops as a result. The overall ecological state of cities also improves. The ability for the residents of a city to easily improve their access to greater wealth is also generated through the successful construction of trains. Finally, rail transit on the whole serves as an economic driver in urban metropolitan areas, making the lives of all residents better. Every city should consider investing in rail transportation for an easy way to gain these benefits.

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