

The Role of Transportation Efficacy in Transportation Equity

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Transportation is key to the nation's quality of life and economic development. Transportation infrastructure affects congestion on roadways, traffic collisions, and the public's everyday quality of life. Both public and private infrastructure sectors need to recognize and take action to meet their responsibility to the public or risk the negative effects that would affect every aspect of an American's life. Specifically, this system could be contributing to systemic inequality in the country. To attempt to improve the transportation infrastructure of the Commonwealth, this technical project aims to identify and integrate space, air, terrestrial and maritime resources and apply them in new ways that address transportation efficiency in Virginia. If this project meets its objectives, the University of Virginia engineering undergraduate students and UIX-MITRE will provide new means to help solve transportation efficiency problems in Virginia.

This STS research paper aims to analyze how substandard and decaying urban transportation infrastructure affects the quality of life of historically marginalized groups of Americans, including people of color and people with disabilities. These marginalized groups have a higher risk of financial vulnerability which, coupled with systemic discrimination in America, leaves these groups with an undeserved disadvantage in almost every aspect of their daily lives. This STS paper will mainly focus on the correlation associated with the economic factors marginalized groups face and decaying or poorly designed urban systems causing a deficit in access to transportation and a break in their journey chain. The ethics of the issue of transportation efficiency is due to the break in journey chain as it relates to transportation equity. Transportation equity is the accessible and affordable transportation for everyone in a community, whether that is rural, urban, or suburban. Transportation patterns and conditions can

worsen or mitigate systemic issues in transportation inequity as traffic and substandard infrastructure can have far greater consequences for marginalized groups of people. The STS topic and technical project are tied together by analyzing the ways people of color and people with disabilities are most affected by transportation shortcomings and how the lack of access to it may have a significant role in discrimination.

The Emplacement of Historically Marginalized Groups in America

Decaying and substandard infrastructure is a hotly debated topic in both the current political climate and during the 2016 Presidential election. Public transportation is dependent on the transportation infrastructure the American government provides like railroads, highways, subways, and the traffic patterns these systems affect. “Deteriorating infrastructure, long known to be a public safety issue, has a cascading impact on our nation’s economy, impacting business productivity, gross domestic product, employment, personal income and international competitiveness,” warned the American Society of Civil Engineers, which has given US infrastructure a D+ grade (Fleming, 2016). The negative impact spreads beyond the economy and into the lives of the American people. Transportation has a tremendous effect on the quality of people’s lives and transportation inequity by definition is another form of discrimination the United States is contributing to. Historically marginalized groups such as people of color and people with disabilities feel the impact of that discrimination and transportation plays a role in the inequality these groups face in the US.

Historically marginalized groups experience systemic discrimination in America leading to inequality in almost every aspect of daily life including economic factors. People of color make up about 27.6% of the United States population and over represent the percentage of families in low-income households at 52% (Milner, 2013). In addition, according to the Census,

people of color make up a larger percent of urban areas in comparison to suburban and rural areas (Parker, 2018). People of color are more likely to be below the poverty line due to institutional obstacles such as limited work or advancement opportunities, inadequate school systems, the effects of generational poverty, and other factors. People with disabilities live with a higher risk of financial vulnerability than people without disabilities. As a group, people with disabilities appear to be particularly vulnerable financially due to 1) reduced earning capacity often associated with functional limitations, 2) the often-substantial costs of accommodating these limitations, and 3) their high susceptibility to certain financial shocks (Batavia & Beaulaurier, 2001). These higher expenses can include personal assistance and transportation costs, as there are barriers for people with disabilities using public transportation. For people with disabilities, any barriers in the built environment can prevent them from using public transport in the first place. For example, the lack of and poor quality footpaths such as uneven surfaces due to cracks were identified as a common issue. Lack of curb ramps or lighting can cause potential hazards. Furthermore, there is the idea of journey chain, which includes all the transportation and paths taken from when an individual leaves their home. If the infrastructure or environment along that journey chain creates any barriers it can be detrimental for the individual using that route (Park & Chowdhury, 2018). These economic barriers for both groups, coupled with the physical barriers faced, affect commutes due to increased traffic and delays. This in turn leads to inadequate transportation conditions, lack of public preparedness, and failing infrastructure, which ultimately create a system of transportation inequity for people traveling from disadvantaged neighborhoods.

Defining the Differences in Barriers along Journey Chain

Decaying infrastructure causes delays in networks such as the New York subway system which disproportionality affects people who are low income. Therefore, because people with disabilities and people of color are systemically trapped in poverty at higher rates, these transportation networks disproportionately affect these marginalized people. This hypothesis can be proven through the New York subway system. Even though subway users are riding the same trains and waiting in many of the same stations, commute experiences, including commute duration, vary widely. Using 2012-16 data from the American Community Survey (ACS), lower-income areas and higher-income areas were plotted with their corresponding commute times; moreover, the conclusion from the data is that higher incomes are associated with lower commute times (Gorton & Pinkovskiy, 2018). A shorter commute is valued as more expensive because housing demand is higher in city centers where people work and want to live, hence paying higher costs for transportation efficiency. Subway riders with the longest commute times are also less able to substitute away from a troubled line because the next subway line or station may be very far away. In addition, workers traveling during off hours are far more likely to be at the mercy of planned work for transportation infrastructure. Median household income against subway performance was plotted and concluded individuals from lower income areas must commit more time to ensure against lengthy delays. As an area's household income declines, the length of extreme subway downtime spells increases. This is the result of a combination of the increased risk of experiencing downtime associated with a longer commute, the distribution of trains to which each block group has access, and differences in morning departure times (Gorton & Pinkovskiy, 2018). In comparison to city centers where high-income housing pays for transportation efficiency, suburbanization has caused a "reverse commute" where bus schedules

and capacity can no longer meet the needs of low-income commuters. The decaying and substandard transportation infrastructure patterns have become out of date in these areas. Transportation research that focuses on physical infrastructure like roads, bridges, and operations have elaborate testing facilities and research centers that spend many millions of dollars annually. Although TEA-21 allocated \$3.3 billion over six years for surface transportation research and development to ensure that the United States will be a world leader in these areas, only a relatively miniscule fraction of those funds is spent on research examining transportation's effect on poverty and social outcomes (Sanchez, 2008). In addition, it is important to note commute time may also be affected by weather and road conditions, which could receive more funding to inform the public and resolve human errors in an already flawed transportation system. Another study shows the lack of understanding the actors of location play in this system. City governments are unwilling to cater to the needs of poor communities, which as discussed earlier, often include marginalized groups at higher rates. Cities refuse to use poverty mapping when planning for transportation upgrades, which adds to inaccessibility and decaying transportation infrastructure in poorer areas (Grieco, 2015). In addition, lack of funding to these areas' roadways includes lack of information to the public about weather conditions, which could better inform the public. These negative interactions between the actors only exacerbate the inequality and failure of the system surrounding access to transportation.

Evaluating Barriers: Substandard Transportation Patterns and Conditions

There are over 57,000 miles of roadways that need to be maintained by the state of Virginia and the Virginia Department of Transportation alone and these journey chains are crucial to transportation efficiency and the daily lives of the public; therefore, they are also essential to transportation equity (Kastenhofer, 2007). Currently, national regulations only

enforce the inspection of roadways every 5 years and the inspection of bridges every 2 years (Gee, 2007). Current methods of roadway infrastructure inspection are inefficient and accomplished by only using a variety of ground-based systems. These ground-based systems also have drawbacks, including traffic buildups, lane closures, as well as being labor intensive (Vaghefi, 2012). To improve the inspection process, the solution must include remote-sensing enhanced nondestructive evaluation and satellite technology through a spacecraft in order to sense incoming traffic conditions due to weather. A satellite could send data to VDOT and allow them to focus on maintaining worn roads instead of repairing broken roads. This would create a more efficient system for the state's roadways for cheaper cost, less labor, and with fewer transportation infrastructure delays.

Maintaining transportation infrastructure and economizing transportation patterns is vital for the wellbeing of the state and public. The collapse of bridges is extremely dangerous as shown by the death of 13 people when I-35W collapsed in Minnesota in 2007 (Astaneh-Asl, 2008). Although the collapse has led to reform in how infrastructure is inspected, those methods are now dated and could be improved for more efficient and less costly methods of inspection. Research indicates that as road conditions deteriorate, there are more collisions and accidents tend to be more severe (Alhasan, 2018). In addition, the environments also affect road conditions and wear greatly. Therefore, my capstone group proposes the Commuter Live Aggregated Yield Traffic Observation Network (CLAYTON). This satellite would have the capabilities to sense all transportation patterns and their effects from the weather continuously while also having an eye on the infrastructure affected by these conditions. It would be possible to identify which roads are deteriorating at faster rates and put more time and effort into these problematic areas. Furthermore, if the problematic areas fall in a range of disadvantaged neighborhoods, it is crucial

to repair and take under advisement the factors and systematic planning that happened historically for more transportation inadequacies to occur in those areas. In addition, major roadway conditions and traffic patterns can change from start to end of a journey chain. There is a lack of understanding of current weather impacts on road safety for the average commuter. Eliminating this human error with more research only alleviates the addition that human biases and errors can add onto transportation inequity that is put in place by the spatial environments people commute and work in. A paper published by Devin Harris, a Civil Engineering Professor at the University of Virginia, says “Remote sensing technologies can be used to assess and monitor the condition of bridge infrastructure and improve the efficiency of inspection, repair, and rehabilitation efforts” (Vaghefi, 2012). Designing a system that will be able to see all the roads of Virginia and accurately determine which roads and bridges have risk from environmental conditions is a partial solution in correcting the inequality throughout the United States’ transportation designs and patterns.

Emphasis on Transportation Equity in Future Transportation Efficacy Designs

In a review of locations where marginalized groups are most affected by decaying transportation infrastructure and traffic patterns, it was found that in metropolitan areas as poverty increases, commute time increases and proximity to job access decreases (Hu & Giuliano 2017). This review is necessary to have a working understanding of the negative effect that these traffic patterns will have on the neglected transportation. The relationship between social justice and transportation equity is clear due to the United States’ negative history concerning marginalized groups of people. Historically, American policies, whether part of transportation or not, have targeted people of color. However, in contemporary America transportation policies disenfranchise the poor with overtones of discrimination against people of

color and people with disabilities. In the mid-2000s, 24% of African Americans, 17% of Latinos, 13% of Asian Americans and 7% of Caucasians lacked access to a private automobile (Wellman, 2015). This social justice research paper quotes “Specifically, with regard to transportation, the average American family presently spends more on transportation-related expenses than all other types of expenses except housing. Critically, the percentage of net income spent on mobility-related expenses increases as income decreases. In other words, because of the strongly regressive nature of transportation expenses, the poorer an individual is, the more it costs them to travel from one location to the next. Isolating the poor is explicitly achieved by creating poor public transportation accompanied by ‘massive public investment in urban freeways to empty out central cities of middle- and upper-income residents’” (Wellman, 2015). In order to conceptualize and quantify the negative social and economic effects caused by the failing frameworks of transportation equity, one must consider the exploitation of the poor that is also at least partially accomplished by isolating historically marginalized groups with inadequate public transportation, requiring large investments in personal cars, subsidizing the middle-class flight to the suburbs through the action of continually widening and increasing expressways, and in the negative health effects of those large freeways when they are built or widened in socially disadvantaged neighborhoods whose residents are frequently too poor to utilize those means of transportation (Wellman 2015). This evidence draws on the correlation between marginalized groups and higher poverty rates and then overlays those factors with neglected transportation systems and their location; therefore, these factors define lack of transportation equity for people of color and people with disabilities. With these details, it is conclusive that current transportation infrastructure and traffic patterns help to amplify the systemic discrimination in the United States.

Conclusion

Based on all the collected data and research, marginalized groups such as people with disabilities and people of color are affected at unequal rates by the effects of decaying transportation infrastructure and transportation inequity in traffic patterns, though the literature evidence broadens the scope towards all groups marginalized by poverty historically. As a result of the United States' history of discrimination, socioeconomic factors have kept historically impoverished groups in a cycle of poverty where they have remained marginalized and experience those effects in many forms, primarily including transportation efficacy. Scenarios in which this marginalization could be mitigated may be through policy in the United States in which people from these groups are granted some form of reparations; moreover, regarding transportation, it is important to delve into city planning and funding to improve transportation infrastructure as a whole and budgeting for more information to be distributed to the public about traffic and roadway conditions. The significance of this project is how transportation has a tremendous effect on the quality of people's lives and lack of access plays a significant role in discrimination in another form of American policy. The anticipated outcome in this spacecraft capstone is a design to improve transportation efficacy through roadway condition imaging and sensing by creating evaluation options using a constellation of satellites over the United States. Achieving better transportation efficiency will improve the quality of life for Commonwealth residents and hopefully the rest of the United States.

There is a direct correlation associated with economic factors marginalized groups face and decaying or poorly designed urban systems, causing a deficit in access to transportation and a break in their journey chain. Marginalized groups in the American public are most affected by transportation infrastructure and conditions and lack of access to transportation equity can affect

quality of life, increases in expenses, decreases in job access, and further increase pathways of discrimination into the everyday lives of American people. The understanding that this degree of effect that transportation frameworks have on discrimination only increases inequality exacerbates that these effects should be changed to begin dismantling systemic inequality in America.

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