

Thesis Portfolio

Optimization of VDOT Safety Service Patrols to Improve VDOT Response to Incidents

(Technical Report)

Transportation Systems as a Political Artifact: How Infrastructure Can Improve the Economy and Public Health on Native American Reservations

(STS Research Paper)

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Thesis Prospectus

Sociotechnical Synthesis

Across the United States, thousands of vehicles travel each day for reasons ranging from daily commutes to interstate commerce. Transportation systems seem ubiquitous in today's society despite the wide range of development. Although often recognized for the ability to transport goods and people, the role of transportation infrastructure in safety and socioeconomic stability is often forgotten. The technical portion of the report details the Virginia Department of Transportation's (VDOT) fleet of Safety Service Patrols (SSPs) and their efforts to maintain safety across the state. As an integral part of the transportation system, the patrols assist emergency responders in traffic management to minimize secondary crashes and congestion. An efficient schedule for the SSP operators helps maximize impact and taxpayer dollars. While the transportation budget affords the sponsorship of the SSP program, there are many other transit needs that the government must consider. Among other priorities is the maintenance and development of infrastructure on Native American reservations. Faced with greater socioeconomic and transportation inequalities across several reservations, the need for greater investments in infrastructure does not go unnoticed. Coupled with the history of displacement of indigenous communities, the authority behind budgetary constraints alludes to the control and manipulation of reservation societies to limit their social progress. As Americans, the effective use of limited a budget maximizes the influence of infrastructure like roadway maintenance and the SSP program.

With millions of vehicles on the road each day, traffic delays and interstate congestion result in loss of productivity and millions of dollars each year. A majority of these traffic delays are caused by traffic incidents including crashes and disabled vehicles. These incidents are safety hazards and can lead to secondary crashes. Rapid clearance of these events and scene

management during an incident can significantly reduce the impact of congestion. To combat hazardous conditions and decrease congestion related delays, the Virginia Department of Transportation (VDOT) has a fleet of Safety Service Patrols (SSP) that monitor highway conditions and assist emergency responders in scene clearance and traffic management. Managers of the SSP program seek to schedule patrollers in a manner that optimizes their influence on safety and congestion. This paper proposes a Genetic Algorithm based route scheduling algorithm that assigns SSP routes with the goal of minimizing the total time vehicles are stranded before an SSP vehicle arrives. The algorithm adapts to different incident rates and response times to produce schedules that vary by time-of-day and day-of-week. To examine the performance of the algorithm, optimal schedules were made for I-95 in Virginia. A regression model was also developed to estimate the incident rates using a combination of daily traffic counts and historic rates that accounts for the under-counting of incidents in non-patrolled regions. Another model was used to estimate the SSP response times that resolves the inconsistencies with historical response times for incidents that occurred outside of the patrolled roadways. The results indicate that a new route schedule could lead to a reduction in total time waiting for VDOT assistance by approximately 20%, helping VDOT maintain safety, increase impact, and Keep Virginia Moving.

The STS research paper explores the economic and public health struggles on Native American reservations and the opportunity transportation infrastructure presents to curb the effects of those socioeconomic inequalities. Despite a vibrant culture of family and tradition, unemployment and poverty have overwhelmed reservations while obesity, vehicle crashes, and suicide have taken countless lives. The paper demonstrates increased transportation infrastructure investments yields job creation, active commuting, and lower vehicle crash rates,

all aspects of an improved economy and public health. Although many studies on improved infrastructure focus on rural communities, the wicked problem framing lens used in this research reveals the otherwise hidden connection between rural communities and Native American reservations and a unique solution to the complex socioeconomic problem. The paper also includes a socio-technical synthesis of the historical relationship between tribal and American governments and the effect of that relationship on transportation infrastructure investments in Indian Country. Given a history of displacement of Native American communities, the political artifact theory establishes a level of authority exercised over the minority for the last several hundred years. Historical case studies will prove the historic attitude toward the minority, and how that has manifested itself in infrastructure inequalities on reservations. The research adds an application of the political technology theory to the field of STS. In conclusion, this paper will offer a sovereign way for the United States government to close the infrastructure gap on Native Americans while addressing the history of authority and displacement.

Having researched both topics, I have a more comprehensive view of transportation systems and their unique operations. Prior to my research, I understood a transportation budget to cover maintenance, repair and investment in existing and new infrastructure. After working with VDOT, it opened my eyes to the plethora of other departmental responsibilities like the SSP program, which indirectly supports the transit system. In addition, the simultaneous research endeavors allowed me to identify inefficiencies in one transportation initiative while recognizing geographic regions in need of funding. Solutions to inefficient systems yield opportunities for the reallocation of those resources. In the case of my research, the time and money saved in the transportation budget from the optimal scheduling of the SSP program could be allocated to greater investments in infrastructure on Native American reservations. The outcome of the

combined research would include safer, less congested interstates and an improved economy and public health of Native American reservations. Had I not researched the topics together, the connection between the powerful technology reducing costs in favor of socioeconomic equality would have been lost. In a seemingly virtual world where technology and efficiency are at the forefront of design, we must consider how those solutions can maximize impact and help communities in need.