

**SIMULATION AND OPERATIONS OF EV CHARGING RESOURCES IN FREIGHT
SYSTEMS**

DESIGN OF SUSTAINABLE URBAN TRANSPORTATION AROUND THE WORLD

A Thesis Prospectus
In STS 4500
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By
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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

As the world looks toward future innovations for more sustainable practices, the electrification of different types of transportation seem to be a promising path. However, a larger challenge with this is that My technical project focuses on operational optimization of electric vehicles in freight systems, specifically for the Port of Virginia as part of their initiative to be carbon neutral in the next 20 years. In my STS paper, I focus on more commercial sustainable transportation alternatives from around the world. Sustainable infrastructure, which is an umbrella term sustainable transportation falls under, has been defined by “various stakeholders as a set of objectives, principles, and criteria applicable to infrastructure projects for enhancing their utility in promoting sustainable development” (Yanamandra, 2010). Thus, by this description, these transportation alternatives not only serve the purpose of promoting mobility among groups of people but also to encourage sustainable design, implementation, and maintenance. Sustainable transportation can be analyzed in 2 ways: through technology itself and the network on which it exists. Specifically, my paper will explore how sustainable transportation technologies have been designed and implemented in various societies around the world. The prospectus itself will cover the technical project with the Port of Virginia, then will transition into exploring different elements of the STS project such as a dive into the research prompt, identification of various stakeholders both indirect and direct, and the methodologies used for examining the question. The end product of the technical project and STS project will together identify common trends within electric vehicles both in industrial and commercial use that will enable the technology to be more commonplace and thus, work toward a more sustainable future for future generations.

Technical Project

The technical project I am working on for SYS 4055 is with the Port of Virginia entitled “Simulations and Operations of EV Charging Resources in Freight Systems”. Our project focuses on modeling out one specific process within the port and analyzing the environmental impact on the larger system. Much of our literary analysis came from looking at other ports that have taken measures to electrify processes such as the Port of Long Beach. The process we are modeling is the moving of TEUs (Twenty-foot equivalent unit, which is a way to measure containers) with electric UTRs and measuring how many TEUs are able to be moved through the system in a 24 hour period given various constraints such as run time of the TEUs and union-related constraints such as times of operation by the human workers. The team was able to gain a sense of what was being modeled and given additional constraints by attending the port to meet with stakeholders. As the team is building from previous years’ projects, the team identified a key element that was missing. The team found that there was no way in Simio to accurately model out battery depletion throughout the 24 hour period. The team decided to implement a similar model of this process in Python, where we were able to establish a set rate of depletion missing from the model in Simio. In the next semester, we plan to make changes to our model to focus on the bi-directionality of movements of the TEUs from the stacks or the trains. Additionally, we plan to build on last year’s team on working on how to measure the impact of these changes to the port through PowerBi and potentially other softwares. At the conclusion of the project, the team will present our findings at the Systems and Information Engineering Design Symposium (SIEDS) conference held in May.

STS Paper

The research question that I want to address is what alternative sustainable transportation infrastructure exists throughout the world, specifically what technologies are being used as well as larger network systems. What makes transportation such a unique opportunity for sustainable economics and development is its ability to create a product that meets the needs of the people who utilize the system. However, with increasing economic uncertainty as many materials used in the development of transportation systems are sourced from non-sustainability methodologies, the United States is developing a program under the Environmental Protection Agency called Sustainable Materials Management (SMM). SMM was created with the goal of not only “addressing material and resources needs” (EPA, 2023), but also as a way to implement sustainable extraction and production practices in the larger process. The research will examine the underlying factors in order to understand where sustainable changes can be feasible both technologically and logistically. While the literary review will be crucial, I intend to use various experiential learning opportunities I have had in my tenure at UVA such as study abroad programs to both Sweden and India, where implementation of comprehensive transportation that serves as sustainable alternatives have been established. Both of these countries are interesting as they are in different phases of development and implementation and also have different political structures and histories that are important in exploring the question.

There are many relevant social groups that are involved in the development of sustainable transportation systems. Two relationship dynamics in particular I would like to explore is the one between economic stakeholders and marginalized groups as well as economic stakeholders and government entities. By gaining a better understanding of these dynamics both historically and currently, it becomes possible to provide clarity on how the answer to my research question

impacts the most important element within the larger system, the human. Thus, the main framework I plan to use for this project is the actor-network theory as it covers many holistic aspects of the research question posed. After the identification of various “actors”, both human and non-human, it would become the best choice and most aligned with a systems approach to better comprehension of how these actors are integrated and thus make better recommendations regarding root causes. However, actor-network theory can fall short and where I will substitute other methodologies for understanding the problem is that it does not inherently take into account the various power dynamics that exist within actors but on a larger network-to-network scale. This becomes critical in understanding sustainability-related topics because many societal issues such as racism, sexism, ableism, etc. bleed into the preconceived perspectives and opinions held around the topic. To address this, I will also use some elements of the Social Construction of Technology framework which provides more flexibility in understanding regarding the social interactions between different groups.

As it relates to the timeline of the paper, I plan to use both literature and experiential learning to foster my understanding of how sustainable transportation is implemented. Additionally, I would like to find subject-matter experts around grounds to give their input on the topic. Specifically, I will use literature focused around transportation systems and networks in urban areas as well as papers that focus on government entities that have been successful in the implementation of sustainable transportation infrastructure. I intend to look at communities where I have studied in to better understand and use first-hand knowledge to further strengthen my arguments.

Conclusion

In my technical report, I hope the group is able to continue to build on the work of prior teams as they help support the Port of Virginia toward their goal of being carbon neutral by 2040. We plan to build on the existing model by planning to create a full-scale model of the entire facility while incorporating different systemic constraints that impact production such as union rules and general life of products and maintenance schedules. After building out the model, we plan to implement different electric vehicle technologies specifically related to the trucks being used to transport crates from ships to land. Through this, we will assess if it is both economically feasible and optimal in the long run to pursue different types of electric vehicles knowing that maintenance and charging times can affect overall port performance efficiency. We plan to measure this through already existing metrics, which have been identified by the client. In my STS project, I hope to learn more about different transportation alternatives that have been successfully implemented globally.

Resources

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