An analysis of Mass Transit Infrastructure in Southern Sweden and the National Capital Region of India

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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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STS Research Paper

Introduction

Mobility is an idea that "one can move freely and intentionally" (Crisman, 2023) throughout one's environment and has become a key pillar in what sustainability in the 21st century will become. Transportation is the one science that can help policymakers and those with influence make decisions that will enable more people to become mobile. With projections suggesting that urban populations are "expected to increase from 55% from 2018 to 68% by 2050" (European Commision), there has to be major changes both in transportation design and in human behavior in order to accommodate a more mobile society. The question I want to explore is what has already been implemented around the world that could serve as a solution to this growing problem in the United States? There are two specific places that are vastly different that I find both unique in their solutions: Sweden and India. These two countries were selected as they share some sort of commonality with the United States; Sweden being similar to the U.S. in terms of economic status and government systems and India being similar in regards to land size and in fact larger in density than the United States. In this paper, I will explore aspects of their transportation that have made their urban populations more mobile through both the Actor Network Theory (ANT) and the Social Construction of Technology (SCOT) Framework to fully frame the problem, solution, and limitations. The paper will include a literature review that will go over various elements of the question such as defining key metrics and understanding the history regarding transportation from both a design and policy perspective. The paper will transition into understanding the frameworks and how they will be applied to the question. Finally, the paper will discuss the newly identified design elements that have made these systems effective in their goal and will address the implications of these findings.

Literature Review

Understanding Key Metrics of Advancing Mass Rapid Transportation Infrastructure

When attempting to understand the metrics that are involved with understanding how well or efficient a transportation system is, there are two lenses of which we can analyze. The first is through technological advancement. Automation of various processes, electric and renewable energy fleets, and dynamic solutions are just a few of the technological advances that are being made in the transportation field. According to a report conducted by the International Association of Public Transport, artificial intelligence will be used in the near future to understand patterns of "smart grids" and the creation of "smart stations" (UITP, 12). However, it is important to note that since these transportation systems are designed for human interaction and ridership, AI can not become the sole decider of transportation systems. The second way of understanding specific metrics that interpret the value of mass rapid transportation systems is through a sustainable lens. According to the United States Environmental Protection Agency (EPA), a key metric in understanding how sustainable mass rapid transportation is through "transit ridership" (EPA, 9). This is because there is a larger volume of people moving through a transportation system versus what is typically done in the United States, which is major highways filled with cars that only have one passenger occupying the space. Additionally, in their report, they used the metric of "destinations accessible by transit" (EPA, 11). This metric applies to understanding this larger topic in many ways, but as it relates to sustainability, people tend to take the most convenient option for them and if mass transit allows for them to end close to their final destination, they will be more likely to utilize the service. These metrics in combination with various economic and social metrics provide a comprehensive basis for understanding how advancement within the systems can occur and progress.

History of Transportation Development in the Malmo Metropolitan Region

The Malmo Metropolitan Region has been characterized by both its historic and current larger goal to lead as a region of innovation. Malmo was originally connected to other parts of Sweden in the late 1800s, as part of the Oresund Link. However, it was not until the late 20th and early 21st century that the implementation of regional connectedness became a goal of the policymakers. This is most notably seen through the Oresund Bridge which is a 16 km tunnel bridge structure that connects the countries of Sweden and Denmark through both roadway and train. In 1991, the bridge was agreed upon by both the Danish and Swedish governments as a bi-governmental project. By 1995, construction began by a Swedish contractor, and by 2000, the bridge "successfully connected Sweden and Denmark" (Zavatti) through various transportation modes. According to the statistics kept by the Oresundsbron, the rail portion of the bridge alone brought 582 million DKK or nearly $23 million USD. Not only has this infrastructure project been beneficial to both countries economically, it has also served as a representation of a new chapter in Swedish-Danish relations.

History of Mass Rapid Transportation in the National Capital Region of Delhi

Delhi's story of mass rapid transportation is reflective in its history post-colonialism to both rebuild and advance technologically. During British colonization, rail infrastructure was used specifically to move goods from the interior of the country to various port cities such as Bombay (Mumbai). However, rail-based transportation within the National Capital Region did not fully take off until the 1980s nearly fourty years after colonization, due to the heavy congestion the region was starting to face. One major stakeholder which played a key role in the development of the metro system, the Delhi Metro Rail Corporation (DMRC), was founded in 1995 and began construction on the Delhi Metro in 1998. Additionally, the National Capital

Region Transport Corporation (NCRTC) has taken steps to expand much of its reach across the region, creating high-speed accessibility from various satellite cities such as Ghaziabad and Meerut into Delhi. Additionally, the rise of intra-regional transit options are becoming more popular options for wealthier satellite cities such as Gurgaon. According to a report from the Hindustan Times from 2009, Haryana planned to invest "900 crore for transportation through its residential areas" or nearly 190 million USD for the project. Currently as it stands, the Delhi metro is "the 12th longest metro system in the world" and "sees nearly 2.5 million commuters a day" (ICE), which is nearly 13% of the cities population.

Policy's Influence on Development

Policy heavily influences the advancements that can be made in urban settings, especially transportation ones. Particularly, policies after Covid-19 have impacted the way cities and stakeholders deal with the implementation of the new transit systems. Since more people have the flexibility to work from home, this means that ridership, while still having peaks during rush hour traffic, has also seen an increase of ridership throughout the day. Additionally, due to these work from home policies, according to George and Tomer, "Remote work remains higher in places where pre-pandemic ridership was high", meaning that the future policy and implementation must encourage and regain the usership of choice riders. Two other policy choices that impact the accessibility and effectiveness of mass transit systems would be investing in multimodality and building systems that can last through climate change, according to the World Economic Forum. Additionally, the delay of AI-related policy that exists with all emerging technologies will impact the types of implementations and privacy issues that naturally arise with the centralization of transportation systems. These forward facing policy decisions will play a major role in the effectiveness of these systems for both the captive and choice rider.

Methods and Framework

For this paper, I will use a combination of both secondary sources and personal accounts. This will ensure that this paper will account for both objective and subjective perspectives on the matter. The secondary sources will be used to specifically quantify the evidence of performance of the two transit systems while the personal accounts will be used to gain a better understanding of how the human fits into the larger system. The secondary sources will also be used to understand what metrics that have been correlated with success within rapid transit. Since there are many social groups and stakeholders that are key in the development of these rapid transit systems, there are dynamics that are worth exploring. Two dynamics in particular I will explore will be the one between economic stakeholders and the users of the system as well as the economic stakeholders and government entities. By analyzing these dynamics both historically and currently, there will be insight into how the larger system is impacted by these more unpredictable forces. Thus, the first framework I will use in this paper is the Actor Network Theory (ANT). This will enable proper analysis of the social, economic and political dynamics among the various actors. The other framework I will use in this paper to tackle the research question is the Social Construction of Technology (SCOT). This framework will look to draw insights from a different perspective of understanding how people have influenced the technology being used.

Limitations

When discussing transportation solutions in urban areas, many engineers and researchers take a multi-modal approach to understand the interactions among different people in different modes. However, this paper will focus specifically on public transportation and associated infrastructure, specifically rapid transit, which includes train networks, metros, and subways.

This paper is intentionally focusing on this mode of transportation as it is one most commonly found in major metropolitan areas that can move a large amount of people in a set amount of time, usually is not impeded in ways that roadways with cars, and is heavily influenced by policy and culture. It is important to note that cities do become more mobile when people have options on when and how they choose to travel throughout their environment; for the length and scope of this paper, choosing this mode makes the most sense when discussing the larger issue within the research question. In India, a common mode of transportation in Delhi is via rickshaw, which has its own unique circumstances which makes the addition of this mode quite difficult to analyze in conjunction with the Metro. Additionally, this paper focuses on two metropolitan areas within these two countries. The locations, the Malmö metropolitan area and the National Capital Region (NCR) of India were chosen as points of analysis specifically for the availability of first-hand accounts as well as their difference in size and development that can be a contributing factor to understanding the research question.

Discussion - What has worked?

When discussing what has worked in both of these countries that has allowed for the implementation, understanding the various actors that have contributed to these transportation and societal successes is crucial. In the case of Oresund Bridge, one key relationship is the relationship between Sweden, Denmark, and their economies. Before the development of the bridge, travel between the two major metropolitan hubs of Malmo and Copenhagen was nearly non-existent. Historically, this made sense as Southern Sweden had once belonged to Denmark and thus created a desire to establish a more "Swedish" identity within the region. However, due to globalization and the increased economic opportunity for both of the countries, they were able to combine resources to establish something that has proven to be successful in both an

economic and geopolitical way. Additionally, this project has also proven beneficial for many different types of users, specifically for choice riders. Before the bridge, much of southern Sweden was not accessible from Denmark for tourists as the options were to fly or take the ferry, options that both presented some sort of opportunity cost whether it was money or time. Since the bridge has opened, it has served as a gateway for tourists to explore Sweden and engage in the Malmo region's economy as travel is simply a forty minute train ride directly from the Copenhagen Airport to the Malmo Central Station made possible by the development of the bridge.

When examining what has been beneficial in the case of the National Capital Region, human influence with technology has served as a common thread for success of their metro system. Delhi's transit situation is quite unique as it is a city with both a high population and high population density. The Delhi Development Authority (DDA) saw in the early 1980s that people were interacting more with each other through means of transportation and decided to seize an opportunity to foster these experiences through a Metro system. Recently, the DDA identified that both captive and choice riders were interacting with the metro at high rates, which led them to the approval of two more metro corridors with hopes to "make locations in Delhi desirable for redevelopment and investment" (Hindustan Times). External researchers have also been able to identify various factors that people indicated were influential in their experience such as "safety concerns, last-mile connectivity, and their perspectives of travel time" (Bajaj and Singh) which has lead to external investment. Additionally, the DDA has made significant increases to the expansion budget for additional renovations and lines, according to the Tribune India. The DDA was able to identify these areas of improvements by identifying how people were moving through the city in order to create a more mobile society.

Conclusion

  After analyzing two cases internationally related to sustainable transportation, it was found that the United States can learn from both of these countries and relationship types that will enable the United States to have a more comprehensive transportation system that is not solely car reliant. Both Sweden and India, in their own right, have found different ways to decenter cars, proving that it is possible for countries to do, no matter what stage of globalization-related development they are currently in. For Sweden, it was creating new relationships with other countries and working toward a common goal. For India's NCR, it was the identification of needs based on people's movements and understanding which methods and systems would be optimal in working toward that goal. The U.S. can provide its citizens much of mobility needed to foster a healthy, balanced lifestyle through the same methods posed by these two countries.

Future Work

  Future work for this research would include at other modes of transportation such as passenger vehicles and rickshaws and understanding their social and economic impact for the region. This will allow for better understanding of whether or not these implimentations are viable and beneficial in an American context. Additionally, gathering interviews about their experiences using both systems to gain a human perspective of how these systems have benefitting or not benefitting the people who interact with them daily. This will provide policy-related and public-facing strategies to help with the acceptance of these new investments and initiatives.

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