Title

Matching Technique with Authority: A Study of How Local DOTs Can Narrow the Gap between their Network Management Authority and their Analytical Capacity

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16. Abstract

This report explores how local DOTs can leverage advanced traffic modeling software to narrow the gap between their network management authority and their analytical capacity. Limited computational and analytical capacity among local DOTs has historically made detailed on-demand analytics inaccessible. Using the Mobiliti traffic simulation platform, we examine the City of San José's Safer Streets program to determine the operational and social impacts of the city's traffic management strategies. We find that imposing a 20 mph speed limit cap on residential streets in San José's Equity Priority Communities leads to a 39% reduction in passthrough traffic on those streets, but a 76% increase in traffic on streets in the surrounding network. Using this analytical approach, instead of relying on technical assistance from MPOs network managers can more quickly gain quantified insights into the response of network dynamics to localized interventions.

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DOT	Department of Transportation
EPC	Equity Priority Community
MPO	Metropolitan Planning Organization
VHD	Vehicle Hours Travelled
VMT	Vehicle Miles Travelled

Executive Summary

Executive Summary

Inequities in exposure to traffic externalities are often discussed in the context of environmental justice and public health (Marcantonio et al. 2017; Martens et al. 2019). The distribution of transportation-related burdens has been well-studied, encompassing areas such as exposure to vehicle emissions (Lu 2023; Elliott and Smiley 2017) and safety (Raifman and Choma 2022; Appleyard 2015). Studies have documented that demographic characteristics like race and income correlate with disproportionate exposure to traffic externalities (Golub et al. 2013). Lower-income non-white households are more likely to live in areas that experience higher traffic volumes (Rodier et al. 2009), owing to the legacies of discriminatory zoning and lending policies, and the planning and building of transportation infrastructure that enforced and perpetuated discrimination and segregation (Marcantonio et al. 2017; Jackson 1985; Blumenberg 2017). Consequently, these households face higher rates of exposure to air and noise pollution from vehicles (Martens et al. 2019; Lu 2023; Elliott and Smiley 2017) and are more likely to suffer from traffic-related casualties (Raifman and Choma 2022).

Moreover, these communities are disproportionately impacted by externalities produced by commuters who traverse these areas (Lu 2023; Elliott and Smiley 2017; Balcik et al. 2010; Rodier et al. 2009). In this report, we explore the dynamics of “passthrough” traffic—travel neither originates nor ends in these vulnerable communities. Passthrough traffic dynamics are shaped by factors such as convenience, driver knowledge, and the interplay between land use and road networks.

With local transportation agencies increasingly incorporating equity in their planning and network management efforts, detailed analyses of how different types of traffic respond to circulation management strategies is crucial for measuring and interpreting the equity impacts of traffic dynamics. City-scale network management does not happen in a closed system; traffic movements within a city are a subset of regional traffic dynamics. Local interventions have mixed effects on the network that must be acknowledged and monitored, especially when considering how those effects impact society. However, while local agencies have the authority to implement strategies within their borders, they have limited analytical capacity to measure the broader network dynamics that affect and are affected by their operations decisions; they often need to rely on larger Metropolitan Planning Organizations (MPOs) for time-intensive and computationally demanding travel demand modeling and analysis of regional traffic dynamics.

In this report, we show how local departments of transportation (DOTs) can leverage advanced traffic modeling software to narrow the gap between their network management authority and their analytical capacity. Using the Mobiliti traffic simulation platform, we model the City of San José's Safer Streets strategy to study the operational and social impacts of traffic management strategies. Specifically, we quantify how passthrough traffic on residential streets in San José's Equity Priority Communities (EPCs) responds to the imposition of a 20-mph speed limit cap on those streets. We find that this leads to a 39 percent reduction in passthrough traffic on those streets, and in some cases, the diverted vehicles contribute to a 76 percent increase in traffic on streets in the surrounding network. The broader network impacts are mixed and have social and operational implications for local DOTs. We measure these impacts by comparing the distribution of traffic flows in the San José street network between a baseline and an experimental scenario. Using the analytical approach offered in this study, network managers can more quickly measure and gain quantified insights into the response of network dynamics to localized interventions.

This work zooms in on the social and operational impacts of passthrough traffic dynamics, an understudied area in equity-focused traffic management research. Our results show we can quantify the effect of discouraging passthrough trips by lowering speed limits on residential streets. However, the land use and road network context complicate the resulting distribution of traffic externalities and operational impacts. The analytical approach employed in this paper can empower local transportation agencies to conduct iterative exploration and evaluation of local traffic management strategies and their impacts at the local, city, and regional scales. Instead of relying on technical assistance from MPOs, local DOTs can perform in-house iterative exploration of possible strategies. Limited computational and analytical capacity among local DOTs has historically made these detailed analytics inaccessible on-demand, if at all. Ultimately, we argue that it is important to match local DOT analytical capacity with network management authority.

Contents

1. Introduction

Inequities in exposure to traffic externalities are often discussed in the context of environmental justice and public health (Marcantonio et al. 2017; Martens et al. 2019). The distribution of transportation-related burdens has been well-studied, including exposure to vehicle emissions (Lu 2023; Elliott and Smiley 2017) and safety (Raifman and Choma 2022; Appleyard 2015). Studies have documented that demographic characteristics like race and income correlate with disproportionate exposure to traffic externalities (Golub et al. 2013). Lower-income non-white households are more likely to live in areas that experience higher traffic volumes (Rodier et al. 2009), owing to the legacies of discriminatory zoning and lending policies, and the planning and building of transportation infrastructure that enforced and perpetuated discrimination and segregation (Marcantonio et al. 2017; Jackson 1985; Blumenberg 2017). Consequently, these households face higher rates of exposure to air and noise pollution from vehicles (Martens et al. 2019; Lu 2023; Elliott and Smiley 2017) and are more likely to suffer from traffic-related casualties (Raifman and Choma 2022).

Moreover, these communities are disproportionately impacted by externalities produced by commuters traverse these areas without stopping (Lu 2023; Elliott and Smiley 2017; Balcik et al. 2010; Rodier et al. 2009)—also known as "passthrough" traffic that neither originates nor ends within the community—that less vulnerable communities are not exposed to. The dynamics of passthrough traffic are shaped by factors such as convenience, driver knowledge, and the interplay between land use and road networks.

With local transportation agencies increasingly incorporating equity in their planning and network management efforts, detailed analyses of how different types of traffic respond to circulation management strategies is crucial for measuring and interpreting the equity impacts of traffic dynamics. City-scale network management does not happen in a closed system; traffic movements within a city are a subset of regional traffic dynamics. Local interventions have mixed effects on the network that must be acknowledged and monitored, especially when considering how those effects impact society. However, while local agencies have the authority to implement strategies within their borders, they have limited analytical capacity to measure the broader network dynamics that affect and are affected by their operations decisions; they often need to rely on Metropolitan Planning Organizations (MPOs) for time-intensive and computationally demanding travel demand modeling and analysis of regional traffic dynamics. In this report, we show how local DOTs can match their analytical capacity to their network management authority.

Move San José is the city's access and mobility plan adopted by the city council in August 2022. Focused on equity, *Move San José* is based on extensive community input. The city performs needs assessments to "prioritize neighborhood-specific strategies."[1] The plan's Safer Streets Strategy is designed to rebuild streets to

[1] *Move San José* interactive webpage: https://storymaps.arcgis.com/stories/096082d53c5c4e5baf9eb6afe15a1f0f

make them safer, prioritizing the needs of those with mobility impairments, adding bike lanes, building bus boarding areas, reducing speed limits, and creating café/retail space, among other things.

Using the Mobiliti traffic simulation platform, we model the City of San José's Safer Streets strategy to study the operational and social impacts of equity-focused traffic management strategies. Specifically, we look at how passthrough traffic on residential streets in San José's Equity Priority Communities (EPCs) responds to the imposition of a 20-mph speed limit cap on those streets. EPCs are census tracts with significant concentrations of traditionally underserved populations, including low-income households and racial minorities. With the simulation results, we can infer the operational and social impacts of this strategy based on existing research in scholarship and practice.

Using the analytical approach offered in this study, city officials can more quickly gain quantified insights into the response of network dynamics to local interventions through in-house iterative exploration of possible strategies. These insights can inform equity analyses and support adaptive network management that responds to the resulting social and operational impacts. Ultimately, we argue that it is important to match local DOT analytical capacity with network management authority. As will be discussed in the subsequent literature review, existing scholarship highlights the discrepancies between local and regional authority and the tools available for that analysis; and the limitations, challenges, and conflicts that are associated with local authorities participating in and implementing regional initiatives.

The remainder of this report is structured as follows: In Section 2, we review existing scholarship on traffic simulation in relation to local capacity. In Section 3, we present our analytical approach for studying the safety impacts of lowering speed limits on residential streets in San José's EPCs. We employ the Mobiliti traffic simulation platform to model the traffic management strategy. In Section 4, we describe the simulation results and analyze their social and operational consequences. Section 5 discusses the practical applications of our analytical approach for local transportation agencies and concludes with considerations for policy and further research.

2. Background

Below, we review scholarship that discusses the measurement, modeling, and simulation of traffic externalities, and the geographic scales of transportation system governance and analysis. We highlight the differences in transportation equity analytical capacity and implementation authority between local and regional transportation agencies. In calling attention to these differences, we discuss opportunities to strengthen the connection between analysis and intervention.

2.1 Measurement, Modeling, and Simulation of Traffic Externalities

Balcik et al. (2010) study equity in vehicle routing decisions in public service provision (e.g. disaster relief distribution, mobility services, and hazardous materials transportation). Their work, particularly their discussion on hazardous goods transport, contributes to research on the spatial distribution of freight pollution as freight transportation is a key source of greenhouse gas emissions (Palaniappan et al. 2006) and freight corridors and terminals (which are also major sources of industrial pollution) are often near neighborhoods whose residents are predominantly non-white and low-income (Lu 2023; Elliott and Smiley 2017; Palaniappan et al. 2006). Researchers have also found that vulnerable communities are exposed to higher levels of emissions from passthrough traffic because such communities are located along or near high-volume roadways (Elliott and Smiley 2017; West Oakland Truck Survey 2009; Palaniappan et al. 2006).

Lu (2023) finds that in the Los Angeles region, residents who drive longer distances are exposed to less vehicle-generated fine particulate matter (PM2.5) than residents who live closer to the city center and drive shorter distances. Even more striking is their finding that residents in ethnic minority and low-income census tracts are subjected to little vehicular PM2.5 yet are more exposed to it than those in white and high-income census tracts where more vehicular PM2.5 is generated. These findings corroborate the long understood spatial and racial disparities in vehicular externality generation and exposure (Marcantonio et al. 2017; Elliott and Smiley 2017).

Dynamic routing facilitated by navigation apps generates an unpredictable landscape of negative externalities (Macfarlane 2019; Lazarus et al. 2018; Kuncheria et al. 2023) including increased risk and incidence of auto-pedestrian traffic casualties (Appleyard 2015), increased neighborhood exposure to pollutants (Rodier et al. 2009; Elliott and Smiley 2017), and increased congestion on roadways that are not designed to carry redistributed traffic loads (Macfarlane 2019).

Many studies have employed modeling software to analyze network performance (Kuncheria et al. 2023; Bills 2022; Barth and Boriboonsomsin 2009) and the distribution of impacts following physical changes to roadways or policy implementation (Bills 2022; Golub and Martens 2014). Kuncheria et al. (2023), in their simulations of Bay Area traffic dynamics using Mobiliti, find that disadvantaged communities bear a disproportionate share of vehicle miles travelled (VMT) load in routing strategies that optimize for fuel consumption, system travel time, and user equilibrium travel time. Of note, their study showed that in San José, the street network in Equity Priority Communities makes up 23 percent of the total network miles in the city but carries 36 percent of the city's VMT and 46 percent of the city's vehicle hours travelled (VHD), results that Kuncheria et al. (2023) attribute to the tendency of these communities to be located near highways with high flow rates.

A small body of literature examines the equity outcomes of implemented traffic control strategies. Zhang and Levinson (2005) study the impact of ramp metering in Minneapolis-St. Paul and find the most efficient metering strategies are also the least equitable in terms of the study objective, equalizing delay. They identify minimizing weighted travel time as a ramp metering objective that balances efficiency and equity. Zhou et al. (2022) find that in Rhode Island, the reduction in the number of lanes from to four to three, also known as a road diet, lead to a 29 percent decrease in total crashes and a 37 percent decrease in fatal and injury crashes. Their literature review of ex-post evaluations of road diets shows that safety benefits vary, but all studies find reductions in the incidence of crashes. Streets in vulnerable neighborhoods are often wider and straighter, conditions that encourage faster driving and lead to heightened risks of auto-related casualties (NACTO 2013).

2.2 Geographic Scales of Transportation System Governance and Analysis

Title VI of the Civil Rights Act of 1964, prohibits discrimination based on race, color, or national origin in federally funded programs, including those managed by MPOs. This provision was later reinforced by Executive Orders such as EO 12898, 59 F.R. 7629 (Feb. 16, 1994), which directed federal agencies to address adverse human health and environmental outcomes on minorities and low-income populations.[2] EO 14096,[3] 88 F.R. 25251 (Apr. 26, 2023) further builds upon this directive, emphasizing the importance of scientific research, high-quality data, and community engagement in addressing environmental justice concerns.[4] Guidance from the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) clarifies that Title VI applies not only to project development but also to planning processes and products[5]. Despite this legal framework, assessing compliance with regional equity analyses lacks a clear legal basis, as noted by Sanchez et al. (2003) and Karner (2012). While FHWA published an Environmental Justice Reference Guide in 2015, aimed at standardizing environmental justice analyses, challenges remain regarding data quality and institutional guidance on data procurement, management, and use. Agencies often rely on available and inexpensive data for compliance analyses, highlighting the need for increased attention to data quality and standardized data literacy practices (Macfarlane et al. 2022; Khan et al. 2020; Griffin et al. 2020). Regarding transportation equity analyses, Bills et al. (2017) point out that average measures, while analytically convenient at the city or regional scale, mask the impacts of externalities and the interventions that are designed to address them. “Averages tend to mask finer grain outcomes” and their distribution across population segments (Bills et al. 2017).

The governance scale mismatch (Howell-Moroney 2008; Bertolini et al. 2008), particularly between regional authorities and local governments, has been a pain point for transportation governance in the United States. MPOs are known for being saddled with tremendous responsibility to fulfill federal mandates and being hamstrung by limited authority to advance regional initiatives (Lewis and Sprague 1997; Sciara and Handy 2017; Karner 2012). While much of the capacity for transportation modeling and analysis lies with MPOs (Waddell 2011), they lack the direct authority to operate and manage transportation networks. Conversely, DOTs, especially local DOTs, have network operations and management authority, but have limited capacity to analyze traffic dynamics beyond their borders (Macfarlane and Babur 2024). Regional-scale travel demand

[2] https://www.hud.gov/program_offices/fair_housing_equal_opp/title_vi_civil_rights

[3] The Trump Administration rescinded EO 14096 on January 20, 2025.

[4] https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice

[5] https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Implementing_TitleVI_Requirements.pdf

analyses require high-performance computing (Meyer and Miller 2001; Waddell 2011), specialized analytical skills and tools (Sabri and Witte 2023; Son et al. 2023; Sanchez et al. 2023), and staff time (Waddell 2011).

Bertolini et al. (2008) call for a redefinition of planning institutions “to overcome the mismatch between existing institutions and emerging problems and potential solutions” to address issues of scale (local, regional, state, national) and scope (public governance versus governance arrangements that include non-public entities). Sciara and Handy (2017) argue for regional scale transportation planning “because problems associated with the system do not respect political boundaries…their solutions require cooperation across cities at a regional scale.” Karner (2012) names institutional arrangements—the competing remits of state, regional, and local authorities—as key impediments to advancing planning objectives. These cross-jurisdictional challenges implicate the interactions between localized traffic management strategies and broader network dynamics.

2.3 Summary and Research Objectives

From the literature review, we identify two key points. The first point is that vulnerable communities are disproportionately exposed to externalities generated by passthrough traffic. As shown by Lu (2023), Elliott and Smiley (2017), and Palaniappan et al. (2006), passthrough traffic, in particular, is an important source of safety and emissions hazards for vulnerable communities. The second point is that while regional and local agencies are aware of transportation inequities and are committed to mitigating them, MPOs generally have greater analytical capacity than local DOTs but local DOTs are responsible for implementing traffic policy at the local level. Relatedly, there is great variation in the capacity of local agencies to measure and analyze the social and geographic impacts of transportation activities within and beyond their jurisdictions (Macfarlane and Babur 2024).

Considering these two points together, we observe an opportunity to bolster local DOTs' ability to conduct multiscalar analyses of the operational and social impacts of their traffic management strategies, thereby narrowing the gap between implementation authority and analytical capacity at the local level. We explore this opportunity by studying the impacts of the network response of passthrough traffic to equity-focused traffic management strategies implemented by local DOTs. Using the Mobiliti traffic simulation platform, we model San José's Safer Streets strategy on residential streets in the city's EPCs, a strategy that aims to improve safety by reducing traffic speeds. Through our study, we show that our analytical approach is feasible for use at the local level and bolsters local DOTs' capacity to measure and evaluate the multiscalar operational and social impacts of their traffic management strategies. In the next section, we describe our study design and methodology.

3. Research Design and Methodology

Using the Mobiliti traffic simulation platform (which we describe in Section 3.3. below), we model *Move San José's* Safer Streets strategy in residential streets in the city's EPCs, the study area. The study captures all trips in the San Francisco Bay Area that pass through the study area, which provides an opportunity to explore the interplay between local and regional traffic dynamics. By comparing the behavior of passthrough traffic before and after imposing a 20-mph speed limit cap in our study area, we explore how passthrough traffic responds to lower speed limits and the social and operational impacts of the response.

In the following subsections, we provide background on *Move San José* and summarize the plan's Decision Support System, a tool designed to guide the implementation of the plan's strategies, particularly in the city's EPCs. We describe the plan's Safer Streets strategy, the focus of this report and identify San José's EPCs Following this background, we then describe our simulator, dataset, simulation process, and analytical approach.

3.1 Move San José

The primary stated aims of the *Move San José* plan are to reduce VMT, increase active transportation, and reduce the share of drive-alone trips. The plan outlines goals and their associated key performance indicators and strategies.

The plan's Decision Support System enables staff to "more quickly and accurately diagnose issues, test options, and prioritize what projects to build" as well as "help communicate to residents and officials why the specific projects have been recommended." The system has three modules—Tracking Projects, Monitoring Performance, and Projecting Outcomes—that leverage advancements in data science and technology to help evaluate and prioritize strategies. Our study focuses on the Projecting Outcomes module and analyzes the outcomes of lowering speed limits on residential streets in San José's EPCs, which we describe in the following subsection.

3.2 Equity Priority Communities

The Metropolitan Transportation Commission (MTC) is the San Francisco Bay Area's metropolitan planning organization. Where other regional planning bodies use the terms "vulnerable communities" or "communities of concern," to describe socially and economically disadvantaged communities, in 2021, MTC adopted the term "Equity Priority Communities." EPCs are geographic units made up of census tracts whose race and income demographic characteristics meet certain thresholds. MTC describes EPCs as "census tracts that have a significant concentration of underserved populations, such as households with low incomes and people of color. A combination of additional factors helps define these areas." San José has 56 EPC-designated census tracts.

3.3 Mobiliti

Mobiliti is a traffic simulation platform that provides traffic assignment solutions and regional simulation capabilities. It implements a quasi-dynamic traffic assignment algorithm and runs on the high-performance National Energy Research Scientific Computing Center Cori computer at Lawrence Berkeley National Laboratory. For a detailed description of Mobiliti and its computational architecture and functionality, we direct the reader to "Simulating the Impact of Dynamic Rerouting on Metropolitan-scale Traffic Systems", written by Chan et al. (2023). For a recent example of another research application of Mobiliti, we recommend reading "Socially-Aware Evaluation Framework for Transportation" by Kuncheria et al. (2023), which we have referred to in the literature review; our work builds from that publication. A full description of the simulation is presented in the Technical Appendix. Using Mobiliti we ran a Baseline Scenario representing the existing road conditions. We then ran an Experimental Scenario where we capped the speed limits on roads in the city's EPCs at 20 mph. The simulator then directs reroutable vehicles to links with higher speed limits and therefore away from the EPCs.

Section 4 follows, where we first present the simulation results. We then analyze how the social and operational impacts of lowering traffic speeds addresses the city's stated goals, in light of existing scholarship, and community perception.

4. Results and Analysis

4.1 Response of Study Link Passthrough Traffic by Road Class

In this subsection, we look at how passthrough traffic volumes in the study area responded to the speed limit cap by road class. **Table 1** below shows the counts and percent change in study link passthroughs between the Baseline and Experimental scenarios. As a reminder, our study links—the residential throughways and local streets—consist of arterials, collectors, and local streets. In the study area, local roads saw a 48 percent reduction in passthroughs, collector roads saw a 39 percent reduction, and arterials saw a 30 percent reduction.

Table 1. Response of Study Link Passthrough Traffic by Road Class in San José EPCs.

Road Class	Percent Change from Baseline to Experimental
Arterials	-30%
Collectors	-39%
Local roads	-48%
Total	-39%

For example, one section of Ocala Avenue, a collector road, saw a 72 percent reduction in passthroughs per day because of the lowered speed limit, down from 385 to 279. One section of S. 2nd Street, a local road, went from 38 to 0 daily passthroughs because of the lowered speed limit. Within San José's EPCs, S. 3rd Street saw an approximately 29 percent reduction in passthroughs. The simulated speed limit cap resulted in a reduced traffic load on these residential streets and others in the city's EPCs, which aligns with the slower streets objective of Move San José's Safer Streets strategy. These results are noticeable to residents as well as agency staff; concrete counts of vehicle reductions on residential streets connect with real-world, everyday perceptions of one's environment (San José DOT 2020).

4.2 Response of Traffic Volumes on Roadways Adjacent to Study Links

Table 2 shows the percent change in traffic volumes on the broader network within San José outside the study links. Across all road classes, traffic volumes on the surrounding roadways increased following the imposition of the 20-mph speed limit cap, further underscoring the significant traffic load borne by residential streets in the city's EPCs.

Table 2. Volume Change on Roadways Surrounding (but excluding) Study Links in San José EPCs.

Road Class	Percent Change from Baseline to Experimental
Highway	+43%
Arterials	+62%
Collectors	+34%
Local	+76%

For example, S. King Road, a collector, saw a 79 percent increase in traffic volume with the speed limit cap. Tully Road, an arterial, saw a 34 percent increase in traffic volume. While the diverted traffic in the experimental scenario relieved some of the passthrough traffic burden on residential streets in EPCs, the increased load on the surrounding network within the city has mixed operational and social impacts, which are discussed further in Section 4.4 below. In addition, these results demonstrate the usefulness of Mobiliti to conduct a more extensive exploration of citywide as well as regional impacts of speed limit controls in San José's EPCs. Beyond changes in traffic volume, San José DOT analysts could use the simulation results to study congestion on the streets that receive the diverted traffic.

4.3 Impact of Passthrough Traffic on Broader San José Network (including non-EPC roadways)

Table 3 below shows the percentages of all passthroughs on the broader network within San José (all links within the city). Lowering speed limits on the study links led to an increase in passthroughs on highways and arterials and a decrease in passthroughs on collectors and local roads. In the real-world context, this makes sense because the highest capacity roadways are most likely to absorb diverted traffic. We also note again the finding by Kuncheria et al. (2023) that the roads in San José's EPCs makes up 23 percent of the total network miles in the city but carry 36 percent of the city's VMT and 46 percent of the city's VHD. In addition, as seen in Table 3, highways comprise the largest share of links carrying passthroughs in both the Baseline and Experiment scenarios. In addition, as alluded in Section 4.2 above, analysts could explore speed and density on the links absorbing diverted traffic in alternative scenarios. These results and others that analysts can generate with the simulator can show the citywide effects of localized traffic management strategies.

Table 3. Percent Change in Passthrough Trip Routing by Road Class on All San José Links.

Road Class	Baseline	Experimental
Highway	46%	49%
Arterials	23%	24%
Collectors	26%	22%
Local	5%	4%
Total	100%	100%

4.4 Operational and social impact tradeoffs in achieving the city's equity goals, existing scholarship, and community perception

Having calculated the changes in passthrough traffic dynamics between the Baseline and Experimental scenarios, the next stage in our analytical approach was to consider some of the real-world impacts and tradeoffs of diverting passthrough traffic away from the study area, drawing from traffic control, complete streets, environmental health, and spatial analytics studies in research and practice. Our colleagues, Kuncheria et al. (2023), performed a similar exercise in their study of the social impacts of routing strategies using their Socially-Aware Evaluation Framework (SAEF). That tool assists analysts in understanding how traffic dynamics impact cities. Structured by four themes—Neighborhood, Safety, Mobility, and Environment—the framework aims to better contextualize the social impacts of traffic dynamics resulting from different routing strategies. In their development of SAEF, Kuncheria et al. performed routing analyses using Mobiliti on four Bay Area cities, including San José, to understand the social impacts of different routing optimization schemes by analyzing VMT, VHD, and emissions as key metrics. From our results, we make the following inferences about reduced passthrough traffic resulting from the speed limit cap. We expect that future research will delve further into and quantify how the broader changes in network dynamics impact safety, emissions, and mobility.

4.4.1 Safety Impacts within the Study Area

Fewer passthrough trips might lead to safer conditions on residential local and residential throughway streets. However, less congested streets compel drivers to speed up and ignore speed regulations (San José DOT 2020; Zhou et al. 2022; NACTO 2013), counteracting the safety improvements. Other traffic flow control mechanisms deployed in tandem with the speed limit reductions might discourage or prevent drivers from taking advantage of the less congested streets (Florida Department of Transportation 2020; Appleyard 2015).

4.4.2 Safety Impacts to Network Surrounding the Study Area

The increased traffic load on the surrounding highways and arterials has a mixed safety impact. On one hand, an increase in traffic load on arterials heightens the risk of conflicts between autos and non-motorists (Frank et al. 2019). On the other hand, higher traffic volumes on arterials prompt drivers to slow down, thereby broadening their field of vision and improving responsiveness to roadway activity, consequently reducing the risk and severity of conflicts between autos and non-motorists (Appleyard 2015). Moreover, EPCs contain a disproportionate share of the highway and arterial capacity in the city (Kuncheria et al. 2023), so increased highway and arterial traffic due to diversions away from residential streets may concentrate safety hazards along higher volume roadways.

4.5 Emissions and Mobility Considerations

This study focuses on Move San José's Safer Streets strategy, but the research supporting the above inferences can also support discussions about emissions-related tradeoffs. For example, the reduced passthrough traffic on our study links also implies a reduction in the exposure of residents living along those roadways to traffic pollutants. However, the links absorbing the rerouted traffic will see increases in emissions because of the increased VMT and VHD. In addition, EPCs still contain the city's highest volume roadways, so the overall emissions reductions on our study links resulting from the speed limit reductions might be counteracted by the increased emissions on the nearby highways and arterials absorbing the rerouted traffic. These high-capacity roadways are freeways and arterials that span municipalities and facilitate movements across the entire Bay Area. Furthermore, the concentration of emissions along the high-volume corridors will increase, impacting residents and non-residents/other travelers alike.

Mobility conditions are likely to be optimal on our study links following the speed reductions, owing to the reduction in passthrough, though the most common metric for evaluating mobility conditions—Level of Service—is better suited for arterials and highways, not local and collector roadways (the type of roadways to which our neighborhood residential and residential throughway streets belong). However, the traffic that has been rerouted away from the study links intensifies congestion on the surrounding links. VMT and VHD increased on the non-study links, an expected occurrence given that we take account of mode shift in response to a network change which could lead some drivers to switch from using automobiles to other forms of transportation.

The discussion above is admittedly brief, but we anticipate that future work will provide additional insights.

5. Discussion

In this section, we first discuss the utility of our analytical approach for local and regional transportation equity analyses. Then we describe policy considerations around local agency adoption and use of advanced computing tools. Finally, we conclude with a summary of the key takeaways from this report and present potential future research directions.

5.1 Practical Applications of the Analytical Approach

Our study uses Mobiliti, a tool that allows for high-resolution iterative exploration of how local and regional traffic dynamics respond to routing strategies, traffic control measures, and physical changes to roadways. In particular, local agencies can quickly get a regional perspective of the impacts of their traffic management strategies. No intervention is without its tradeoffs, and the ability to measure the tradeoffs supports a more complete picture of the distribution of the resulting social and operational impacts.

Analysts can adjust network characteristics and vehicle behavior by changing parameters that include lane count, speed limit, and the percentage of vehicles that dynamically optimize their travel time. The simulator runs on high-performance computing platforms that enable analysts to run complete simulations at the regional scale in minutes rather than hours (Chan et al. 2023), a notable performance advantage that opens up a plethora of new applications that were previously unattainable due to computing constraints. These capabilities can give network managers and others valuable and continual insights into the multiscalar relationships of traffic behavior, insights that can support transportation equity evaluations and more agile responsiveness to traffic conditions. Using traffic simulators with properties like those of Mobiliti's allows analysts to concurrently simulate the influence of navigation apps and user-optimal decision making on traffic dynamics and traffic control strategies. The interactions between routing decisions and traffic control strategies allows analysts to explore the behavior of various types of trips at different geographic scales.

As a complement to existing traffic impact and equity analyses, the approach we employed in this study helps address issues around relying on averages (Bills et al. 2017) and coarse-grained views of network performance to explore the impact of localized interventions. In addition, we have shown through our approach that we can measure passthrough traffic, a metric that is difficult to measure in the real-world; this indicator provides quantifiable insights for the equity impacts of traffic dynamics.

Indicator performance can be analyzed in the context of:

- traffic operations and externalities research,
- public perception, and
- agency knowledge of context-specific implementation and enforcement considerations.

5.2 Broader Policy Considerations

Citywide transportation decision support systems can leverage advancements in data science and technology to enable staff to diagnose issues, test options, and prioritize projects. For example, San José DOT's Decision Support System (DSS) includes a Projecting Outcomes module that can be supported by tools like Mobiliti that allow for quantified analysis of how elements like traffic flow, routing, and trip type respond to traffic management strategies.

MPOs can include high-performance simulators like Mobiliti in their toolkits and technical assistance programs. For example, MTC could include Mobiliti in the Bay Area Spatial Information System as a supporting tool in its Transportation and Infrastructure Technical Assistance programs.

Neighboring Bay Area jurisdictions could also adopt this approach which would promote increased intercity collaboration around addressing inequities in exposure to traffic externalities.

Quantifying real-world impacts, such as changes in daily vehicle counts on specific streets, and directly connecting these metrics to lived experiences can foster trust between local agencies and the communities they serve. Clear communication of this connection enhances the accessibility and interpretability of data and supports improved coordination and decision-making among stakeholders operating at various scales of impact, facilitating a more holistic and inclusive approach to transportation planning and management.

5.3 Considerations for Planning Practice

5.3.1 Local-level institutional capacity

Synthesizing quantitative and qualitative approaches is a critical part of the ongoing digital transformation in transportation governance. However, the onus is on transportation modelers and those responsible for the computation infrastructure to build tools that transportation planners can use easily. Models and tools must be accessible to agency staff. Transportation agency staff are under pressure to develop proficiency in advanced computational techniques to manage and analyze large datasets and restructure workflow processes (Sabri and Witte 2023; Son et al. 2023; Sanchez 2023) which can distract from actually doing the needed work around communicating legible results to network managers and the public. Technological advancements can and should play a role but the tools themselves should not become more important than their utility.

5.3.2 Interjurisdictional Coordination

Move San José is focused on improving transportation equity processes and outcomes for San José residents. However, San José—like all other regional locales—is a nest of transportation nodes and links within the broader Bay Area transportation network. Local traffic control interventions, like the Safer Streets strategy examined here, needs to be connected to regional traffic dynamics, thereby offering broader network insights that can support a more comprehensive analysis of potential equity outcomes and aid transportation network managers in selecting operational strategies. *Move San José* is a major effort at the local level, and given San José's geographic size, economic prominence, and status as the most populous city in the Bay Area, the plan's strategies will exert influence on the surrounding municipalities.

Sciara and Handy (2017) identify "bottom-up support" through consensus among local governments in defining regional problems and solutions and a "willingness to balance regional solutions with local interests." Tools like Mobiliti can produce results that inform intra- and interjurisdictional corridor management planning that addresses the changes in traffic dynamics triggered by implementing local strategies.

5.4 Future Research

We acknowledge the following limitations of our study:

- We use a single indicator, passthroughs, across one representative day. The road network of the study geography has unique capacities to process diverted traffic (e.g., the presence of more freeways and arterials can accommodate diverted traffic compared to where there are fewer options for diversion), a point which emphasizes that each study is context sensitive. We also did not look at transit.
- Future work can look at other indicators: trip by duration, trip by origin and/or destination, trip by miles traveled, trip by time of day; Chan et al. (2023) find that almost 80 percent of rerouting happens during the morning and evening rush hours.

This study focused on one component of *Move San José's* initiative to improve street safety, but another research effort can look at emissions or noise.

A future project could perform similar analyses for EPCs across the Bay Area. These could vary by evaluation standard, indicator, and routing strategy (see Kuncheria et al., 2023). The routing strategies simulated by Kuncheria et al. did not alter road characteristics including speed limits or lane counts; we see an evaluation of the User Equilibrium Travel Time, System Optimal Travel Time, and System Optimal Fuel Consumption routing strategies following roadway changes as one further extension of this study.

6. Conclusion

Regional and local agencies share language and initiatives around addressing transportation inequities, but there are disconnects in technical resources (which regional agencies have) and the authority to manage networks (which local DOTs have). In response, we have: 1) shown how this study's approach can enhance the analytical capacity and scope of insights available in-house to local agencies while also adding another tool to regional technical assistance programs, 2) shown how improvements in high-performance computing lower the overhead for using advanced analytical tools at the local agency level, and 3) demonstrated for local agencies the utility of tools like Mobiliti alongside other network management tools, thereby bridging the gap between research and practice.

This work zooms in on the social and operational impacts of passthrough traffic dynamics, an understudied area in equity-focused traffic management research. Our results show we can quantify the effect of discouraging passthrough trips by lowering speed limits on residential streets. However, the pattern of land use and road networks complicate the resulting distribution of traffic externalities and operational impacts. The analytical approach employed in this report can empower local transportation agencies to conduct iterative exploration and evaluation of local traffic management strategies and their impacts at the local, city, and regional scales.

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Technical Appendix

A1. Simulation Inputs

The simulator requires a network model and a trip demand input.

Network Model

The road network model was derived from the HERE Technologies map consisting of over 450,000 nodes and over one million links spanning the nine-county Bay Area. Link parameters can be altered to simulate physical changes to roadways including capacity reductions and lowered speed limits.

Demand Input

The trip demand is initialized from an input file with over 19 million trip legs (origin/destination pairs) based on disaggregated simulated trip records from the San Francisco County Transportation Authority SF CHAMP 6.1 model. The San Francisco Chained Activity Modeling Process (SF CHAMP) predicts future travel patterns in the city and is built using data about "residents' observed travel patterns, detailed representations of San Francisco's transportation system, population and employment data, transit line boardings, roadway volumes, and the number of vehicles available to San Francisco households." The SF CHAMP model was developed for applications that include microsimulation modeling and project-level evaluations.

Once the network model and trip demand are specified, the simulator provides a mechanism to assign routes as fixed or dynamic. Each trip leg becomes a route through the network that may or may not be dynamically rerouted based on traffic congestion. The routes are initially assigned by a shortest-path algorithm on a routing graph based on freespeed (the real-world posted speed limit) link traversal times. Routes taken may differ from the initial routes due to dynamic rerouting during the simulation. Chan et al. (2023) find that a 60 percent dynamic rerouting penetration rate is closest to real-world traffic behavior. Therefore, we set the dynamic rerouting penetration rate to 60 percent. This mechanism is responsible for diverting passthrough traffic away from roadways that would increase a vehicle's travel time.

A2. Study Area and Indicator

With the network model, we can geographically delimit our study area and population. Our focus is on San José EPC residents. As described earlier, EPCs boundaries are based on demographic factors, namely, income and race. To study the relationship between regional and local traffic dynamics and its social impact, we selected passthrough trips as our indicator. This indicator is not among *Move San José's* key performance indicators, but this indicator allows for an external assessment of the plan's strategies, based on existing research that highlights the significant impact that passthrough traffic has on vulnerable communities. Within San José EPCs, we focus on residential local and residential throughway links, which are roadway typologies designated by

Kuncheria et al. (2023) as subsets of the functional classes of roadways designated in the HERE Technologies map that constitutes our road network model. Neighborhood Residential and Residential Throughway links span functional classes 3, 4, and 5. Our 11,522 links of interest were identified by overlaying MTC ArcGIS EPC shapefiles on Here GeoJSON data. Each link has nine attributes, five of which can be manipulated. The five changeable attributes include functional class and freespeed (the posted speed limit). **Table A-1** below shows example links from the study area and their changeable attributes. We measure our indicator by observing the number of vehicles on these links.

Table A-1. Example Residential Throughway and Residential Local Links in San José EPCs.

Link ID	Street Name	Link Length (meters)	Freespeed (meters/second)	Capacity (vehicle/hour)
23693494	S. 2nd Street	194.43	6.94 (15 mph)	1000
23693495	S. 2nd Street	186.94	6.94 (15 mph)	1000
23709734	Ocala Avenue	77.60	8.89 (20 mph)	1500
23709737	Ocala Avenue	82.39	8.89 (20 mph)	1500
23709741	Ocala Avenue	77.64	8.89 (20 mph)	3000

A3. Analytical Approach

We structure our application of Mobiliti to *Move San José's* Safer Streets strategy with three stages:

Stage 1: Simulation of chosen traffic management strategies instantiated through physical changes to roadways, traffic control measures, and/or vehicle behavior

Stage 2: Processing simulation outputs according to chosen indicator and geography (neighborhood, city, county, or region)

Stage 3: Contemplation of the interventions' social and operational impact tradeoffs in the context of the transportation agency's stated goals, existing scholarship, and community perception

The analytical approach we adopt puts us in the position of a transportation agency analyst or network manager. Having selected a strategy or set of strategies proposed in a transportation plan, the analyst can use an appropriate simulation platform to measure the response of their indicator of interest to the simulated strategy.

The iterative exploration of scenarios provides analysts with a wide range of opportunities to explore the impacts of different strategies on the network and the communities who experience those impacts. The following section discusses baseline and experimental scenarios simulations using Mobiliti.

A4. Simulations: Baseline and Experimental Scenarios

Stage 1: Simulation of chosen traffic management strategies implemented through physical changes to roadways, traffic control measures, and/or vehicle behavior

We run a baseline Mobiliti simulation (Baseline Scenario) wherein link attributes are unchanged. We then run an simulation (Experimental Scenario) where the freespeed attribute on Neighborhood Residential and Residential Throughway links in EPCs is lowered to simulate the implementation of *Move San José's* Safer Streets strategy.

Baseline Scenario

In the Baseline scenario, no link attributes are changed.

Experimental Scenario

We structured the Experimental Scenario based on the road network typology presented by Kuncheria et al. (2023). We focused on two of the road network typologies: Neighborhood Residential links and Residential Throughway links. Our experiment imposes a cap of 20 mph on these links in San José EPCs. If the baseline speed limit is greater than 20 mph, it is lowered to 20 mph. If the baseline speed limit is less than or equal 20 mph, it is left unchanged. Mobiliti dynamically reroutes trips to minimize travel time; lowering the speed limits on certain links renders them unfavorable choices in the dynamic rerouting algorithm. These adjustments were made so that the simulator would direct dynamically reroutable vehicles to links with higher speed limits and therefore away from Neighborhood Residential and Residential Throughway links in EPCs.

Stage 2: Processing simulation outputs according to chosen indicator and geography (neighborhood, city, county, or region)

Using the simulation outputs, we compared the number of trips that traverse the study links in both scenarios. To do this, we processed the simulator logs and outputs using a combination of software tools (including R and Python) to isolate the passthrough trips and study their origins and destinations, routing profiles by functional class, and their impact on traffic volumes on the non-study links. The simulator records each vehicle trip as the sequence of links traversed from origin to destination. The number of links recorded across all trips is non-trivial and requires sufficient computer memory (whether on the cloud or desktop) to process the large volume of data outputs from the simulator. The distinction between trips and traversals is important; each trip consists of a sequence of links (the route traveled) while traversals are an instance of a vehicle driving on a link. Link traversals constitute traffic volumes. The 2.2 million trips whose route profiles include San José EPC links consist of over 173 million link traversals. Below in **Table A-2**, we provide a stepwise description of our output processing for passthrough trips:

Table A-2. Description of Simulation Output Processing for Passthrough Trip Analysis.

Output Processing Description for Passthrough Trips
Step 1: Using ArcGIS and the relevant network map, gather all links within geography of interest. Our 11,522 links of interest were identified by overlaying MTC ArcGIS EPC shapefiles on Here GeoJSON data.
For each scenario output:
Step 2: Gather origin link and destination link of each trip
Step 3: Identify and subset all trips that started, ended, or passed through geography of interest
Step 4: Decompose each trip route profile to aggregate all instances of link traversals among trips of interest
Step 5: Group link traversals by functional class to observe how passthrough traffic impacts the network within the geography of interest and the broader region
Step 6: Compare changes in link traversals between scenarios
Analysts can select any particular link and count the number of instances of a vehicle driving on that section of roadway.