

The Value of Transit in Seattle and the King County Region

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This report is a product of researchers at MIT Mobility Initiative and Transit Research Consortium, in collaboration with King County Metro and Puget Sound Regional Council.



Hanyong Xu, James Aloisi and Bhuvan Atluri

Acknowledgments

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Executive Summary

Our cities and urbanized metropolitan areas thrive in part because of public transportation systems that provide people with access to key destinations, increase productivity, help reduce dangerous airborne pollutants, and provide affordable mobility to the most income-vulnerable residents of our society.

This report, and the research that underpins it, is designed to underscore the continued and critical value of public transportation in Seattle and the Seattle region. The value of transit is broad and deep, as it strengthens the Seattle economy, improves residents' quality of life across the region, and supports essential societal objectives that other transportation modes cannot provide at the same scale.

The singular purpose of transit is to provide as many people as possible with as much access to as many opportunities and resources (jobs, healthcare, education, entertainment) as they need. In addition to fulfilling this fundamental purpose, transit offers multiple societal benefits, benefits that are realized by those who take transit and those who do not. In this report, we identify and quantify many of the benefits that arise from transit's role in providing access to the people of Seattle and the region of King County in general. Those benefits include providing a large measure of transport equity and justice by enabling mobility of care trips, supporting equitable economic growth, and making driving (and car ownership) unnecessary for a sufficient number of people who can take transit instead, and thereby easing traffic congestion. Furthermore, this study demonstrates the associated costs and savings of transit service reductions or improvements by examining how shifts in driving behavior affect traffic conditions, environmental emissions, vehicle collisions, and vehicle ownership and operating costs. Among our specific findings:

- The low cost of public transportation in Seattle reduces the overall cost of living for residents by balancing out housing costs to allow Seattle to be the fifth lowest in housing and transportation costs among major metropolitan cities;
- More trips are taken in the city and region for mobility of care purposes than for work commute purpose, and more women and low-income residents depend on public transportation for those essential quality-of-life trips;
- A reduction of transit service by half (assuming inadequate funding) would cause a significant number of trips to be cancelled, reducing annual spending in the region by \$20 million, which means a \$1.8 million reduction in tax collected;
- King County could experience as much as 214 million dollars in additional annual costs due to the increase in driving behavior and vehicle ownership, environmental costs, and the additional collision costs.

These factors play a critical role in shaping long-term, sustainable, and cost-efficient social outcomes. Improved transit service is associated with better public health outcomes through reductions in carbon emissions, particulate matter, and other pollutants, as well as fewer vehicle collisions and lower vehicle-related costs. Together, these impacts underscore the broader value of transit as a critical public investment that delivers compounding social, environmental, and economic benefits beyond direct mobility outcomes.

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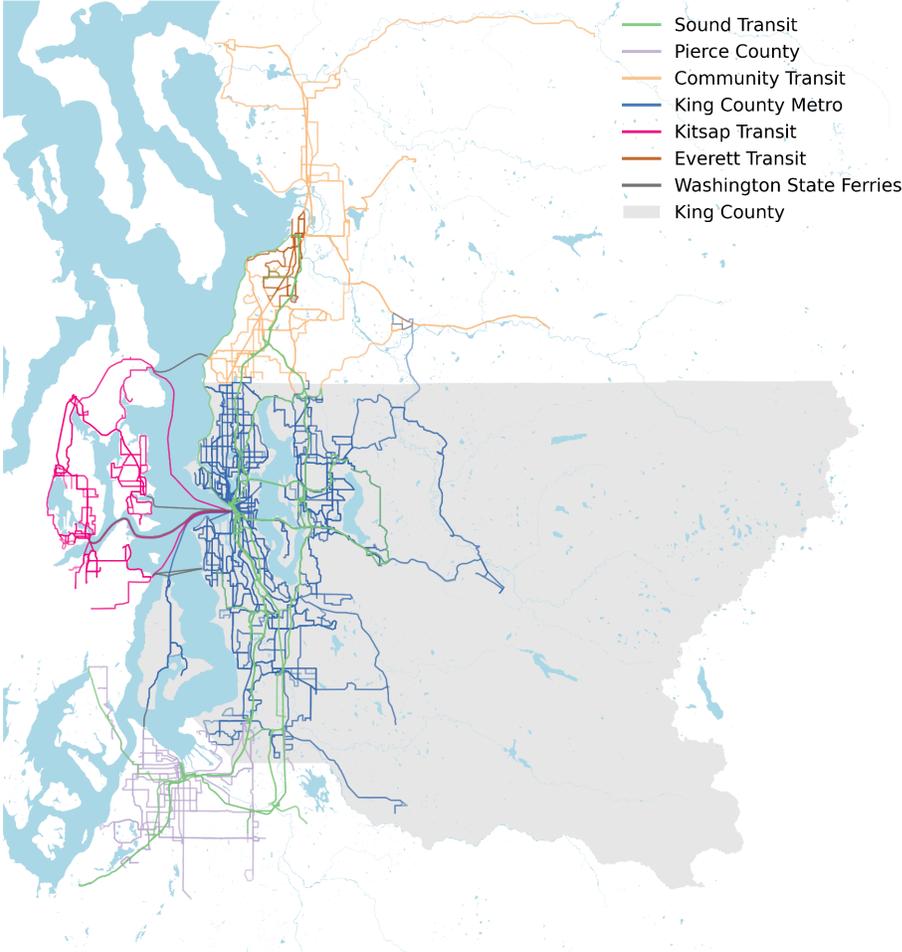
1. Background and Motivation

1.1 Spatial Distribution of Transit Agencies

Located on Puget Sound, King County, WA, is one of the leading counties in the state in terms of its employment and economic growth. It is the home to the Seattle metropolitan area, which hosts the headquarters of various Fortune 500 companies.

Public transit is one of the crucial modes of transportation in the region to move people around. King County Metro is the primary agency that serves the region, offering bus, on-demand, paratransit, vanpool, and water taxi services, and operating the Seattle Streetcar, Sound Transit Link light rail, and express buses¹. Feeder services at the border connect the county with the surrounding counties. Figure 1 illustrates this spatial distribution of major agencies of the region. King County Metro serves the majority of the county, covering most of the urban areas.

Fig. 1: Spatial Distribution of the Transit Services around King County²



¹ “About Metro - King County, Washington.” <https://www.kingcounty.gov/en/dept/metro/about>.
² spatial files from census and Puget Sound Regional Council (PSRC).

1.2 Ridership Over the Years

King County, like most US transit agencies, experienced a significant ridership shock from the pandemic. Figure 2 illustrates the ridership of the main public transit agencies in King County by service types over the years. The ridership drop is still recovering, even five years after the pandemic started. As of March 2025, King County Ridership has recovered around 69.23% of its 2019 Weekday ridership³. Table 1 demonstrates the percentage change in ridership compared to the previous year.

Fig. 2: King County Transit Ridership over Years by Major Modes⁴

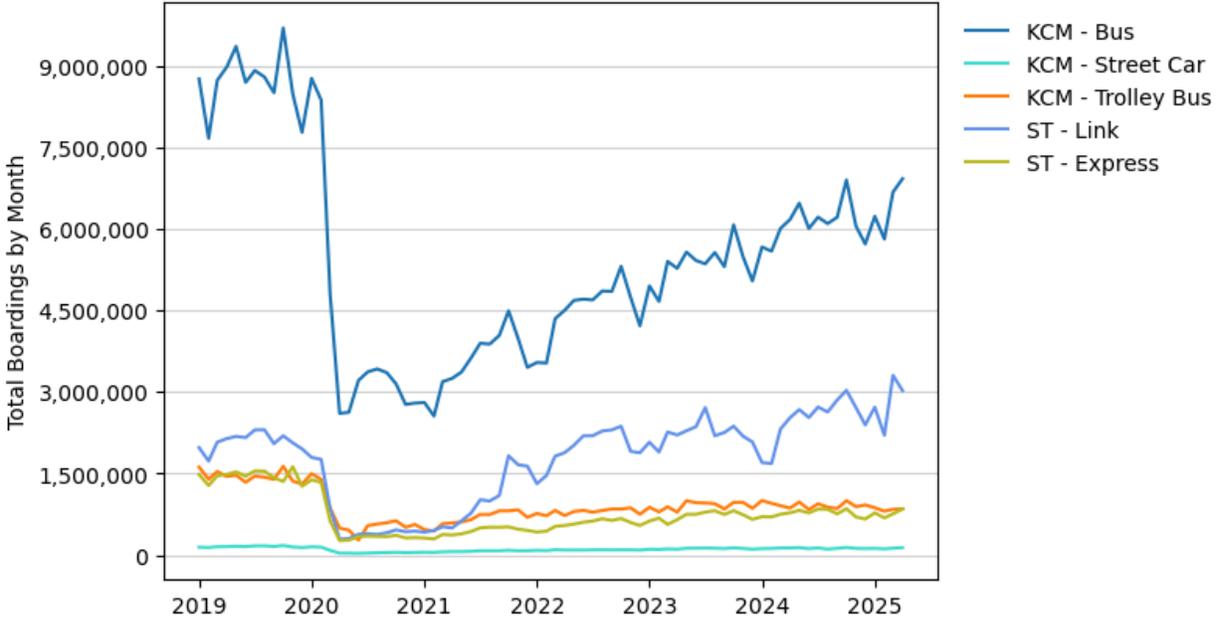


Table 1: King County Metro Transit Percent Change by Year¹

2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
-52.7%	-12.07%	25.97%	18.08%	15.96%

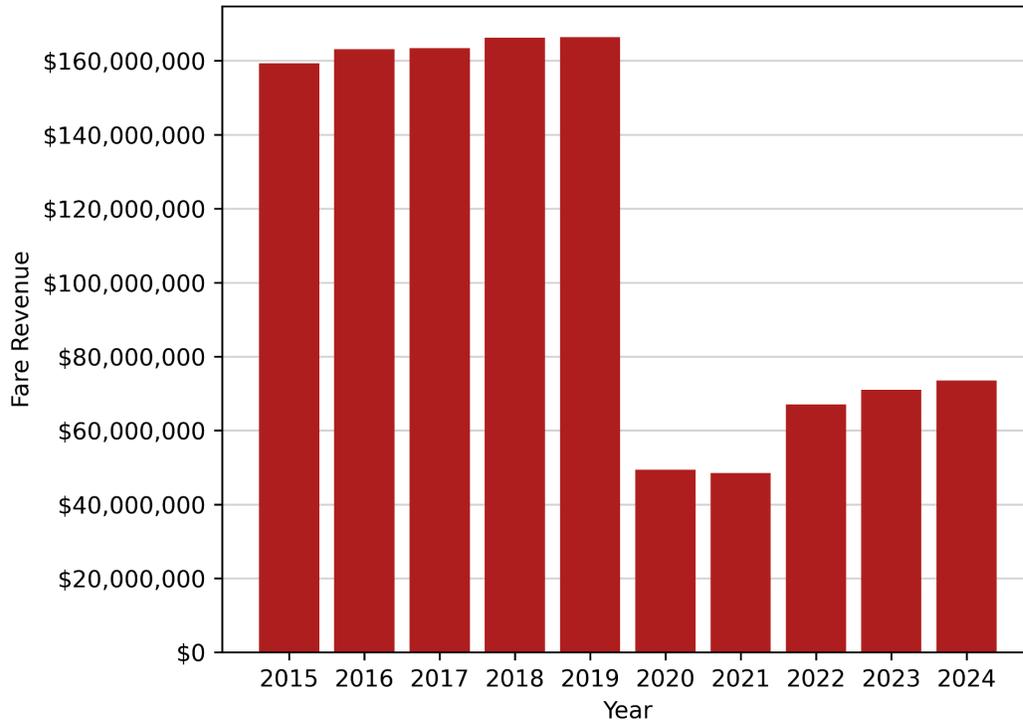
1.3 Fare Revenue Over the Years

As a result of the largely pandemic-induced loss of ridership, there is a significant shortfall and stagnation of fare revenue, which impacts the operating budget in the coming years, as seen in Figure 3. There has been a stark difference in fare revenue even as ridership has gone up. In 2019, fare revenue was an

³ King County Metro, Ten Year Summary, https://docs.google.com/spreadsheets/d/1Qyj31NiW1kc30GX9PCNrmmAn_EEmPn8WaUB_NMkYCOE/pubhtml
⁴ APTA, “Ridership Trends.” <https://transitapp.com/APTA>.
 “KCM” stands for King County Metro and “ST” stands for Sound Transit. Transit boardings are unlinked passenger trips, counting passengers every time they enter a bus and estimated by samples of automatic passenger counters.

estimated \$167 million, while in 2024, fare revenue was an estimated \$73 million⁵. King County Metro reinstated Fare Enforcement Officers starting May 31, 2025⁶.

Fig. 3: King County Metro Fare Revenue by Year⁷



1.4 Research Objectives

The primary objective of this research report is to provide evidence to demonstrate the value of transit systems with updated post-pandemic data and travel behaviors. In addition to economic benefits, this report shows the value of transit in terms of quality of life, social equity, cost of living, and mobility of care.

⁵ Switzer, Jeff, and King County Metro. 2025. "King County Metro Fully Resumes Fare Enforcement May 31." *Metro Matters*, May 27.

<https://kingcountymetro.blog/2025/05/27/king-county-metro-fully-resumes-fare-enforcement-may-31/>.

⁶ Ibid.

⁷ King County Metro, Transit Fare Revenue.

https://docs.google.com/spreadsheets/u/1/d/e/2PACX-1vQk_EEkAemeGpHX4Rprj4Ft7hVZW7dFkyYhZAmnY6_oU1hjlSA3GHUfyxhTpnsISH0IbN3A7OskmIZ0/pubhtml?gid=20&single=true

2. Equity and Mobility of Care

2.1 Vehicle Ownership

Figure 4 demonstrates the average percentage of households without vehicle ownership in King County. Starting in 2020, this has been increasing, emphasizing the steady reliance on transit. As seen in Figures 5-1 and 5-2, in denser areas like Seattle, this portion is even higher, reaching over 50%, with carless households mostly concentrated near neighborhoods such as Downtown, Capitol Hill, and the University District.

Fig. 4: Average Percentage of No Vehicle Ownership in King County Over Years⁸

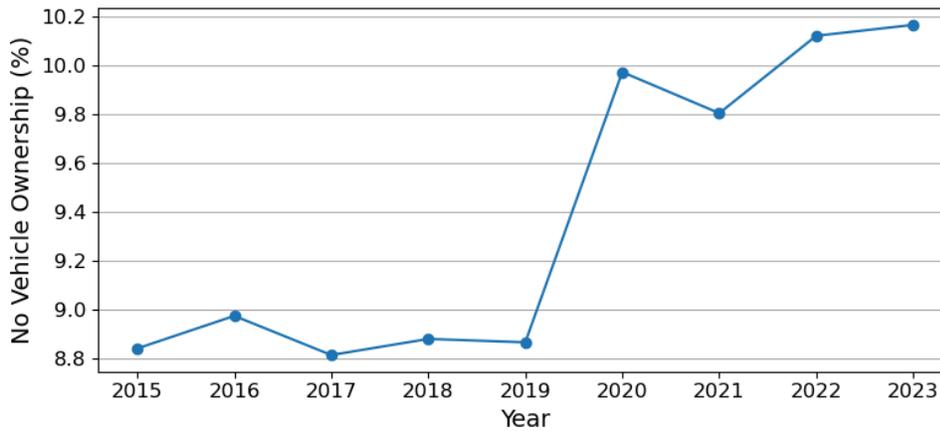
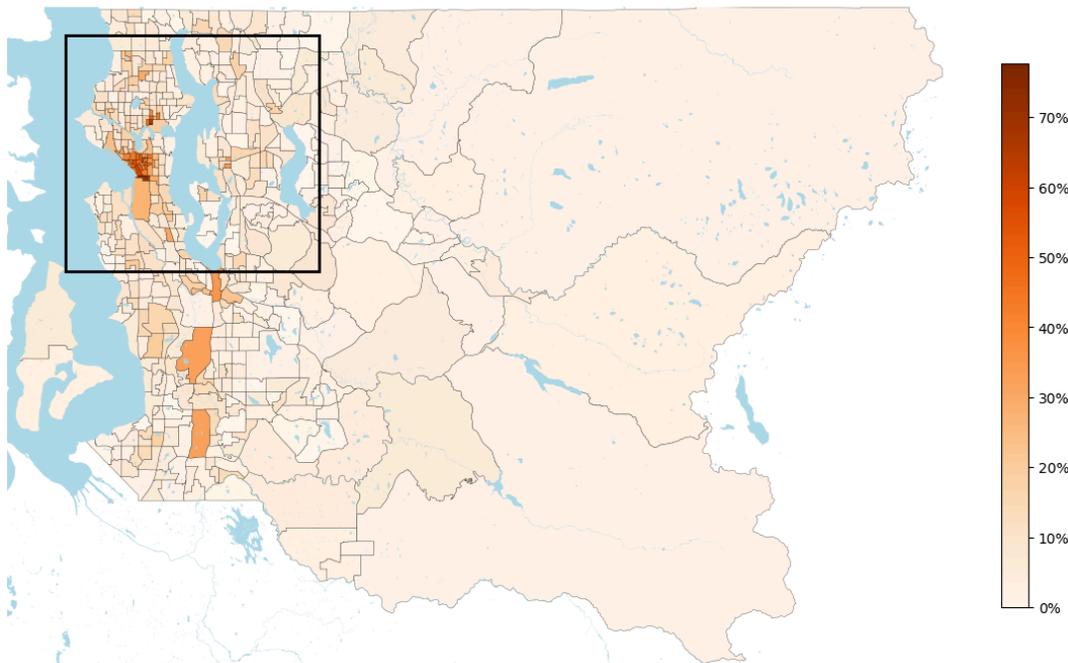


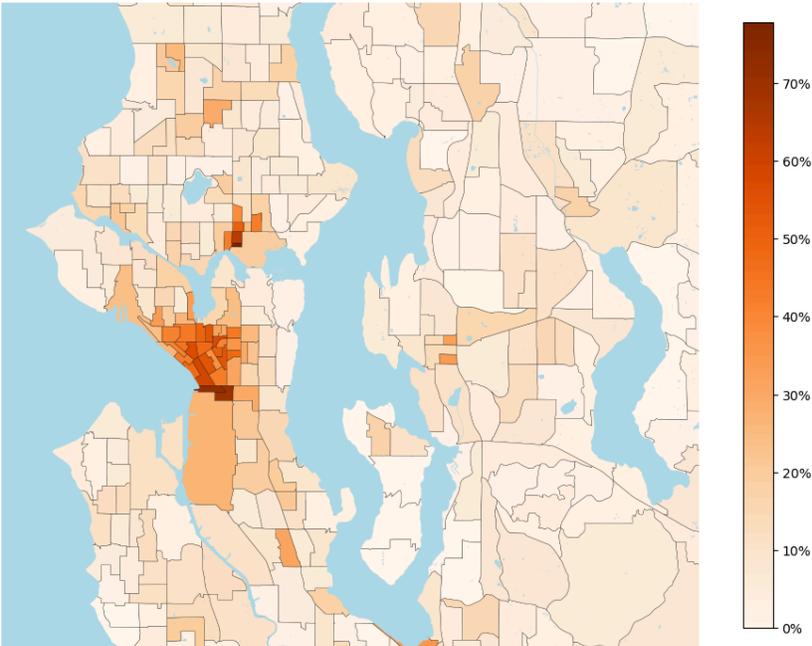
Fig. 5-1: Geographic Distribution of the Percentage of No Vehicle Ownership in 2023 in King County⁹



⁸ 2015-2023 American Community Survey (ACS) Five Year Estimates.

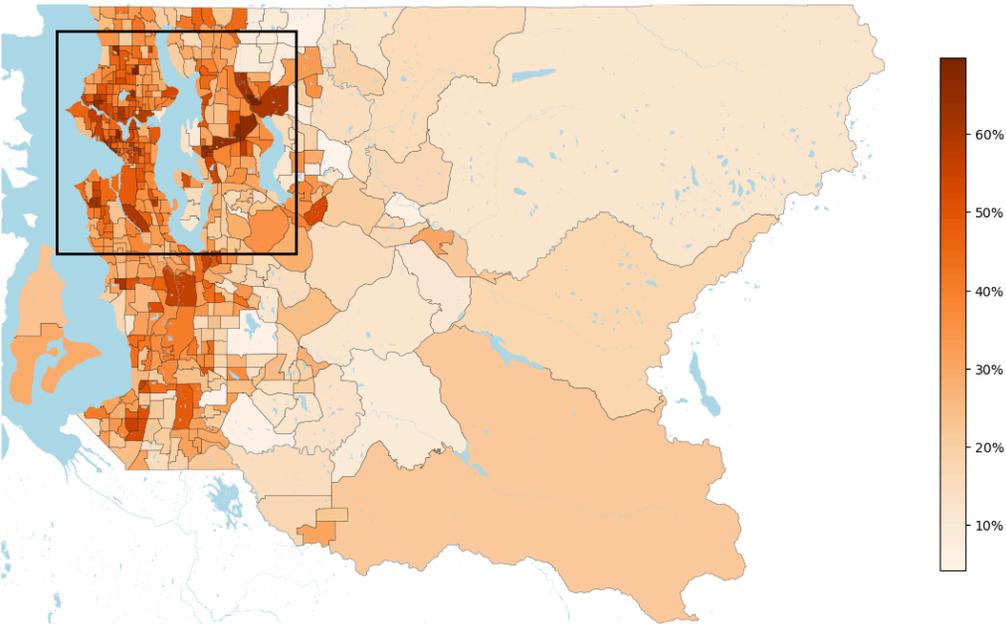
⁹ Ibid.

Fig. 5-2: Geographic Distribution of the Percentage of No Vehicle Ownership in 2023 near Seattle and Bellevue¹⁰



A similar distribution can be found when examining the household one-vehicle ownership in King County, where the urban regions have much higher concentrations, as shown in Figures 6-1 and 6-2.

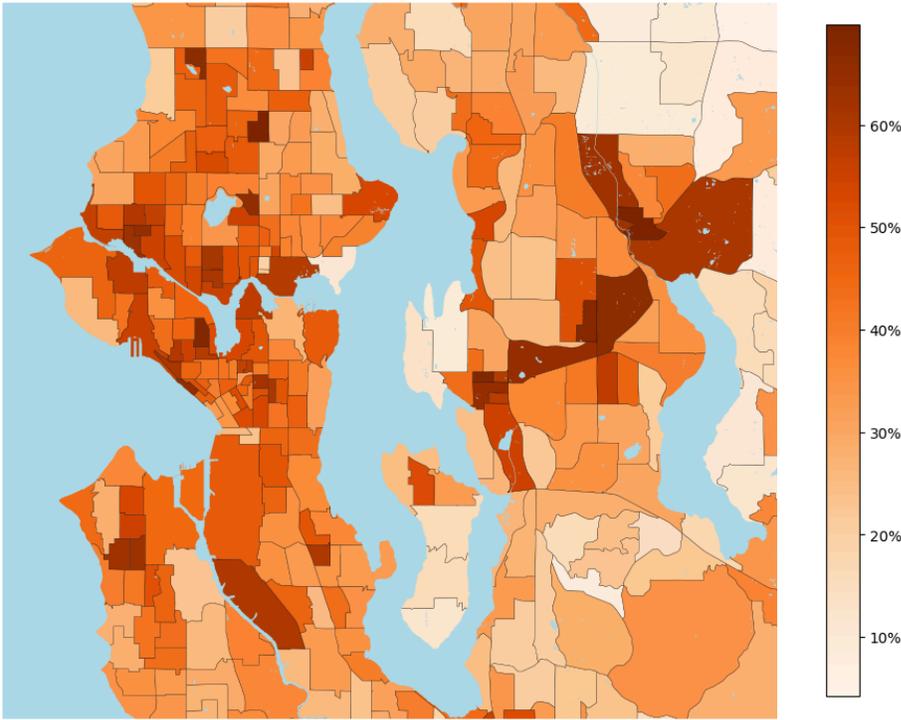
Fig. 6-1: Geographic Distribution of the Percentage of One-Vehicle Ownership in 2023 in King County¹¹



¹⁰ Ibid.

¹¹ Ibid.

Fig. 6-2: Geographic Distribution of the Percentage of One-Vehicle Ownership in 2023 near Seattle and Bellevue¹²



2.2 Cost of Transportation

Owning private vehicles is costly. In King County, the average annual cost of owning an automobile is \$11,487 in 2025¹³. This means that in King County, the regional typical household (defined with the average household size, average number of commuters, and the median King County income of \$107,206)¹⁴ would spend 10.7% of their income on just one car. However, often households with multiple family members need more than one car to travel to work, do errands, and attend events. This means that the cost of transportation would be further driven up by auto ownership prices as well as the cost for vehicle miles traveled. The typical regional household in King County has 1.79 cars per household¹⁵.

The high cost of automobile ownership is especially a burden for low-income households. The King County regional median income for lower-income households, defined as those living below 200% of the federal poverty level, is \$22,100. From 2019-2023 data, 17.6% of the King County population fell under this 200% federal poverty level mark¹⁶.

¹² Ibid.

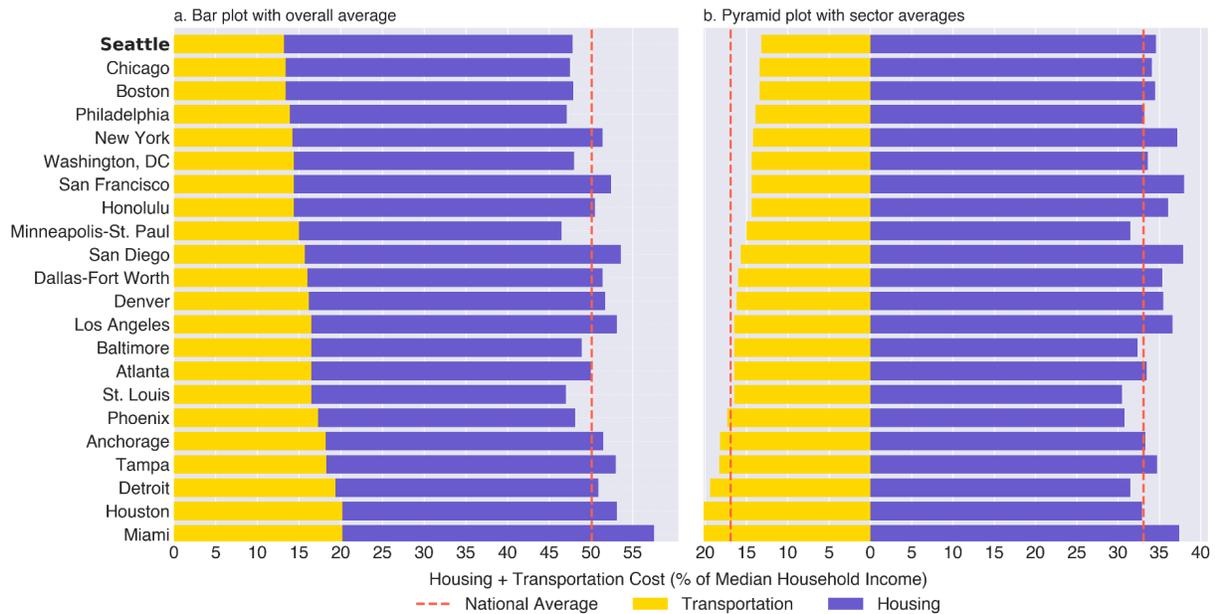
¹³ The Center for Neighborhood Technology's Housing and Transportation (H+T) Affordability Index.

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Communities Count. "Below 200% Poverty Level." <https://www.communitiescount.org/below-200-poverty-level>.

Figure 7: Ranking Percent of Housing and Transportation Cost in Median Household Income by Major U.S. City¹⁷



Moreover, the combination of housing and transportation costs can be burdensome. In King County, an average household in 2022 spent 14% of its income on transportation¹⁸, compared to the 17% national average determined by the U.S. Department of Transportation Bureau of Transportation Statistics¹⁹. As seen in Figure 7, the Seattle area ranked lowest in transit expenditure among major U.S. cities. Though the housing cost is above the national average, the low cost of transportation balances out housing to allow Seattle to be the fifth lowest in housing and transportation costs among major metropolitan cities²⁰. In short, public transportation in King County reduces the overall cost of living for residents and can greatly reduce the economic burden of automobile-based transportation, especially for low-income households.

The spatial distribution of the transportation cost burden in the region tells a similar story. Figures 8-1 and 8-2 below show the percentage of household income that the regional typical household by tract spends on transportation, and are overlaid with transit lines. In areas that King County Metro densely services, such as downtown Seattle and Bellevue, the percentage of household income spent on transportation is lower. At the same time, tracts with less public transit coverage, like tracts further east within King County, have a higher percentage of their income spent on transportation.

¹⁷ The Center for Neighborhood Technology’s Housing and Transportation (H+T) Affordability Index.

¹⁸ Ibid.

¹⁹ “Transportation Economic Trends: Transportation Spending - Average Household.” <https://data.bts.gov/stories/s/Transportation-Economic-Trends-Transportation-Spen/ida7-k95k/>.

²⁰ The Center for Neighborhood Technology’s Housing and Transportation (H+T) Affordability Index.

King County Metro also provides transportation services to those in need. Fares are either subsidized from \$2.75 to \$1 or free for riders who have lower incomes (at or below 200% federal poverty level), riders with disabilities, seniors, and riders under 18 years of age²¹.

Figure 8-1: Percent of Median Household Income spent on Transportation by Tract

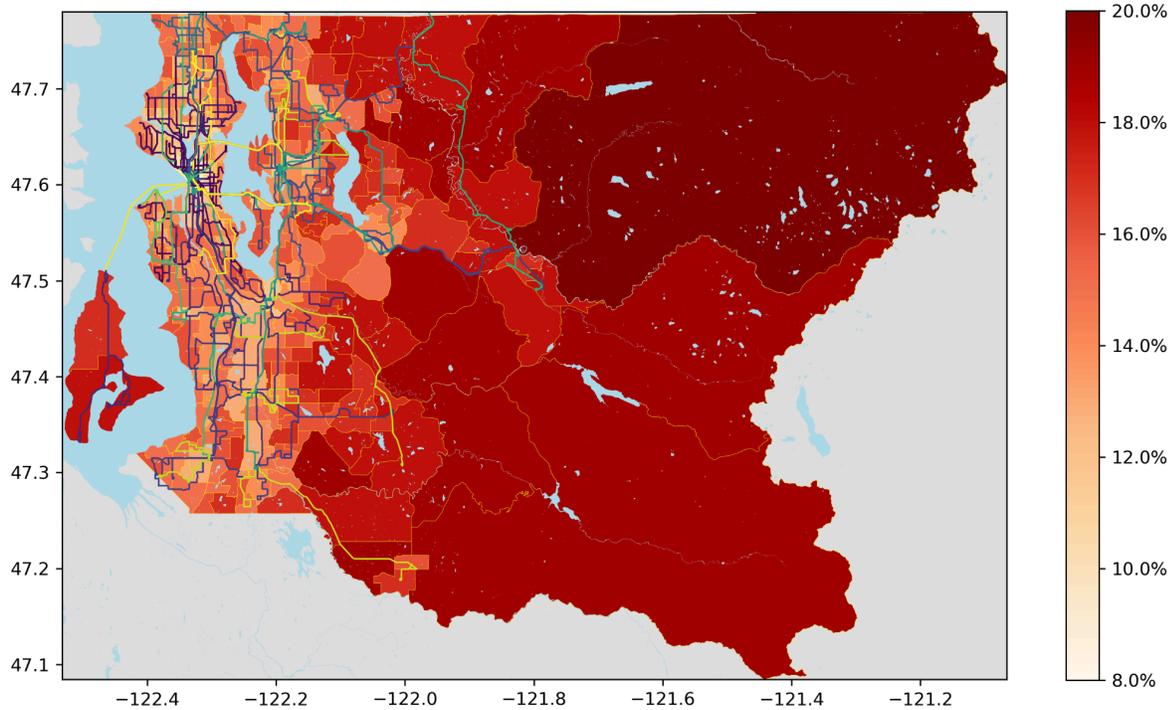
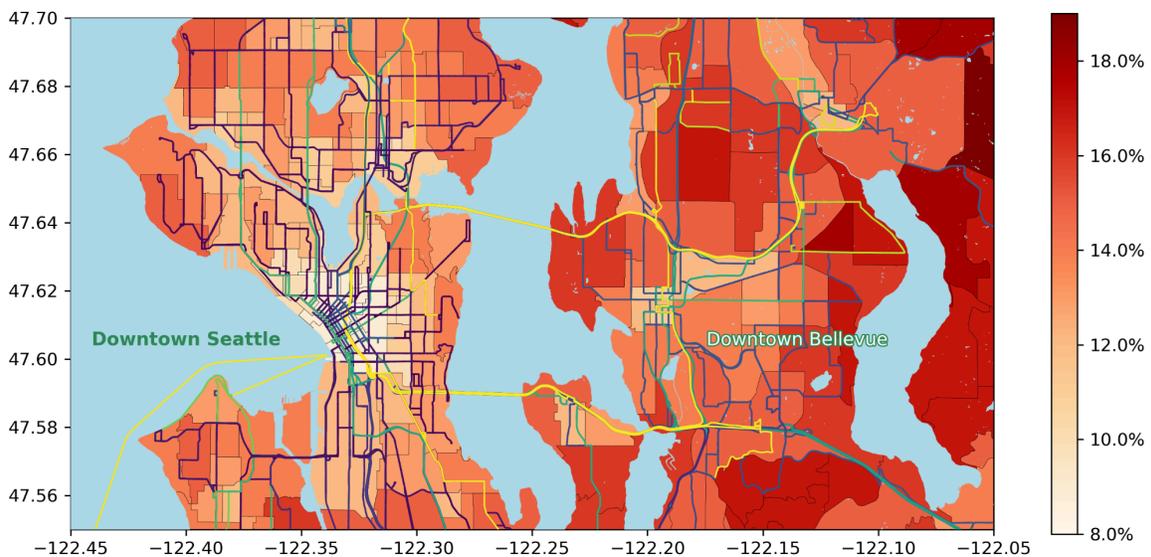


Figure 8-2: Percent of Median Household Income spent on Transportation in Downtown Seattle and Bellevue



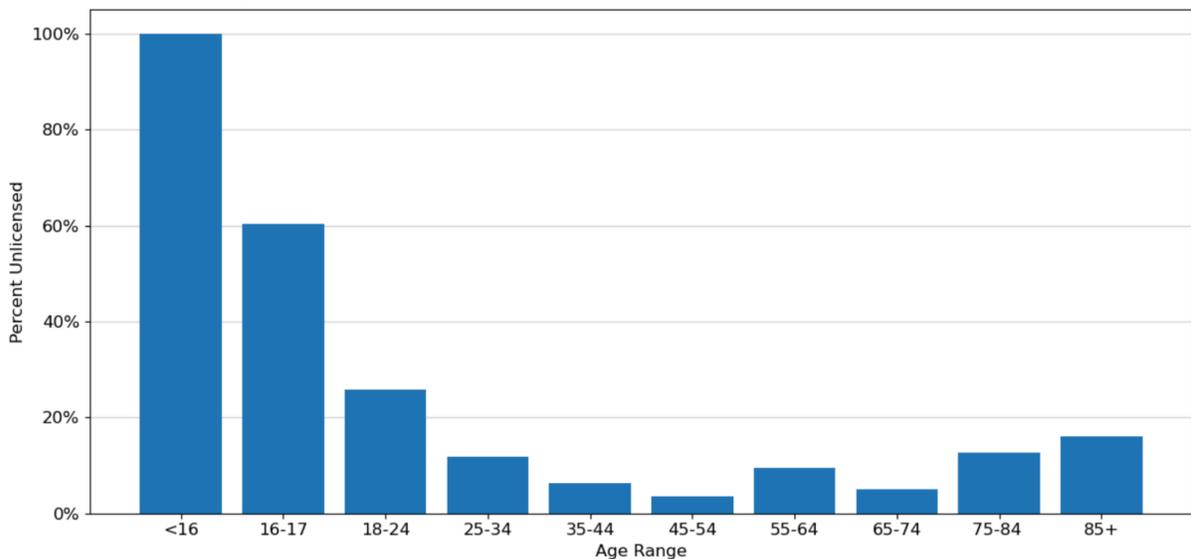
²¹ "ORCA LIFT - King County, Washington." <https://www.kingcounty.gov/en/dept/metro/fares-and-payment/reduced-fares/orca-lift>.

2.3 Movement For All

Not everyone has access to private vehicles, nor is able to drive. Figure 9 represents the percentage of the population without a driving license by age group. The younger and older population, specifically teenagers and younger, as well as adults 85 and older, have higher rates of being unlicensed. Without public transit, this creates a burden upon caregivers to chauffeur others around, whether it leads to parents having to drive their teenagers to various activities or caretakers of the elderly having to drive them to buy groceries or attend medical appointments. This particularly affects households where the caregivers lack time, due to working long hours, where the parent is already stretched thin. Public transit allows for the more independent subgroups of these younger and older populations to freely access their activities without inconveniencing their caregivers and subsequently saving time, gaining more freedom of movement, and control of their lives.

There is also a different level of driving licensing proportion in different demographics. In most age groups, a higher ratio of women is unlicensed compared to the ratio of unlicensed men, particularly in the older ages. In the 18-24 age group in the PSRC Household Travel Survey, 13.78% of men are unlicensed, while 28.71% of women are unlicensed. In the group of 85 and over, 6.52% of men are unlicensed compared to 25.63% of women.

Fig. 9: Percentage of Population without a Driving License by Age²²

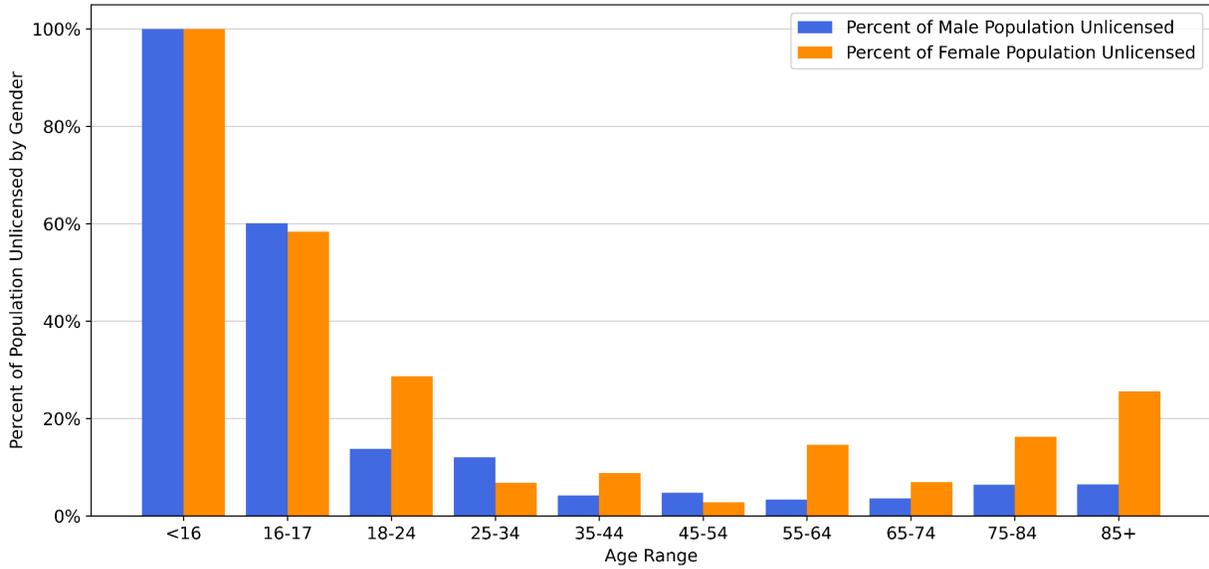


As women disproportionately make mobility of care trips, such as picking up children and buying groceries, which will be discussed in later sections, effective and accessible public transit is important in providing a reliable way to get around. Transit becomes a greater priority, particularly for the higher proportion of women who are unlicensed and lack the option to drive²³.

²² PSRC Household Travel Survey

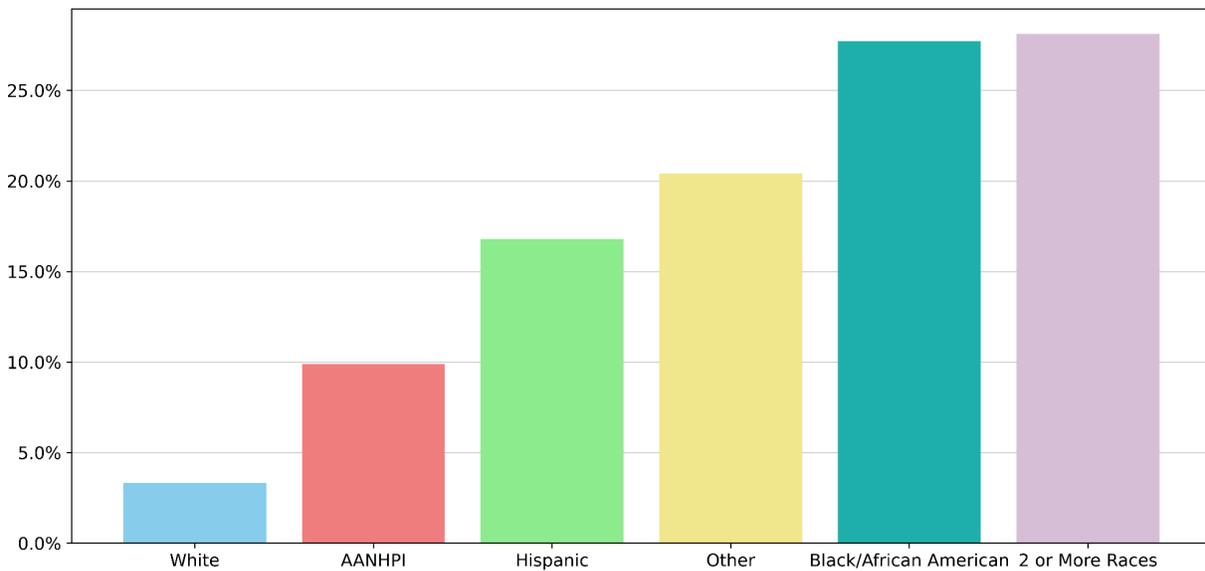
²³ Fong, Amy Z., and F. Atiyya Shaw. 2024. "Well-Being Implications of Mobility of Care: Gender Differences among U.S. Adults." *Transportation Research Part D: Transport and Environment* 129 (April): 104109. <https://doi.org/10.1016/j.trd.2024.104109>.

Fig. 10: Percentage of Population without a Driving License by Age and Gender²⁴



The ratio of the unlicensed population also varies drastically by race. From those aged 16 years and older in King County, a higher proportion of people of color are unlicensed, particularly Black and Hispanic populations. Figure 10 shows the percentage unlicensed by race in the 16-year-old and older population. 3.34% of White respondents answered that they were unlicensed, compared to the much higher 16.81% of Hispanic respondents and 27.71% of Black respondents²⁵.

Fig. 11: Percentage of Population without a Driving License by Race²⁶



²⁴ PSRC Household Travel Survey.

²⁵ Note: sample sizes greatly vary by race, with 3813 answers from White respondents, 1079 from Asian American/Native Hawaiian/Pacific Islander respondents, 371 from Hispanic respondents, 171 from Black/African American respondents, 27 from two or more races, and 123 from others.

²⁶ PSRC Household Travel Survey.

2.4 Mobility of Care

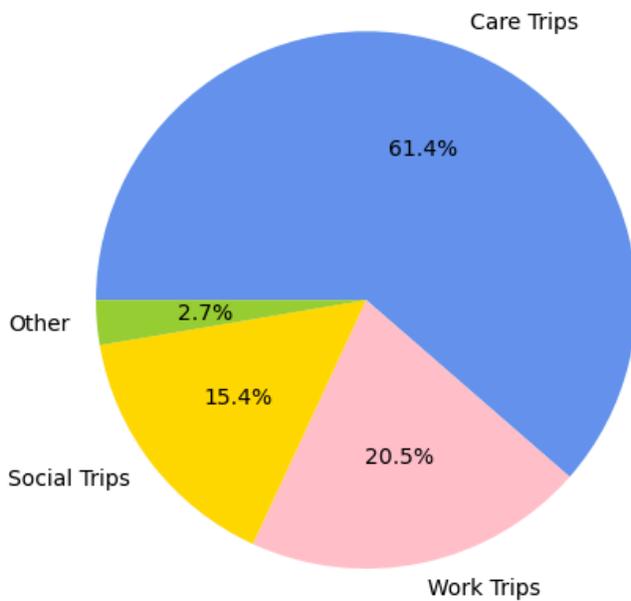
“Mobility of care” is defined as the travel required to perform caregiving and household-serving tasks, which includes getting groceries, pick-up and drop-off to doctor’s appointments or school events, and similar activities²⁷. These care trips are critical quality-of-life trips and they make up a high percentage of all trips made.

Trips were categorized by purpose, with 37 different categories. 24 of these purposes were included as mobility of care trips, including but not limited to the following (see full classification in Appendix):

- Accompanying others
- Appointment, shopping, or errands
- Pick up and Drop off
- Getting gas
- Grocery shopping
- Personal business (e.g. bank, post office)
- Medical Appointments
- Vacation
- Volunteering
- Going to family activities

Planning and accounting for the travel behavior of the mobility of care is important for its prevalence. According to the 2023 Household Survey conducted by the Puget Sound Regional Council (PSRC), which collected data by person, household, and trip, care trips comprise 61.4% of trips made in King County. Comparatively, work trips only accounted for 20.5% of trips, as shown by Figure 12.

Fig. 12: Trips in King County by Type²⁸



²⁷ Fong, Amy Z., and F. Atiyya Shaw. 2024.

²⁸ PSRC Household Travel Survey

While women and men make a similar ratio of total trips, as shown by Figure 13, the percentage of women who make mobility of care trips is 5.6% higher than men. Concurrently, men conduct larger amounts of work and social trips, at almost 16% more, as shown in Figure 14.

Fig. 13: Trips in King County by Gender²⁹

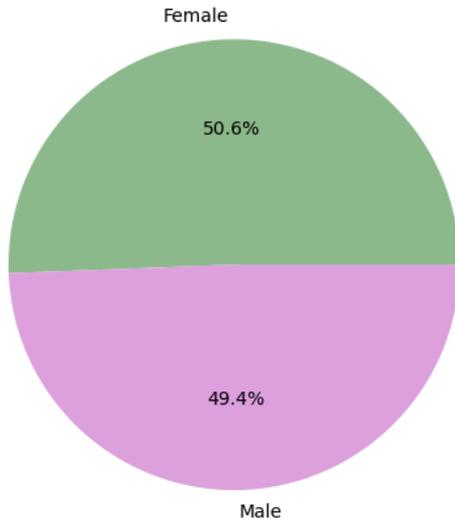
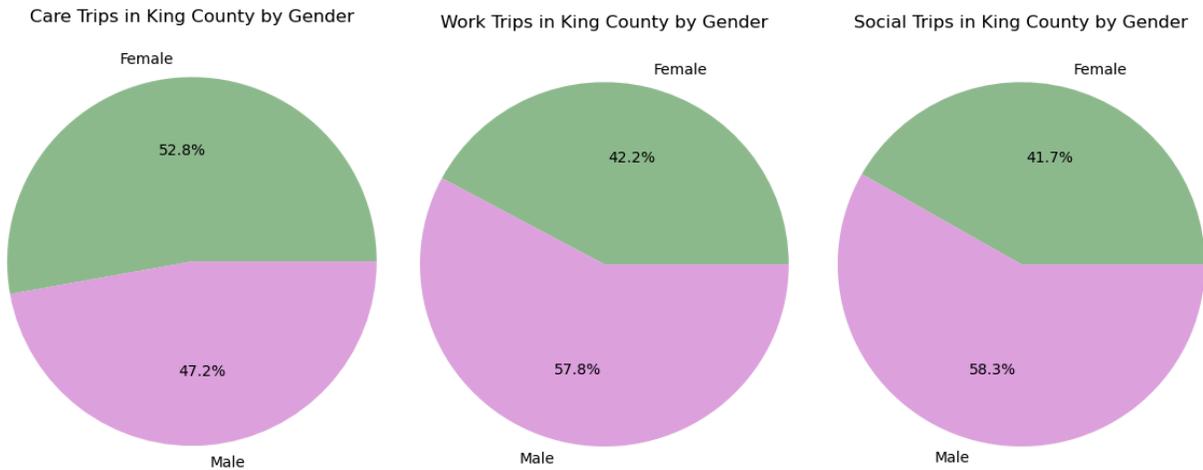


Fig. 14: Trips in King County by Type and Gender³⁰



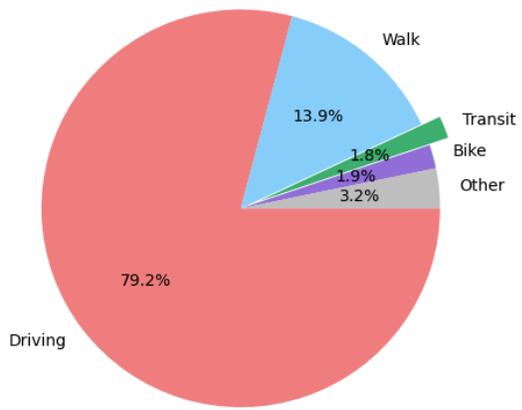
Transit provides essential services for people to conduct mobility of care. While driving remains the primary mode of travel for care trips, as the overall region is largely car-dependent, driving can also be more expensive. We define people from households making less than \$75,000 as lower income, while those making more were classified as upper income, see detailed classification in the Appendix. Figure 15 illustrates that lower-income residents of King County are also more likely to choose the lower monetary cost of transit: 6.2% of trips made by lower-income residents were on transit, while a mere 1.8% of higher-income residents chose transit as their mode.

²⁹ Ibid.

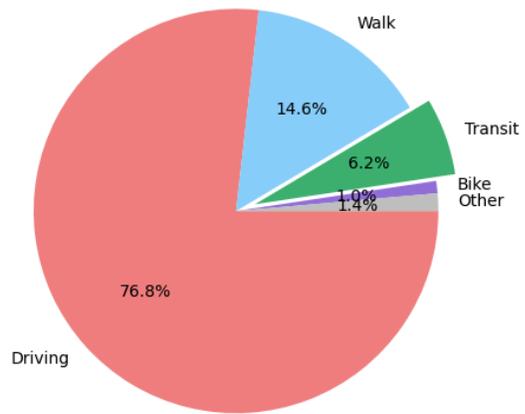
³⁰ Ibid.

Fig. 15: Care Trips in King County by Mode and Income³¹

Care Trips in King County by Mode (Upper Income)



Care Trips in King County by Mode (Lower Income)



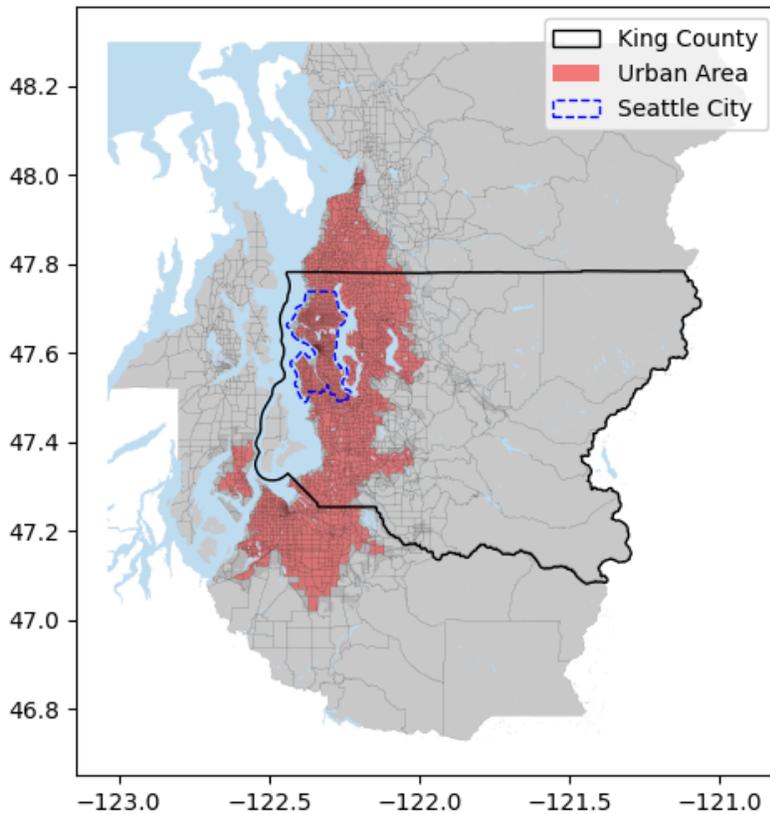
³¹ Ibid.

3. Analysis of Transit Service Change Scenarios

3.1 Study Areas

This project focuses on two scales of the targeted area, namely King County for holistic representation of the region, and Seattle city for representing the travel behavior in dense urban settings. Figure 16 displays the boundary of these two study areas, while the shaded grey areas represent the central Puget Sound regions, including King, Kitsap, Pierce, and Snohomish counties, for context.

Fig. 16: Study Areas Subdivided by Transportation Analysis Zones



3.2 Methodology

3.2.1 PSRC Demand Model SoundCast

For this project, we collaborated with the Puget Sound Regional Council (PSRC) to implement the service cut scenario in their travel demand model, SoundCast. SoundCast is an activity-based travel demand model used in the central Puget Sound region, including King, Kitsap, Pierce, and Snohomish counties, to simulate individual and household-level travel behavior. Unlike traditional trip-based models, SoundCast utilizes the DaySim platform to replicate the daily activities and travel patterns of a synthetic population,

with inputs informed by land-use forecasts from UrbanSim³². The model accounts for how people make travel decisions based on long-term choices (like work location or car ownership), as well as dynamic factors like congestion and accessibility. By integrating these components, SoundCast can forecast outcomes such as highway volumes by hour, transit boardings by line, and person-level measures like commute distance or number of transit trips taken.

The SoundCast modeling pipeline comprises several major components: DaySim-generated person trip demand, additional submodels for external, truck, and special generator trips (e.g., to airports or military bases), and network assignment using EMME. These steps are repeated iteratively to reach system-wide equilibrium. The result is a detailed, parcel-level view of travel activity that reflects both individual behavior and system-level dynamics, making SoundCast a powerful tool for evaluating the downstream impacts on the local development, economy, and socio-environment of any potential service change. In the case of this project, the SoundCast model provides valuable insights into what would happen if there were a significant transit service cut.

The model is calibrated to Spring 2023, but because transit ridership is increasing, the PSRC modeling team calibrated transit to the latest observed data before the Lynwood light rail expansion.

To evaluate the travel behavior change and the resultant impact on the system, two scenarios were run with SoundCast:

1. Base Scenario: This scenario is the status quo scenario calibrated to Spring 2023;
2. Halving Transit Scenario: This scenario incorporates a 50% system-level transit service cut, implemented by doubling the headway for all the transit services in the region compared to the Base Scenario.

The resulting output from both scenarios will be compared to conduct economic analyses specifically for the case of reducing transit service by half.

3.2.2 Headway Elasticity

In addition to demand model estimation, this project employs economic analysis with elasticities to understand the system impact with more recent data and with multi-level transit service change, including both increasing and decreasing transit services. Headway elasticity (or frequency elasticity) has been thoroughly studied to understand the relationship between ridership and service headway (frequency) changes in the realm of public transportation, and can be understood as the sensitivity of the ridership to these service changes. It measures the percent change in ridership resulting from a percent change in headway. It can be formally defined as the following:

$$\ln(\text{Ridership}) = \alpha + \beta \ln(\text{Headway}), \text{ or } (R_2/R_1) = (H_2/H_1)^\beta,$$

where H_1 and H_2 represent the headways before and after the service change, while R_1 and R_2 represent the ridership in the two periods, respectively. Here, β represents the headway elasticity. A smaller

³² Puget Sound Regional Council. “Activity-Based Travel Model: SoundCast.” <https://www.psrc.org/activity-based-travel-model-soundcast>.

magnitude means ridership is less reactive to headway change compared to larger magnitudes. Negative value means longer waits reduce ridership.

From a series of literature reviews covering North American service changes in recent years, including during and after the COVID-19 pandemic, this project assumes the headway elasticity to be -0.5, a conservative value of the elasticity when compared to those determined in these studies. Such a value is also supported by multiple literature³³. Although purely using elasticity to estimate ridership change has its limitations, it provides an overall estimate that can be referred to for future resource planning. A detailed literature review can be found in the Appendix.

In addition to the two scenarios mentioned in the previous section, this project also estimated three more scenarios with the flexibility of the headway elasticities. Thus, there are five scenarios in total, namely:

1. Base Scenario: This scenario is the status quo scenario using Replica data in Spring 2025 (which will be described in the next section);
2. Halving Transit Scenario: This scenario incorporates a 50% system-level transit service cut, implemented by doubling the headway for all the transit services in the region compared to the Base Scenario;
3. Decreasing Transit Service by 20% Scenario: This scenario incorporates a 20% system-level transit service cut;
4. Increasing Transit Service by 20% Scenario: This scenario incorporates a 20% system-level transit service increase;
5. Doubling Transit Scenario: This scenario incorporates doubling the system-level transit service, implemented by halving the headway for all the transit services in the region compared to the Base Scenario.

With a headway elasticity of -0.5, one can calculate the respective change in ridership in Table 2. Note that since this elasticity takes the log form, it produces nonlinear, asymmetric ridership effects for increases versus decreases in headway.

Table 2: Respective Ridership Change with Different Levels of Service Change

* Assuming Headway Elasticity = -0.5.

Transit Service Change	Headway Change	H₂/H₁	R₂/R₁	Ridership Change (%)
halve	double	200%	70.71%	-29.29%
decrease by 20%	increase by 20%	120%	91.29%	-8.71%
increase by 20%	decrease by 20%	80%	111.80%	11.80%
double	halve	50%	141.42%	41.42%

³³ Litman, Todd. 2004. "Transit Price Elasticities and Cross - Elasticities." *Journal of Public Transportation* 7 (2): 37–58. <https://doi.org/10.5038/2375-0901.7.2.3>.

Richard H., Pratt, and Evans John E. (Jay) IV. 2003. *Traveler Response to Transportation System Changes*. 3rd ed. TCRP Report 95. Transportation Research Board. https://www.trb.org/publications/tcrp/tcrp_rpt_95c10.pdf.

The ridership change in public transit in conjunction with the mode shift patterns learned in the SoundCast demand model will be used to estimate the amount of convergence from transit to driving, or vice versa, given a transit service cut or increase.

3.2.3 Replica Data

The Replica platform provides a nationwide, seasonal simulation that captures population characteristics and travel behavior at a high level of detail. The resulting data support transportation and land-use planning, system performance monitoring, and analysis of how people move through and engage with the built environment. Its seasonal trip tables constitute a well-calibrated, country-scale travel demand model. The dataset includes comprehensive population and trip records for representative weekday and weekend conditions within a given season and region. An alignment check with descriptive statistics of the Replica data with comparable models, including SoundCast and LOCUS (a location-based service data platform used by King County Metro) can be found in the Appendix section.

This project also leverages Replica's network link volume data, which was derived from its seasonal model, providing the volume of trips on different levels of street links in a typical weekday or typical weekend in a given season of a 13-week period. The volume data can be disaggregated by hour and mode of transportation. Two types of volumes on major links on the street networks³⁴ are considered: public transit volumes and motor vehicle volumes, including private automobiles, commercial freight vehicles, and taxi and TNC services. These volumes will be used in conjunction with headway elasticities and mode shift outputs from the SoundCast model to estimate system-level impacts of transit service changes.

The combination of elasticity and the Replica data not only reflects the most recent data that differentiates private auto driver, passenger, and on-demand auto, but also allows estimation of different levels of increases or decreases in transit service.

3.2.4 Economic Estimations

The economic estimations are based on the change in transit usage and the corresponding change in driving in different scenarios mentioned above. Specifically, the population affected will be used to estimate the additional vehicle ownership cost, while the increased or decreased driving distance with respect to the transit service change will be used to estimate the change in vehicle operating costs, the change in emissions, and the change in crashes.

First, to estimate the change in vehicle ownership cost or savings, this project filtered the transit trips and calculated the number of persons potentially affected by the transit service change who do and do not own any vehicles for both the SoundCast and Replica data. The ridership change percentage in Table 2 is assumed to apply in the long-term vehicle purchase behavior, e.g. if doubling the transit service results in a 29% ridership decrease, the group affected will convert to driving in the long term, then 29% of the existing transit users who move away from transit will purchase vehicles. Conversely, if transit service increased, the increased ridership would lead to people reducing vehicle ownership, thus saving costs in

³⁴ These include Motorways & Trunks, Primary, Secondary, and Tertiary links in the network.

the long run. The annual average automobile ownership cost in King County in 2025 is \$11,487, and in Seattle is \$10,112³⁵, which will be used to estimate the additional vehicle ownership cost in the region.

Second, this project estimates the change in driving distance in two ways. With the SoundCast model, the differences in the total simulated trip distances between the Halving Transit Scenario and the Base Scenario will be calculated. With the elasticity and the Replica data, the percentage change in transit ridership in Table 2 and the mode shift pattern observed in section 3.3.1 will be applied to the existing transit volumes on a given weekday or weekend day, then the changing traffic volume is multiplied by the distance at each link, and summed up for the total change in distance traveled.

Third, with the change in driving distances calculated at the system level for the study areas, it is possible to estimate the costs or savings of emissions, crashes, and vehicle operation. The increased or decreased emissions of nitrogen oxides (NO_x), sulfur oxides (SO_x), fine particle matter (PM_{2.5}), carbon dioxide (CO₂), and their associated costs and savings per unit are presented in Table 3.

Table 3: Net Emission Rates and Monetary Values

	Net Emission Rates (grams/mile)³⁶	Cost per Metric Ton (in 2023 \$)³⁷
NO_x	0.018	\$19,000
SO_x	0.0013	\$51,900
PM_{2.5}	0.0006	\$928,000
CO₂	400	\$210

For the crash-related estimation, the net crash rate can be estimated with the existing crash data in King County, which can be converted to monetary values, as shown in Table 4.

Lastly, the vehicle operating costs, including gas, maintenance, tires, and depreciation, can be estimated using the change in driving distance in the system. Assuming all changes in driving distance are conducted by light-duty vehicles, the vehicle operating cost is \$0.56 per mile driven in 2023 dollars level³⁸.

³⁵ The Center for Neighborhood Technology’s Housing and Transportation (H+T) Affordability Index, note that the auto ownership cost refers to "the cost of depreciation, finance charges, insurance, license, registration, and taxes (state fees) per auto. These costs are largely fixed, less determined by use, and therefore, a result of simply owning an automobile."

³⁶ California Air Resources Board; US EPA. 2016. "Greenhouse Gas Emissions from a Typical Passenger Vehicle." <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>.; AECOM. 2023. *Value of Northern Virginia Transit to the Commonwealth*. Northern Virginia Transportation Commission.

³⁷ 2025 Benefit-Cost Analysis Guidance for Discretionary Grant Programs; "EPA Values for the Social Cost of Greenhouse Gases." <https://costofcarbon.org/epa-values-for-the-social-cost-of-greenhouse-gases>.

³⁸ 2025 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.

Table 4: Net Crash Rates and Monetary Values

* Total annual miles driven in King County in 2023 were 1,091 million miles.

	Number of Incidents (2023, King) ³⁹	Net Crash Rate (per 100 million vehicle miles) ⁴⁰	Monetized Life Time Value per Crash (in 2023 \$) ⁴¹
PDO	1,155	105.87	\$9,500
Injury	518	47.48	\$329,500
Fatal	9	0.82	\$14,806,000

3.3 Results

3.3.1 SoundCast Mode Shift

As shown in Table 5, the SoundCast model demonstrates that there is a mode shift after reducing the transit service in half. The transit usage dropped significantly, while there is a moderate increase in driving and cancelled trips, and a relatively small increase in other modes.

Table 5: Mode Shift Due to Transit Service Cut in SoundCast in King County

Mode		Change in Trip Count (Daily)	Percentage Change Relative to Transit Trip Count Change
Driving	Single Occupancy Vehicle	18,241	43.58%
	High Occupancy Vehicle with 2 occupants	2,479	5.92%
	High Occupancy Vehicle with 3+ occupants	3,747	8.95%
Cancelled Trips		12,962	30.97%
Other Modes (Biking, Walking, etc.)		4,430	10.58%
Transit		-41,859	-

To compare how much mode shift has occurred in percentage, this table showcases the percentage of the increase in daily trip count for non-transit modes compared to the reduction in transit trip count. These mode shifts will be applied after the elasticity estimation to capture the short-term mode shift when transit services decrease.

3.3.2 SoundCast Trip purpose Change & Spending Estimate

Table 6: Cancelled Trips and Corresponding Reduction in Annual Spending

* **The numbers in parentheses represent negative values**

³⁹ King County Road Services Division 2023 Collision Data Report.

⁴⁰ Ibid.

⁴¹ 2025 Benefit-Cost Analysis Guidance for Discretionary Grant Programs.

Category	Cancelled Trips Percentage	Annual Average Household Spending ⁴²	Annual Total Spending Change
Meal	(0.29%)	\$ 6,041	\$ (16.9 M)
Shop	(0.16%)	\$ 2,083	\$ (3.1 M)
Total	-	\$ 8,124	\$ (20.0 M)

A portion of trips are cancelled due to the reduction in transit services, coupled with travelers not being able to access other modes of transportation, as shown in Section 3.3.1. Many of these cancelled trips include trips to get meals and shopping. This would lead to a reduction in taxable spending in the King County region (in addition to the reduction in resident quality-of-life). The Bureau of Labor Statistics estimated that the average spending on eating out, the “Food Away from Home” category, and the “Apparel and Services” category is \$8,124 per household in the year 2023-24. Given the 0.95M households in King County⁴³, and considering the cancelled trips for the purpose of getting meals and shopping in the SoundCast demand model, this would translate into **a reduction of \$20 million in annual spending, which means a \$1.8 million reduction in tax collected**. Note that this is only the lower bound of potential impact due to the cancelled trips. If there is an additional cost burden due to vehicle purchasing or leasing, the consumer spending will be affected to a much larger degree. Such a projection will be discussed in detail in Section 3.3.5.

3.3.3 Spatial Change with Elasticity Assumption

The analyses in this and the next section focus on Seattle as a case study for its dense population and high transit usage. They follow the headway elasticity assumption under the Halving Transit Scenario scenario, which means a 50% decrease in transit service leads to a 29.29% decrease in transit ridership. Then the mode shift percentages described in Table 5 from Section 3.3.1 are applied to the number of people who are moving from transit to auto-based mobility.

Figure 17 shows the hourly volume of all autos (excluding transit) and the mode shift from transit to the automobile under the 50% Transit Cut Scenario. The shift from transit to auto-based travel was mapped according to the bus routes or to the closest possible streets (for light rail trips), so they do not necessarily go through express highways. The change in volume for travelers shifting from transit to cars can reach almost 500 vehicles in high-density street links in the AM peak. Even though this number is a small portion compared to the total volume on the network, this additional volume spike can create significant stress to certain parts of the network that are less in capacity.

⁴² Bureau of Labor Statistics. n.d. “Consumer Expenditures in the Seattle Metropolitan Area — 2023–24.” https://www.bls.gov/regions/west/news-release/consumerexpenditures_seattle.htm.

“The Value of Transit in Chicago and the Chicago Region.” MIT and the Argonne National Laboratory, 2024.

⁴³ ACS census data.

Fig. 17: Existing and Estimated Average Change in Volume of Transit Trips Shifting to Car Trips on Major Roads during the AM Peak (6-9 AM)⁴⁴

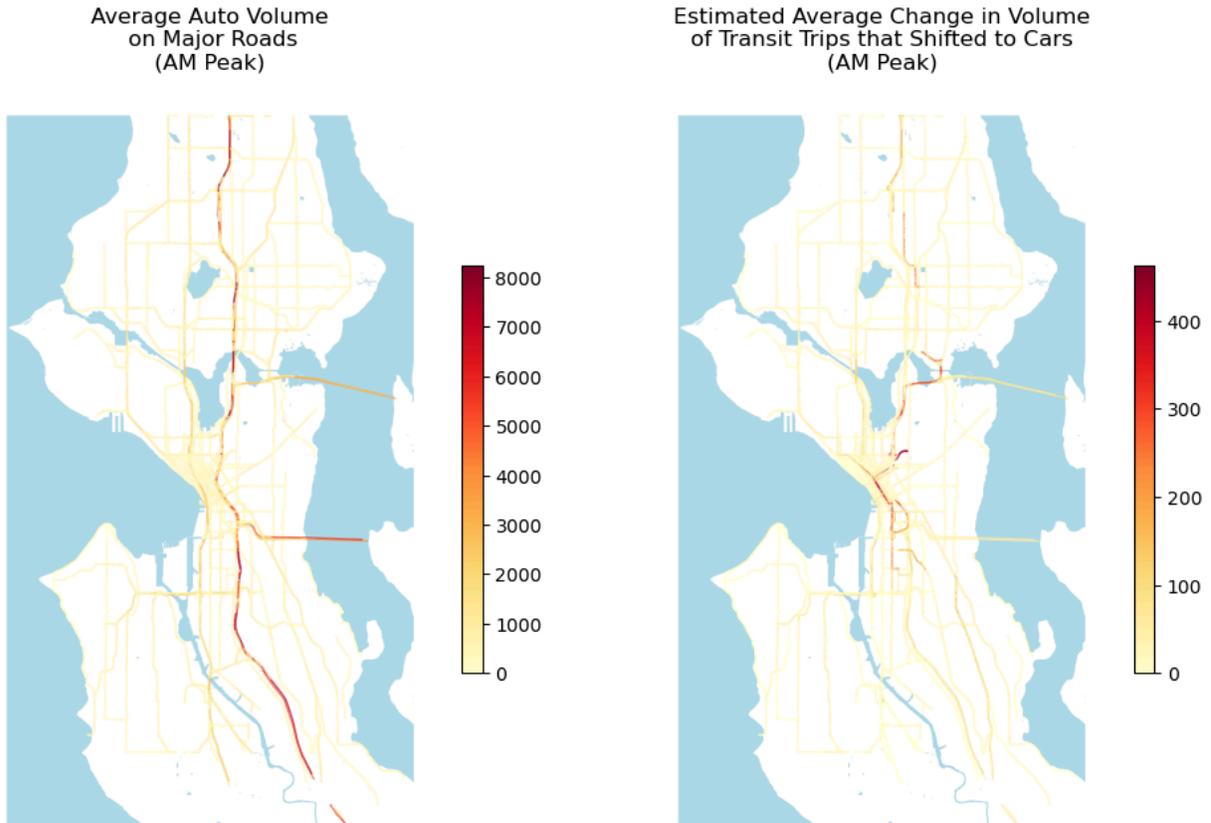
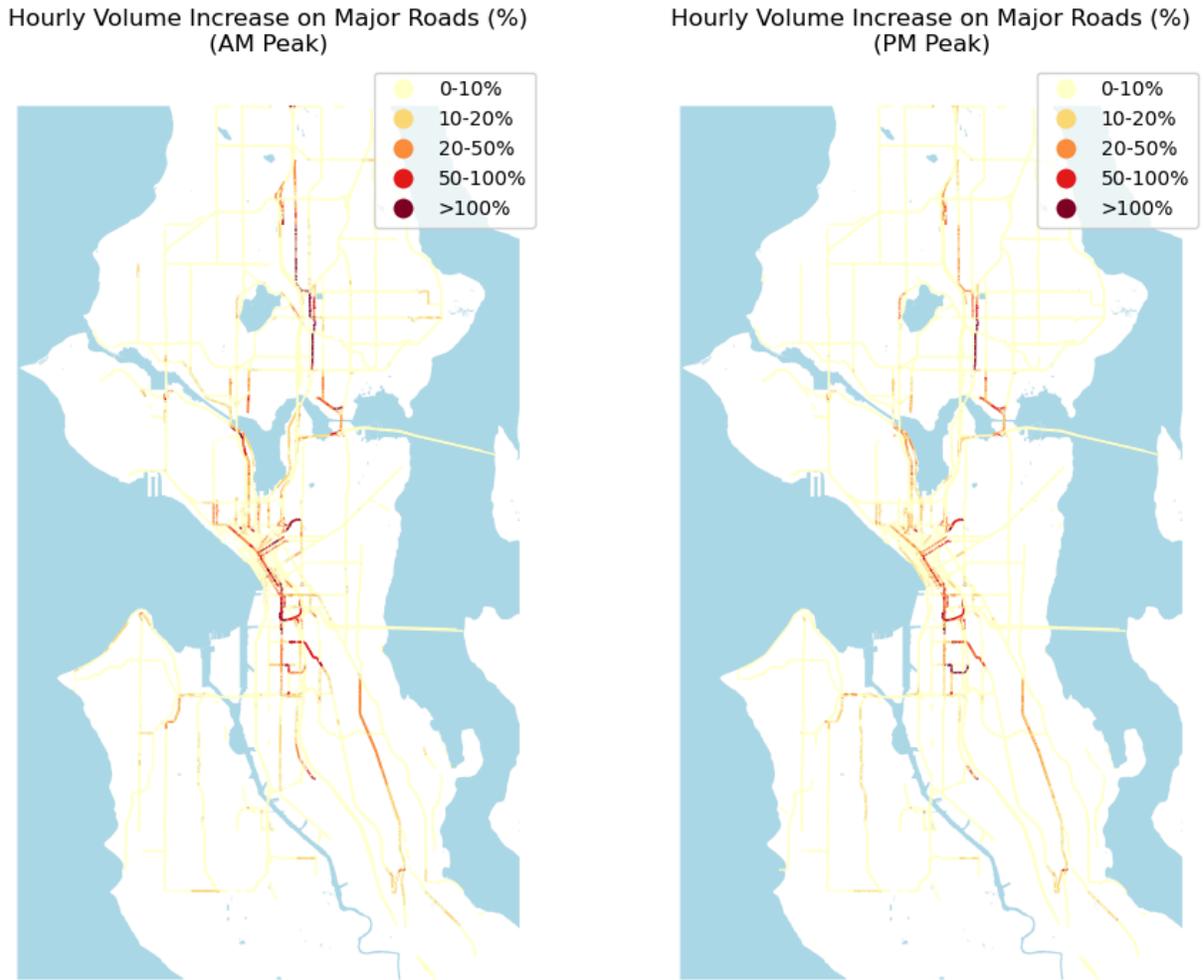


Figure 18 displays the percentage increase in the additional volume during the AM and PM peaks. The streets with large hourly volume increase in percentage are not just the large major roads (I-5, I-90), but primary and secondary roads, which align with the different hotspots in the previous two graphs. Key links in Downtown, Chinatown-International District, East Queen Anne, University District, as well as major arterials in the north and south of Seattle, would experience larger stress with traffic increasing more than 20%.

⁴⁴ Replica Model Seasonal Trip Table and Network Link Volume, Spring 2025.

Fig. 18: Hourly Volume Percentage Increase on Major Roads in AM Peak (6-9 AM) and PM Peak (15-18 PM)⁴⁵

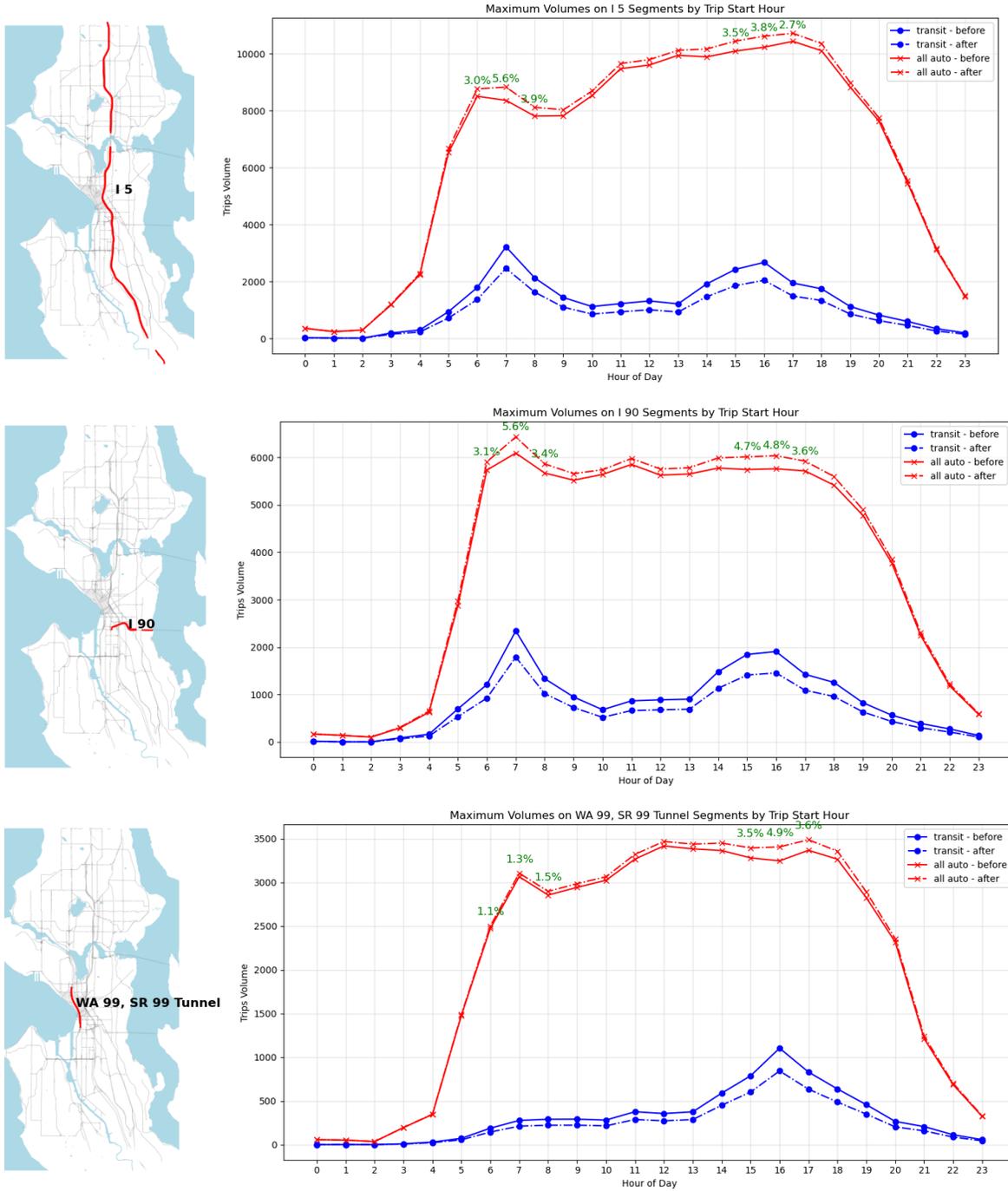


3.3.4 Temporal Change with Elasticity Assumption

Figure 19 demonstrates the change in volume from transit to driving under the same scenario. Key highways and corridors would experience increased levels of stress, especially during peak hours. During daytime busy hours, both I-5 and I-90 would experience about 3-6% additional traffic, reaching around 200 to 400 additional vehicles going through them hourly.

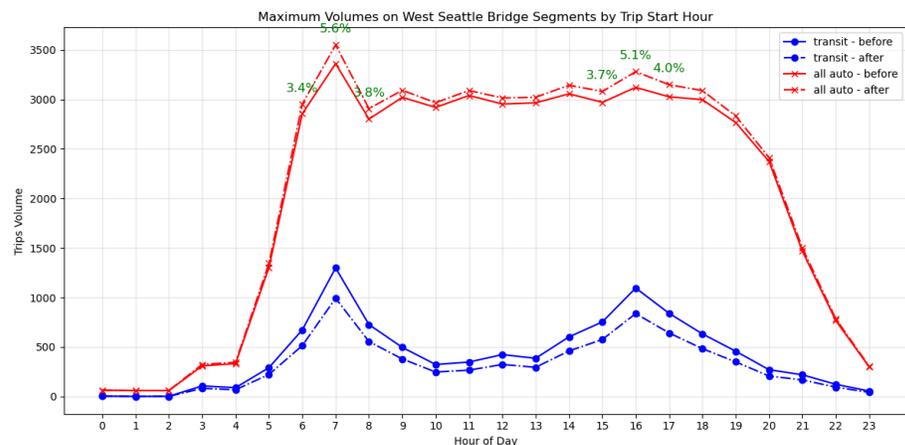
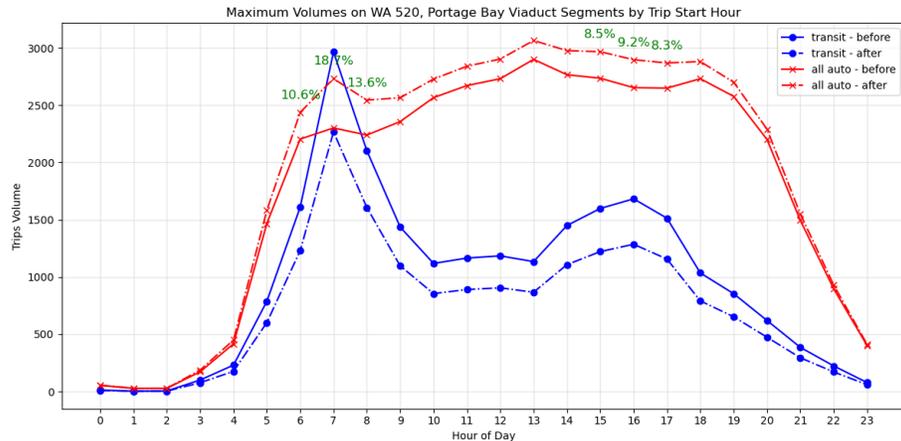
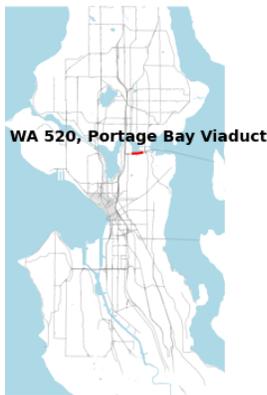
⁴⁵ Ibid.

Fig. 19: Maximum Volumes on Key Corridors by Trip Start Hour⁴⁶



⁴⁶ Ibid.

Note: the hourly traffic has been cross-validated with WSDOT's Traffic Count (TCDS) tool (<https://wsdot.public.ms2soft.com/tcds/tsearch.asp?loc=Wsdot&mod=TCDS>) which displays a similar hourly volume level as Replica data.



3.3.5 Economic Estimation

Seattle’s traffic congestion was ranked number 10 in the US, with each driver losing 68 hours in 2025, equivalent to \$1,252 of annual cost per driver, which led to a city-level cost of \$1.9 billion dollars⁴⁷. With an additional transit service cut and the consequent mode shift effects we have previously shown, the time lost in traffic is bound to increase. Conversely, having additional transit service encourages more transit usage and reduces transportation costs and congestion.

The following tables represent the economic impact estimation with 1) the SoundCast output calibrated to 2023 and 2) the Elasticity Estimation with 2025 Replica data, following the methodology described in Section 3.2⁴⁸.

Tables 7 and 8 represent the forecasted results in terms of traffic, emissions, collisions, and the corresponding dollar costs when the transit services are reduced by half in the SoundCast model. Under

⁴⁷ 2025 INRIX Global Traffic Scoreboard. <https://inrix.com/scorecard/>

⁴⁸ Estimation is based on the change in traffic due to change in the mode of driving alone and assumes other modes do not change or make an impact (ignoring the reduction in traffic in transit); since transit users are only a small portion of the total travel, this assumption can be justified.

Replica data has both typical weekday and weekend and are annualized according to the number of weekday and weekend in a year; PSRC data only has typical weekday, which was directly annualized by multiplying 365.

this analysis, **King County could experience as much as 214 million dollars in additional annual costs** due to the increase in driving behavior, environmental costs, and the additional collision costs, while **the city of Seattle would experience a heavy burden of 132 million dollars in annual costs**. These values would translate to a per-household cost of \$225 to \$375 per year in the region⁴⁹. Since the SoundCast model was calibrated to the 2023 data, where travel behavior is still recovering from the pandemic, this estimation is likely to be conservative and will be larger if applied to the current data.

Table 7: Additional Annual Traffic, Emissions, Collisions from SoundCast 2023⁵⁰

	Seattle	King County
VMT (miles)	10.3M	41.7M
Emission (metric Ton)	NO _x 0.19; SO _x 0.01; PM _{2.5} 0.01; CO ₂ 4,120	NO _x 0.75; SO _x 0.05; PM _{2.5} 0.03; CO ₂ 16,670
Collision (incidence)	PDO 10.9; Injury 4.9; Fatality 0.1	PDO 44.1; Injury 19.8; Fatality 0.3

Table 8: Additional Annual Economic Costs from SoundCast 2023⁵¹

Cost Type	Seattle	King County
Vehicle Operating (from additional driving: gas, maintenance, tires, and depreciation)	\$5.8M	\$23.3M
Emission	\$0.86M	\$3.5M
Collision	\$3.0M	\$12.0M
Cost of Maintaining Additional Vehicles (lease, insurance, depreciation, etc.)	\$122.9M	\$174.9M
Total	\$132M	\$214M
Per Household	\$375	\$225

This project also analyzed additional scenarios for other levels of transit service change with headway elasticity and the most recent Replica data from Spring 2025. The elasticity assumption allows for

⁴⁹ Household count in the region came from the ACS census data.

⁵⁰ PSRC SoundCast Model;

California Air Resources Board; US EPA. 2016. "Greenhouse Gas Emissions from a Typical Passenger Vehicle."; AECOM. 2023. *Value of Northern Virginia Transit to the Commonwealth*. Northern Virginia Transportation Commission; King County Road Services Division 2023 Collision Data Report.

⁵¹ 2025 Benefit-Cost Analysis Guidance for Discretionary Grant Programs; "EPA Values for the Social Cost of Greenhouse Gases."

estimating changes more flexibly and helps to envision the impact on the system when there are different levels of transit service change. The results are shown in Tables 9 and 10. Depending on the scenarios, each household may experience as much as \$330 to \$634 additional annual cost as a result of the transit service reduction, yet they can save up to \$628 to \$1,176 per year if the transit service improves significantly.

Table 9: Change in Annual Traffic, Emissions, Collisions with multiple scenarios from Elasticity Estimation with Replica Data 2025⁵²

* The numbers in parentheses represent negative values, or the reduced amount.

		Seattle				King County			
Scenario of service change		halve	-20%	+20%	double	halve	-20%	+20%	double
VMT (miles)		73.3M	21.8M	(59.7M)	(209.5M)	114.3M	34.0M	(93.0M)	(326.5M)
Emission (metric Ton)	NO _x	1.32	0.39	(1.07)	(3.77)	2.06	0.61	(1.67)	(5.88)
	SO _x	0.10	0.03	(0.08)	(0.27)	0.15	0.04	(0.12)	(0.42)
	PM _{2.5}	0.04	0.01	(0.04)	(0.13)	0.07	0.02	(0.06)	(0.20)
	CO ₂	16,670	8,727	(23,874)	(83,780)	45,727	13,603	(37,212)	(130,588)
Collision (incidence)	PDO	77.6	23.1	(63.2)	(221.7)	121.0	36.0	(98.5)	(345.6)
	Injury	34.8	10.4	(28.3)	(99.4)	54.3	16.1	(44.2)	(155.0)
	Fatality	0.6	0.2	(0.5)	(1.7)	0.9	0.3	(0.8)	(2.7)

⁵² 2025 Spring Replica Model Seasonal Trip Table, Network Link Volume; California Air Resources Board; US EPA. 2016. "Greenhouse Gas Emissions from a Typical Passenger Vehicle."; AECOM. 2023. *Value of Northern Virginia Transit to the Commonwealth*. Northern Virginia Transportation Commission; King County Road Services Division 2023 Collision Data Report.

Table 10: Change in Annual Economic Costs from Elasticity Estimation with Replica Data 2025⁵³

* The numbers in parentheses represent values in savings.

Scenario of service change	Seattle				King			
	halve	-20%	+20%	double	halve	-20%	+20%	double
Vehicle Operating (additional driving: gas, maintenance, tires, and depreciation)	\$41.1 M	\$12.2 M	\$(33.4 M)	\$(117.3 M)	\$64.0 M	\$19.0 M	\$(52.1 M)	\$(182.8 M)
Emission	\$6.2 M	\$1.9 M	\$(5.1 M)	\$(17.8 M)	\$9.7 M	\$2.9 M	\$(7.9 M)	\$(27.7 M)
Collision	\$21.2 M	\$6.3 M	\$(17.2 M)	\$(60.5 M)	\$33.0 M	\$9.8 M	\$(26.9 M)	\$(94.2 M)
Cost of Maintaining Additional Vehicles (lease, insurance, depreciation, etc.)	\$155.2 M	\$46.2 M	\$(62.6 M)	\$(219.5 M)	\$206.3 M	\$61.4 M	\$(83.1 M)	\$(291.8 M)
Total	\$224 M	\$67 M	\$(118 M)	\$(415 M)	\$313 M	\$93 M	\$(170 M)	\$(597 M)
Per Household	\$634	\$188	\$(335)	\$(1,176)	\$330	\$98	\$(179)	\$(628)

⁵³ 2025 Benefit-Cost Analysis Guidance for Discretionary Grant Programs; EPA Values for the Social Cost of Greenhouse Gases.

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Appendix

Trip Purpose and Income Group Classification

This section defines classifications for the analyses in Section 2.4 Mobility of Care (Fig. 12-15).

The analyses include only trips that either originate or terminate in King County during survey year 2023. All descriptive statistics are computed using the trip weights provided by the survey (`trip_weights`).

Trip Purpose Classification

Trips are categorized into three primary groups: care trips, work trips, social trips, and other trips. Classification is based on the trip destination purpose (`dest_purpose`) and, for home-based trips, the origin purpose (`origin_purpose`).

Home-based trips are defined as trips whose destination purpose is either: “Went home”, or “Went to another residence (e.g., someone else's home, second home)”.

Care Trips

Care trips are broadly defined as trips associated with caregiving responsibilities, household maintenance, education, and personal errands. A trip is classified as a care trip if:

1. The destination purpose belongs to one of the care-related categories listed below; or
2. For home-based trips, the origin purpose belongs to one of these categories.

Care-related purposes include (note that education trips are considered as care trip here, as part of personal care):

- Accompany someone only (e.g., go along for the ride)
- Appointment, shopping, or errands (e.g., gas)
- Both pick up and drop off
- Drop someone off
- Dropped off, picked up, or accompanied another person
- Got gas
- Went to medical appointment (e.g., doctor, dentist)
- Went grocery shopping
- Other appointment/errands
- Went to other shopping (e.g., mall, pet store)
- Conducted personal business (e.g., bank, post office)
- Pick someone up
- Went to religious/community/volunteer activity
- Vacation/traveling (rMove only)
- Volunteering
- Went to a family activity (e.g., child's sporting event)
- Went to exercise (e.g., gym, walk, jog, bike ride)
- Attend K–12 school
- Attend college/university

- Attend daycare or preschool
 - Attend other education-related activity (e.g., field trip)
 - Attend other type of class (e.g., cooking class)
 - Attend vocational education class
 - Went to school/daycare (e.g., daycare, K–12, college)
3. Additionally, trips between residential locations, i.e., trips where both the origin and destination purposes are either “Went home” or “Went to another residence (e.g., someone else's home, second home)”, are also classified as care trips.

Work Trips

Trips are classified as work trips if the destination purpose, or the origin purpose for home-based trips, corresponds to work-related activities, including:

- Went to primary workplace
- Went to other work-related activity
- Went to work-related activity (e.g., meeting, delivery, worksite)
- Went to work-related place (e.g., meeting, second job, delivery)

Social and Leisure Trips

Trips are classified as social trips if the destination purpose falls into one of the following categories:

- Attended social event (e.g., visit with friends, family, co-workers)
- Attended recreational event (e.g., movies, sporting event)
- Went to restaurant to eat or get take-out
- Other social/leisure

Other Trips

Any trips not falling within the above categories are considered as other trips in the analysis.

Income Classification

For analyses involving income (Fig. 15), household-level information was joined to the trip dataset. Households are grouped into two income categories based on the variable `hhincome_broad`:

- **Higher-income households:**
 - \$75,000–\$99,999
 - \$100,000–\$199,999
 - \$200,000 or more
- **Lower-income households:**
 - Under \$25,000
 - \$25,000–\$49,999
 - \$50,000–\$74,999

Trips are then assigned to these income groups based on the income category of the associated household.

Headway Elasticities in Literature

The following table displays relevant recent studies that calculate headway (frequency) elasticities. It is worth noting that there is a wide range of headway elasticities based on empirical evidence. Less frequent services with larger headways typically result in more responsive ridership; in contrast, already-frequent routes, such as those with less than 10-minute headway, see diminishing returns in ridership. To account for these factors, this project sets a very conservative elasticity number across literature, and assumes headway elasticity to be -0.5.

Reference	City/Agency	Data Year	Service Level and Change	Notes	Headway Elasticity (log from)
Redelmeier, P., & El-Geneidy, A. (2024). If You Cut It Will They Ride? Longitudinal Examination of the Elasticity of Public Transport Ridership in the Post-Pandemic Era. <i>Transportation Research Record</i> , 2678(11), 241–252. https://doi.org/10.1177/03611981241240754	Montreal, Canada / Société de transport de Montréal (STM)	2010 - 2023	High frequency service (10min max, takes up to 5-18% of all routes); on average 90-100 trips per route daily -35% to 22% of frequency change; on average 10% decrease in 2022 compared to pre-pandemic	Mid to long-term	-1.3 to -1.39 (pre-COVID) -1.51 to -1.6 (post-COVID)
Berrebi, S. J., Joshi, S., & Watkins, K. E. (2021). On bus ridership and frequency. <i>Transportation Research. Part A, Policy and Practice</i> , 148, 140–154. https://doi.org/10.1016/j.tara.2021.03.005	Portland / TriMet, Miami / Miami-Dade, Minneapolis -St-Paul / MTM, Atlanta / MARTA	2012 - 2018	First three agencies have on average ~2,000,000 vehicle revenue hours; MARTA has ~2,200,000 vehicle revenue hours per markup	Short-term and cross-sectional	-0.78 to -0.66 (within-route, short-run elasticity on weekdays); -1.5 to -1.21 (cross-sectional)
Taylor, B. D., Miller, D., Iseki, H., & Fink, C. (2009). Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized areas. <i>Transportation Research Part A: Policy and Practice</i> , 43(1), 60–77.	265 urbanized area in the US	2000	Varies, including both oversupply and undersupply regions	cross-sectional	-0.5 (overall) to -0.48 (per-capita)

https://doi.org/10.1016/j.tra.2008.06.007					
<p>Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Wardman, M., Shires, J., & White, P. (2006). The demand for public transport: The effects of fares, quality of service, income and car ownership. <i>Transport Policy, Innovation and Integration in Urban Transport Policy</i>, 13(4), 295–306. https://doi.org/10.1016/j.tranpol.2005.12.004</p> <p>Balcombe, R., Mackett, R., Paulley, N., Preston, J., Shires, J., Titheridge, H., Wardman, M., & White, P. (2004). <i>The demand for public transport: A practical guide</i>. Retrieved https://www.trl.co.uk/uploads/trl/documents/TRL593%20-%20The%20Demand%20for%20Public%20Transport.pdf</p>	UK & global meta-study	1980s -2000s	Varies	meta-study	On average -0.38 (short-run) & -0.66 (long-run) higher in off-peak/low-service periods
Pratt, R. H. and Evans J. E., IV. (2003). <i>Traveler response to transportation system changes</i> (3rd ed.). Transportation Research Board. Retrieved https://www.trb.org/publications/tcrp/tcrp_rpt_95c10.pdf	US case studies	1980s -2000s	Varies		-0.5 (meta average)
	Dallas Route 428 DART	1994 -1995	Headway change of 30min to 20min in peak hour, 60min to 30min in the base	Short term	-0.49
	King County Metro	1994 -1998	Headway change of 20-30min to 15min in the peak,	Long term	-0.8 (compensating for the population and

			30-60min to 30min midday, Sat, Sun. Service hours improved 11.7%;		employment growth; Ridership increase by 19% in total)
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Alignment Check for Replica Data

The data from the Replica platform is closely aligned with the SoundCast model output and comparable to the LOCUS data.

Region	Mode	Metric	SoundCast 2023	Replica 2025	LOCUS 2024
King County	Transit	Number of Trips	310,255	312,220	265,630
		Mode Share	3.2%	3.2%	4%
	Driving	Number of Trips	7,499,909	7,729,952 (5,481,818 if excluding auto passenger)	6,660,173
		Mode Share	78%	78.8% (72.5% if excluding auto passenger)	88%
Seattle	Transit	Number of Trips	242,924	256,918	210,158
		Mode Share	6.5%	6.8%	~8%
	Driving	Number of Trips	2,549,310	2,686,998 (1,940,116 if excluding auto passenger)	2,556,870
		Mode Share	67.8%	71.4% (64.3% if excluding auto passenger)	~75%