

Presentations on the future of transportation in a post-pandemic world
Transportation Finance and Policy Committee, Minnesota House of Representatives
Jan. 14th, 2021

Future of Transportation in a Post-Pandemic World: A Spatial Data Science Perspective

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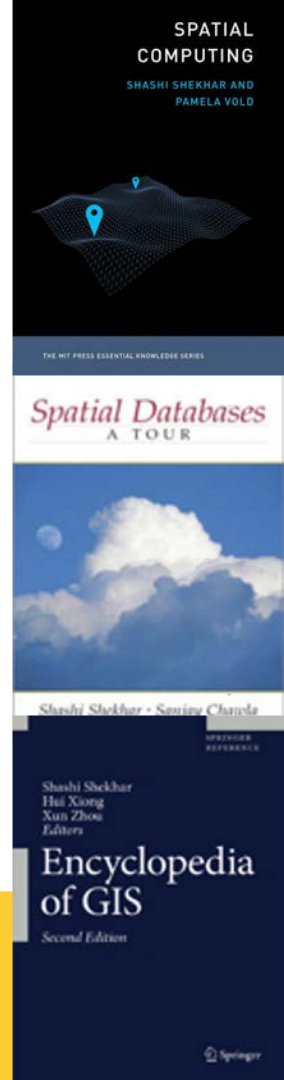
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University Distinguished Teaching Professor
University of Minnesota

Details: http://www.spatial.cs.umn.edu/Project/covid_19.html

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UNIVERSITY OF MINNESOTA
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Acknowledgements

- Metropolitan Council ([Ashley Asmus](#), [Jonathan Ehrlich](#))
- [MN](#): MnDOT ([Sean Barton](#), [Michael Iacono](#)), MMB ([Aaron Berger](#), [Weston Merrick](#)), MN DHS
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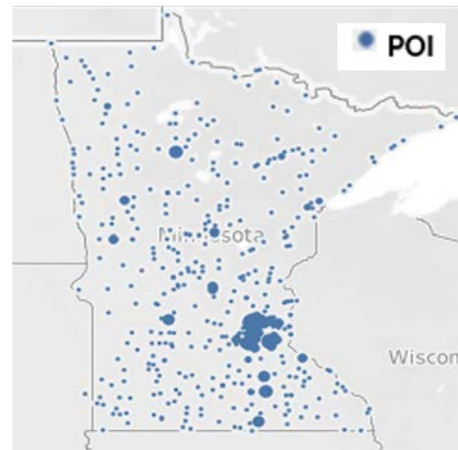
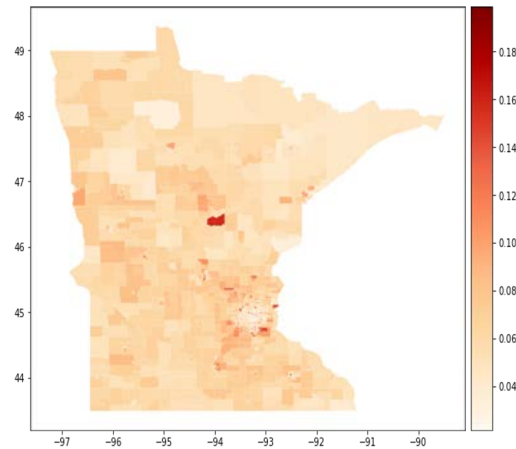
Special Thanks

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- National Science Foundation (NSF)
 - 2040459: [EAGER: Spatiotemporal Big Data Analysis to Understand COVID-19 Effects](#)
 - [1901099](#) : Spatio-temporal Informatics for **Transportation** Science
 - [1840432](#) : Planning Grant: Engineering Research Center for Intelligent **Infrastructure** for Safe, Efficient and Resilient **Mobility** (ERC-I2SERM)
 - [1737633](#) : [S&CC-IRG Track 1: Connecting the Smart-City Paradigm with a Sustainable Urban Infrastructure Systems Framework to Advance Equity in Communities](#)
- USDOE-ARPE
 - [Cloud-Connected Delivery Vehicles: Boosting Fuel Economy Using Physics-Aware Spatio-temporal Data Analysis and Real-Time Powertrain Control](#), 2017- 2020. (PI: W. Northrop).

SafeGraph Overview

- MN Coverage:
 - 294,014 mobile devices , e.g., smartphones
 - 4,107 (out of 4,111) Census Block Groups (CBGs)
 - 73,548 Points of Interests (across 261 NAICS categories)
- Privacy Protection:
 - Census like aggregates
 - Differential Privacy Protection (adds noise)
 - Can not infer individual information
- Multiple datasets:
 - Social distancing: average range by census block groups
 - Weekly pattern: POI visits by hour, day, and week
 - ...

Sampling rate by CBGs
(device count / population)



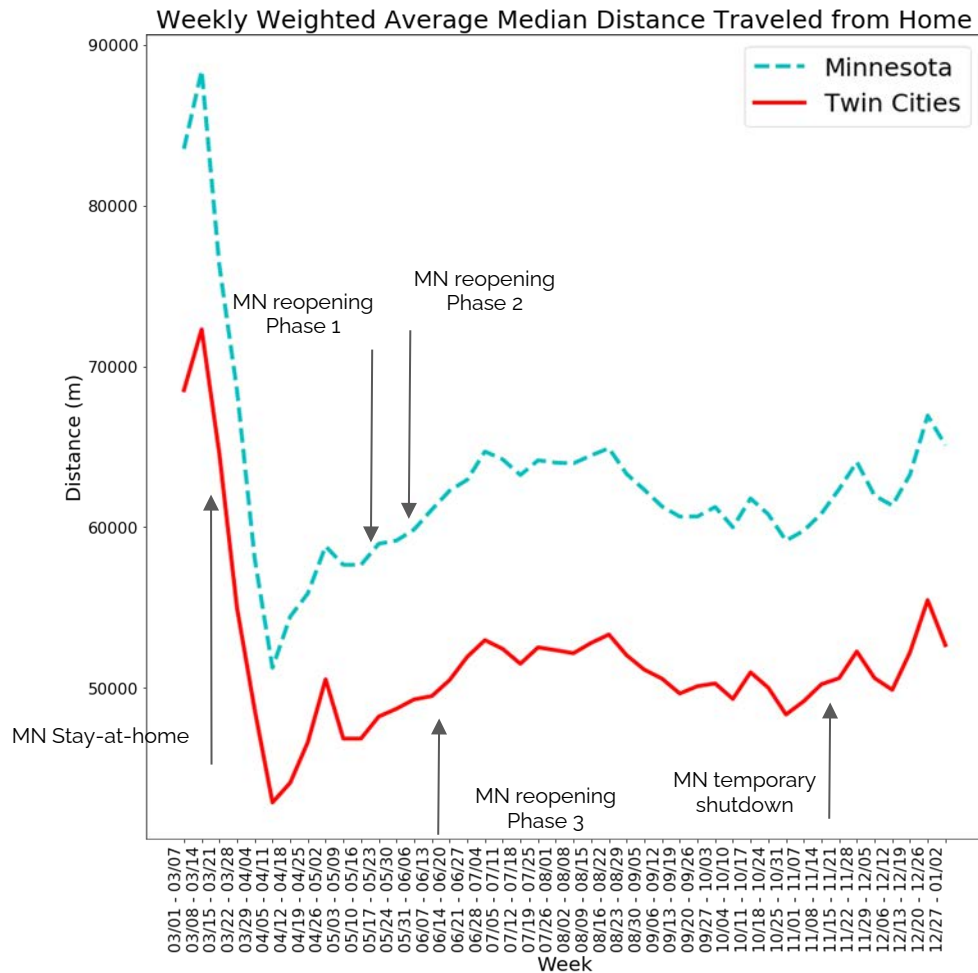
POI density map

Analysis of MN Daily Range

- **Trends:**

- Sharp Decline in March
- Still 20% below March 2020

- **Data:** Safegraph Social Distancing
 - Avg. median distance traveled
 - By MN census block group (cbg)
 - Weighted by device count in cbg
 - Note: Data reporting changed on 5/10



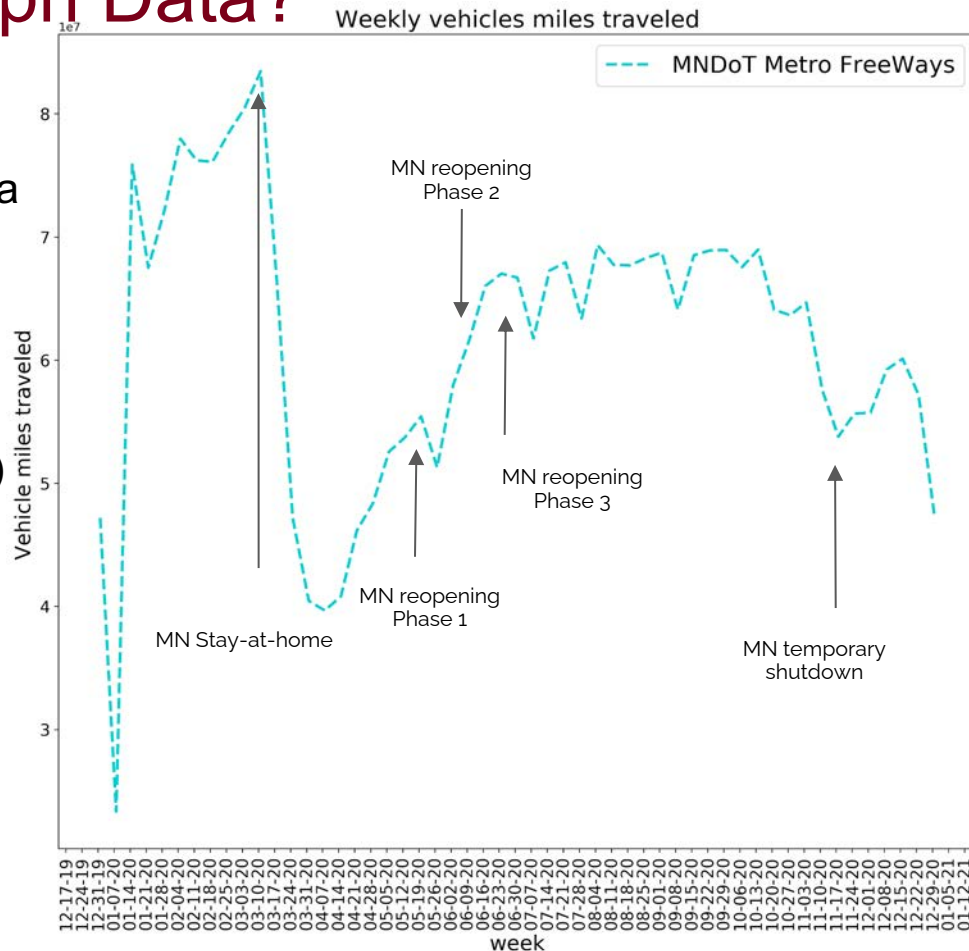
Should we trust SafeGraph Data?

- **Trends:**

- Similar trend in MnDOT RTMC Data
- Sharp Decline in March
- Still 20% below March 2020 levels

- **MnDOT RTMC Data:**

- Weekly vehicle miles traveled (vmt)
- Twincities freeways [1].
- 4000 loop detectors [2].

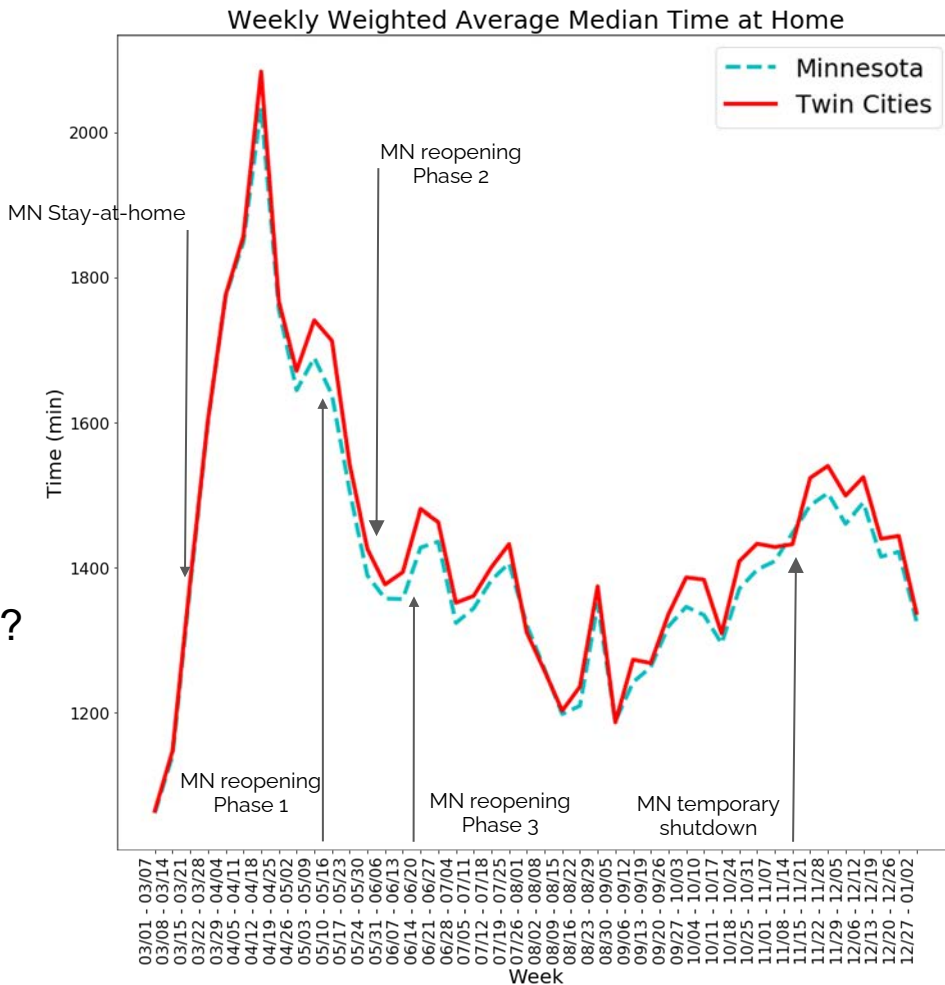


[1] Metropolitan council Metro Transit MN, Jan. 7th 2021, <https://metrotransitmnh.shinyapps.io/covid-traffic-trends/>.

[2] Metropolitan council Metro Transit MN Data Tools, <http://data.dot.state.mn.us/datatools/>. Jan 7, 2021

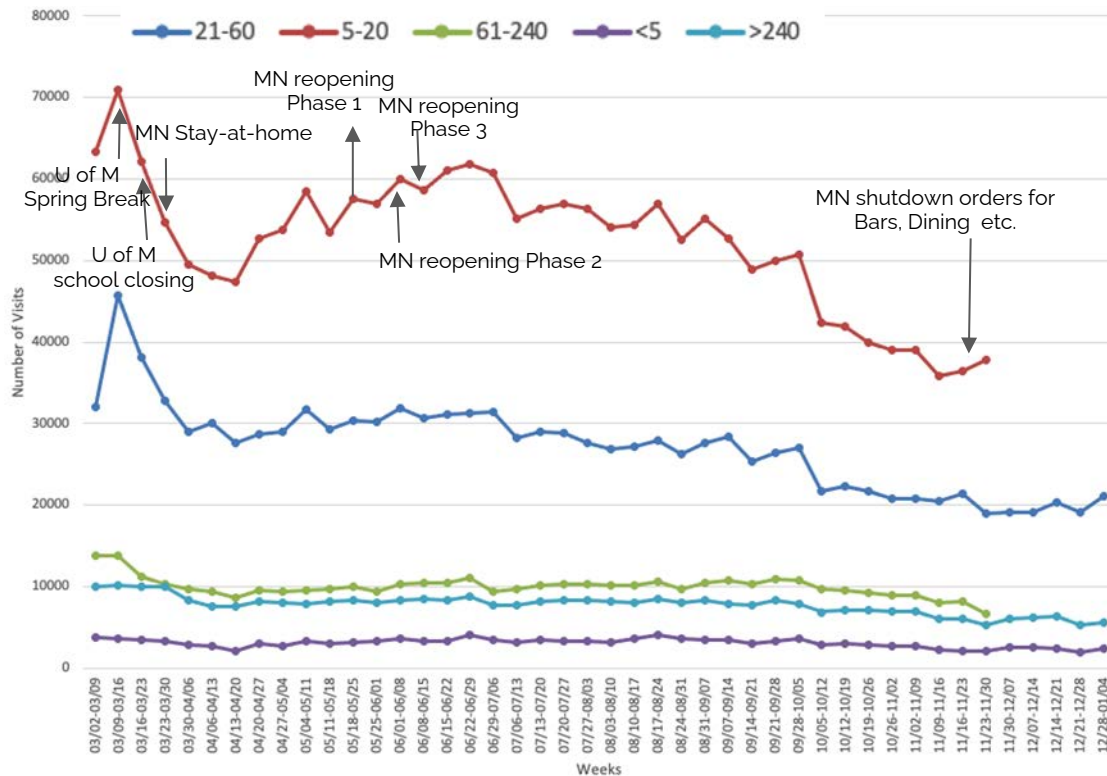
Daily average time at home

- **Data:** average median time at home in each census block group in MN weighted by the corresponding device count.
- **Trends:**
 - Increases in March then declines after mid-April
 - Spend 15%-20% more time at home during pandemic
- Q? Where were people going after mid-April?
POI visit data



MN Grocery Stores Visits (3/2/20 - 1/4/21)

- SafeGraph Social Distancing Dataset, Grocery Store = NAICS Code: 445110.
- Trends: **Short trips dominate**, March bump



Dwell Time	Visits
<5	135665
5-20	2044371
21-60	1195056
61-240	389982
>240	324273

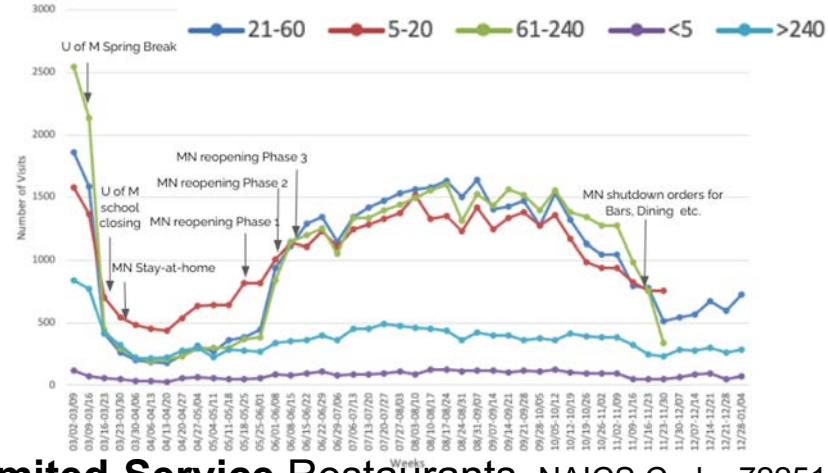
MN Restaurants Visits by Duration (3/2/20 - 1/4/21)

Trends:

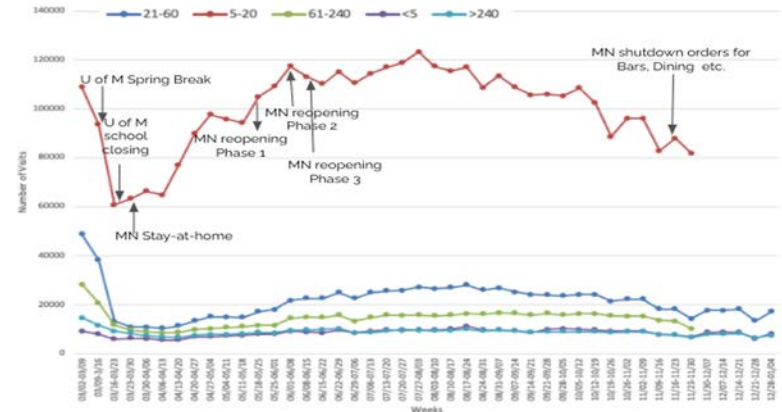
- Long visits dominate Full-Service Restaurants
- Short visits dominate Limited Service Restaurants

Dwell Time	Visits (Full-service)	Visits (Limited-service)
<5	266557	372492
5-20	3059155	3905936
21-60	2512080	937166
61-240	2064369	557819
>240	953015	387331

- Full-Service Restaurants.** NAICS Code: 722110.

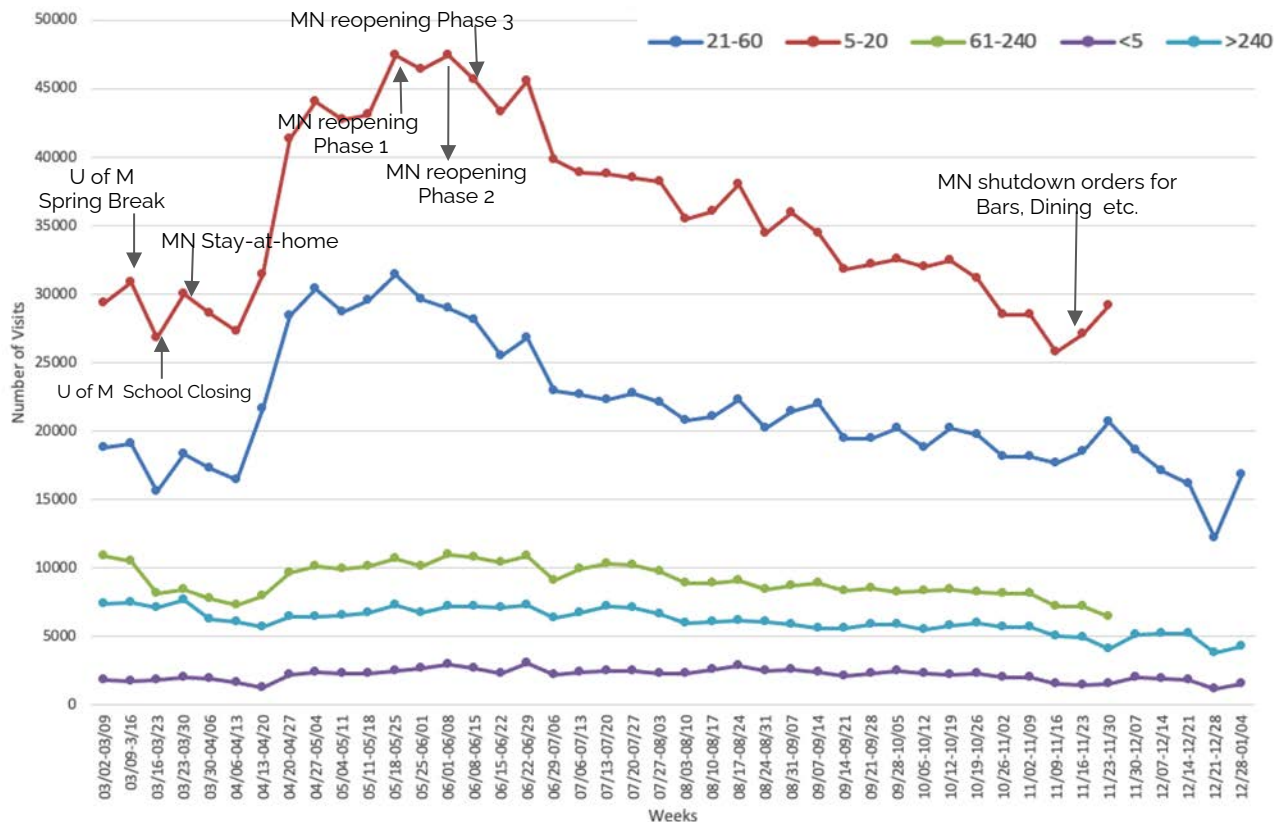


- Limited-Service Restaurants,** NAICS Code: 722513.



MN Hardware Store Visits (3/2/20 - 1/4/21)

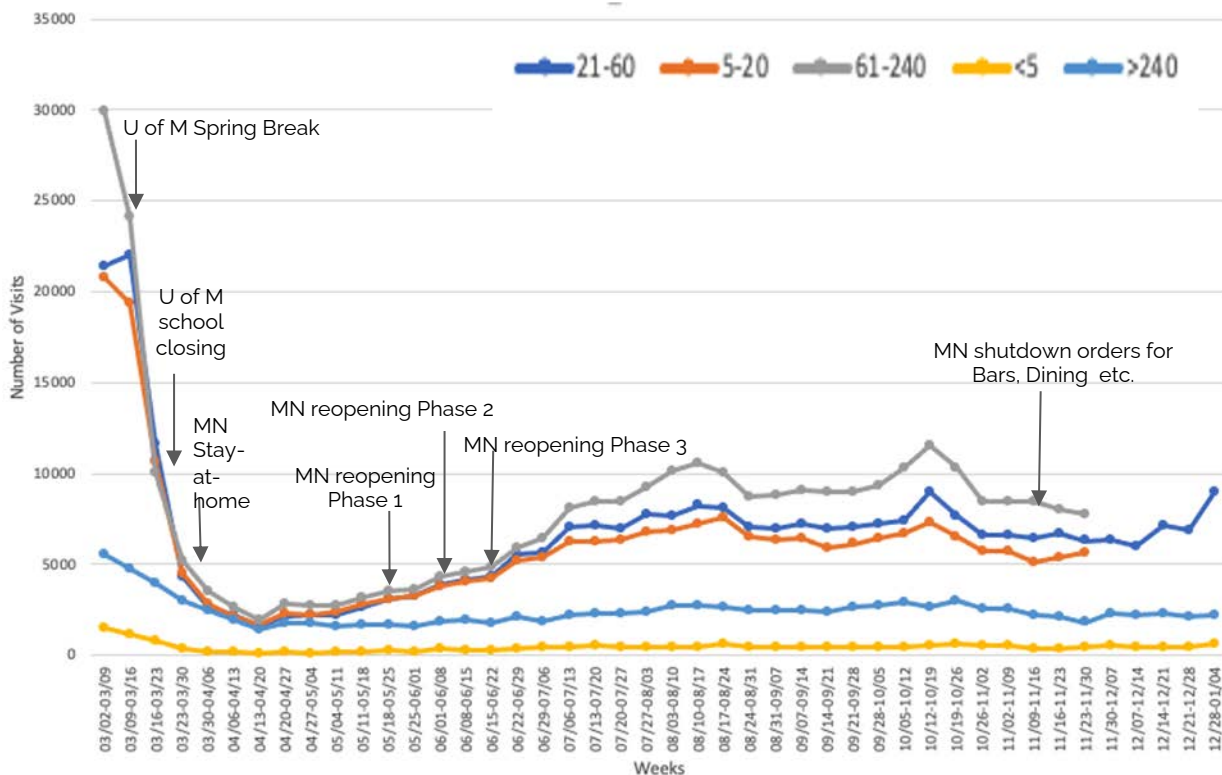
- Hardware Store, NAICS Code: 444130.
- Trends: **Short visits dominate**, Visits went up during stay at home.



Dwell Time	Visits
<5	94261
5-20	1390897
21-60	945976
61-240	352864
>240	268928

MSP Airport Visit Durations

- **Trend:** Number of visits well below pre-pandemic levels
- March 2nd 2020 – Jan. 4th, 2021



Dwell Time (min)	Visits
>5	19770
5-20	234094
21-60	292813
61-240	314524
>240	106652

Airport Moving From passengers to Freight

Jan. 12, 2021

The New York Times

Air Cargo Construction Is Booming, Thanks to Amazon

Airports across the United States are devoting more space to freight shipments as online shopping surges in the pandemic.

“The traffic in cargo is responsible for all the new demand at airports now,” said Rex J. Edwards, an industry analyst and vice president of the Campbell-Hill Aviation Group, a Northern Virginia consulting firm. “The cargo carriers want more airport space. They need room to park planes and facilities that meet next-day delivery requirements. That is the evolution of the business now.”

Before the pandemic, e-commerce sales were growing more than 10 percent annually, pushing total air cargo to 12 million tons last year, according to the Bureau of Transportation Statistics, a unit of the Transportation Department. Federal analysts project that air cargo will reach 45 million tons annually by midcentury. But executives at big air shippers, airports and airplane manufacturers say that the pandemic altered online commerce so substantially that the industry will hit that mark a decade sooner.

Safety: Accident Death Rate Up

Staying Safe on the Roads in the Time of COVID-19



Insurance Insights

December 18, 2020

As traffic levels trended downward, so did the number of driving violations—and the number of accidents and insurance [claims](#). While that might sound like good news, there's a flip side to it. Though violation levels declined, violation severity has increased. The National Safety Council reports that compared to 2019, there was a 20% jump in the traffic accident death rate between January and June 2020.[\[iii\]](#) This increase occurred despite a 17% reduction in the number of miles driven for the same period.

Details: [Staying Safe on the Roads in the Times of COVID-19](#),

Adam Pichon, LexisNexis.com, Dec. 18th, 2020.



Adam Pichon,
Vice President, Product Management

Safety: Major Speeding, DUI Up

December 18, 2020

Preliminary data from a recent study we conducted (more to come about this in the new year) support these findings, indicating that during the time of COVID-19:

- Major speeding has almost tripled as a percentage of total speeding violations (see chart below).
- Speed-racing, while relatively lower in absolute numbers, has seen no reduction in absolute counts.
- DUIs, which have changed very little in recent periods, as ratio to total violations, increased significantly, with an especially steep increase for March and April.
- DUIs have remained elevated through 2020 at more than two times the ratio to total violations, relative to 2019 figures.
- While DUIs in general appear to be at an elevated rate compared to total violations, DUI rates for female drivers have increased over the rates for male drivers.

Details: [Staying Safe on the Roads in the Times of COVID-19](#),

Adam Pichon, LexisNexis.com, Dec. 18th, 2020.



Adam Pichon,
Vice President, Product Management

Pandemic Reduced Emissions Temporarily

- Pandemic reduced transportation emission by 14.7% in 2020

Jan. 12, 2021

The New York Times

Covid-19 Took a Bite From U.S.

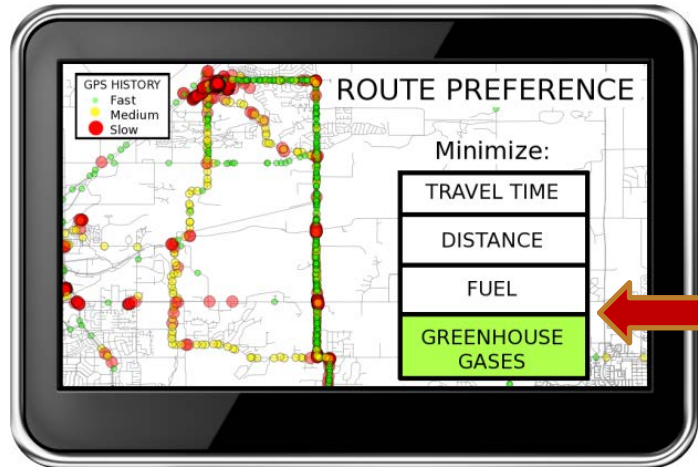
Greenhouse Gas Emissions in 2020

Emissions plunged more than 10 percent. If the trend can be sustained, it would put the United States within striking distance of one of its major goals under the Paris climate agreement.

WASHINGTON — America's greenhouse gas emissions from energy and industry plummeted more than 10 percent in 2020, reaching their lowest levels in at least three decades as the coronavirus pandemic slammed the brakes on the nation's economy, [according to an estimate published Tuesday](#) by the Rhodium Group.

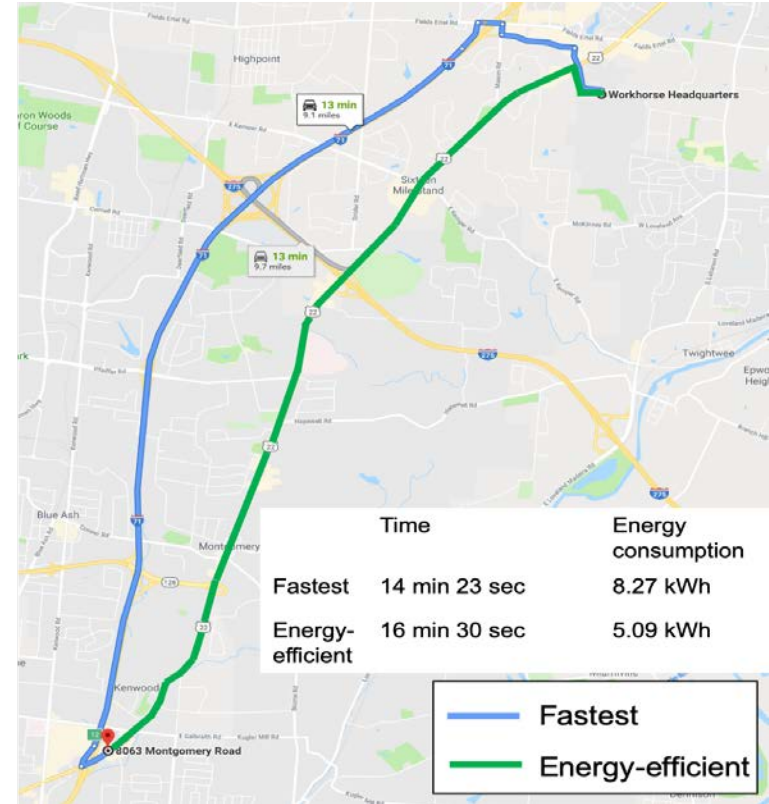
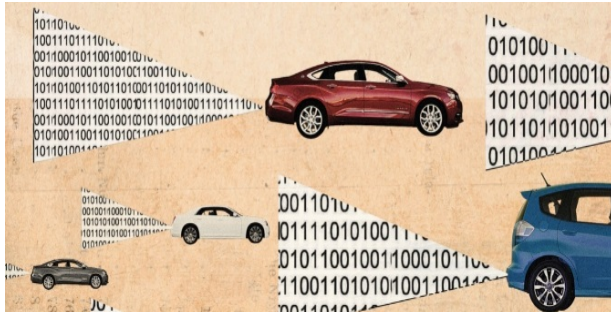
Transportation, the nation's largest source of greenhouse gases, saw a 14.7 percent decline in emissions in 2020 as millions of people stopped driving to work and airlines canceled flights. While travel started picking up again in the latter half of the year as states relaxed their lockdowns, Americans drove 15 percent fewer miles over all last year than they did in 2019 and the demand for jet fuel fell by more than one-third.

PPO1: Navigation App to Reduce Emission, Energy use



Quality of current routing systems

Rate) and, Variety



Details: Y. Li, P. Kotwal, P. Wang, Y. Xie, S. Shekhar, and W. Northrop, [Physics-guided Energy-efficient Path Selection Using On-board Diagnostics Data](#), ACM/IMS Trans. Data Sci. 1(3), Article 22, Sept. 2020), 28 pages.

PPPO 2: Spatial Big Data

- Location traces
 - 2 billion GPS receivers today (7 billion by 2022)
 - Help understand Spatio-temporal patterns of life
- Other:
 - Vehicle OBD data,
 - (Nano-)Satellite Imagery



The World Economy
Runs on GPS. It Needs a
Backup Plan

Bloomberg Businessweek

July 25, 2018, 4:00 AM CDT

ENSURING RESOURCE AVAILABILITY

Advanced technology, including many types of Earth information, will unlock up to **\$1.6 trillion** in economic savings for energy generation and use by 2035.

Satellite observations can also help ensure water availability, which is particularly important to the 20% of the world now living in areas of water scarcity.

McKinsey Global Institute

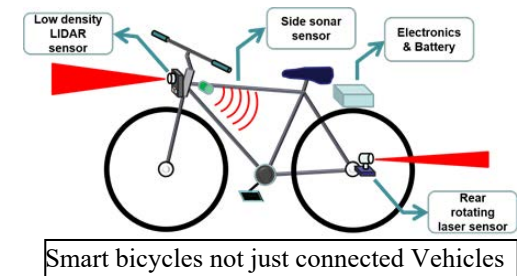
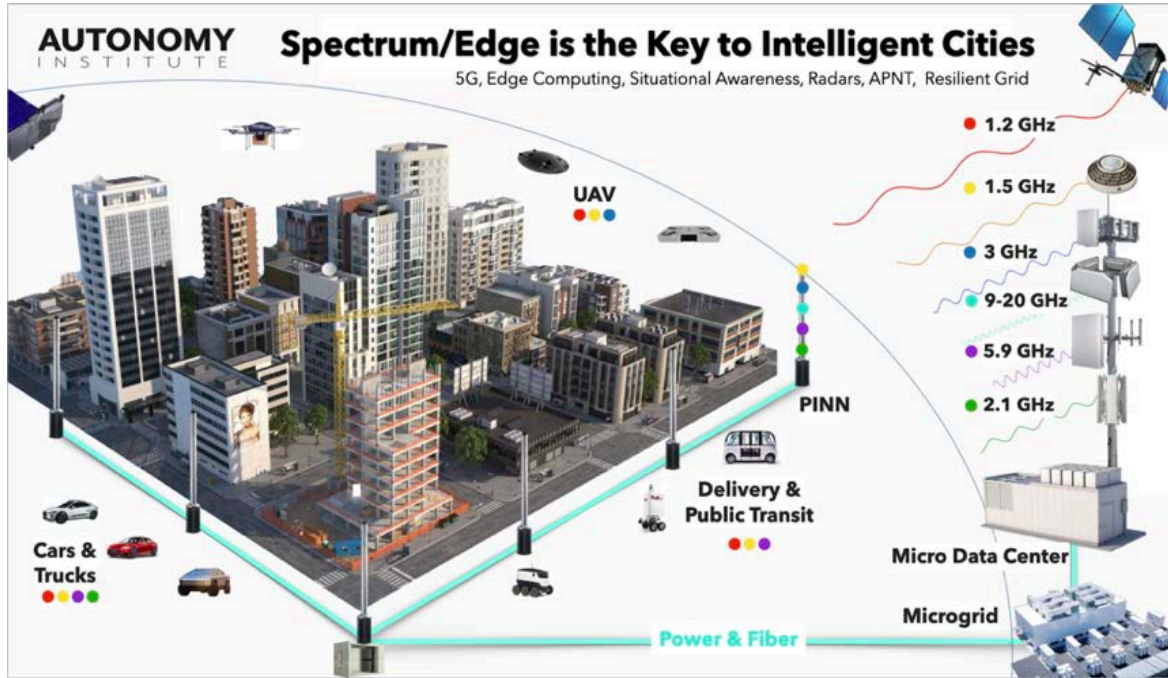
The study estimates that the use of **personal location data** could save consumers worldwide more than **\$600 billion** annually by **2020**. Computers determine users' whereabouts by tracking their mobile devices, like cellphones.

The New York Times

Published: May 13, 2011

PPPO 3: Smart Cities

- Future Transportation for Smart and Connected Communities
- Ex. Internet of (Road) Transportation Things, e.g., CAVS, smart bicycles, etc.
 - Nextgen positioning/navigation, communication, sensing, data, computing infrastructure



Source: autonomy.institute/infrastructure/

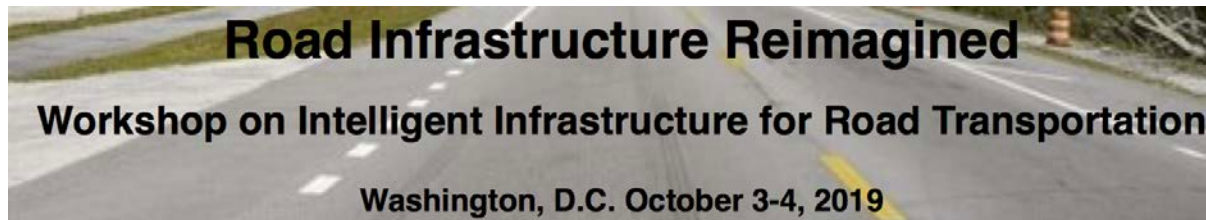
An Invitation

- 2nd Workshop (email Shekhar@umn.edu for details or invitation)

Connected Roads and Vehicles: A Next Generation Mobility Workshop

Thu, Feb 25, 2021 8:00 AM - 10:30 AM CST

- Details: [Connected Roads and Vehicles: A Next Generation Mobility Workshop](https://www.kcdigitaldrive.org/event/connected-roads-and-vehicles-a-next-generation-mobility-workshop/), kcdigitaldrive.org, Jan. 11th, 2021, <https://www.kcdigitaldrive.org/event/connected-roads-and-vehicles-a-next-generation-mobility-workshop/>
- [1st Workshop](#) Oct. 2019: [report](#)



Summary & Next Steps

- Summary

- Pandemic uncovered value of Spatial Big Data
- Pandemic accelerated adoption of technology
- Many compelling opportunities ahead
 - Eco-navigation, Eco-routing
 - Internet of Transportation Things for Smart Communities

- Policy Needs

- Encourage Public-private partnerships for Smart Communities
- Fairness, Accountability, Transparency, Ethics
- Ex. Encourage transparency of data quality, e.g., selection bias

- More: http://www.spatial.cs.umn.edu/Project/covid_19.html

