Is detour a good choice to reduce commute delay caused by crash?

A case study of I-24 smart corridor in Tennessee

THE UNIVERSITY OF TENNESSEE KNOXVILLE

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GATLINBURG TENNESSEE

You've never been closer.

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Background

I-24 smart corridor (2018-now)

- A major route for commuters and freight between Nashville-Davidson and Murfreesboro-Rutherford
- Integrates arterial routes and freeways
- **A series of improvements**, e.g., ramp extension, variable speed limit, lane control signs and so on.
- Improve travel time reliability, safety, and mobility

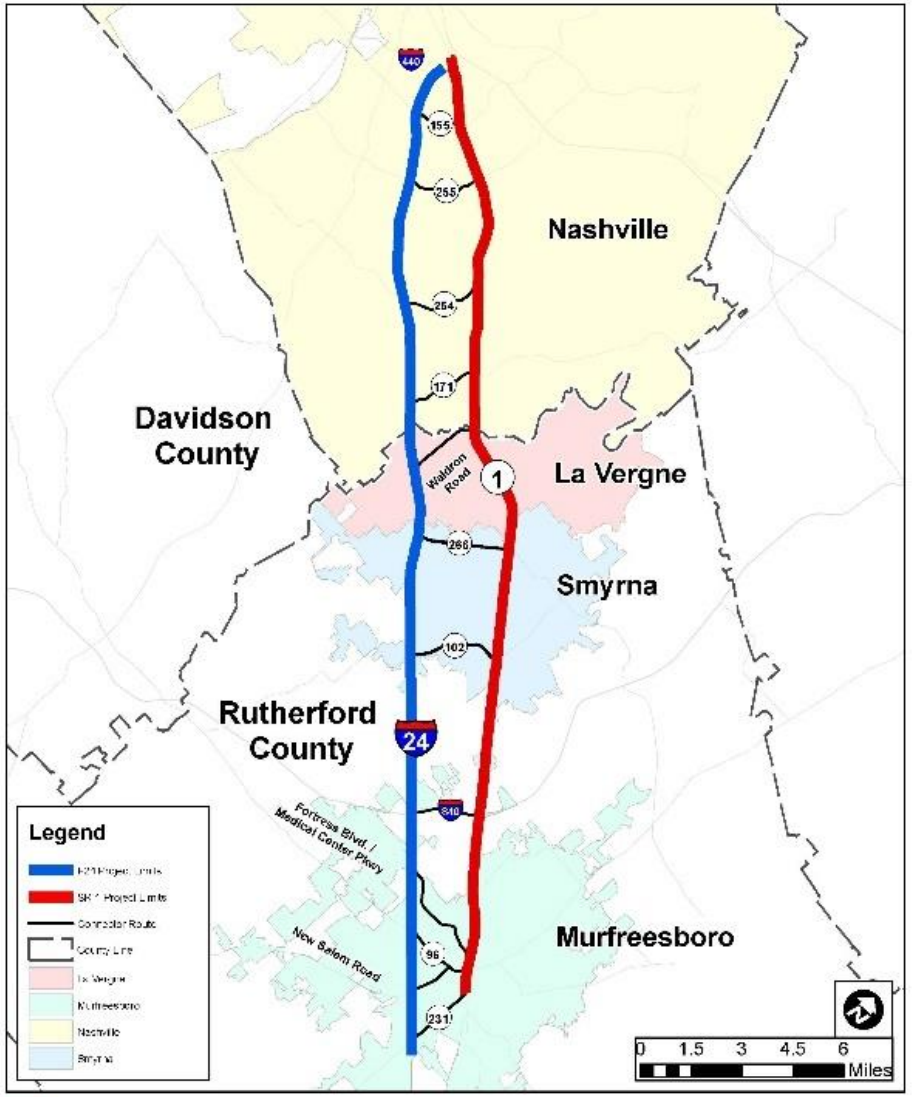
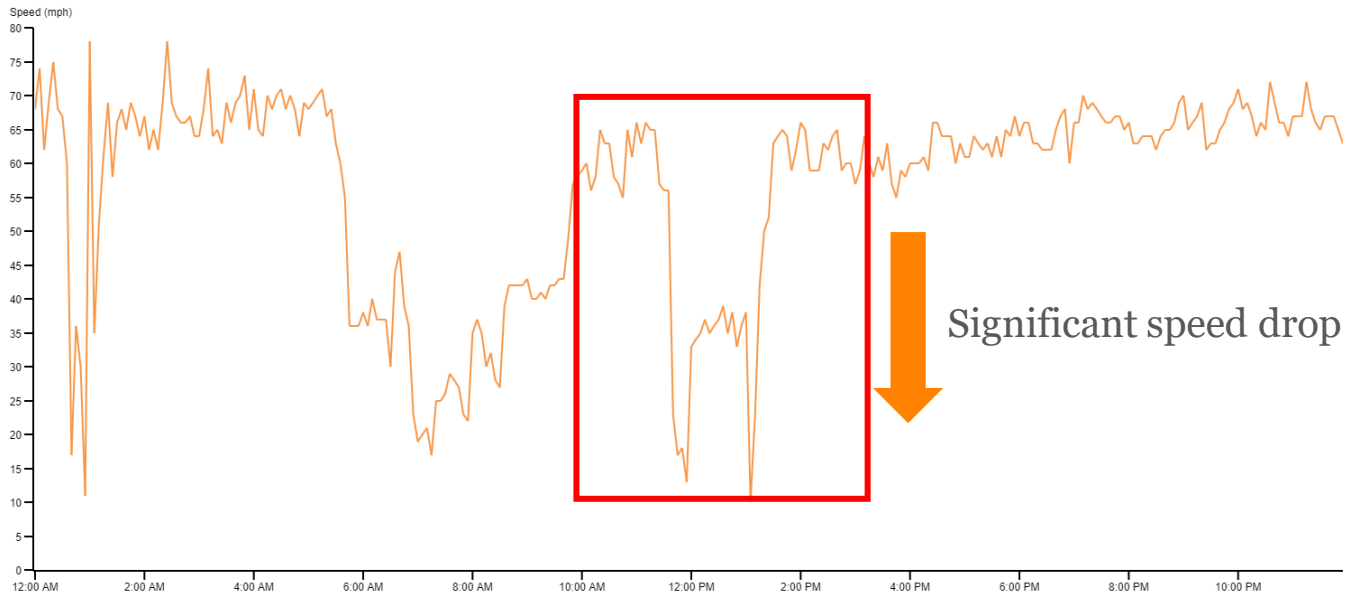


Image source: https://www.tn.gov/tdot/projects/region-3/i-24-smart-corridor.html

Background

Crash → **Lane close** → **Travel delay**, **Queue**, **Secondary crash**



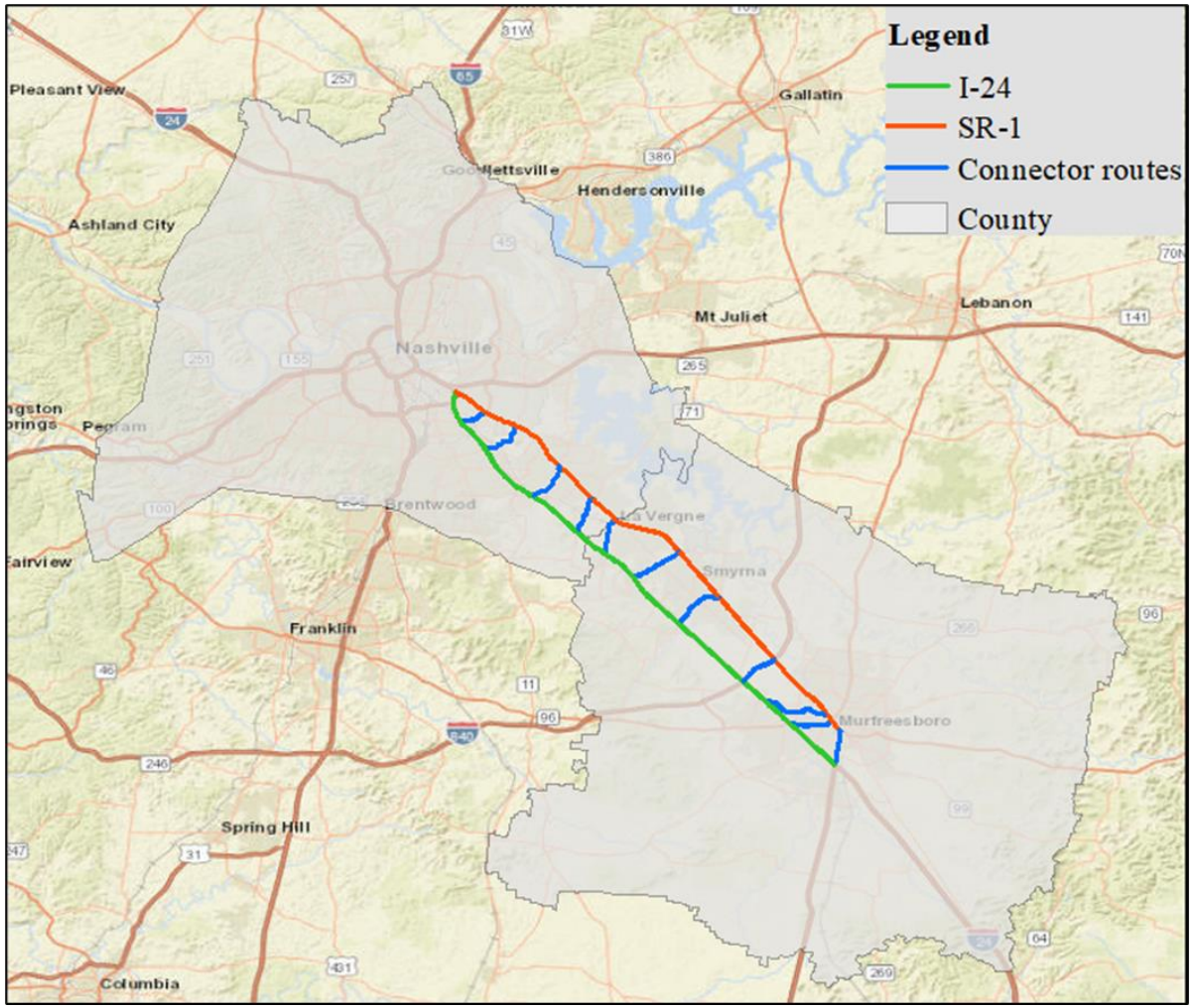
Research Story

When a crash occurs, what should we do….

Stay on current route

Or

Detour



Research Data

Data

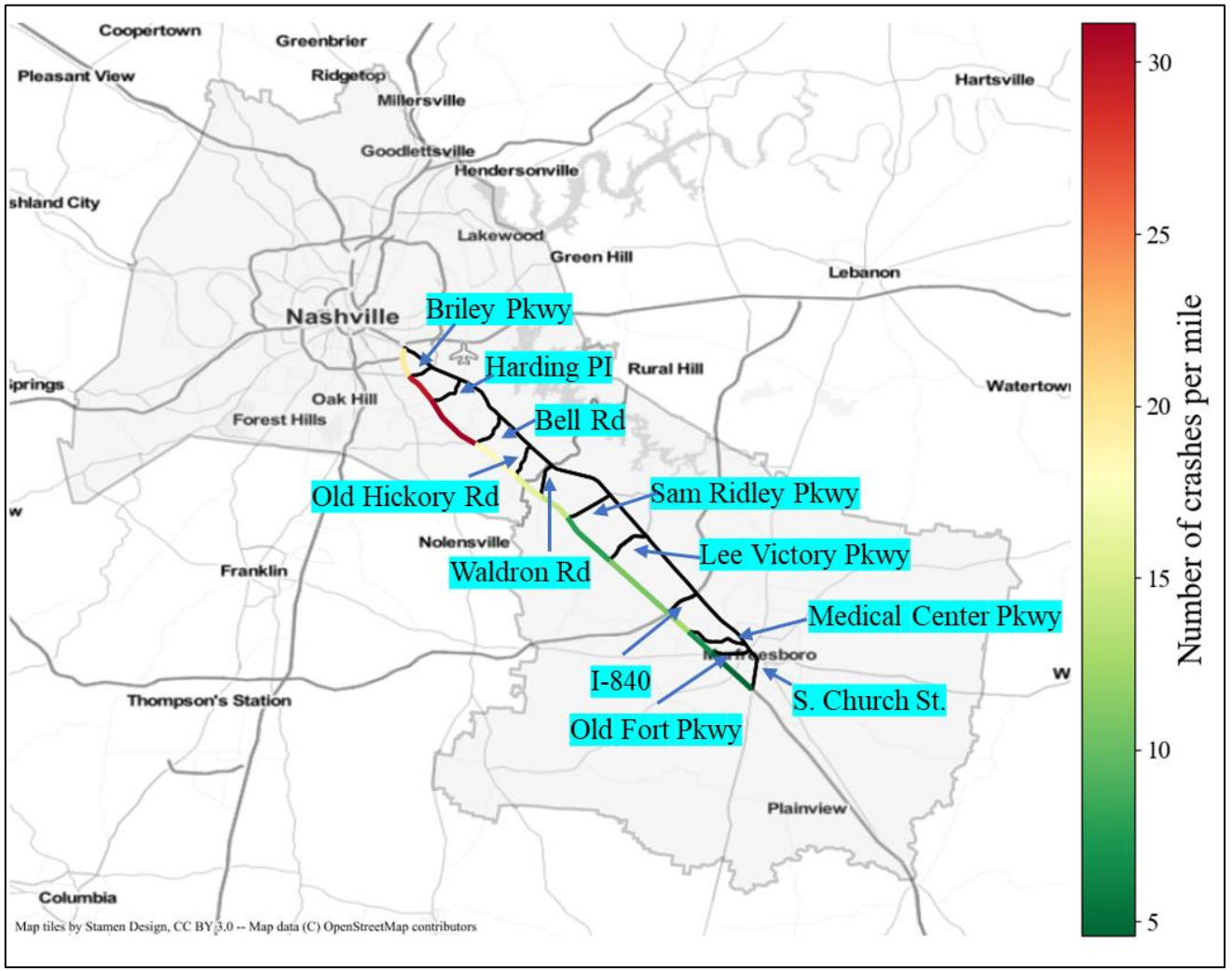
- Crash data
- Waze segment speed
- Road geometry (segment length)

Study period

- May – November 2022 (six months)

- Crash spatial distribution
  - Segment between Briley Pkwy and Bell Road suffer from higher crash frequency.

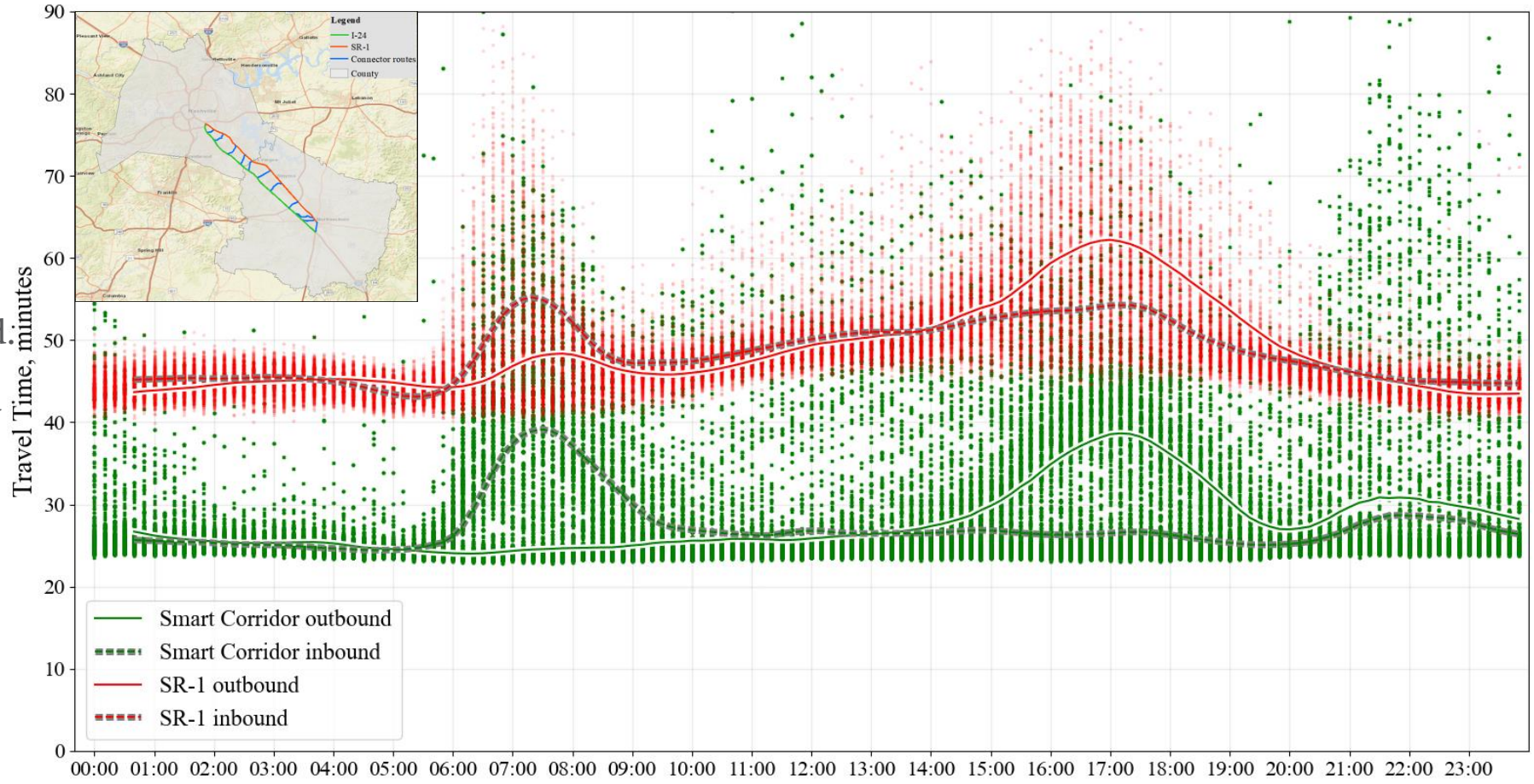
Figure. Crash Spatial Distribution



Primary data analysis

- Travel time of I-24 (green lines) are much lower than SR-1 (red lines)
- Both routes have a single peak period.
- Nighttime SR-1 travel time reliability is higher than I-24

Figure. Travel time between Nashville and Murfreesboro



Methodology

Detour scheme:

→ Exit the smart corridor

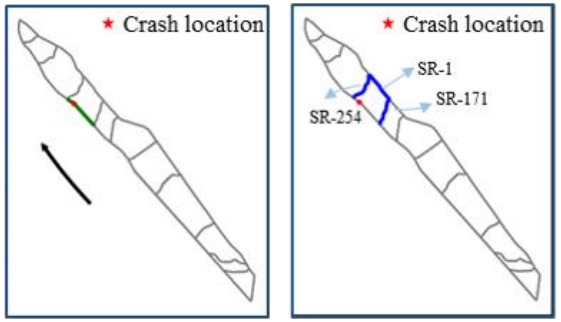
→Travel on a section of SR-1

→ Re-enter smart corridor

Figure. Dynamic Travel time estimation for direct and detour route

	Detour Route	SR-171	SR-1	SR-254
	Length (mi)	2.24	2.65	2.47
Departure time	6:15	33	32	28
	6:16	35	30	28
	6:17	35	30	27
	6:18	33	30	27
	6:19	34	29	27
	6:20	33	29	27
	6:21	33	29	26
	6:22	32	30	26
	6:23	36	32	25
	6:24	37	33	27
	6:25	36	31	29
	6:26	35	30	26
	6:27	34	30	26
	6:28	34	31	30
	6:29	33	29	30

Instantaneous travel time = 14.32 minutes



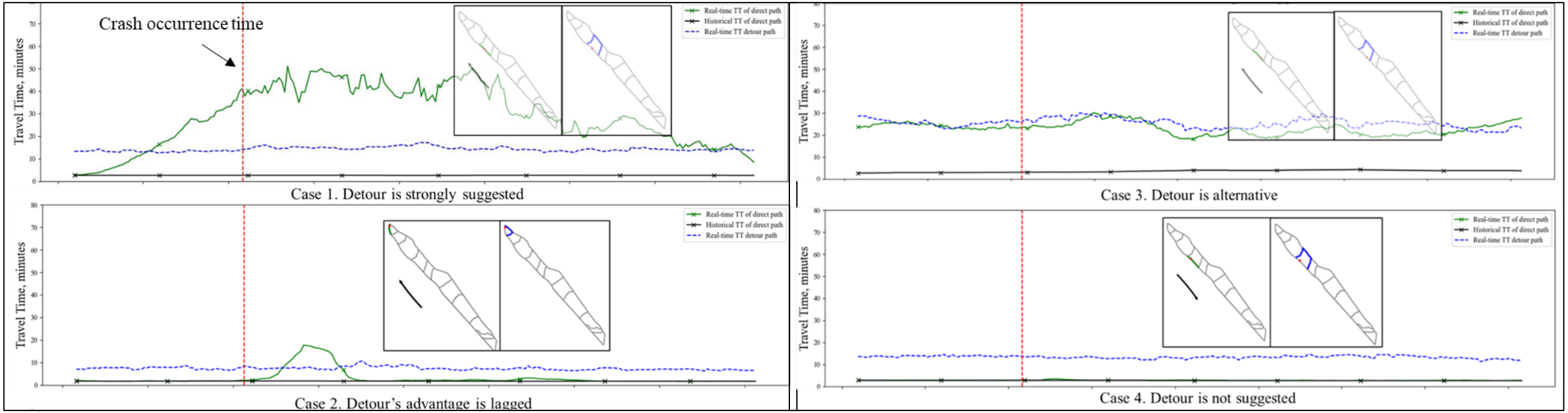
Direct Route

Detour Route

Dynamic travel time = 12. 47 minutes

Methodology

Figure. Travel time patterns of direct and detour routes



Detour efficiency (DE)

~Percent of travel time saved.

Table 1 Detour scenarios determined by detour efficiency.

	Criterion	Comments	Possible Cases
Scenario 1	DE>5%	Detour is strongly suggested	Case 1
Scenario 2	0%<DE<5%	Detour is alternative	Case 2 and 3
Scenario 3	DE<0%	Detour is not suggested	Case 2, 3, and 4

Detour or not

- For each crash scenario, we calculated the probability of detour, alternative detour.

- Clustering → Detour is NOT suggested in next one hour
  → Detour is suggested in next one hour

Figure. K-means clustering results.

Cluster	Centroids of cluster	Explanation
Cluster 1	(Detour probability = 0.0133, alternative detour probability = 0.0029)	Detour is **NOT** suggested in next one hour.
Cluster 2	(Detour probability = 0.6303, alternative detour probability = 0.0228)	Detour is **suggested** in next one hour.

Detour or not

Bootstrapping logistic regression

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_i x_i$$

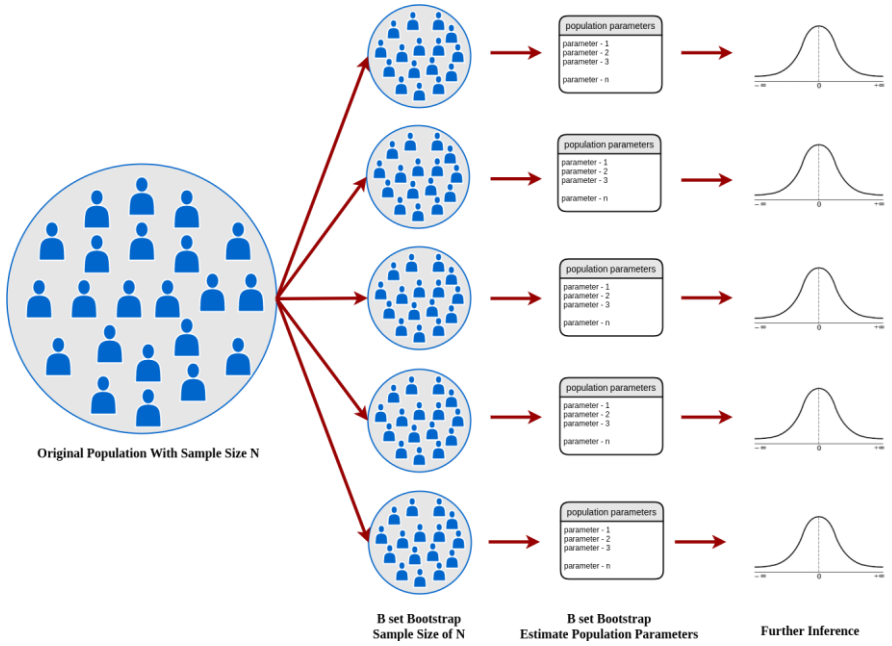


Table. Descriptive statistics of variables

Continuous variable	Min	Mean	Max	Std.
Detour ratio in distance	1.51	2.66	5.97	0.98
Number of Injuries	0	0.79	8	1.04
Discrete variable	Frequency (Yes)		Frequency (No)	
Detour choice (outcome)	51		409	
Crash occurs in peak hours	324		136	
Crash occurs in HELP patrol area	279		181	
Crash on roadway	371		89	

1. Total number of observations is 460.
2. Detour ratio is the ratio of detour distance to direct distance.
3. Peak hours refer to 6-10 and 15-19 on weekdays, rest are non-peak hours.

Results

- Higher number of injuries, the more likelihood of making a detour.
- Crash in peak hours, staying on I-24 seems to be a better choice
- Crash in HELP patrol areas, detour is not suggested.
- Detour is suggested when travel lanes are blocked.
- The larger ratio of detour distance to direct distance,

  The less likelihood of taking a detour

Figure. Coefficients of Logit regression under bootstrap framework

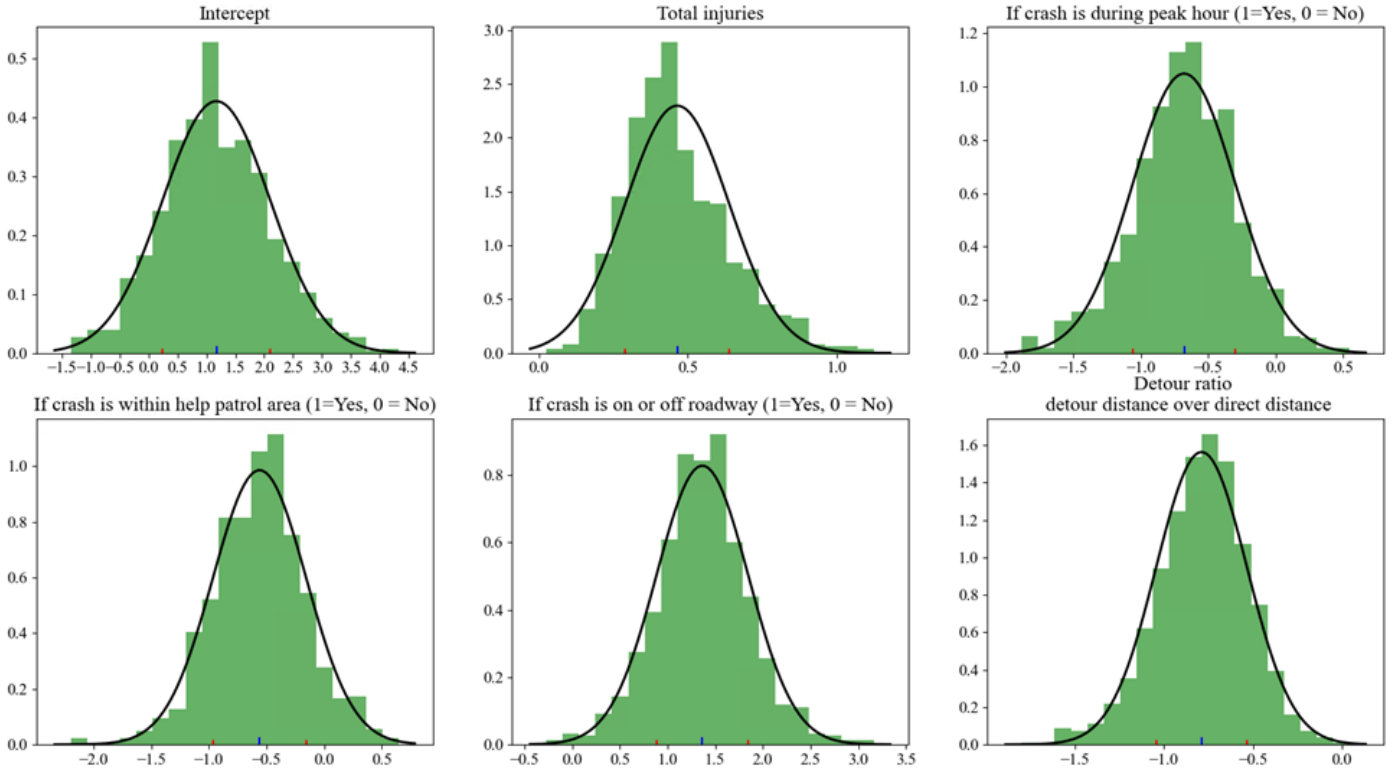


Table 1 Coefficient Estimation

Parameters	Lower bound	Average	Upper bound	Average Marginal Effect
Intercept	1.1705	1.1722	1.1739	222.9%
Number of Injuries	0.4640	0.4643	0.4547	59.1%
Crash occurs in peak hours	-0.6801	-0.6794	-0.6787	-49.3%
Crash occurs in HELP patrol area	-0.5609	-0.5601	-0.5594	-42.9%
Crash on roadway	1.3640	1.3649	1.3658	291.5%
Detour ratio in distance	-0.7895	-0.7891	-0.7886	-54.6%

Future study

- Consider local streets for detour route choice
- Consider the emission of detour vs. direct route
- Consider the comfort and cost of detour vs. direct route.

Thank you!

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