The deviation between actual and shortest travel time paths

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Abstract

- This study challenges the widely applied shortest path assumption by evaluating routes followed by residents of the Minneapolis - St. Paul metropolitan area, as measured by the GPS Component of the 2010 Twin Cities Travel Behavior Inventory conducted by the Metropolitan Council.

- It finds that most travelers used paths longer than the shortest path. This is in part a function of trip distance, trip circuity, number of turns, and age of the driver.

- The same traveler often used multiple routes between home and work on different days.

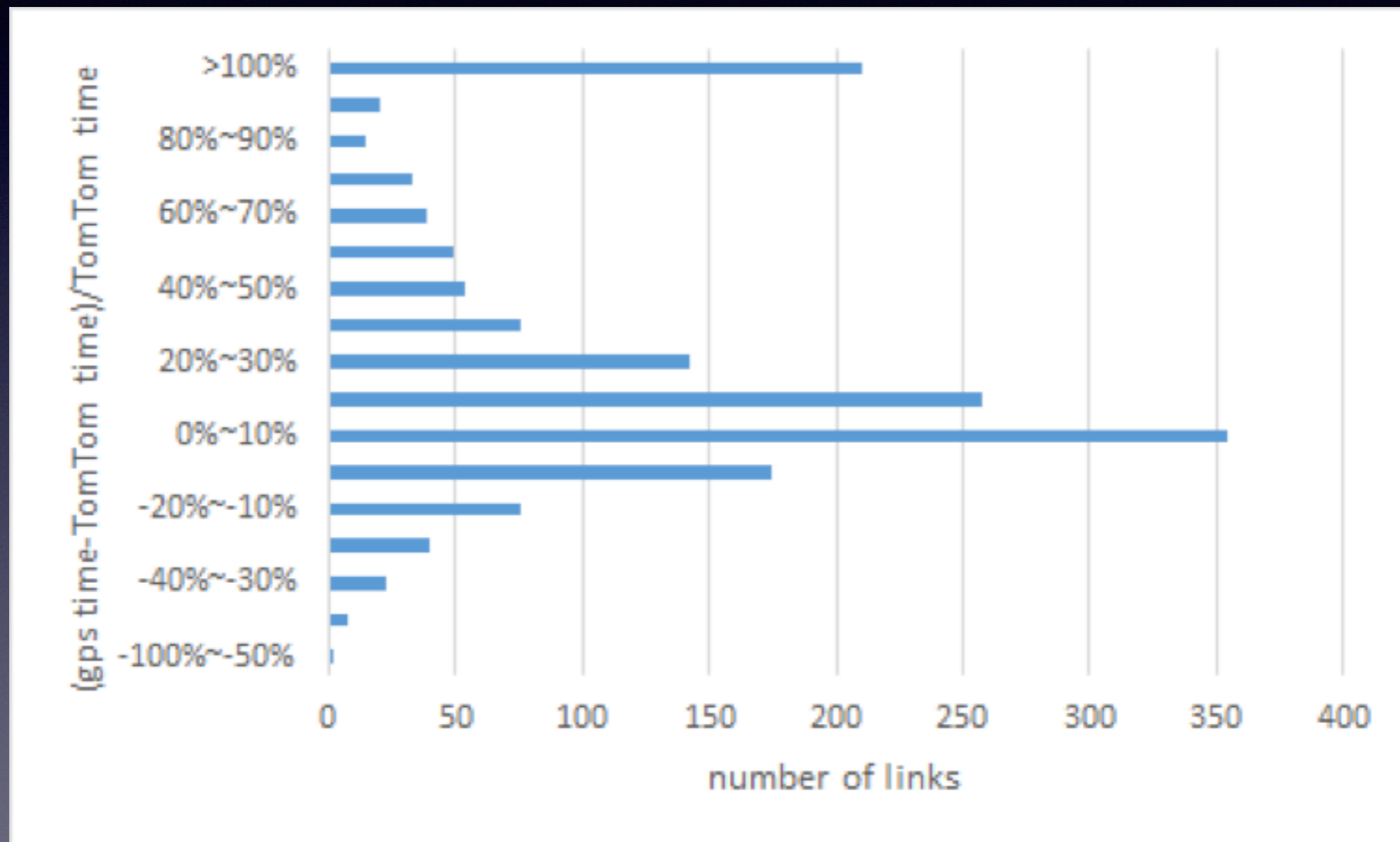- Some reasons for these findings are conjectured.

Background

- Route Assignment general assumes travelers care only about minimizing travel time.

- Research has shown travelers care about money, avoiding stops, reliability, aesthetics.

- Research has shown travelers misperceive travel time.

Data

- 2010-11 Travel Behavior Inventory from Metropolitan Council of the Twin Cities

- GPS Component: 250 Households issued pendant GPS units for 7-days —> 278 persons with valid data.

- TomTom road speed network data for 2010 for MSP region

- TLG base network (290,231 links)

Figure 1: Travel Time Comparison on Links Between TomTom GPS and TBI GPS data. On average TomTom travel times are lower than observed in the TBI.

Trip Filtering

Steps	Remaining Number of Trips	Description
Original number of trips	16902	The identification was based on time gap between two successive GPS points. If the dates of two GPS points were different and were not at midnight, the latter one was consider as the origin of next trip. If the dates of two GPS points were the same, then time will be checked. If time gap was greater than a threshold (300 seconds), they were assigned as different trips.
remove speed=0	12572	Remove trips in which speed is always zero.
remove wrong duration	8461	Remove trips where trip duration was less than 5 minutes.
remove speed < 2	4895	Because in some trips the speed is '2' or '0' with no other numbers, remove the trips with average speed less than 2.
select H2W, Auto	142	Use the method in the report to identify trips.
remove indirect trips	124	1) Destinations of two of the trips are not in the Twin Cities GIS network, so were excluded. 2) Some of the trips involved indirect travel from home to work. In part 3.3 and Figure 1, we describe how to identify whether these trips might have other unidentified purposes during the trips. Very indirect trips were excluded from the H2W category, and instead included in H2O.

Identify trip purpose

Destination	Origin				
	worker			non-worker	
worker	$H \leq 500m$	$W \leq 500m$	$H+W > 500m$	$H \leq 500m$	$H > 500m$
$H \leq 500m$	H2H	W2H	O2H	-	-
$W \leq 500m$	H2W	W2W	O2W	-	-
$H+W > 500m$	H2O	W2O	O2O	-	-
non-worker					
$H \leq 500m$	-	-	-	H2H	O2H
$H > 500m$	-	-	-	H2O	O2O

Figure 2: Measuring Trip Angles. Calculation of trip angles at five and ten minutes after leaving and before arriving. Trips where the direction of travel was in the opposite direction from the origin were assumed to have side activities.
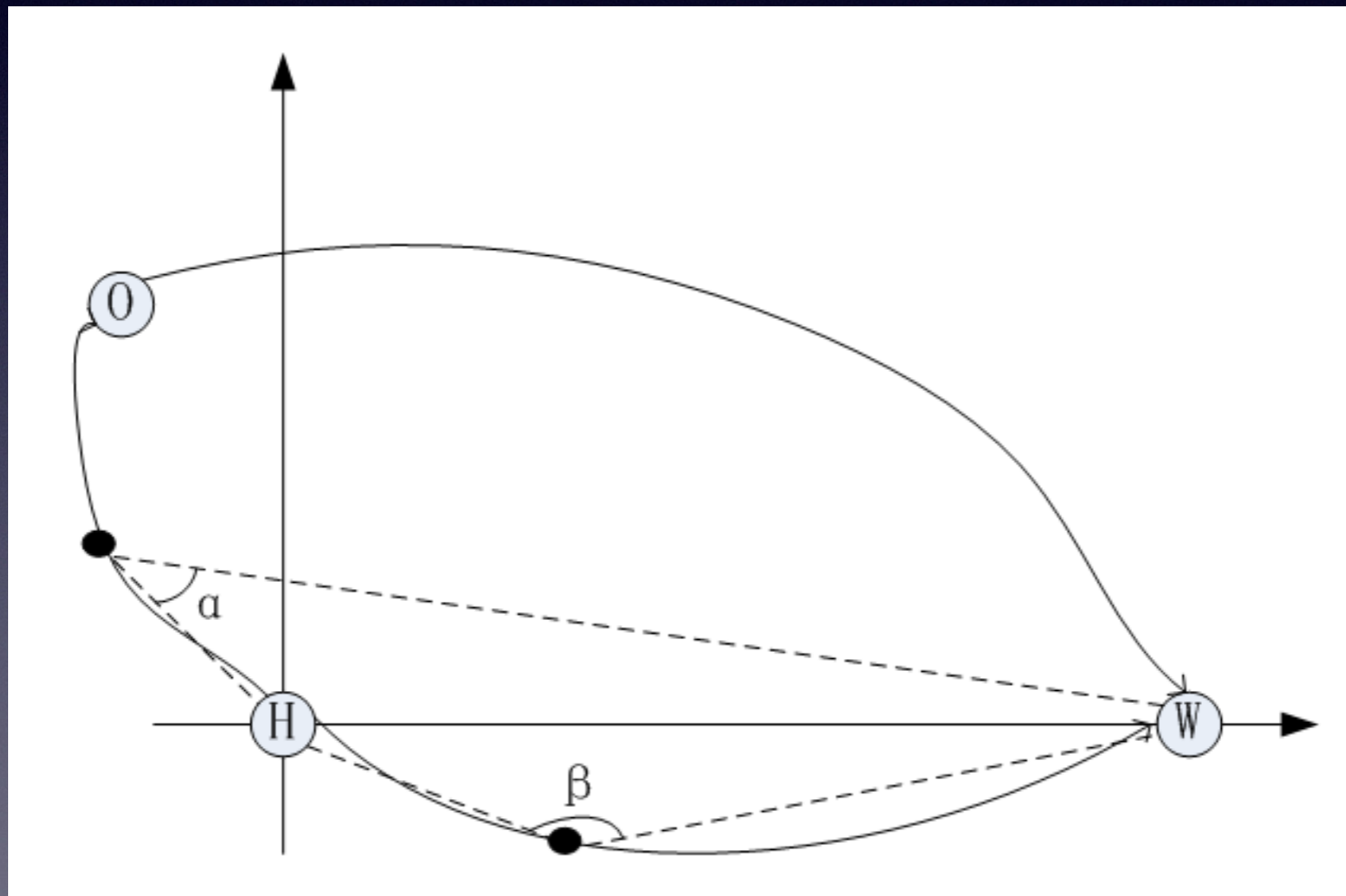
Mode Identification

1. Walk:

   (a) Maximum speed of all points ≤ 20km/h;

   (b) Duration > 60s;

   (c) Percentile of speed of all points ≤ 10km/h;

   (d) Average speed of all points ≤ 6km/h.

2. Rail:

   (a) Distance from first point of speed accelerates to 10km/h to the nearest rail station <150m;

   (b) Distance from last point that speed is greater than 10km/h to the nearest rail station <150m;

   (c) Average speed of all points >10km/h.

3. Bus:

   (a) Distance from first point of speed accelerates to 10km/h to the nearest bus stop <50m;

   (b) Distance from last point that speed is greater than 10km/h to the nearest bus stop <50m;

   (c) Average speed of all points >10km/h.

4. Bicycle:

   (a) 85th percentile of speed of all point ≥10km/h and <20km/h;

   (b) Max speed of all points ≤30km/h.

5. Car: the remaining trip segments with average speed of all points >10km/h

Number of Trips by Mode and Purpose

	H2W	H2O	O2H	W2H	W2O	O2W	O2O	H2H	Total	Percentage
Walk	1	24	3	0	0	17	67	26	138	2.82
Train	0	0	0	0	0	0	1	0	1	0.02
Bus	8	26	104	14	12	14	110	0	288	5.88
Bike	0	13	8	2	0	4	36	0	63	1.29
Drive	124	969	982	90	68	85	1073	10	3419	69.85
Not identified	43	260	313	12	15	53	308	0	986	20.14
Total	176	1292	1410	118	95	173	1595	36	4895	100.00
Percentage	3.60	26.39	28.80	2.41	1.94	3.53	32.58	0.74	100.00	

Comparison of Shortest and Actual Path
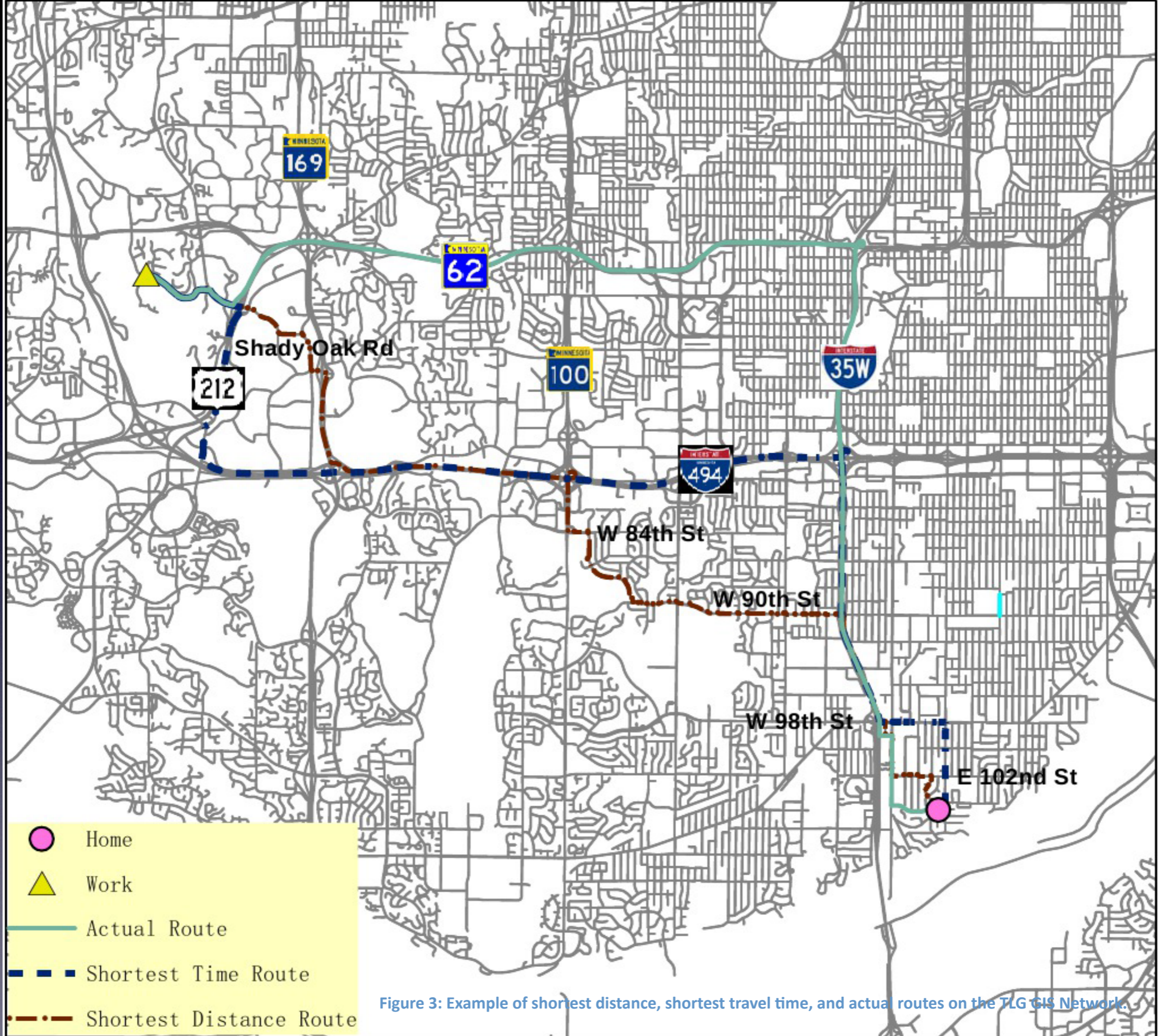
Figure 3: Example of shortest distance, shortest travel time, and actual routes on the TLG GIS Network.

Figure 4: Summary Information for Each Difference Intervals $(t_{GPS}-t_{sp})/t_{sp}$. As the percentage difference between the two data sets increases, the length and duration increase.

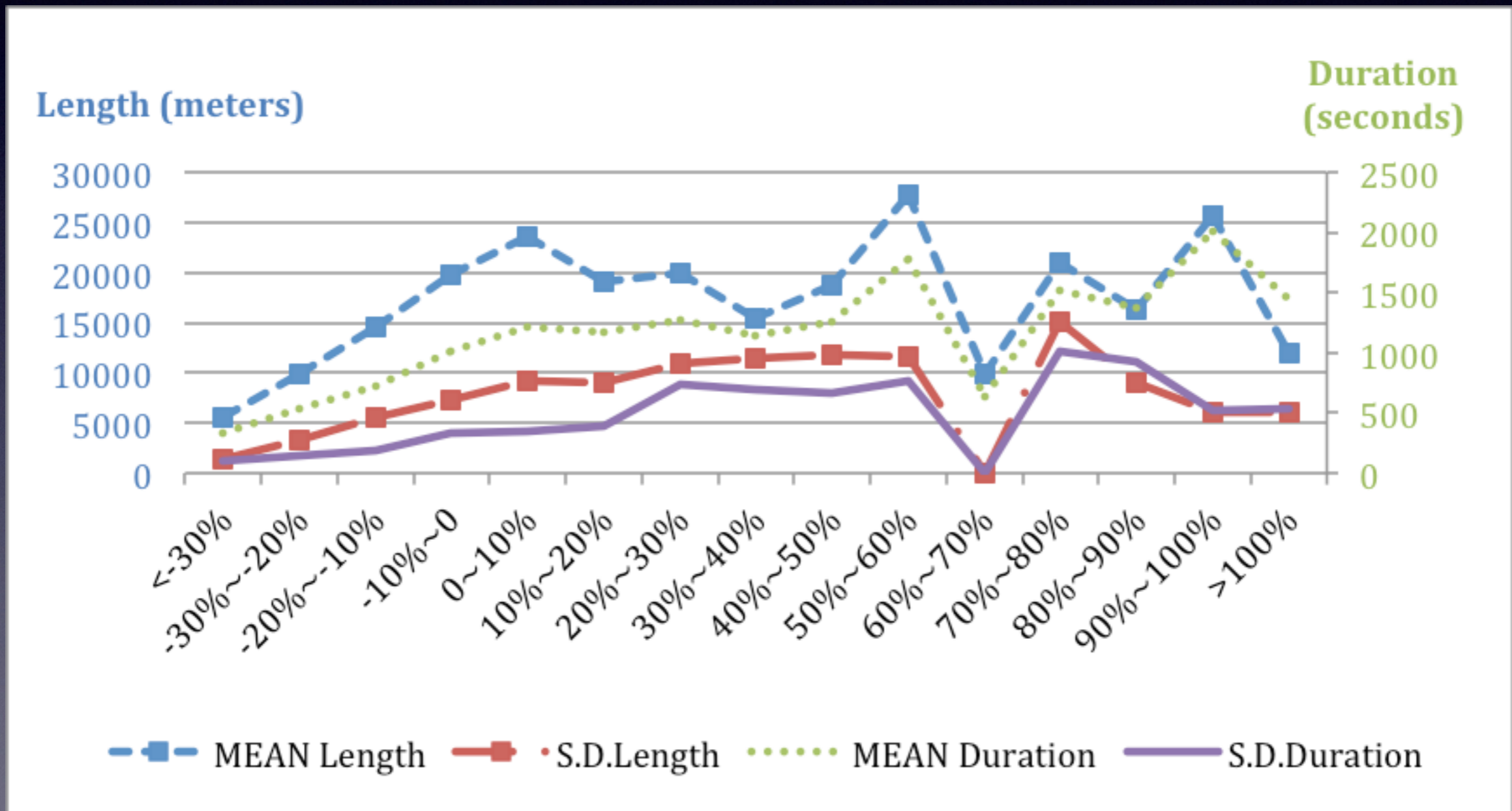Figure 5: Percent of Trips in Each Difference Interval for Each Trip Duration Interval (min). As trip duration increases, the difference between the two data sets is also larger in percentage terms.

Figure 6 Percentage of Overlap between the actual route and shortest path, Same Route (SR) Travelers.
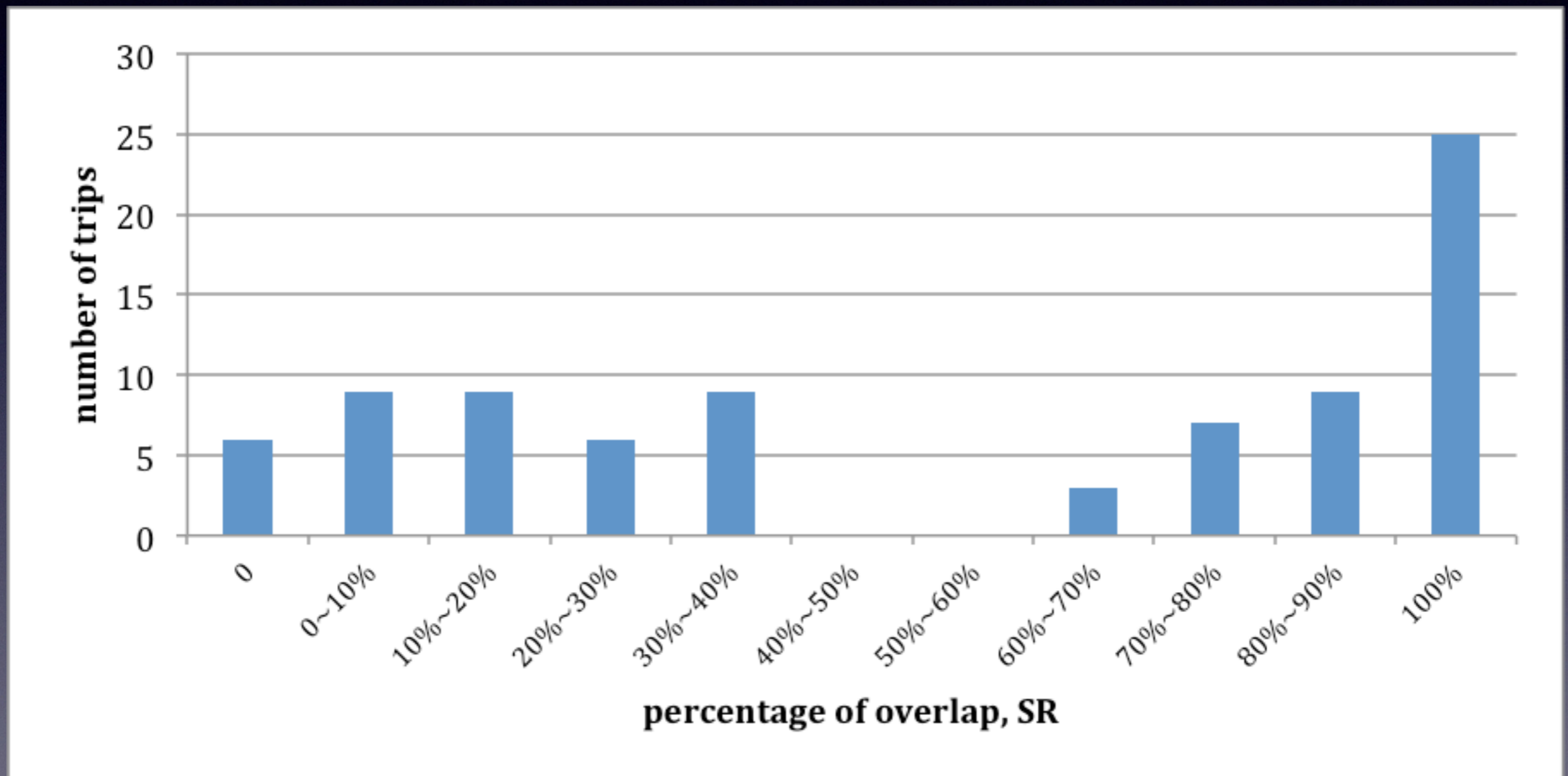
Figure 7 Percentage of Overlap between the actual route and shortest path, Not Same Route (NSR) Travelers.
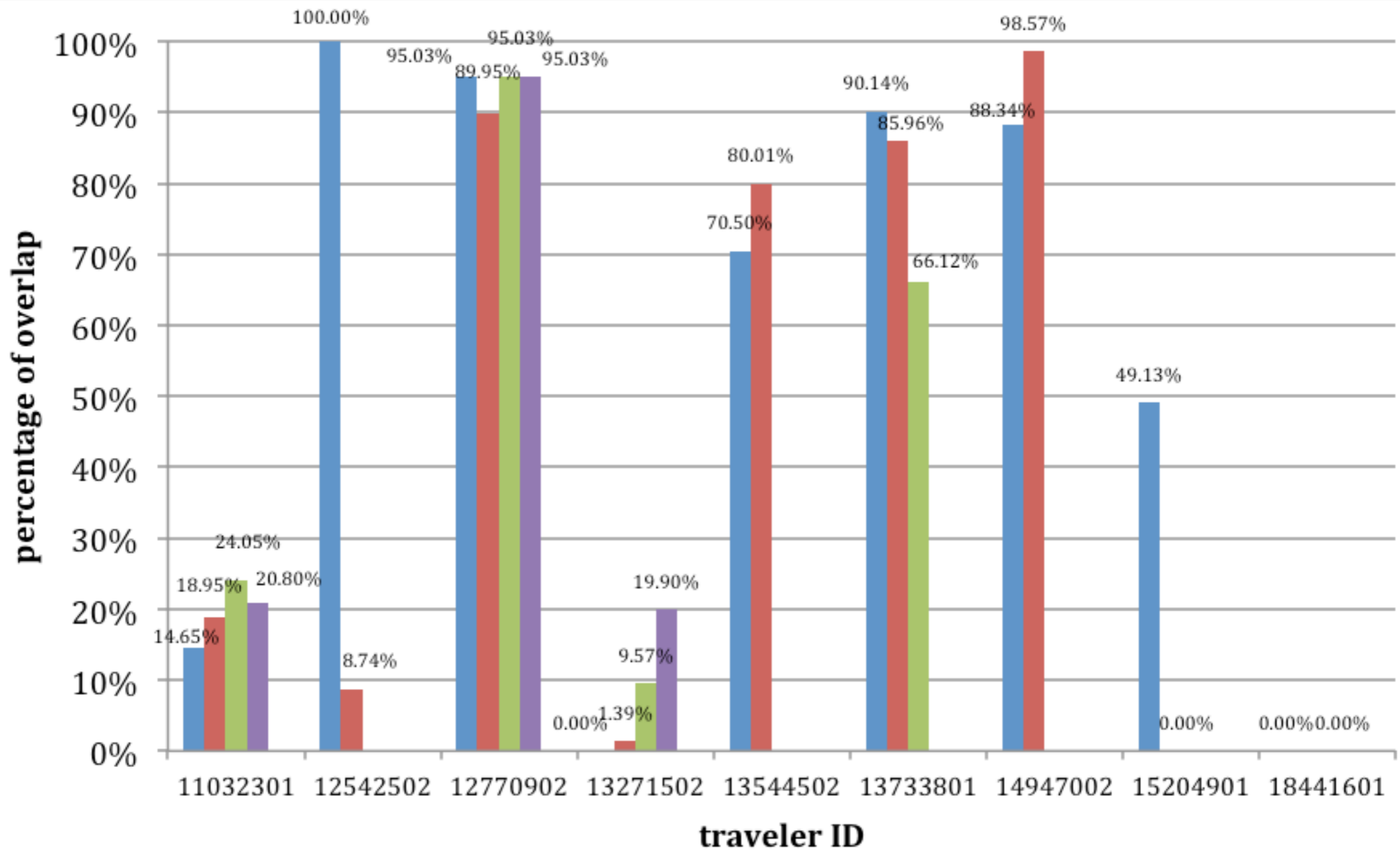
Figure 8: Travel Time Comparison (percentages) between TBI GPS time (tGPS) on actual routes and TomTom GPS time (tsp) on shortest time route.
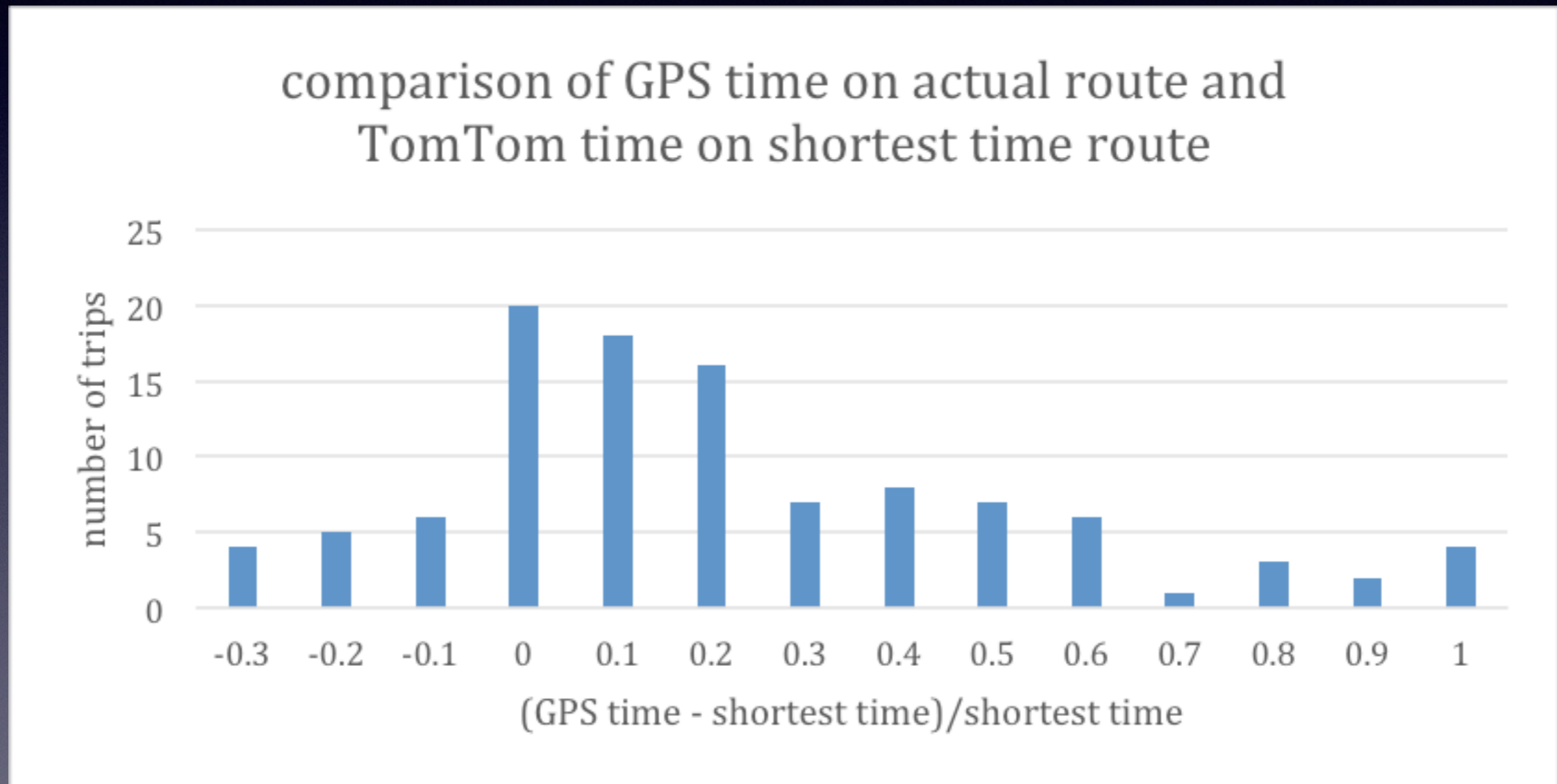
Figure 9: Travel Time Difference (minutes) between TBI GPS time (tGPS) on actual route and TomTom GPS time (tsp) on shortest time route.
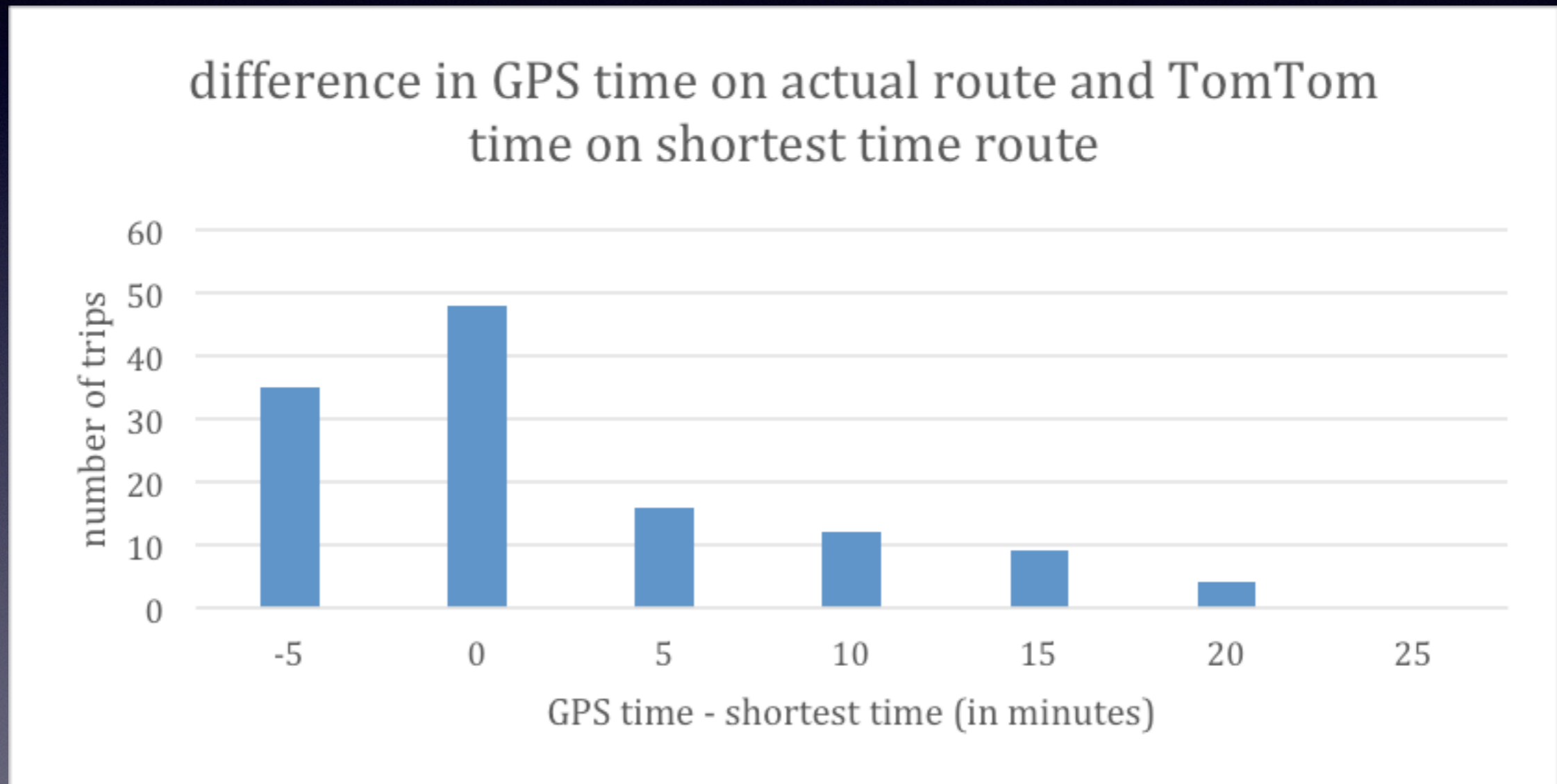
Figure 10: Percentage of Overlap: Difference Between Actual Route and Shortest Distance Route

percentage of overlap: difference between actual route and shortest distance route
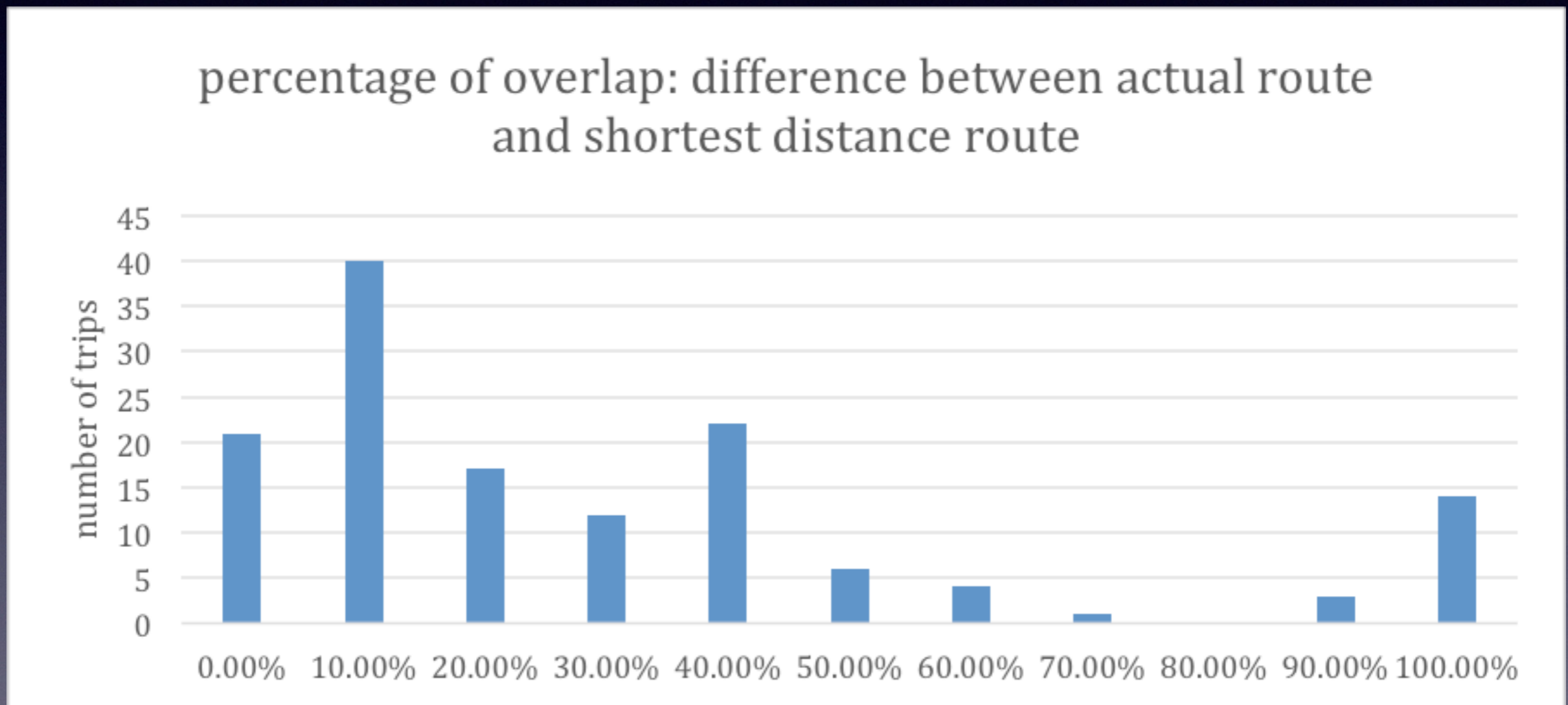
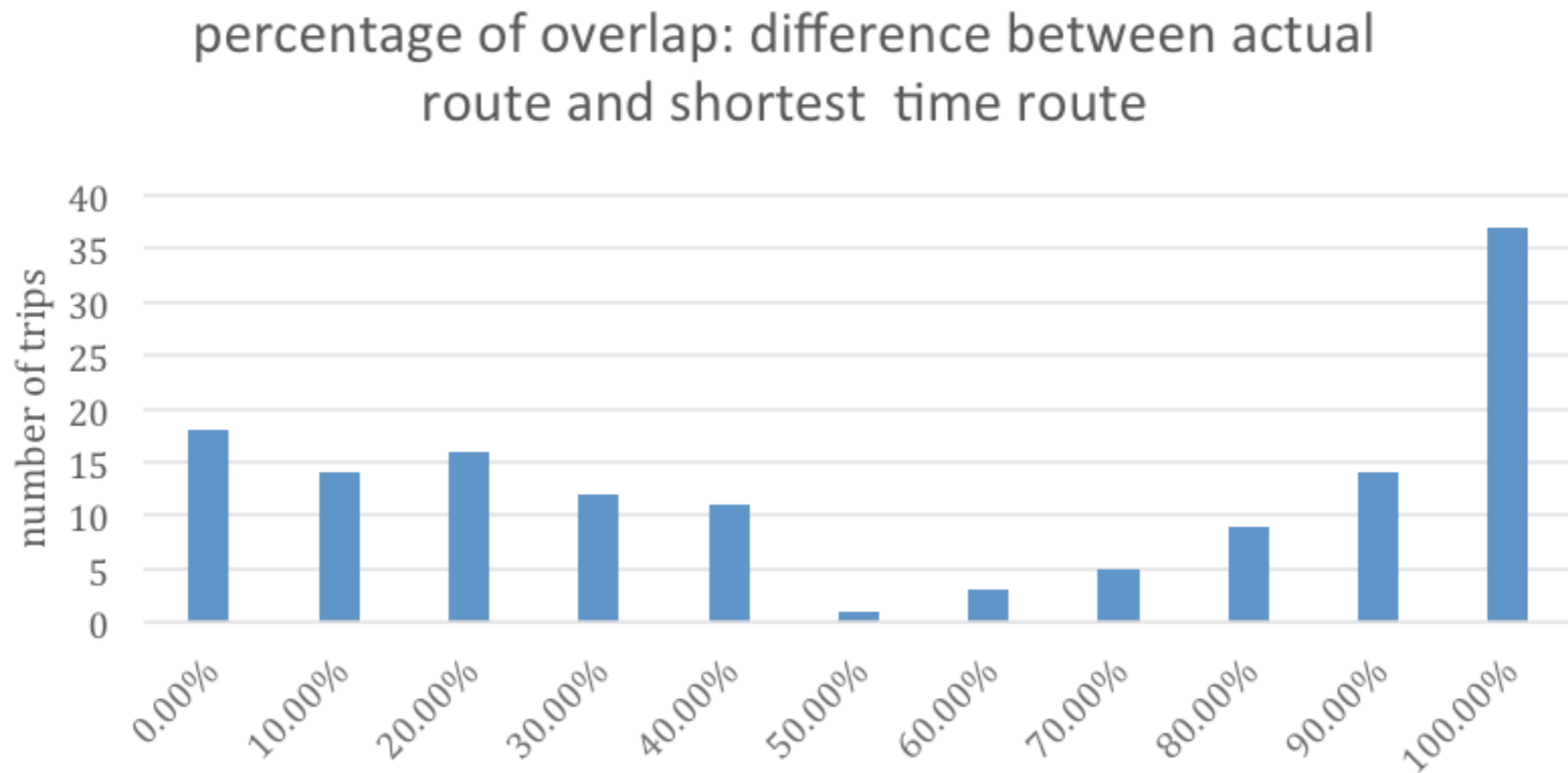Figure 11: Percentage of Overlap: Difference Between Actual Route and Shortest Travel Time Route

Figure 12: The Relationship Between Time Difference and Circuity (DNetwork/DEuclidean) of Actual Route.
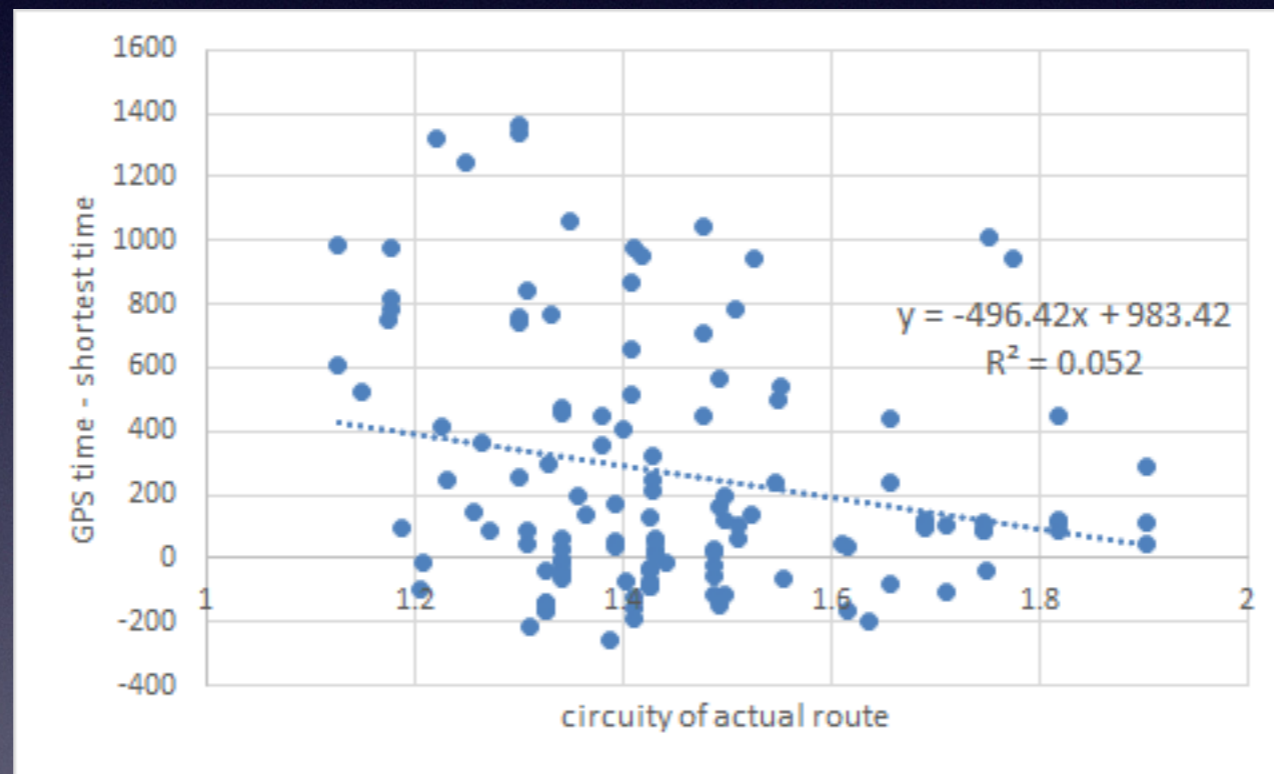
Figure 13: The Relationship Between Time Difference and Number of Turns on the Actual Route.
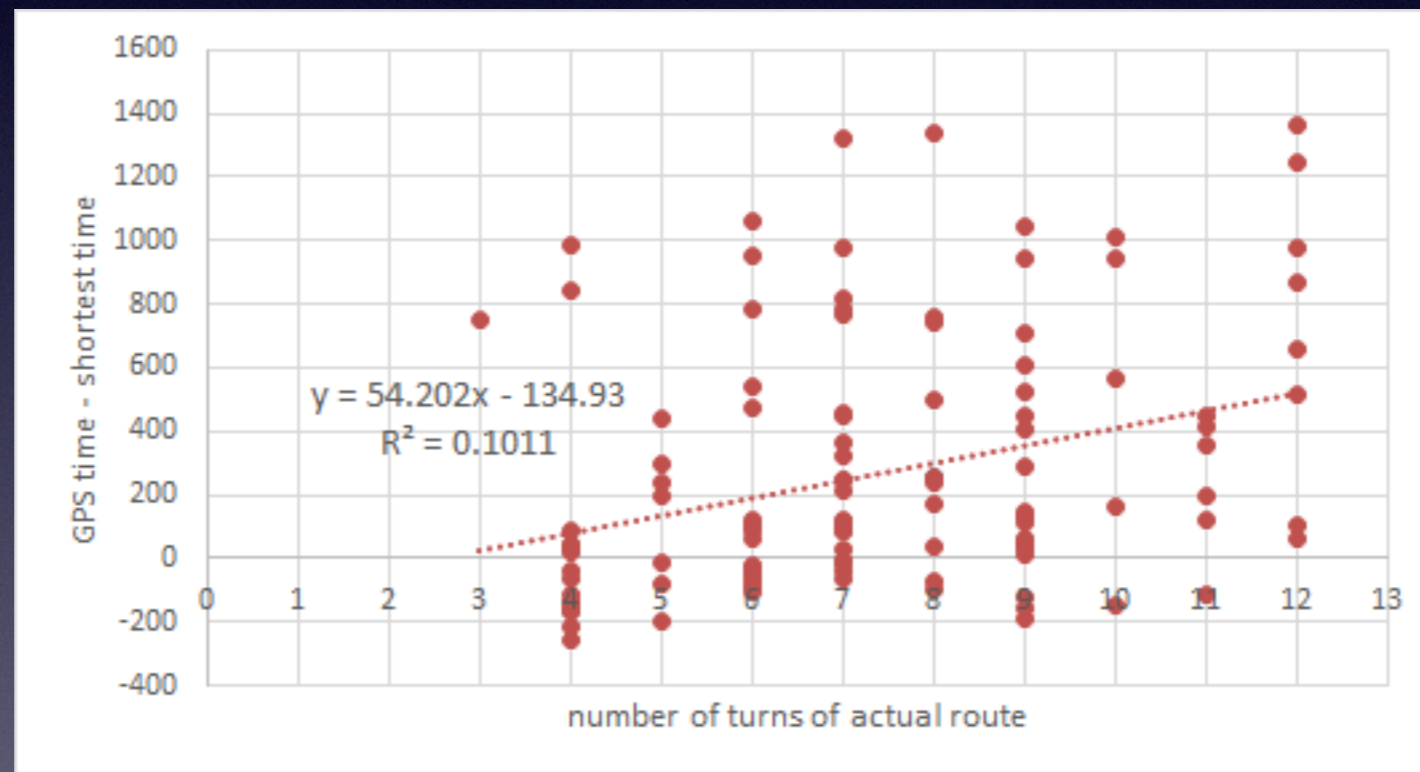
Table 5: Explaining τ, the ratio of GPS travel time to shortest path travel time

Independent Variables	Coef.	Std. Err.	t	P>|t|
Distancesp	-0.0000185	6.67E-06	-2.78	0.006
CircuityGPS	-0.6569722	0.3180107	-2.07	0.041
Circuitysp	-0.8381146	0.4148644	-2.02	0.046
TurnsGPS	0.0597149	0.0232824	2.56	0.012
Age i	-0.0096658	0.0049401	-1.96	0.053
Constant	3.684621	0.621362	5.93	0.000
Adjusted R^2	0.1457			
Sample Size (N)	124			

Conjectures: Why aren't people taking the shortest path

- Selflessness

- Rationality

- Perception

- Computation

- Information

- Valuation

- Objective

- Search Costs

- Route Quality

- Reliability

- Pleasure of Travel