

## APPENDIX D

### LIKE TRIP DETERMINATION AND ANALYSIS

This appendix describes the tools used in the like trip determination and data analysis processes. The chart types based on output obtained are as follows:

- Stratification of Like Trips,
- Like Trips Per Driver,
- ICC and Non-ICC Trips Per Driver,
- Trip Length Distribution,
- Trip Sets by Driver and ICC Usage, and
- Like Trips by Set Number.

These charts are described in this appendix and all charts are included in the final section.

#### D.1 Like Trip Determination Process

The difference in spatial location between trips for both origin and destination were categorized into four bins: 0.1 km, 0.5 km, 2 km and 111 km. The difference between start time of day for two trips was also divided into four bins: 0.25 hour, 1 hour, 6 hours, and 24 hours (no time of day restriction). The difference between trip lengths was subject to four divisions: 0.1 km, 1 km, 10 km and 1000 km. Each trip also met a minimum trip length criterion of one kilometer. Combination of the above factors produced 64 scenarios for analysis. The FORTRAN program SENSIV.EXE created these 64 scenarios and recorded them in SENSIV.DAT.

**Table D- 1 Output Format for SENSIV.DAT**

Field	Parameter	Description
1	Lat_tol1	Start Latitude Tolerance
2	Lat_tol2	End Latitude Tolerance
3	Lon_tol1	Start Longitude Tolerance
4	Lon_tol2	End Longitude Tolerance
5	Tod_tol1	Start Time of Day for Trip Tolerance
6	Tod_tol2	Start Time Allowance (24 - Tod_tol1)
7	Dis_tol	Total Trip Distance Tolerance
8	Dis_min	Minimum Trip Distance

The following is a section from the scenario data file SENSIV.DAT.

**Table D- 2 Sample Scenarios 40 through 50**

0.0045045	0.0045045	0.00610	0.00610	24.00	0.00	6.2150	0.622
0.0180180	0.0180180	0.02440	0.02440	0.25	23.75	6.2150	0.622
0.0180180	0.0180180	0.02440	0.02440	1.00	23.00	6.2150	0.622
0.0180180	0.0180180	0.02440	0.02440	6.00	18.00	6.2150	0.622
0.0180180	0.0180180	0.02440	0.02440	24.00	0.00	6.2150	0.622
1.0000000	1.0000000	1.00000	1.00000	0.25	23.75	6.2150	0.622
1.0000000	1.0000000	1.00000	1.00000	1.00	23.00	6.2150	0.622
1.0000000	1.0000000	1.00000	1.00000	6.00	18.00	6.2150	0.622
1.0000000	1.0000000	1.00000	1.00000	24.00	0.00	6.2150	0.622
0.0009009	0.0009009	0.00122	0.00122	0.25	23.75	621.500	0.622

As indicated above, trips were paired based upon driver number. The program TRIPTLR4.EXE produced a data file for each scenario (SCEN\_###.DAT) containing all paired like trips for that scenario. This program required two input files: SENSIV.DAT as described above and TRIP\_TAB.TXT. Table D- 3 shows the format for TRIP\_TAB.TXT and Table D- 4 shows the format for SCEN\_###.DAT.

**Table D- 3 Output Format for TRIP\_TAB.TXT**

Field	Data	Notes
0	Software Version	
1	Driver Number	
2	Trip Number	
3	Start Time	Fraction of Days since
4	End Time	30 Dec 1989
5	Duration	Minutes
6	Start Latitude	Degrees
7	Start Longitude	Degrees
8	Start Altitude	
9	End Latitude	Degrees
10	End Longitude	Degrees
11	End Altitude	
12	Trip Distance	Miles
13	Distance Engaged	Miles
14	ICC enabled	0 = manual, 1 = engaged

**Table D- 4 Format for SCEN\_##.DAT**

Field	Description
1	Driver Number
2	Trip 1 of Pair
3	Trip 2 of Pair

### D.1.1 Like Trip Determination Check

The accuracy of TRIPTLR4.EXE was determined by checking for like trip pairs using a spreadsheet. The program TRIPTLR4.EXE found the following trip pairs for driver 3:

**Table D- 5 Trip Pairs for Driver Three (TRIPTLR4.EXE)**

2	25
19	22
19	24
19	26
19	31
22	24
22	26
24	26
31	37

The spreadsheet example therefore compared the trips 2, 15, 17, 19, 22, 24, 25, 26, 31 and 37. The cell value equals 'NONE' if the pair of trips is not similar. The cell value equals 'trip length difference tolerance, TOD tolerance' met by pair otherwise. The spreadsheet cells obtained for the scenario 49 tolerance check are shown below.

**Table D- 6 Spreadsheet Trip Pair Analysis**

0.1 KM	2	15	17	19	22	24	25	26	31
2									
15	NONE								
17	NONE	NONE							
19	NONE	NONE	NONE						
22	NONE	NONE	NONE	0.0622, 0.25					
24	NONE	NONE	NONE	0.0622, 0.25	0.0622, 0.25				
25	6.215, 0.25	NONE	NONE	NONE	NONE	NONE	NONE		
26	NONE	NONE	NONE	0.0622, 0.25	0.0622, 0.25	0.0622, 0.25	NONE		
31	NONE	NONE	NONE	0.0622, 0.25	0.0622,1	0.0622,1	NONE	0.0622,1	
37	NONE	NONE	NONE	0.0622,1	0.0622,1	0.0622,1	NONE	0.0622,1	0.0622, 0.25

The trip length tolerance was recorded in miles and the time of day start tolerance was presented in hours. Scenario 49 required that the maximum trip length tolerance equal 1000 kilometers (621.5 miles) and the maximum start time of day tolerance be 0.25 hour. From the above spreadsheet the like trip pairs for scenario 49 are:

**Table D-7 Trip Pairs for Driver Three by Spreadsheet**

2	25
19	22
19	24
19	26
19	31
22	24
22	26
24	26
31	37

The pairs determined from the spreadsheet example are identical to the pairs given in the output file Scen\_49.dat for driver three.

Once trip pairs were identified for each driver, the pairs were assembled into groups of like trips. TRIPSRT2.EXE performed this group assembling using the scenario data files created by TRIPTLR4.EXE. The output files were NUMTRIPS.OUT which listed the number of like trips by scenario number and SCEN\_#.OUT which had the form shown in Table D- 8.

**Table D- 8 Format of SCEN\_#.OUT**

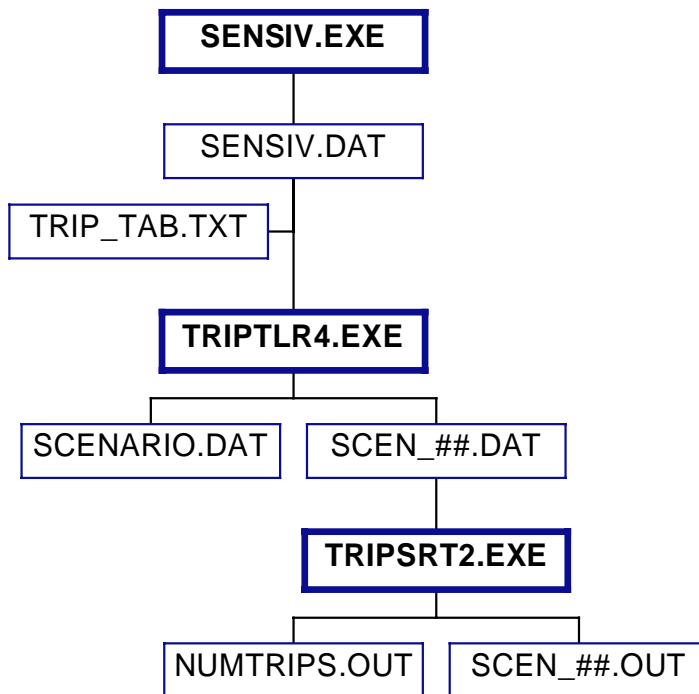
Field	Description
1	Driver Number
2	Set Number (Reset for Each Driver)
3	Number of Like Trips In Set
4 +	Trip Numbers

The like trip sets can be determined using the above spreadsheet for example driver three. Note that only trips 2 and 25 have a trip length tolerance of 6.215. All of the other trip pairs have trip length tolerances of 0.0622. Therefore there are two sets, one with trips 2 and 25 and the other with the remaining trips – 19, 22, 24, 26, 31, and 37. This matches the output found in SCEN\_49.OUT for driver three.

**Table D- 9 SCEN\_49.OUT Output (Driver Three)**

3	1	2	2	25				
3	2	6	19	22	24	26	31	37

A summary of the like trip determination process is presented in Figure D- 1 below.

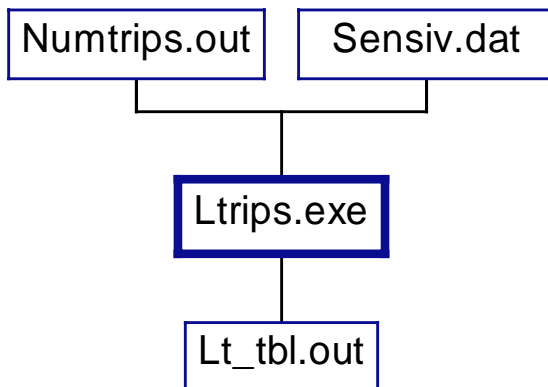


**Figure D- 1 Like Trip Determination Process**

## **D.2 Intelligent Cruise Control Data Analysis**

### *D.2.1 Like Trips Tables*

The program **LTRIPS.EXE** assembled **NUMTRIPS.OUT** (like trips by scenario number) into table format. The output **LT\_TBL.OUT** was used to create the stratification graphs. The like trips table creation process is summarized Figure D- 2.



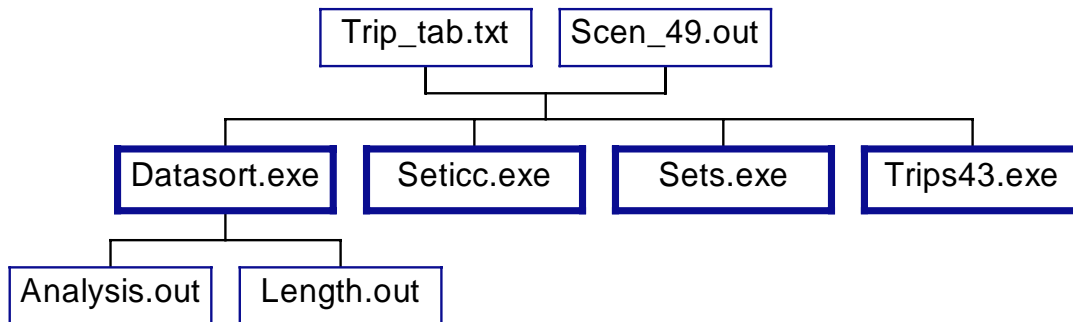
**Figure D- 2 Like Trips Table Creation Process**

#### *D.2.2 Scenario 49 Data Analysis*

Scenario 49 was chosen for further analysis. As described earlier, the most rigorous like trip criteria was used since 1309 like trips were available. Therefore the spatial location of origin and destination tolerance was 0.1 km and the trip start time difference tolerance was 0.25 hour. The trip length difference tolerance was kept at its maximum value of 1000 km and the minimum trip length criterion was 1 km.

The analysis used four executables: DATASORT.EXE, SETICC.EXE, SETS.EXE, and TRIPS43.EXE. Each of these programs required the TRIP\_TAB.TXT and SCEN\_49.OUT files as input. This process is presented below in Figure D- 3.





**Figure D- 3 Scenario 49 Data Analysis Process**

Although not indicated in the figure above, the output files for SETICC.EXE, SETS.EXE and TRIPS43.EXE are SETICC.OUT, SETS.OUT and TRIPS43.OUT respectively. (Each of the above programs required that the number of lines be added as the first line of the SCEN\_49.OUT file.)

**DATASORT.EXE** This program created nine output files. ANALYSIS.OUT and LENGTH.OUT were used for the output in this report. ANALYSIS.OUT recorded the number of ICC and Non-ICC trips by driver and counted trips by driver into trip distance and duration bins. LENGTH.OUT counted trips by driver and ICC usage into trip length bins.

**Table D- 10 Output Format of ANALYSIS.OUT**

Field	Description
1	J = 1,2,3,...,15 as described below
2	Driver Number
3	Count(Driver, J)

**Table D- 11 J-Values of ANALYSIS.OUT**

J Value	Description
1	Number of Similar Trips
2	ICC Trips
3	Non-ICC Trips
4	Trip Length 0 – 10 km
5	Trip Length 10 – 50 km
6	Trip Length 50 – 100 km
7	Trip Length 100 – 500 km
8	Trip Length 500 – 1000 km
9	Trip Distance Tolerance 0 – 10 km
10	Trip Distance Tolerance 10 – 50 km
11	Trip Distance Tolerance 50 – 100 km
12	Trip Distance Tolerance 100 – 500 km
13	Trip Distance Tolerance 500 – 1000 km
14	Total ICC Trips
15	Total Non-ICC Trips

**Table D- 12 Output Format of LENGTH.OUT**

Field	Description
1	J = 1,2,3,...,10 as described below
2	Driver Number
3	Count(Driver, J)

**Table D- 13 J-Values of LENGTH.OUT**

J Value	Description
1	ICC Trip Length 0 – 10 km
2	ICC Trip Length 10 – 50 km
3	ICC Trip Length 50 – 100 km
4	ICC Trip Length 100 – 500 km
5	ICC Trip Length 500 – 1000 km
6	Non-ICC Trip Length 0 – 10 km
7	Non-ICC Trip Length 10 – 50 km
8	Non-ICC Trip Length 50 – 100 km
9	Non-ICC Trip Length 100 – 500 km
10	Non-ICC Trip Length 500 – 1000 km

**SETICC.EXE** This program produced the output SETICC.OUT. SETICC.EXE recorded the number of ICC and Non-ICC trips according to driver and set number.

**Table D- 14 SETICC.OUT**

Field	Description
1	Driver Number
2	Set Number
3	Number of ICC Like Trips
4	Number of Non-ICC Like Trips

**SETS.EXE** produced the output SETS.OUT. SETS.EXE recorded the number of sets for each driver with greater than one ICC trip, greater than one Non-ICC trip and number of sets with at least one of each ICC and Non-ICC trip.

**Table D- 15 SETS.OUT**

Field	Description
1	Driver Number
2	Number of Sets For Driver
3	Number of Sets With More Than 1 Non-ICC Trip
4	Number of Sets With More Than 1 ICC Trip
5	Number of Sets with More Than 1 ICC and Non-ICC Trips

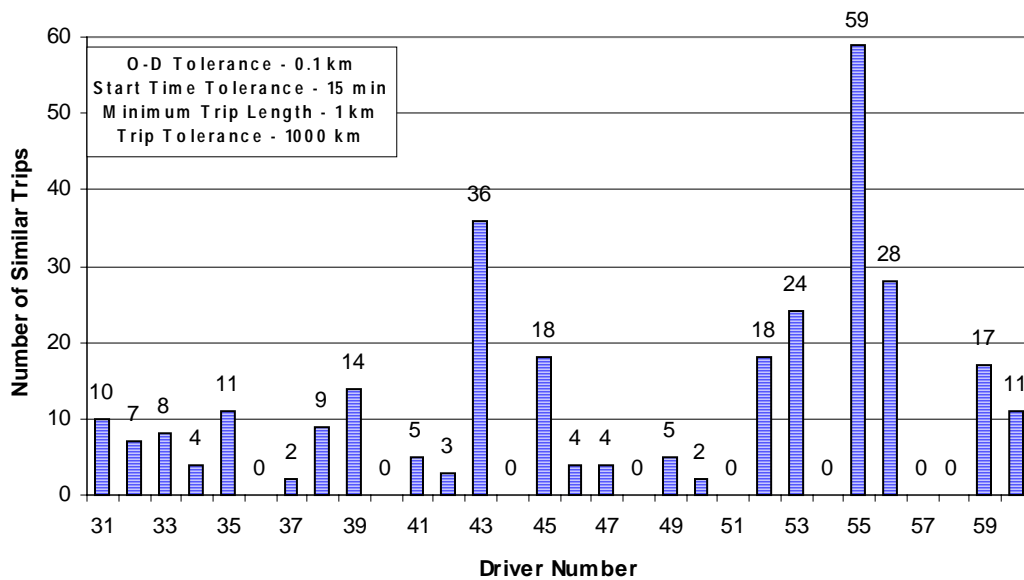
**TRIPS43.EXE** produced the output file TRIPS43.OUT. TRIPS43.EXE recorded the length and duration of each ICC and Non-ICC trip for driver 43.

**Table D- 16 TRIPS43.OUT**

Field	Description
1	Driver Number
2	Set Number
3	Trip Number
4	ICC Flag (Flag = 1 if ICC used, Flag = 0 otherwise)
5	Length of Trip
6	Duration of Trip

**D.2.3 Like Trips Per Driver**

As seen in Figure D- 4 below, the number of like trips was found on a driver basis. From these results drivers with a greater number of like trips were identified. From Figure D- 4 it seems that drivers 43 and 55 may be candidates for further detailed analysis. Drivers 66, 76, 78, 79, 81, 85, 88, 89, 96 and 104 all performed more than 30 like trips.



**Figure D- 4 Number of Like Trips for Driver 31 Through Driver 60**

D.2.4 ICC and Non-ICC Like Trips Per Driver

The like trips per driver were separated into ICC and non-ICC trips as shown in Figure D- 5. From these charts it can be determined which drivers make the most like trips and which drivers make the most ICC and non-ICC like trips. Both drivers 43 and 55 made ICC and non-ICC trips. Driver 43 made 20 ICC trips and 16 non-ICC like trips while driver 55 made 20 ICC and 39 non-ICC like trips. Both drivers could be considered further since they both performed a large number of both ICC and non-ICC trips. Driver 79 as mentioned in the previous section, performed 4 ICC and 30 non-ICC like trips. A detailed analysis on this driver would therefore not be desired.

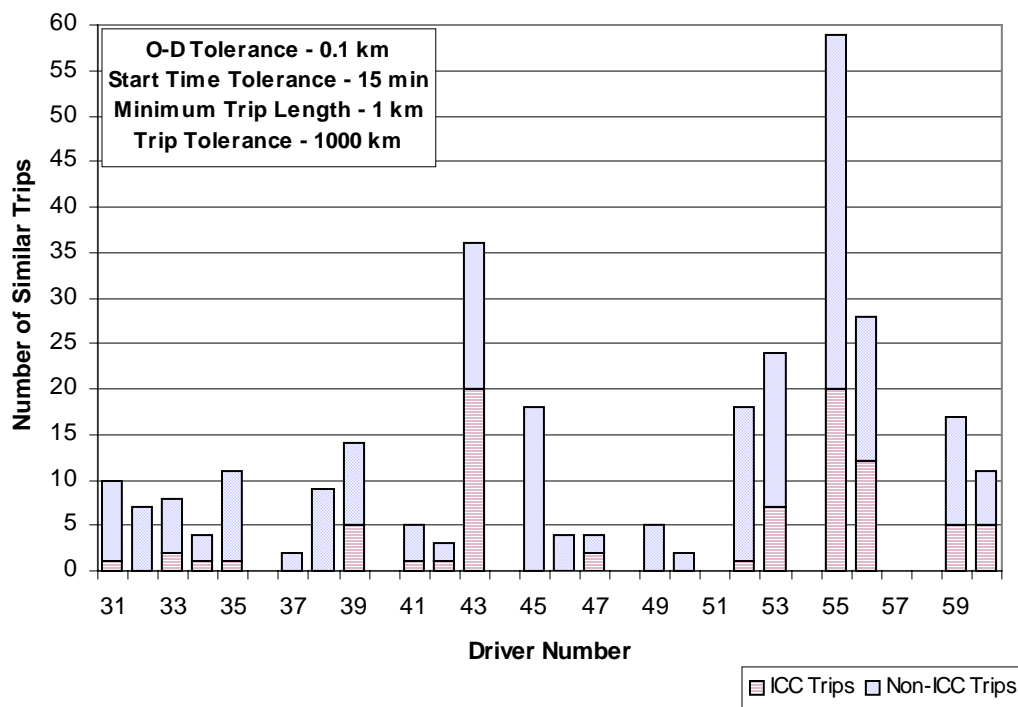
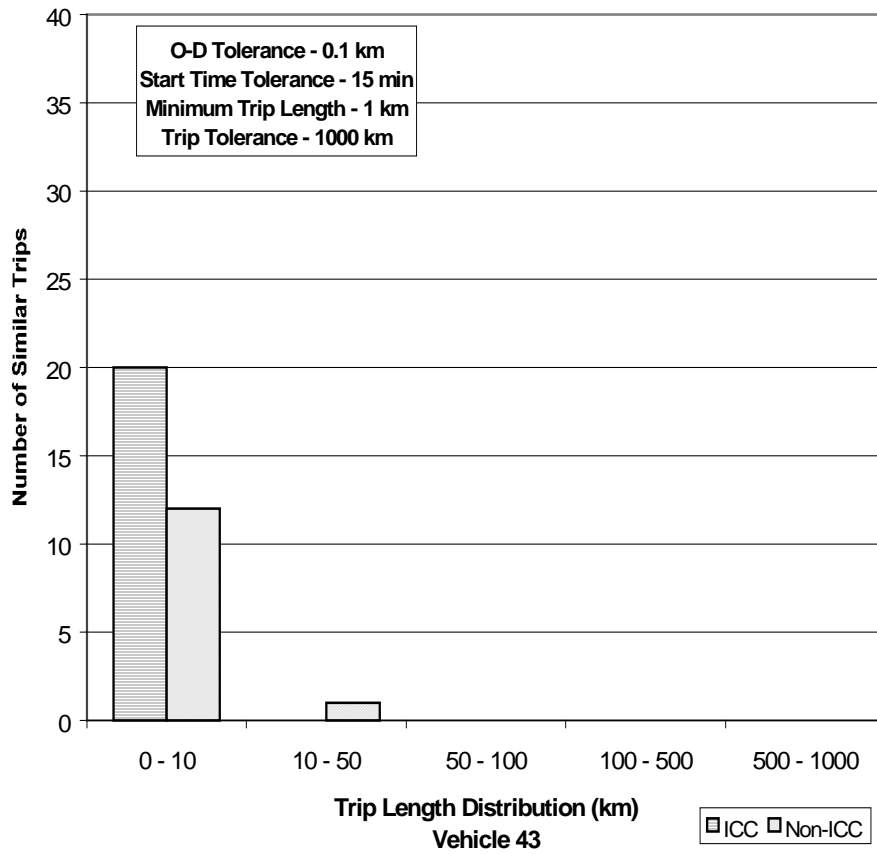


Figure D- 5 ICC and Non-ICC Like Trips - Driver 31 through Driver 60

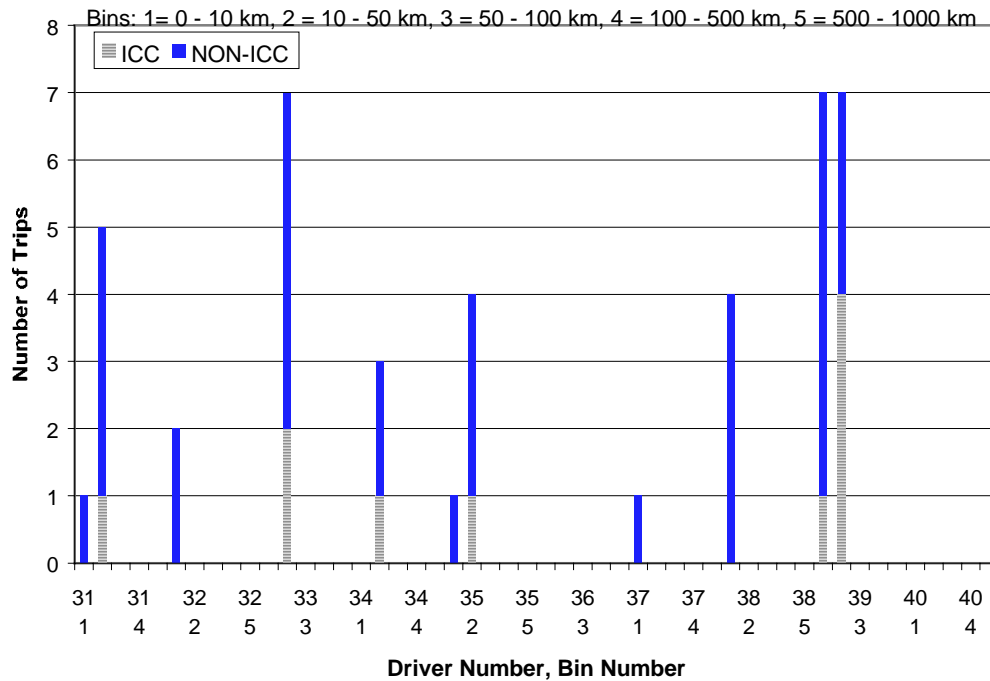
D.2.5 Trip Length Distribution

As Figure D- 6 indicates, 32 out of 33 like trips made by driver 43 were less than 10 km in length. Driver 43 performed both ICC and Non-ICC trips at this distance.



**Figure D- 6 Trip Length Distribution of Like Trips for Driver 43**

Trip length distributions were determined for all drivers based on Intelligent Cruise Control usage and five trip-length bins. Figure D- 7 shows the trip length distributions for drivers 31 through 40.



**Figure D- 7 Trip Length Distribution for Drivers 31 through 40**

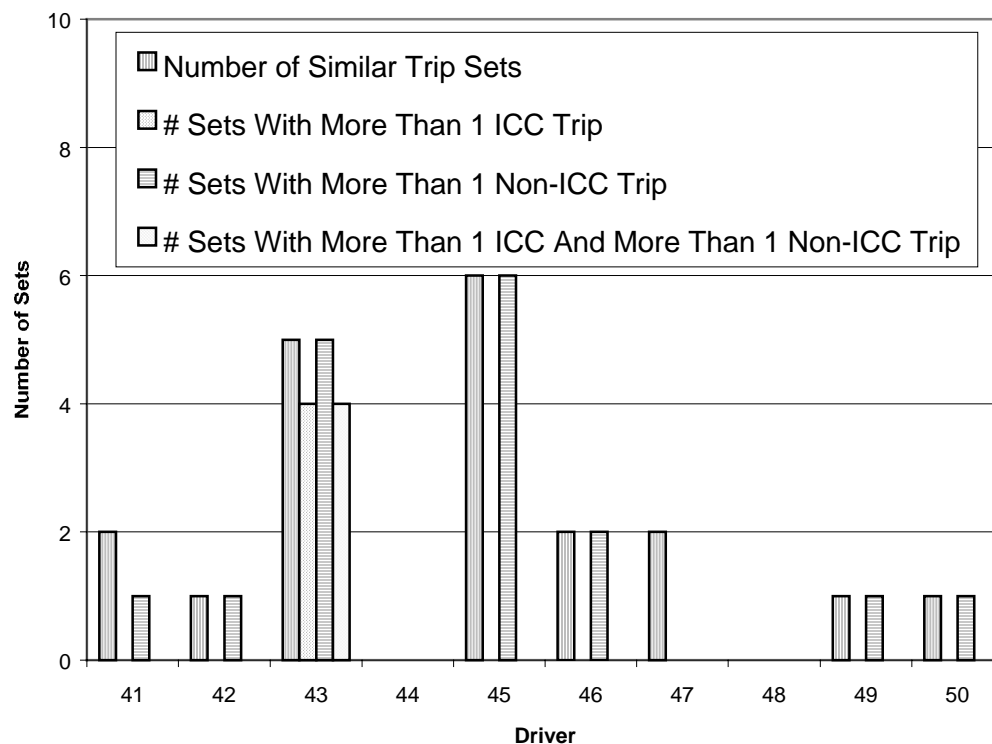
As seen in the above figure, all trips were less than 50 km in length for drivers 31 through 40. There were, however, 15 drivers who performed trips over 50 km. There were no like trips recorded for trip distances over 500 km.

The usage of ICC varied among drivers, as expected. Drivers who made trips across several bins may have followed certain patterns, but not always. Driver 53, for example, made both ICC and Non-ICC like trips across bins one, two and three. Driver 55 made both ICC and Non-ICC like trips under 50 km in length but for trips which fall into bin 4 (100 – 500 km) all trips were ICC trips. Other drivers tended to not use ICC for shorter trips. Drivers 76, 84, 103 and 111 did not use ICC in their trips of 10 km or less. Driver 92, however, only made ICC like trips under 10 km.

Drivers 76, 78, 92 and 103 made both ICC and non-ICC like trips for their trips that were greater than 10 km in length. Driver 111 as mentioned above performed non-ICC like trips only under 10 km in length. Like trips which were 10 – 50 km in length were all ICC and then trips of lengths 50 – 100 km were both ICC and non-ICC. Therefore there is no definite trend in ICC usage based upon trip length.

**D.2.6 Trip Sets by Driver and ICC Usage**

Until now like trips have been divided based upon driver number. In the next two sections trips are categorized by driver and set number.



**Figure D- 8 Sets by driver and ICC usage – drivers 40 through 50**

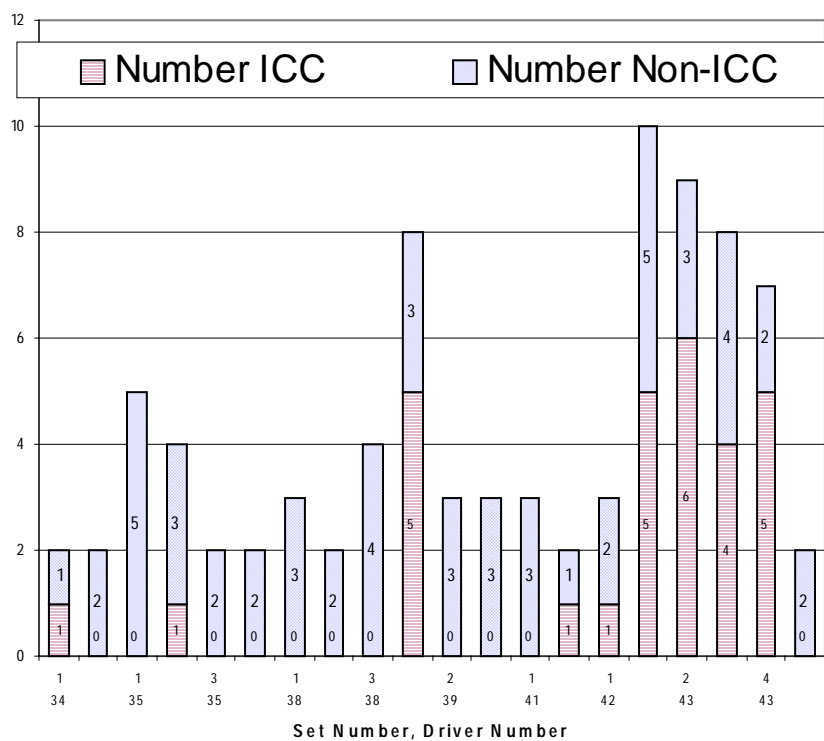
The above chart is useful in determining which drivers have the most sets of like trips with both ICC and non-ICC like trips. Driver 43 above had five similar trip sets with four having more than one of each ICC and non-ICC like trips. From the previously



mentioned drivers, only three had more than one set of like trips containing both ICC and non-ICC trips. Driver 43 had four sets, driver 76 had three sets and driver 104 had two sets. Drivers 78, 85, 88 and 96 did not have any sets with both ICC and non-ICC trips. Drivers 55, 66, 81, and 89 each had one set with ICC and non-ICC trips.

**D.2.7 Like Trips by Set Number**

As mentioned in the previous section, driver 43 had four like trip sets that had more than one ICC and Non-ICC trip. Figure D- 9 shows the exact number of trips in each set by ICC usage. For example, set one of driver 43 had 5 ICC trips and 5 Non-ICC trips.



**Figure D- 9 Like Trips Based on Driver and Set Number - Drivers 34 to 43**

### D.3 Complete Set of Output Charts

#### D.3.1 Like Trips per Driver

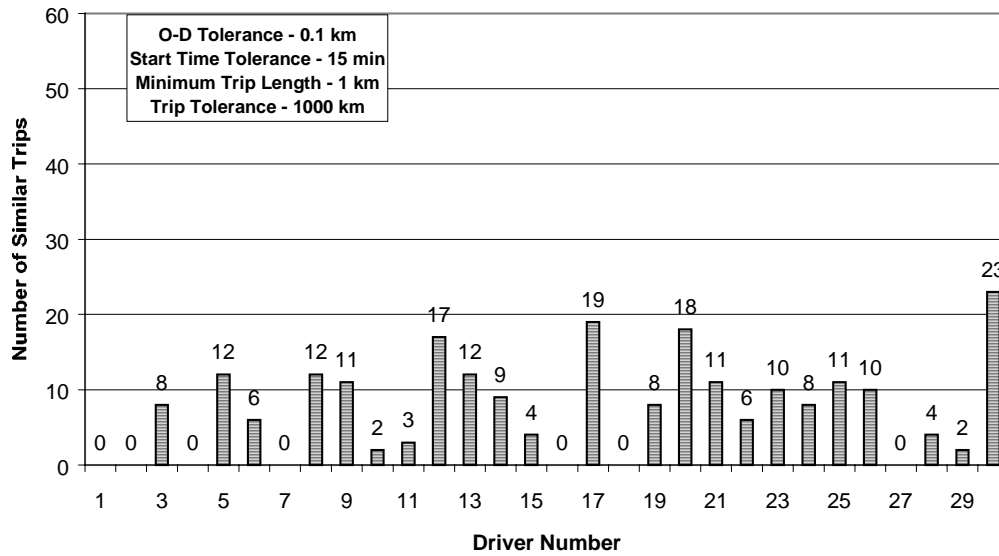


Figure D- 10 Number of Similar Trips Per Driver (Drivers 1 through 30)

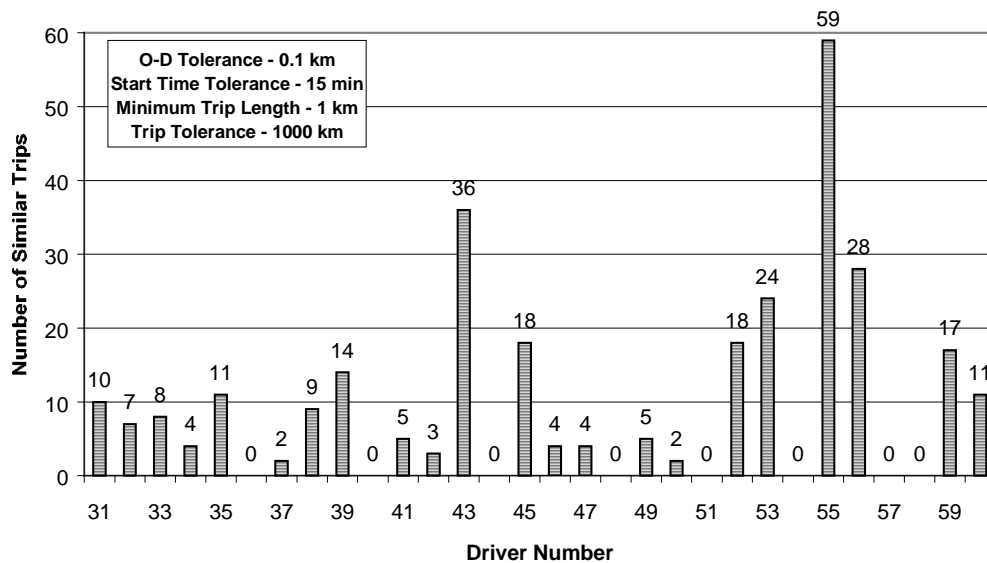


Figure D- 11 Number of Similar Trips Per Driver (Drivers 31 through 60)

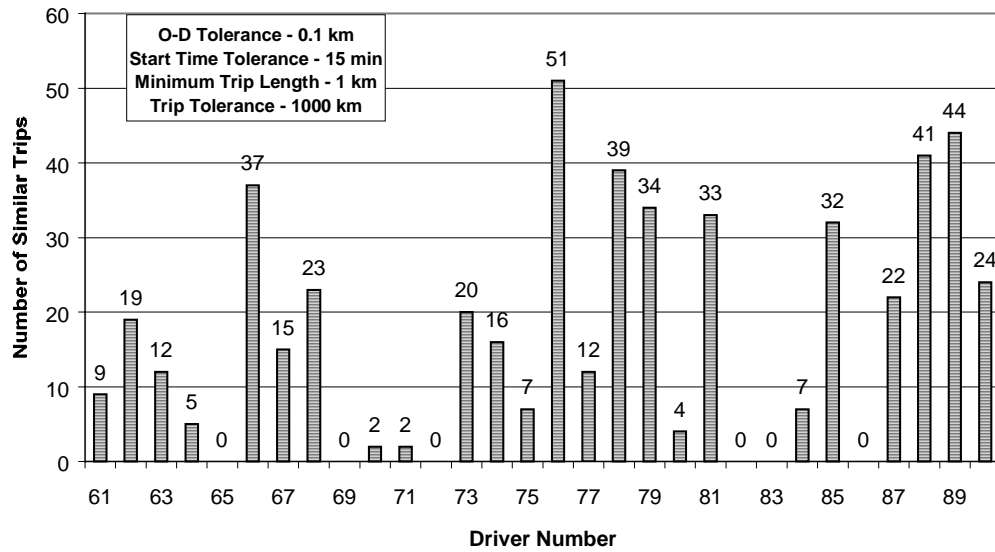


Figure D- 12 Number of Similar Trips Per Driver (Drivers 61 through 90)

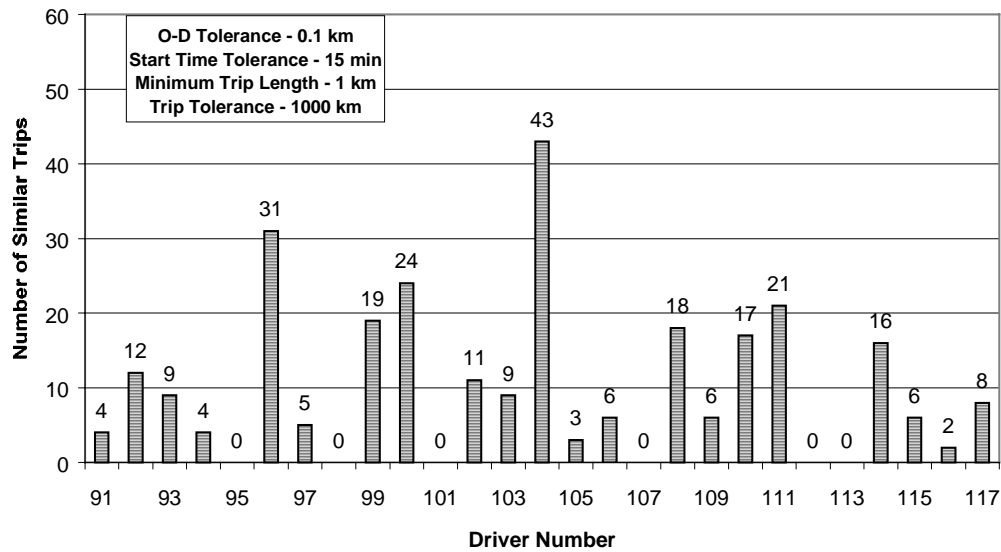


Figure D- 13 Number of Similar Trips Per Driver (Drivers 91 through 117)

D.3.2 ICC and Non-ICC Like Trips Per Driver

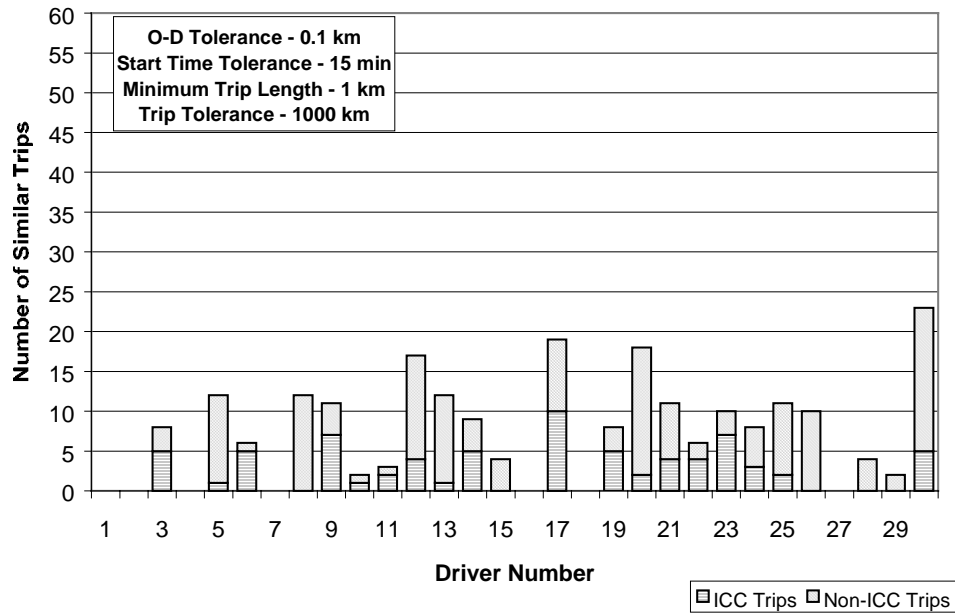


Figure D- 14 ICC and Non-ICC Similar Trips (Drivers 1 through 30)

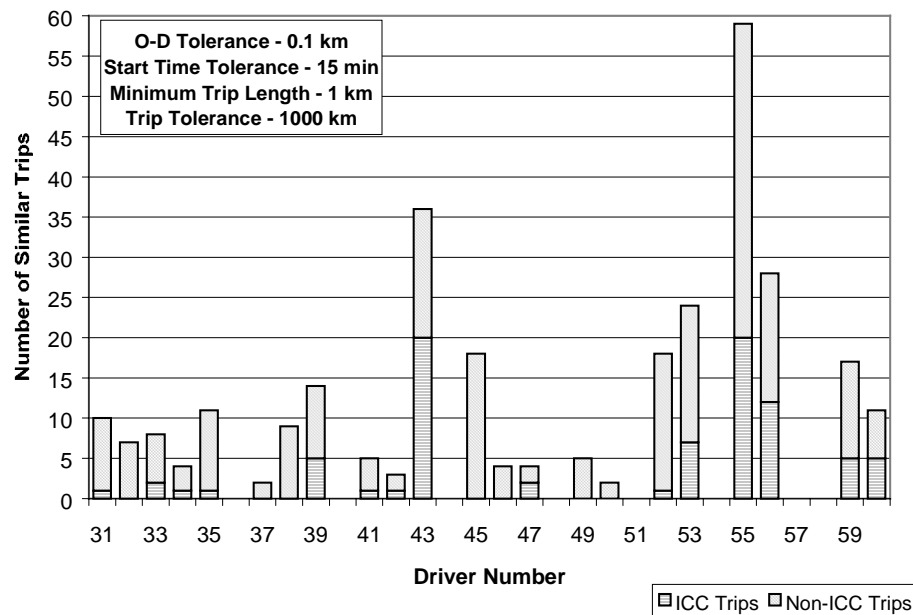


Figure D- 15 ICC and Non-ICC Similar Trips (Drivers 31 through 60)

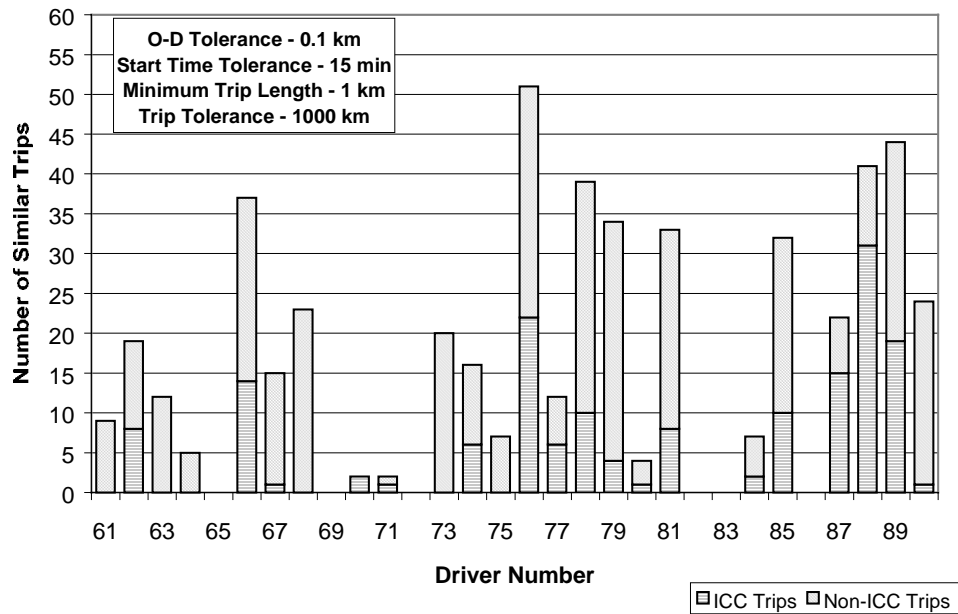


Figure D- 16 ICC and Non-ICC Similar Trips (Drivers 61 through 90)

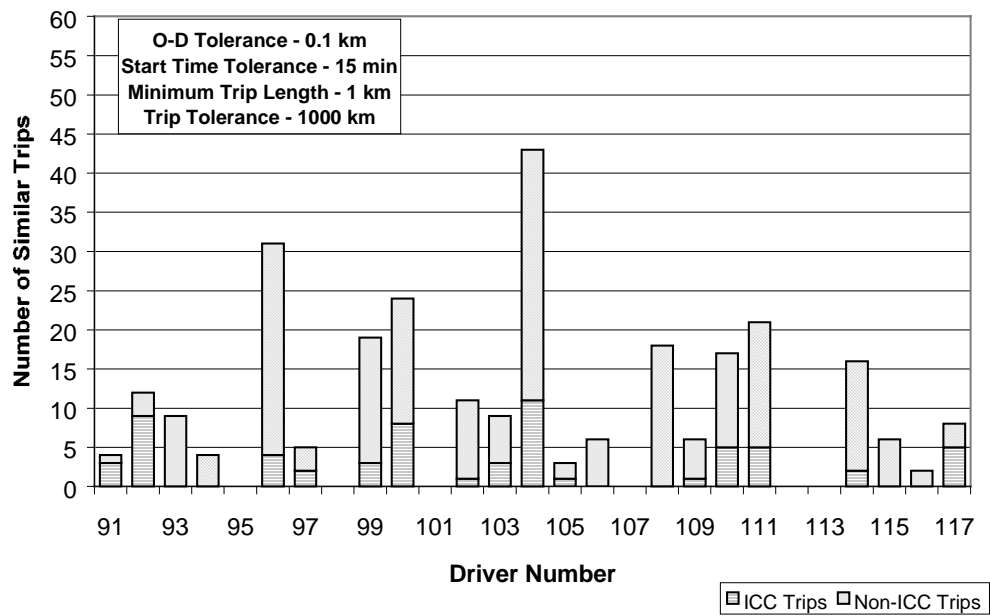


Figure D- 17 ICC and Non-ICC Similar Trips (Drivers 91 through 117)

D.3.3 Trip Length Distribution

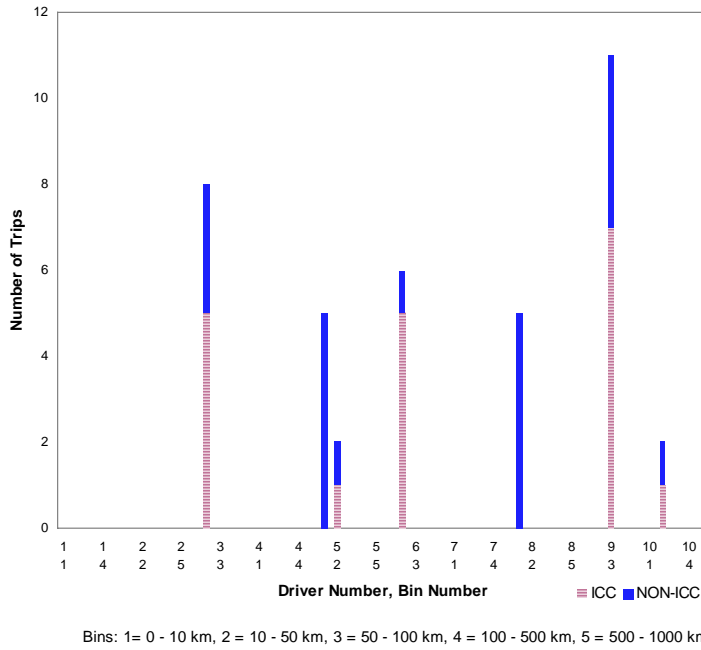


Figure D- 18 Trip Length Distribution (Drivers 1 through 10)

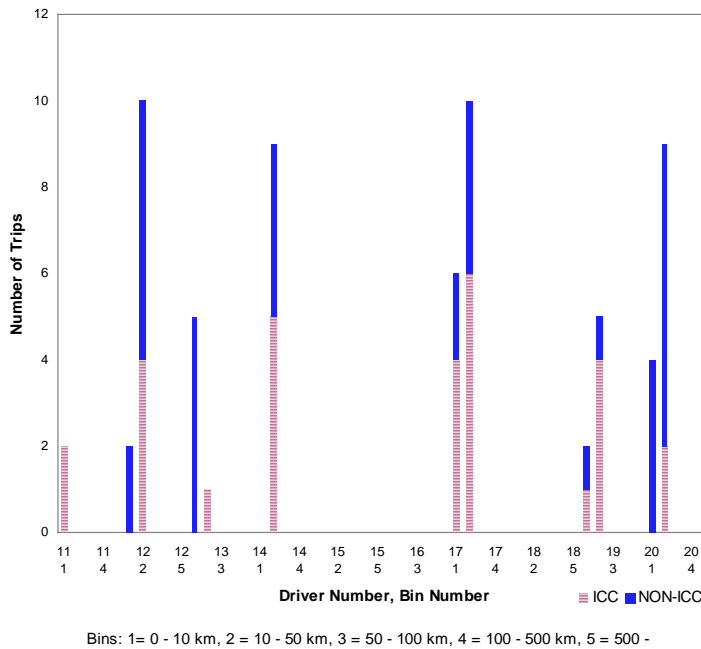


Figure D- 19 Trip Length Distribution (Drivers 11 through 20)

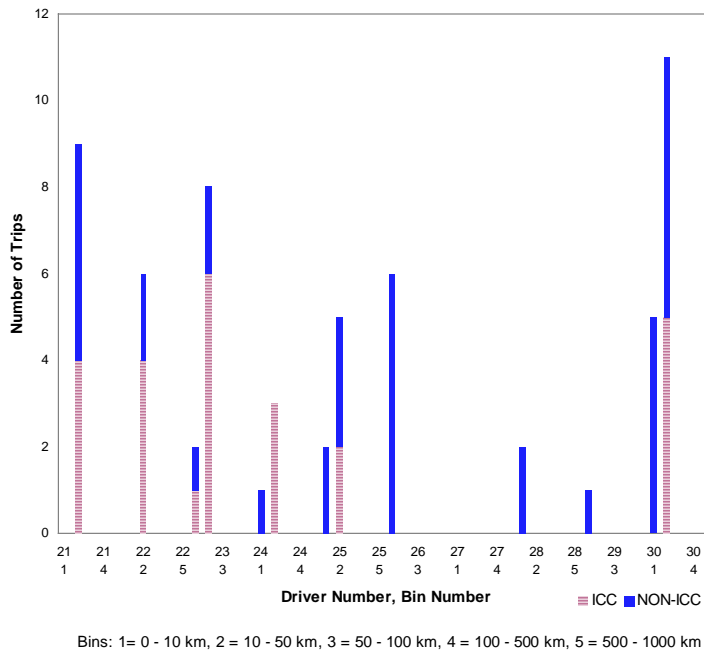


Figure D- 20 Trip Length Distribution (Drivers 21 through 30)

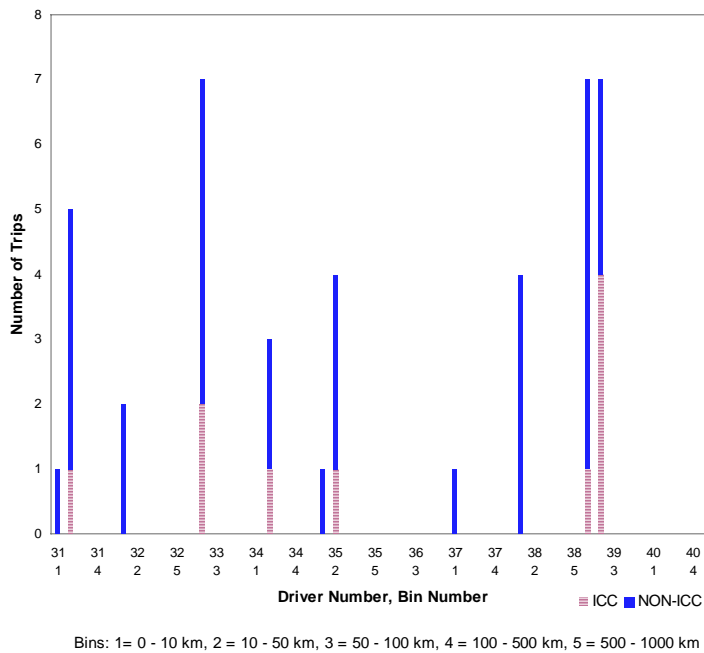


Figure D- 21 Trip Length Distribution (Drivers 31 through 40)

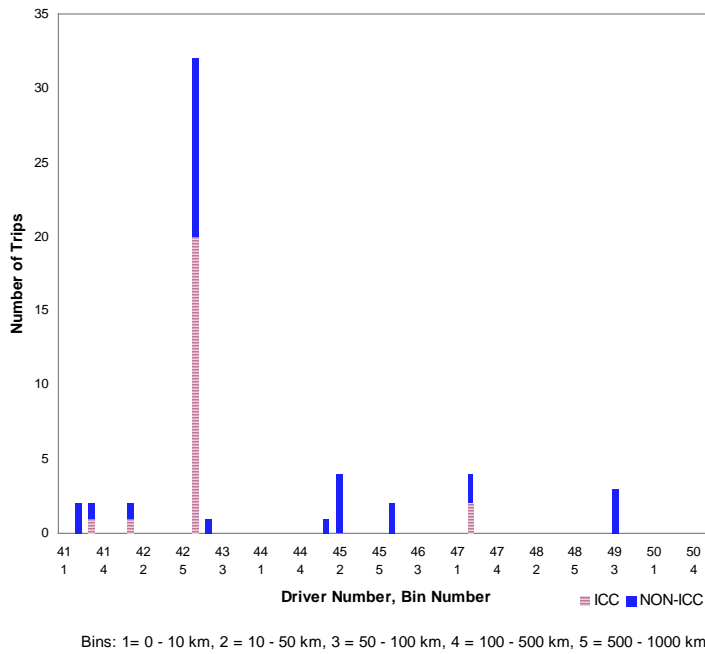


Figure D- 22 Trip Length Distribution (Drivers 41 through 50)

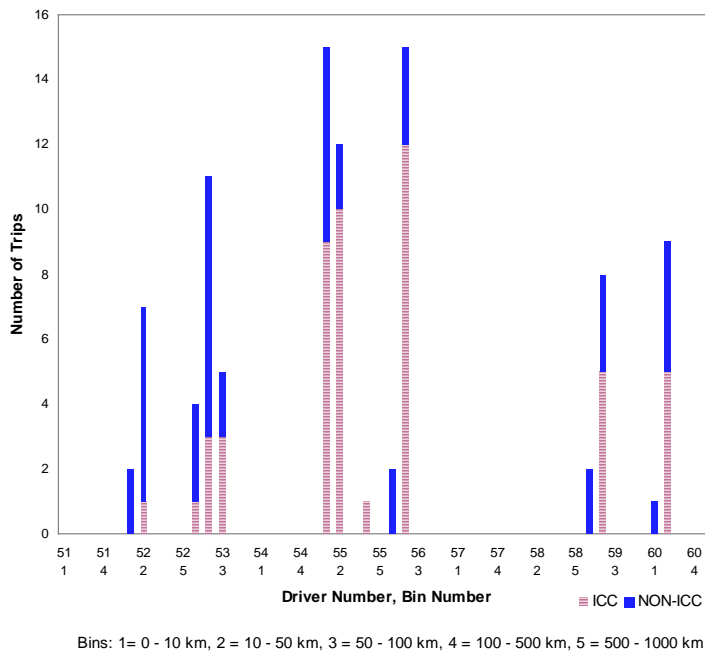


Figure D- 23 Trip Length Distribution (Drivers 51 through 60)



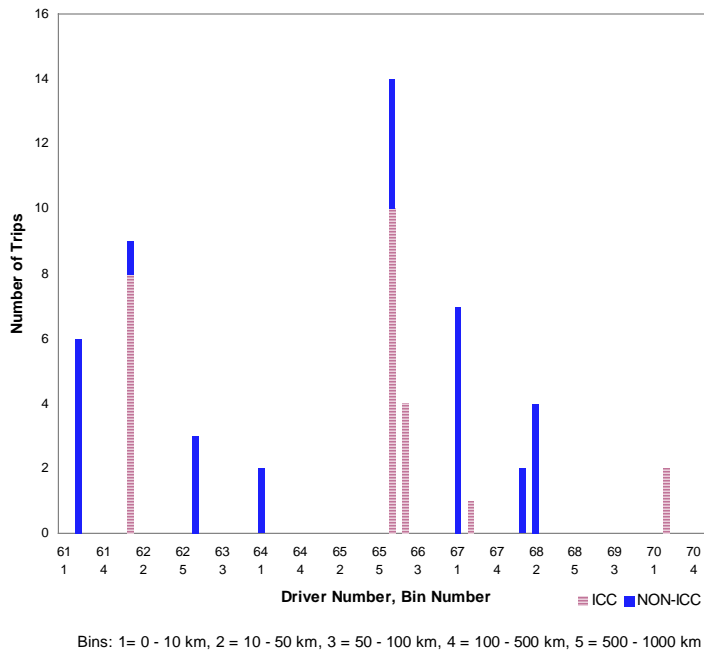


Figure D- 24 Trip Length Distribution (Drivers 61 through 70)

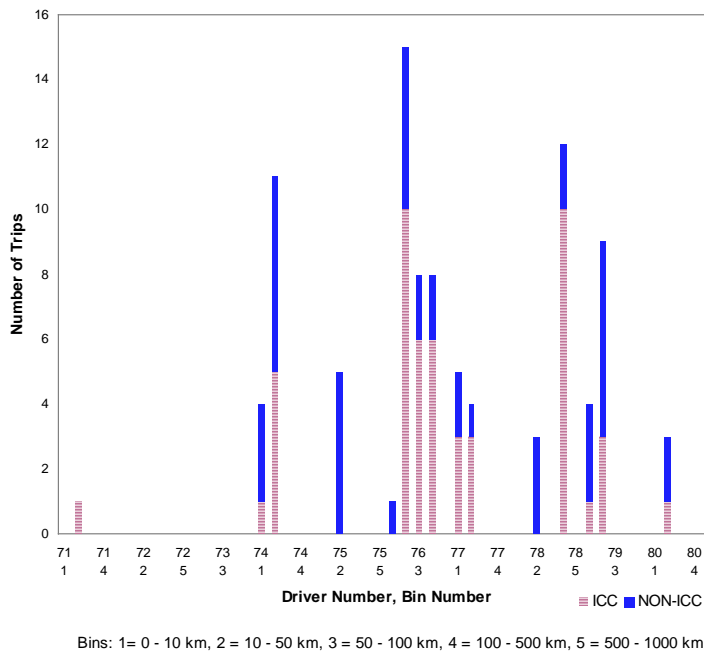


Figure D- 25 Trip Length Distribution (Drivers 71 through 80)

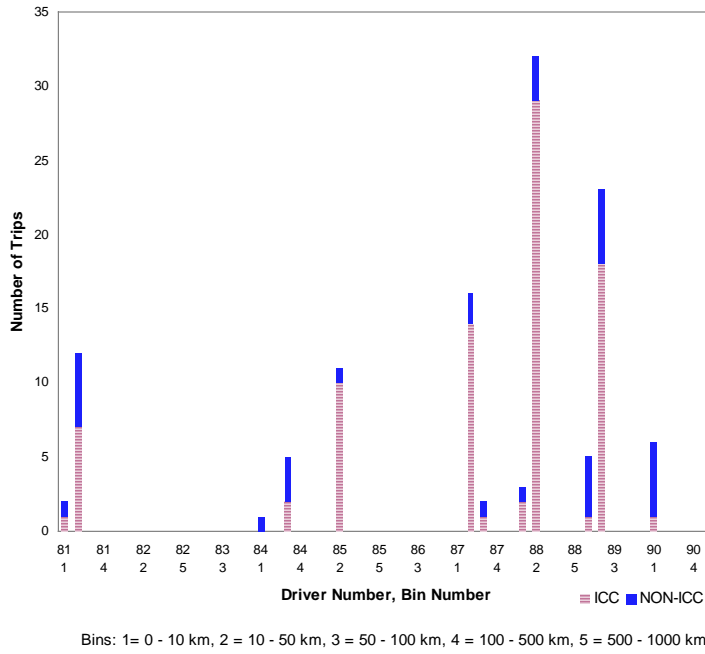


Figure D- 26 Trip Length Distribution (Drivers 81 through 90)

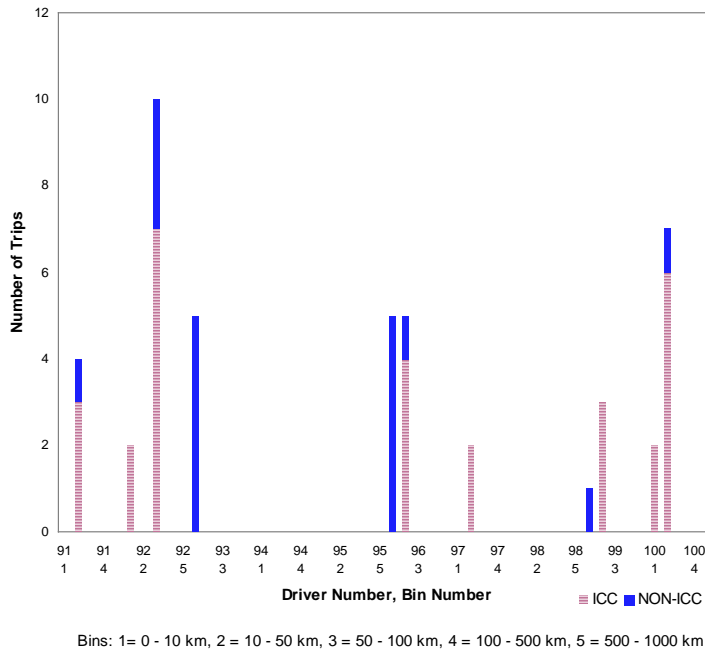


Figure D- 27 Trip Length Distribution (Drivers 91 through 100)

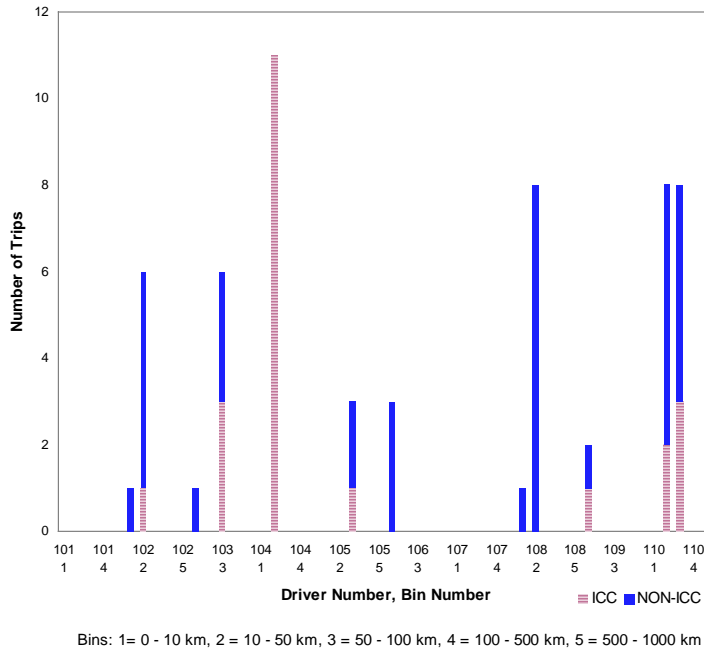


Figure D- 28 Trip Length Distribution (Drivers 101 through 110)

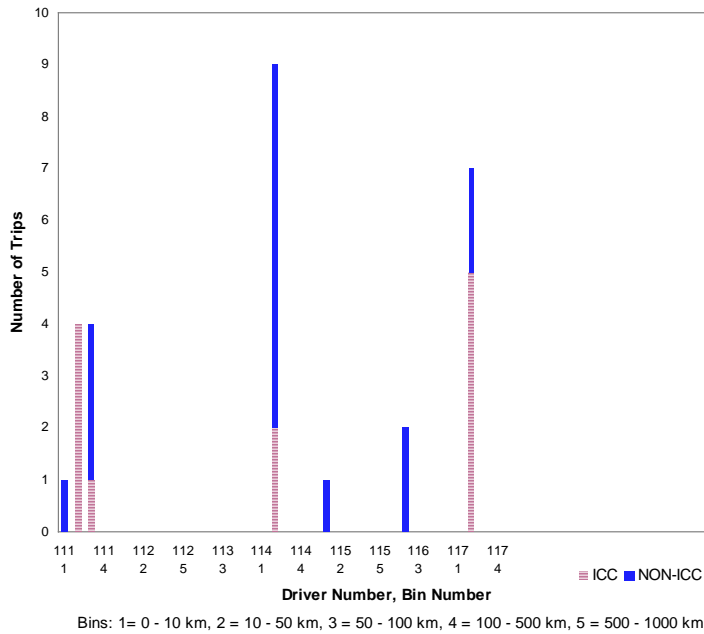


Figure D- 29 Trip Length Distribution (Drivers 111 through 117)

D.3.4 Trip Sets by Driver and ICC Usage

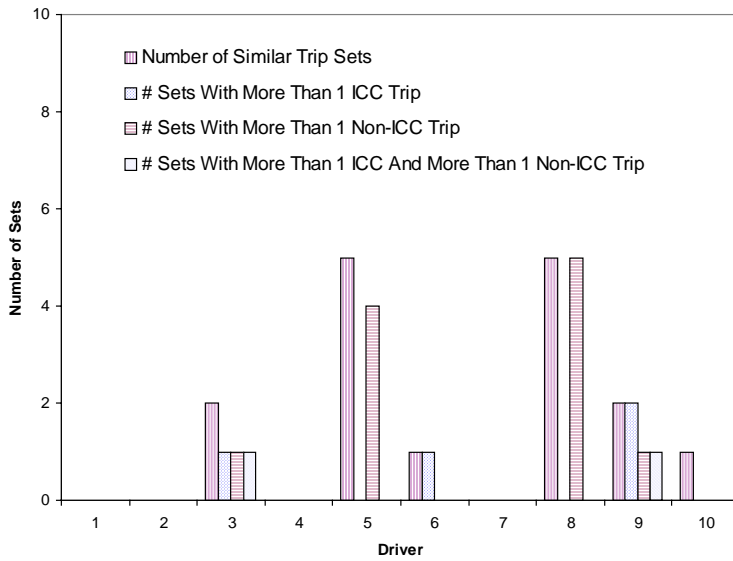


Figure D- 30 Trip Sets by ICC Usage (Drivers 1 through 10)

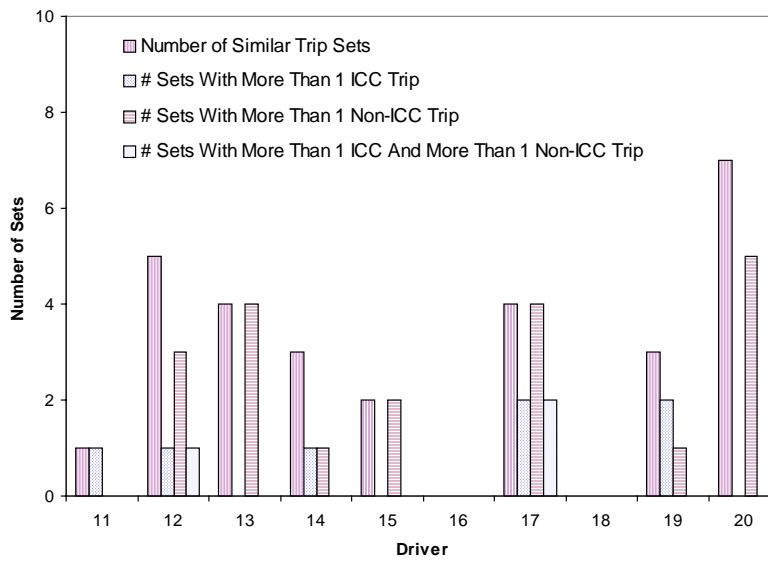


Figure D- 31 Trip Sets by ICC Usage (Drivers 11 through 20)

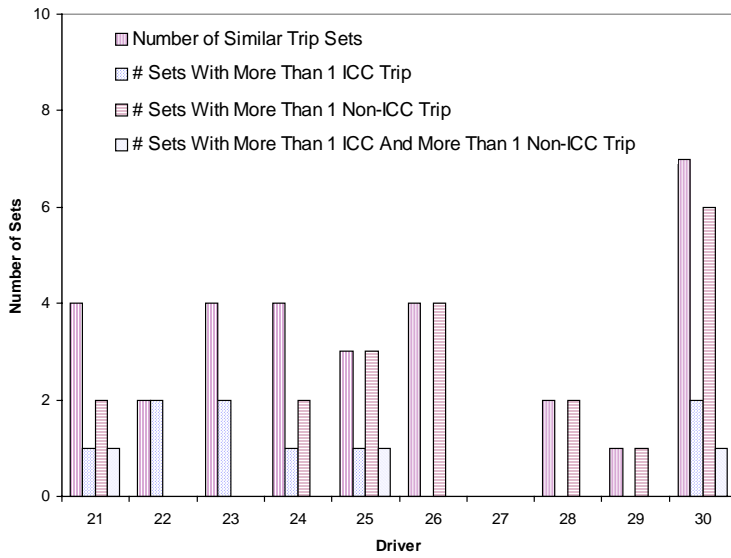


Figure D- 32 Trip Sets by ICC Usage (Drivers 21 through 30)

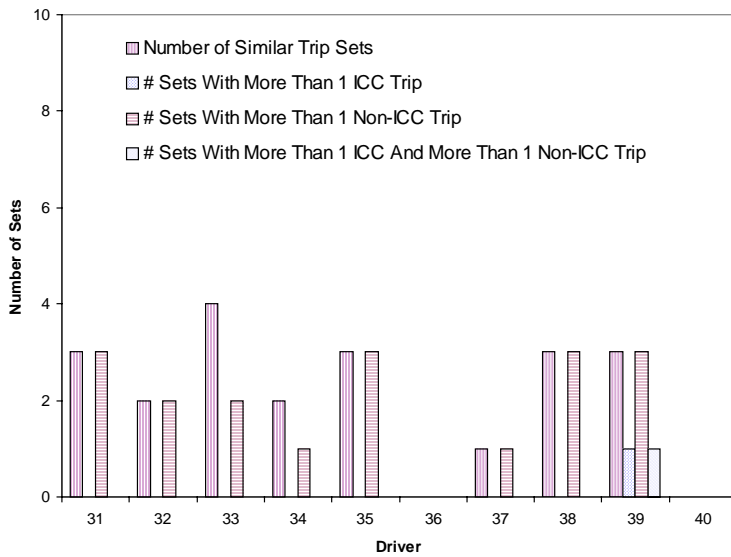


Figure D- 33 Trip Sets by ICC Usage (Drivers 31 through 40)

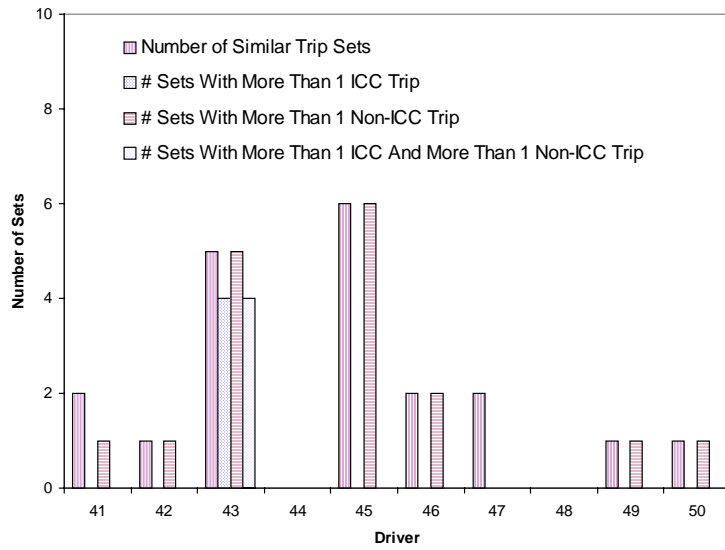


Figure D- 34 Trip Sets by ICC Usage (Drivers 41 through 50)

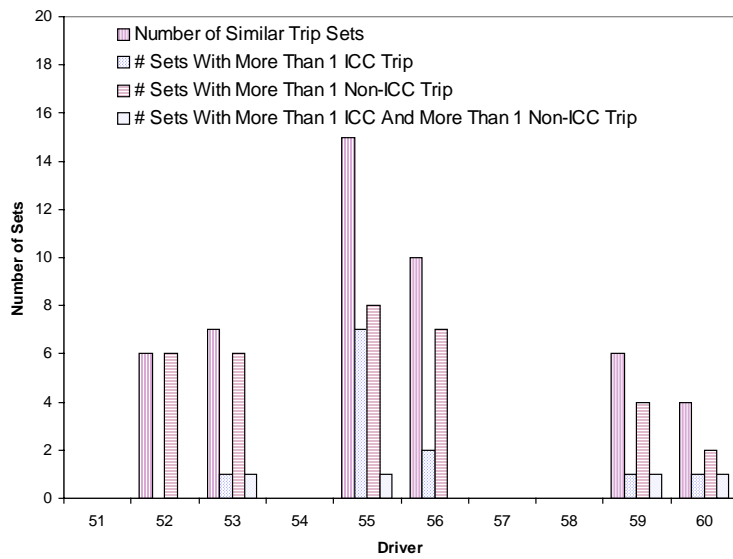


Figure D- 35 Trip Sets by ICC Usage (Drivers 51 through 60)

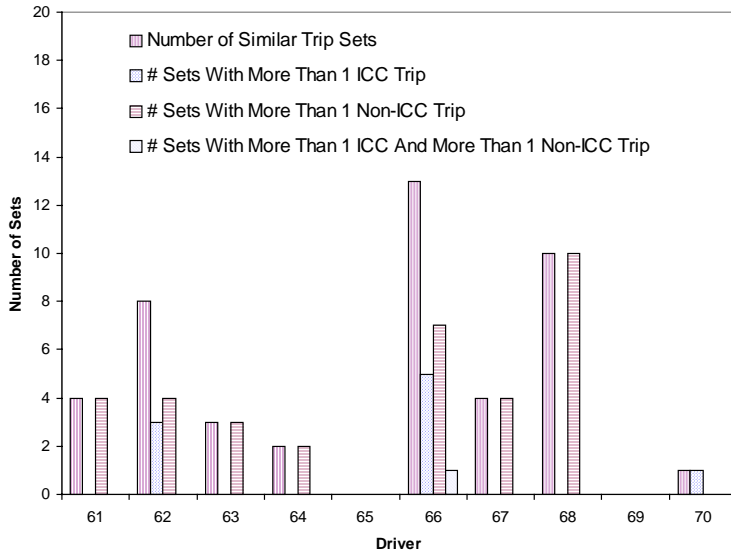


Figure D- 36 Trip Sets by ICC Usage (Drivers 61 through 70)

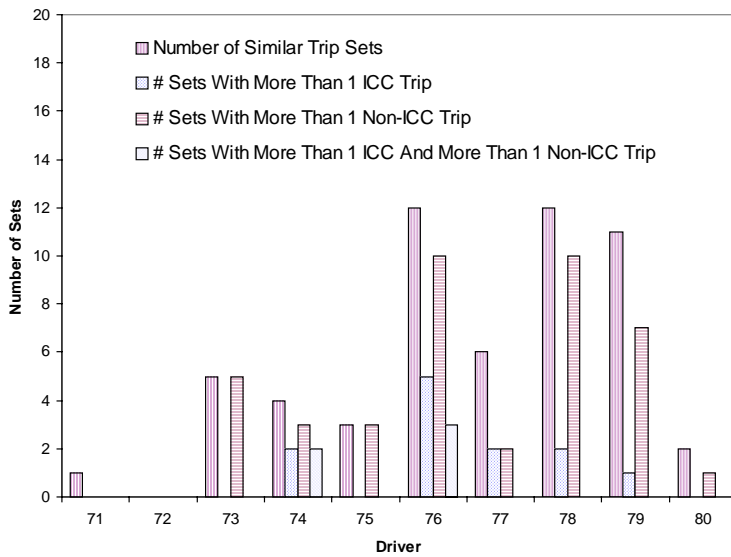


Figure D- 37 Trip Sets by ICC Usage (Drivers 71 through 80)

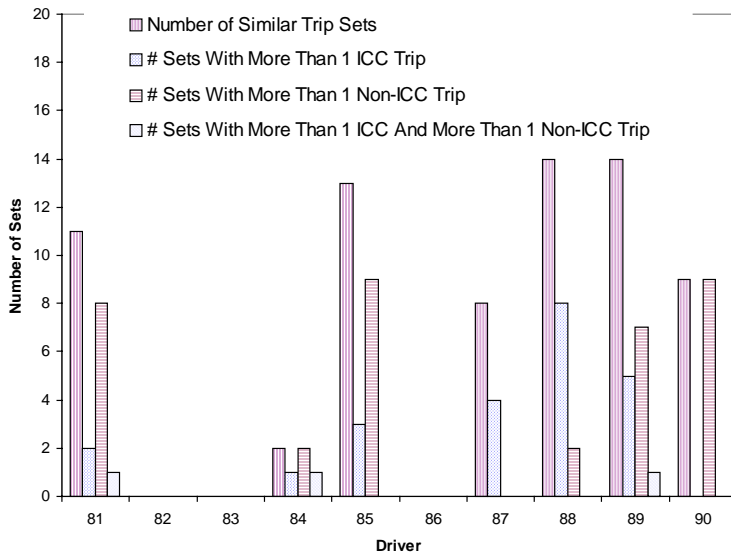


Figure D- 38 Trip Sets by ICC Usage (Drivers 81 through 90)

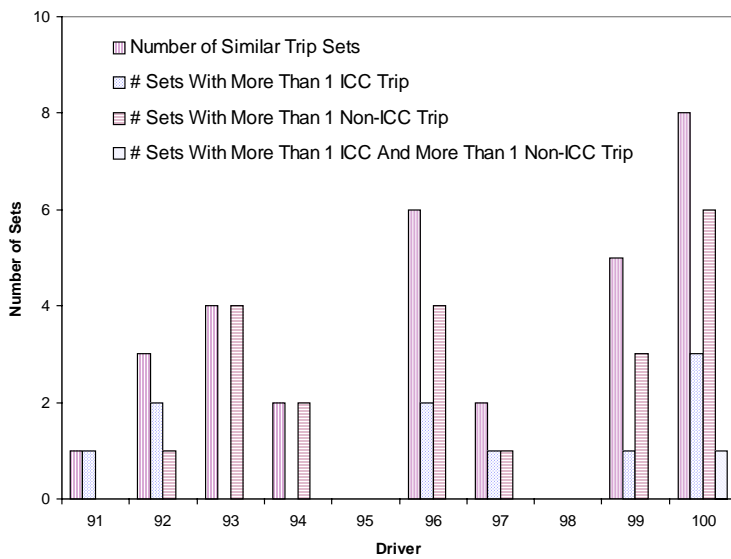


Figure D- 39 Trip Sets by ICC Usage (Drivers 91 through 100)



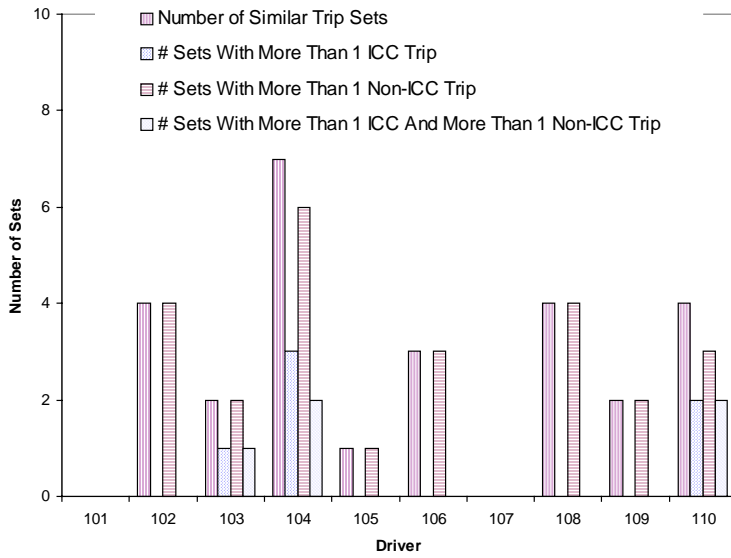


Figure D- 40 Trip Sets by ICC Usage (Drivers 101 through 110)

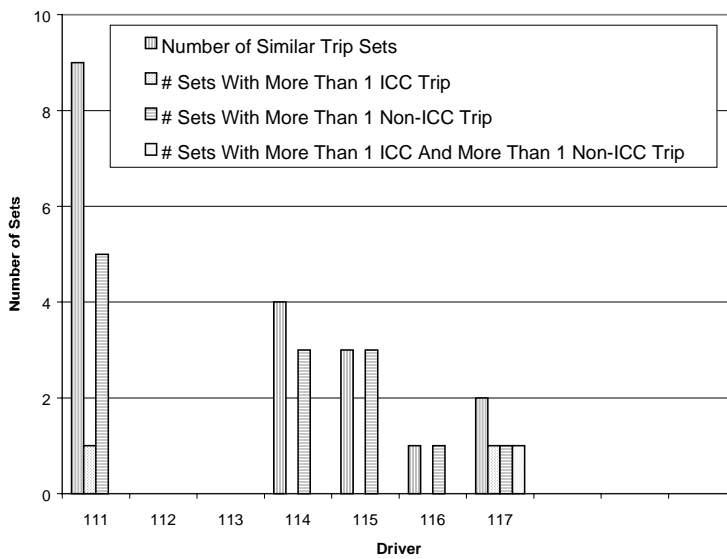


Figure D- 41 Trip Sets by ICC Usage (Drivers 111 through 117)

D.3.5 Like Trips by Set Number

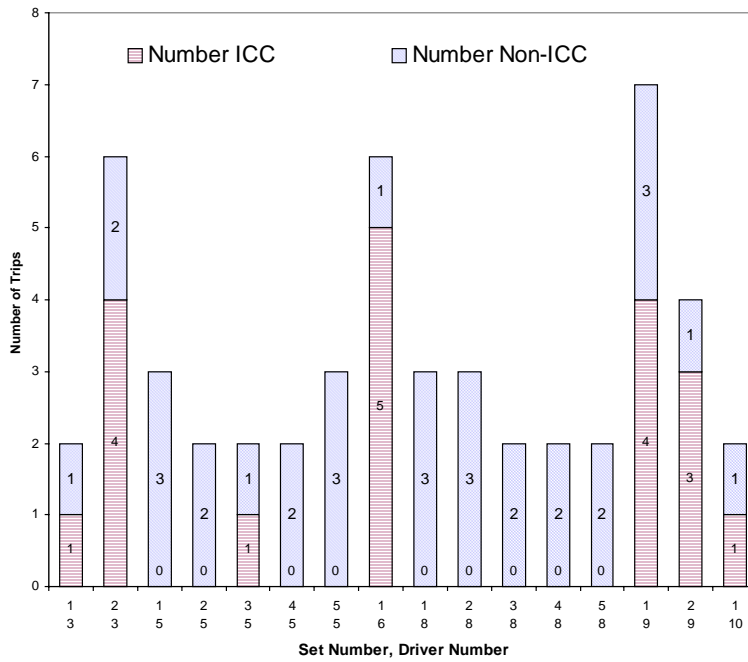


Figure D- 42 Similar Trips by Set Number (Drivers 1 through 10)

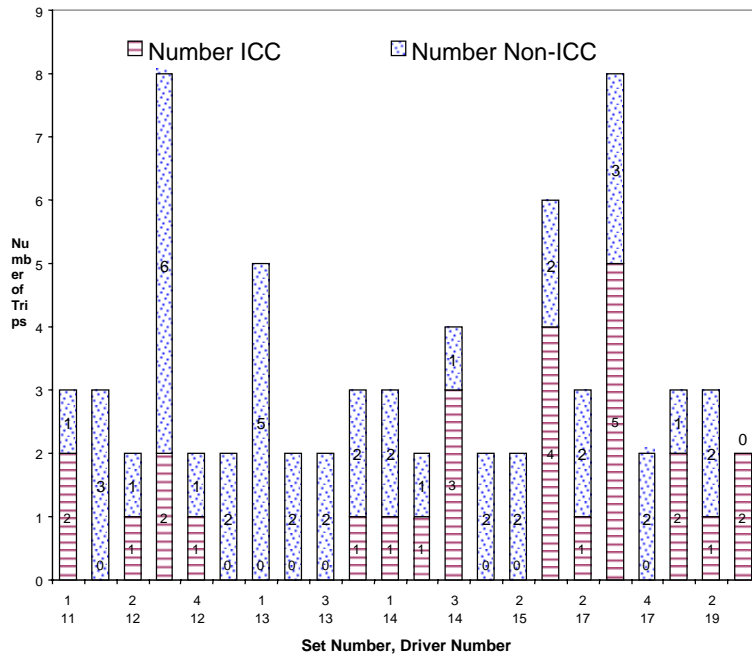


Figure D- 43 Similar Trips by Set Number (Drivers 11 through 19)

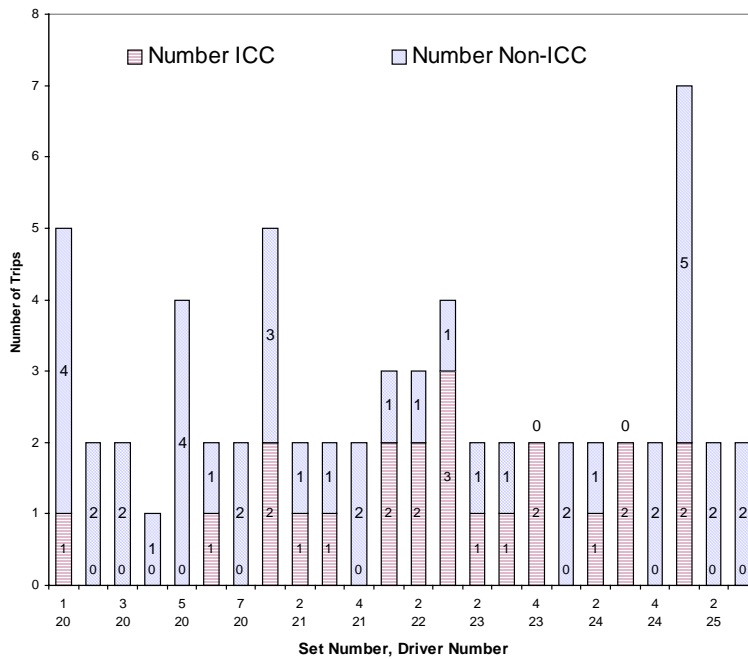


Figure D- 44 Similar Trips by Set Number (Drivers 20 through 25)

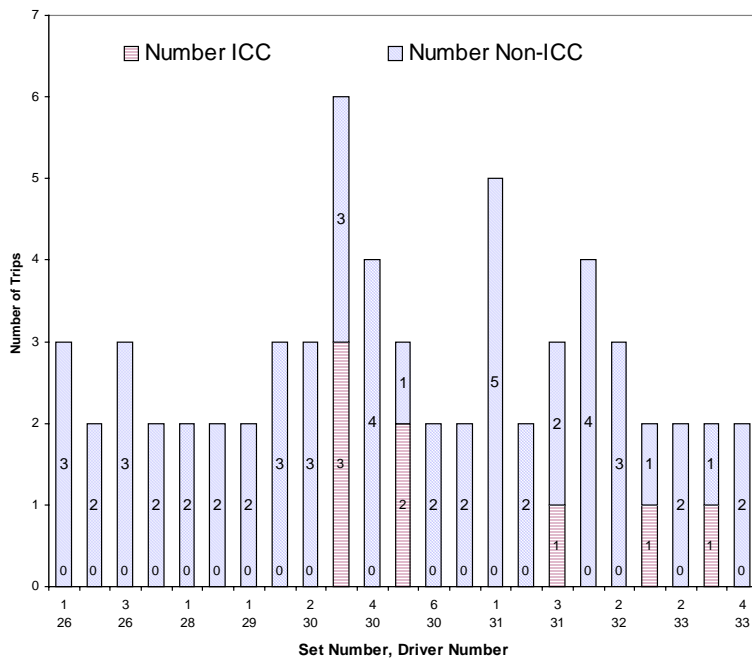


Figure D- 45 Similar Trips by Set Number (Drivers 26 through 33)

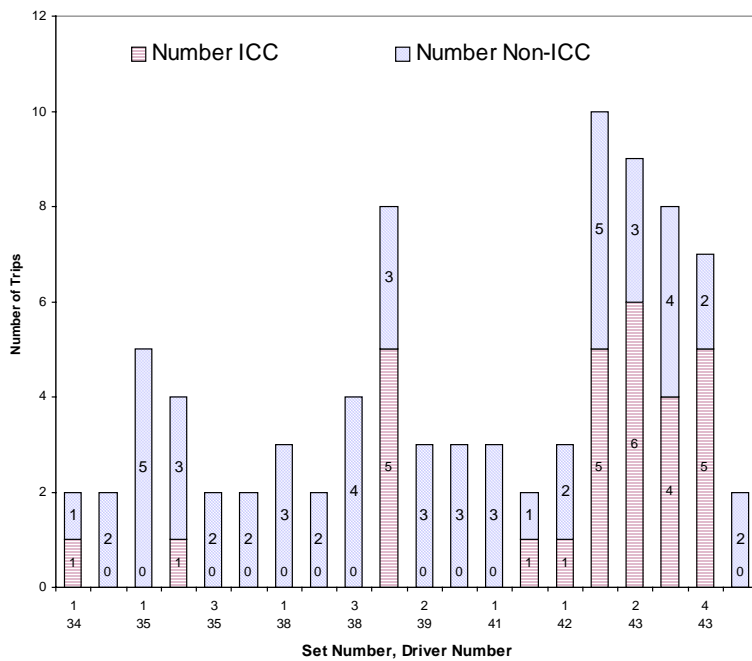


Figure D- 46 Similar Trips by Set Number (Drivers 34 through 43)

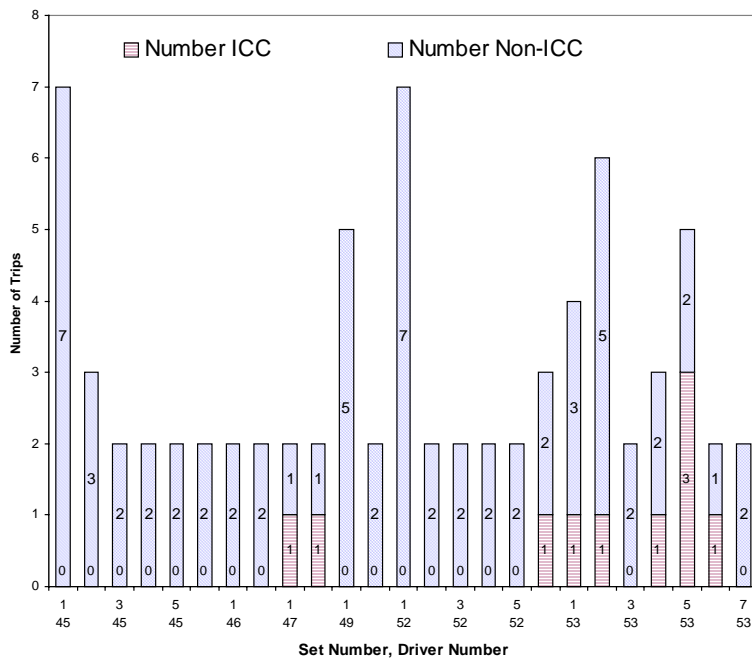


Figure D- 47 Similar Trips by Set Number (Drivers 45 through 53)

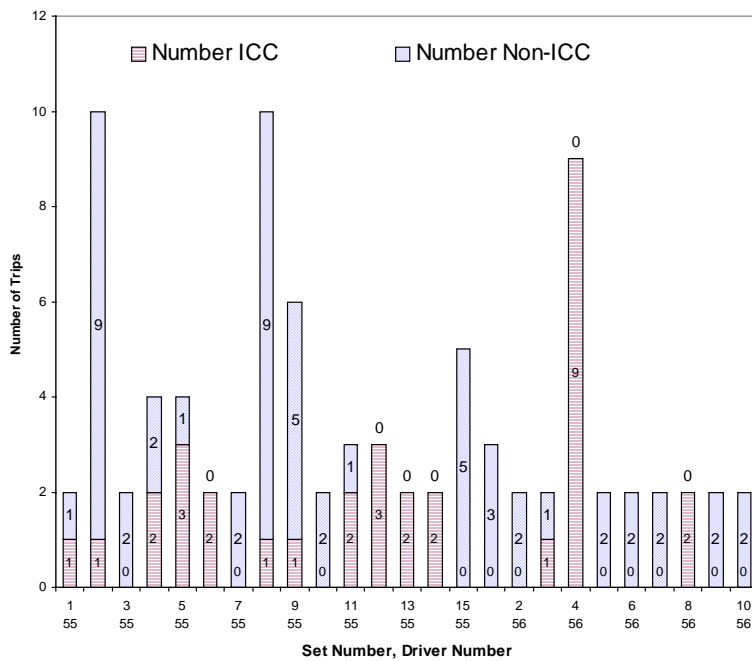


Figure D- 48 Similar Trips by Set Number (Drivers 55 and 56)

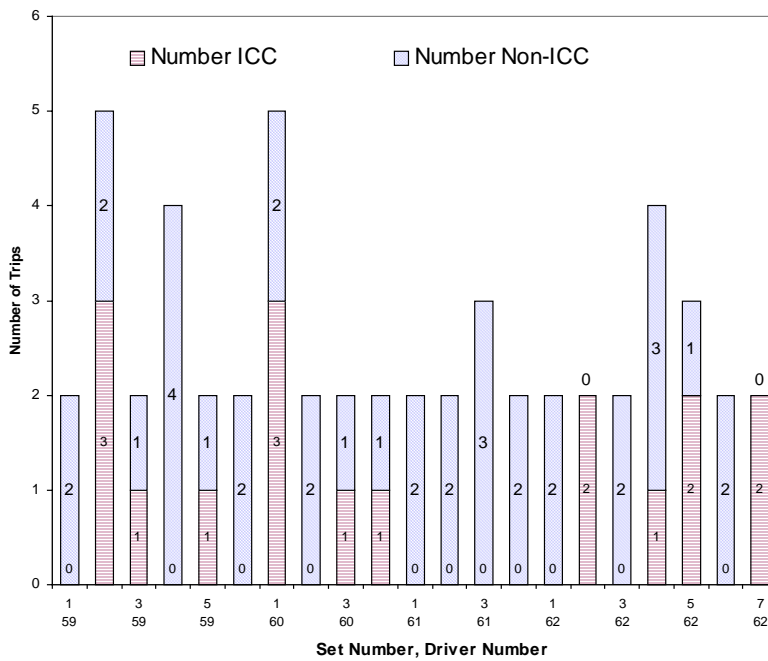


Figure D- 49 Similar Trips by Set Number (Drivers 59 through 62)

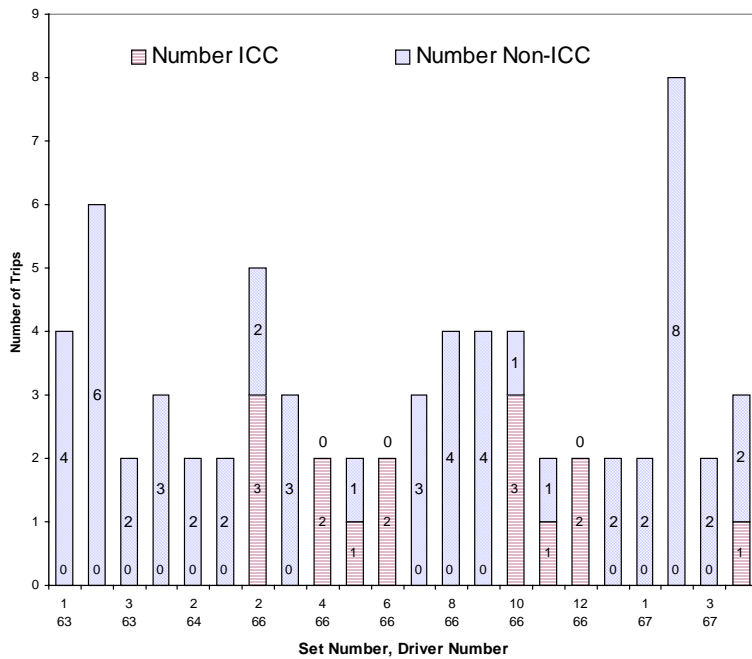


Figure D- 50 Similar Trips by Set Number (Drivers 63 through 67)

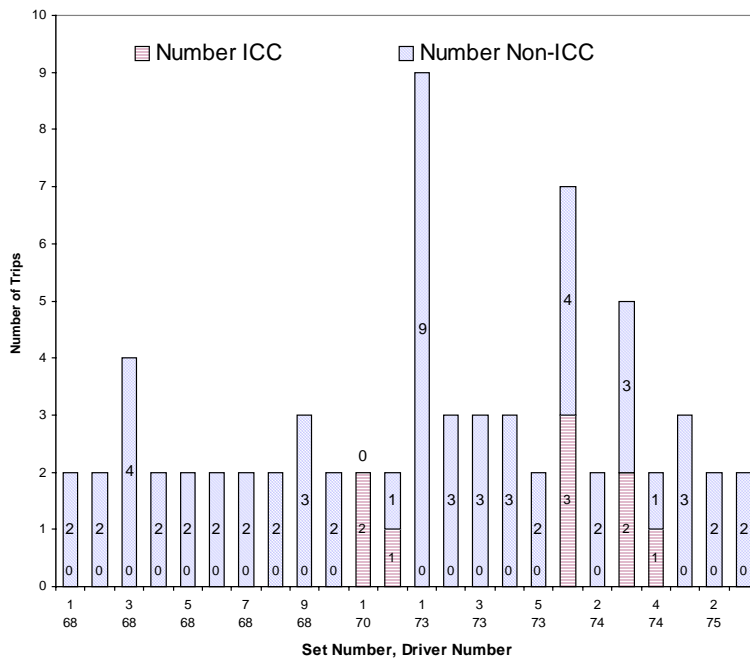


Figure D- 51 Similar Trips by Set Number (Drivers 68 through 75)

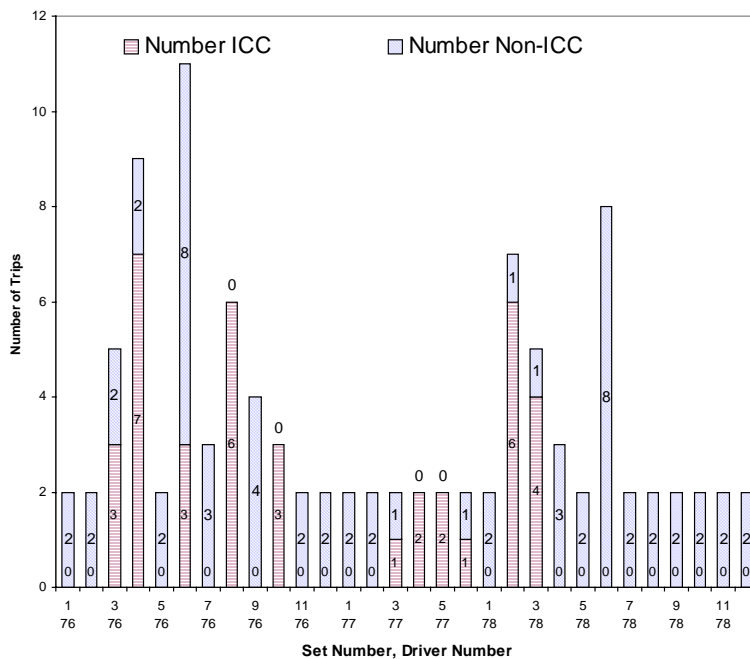


Figure D- 52 Similar Trips by Set Number (Drivers 76 through 78)

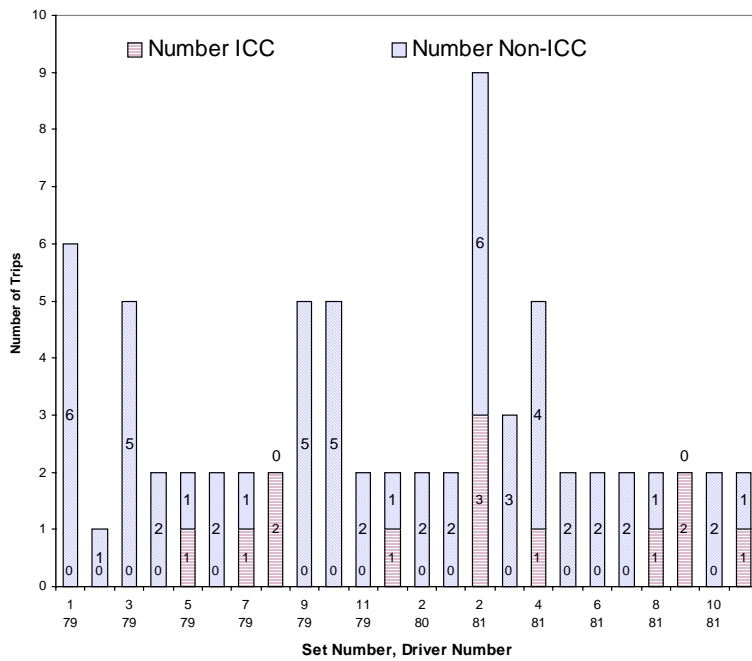


Figure D- 53 Similar Trips by Set Number (Drivers 79 through 81)

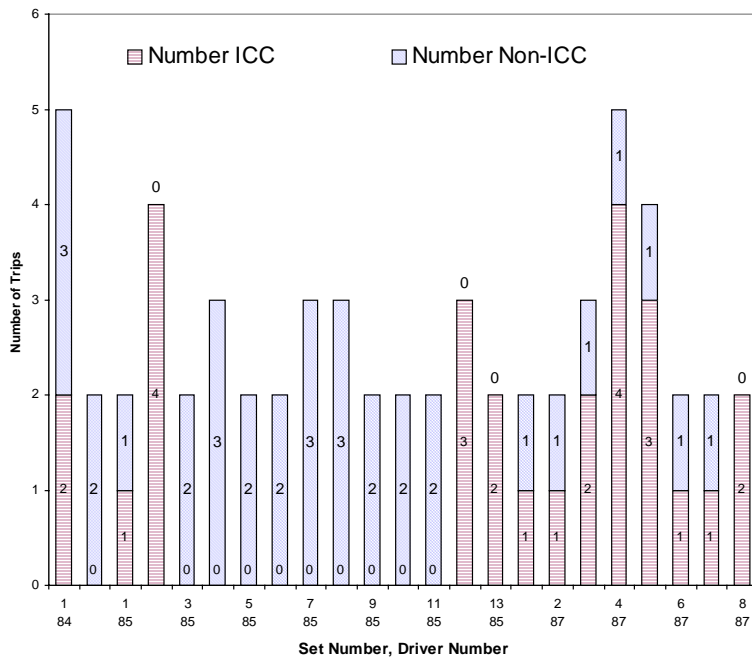


Figure D- 54 Similar Trips by Set Number (Drivers 84 through 87)



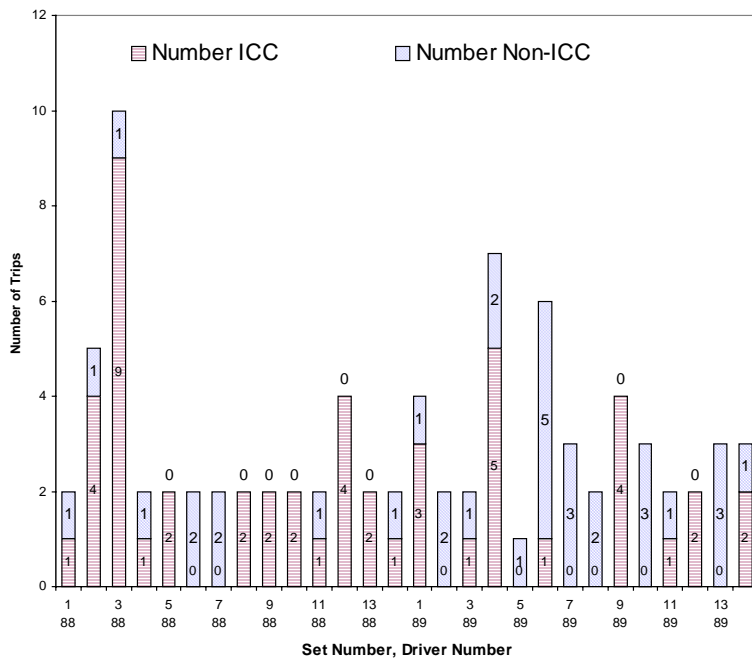


Figure D- 55 Similar Trips by Set Number (Drivers 88 and 89)

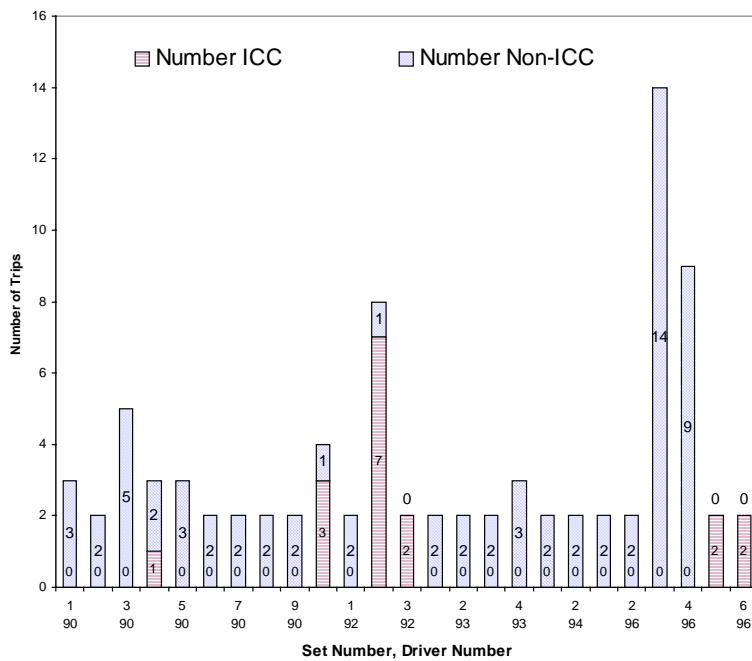


Figure D- 56 Similar Trips by Set Number (Drivers 90 through 96)

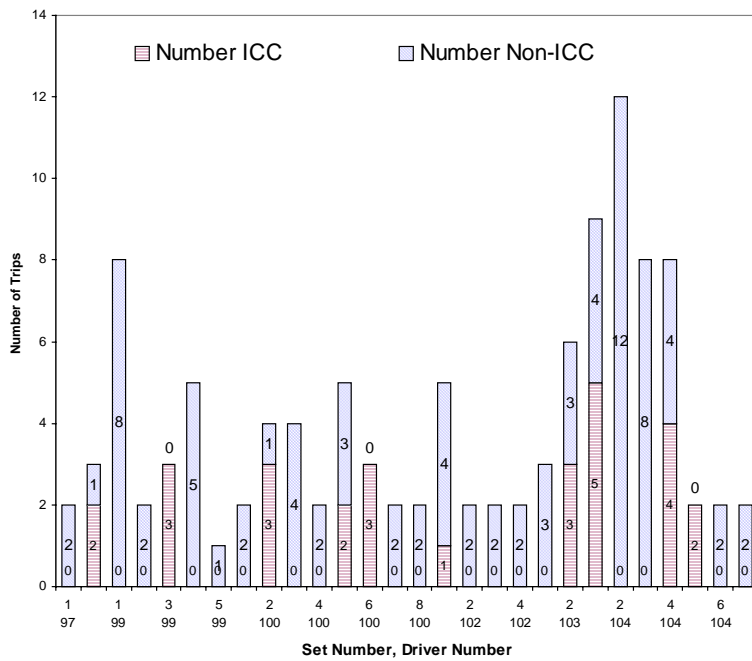


Figure D- 57 Similar Trips by Set Number (Drivers 97 through 104)

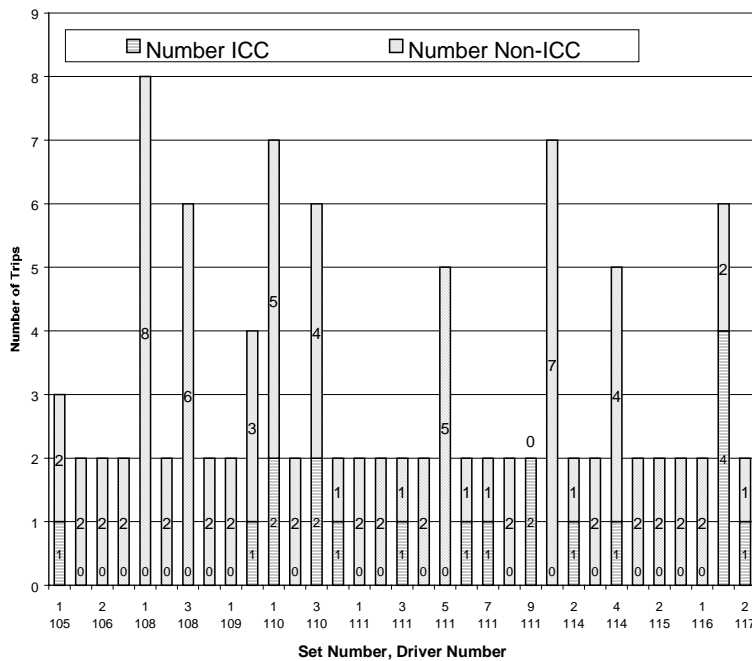


Figure D- 58 Similar Trips by Set Number (Drivers 105 through 117)