



7° Πανελλήνιο Συνέδριο Οδικής Ασφάλειας Λάρισα, 11-12 Οκτωβρίου 2018

Quantifying the Need for Driving Data Collection in Driving Behaviour Assessment Using Smartphone Data



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- Methodological approach for

- Specifying the required amount of **driving data** that should be collected for each driver





- Elimination of limiting barriers existed so far

- Mobile phone technology
- High cost of
 - in-vehicle data recording systems (e.g. OBD)
 - data plans
 - cloud computing
- Low penetration rate of smartphones and social networks
- Inability to manage and exploit Big Data

- Current technological advances

- collect and exploit data through mobile phones
- easier and more accurately





State-of-the-art (2/2)

- Driving data collection

- On-road experiments
- Naturalistic driving experiments
- Driving simulator experiments
- In-depth accident investigation
- Surveys on opinion and stated behaviour
- Driving metrics Adequate **amount**
 - assessment of each driver
 - deficient amount of data => uncertain or unreasonable results
 - excessive amount of data => significantly
 increase required processing time







Smartphone data collection

- A mobile **application** to record user's driving behaviour (automatic start / stop)
- A variety of **APIs** is used to read mobile phone sensor data
- Data is **transmitted** from the mobile App to the central database
- Data are **stored** in a sophisticated database where they are managed and processed
- Indicators are designed using
 - machine learning algorithms
 - big data mining techniques



Source: OSeven Telematics



Data sample - parameters examined

- Data sample of

- 171 Drivers
- 49,722 Trips
- **Risk exposure** indicators: - Total **distance** (mileage)

- Driving behaviour indicators:

- Number of harsh events
 - harsh braking (longitudinal acceleration)
 - harsh acceleration (longitudinal acceleration)
- Speeding
 - seconds driving over the speed limit
- Mobile phone use distraction
 - seconds using the mobile phone







Data investigation (1/7)

- Convergence index

- Moving window of 40 trips
- at least 200 km
- ≤ 5%





<u>Urban</u>

- Weak **positive correlation** between HA and required distance for convergence
- Required monitoring distance is **higher** for **more** aggressive/ risky drivers
- **No** apparent **trend** for the rest of the metrics





Data investigation (3/7)

<u>Urban</u>

- **Same** sampling **periods** are required for drivers of different percentile value range
- **Maximum** median **distance** value
 - all metrics should have converged to their cumulative average
 - the driving sample acquired is adequate
 - the input/ output ratio is relatively constant to perform DEA analysis

Metric	Percentile range	Metric descriptive statistics				Distance to convergence		
		Average	St. Dev	Min	Max	Average	Median	St. Dev
HA	0% – 25%	8.18	2.61	-	11.61	3.89	3.09	1.77
	25% – 50%	15.92	2.8	11.61	20.54	3.99	3.36	2.08
	50% – 75%	25.01	2.48	20.54	30.14	4.15	3.22	2.46
	75% – 100%	43.23	10.92	30.14	-	5.26	5.19	2.93
110	0% – 25%	3.05	1.26	-	4.95	5.15	4.78	1.79
ЦR	25% – 50%	6.17	0.69	4.95	7.32	4.08	3.35	1.55
нв	50% – 75%	8.6	0.83	7.32	10.61	5.58	4.31	3
	75% – 100%	15.65	3.12	10.61	-	4.69	3.41	2.48
MU	0% – 25%	204	101	-	332	5.59	4.07	3.95
	25% – 50%	495	78	332	606	4.4	3.47	1.74
	50% – 75%	799	111	606	1041	4.43	3.81	2.47
	75% – 100%	2063	994	1041	-	4.93	3.66	3.1
	0% – 25%	727	194	-	947	4.89	3.39	3.08
SP	25% – 50%	1081	67	947	1198	3.43	2.93	1.23
	50% – 75%	1402	119	1198	1594	3.78	3.12	1.88
	75% – 100%	1919	318	1594	-	4.55	3.48	2.87

- **519** km

- 75 trips



Data investigation (4/7)

<u>Rural</u>

- Weak **negative correlation** between HA, HB, mobile usage and the required distance for convergence
- Required monitoring distance is **higher** for **less** aggressive/ risky/ distracted drivers
- No apparent trend for speeding





<u>Rural</u>

- **Different** sampling **periods** are required for drivers of different percentile value range
 - less volatile than in urban road
- **Maximum** median **distance** value
- **579** km - 81 trips

Metric	Percentile range	Me	etric descrip	tive statis	Distance to convergence			
		Average	St. Dev	Min	Max	Average	Median	St. Dev
НА	0% – 25%	3.69	1.7	-	6.42	5.07	4.31	2.19
	25% – 50%	8.8	1.33	6.42	10.79	4.05	3.76	1.34
	50% – 75%	13.58	1.98	10.79	17.02	4.99	4.17	2.7
	75% – 100%	27.27	11.04	17.02	-	3.49	3.36	0.85
НВ	0% – 25%	2.05	0.84	-	3.15	5.2	4.39	2.21
	25% – 50%	4.35	0.67	3.15	5.6	4.29	4.03	1.26
	50% – 75%	6.92	0.69	5.6	8.28	4.89	4.40	2.21
	75% – 100%	13.54	7.16	8.28	-	3.89	3.60	1.87
MU	0% – 25%	85	48	-	157	6.3	5.79	2.61
	25% – 50%	263	50	157	371	4.85	4.42	2.09
	50% – 75%	511	92	371	747	5.01	4.48	1.92
	75% – 100%	1334	684	747	-	4.11	3.62	1.66
SP	0% – 25%	454	170	-	745	4.48	3.99	1.89
	25% – 50%	851	74	745	970	4.44	3.97	2.21
	50% – 75%	1142	112	970	1315	4.19	3.88	1.72
	75% – 100%	1526	181	1315	-	4.25	3.56	1.95



Data investigation (6/7)

<u>Highway</u>

- Weak **negative correlation** between HA, HB, mobile usage and the required distance for convergence
- Required monitoring distance is **higher** for **less** aggressive/ risky/ distracted drivers
- No apparent trend for speeding





<u>Highway</u>

- **Different** sampling **periods** are required for drivers of different percentile value range
 - less volatile than in urban road
- **Maximum** median **distance** value

- **611** km

- is not investigated

Metric	Percentile range	Me	etric descrip	tive statis	Distance to convergence			
		Average	St. Dev	Min	Max	Average	Median	St. Dev
НА	0% – 25%	0.74	0.29	-	1.1	6.78	5.85	4.4
	25% – 50%	1.26	0.12	1.1	1.54	6.39	6.05	2.34
	50% – 75%	1.87	0.24	1.54	2.3	6.07	6.11	2.42
	75% – 100%	3.77	2.12	2.3	-	5.93	5.29	2.89
НВ	0% – 25%	0.36	0.12	-	0.56	7.05	5.92	4.13
	25% – 50%	0.83	0.1	0.56	0.97	7	5.62	3.76
	50% – 75%	1.15	0.13	0.97	1.38	5.72	6.06	1.74
	75% – 100%	2.05	0.64	1.38	-	5.42	4.72	2.51
MU	0% – 25%	35	20	-	66	7.22	5.92	4.68
	25% – 50%	101	18	66	135	6.23	4.98	2.85
	50% – 75%	174	26	135	223	5.64	5.40	1.96
	75% – 100%	455	206	223	-	5.33	4.45	3.49
SP	0% – 25%	193	124	-	346	6.1	5.50	2.85
	25% – 50%	505	91	346	641	6.49	5.92	3.92
	50% – 75%	807	100	641	950	6.66	6.01	2.95
	75% – 100%	1168	249	950	-	5.44	4.64	2.41



Conclusions

- The required **sampling** mileage is identified, different for each:
 - road type
 - driving metric
 - driving aggressiveness
- Not a single critical metric to determine the required driving data amount
- **More** aggressive/ risky drivers need **less** monitoring in rural road and highways







Future challenges

- Exploit a larger driving sample

- relationship between the aggressiveness of a driver and the necessary monitoring distance

- Examine a higher number of driving **attributes**

- Study **dynamic evolution** of driving behaviour attributes











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