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**Identification and Ranking of  
Dangerous Violation Types: Abu  
Dhabi Case Study**

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*"What Hershey bar? I don't see any Hershey bar."*



# Introduction

- Traffic crashes affect **millions of human lives** and costs billions of dollars in economic.
- The success of any initiative or strategy in reducing accident occurrences hinges upon the existence of **reliable methods** that provide accurate estimates of road safety parameters.
- Several studies showed that drivers' error contributes to approximately **75-90%** of all traffic accidents.
- Thus, safety initiatives focusing on the drivers should often lead to significant reductions in accident occurrence.
- It is **not easy to understand** the complex human driving behavior, which is not only governed by individual's knowledge and skills but also by the surrounding environment.

# Introduction

- The three main components of road safety strategies: **E**ngineering , **E**nforcement and **E**ducation ( **3 - Es** ).
- **Traffic law enforcement** is the most efficient for improving drivers' behaviour.
- Identifying violation types that are considered more "hazardous" is essential for refining the traffic law penalties.
- So that, a violation type that would be considered **more hazardous** should be **more strictly penalized**.
- This is particularly important for a country like the **UAE** where **more than 200 different nationalities** with different education levels, cultural backgrounds, languages, and driving skill sets live in the country.

# Objective

- A question of interest is whether the penalties listed in the traffic law are actually consistent with the dangerousness level of the traffic violation type.
- A more authentic question is how to identify and rank dangerous violation types.



To identify and rank hazardous traffic violation types in Emirate of Abu Dhabi

From our perspective, a dangerous/hazardous violation type is the one which may lead to more severe accident occurrences.

**REPEATED TRAFFIC OFFENCE IN DELHI? PAY MUCH MORE**

From Tuesday, pay up to 200% more than the first time. Commit the offence a third time & your licence will be seized.

OFFENCE	FIRST TIME	REPEAT OFFENCE
Overspeeding	400	1,000
Red-light jumping	100	300
Driving drunk	Up to 2,000	Up to 3,000 or 2-year jail term
Using mobiles while driving	1,000	2,000
Passengers in goods vehicles	100	300
Driving without seat belt	100	300
Driving without helmet	100	300

Figures in ₹. Source: TN

# Background about road safety in Abu Dhabi

Tangible efforts have been recently undertaken to improve road safety by focusing on strategies targeting enhancements in the engineering, education and enforcement.

	2010	2016		
<b>Severe crashes</b>	2,537	1,738	↓	31.5%
<b>Crashes fatalities</b>	376	288	↓	23.4%
<b>Fatality rate</b>	12.3	8.7	↓	28.7%

A better understanding of the drivers' behavior is likely to support the development of better traffic laws and legislation.

# Literature Review

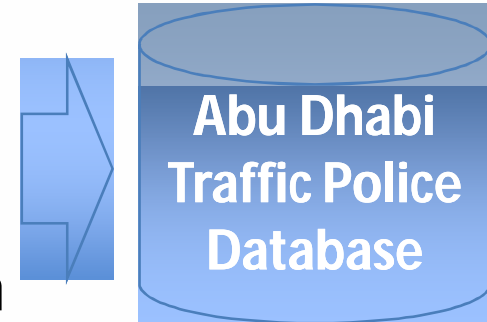
- An early study by *Peck et al. (1971)* suggested **that it is difficult to accurately predict** drivers who will or will not be involved in accidents in the future.
- One year later, (*Stewart and Campbell 1972*) made use of a four-year history of accident and traffic violation records of North Carolina drivers to predict the future accidents of drivers.
- Later, (*Lui and Marchbanks 1990*) analyzed the relationship between previous traffic violations and fatal accidents and they suggested that **the involvement in a fatal accident is not a random event**.
- Since that date, many researches showed a statistically significant relationship between the future frequency of accident involvements and the previous violation record of the drivers.
- Some studies found that the driver's violation records are better than accident history records to predict dangerous drivers.

# Literature Review

- Other studies showed that certain violation types such as **speeding** and **driving under alcohol or drugs** lead to higher probability of future accident occurrences.
- Some researchers used **self-reported techniques** to identify the interaction between drivers' history of violations and his/her accident involvements. These studies proved the tendency of drivers who frequently take traffic tickets to be involved in traffic accidents.
- In a recent study used, (*Machado, et al. 2016*) used a Stated Preference (SP) ranking survey to explore the accident risk perception among a sample of 492 drivers on an inter-city, two-way road. The study showed that risky driving behaviors led to a significant increase in accident risk perceptions.

# Data Description

- 1) Traffic violation records
- 2) Severe accidents
- 3) Licensed drivers' information



Eight years of data (from 2008 to 2015) were queried from each dataset and saved separately

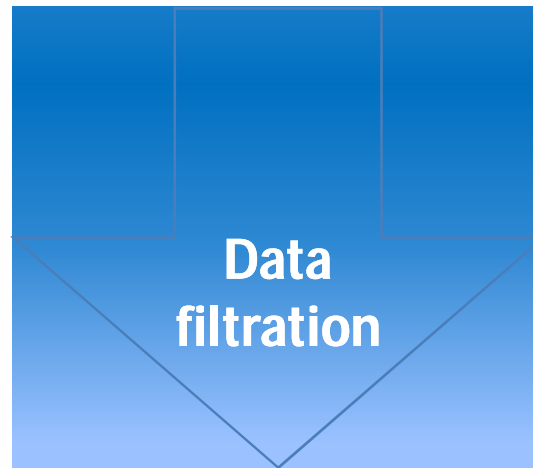


Integrated into one comprehensive database

TCN (Unique Driver's Code)	No. of Violations	Severe Accidents	PDO Accidents	Total Accidents	Black Points Violations	Black Points	Hazardous Violations
1980199378	27	4	8	12	5	26	3

# Data Description

About **1.25 million** licensed drivers in the database



- Private driver's licenses
- Zero records of both violations and accidents were omitted.
- Diver's licenses after 2008 were also removed

The final sample included **624,568** drivers

- ✓ Committed a total **4,116,149** traffic violations
- ✓ Involved in **7,676** severe accidents

# Data Analysis Methodology

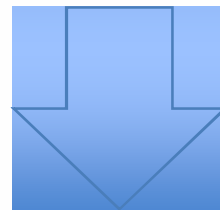
The methodology has three steps:

1. Selection of Potential Dangerous Violation Types
2. Calculation of Severe Accident Rate by Violation Type
3. Identification and Ranking of the Most Dangerous Violation Types

# Data Analysis

## Step 1 : Identification of Dangerous Violation Types

Not all types of traffic violations may be indicative of risky behavior or may lead to an involvement in a severe traffic accident.



Engineering judgement by traffic experts

The initial list of candidate dangerous violation types included **30 violation types**

# Data Analysis

## Step 2: Calculation of Severe Accident Rate by Violation Type

$$\text{Accident rate} = \lambda_i = \frac{1000 y_i}{M_i} \quad \& \quad \% \text{ of drivers} = r_i = \frac{m_i}{M_i}$$

$\lambda_i$  = Accident rate per 1000 drivers for each violation type  $i$ ,

$r_i$  = the ratio of drivers involved in severe accidents and committing a violation of type  $i$  to the total number of drivers committing a violation of type  $i$ .

$i$  = index for the violation type,

$n_i$  = the total number of studied violation types,

$M_i$  = the total number of drivers committing a violation of type  $i$ ,

$m_i$  = the number of drivers involved in severe accidents and committing a violation of type  $i$ ,

$y_i$  = the total number of observed severe accidents for drivers committing a violation of type  $i$ ,

# Data Analysis

## Example of the calculation table

Violation ID	Violation Type	Drivers involved in severe accidents ( $m_i$ )	No. of drivers ( $M_i$ )	No. of severe accidents ( $y_i$ )	Severe accident rate /1000 driver ( $\lambda_i$ )
1	Overtaking in a wrong way	34	1,301	42	32.3
2	Racing on the road	84	1,670	93	55.7
3	Not wearing helmet while driving a motorbike	17	302	20	66.2
4	Running away from a traffic policeman	108	1,578	117	74.1
5	Tailgating	565	13,048	611	46.8
6	Exceeding speed over 60kph	1514	36,485	1661	45.5
30					

# Data Analysis

## Step 3: Identification and Ranking of the Most Dangerous Violation Types:

### 4 methods were used

- The percentage of drivers involved in severe accidents
- Confidence interval (CI) method.
- Rate quality control (RQC) method
- A survey taken experts and drivers' opinions

# Data Analysis

## Step 3: Identification and Ranking of the Most Dangerous Violation Types:

### ➤ Confidence interval (CI) method.

- A simple statistical technique based on the assumption that the observed severe accident rates are normally distributed

$$\lambda_{critical} = \bar{\lambda} + k \cdot \sigma$$

- Violation type  $i$  consider as hazardous when  $\lambda_i > \lambda_{critical}$

$k$  = a constant related to confidence level obtained from the normal distribution function ( $k = 1.645$  for 90% confidence level)

$\sigma$  = standard deviation of accident rate of the population of violation types.

# Data Analysis

## Step 3: Identification and Ranking of the Most Dangerous Violation Types:

### ➤ Rate quality control (RQC) method

- The rate quality control technique was proposed by Norden et al. (1956), and it has been widely used by highway agencies to identify hazardous locations.

$$\lambda_{critical} = \bar{\lambda} + k \sqrt{\frac{\bar{\lambda}}{M_i} + \frac{1}{2 \cdot M_i}}$$

- The main assumption of the technique is that the number of accidents occurring within a given violation type during a given time period can be approximated by the Poisson distribution.

## Example of the result

Violation Type	RQC Technique		
	$\lambda_{critical}$	Hazardousness	CR <sub>i</sub>
Exceeding speed over 60kph	42.59	Hazardous	1.07
Dangerous loading of a heavy vehicle	45.97	Hazardous	2.18
Dangerous overtaking of a heavy vehicle	44.04	Not Hazardous	0.45
Non Lane-discipline heavy vehicle	42.95	Not Hazardous	0.50
Stopping a vehicle at a dangerous location or blocking traffic	42.92	Not Hazardous	0.67
Not wearing helmet while driving a motorbike	43.15	Hazardous	1.53
Overtaking in a wrong way	42.83	Not Hazardous	0.75
Overtaking at a prohibited location	42.83	Hazardous	1.17
Racing on the road	42.80	Hazardous	1.30
Turning at undesignated points	42.69	Not Hazardous	0.52
Running away from a traffic policeman	42.80	Hazardous	1.73
Failure to follow the directions of the policeman	42.71	Hazardous	1.14
Overtaking from the right	42.68	Not Hazardous	0.98
Reckless driving	42.73	Hazardous	1.59
Driving under the influence of alcohol or drugs	42.78	Hazardous	2.93
Sudden entering a road	42.66	Not Hazardous	0.77
Sudden swerve	42.63	Hazardous	1.10
Tailgating	42.63	Hazardous	1.10
Driving dangerously	42.67	Not Hazardous	0.82
Not using indicators when changing direction or turning	42.63	Not Hazardous	0.74
Not giving pedestrians priority	42.61	Not Hazardous	0.50

# Data Analysis

## 3) Identification and Ranking of the Most Dangerous Violation Types:

- A survey taken experts and drivers' opinions

By **10 experts** from the Traffic Engineering Department of the ADP and **35 experienced drivers**

ID	Violation Type	Score
1	Dangerous loading of a heavy vehicle	7.0
2	Dangerous overtaking of a heavy vehicle	9.0
3	Non Lane-discipline heavy vehicle	7.2
4	Stopping a vehicle at a dangerous location or blocking traffic	6.5
5	Not wearing helmet while driving a motorbike	7.7
6	Overtaking in a wrong way	7.1
7	Overtaking at a prohibited location	7.4
8	Racing on the road	9.1
9	Turning at undesignated points	6.9
10	Running away from a traffic policeman	8.8
11	Failure to follow the directions of the policeman	6.9
12	Overtaking from the right	6.4
13	Reckless driving	8.9
14	Driving under the influence of alcohol or drugs	9.5
15	Sudden entering a road	8.4
16	Driving dangerously	9.1
17	Not using indicators when changing direction or turning	6.6
18	Not giving pedestrians priority	7.5
19	Driving on the wrong direction	9.0
20	Sudden swerve	8.8
21	Tailgating	8.0
22	Using hand-held mobile phone while driving	9.2
23	Red light crossing	9.6
24	Exceeding speed over 60kph	9.0
25	Light vehicle lane discipline	6.3
26	Exceeding speed between 50-60kph	7.9
27	Not use seat belt while driving	7.3
28	Exceeding speed between 40-50kph	6.8
29	Exceeding speed between 30-40kph	6.0
30	Exceeding speed up to 30kph	5.2

# Final Results

Violation Group	Ranking			
	C. I Technique	RQC Technique	% of Drivers Inv. in Accidents	Experts' Opinion
Driving under the influence of alcohol or drugs	1	1	1	2
Dangerous loading of a heavy vehicle	2	2	2	21
Running away from a traffic policeman	3	3	3	10
Reckless driving	4	4	4	9
Not wearing helmet while driving a motorbike	5	5	5	15
Racing on the road	6	6	6	4
Overtaking at a prohibited location	7	7	10	17
Failure to follow the directions of the policeman	8	8	11	23
Sudden swerve	9	9	8	11
Tailgating	10	10	7	13
Exceeding speed over 60kph	11	11	9	8
Overtaking from the right	12	12	13	27
Exceeding speed between 50-60kph	13	13	12	14
Driving dangerously	14	14	14	5
Red light crossing	15	15	15	1
Sudden entering a road	16	16	17	12
Overtaking in a wrong way	17	17	19	20
Exceeding speed between 40-50kph	18	18	16	24
Not using indicators when changing direction or turning	19	19	18	25
Not use seat belt while driving	20	20	21	18
Driving on the wrong direction	21	21	20	7
Stopping a vehicle at a dangerous location or blocking traffic	22	22	24	26
Light vehicle lane discipline	23	23	23	28
Exceeding speed between 30-40kph	24	24	22	29
Exceeding speed up to 30kph	25	25	25	30
Turning at undesignated points	26	26	27	22
Using hand-held mobile phone while driving	27	27	29	3
Non Lane-discipline heavy vehicle	28	29	26	19
Not giving pedestrians priority	29	28	30	16
Dangerous overtaking of a heavy vehicle	30	30	28	6

## Conclusion

- Among 147 violation types, an initial selection of dangerous 30 violation types.
- For each violation type, different safety metrics were calculated and different methods were applied for ranking.
- The RQC identified 11 violation types as most hazardous.
- The ranking of the two methods was identical and in general agreement with the ranking based on % of drivers involved in severe accidents.
- The methods applied in this paper can be used by legislation authorities to adjust/modify the list of penalties according to the hazardousness of each violation type.

By first of this year, new fines and penalties list was applied in AD, more intensive initiatives in the most hazardous violations are conducted, as a result, up to the end of September 2017 about **20% reduction in crash fatalities**



**Thank You**  
**For your attention**