DUBAI WORLD CONGRESS
FOR SELF-DRIVING TRANSPORT
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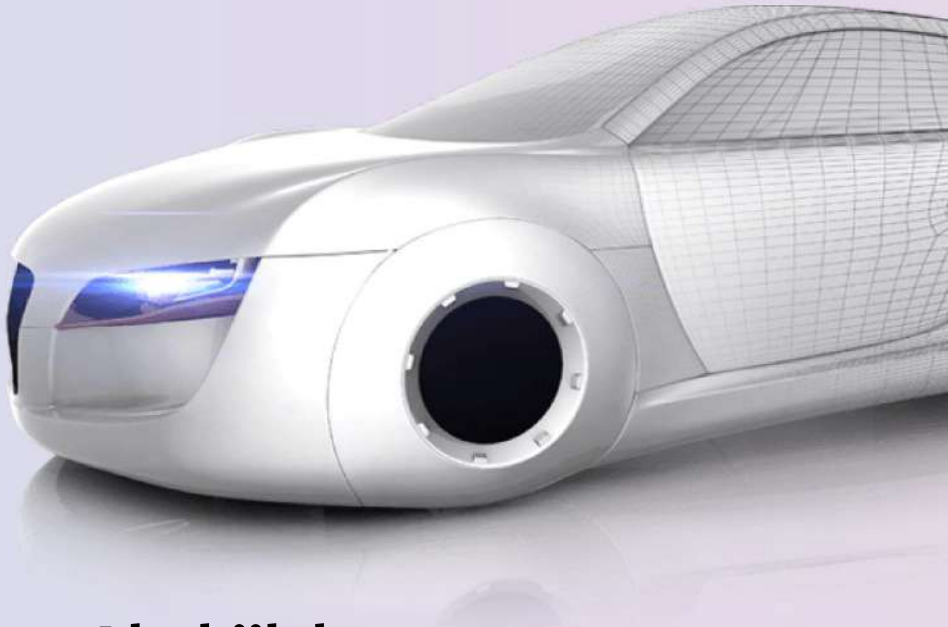
Identifying safety benefits of autonomous taxi by analyzing the human factor



Eng. Mohamed Mahboob
Phd Student, The British University in Dubai

Prof. Bassam Abuhijleh
Dean of Engineering and IT, The British University in Dubai

AGENDA

- Background
- Introduction
- Motivation
- Problem Statement
- Research Question
- Aims and Objectives
- Methodology
- Results
- Discussion
- References

Background

Challenges of regulating the autonomous Taxi

Dubai's vision on Autonomous vehicles

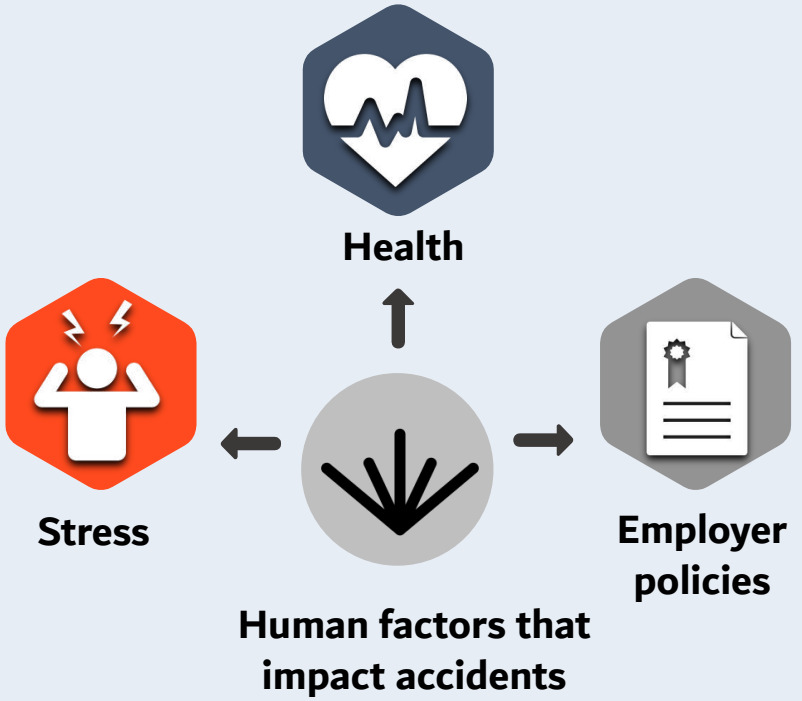
Safety Significance of Autonomous Taxi

Taxi Drivers

Challenges and safety

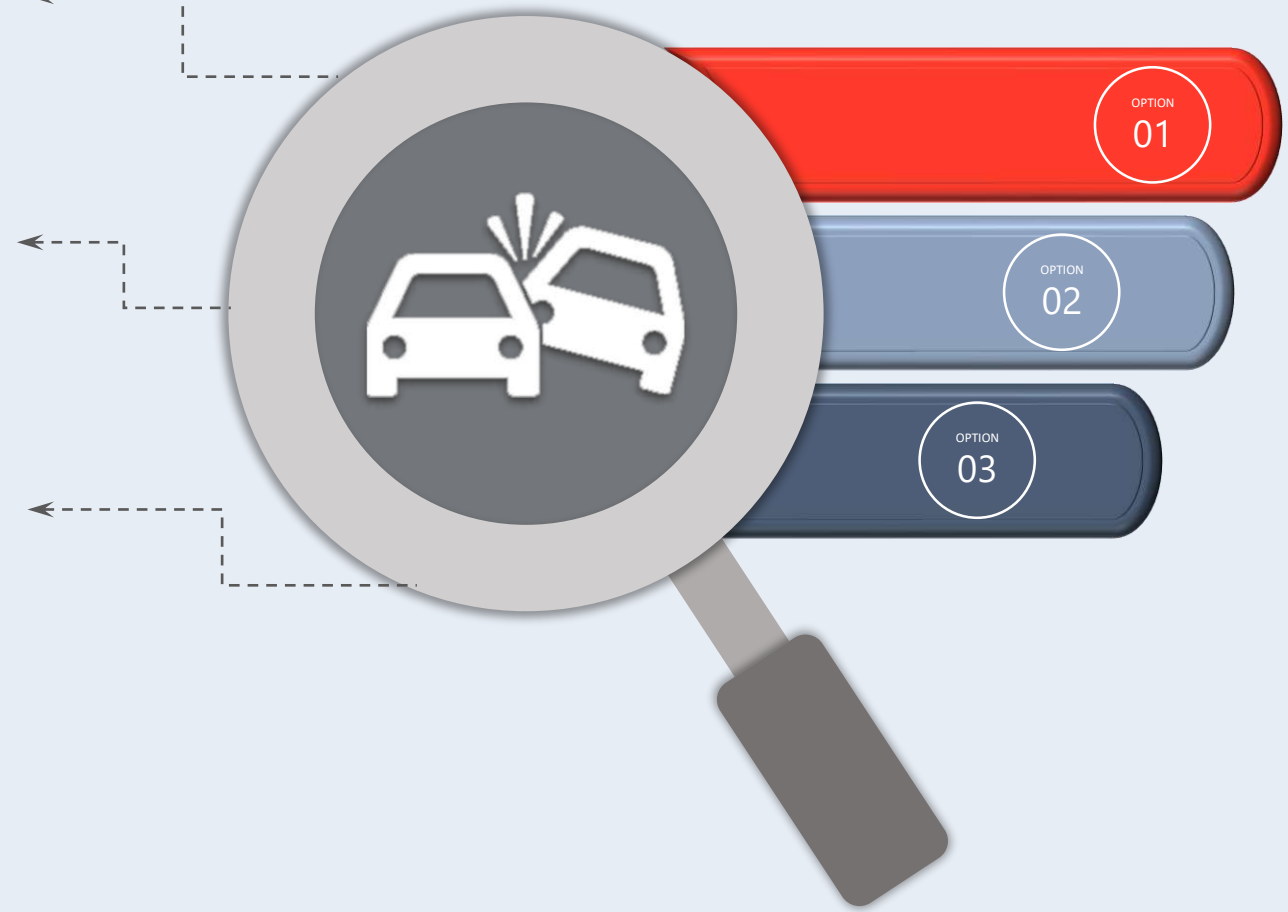
Introduction - Taxi driver challenges

- 94 % of critical pre-collision caused by drivers (NHTSA)
- Distractions, overspeed, disobedience of traffic rules and misjudgment of road conditions (Diller, et al. 2014).
- Risk factors are Driving for longer hours, different routes, occupational health problems (Wang, Y, Du and Mao, 2015).
- Dubai Taxi is one of the safest in the world at 0.23 accidents per 100 thousand km (KhaleejTimes, 2017).
- RTA safety investments includes driver monitoring systems, speed cap and brake-plus system.

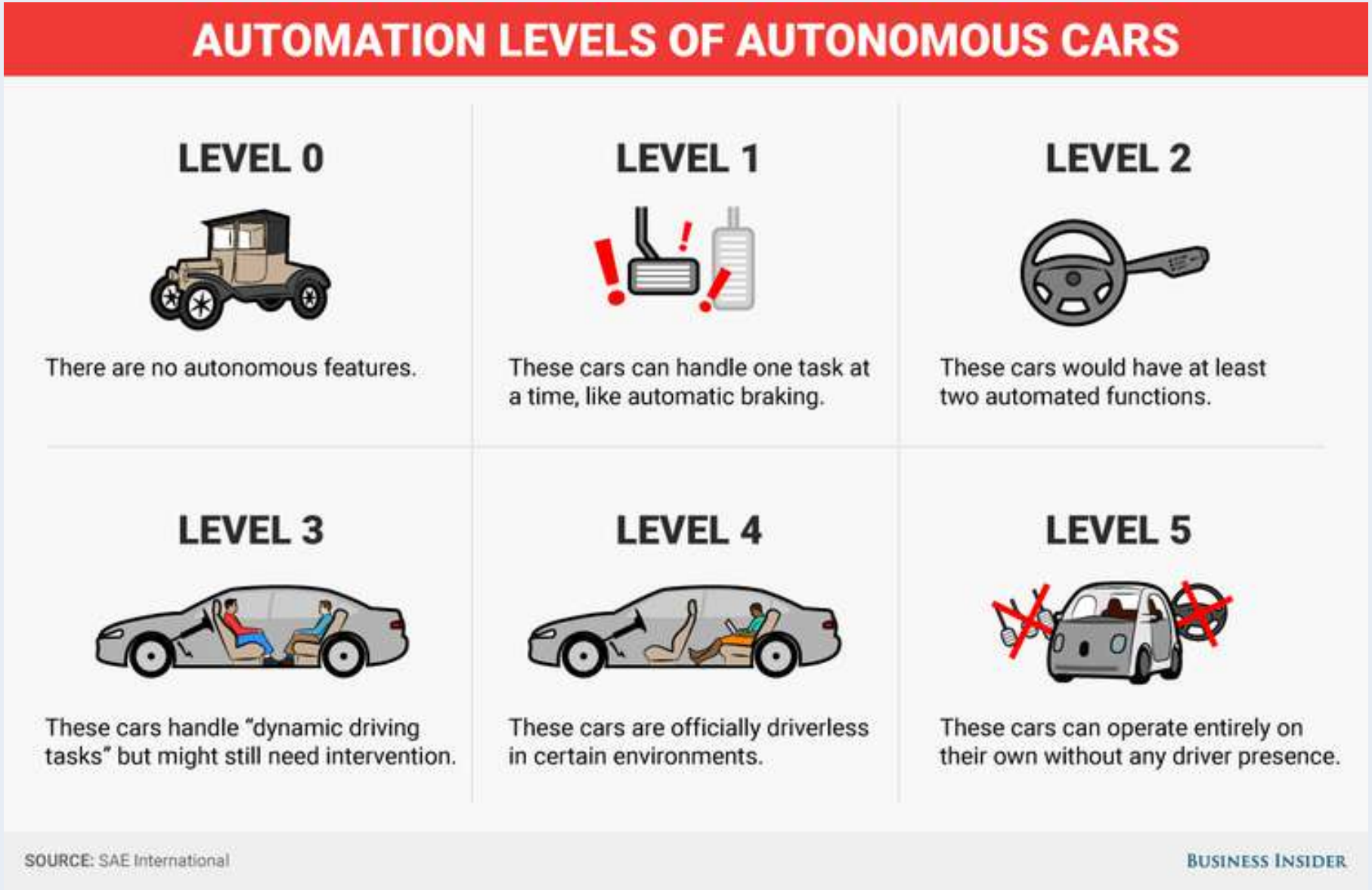


Introduction - Statistical Analysis for accidents studies

- Statistical analysis is used to investigate root causes of accidents and for studying appropriate regulatory policies (Mannering & Bhat, 2014)
- Factors studied: Drivers, roads and vehicles using Chi-square, T,and the F-test (Abbas ,2004)
- Taxi driver fatigue and traffic accidents are correlated(Burgel et al, 2012).

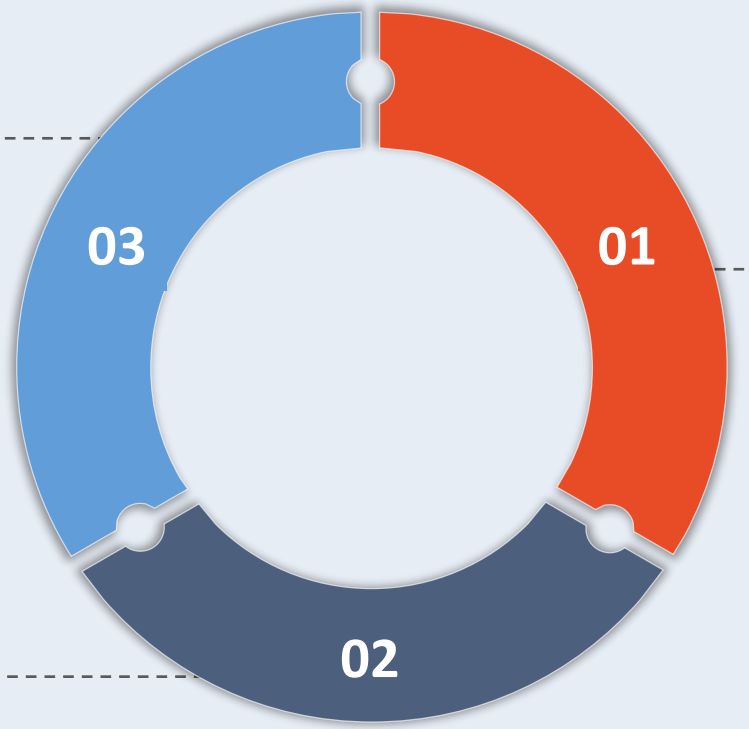


Introduction - Autonomous Level



Introduction – AV expected benefits

Removing the human factor shall reduce the traffic collisions (Nicolaides, et al. 2017)

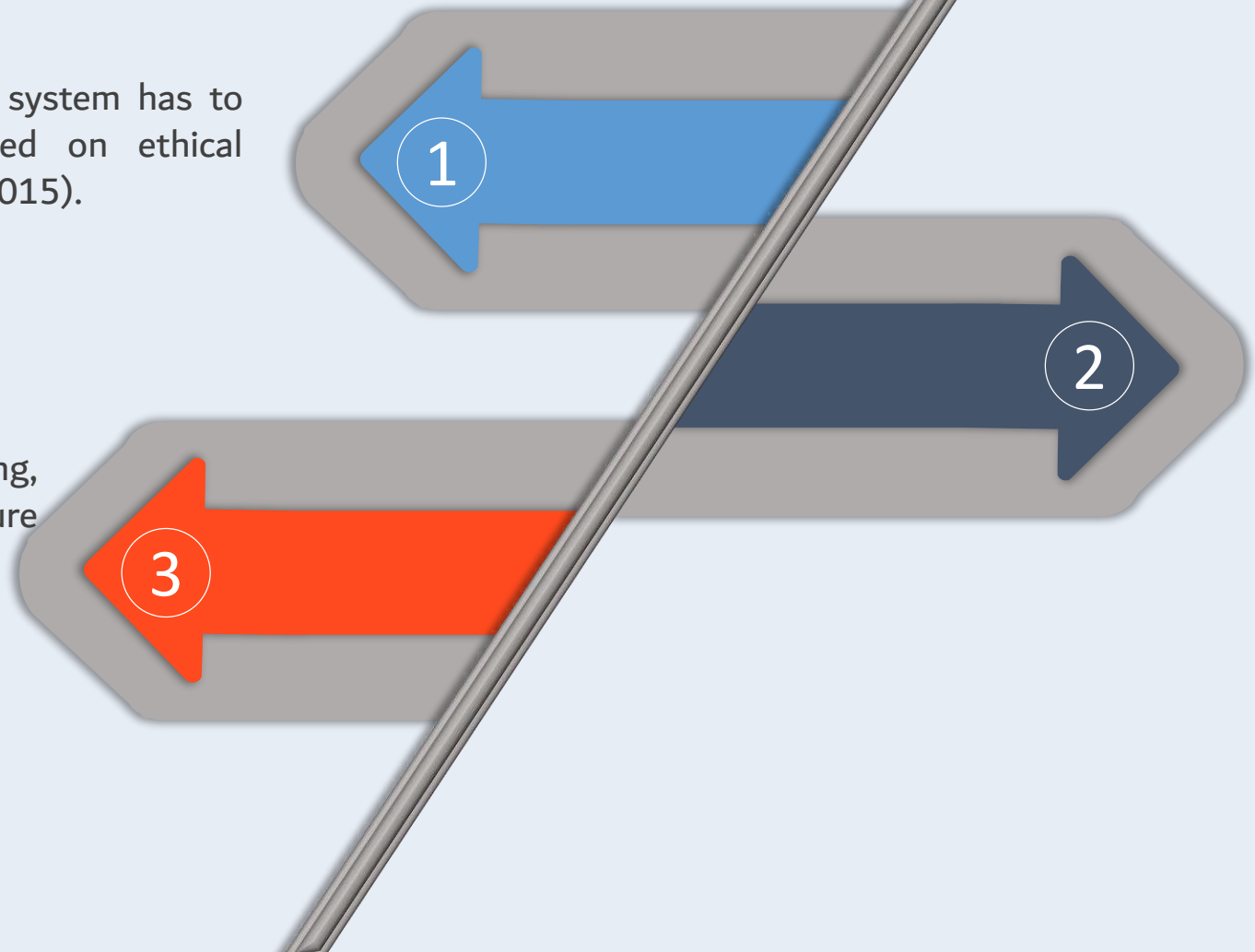


In urban areas, Autonomous taxi are economically more competitive (Bösch et al, 2017).

Level 5 AV will reduce insurance premium by 40%–80% (Stephens et al, 2016).

Introduction - AV expected limitations

Occasionally, the AV system has to make decisions based on ethical considerations (Lin, 2015).



AV will only decrease the probability of accidents (Marchant & Lindor 2012).

AV challenges are hacking, system or hardware failure (Kaur & Giselle, 2018).

MOTIVATION

Identify human factor contributes to taxi accidents

Reduce traffic collision caused by taxi

Explore the contribution of Autonomous Taxi

Research Question

1- What are the key benefits of deploying autonomous taxi for traffic collision avoidance

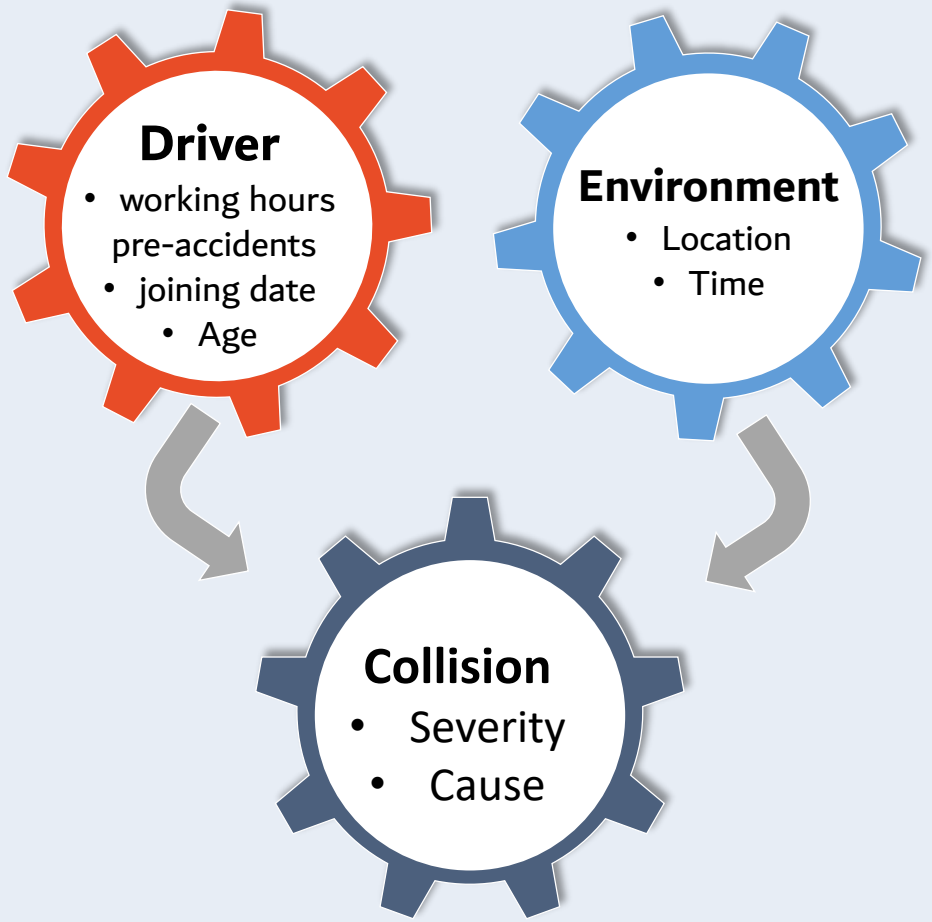
Sub Question 1	What are the human factors that impact traffic Collison for taxi industry
Sub Question 2	What is the baseline for the Benefits of autonomous taxi for traffic collision avoidance

Methodology - Statistical Analysis

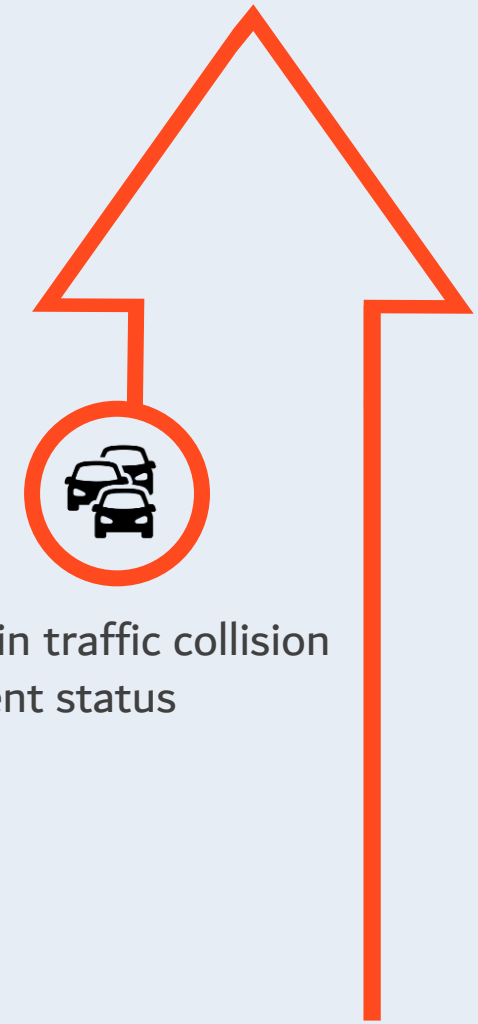
1. Study main characteristics that causes accidents using statistical tests

2. Data : traffic cases between 2016-2017 taxi driver faulty as per police report

3. Analysis will justify road section that will be analyzed by simulation

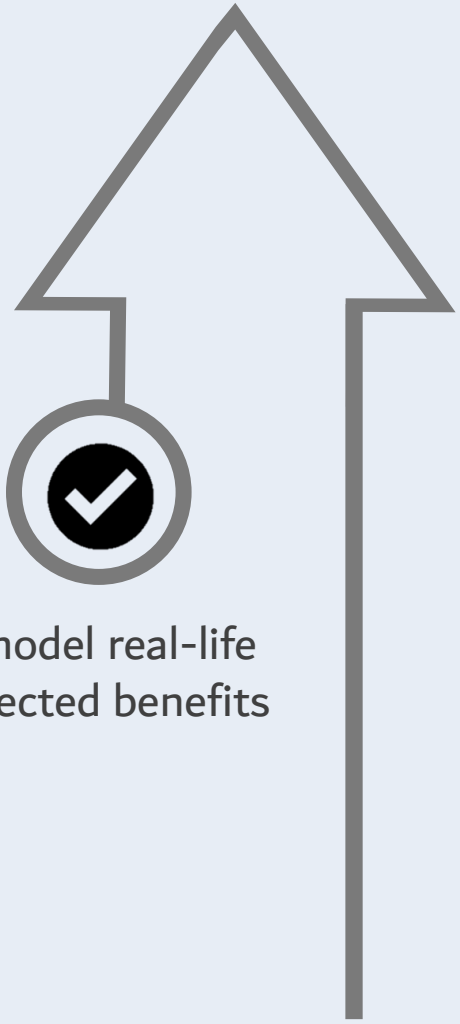


Methodology - Selection Justification



Explain traffic collision current status

Data Availability



Provide simulation model real-life data to evaluate expected benefits

Methodology – Data

Variable	Type	Units	Explanation	Note
Driver ID	nominal	Numbers	Distinguish employee ID	Recently joined drivers have larger ID numbers
Driver's Age	Scale	years	Driver age at the time of traffic collision	Range 20 - 65
Driver's experience	Scale	years	Driver experience at the time of collision	Range 0 - 22
Injury	nominal	0/1	Injuries due to traffic collision	0 is uninjured 1 is injured
Accident Date	Ordinal	Dd/mm/yyyy	Date of occurrence	Between 1st of Jan 2016 and 23-OCT-2017
Accident Reason	nominal	R1 to R10	Collision cause according to police report	To avoid confusion, some reasons were grouped
Accident Location	nominal	0 to 182	Location on the road	Indicates location of traffic collision
Damage location on Unit	nominal	C1 to c12	Rear, front, right, etc.	Location of damage per police report
Accident Level	ordinal	1 to 4	From minor to total loss	According to the insurance company's report
Driving time	Scale	hh:mm:ss	Time between signing on and off. Calculates duty time	Some drivers forgets to sign off causing inaccurate time input.

Results – Descriptive statistics

Most of the drivers are young considering mean, median and range.

Variable	Minimum	Maximum	Mean	Median	Std. Deviation
Accident Level	1	4	1.34	1	.756
exp-TOA (years)	0	22	2.83	1	4.100
age-TOA (years)	21	65	34.32	33	9.175

Most accidents are injury free and no fatalities

	Percent	Cumulative Percent
Non-injury	99.8	99.8
Injury	.2	100.0

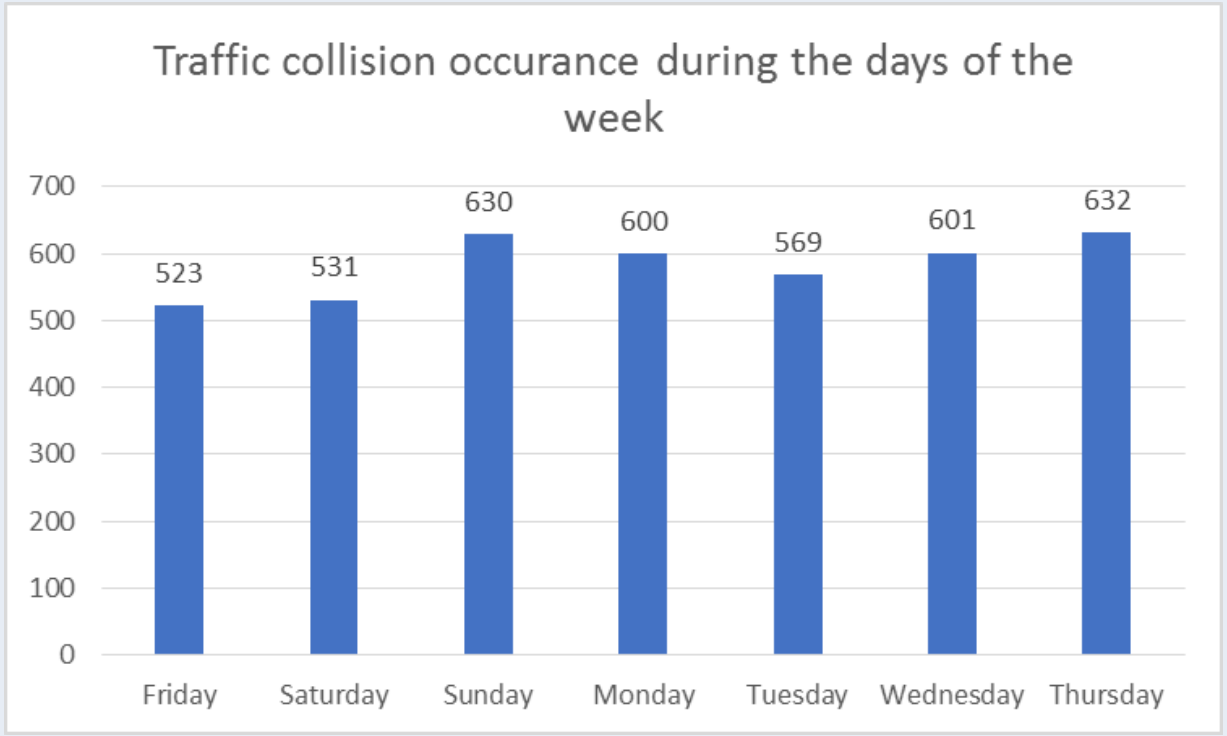
Results – weekday analysis

01

Accidents increases at the start and end of the working days

02

Decline in weekend



Results – Accidents locations

Selection based on accidents density (highest Accidents per area) **01**

Muraqbat and Qusais 1 highest Accident rate **02**

Area code	Area name	Total traffic collision share	Traffic collision per km2
11	Muraqbat	7.2	209
25	Qusais 1	13.3	205
77	Al Barsha 1	9.3	105
17	Rashidiya	7.2	68
157	Bur Dubai	13.9	17

Results – Accident Level

About 90% of accidents are non major

1

No fatalities

2

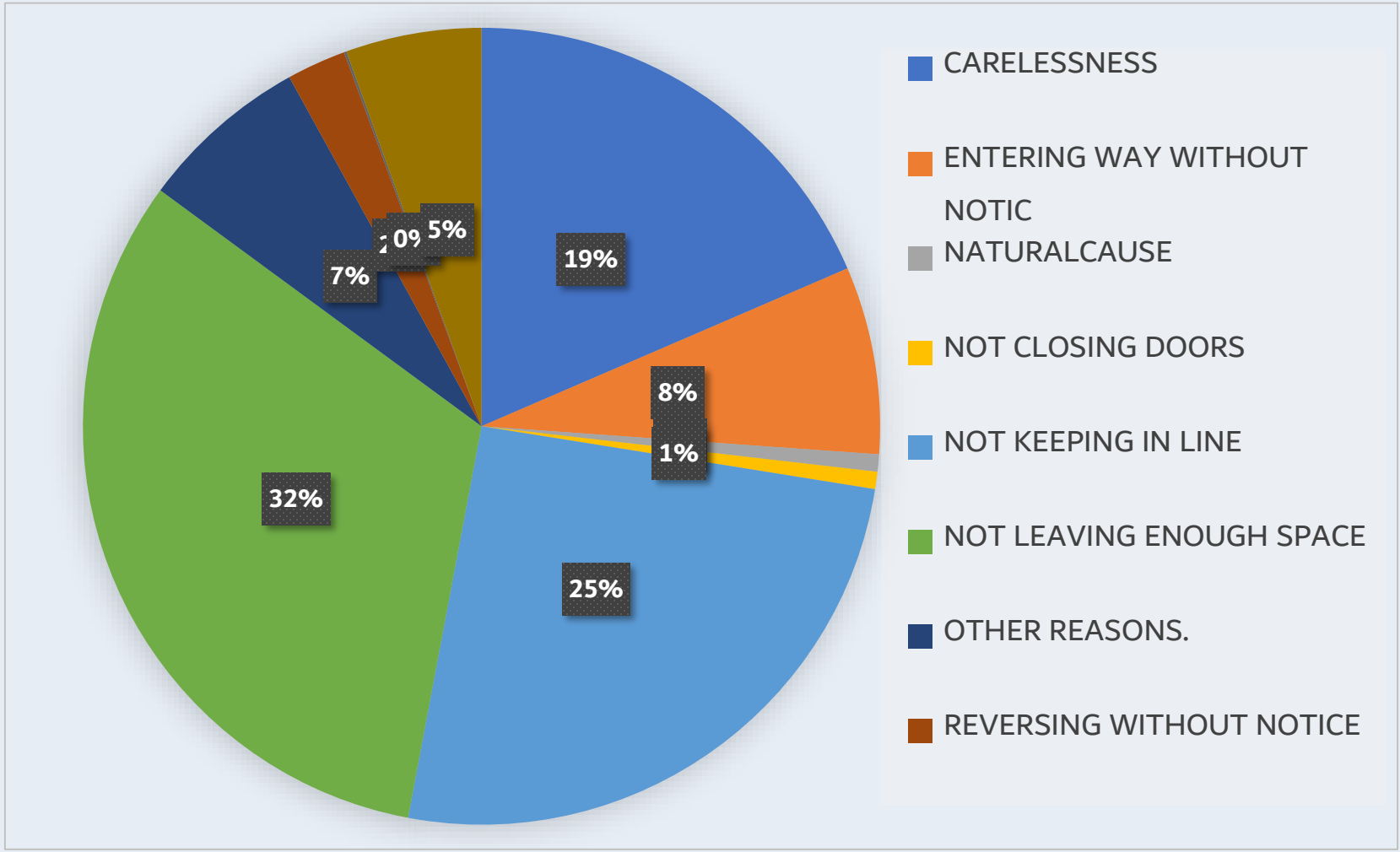
		Percent	Cumulative Percent
Valid	minor	80.3	80.3
	medium	9.0	89.3
	major	7.3	96.6
	total loss	3.4	100.0
	Total	100.0	

Results – Reason of accident

1. Outcome based on police report

2. Not keeping enough distance ,not keeping in line and carelessness contributes to 76%.

3. Most of the reasons above are related to human errors



Results – Age Group

Mean age is 34 years old

Drivers aged over 46 contributed to 13.6 % of the traffic collisions

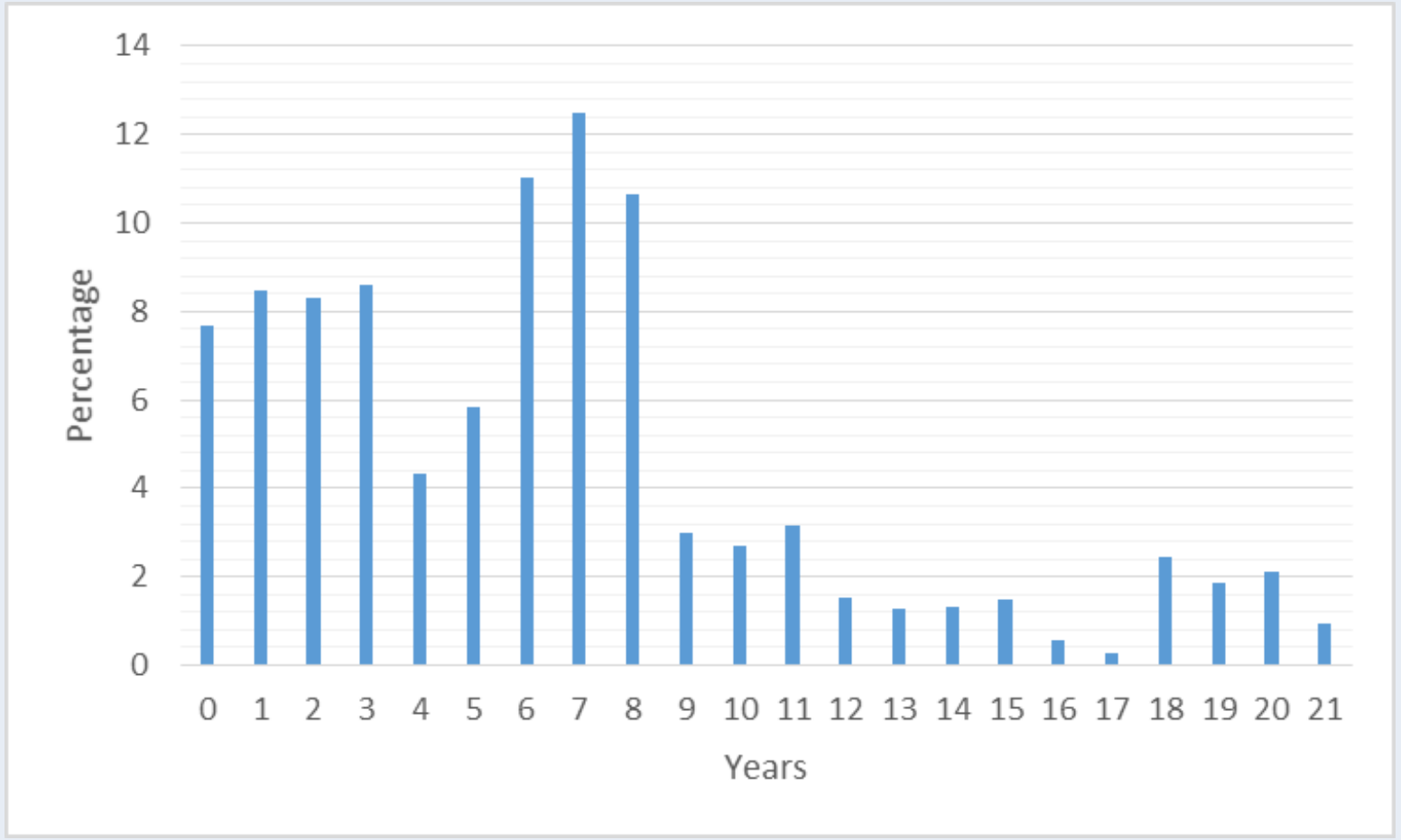
Data is not age normalized

Age group	Percent
21-25	18.40431
26-30	22.46696
31-35	20.53353
36-40	14.83113
41-45	10.13216
46-50	7.684777
51-55	3.230543
56-60	1.933431
61-65	0.783162
Total	100

Results – Overall experience distribution of taxi drivers

More than third of the taxi drivers (34.2%) have between 6-8 years of taxi driving experience in Dubai

25% of taxi drivers have less than 3years of experience.

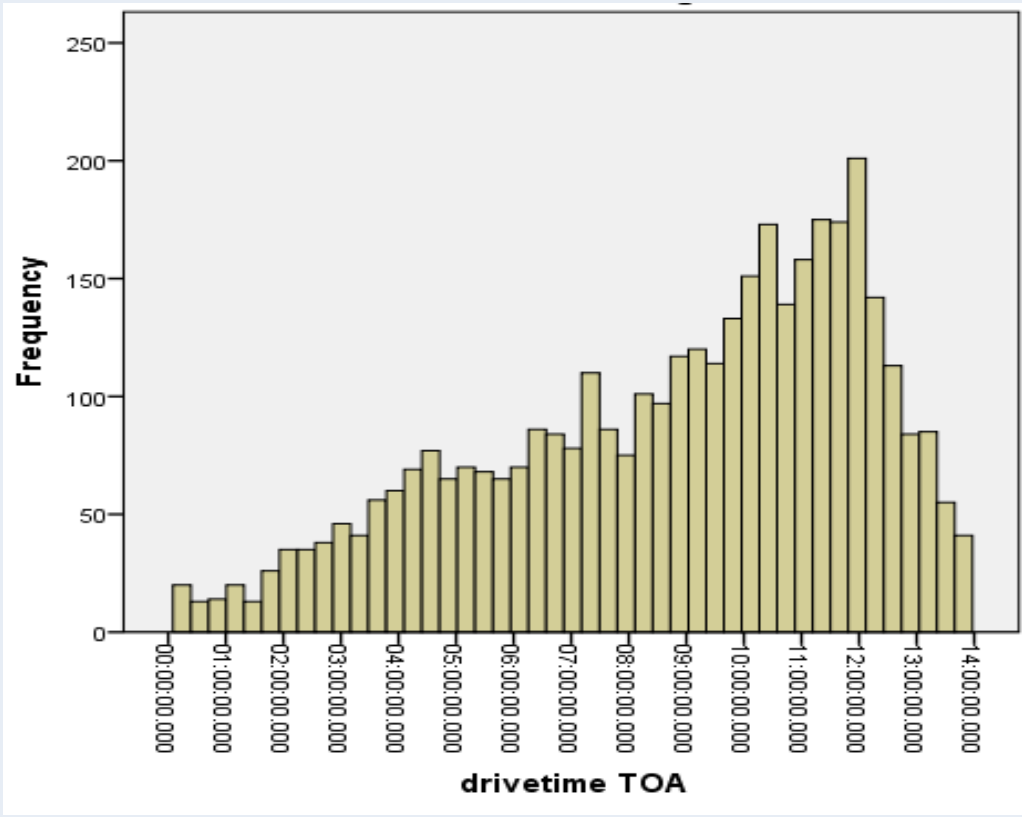


Results – Drivetime

Input errors are related to above 12 hours entry

maximum 12 driving hours with several breaks in between

Figure illustrates a linear relationship



Results – Data reliability

01

Reliability test to study internal relationships within model's variables.

02

Only highly correlated factors are the age to the driver's experience (r=0.671)

03

No signs of multi-correlation

04

Other test conducted ex: Component transformation matrix, heteroscedasticity & autocorrelation test.

		Injury Fatality	exp-TOA	Accident Date	Accident Reason	Accident Location	Accident Cause (damage location on Unit)	Accident Level	ON TIME	OFF TIME	age-TOA	drivetime TOA
Correlation	Injury Fatality	1.000	.002	.008	-.049	.015	.044	.061	.008	.009	.007	.176
	exp-TOA	.002	1.000	-.060	-.013	.035	.013	.011	-.060	-.060	.671	-.018
	Accident Date	.008	-.060	1.000	.021	-.101	.012	-.075	1.000	1.000	-.100	-.004
	Accident Reason	-.049	-.013	.021	1.000	-.023	.024	.026	.021	.021	-.002	-.035
	Accident Location	.015	.035	-.101	-.023	1.000	.014	.036	-.101	-.101	.034	.036
	Accident Cause(damage location on Unit)	.044	.013	.012	.024	.014	1.000	-.008	.012	.012	.017	.019
	Accident Level	.061	.011	-.075	.026	.036	-.008	1.000	-.075	-.074	-.015	.140
	ON TIME	.008	-.060	1.000	.021	-.101	.012	-.075	1.000	1.000	-.100	-.004
	OFF TIME	.009	-.060	1.000	.021	-.101	.012	-.074	1.000	1.000	-.100	.000
	age-TOA	.007	.671	-.100	-.002	.034	.017	-.015	-.100	-.100	1.000	.002
	drivetime TOA	.176	-.018	-.004	-.035	.036	.019	.140	-.004	.000	.002	1.000

a. Determinant = .000

b. This matrix is not positive definite.

Results – Hypothesis test 1 (ANOVA)

01

Level of accident and drive time relationship

02

Reject the null hypotheses since we have statistical evidence that longer drive times are more likely to cause more serious traffic collisions.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	372129787387.503	3	124043262462.501	27.668	.000
Within Groups	18300887977085.820	4082	4483314056.121		
Total	18673017764473.324	4085			

Results – Hypothesis test 2 (Chi-Square Tests)

Relationship between the location of traffic collision and passengers injuries

1

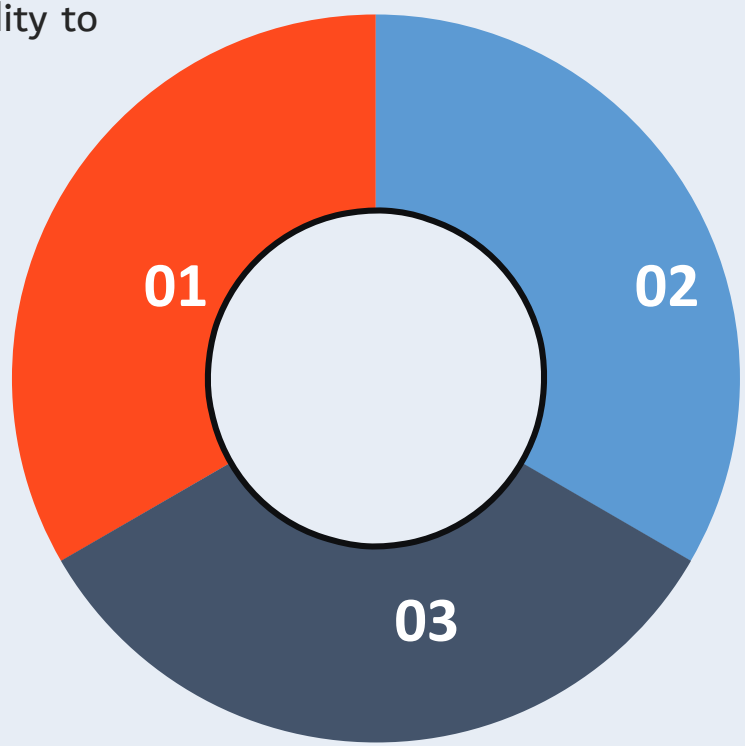
significance is 0.004, reject the null hypotheses and assume a relationship.

2

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	178.469	131	.004
Likelihood Ratio	21.707	131	1.000
Linear-by-Linear Association	.868	1	.351
N of Valid Cases	4086		

Results – Hypothesis test 3 (Ordinal Regression)

Fail to reject hypothesis and assume model improves ability to predict



How accident level can be predicted by accident reason, driver's experience and age

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval		Exp_B	Lower	Upper
							Lower Bound	Upper Bound			
Threshold	[AccidentLevel = 1]	-0.397	0.774	0.263	1	0.608	-1.914	1.12	0.673	0.148	3.066
	[AccidentLevel = 2]	0.355	0.774	0.211	1	0.646	-1.162	1.872	1.426	0.313	6.504
	[AccidentLevel = 3]	1.71	0.777	4.84	1	0.028	0.187	3.233	5.527	1.205	25.343
Location	ageTOA	0.025	0.013	3.523	1	0.049	-0.001	0.051	1.025	0.999	1.052
	expTOA	-0.012	0.006	3.788	1	0.048	-0.024	0	0.988	0.977	1
	[AccidentReason=R1]	-1.093	0.768	2.029	1	0.154	-2.597	0.411	0.335	0.074	1.509
	[AccidentReason=R10]	-1.429	0.769	3.453	1	0.063	-2.937	0.078	0.239	0.053	1.081
	[AccidentReason=R2]	-2.121	0.763	7.741	1	0.005	-3.616	-0.627	0.12	0.027	0.534
	[AccidentReason=R3]	-1.072	0.758	1.997	1	0.158	-2.558	0.415	0.342	0.077	1.514
	[AccidentReason=R4]	-1.662	0.762	4.758	1	0.029	-3.156	-0.169	0.19	0.043	0.845
	[AccidentReason=R5]	-1.768	0.778	5.163	1	0.023	-3.294	-0.243	0.171	0.037	0.784
	[AccidentReason=R6]	-2.672	0.853	9.815	1	0.002	-4.344	-1	0.069	0.013	0.368
	[AccidentReason=R7]	3.346	0.89	14.138	1	0	1.602	5.09	28.391	4.962	162.431
	[AccidentReason=R8]	-22.831	0		1		-22.831	-22.831	0	0	0
	[AccidentReason=R9]	0			0				1		

Accident reason with lowest odds is number 6 (reverse without notice) indicates that its usually associated with accidents of lower level. Natural causes (number 7) and not leaving enough space causes more serious accidents

Discussion

- Human factor relevant for most taxi accidents
- Maintain experienced taxi drivers
- Drive time cap policy is effective
- AV systems are expected reduce accidents greatly.
- Further simulation to validate assumptions.

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Any Questions?

Thank you for your listening