ITS SEMINAR AND EXHIBITION 2017

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INTELLIGENT TRANSPORT SYSTEM ASSOCIATION OF MALAYSIA

Preliminary Analysis of Rollover Scenario Considering Overloading Situation

Presented by:

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Project Overview

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Year	Total
2009	46724
2010	50438
2011	53078
2012	42158

Table 1: Total of Heavy vehicles Involved in Road Accidents, Malaysia, 2009-2012. [2]

Fig. 1: Rollover of Single Truck-Trailer on curve road [4]

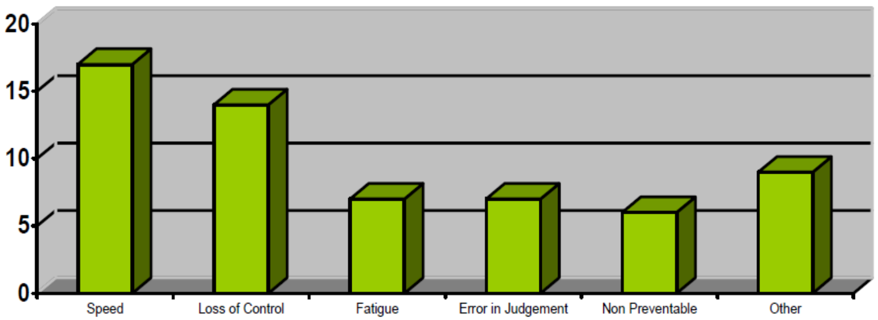

Table 2: Cause of rollover prepared by Safety Advisory Group European Industrial Gases Association [9]

Project Overview

Vehicle rollover contributes a significant percentage of fatal accidents, mainly in the Malaysia.

It happen when the heavy vehicle is being unstable during cornering due to vehicle characteristics, road conditions, and driving behaviour.

Consequences of heavy vehicle accident

- Vehicle and cargo damage are significant to the company expenses
- Severe traffic disruption
- Hazardous cargos have the potential to cause environmental or human disaster if they are spilled
- Rollover crashes are much more likely to result in driver fatalities than crashes that do not involve rollover

Fig. 2: Overloading and speeding heavy vehicle spotted in Malaysia

Project Overview

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OBJECTIVES OF THE RESEARCH

– To develop and simulate the virtual heavy vehicle model on curve road with varies parameters

– To examine the effects of vehicle characteristics, namely the Gross Vehicle Weight (GVW), vehicle types and speeds, and road conditions (wet and/or dry) on rollover

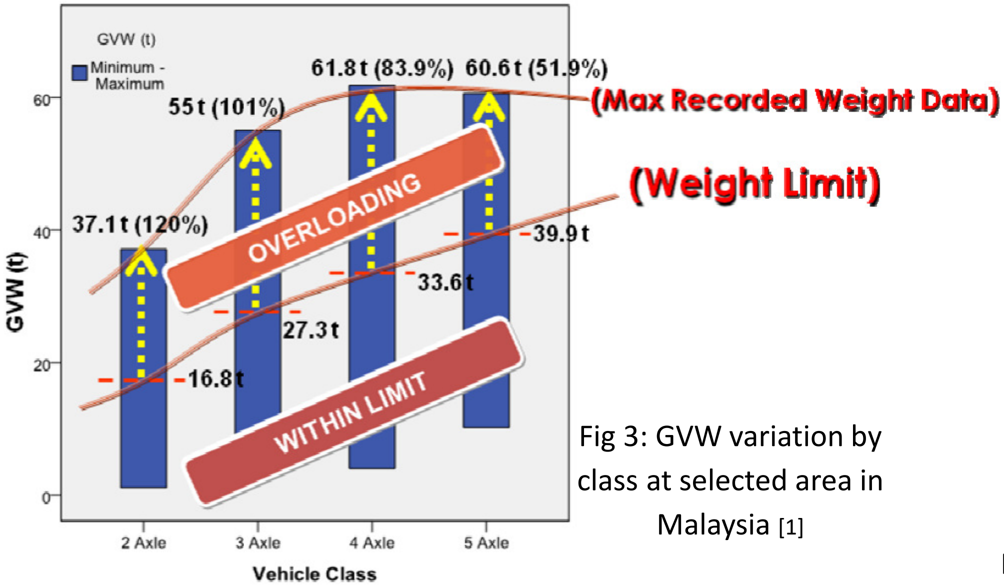

Fig 3: GVW variation by class at selected area in Malaysia [1]

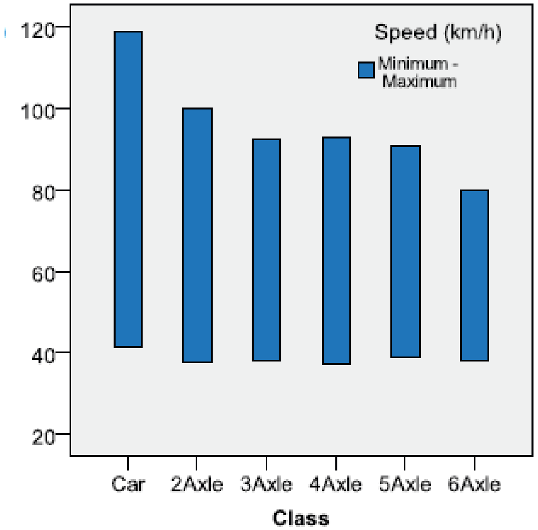

Fig 4: The matrix scatter plot showing the relationship of speed over vehicle class on selected area in Malaysia [3]

Methodology

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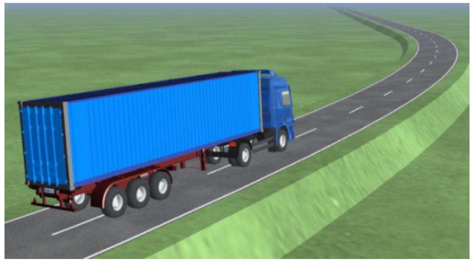
HV's model development

HV model validation

HV model configuration and simulation setting

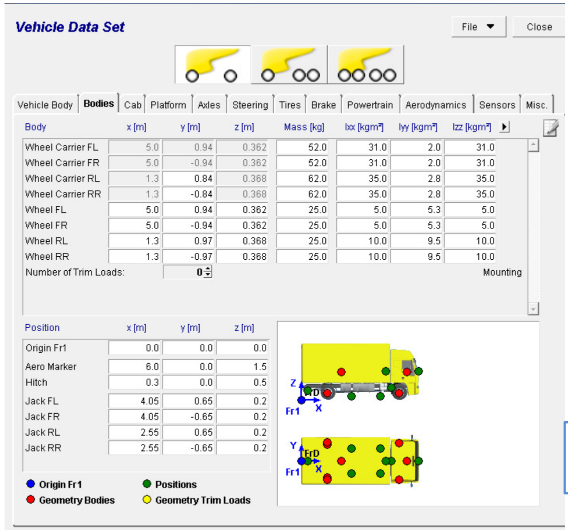
Simulation

Data Preparation, Result and Discussion



Methodology

Vehicle Development and validation



Tyre size and type?

Suspension system?

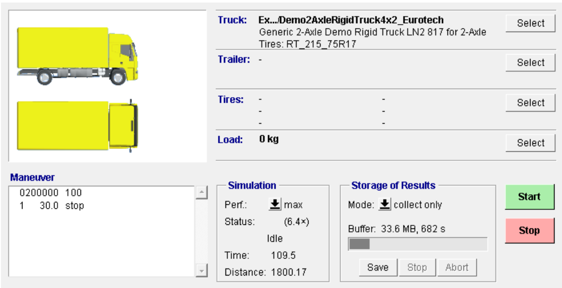
Steering system?

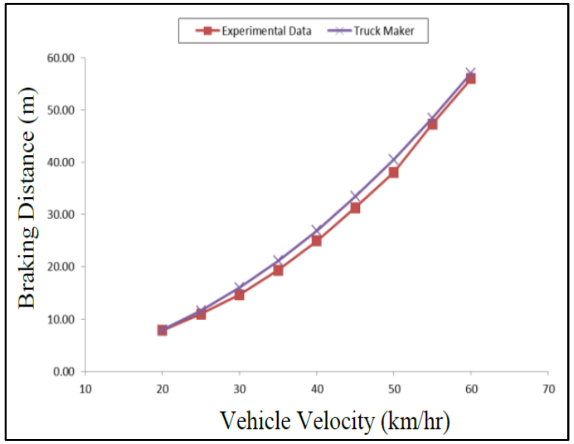
Powertrain and Drivetrain?

Vehicle dimension?

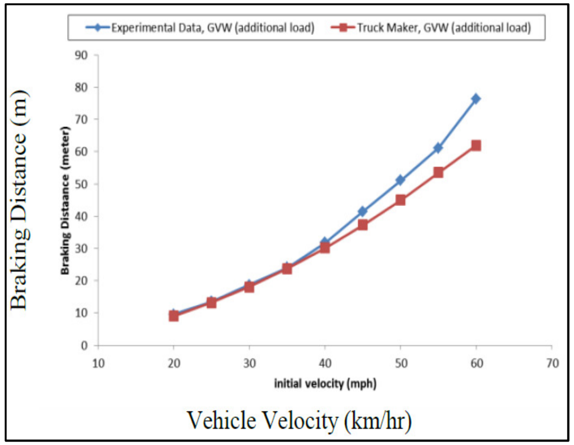
Brake system?

Vehicle graphic?





(a)



(b)

Fig 5: Axle SUT model validation for braking test on straight line. (a) Kerb Weight, (b) 5 tonne load [5]

Methodology

Heavy Vehicle Configuration and Simulation Setting

Environmental Conditions

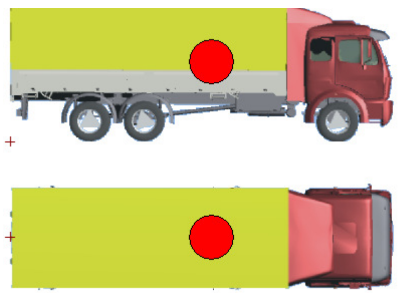
- Coefficient of friction
- Radius of curvature
- Super Elevation

Vehicle's characteristics

- GVW
- Vehicle Type (SUT, STT)
- Load CoG
- Speed

Driver's characteristics

- Normal



GVW	Varies with type of Heavy Vehicle
Cornering radius	150 m, curve to the left side
Speed	From 40km/h until 120km/h (10km/h interval)
Coefficient of friction	0.3, 0.5 and 0.7
Driver mode	Normal, drive on left lane
Load CoG	Center of wheelbase, track width and height

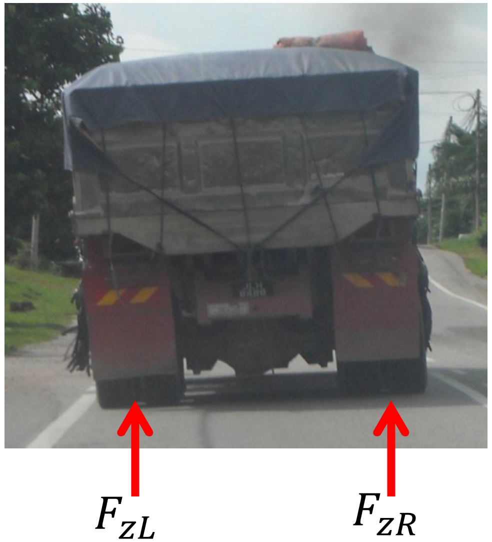
Table 3: Simulation Setting for Road Design and Driver Mode

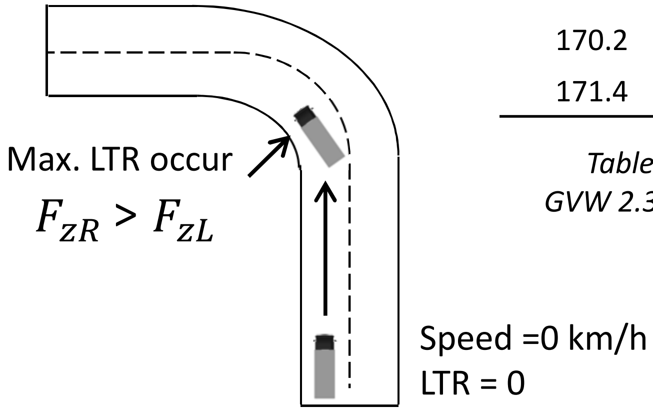
Vehicle type	Model	Kerb Weight (tons)	Maximum load added (tons)
2-Axle SUT	Iveco-Eurotech	2.3	35
3-Axle SUT	MB-Atego	6.9	50
4-Axle SUT	MB-Atros	10.0	60
4-Axle Truck-trailer	MB-Atros	11.0	60
5-Axle Truck-trailer	MB-Atros	13.0	75

Table 4: Vehicle Type and Basic Design Specification

Result and Discussion

Load Transfer Ratio (LTR)





$$LTR = \frac{F_{zR} - F_{zL}}{F_{zR} + F_{zL}}$$

Heavy Vehicle Type	2 Axle SUT	3 Axle SUT	4 Axle SUT	4 Axle STT	5 Axle STT
Total Simulation	216	297	351	351	432

Table 5: Total simulation number for each heavy vehicle type

Time (s)	Load Transfer Ratio
0.3	0.000088
0.6	0.000059
.	.
.	.
100.2	$\boxed{0.07}$
.	.
.	.
170.2	0.000048
171.4	0.000069

Table 6: 2 axle SUT simulation with GVW 2.3 tonne (μ=0.3, Speed=40km/h)

GVW (tonne)	Coefficient of friction		
	0.3	0.5	0.7
	Load Transfer Ratio		
2.3	$\boxed{0.07}$	0.07	0.07
7.3	0.08	0.08	0.08
12.3	0.09	0.08	0.08
17.3	0.09	0.09	0.09
22.3	0.13	0.10	0.09
27.3	0.16	0.13	0.11
32.3	0.17	0.16	0.14
37.3	0.24	0.19	0.17

Table 7: Maximum LTR obtained for 2 axle SUT (Speed=40 km/h)

= Safe
= Unsafe

Result and Discussion

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GVW (tonne)	Coefficient of friction		
	0.3	0.5	0.7
	Load Transfer Ratio		
2.3	0.54	0.51	0.52
7.3	0.56	0.55	0.54
12.3	0.60	0.57	0.55
17.3	0.68	0.59	0.57
22.3	0.96	0.62	0.61
27.3	0.97	0.64	0.63
32.3	0.98	0.66	0.64
37.3	0.99	0.98	0.70

Table 8: Maximum LTR obtained for 2 axle SUT (Speed = 80 km/h)

GVW (tonne)	Coefficient of friction		
	0.3	0.5	0.7
	Load Transfer Ratio		
2.3	0.69	0.63	0.62
7.3	0.79	0.68	0.66
12.3	0.88	0.78	0.72
17.3	0.97	0.82	0.81
22.3	0.97	0.95	0.99
27.3	0.98	0.97	0.99
32.3	0.98	0.99	1.00
37.3	1.00	1.00	1.00

Table 9: Maximum LTR obtained for 2 axle SUT (Speed = 120 km/h)

= Safe

= Unsafe

Result and Discussion

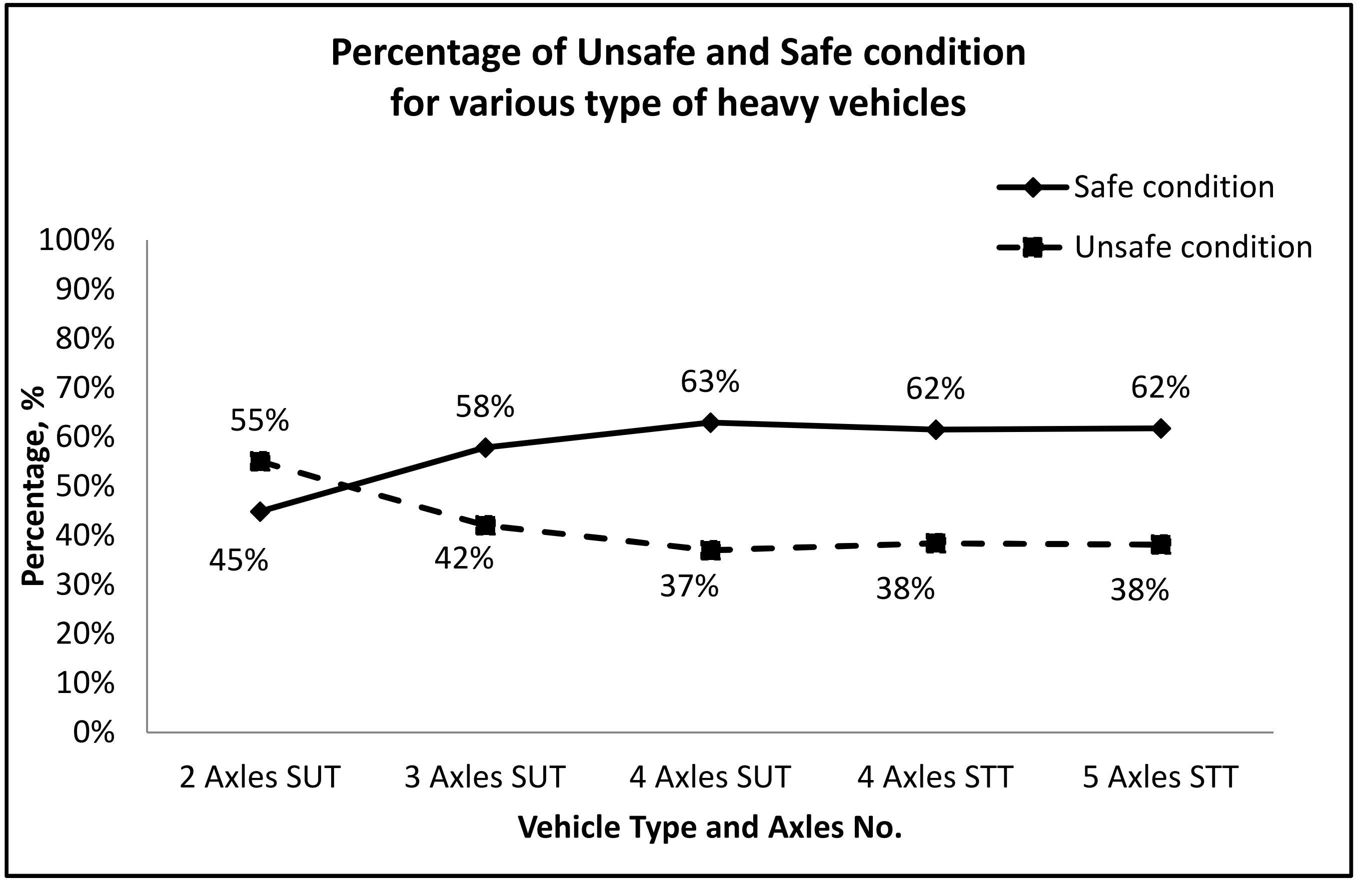


Figure 6: Percentage distribution of safe and Unsafe condition

Result and Discussion

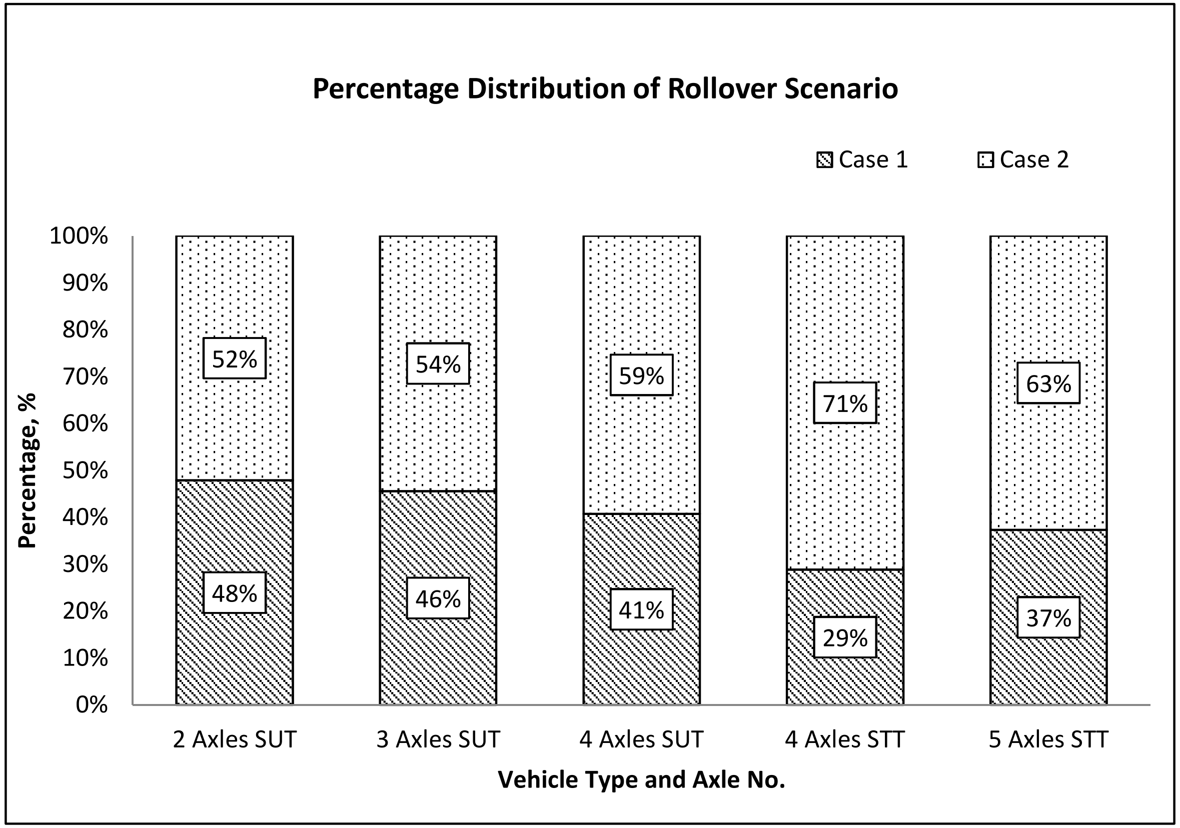
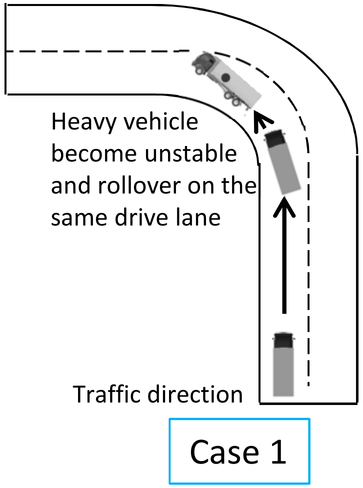
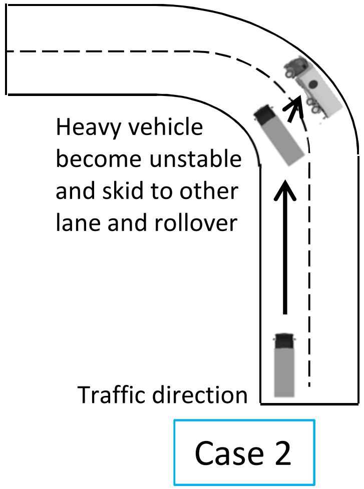


Figure 7: Rollover Scenario percentage distribution.
Case 1: Rollover on Drive lane; Case 2: Rollover on other lane or out of bound





Conclusion

From the research done, it clearly show there were significant effect of GVW, speed and road condition on rollover when cornering at 150m curve radius.

It also shown that **unsafe condition** can be identified through the calculation of the maximum **load transfer ratio** (LTR) during cornering.

From the simulation result, 2 Axles SUT showed the highest percentage of Unsafe condition compare to the other type of heavy vehicles.

It also observed that the rollover scenario could occur on the same drive lane, skid to the other lane, or out of bound and rollover. The overall percentage of rollover occurring on the same drive lane decreases by number of axles for SUT, but increases for STT.

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ACKNOWLEDGMENT

The authors gratefully acknowledge support from Science fund Grant (ref No: 03-01-03-SF0772) and PPP (Peruntukan Penyelidikan Pascasiswazah) Grant (Project No: PG093-2013B)

Thank You
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