

# ANALYSIS OF THE IMPACT OF ENGINEERING MEASURES ON TRAFFIC SPEED CALMING

Vladimir Ilić, Boško Matović, Radoje Vujadinović, Milanko Damjanović, Sreten Simović

University of Montenegro, Faculty of Mechanical Engineering

*"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."*

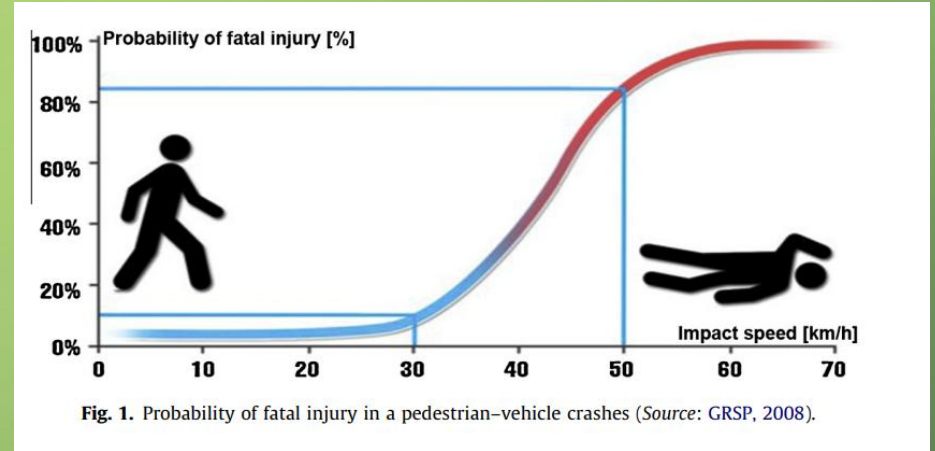
**Partnership for Promotion and Popularization of Electrical Mobility through Transformation and Modernization of WB HEIs Study Programs/PELMOB**

Call: ERASMUS-EDU-2022-CBHE-STRAND-2

Project Number: 101082860

## THE PROBLEM OF SPEED IN TRAFFIC

- The problem is most pronounced in areas with high speed dispersion, as well as in urban environments
- Speed primarily affects the likelihood of a traffic accident occurring, but also influences the severity of its consequences

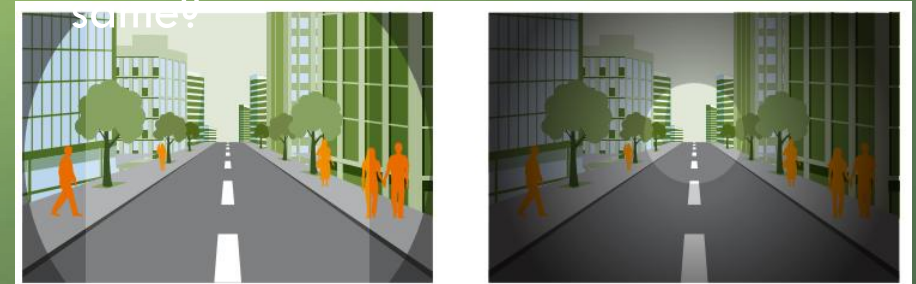


AN ANALYSIS OF TRAFFIC SAFETY PERFORMANCE INDICATORS IN MONTENEGRO



In 2023, the overall rate of speeding violations reached **58%**

30 km/h and 50 km/h are not the same?



## TRAFFIC CALMING MEASURES

Vibro-acoustic strips



Small dot-shaped rubber bumps



Small plastic bumps



Speed cushions



Raised platform



Rubber bump on the road



Raised pedestrian platform

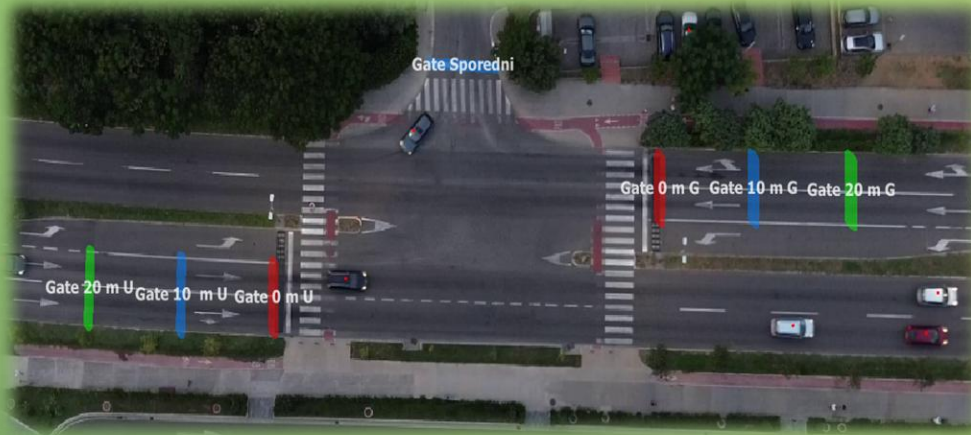


Damaged rubber elements

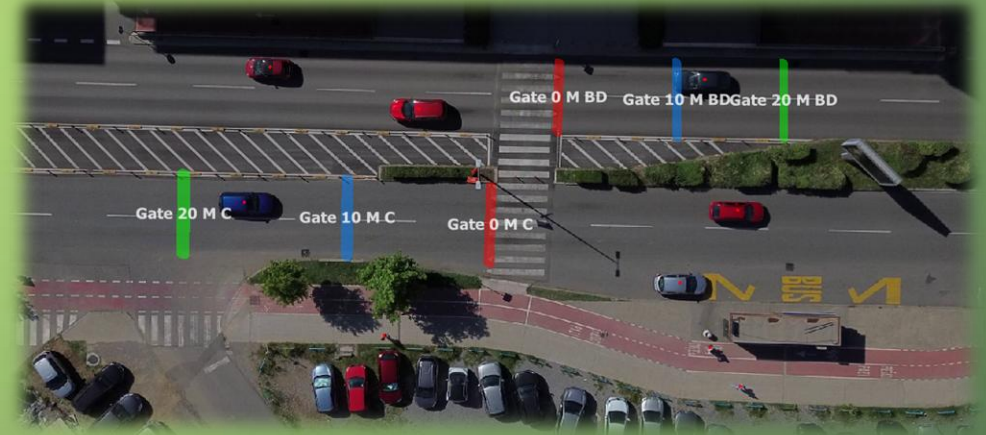


## RESEARCH

**Location A** – Boulevard of Montenegrin Commanders  
Rubber Traffic Calming Elements  
Height of rubber elements: 5 cm



**Location B** - Cetinje Road  
Asphalt Traffic Calming Platform  
Height of the platform: 4 cm



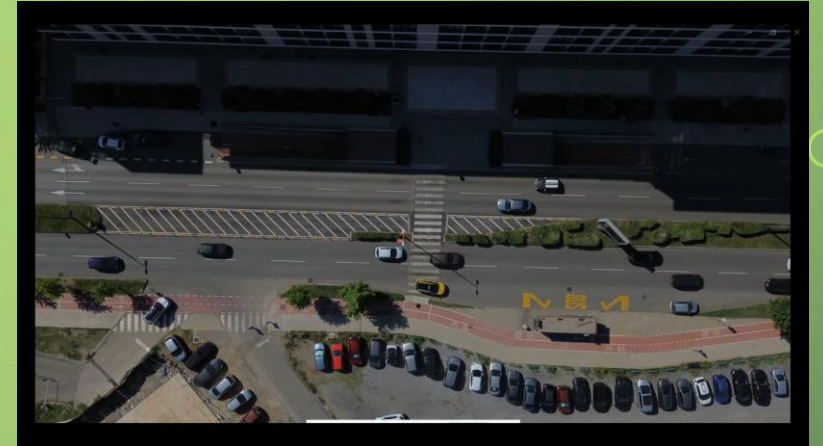
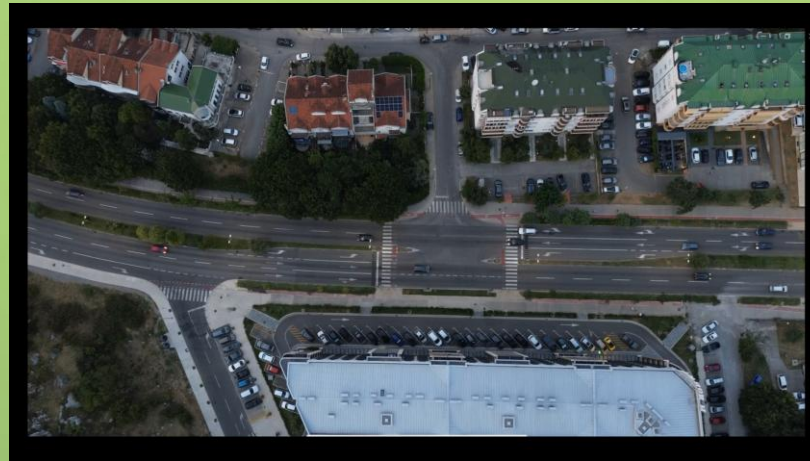
Speed limit at locations:  
30 km/h



## RESEARCH



Drone DJI MINI 3



## DATAFROMSKY

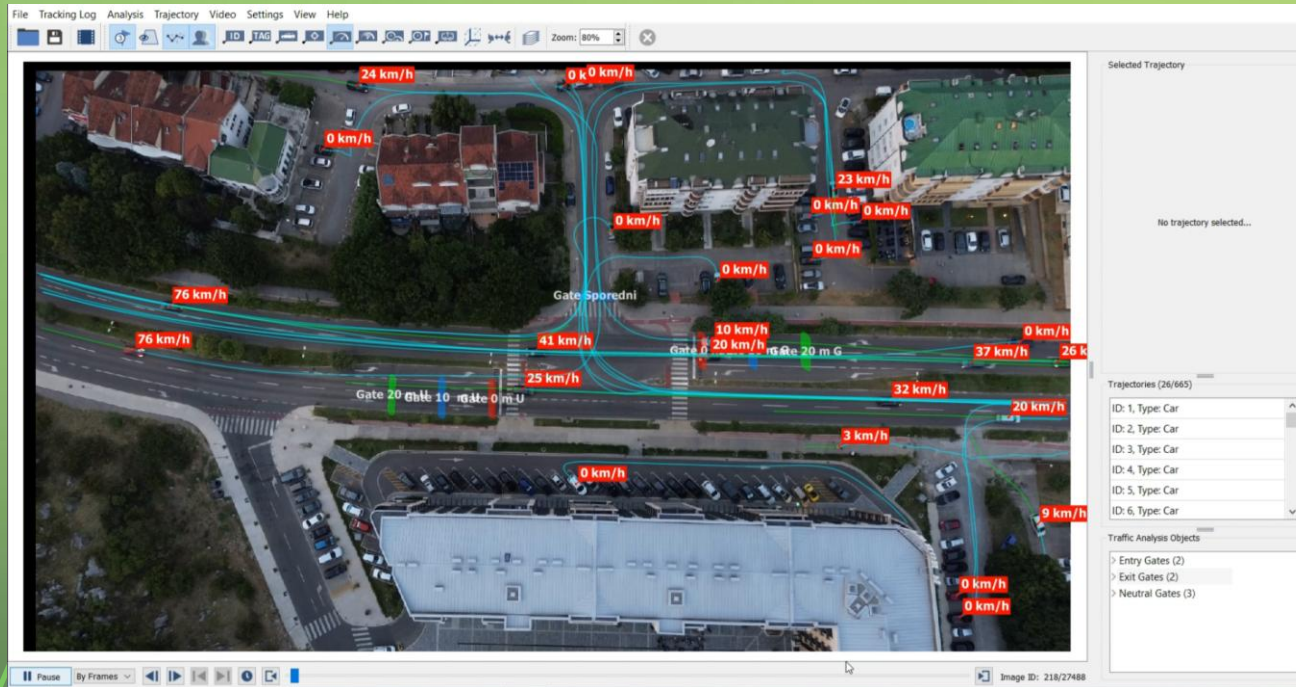
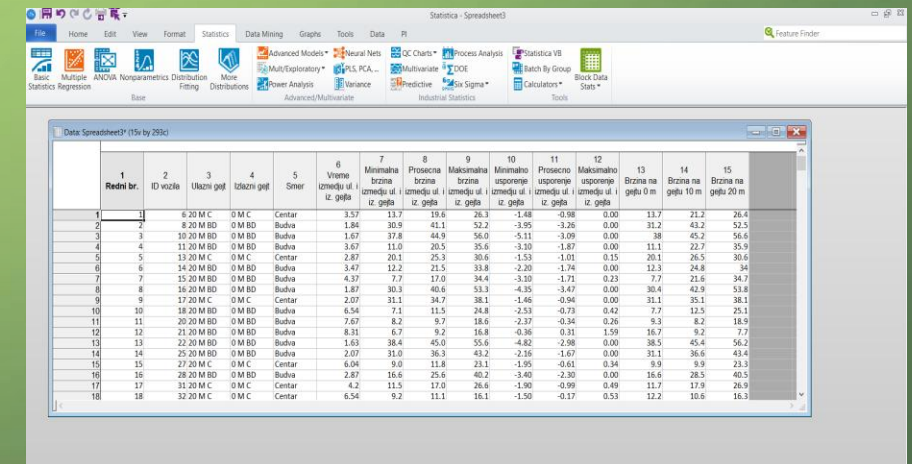
- Software in which the obtained data were processed



## STATISTICA



## Data analysis

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Redni br.	ID vozila	Ukazni get	Izlazni get	Smjer	Vrijeme između ul i iz geta	Minimalna brzina između ul i iz geta	Prosečna brzina između ul i iz geta	Maksimalna brzina između ul i iz geta	Minimalno usporeno između ul i iz geta	Prosečno usporeno između ul i iz geta	Maksimalno usporeno između ul i iz geta	Brzina na getu 0 m	Brzina na getu 10 m	Brzina na getu 20 m
1	6 20 M C	O M C	Centar		3,57	13,7	19,6	26,3	-1,48	-0,98	0,00	11,7	21,2	26,4
2	8 20 M BD	O M BD	Buđva		1,84	30,9	41,1	52,2	-3,95	-3,26	0,00	31,2	43,2	52,5
3	10 20 M BD	O M BD	Buđva		1,67	37,8	44,9	54,0	-5,11	-3,09	0,00	38	45,2	56,6
4	11 20 M BD	O M BD	Buđva		3,67	11,0	20,5	35,6	-3,10	-1,87	0,00	11,1	22,7	35,9
5	13 20 M C	O M C	Centar		2,87	20,1	25,3	30,6	-1,53	-1,01	0,15	20,1	26,5	30,6
6	14 20 M BD	O M BD	Buđva		3,47	12,2	21,5	33,8	-2,20	-1,74	0,00	12,3	24,8	34
7	15 20 M BD	O M BD	Buđva		4,37	7,7	17,0	34,4	-3,10	-1,71	0,23	7,7	21,6	34,7
8	16 20 M BD	O M BD	Buđva		1,87	30,3	40,6	53,3	-4,35	-3,47	0,00	30,4	42,9	53,8
9	17 20 M C	O M C	Centar		2,07	31,1	34,7	38,1	-1,46	-0,94	0,00	31,1	35,1	38,1
10	18 20 M BD	O M BD	Buđva		6,54	7,1	11,5	24,8	-2,53	-0,73	0,42	7,7	12,5	25,1
11	20 20 M BD	O M BD	Buđva		7,67	8,2	9,7	18,6	-2,37	-0,34	0,26	8,3	8,2	18,9
12	21 20 M BD	O M BD	Buđva		6,31	6,7	9,2	16,8	-0,36	0,31	1,59	16,7	9,2	7,7
13	22 20 M BD	O M BD	Buđva		1,63	38,4	45,0	55,6	-4,82	-2,98	0,00	38,5	45,4	56,2
14	25 20 M BD	O M BD	Buđva		2,07	31,0	36,3	43,2	-2,16	-1,67	0,00	31,1	36,6	43,4
15	27 20 M C	O M C	Centar		6,04	9,0	11,8	21,1	-1,95	-0,61	0,34	9,9	9,9	23,3
16	28 20 M BD	O M BD	Buđva		2,87	16,6	25,6	40,2	-3,40	-2,30	0,00	16,6	28,5	40,5
17	31 20 M C	O M C	Centar		4,2	11,5	17,0	26,6	-1,90	-0,99	0,49	11,7	17,9	26,9
18	32 20 M C	O M C	Centar		6,54	9,2	11,1	16,1	-1,50	-0,17	0,53	12,2	10,6	16,3

Gate positions, a total of 6 intersections where data is recorded

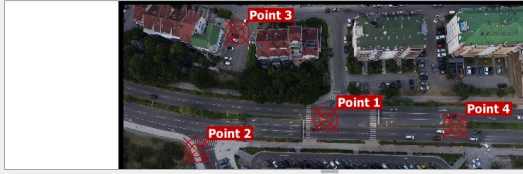
Device for georeferencing points



## HOW TO OBTAIN VEHICLE SPEEDS IN KM/H


Manual Geo-Registration Wizard

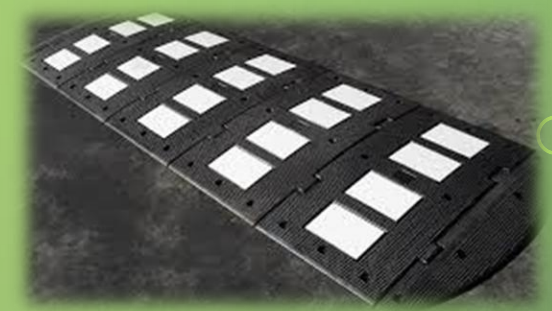
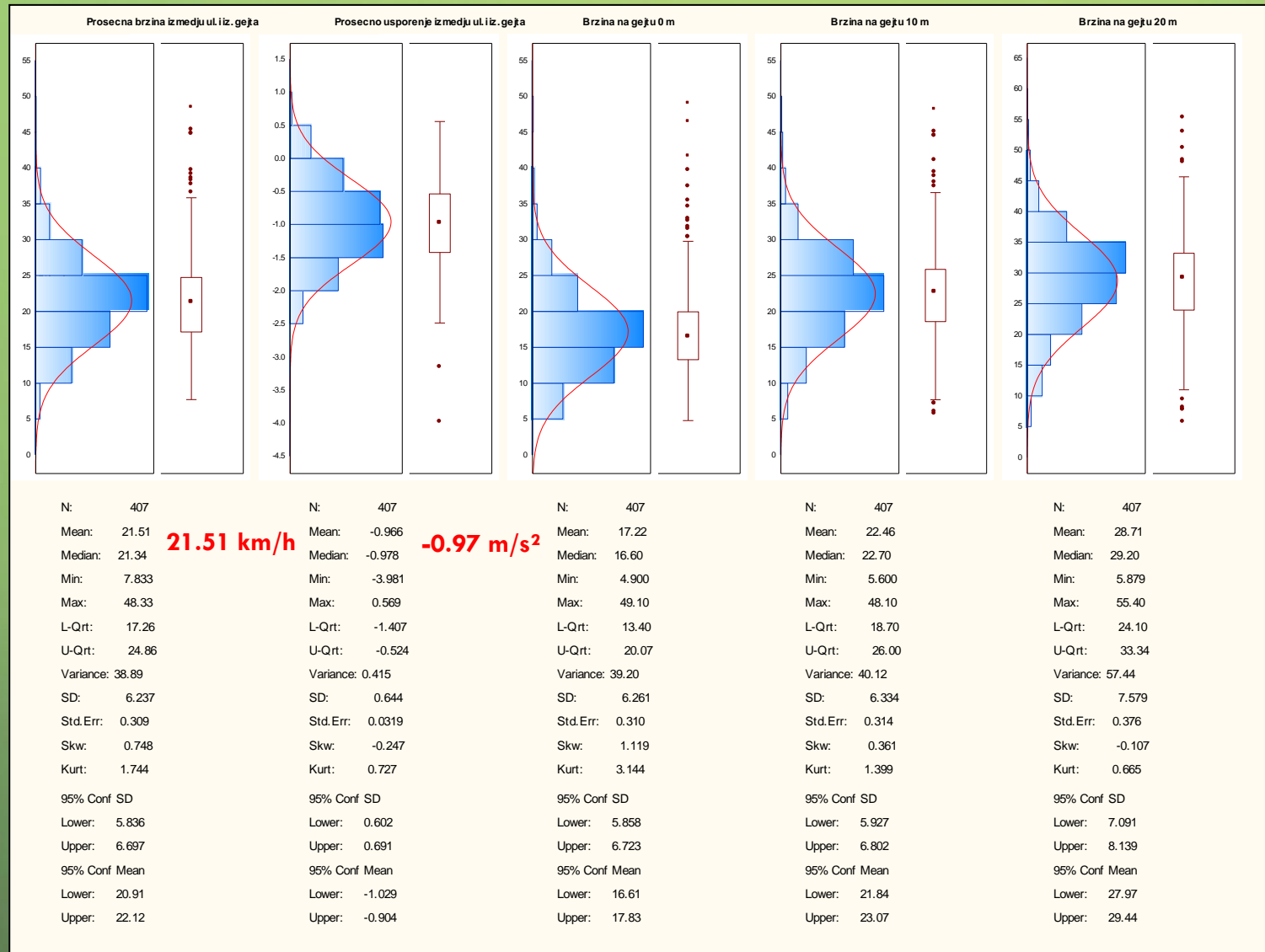
**Corresponding Points**  
Provide at least four corresponding points with map coordinates.



Tag	Latitude [deg]	Longitude [deg]	Image X [px]	Image Y [px]
Point 1	42.4327552000	19.2559560000	980	560
Point 2	42.4328907000	19.2551170000	368	706
Point 3	42.4333357000	19.2556720000	562	147
Point 4	42.4325317000	19.2566462000	1591	590

< Back   Next >   Cancel





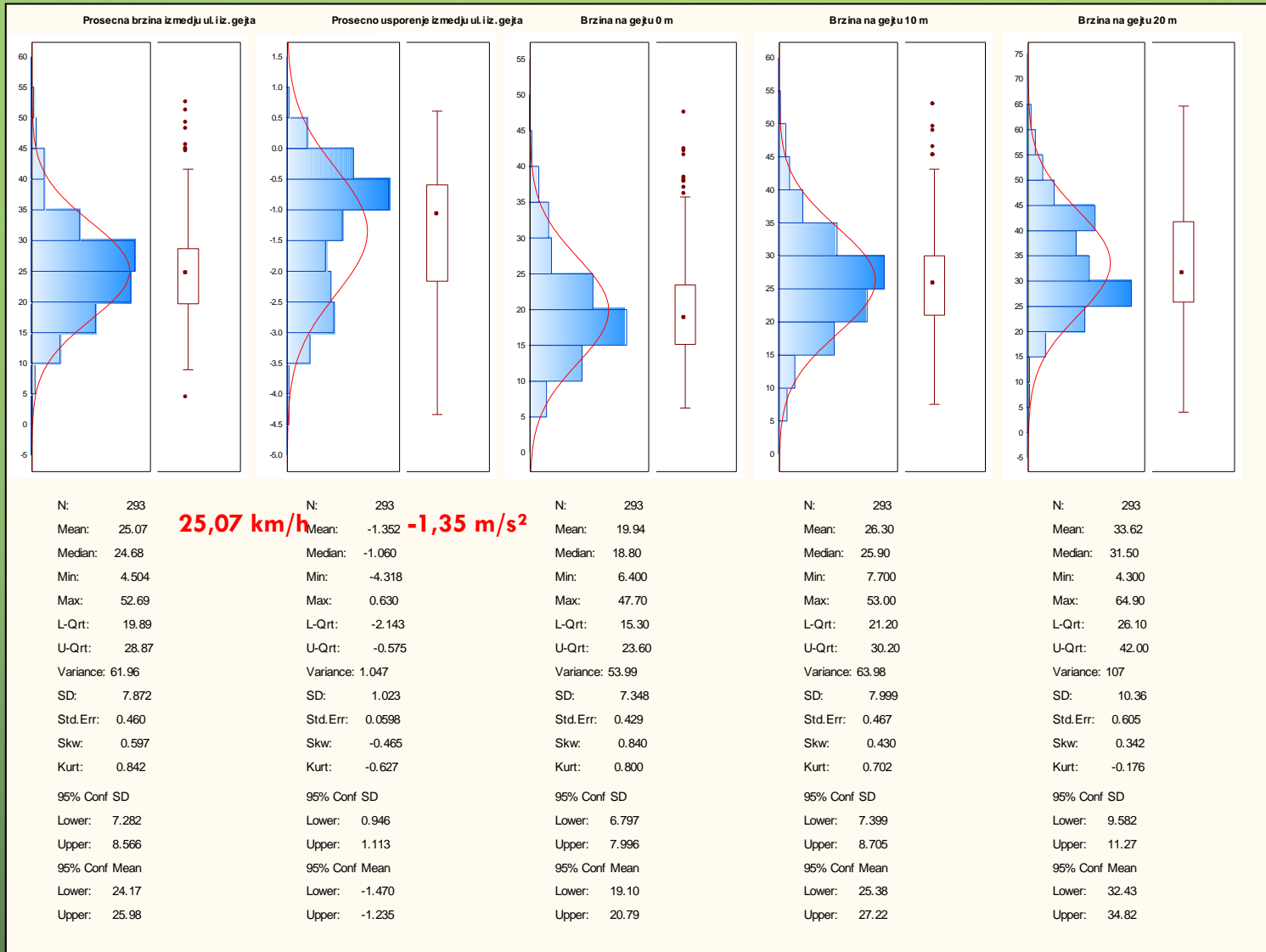
## LOCATION A

Number of vehicles: 407

Gintaš-Union: 47,7%

Union-Gintaš: 52,3%

Distances of intersections  
(gates): 0m, 10m and 20m



## LOCATION B

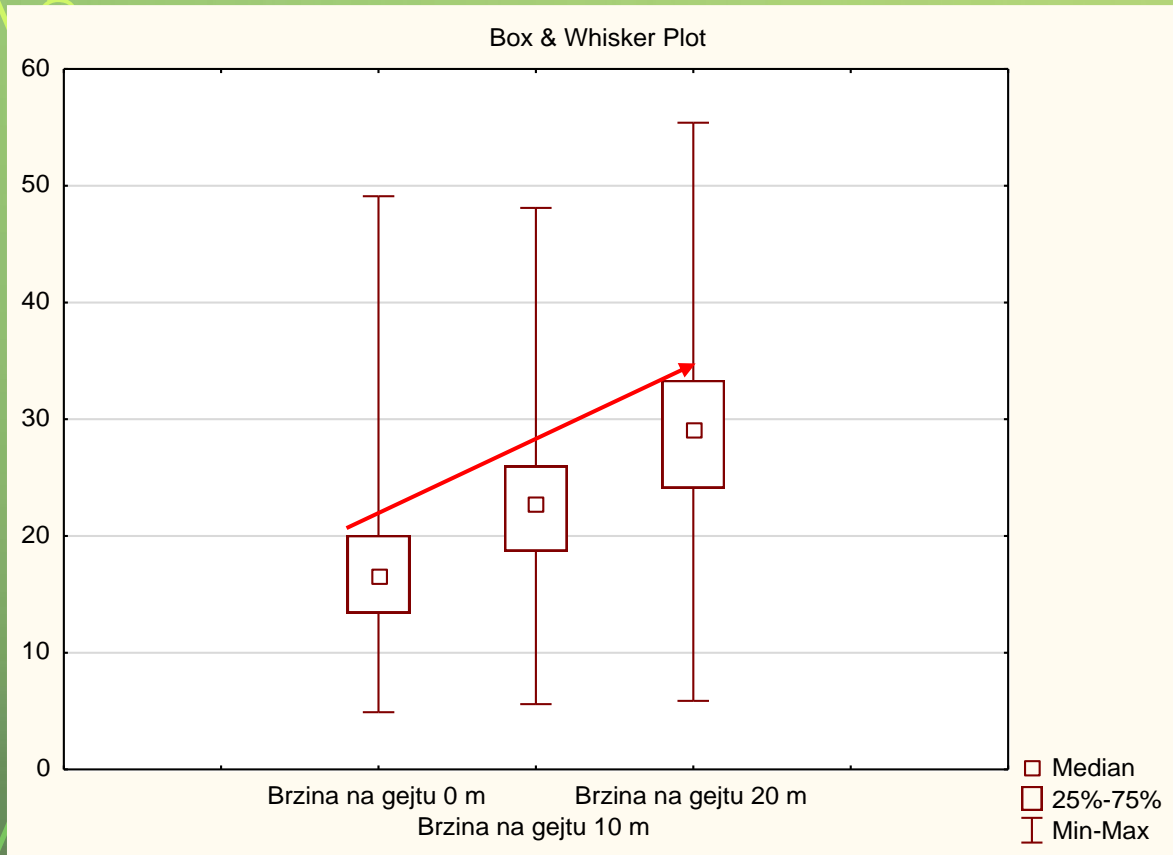
Number of vehicles : 293

Budva-Centar: 47,5%

Centar-Budva: 52,5%

Distances of intersections  
(gates): 0m, 10m and 20m

## LOCATION A



## LOCATION B



## LOCATION A

Mann-Whitney U Test (w/ continuity correction) (Spreadsheet7 in Workbook1)					
By variable Smer					
Marked tests are significant at p <.05000					
Rank Sum Gintaš	Rank Sum Union	U	Z	p-value	Z adjusted
38436.0	44592.0	19521.0	-0.96135	0.33637	-0.96135

The p-value is compared to the defined significance threshold

## LOCATION B

Mann-Whitney U Test (w/ continuity correction) (Spreadsheet3)					
By variable Smer					
Marked tests are significant at p <.05000					
Rank Sum Centar	Rank Sum Budva	U	Z	p-value	Z adjusted
17003.0	26068.0	5068.0	-7.7804	0.00000	-7.7804

Average speed between the entry and exit gates:

Gintaš-Union: 21.1 km/h

SD=5.8

Union-Gintaš: 21.9 km/h

SD=6.57

### Speed at gejt 0m

Average speed between the entry and exit gates:

Budva-Centar: 28.68 km/h

SD=8.06

Centar-Budva 21.8 km/h

SD=6.08

T-tests; Grouping: Vrsta elementa (Spreadsheet7 in Workbook1)									
Group 1: Gumeni									
Group 2: Platforma									
Variable	Mean Gumeni	Mean Platforma	t-value	df	p	Valid N Gumeni	Valid N Platforma	Std.Dev. Gumeni	Std.Dev. Platforma
Brzina na gejtu 0 m	17.2195	19.9409	-5.2723	696	0.00000	407	290	6.26098	7.34791

**THERE IS A STATISTICALLY SIGNIFICANT DIFFERENCE BETWEEN THE SPEED VALUES AT LOCATIONS A AND B**

## Location A

Average deceleration:  
**-0,966 m/s<sup>2</sup>**

Average speed between  
the gates 0m and 20m:  
**21,51 km/h**

Average speed at gejt  
0m: **17,2 km/h**

Exceeded the speed limit:  
**45,2%**

## Location B

Average deceleration:  
**-1,352 m/s<sup>2</sup>**

Average speed between  
the gates 0m and 20m:  
**25,07 km/h**

Average speed at gejt  
0m: **19,9 km/h**

Exceeded the speed limit:  
**55,6%**

## Summary

Higher at location B by  
**0,386 m/s<sup>2</sup>**

Higher at location B by  
**3,56 km/h**

Higher at location B by  
**2,7 km/h**



# INNOVATIVE SOLUTIONS

## APPLICATION OF HORIZONTAL CURVES IN ROAD DESIGN



## SMART TRAFFIC CALMING DEVICE

## RESEARCH IN BAR, 2024



# THANK YOU FOR YOUR ATTENTION

