Interreg

Danube Transnational Programme

RADAR

Project co-funded by European Union funds (ERDF, IPA, ENI)

O.T. 3.2. f Databases on Pilot Actions

TA3 ITS - CROATIA

RADAR – Risk Assessment on Danube Area Roads

https://www.interreg-danube.eu/radar

Internal Report Hierarchy Level			
Activity Number	5.3	Activity Title	Pilot Action ITS for speed management
Work Package Number	5	Work Package Title	Road Safety Pilot Actions
Authors (per company, if more than one company provide it together)	**University of Zagreb, Faculty of Transport and Traffic Sciences (FPZ); ST Line Ltd.** Sanja Leš, LL.M. Prof. Marinko Jurčević Bojan Jovanović, mag.ing.traff. Juraj Leonard Vertlberg, mag.ing.traff. Saša Tomašić, mag.ing.traff.		
Status (F: final, D: draft, RD: revised draft):	F		
Version Number	1.0		
File Name	f. O.T.3.2_Databases_ITS_Croatia.docx		
Issue Date	08.06.2021.		
Project start date and duration	June 1, 2018 – 36 months		

Revision log

Version	Date	Reason	Name and Company
1.0	June 8th 2021		Sanja Leš, LL.M., FPZ; Juraj Leonard Vertlberg, Msc Traff. Eng., FPZ

Abbreviation list

ITS	Intelligent Transportation System
RADAR	Risk Assessment on Danube Area Roads
SAS	Statistical Analysis System
AADT	Annual Average Daily Traffic
FPZ	Fakultet prometnih znanosti (eng. Faculty of Transport and Traffic Sciences)
PP	Project partner
ASP	Associated strategic partner

Table of Contents

Table of figures

1. Introduction

In recent years, the accelerated development of ITS systems and modern systems based on the application of artificial intelligence, opens new opportunities for real-time monitoring and intelligent management of traffic flows in the road network and thus achievement of a higher level of safety in the road transport system. The ITS system can be viewed as an additional subsystem of the entire transport system, or as its upgrade with which a higher level of traffic quality can be achieved without the need for extensive interventions on the design elements of road infrastructure. Road capacity as well as the level of service and safety of the road system can also be increased, and at the same time a reduction in external costs can be achieved.

The fifth Work package of the RADAR project is concerned with Road Safety Pilot Actions and its objective is to give Project partners (PPs) and Associated strategic partners (ASPs) practical experience in using the techniques and information that has been gathered in the other activities of the RADAR projects. Pilot Actions test practical procedures and tools acknowledged through the training courses and benefit of the most relevant examples that study visits selected and also test best practice and methodologies that have been discussed and selected through the work done with the RSEG and included in the Thematic Reports. The Faculty of Transport and Traffic Sciences of University of Zagreb (FPZ) is responsible for a Pilot Action on ITS for speed management.

The aim of this Database on Pilot Action in ITS for Speed Management - Croatia Report is to provide an overview of the entire process of conducting the research required for an adequate analysis of the ITS system which was the main subject of the research. The research process itself primarily required conducting a field research of previously identified locations. The data obtained from the field research were the input data for the implementation of a detailed analysis based on which conclusions and guidelines were later given.

The steps carried out as part of the research are explained in more detail below.

2. Database on Pilot Action on ITS for Speed Management - Croatia Report

As previously mentioned in the Introduction, the aim of the Database Report is to provide information on the entire process of conducting the research required for an adequate analysis of the subject of the Pilot.

Briefly, entire process, discussed in more detail below, can be divided into four basic steps:

- Characteristic location selection
- Field research
- Analysis of the data gathered by field research
- Research results

2.1. Characteristic Location Selection

In order to get relevant data, it was necessary to select adequate locations for conducting field research. For this purpose, a total of six locations in the Republic of Croatia were selected, which included a total of four different types of pedestrian crossings (explained in more detail in the Pilot Report itself).

The locations selected were:

- Čazma -> First type (P1) - Pedestrian crossing with horizontal and vertical signalization (traffic signs and/or road markings);
- Sirač -> First type (P1) - Pedestrian crossing with horizontal and vertical signalization (traffic signs and/or road markings);
- Velika Trnovitica -> Second type (P2) - Pedestrian crossing with horizontal and vertical signalization with implemented speed display;
- Rovišće -> Third type (P3) - Signalized pedestrian crossing with a pedestrian announcement system (push button);
- Patkovac -> Fourth type (P4) - Pedestrian crossing with implemented ITS system for automatic vehicle speed display and speed-activated traffic lights control (also including a pedestrian announcement system-push button);
- Ljubeščica -> Fourth type (P4) - Pedestrian crossing with implemented ITS system for automatic vehicle speed display and speed-activated traffic lights control (also including a pedestrian announcement system-push button).

It should also be noted that it was necessary to select locations of similar technical and traffic characteristics for the later comparison to be valid.

Selected locations are shown in the Figure 3.

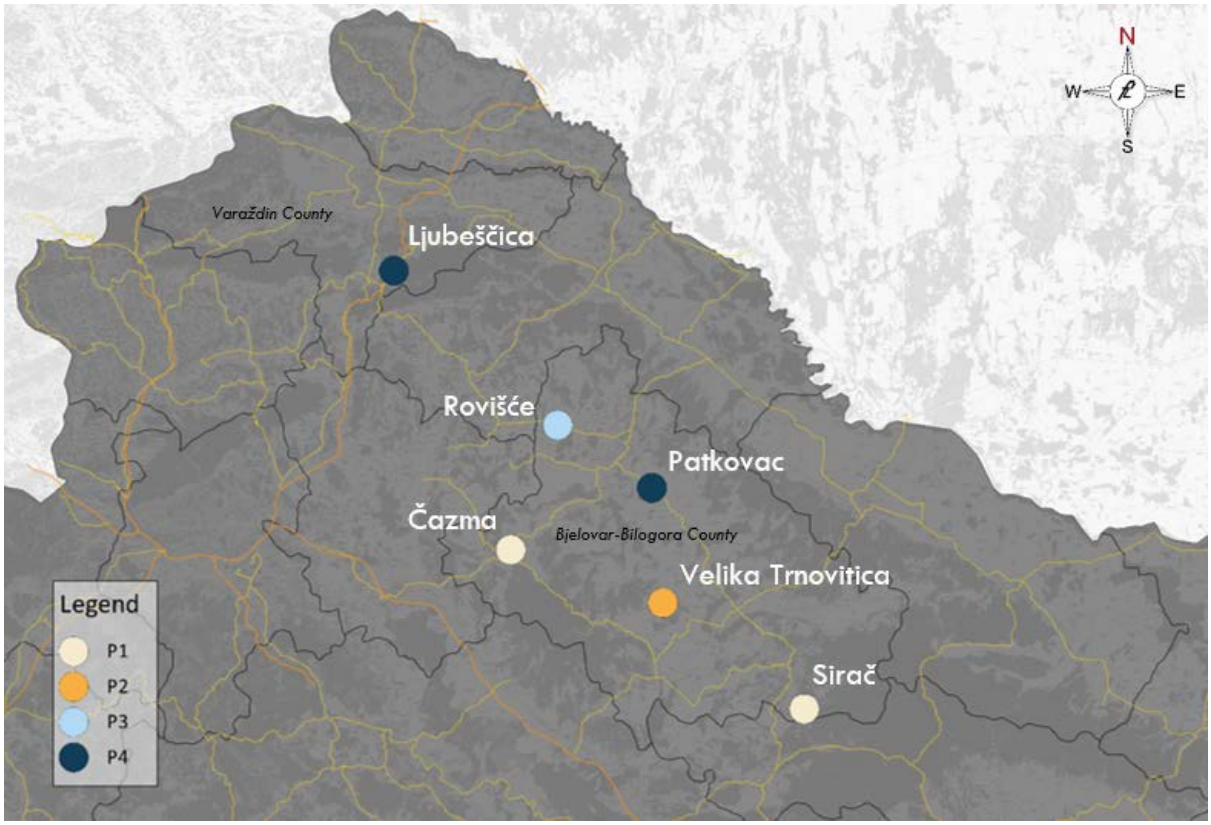


Figure 1 Locations selected for Field research

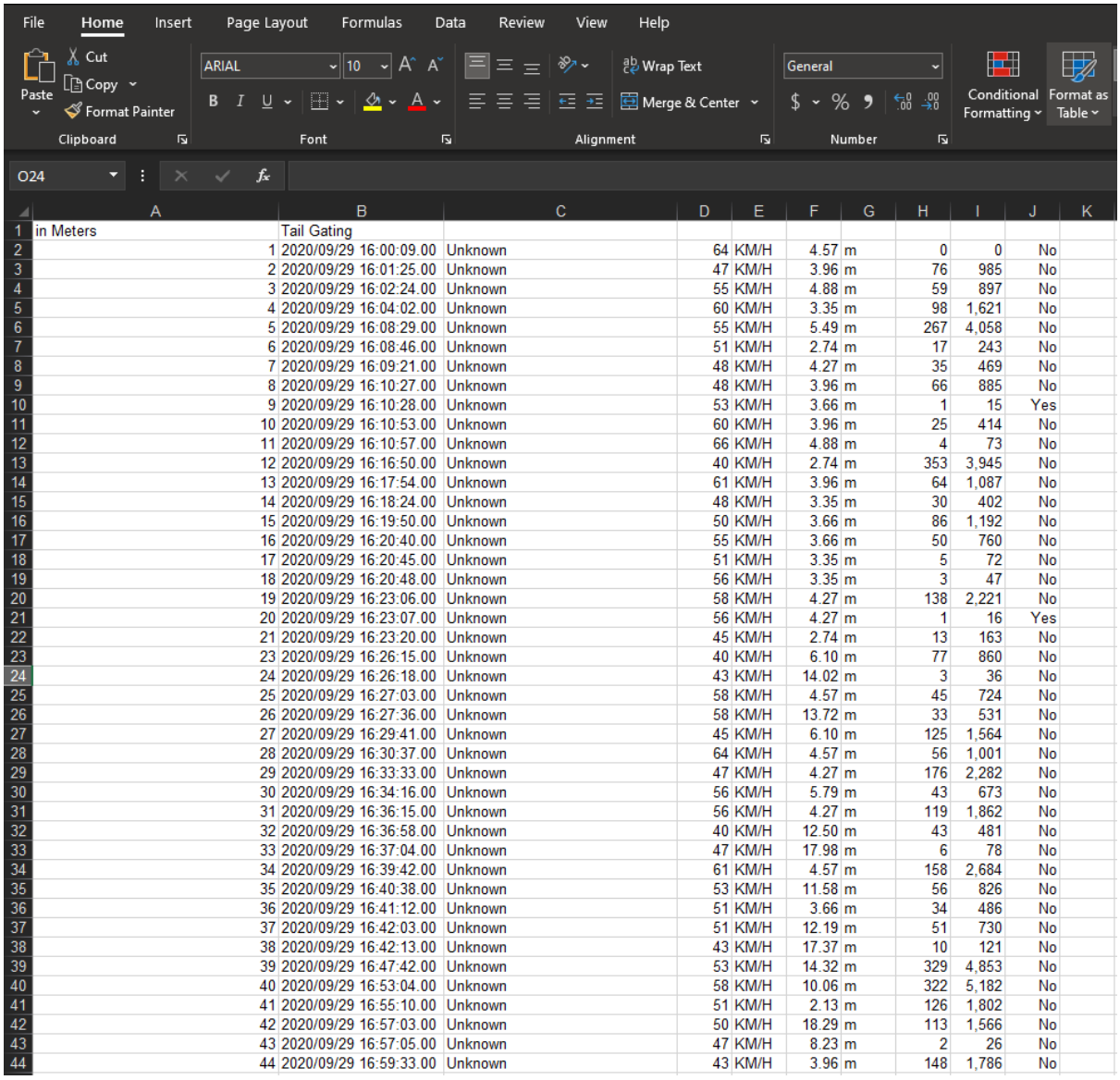
2.2. Field Research

After the locations were selected, field research was conducted. The data necessary for further analysis should have included traffic load, vehicle distribution and vehicle speed for both directions at all six locations.

The data was gathered using two types of automatic traffic counters (magnetic and radar counters), shown in Figure 4.

Figure 2 Automatic traffic counters

Using *Highway Data Management* and *Highway Data Sequential* softwares, the data was converted into a *.xlsx* format (shown in Figure 5) suitable for further data processing.



	A	B	C	D	E	F	G	H	I	J	K
1	in Meters	Tail Gating									
2	1	2020/09/29 16:00:09.00	Unknown	64	KM/H	4.57	m	0	0	No	
3	2	2020/09/29 16:01:25.00	Unknown	47	KM/H	3.96	m	76	985	No	
4	3	2020/09/29 16:02:24.00	Unknown	55	KM/H	4.88	m	59	897	No	
5	4	2020/09/29 16:04:02.00	Unknown	60	KM/H	3.35	m	98	1,621	No	
6	5	2020/09/29 16:08:29.00	Unknown	55	KM/H	5.49	m	267	4,058	No	
7	6	2020/09/29 16:08:46.00	Unknown	51	KM/H	2.74	m	17	243	No	
8	7	2020/09/29 16:09:21.00	Unknown	48	KM/H	4.27	m	35	469	No	
9	8	2020/09/29 16:10:27.00	Unknown	48	KM/H	3.96	m	66	885	No	
10	9	2020/09/29 16:10:28.00	Unknown	53	KM/H	3.66	m	1	15	Yes	
11	10	2020/09/29 16:10:53.00	Unknown	60	KM/H	3.96	m	25	414	No	
12	11	2020/09/29 16:10:57.00	Unknown	66	KM/H	4.88	m	4	73	No	
13	12	2020/09/29 16:16:50.00	Unknown	40	KM/H	2.74	m	353	3,945	No	
14	13	2020/09/29 16:17:54.00	Unknown	61	KM/H	3.96	m	64	1,087	No	
15	14	2020/09/29 16:18:24.00	Unknown	48	KM/H	3.35	m	30	402	No	
16	15	2020/09/29 16:19:50.00	Unknown	50	KM/H	3.66	m	86	1,192	No	
17	16	2020/09/29 16:20:40.00	Unknown	55	KM/H	3.66	m	50	760	No	
18	17	2020/09/29 16:20:45.00	Unknown	51	KM/H	3.35	m	5	72	No	
19	18	2020/09/29 16:20:48.00	Unknown	56	KM/H	3.35	m	3	47	No	
20	19	2020/09/29 16:23:06.00	Unknown	58	KM/H	4.27	m	138	2,221	No	
21	20	2020/09/29 16:23:07.00	Unknown	56	KM/H	4.27	m	1	16	Yes	
22	21	2020/09/29 16:23:20.00	Unknown	45	KM/H	2.74	m	13	163	No	
23	23	2020/09/29 16:26:15.00	Unknown	40	KM/H	6.10	m	77	860	No	
24	24	2020/09/29 16:26:18.00	Unknown	43	KM/H	14.02	m	3	36	No	
25	25	2020/09/29 16:27:03.00	Unknown	58	KM/H	4.57	m	45	724	No	
26	26	2020/09/29 16:27:36.00	Unknown	58	KM/H	13.72	m	33	531	No	
27	27	2020/09/29 16:29:41.00	Unknown	45	KM/H	6.10	m	125	1,564	No	
28	28	2020/09/29 16:30:37.00	Unknown	64	KM/H	4.57	m	56	1,001	No	
29	29	2020/09/29 16:33:33.00	Unknown	47	KM/H	4.27	m	176	2,282	No	
30	30	2020/09/29 16:34:16.00	Unknown	56	KM/H	5.79	m	43	673	No	
31	31	2020/09/29 16:36:15.00	Unknown	56	KM/H	4.27	m	119	1,862	No	
32	32	2020/09/29 16:36:58.00	Unknown	40	KM/H	12.50	m	43	481	No	
33	33	2020/09/29 16:37:04.00	Unknown	47	KM/H	17.98	m	6	78	No	
34	34	2020/09/29 16:39:42.00	Unknown	61	KM/H	4.57	m	158	2,684	No	
35	35	2020/09/29 16:40:38.00	Unknown	53	KM/H	11.58	m	56	826	No	
36	36	2020/09/29 16:41:12.00	Unknown	51	KM/H	3.66	m	34	486	No	
37	37	2020/09/29 16:42:03.00	Unknown	51	KM/H	12.19	m	51	730	No	
38	38	2020/09/29 16:42:13.00	Unknown	43	KM/H	17.37	m	10	121	No	
39	39	2020/09/29 16:47:42.00	Unknown	53	KM/H	14.32	m	329	4,853	No	
40	40	2020/09/29 16:53:04.00	Unknown	58	KM/H	10.06	m	322	5,182	No	
41	41	2020/09/29 16:55:10.00	Unknown	51	KM/H	2.13	m	126	1,802	No	
42	42	2020/09/29 16:57:03.00	Unknown	50	KM/H	18.29	m	113	1,566	No	
43	43	2020/09/29 16:57:05.00	Unknown	47	KM/H	8.23	m	2	26	No	
44	44	2020/09/29 16:59:33.00	Unknown	43	KM/H	3.96	m	148	1,786	No	

Figure 3 Traffic counters data converted in .xlsx format

2.3. Analysis of the Data Gathered by Field Research

The analysis of the collected data was performed using the SAS statistical tool (SAS JMP; shown in Figure 6) according to the following steps:

- Downloading the data from a traffic counter (previously explained);
- Determining atypical values of data collected at a particular location, according to two categories: speed and length of the vehicle, and in such a way that all values of speed and length that could not be logically explained (e.g. speed 140 km/h, and length greater than 40 m) were not used in processing. Less than 1% of such values were recorded at each location;
- Analytical and graphical comparison of average hourly speed by location type;
- Implementation of descriptive statistics of measured speed according to location type;

- Determining a statistically significant difference in average hourly speeds by location type;
- Interpretation of the obtained results.

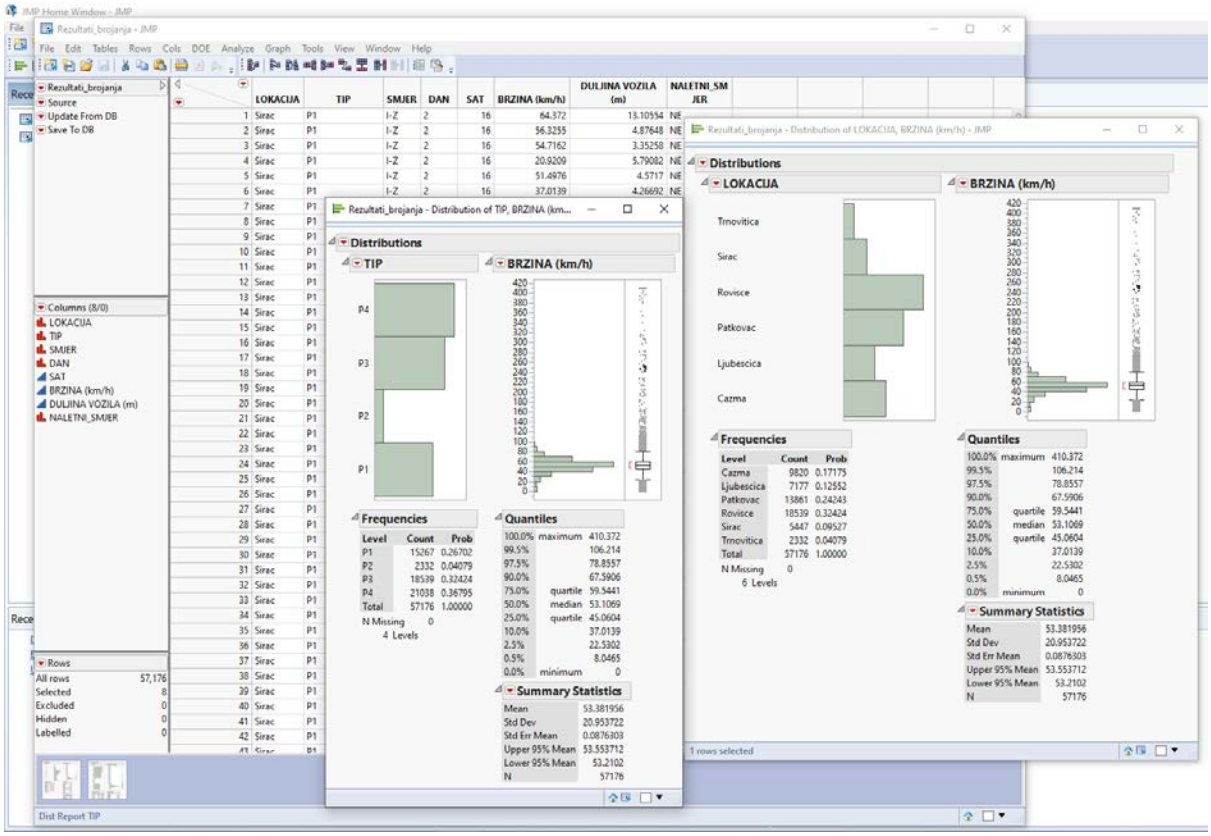


Figure 4 SAS statistical tool

2.4. Research Results

In the step of the research, the level of efficacy of the ITS system was determined based on the established results of descriptive and inferential statistics.

It should be noted that vehicle speed represented the most important input. Therefore, three further analysis were done.

2.4.1. Graphical Speed Analysis

The results of the graphical speed analysis show:

- maximum average hourly speed
- minimum average hourly speed
- hourly average per day

Microsoft Excel was used for data processing and results of graphical speed analysis creating (Figure 7).

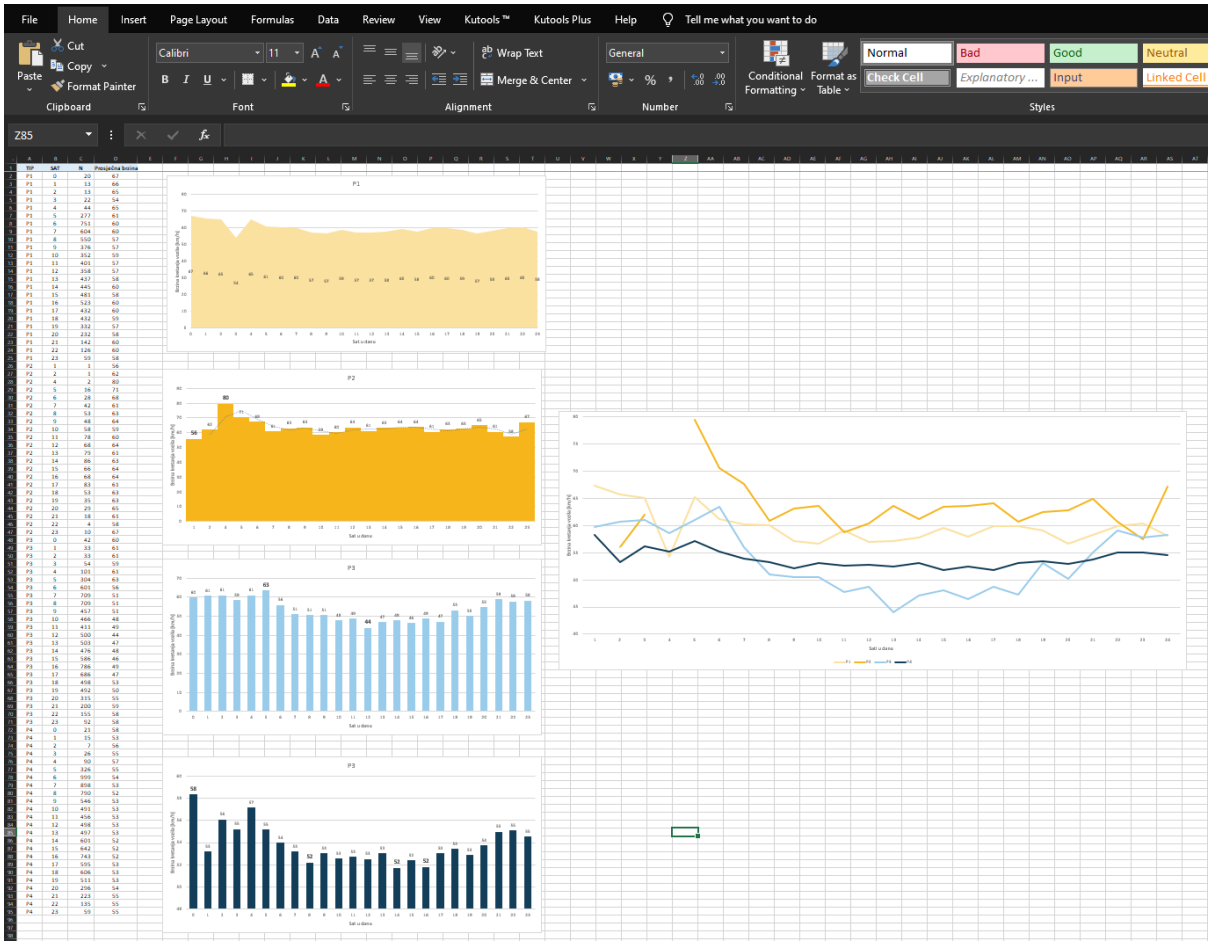


Figure 5 Graphical speed analysis

2.4.2. Descriptive Speed Statistics

In order to determine differences in a traffic flow speed a descriptive statistics analysis was performed.

Descriptive speed statistics showed:

- total number of samples by each pedestrian crossing type;
- average and median speeds for each pedestrian crossing type;
- 85-percentile speed analysis for each pedestrian crossing type;
- standard deviation for each pedestrian crossing type.

As well as for the Graphical speed analysis, Microsoft Excel was used for the Descriptive Speed analysis (Figure 8).

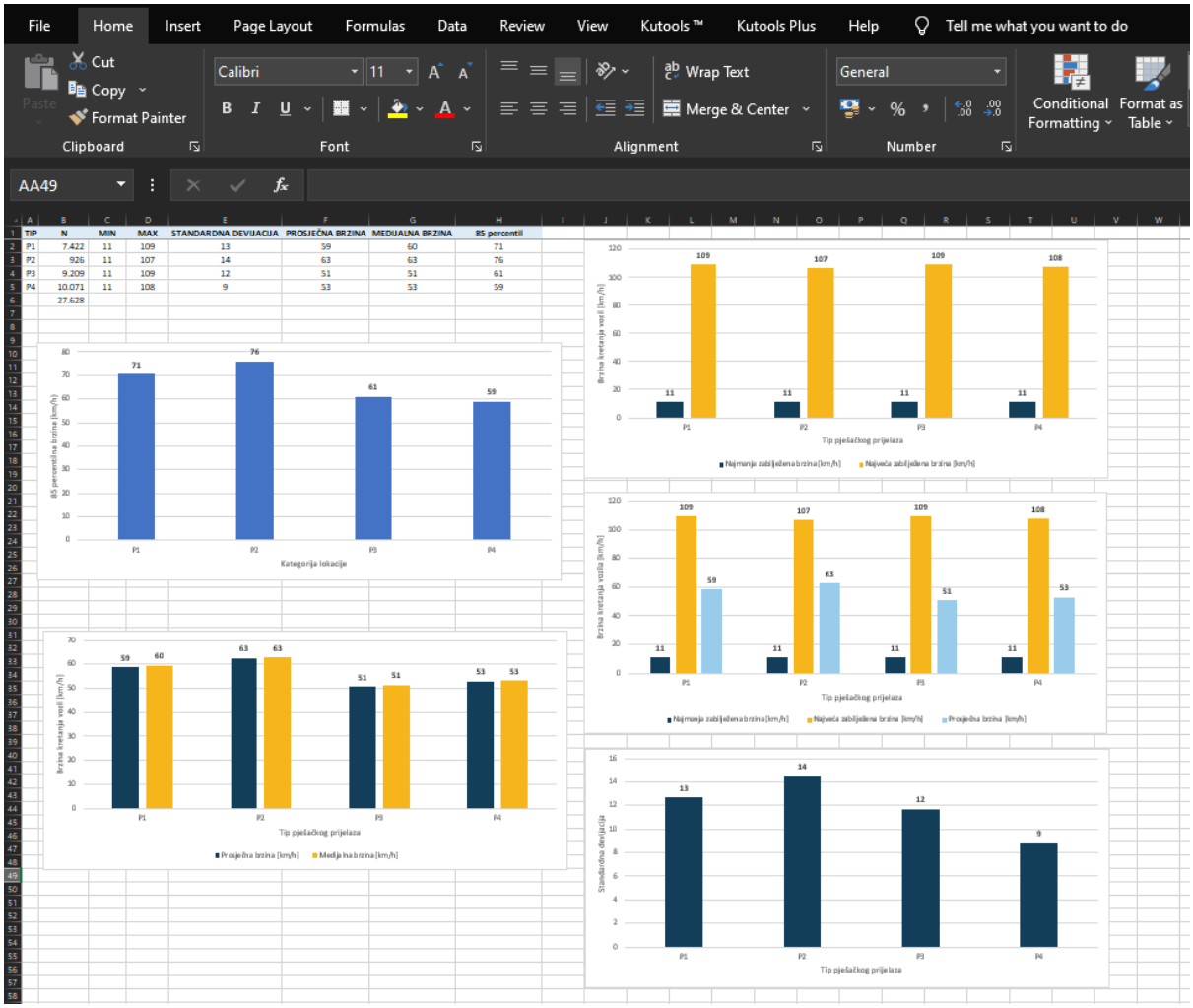


Figure 6 Descriptive speed analysis

2.4.3. Statistical Difference in Average Speed

This analysis was performed in order to determine the statistical significance of the difference in the average vehicle speed per certain type of pedestrian crossing. It should be noted that it was performed using the Tukey-Kramer test[1]. Tool which was used to carry out the analysis was SAS statistical tool (SAS JMP), shown in

[1] The Tukey-Kramer test is a multiple comparison test that can find means that are significantly different.

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
2,56919	0,05

LSD Threshold Matrix

Abs(Dif)-HSD

	P2	P1	P4	P3
P2	-1,332	2,773	8,568	10,877
P1	2,773	-0,470	5,342	7,646
P4	8,568	5,342	-0,404	1,899
P3	10,877	7,646	1,899	-0,422

Positive values show pairs of means that are significantly different.

Connecting Letters Report

Level		Mean
P2	A	62,602592
P1	B	58,830735
P4	C	53,050013
P3	D	50,737425

Levels not connected by same letter are significantly different.

Ordered Differences Report

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
P2	P3	11,86517	0,3845839	10,87710	12,85324	<,0001*
P2	P4	9,55258	0,3830772	8,56838	10,53678	<,0001*
P1	P3	8,09331	0,1740137	7,64624	8,54038	<,0001*
P1	P4	5,78072	0,1706579	5,34227	6,21917	<,0001*
P2	P1	3,77186	0,3887910	2,77298	4,77073	<,0001*
P4	P3	2,31259	0,1608429	1,89935	2,72582	<,0001*

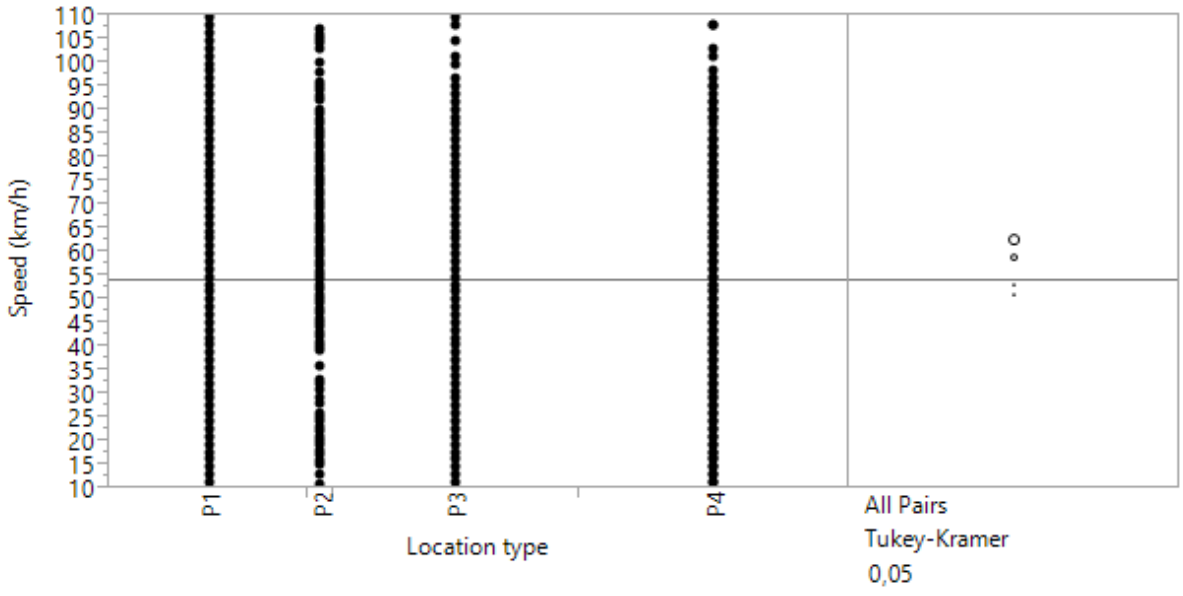


Figure 7 SAS statistical tool used to perform Tukey-Kramer test