Danube Transnational Programme

RADAR

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O.T.3.2.h Databases on Pilot Actions

TA5 COVID-19 - HUNGARY

RADAR – Risk Assessment on Danube Area Roads

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

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Abbreviation list

AADT	Annual Average Daily Traffic
ARM	A family of reduced instruction set computing (RISC) architectures for computer processors
iRAP	International Road Assessment Programme
ITS	Intelligent Transport System
KTI	KTI Institute for Transport Sciences Non-profit Ltd.
PA	Pilot Action
PECA	PEdestrian Crossing Analyzer application
PP	Project Partner
RADAR	Risk Assessment on Danube Area Roads
TA	Thematic Area
WP	Work Package

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1. Introduction

The RADAR (*Risk Assessment on Danube Area Roads*) project implements learning and transnational cooperation activities at different levels to help the responsible road safety organizations in the Danube area identify risk on their road networks and also helps them reduce risk systematically, by improving infrastructure and road layout. RADAR addresses all road users but pays particular attention to vulnerable road users as well as to safety on major roads near schools. It also holistically approaches the issue of safety and tackles speed as a major risk on roads. By the extension of RADAR, the transport safety related aspects of the COVID 19 pandemic, and the Amendment (Directive 2019/1936) of the Directive 2008/96/EC on road infrastructure safety management are also considered in the project.

As part of the extension of the fifth Work Package, PP3-KTI performed a Pilot Action (PA) to test a proposed solution related to one of the additional Thematic Areas (TA), namely TA5: Transport Safety and COVID 19. The pilot used previous results and experiences in the field of speed management following work on Thematic Area 3 (ITS and speed management), addressing also the safety of pedestrians (Thematic Area 2 - Road safety of vulnerable road users). The COVID 19 pandemic made it even more important to address safety issues arising from higher vehicle speeds due to the reduction of traffic volume.

According to the results of our previous Pilot Action in WP5 (Activity 5.3 - Pilot Action ITS for speed management), vehicle activated signs near the roads proved to be effective in reducing the operational speed of the traffic and the number of speed violators. In accordance with this, a new ITS solution was developed in Hungary addressing speed issues at pedestrian crossings. The referred ITS device consists of:

- a pedestrian crossing warning sign with interior lighting and a LED text (Lassíts! – "Slow down!") that should be placed 50-100m in front of the pedestrian crossing, and
- a yellow blinker to be placed right near the pedestrian crossing.

A speed measuring radar, and a WiFi transmitter complement both elements of the device. It operates based on the presence, and speed of arriving vehicles, while it is also able to collect the speed data. The threshold value of speed required for operation of the device can be determined by the analyst/operator. Note, that the Pilot Action did not include any investments in the development or installation of the ITS device.

During our Pilot Action, the effects of the presented ITS solution was assessed at one location by measurements. Speed data have been analysed using mathematical-statistical methods. The device proved to be effective in terms of reducing the average and v85 speeds, and the ratio of speeders. The average speed decreased by 6.9% 50 meters in front of the pedestrian crossing, and 9.3% in the line of the crossing. An interesting observation was that the device achieved greater effects under daylight visual condition than after sunset.

The aim of this document is to present the databases created during the above mentioned work process.

1.1. Process of data collection

In the following chapter, the data collection processes and applied equipment are presented.

The investigated vehicle activated ITS device consists of two main parts:

1. A pedestrian crossing warning sign with interior lighting and a LED text (Lassíts! – "Slow down!") that should be placed 50-100m in front of the pedestrian crossing, complemented by a speed measuring radar (first radar) and WiFi transmitter

The first radar of the device is a BX-946 microvawe detector. The measurement principle of this detector is based on the Doppler effect. The detector unit is bouncing a microwave signal off to a desired target and analysing how the motion of the object has changed the frequency of the returned signal. Calculations of the Doppler effect accurately determine the velocity of the detected objects. This radar is able to detect arriving vehicles, and measure their speed within its range, which is about 20-25 meters (depending on weather and visibility conditions). This radar is not applicable for continuous data recording by tracking the vehicles.

2. A yellow blinker to be placed right near the pedestrian crossing, complemented by a speed measuring radar (second radar) and WiFi transmitter.

The second radar of the device is a digital Falcon Plus II intelligent microwave detector, together with an ARM[1] based computer (self-developed by KTI's subcontractor). The measurement principle of this detector is also based on the Doppler effect. However, this unit has both a counting and tracking function. The equipment can also detect if the vehicle is arriving or leaving, therefore it is able to detect movement either uni- or bidirectional. During the measurement, the computer is recording the exact time and location of the measurement and the time vs. speed data continuously in microsecond intervals from the first moment the vehicle is within the range until it is detectable. Several speed samples are available for each vehicle, therefore speed vs. time or distance curves can be also generated. The radar unit is also equipped with a sophisticated communication module to provide the data remotely even during the measurement real time or afterwards. The range of this radar is about 50 meter (depending on weather and visibility conditions).

During the measurements of the Pilot Action, the devices were powered by external batteries.

The operation of the presented device was based on the arrival of vehicles to the pedestrian crossing.

The first radar detected incoming vehicles and measured their speed. When an incoming vehicle was detected, the interior lighting of the pedestrian crossing warning sign was turned on (regardless of the vehicle speed). If the vehicle arrived at a speed higher than the speed limit, the text "Lassíts" was also displayed. If no new vehicle has arrived, the lights turned off after 5 seconds.

When detecting an incoming vehicle, the first radar also activated the yellow blinker located on the column of the designated pedestrian crossing sign (regardless of speed). It switched off after 10 seconds without a new vehicle arriving.

The speed data used for the analysis were provided by the Falcon radar, located on the column of the designated pedestrian crossing sign. By these data, the speed on a 50 meter long section in front of the pedestrian crossing became analysable.

Measurements have been done in the August of 2021, at weekdays. Based on the operational method of the ITS device (interior lighting), the greatest effects were expected in dark, so the measurements were carried out each day between 17:00 and 23:59. Before and after measurements were performed, meaning that the measurements were done in the first week

[1] ARM – a family of reduced instruction set computing (RISC) architectures for computer processors

(2021.08.23-08.27) in the original condition of the environment of the pedestrian crossing. Then on the following week (2021.08.30-09.03), the ITS devices were installed and their effects were measured according to the same methodology as before.

The competent authorities (road operator, police) approved and supported the measurements.

1.2. Method of data processing

The maximum range of the measuring radar was 50 meters, but could vary according to the weather conditions, colour and size of the measured vehicles, etc. The equipment could detect vehicles almost up to its own location (line), therefore we considered the last measured point 1 meter away from the device, which was mounted on the pole of the pedestrian crossing sign.

Based on the recorded time and speed data, the elaborated data processing software was able to calculate the distance of the vehicles from the measuring equipment in case of each fixed measurement time moment. For the analysis, the vehicle speeds were determined for every integer meter value by linear interpolation, starting from 1 meter away from the line of the measuring equipment. Note, that the measuring equipment was in line with the pedestrian crossing.

Due to the operating principle of the radar, the following difficulties had to be overcame:

- The equipment measured both traffic directions. However, the speeds in the different directions were recorded with different signs (arriving vehicles: positive; leaving vehicles: negative). This made it possible to remove unnecessary data measured in the undesired direction.
- The radar could not distinguish between vehicles moving close to each other in the same direction. Thus, it recorded the data in case of an arriving group of vehicles continuously, without interruption. We dealt this phenomenon using the counted distance values: in case of a close group of cars in the same direction, the distances calculated starting from the line of the equipment became high due to the large amount of continuously recorded data. As the maximum range of the instrument was 50 meters, data points calculated for a greater distance have been deleted. With this approach (assuming that the difference in speed within the close group of vehicles is minimal), we kept the data of the last vehicle of the group for each group of vehicles.

During the procession of the measurement data, further data filtering has been performed as follows:

- Measurements were deleted if the equipment did not “see” the vehicle at a distance of at least 20 meters.
- Measurements were deleted if the equipment did not record at least 10 measurement points (time moments) of a vehicle.
- Measurements were deleted if the distance between two adjacent measurement points for the same vehicle was higher than 5 meters. (In these cases, the coherent data probably belong to two different vehicles).

- Measurements were deleted if the speed of a vehicle was lower than 30 km/h at 10 meters in front of the pedestrian crossing, or lower than 30 km/h at the line of the pedestrian crossing. According to our observations, lower than 30 km/h speed data was observed only in those cases, when a vehicle intended to turn left before the pedestrian crossing, or slowed down to give priority for a pedestrian.
- Measurements were deleted if the standard deviation of speed values of a vehicle was higher than 15% of the speed limit. (For some data sets, there was an unrealistic standard deviation due to measurement errors).

2. Database on Pilot Action on TA5 in Hungary

In the following chapters, databases collected by the above described methods are presented in details. The database of speed measurements has been uploaded to the following folder in Seafile in Excel format:

- 04 RAD_PM/WP6-Extension/AT4.3 Pilot Actions TA5 and TA6/4.3.1 Implementation-Ready Road Layout Concept Plans TA5

In the Excel, 2 worksheets can be found. The first worksheet of the Excel file ("First week") describes the measured speed data of vehicles approaching the pedestrian crossing in the first week (2021.08.23-08.27). This was the period without the deployment of the ITS device. The second worksheet is of the same structure and contains the speed data of the second week (2021.08.30-09.03), when the ITS device was operating at the spot.

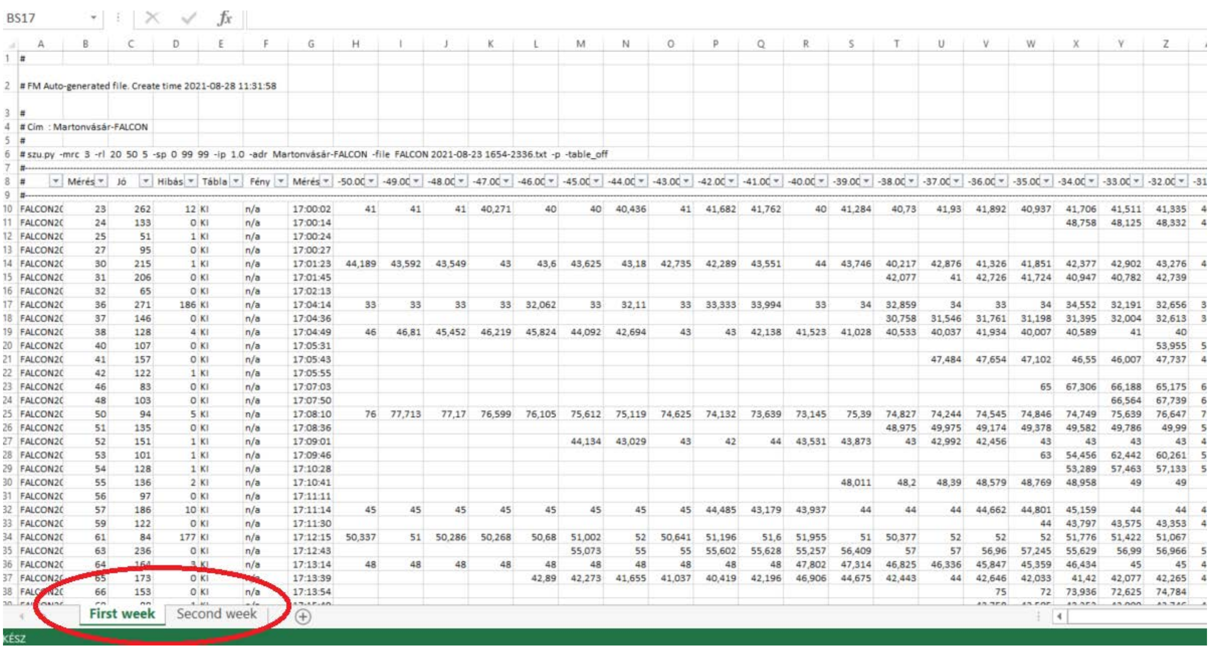

Figure 1 Relevant worksheets in the Excel file

Speed data of individual vehicles are described in the area starting from row 10, between columns A and BL. Vehicles are separated by the rows of the Excel file (each row contains the data of a new measured vehicle).

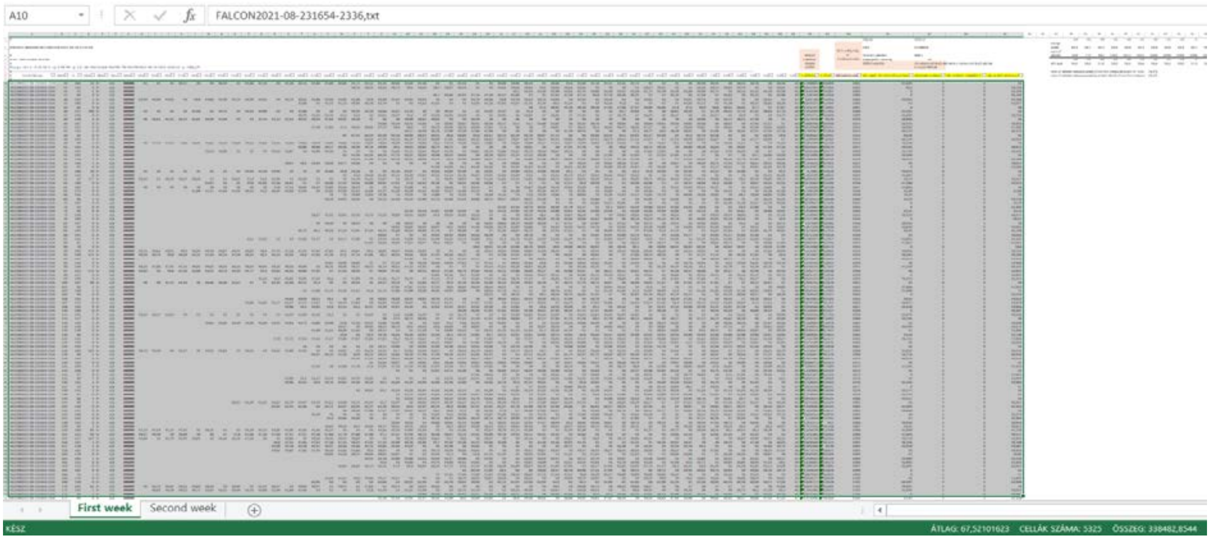

Figure 2 Perspective image of the area describing the speed data of individual vehicles

The worksheets contain the following information in a uniform manner, starting with row 10 (row 8 is the heading):

- Column A: Source file of the measurement (contains the day of the measurement)
- Column B: Daily identifier of the measurement in the source file
- Column C: Number of good measurement instants
- Column D: Number of missed or inappropriate measurement instants
- Column E: Indication of the presence of the ITS device (BE means it was operating, KI means it was not operating)
- Column F: Degree of brightness
- Column G: Arrival time of the vehicle

6 #szu.py -mrc 3 -rl 20 50 5 -sp 0 99 99 -ip 1.0 -adr Martonvásár-FALCON -file FALCON 2021-08-2

7 #--

8	# Forrás fájl neve	Mérés	Jó	Hibás	Tábla	Fény	Mérés	-50.
9	#-------------------------							
10	FALCON2021-08-231654-2336.txt	23	262	12	KI	n/a	17:00:02	
11	FALCON2021-08-231654-2336.txt	24	133	0	KI	n/a	17:00:14	
12	FALCON2021-08-231654-2336.txt	25	51	1	KI	n/a	17:00:24	
13	FALCON2021-08-231654-2336.txt	27	95	0	KI	n/a	17:00:27	
14	FALCON2021-08-231654-2336.txt	30	215	1	KI	n/a	17:01:23	44
15	FALCON2021-08-231654-2336.txt	31	206	0	KI	n/a	17:01:45	
16	FALCON2021-08-231654-2336.txt	32	65	0	KI	n/a	17:02:13	
17	FALCON2021-08-231654-2336.txt	36	271	186	KI	n/a	17:04:14	
18	FALCON2021-08-231654-2336.txt	37	146	0	KI	n/a	17:04:36	
19	FALCON2021-08-231654-2336.txt	38	128	4	KI	n/a	17:04:49	
20	FALCON2021-08-231654-2336.txt	40	107	0	KI	n/a	17:05:31	
21	FALCON2021-08-231654-2336.txt	41	157	0	KI	n/a	17:05:43	
22	FALCON2021-08-231654-2336.txt	42	122	1	KI	n/a	17:05:55	
23	FALCON2021-08-231654-2336.txt	46	83	0	KI	n/a	17:07:03	
24	FALCON2021-08-231654-2336.txt	48	103	0	KI	n/a	17:07:50	
25	FALCON2021-08-231654-2336.txt	50	94	5	KI	n/a	17:08:10	
26	FALCON2021-08-231654-2336.txt	51	135	0	KI	n/a	17:08:36	
27	FALCON2021-08-231654-2336.txt	52	151	1	KI	n/a	17:09:01	
28	FALCON2021-08-231654-2336.txt	53	101	1	KI	n/a	17:09:46	
29	FALCON2021-08-231654-2336.txt	54	128	1	KI	n/a	17:10:28	
30	FALCON2021-08-231654-2336.txt	55	136	2	KI	n/a	17:10:41	
31	FALCON2021-08-231654-2336.txt	56	97	0	KI	n/a	17:11:11	

Figure 3 Example of data in columns A-G

- Columns H-BE: speed data of the vehicles in different distances from the radar that was mounted in the line of the pedestrian crossing (for every integer meter, ranging from -50 to -1 meters)

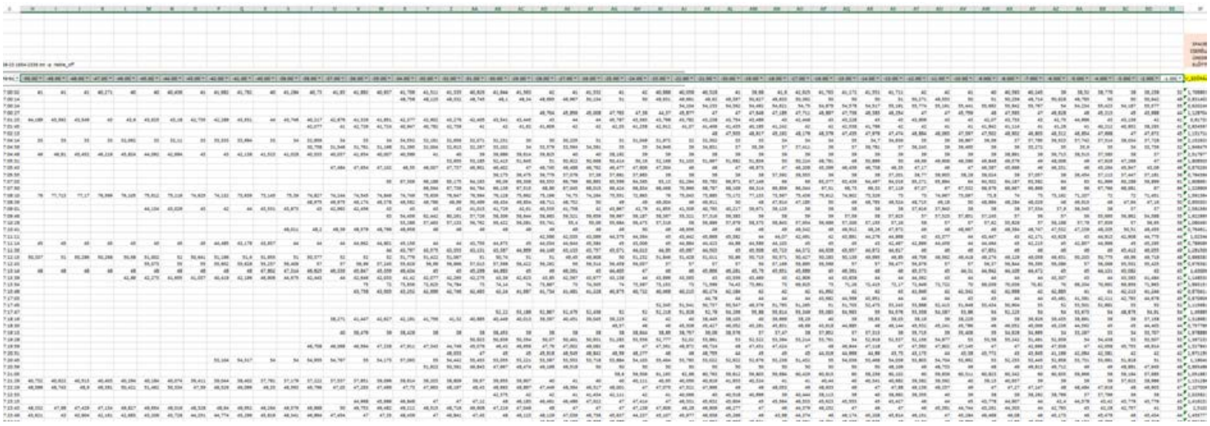

Figure 4 Example of data in columns H-BE

- Column BF: standard deviation of the speed data of the vehicle
- Column BG: average speed of the vehicle
- Column BH: Unique identifier of the vehicle
- Column BI: speed of the vehicle 30 meter away from the display
- Column: BJ: Indicates if the vehicle decreased speed comparing the first and last measurement points of the given vehicle (1- yes, 0 – no)

- Column BK: Indicates if the vehicle decreased speed in by at least 10% of the speed limit, comparing the first and last measurement points of the given vehicle (1- yes, 0 – no)
- Column BL: speed of the vehicle at the first measured point of the given vehicle

E	BF	BG	BH	BI	BJ	BK	BL	BM
				Helyszín	Határ út			
				Irány	Közeledők			
	SPACET CSERÉLNI ÜRESRE ELŐTTE		AZ: 1. számj: nap, 2-4.számj:sorszám	ITS eszköz jelenléte	NINCS			
				Megengedett sebesség	40			
				TÖRÖLT ADATOK	10 méterre 30 km/h alattiak és 1 méterre 30 km/h alattiak			
					5 szórás felettiek			
O(	V_SZÓRÁSA	V_ÁTLAG	AZ. (szűrés után)	Seb. segéd -30 méternél (üres kiütés	Sebességet csökkent-	Seb. csökkent-e legalább 4-e	Seb. az első mérési pontc	
32	1,70690115	40,64018	1001	41,644	1	1	41	
49	0,83140358	49,706294	1002	48,1	0	0	48,758	
55	0,62024937	54,907045	1003	0	0	0	54,104	
44	1,12870439	46,35575	1004	0	1	0	46,704	
41	0,91735993	43,13506	1005	43,541	1	0	44,189	
41	0,83459734	41,439368	1006	42	1	0	42,077	
45	1,13171671	47,340714	1007	0	1	0	48	
36	2,15292931	33,75012	1008	31,231	0	0	33	
32	1,94647066	34,584816	1009	33,202	0	0	30,758	
37	2,51797776	40,23998	1010	39,986	1	1	46	
46	1,80850594	50,095594	1011	52,415	1	1	53,955	
46	0,87026847	46,515703	1012	46,402	1	0	47,484	
36	0,79436678	37,654033	1013	36,173	1	0	36,173	
61	1,90896198	64,636714	1014	66,06	1	1	65	
66	1,32990914	67,846242	1015	66,139	1	0	66,564	
71	1,59139406	74,51588	1016	76,128	1	1	76	
50	0,85030115	49,067289	1017	49,434	0	0	48,975	
35	2,58156837	40,477711	1018	41,729	1	1	44,134	
55	1,92299591	57,961429	1019	58,306	1	1	63	
56	1,08049212	56,852588	1020	56,422	0	0	53,289	
46	0,76461271	48,705077	1021	49	1	0	48,011	
44	1,02340669	43,713071	1022	0	0	0	42,586	
45	0,7890999	44,43158	1023	44,973	0	0	45	
49	1,2815088	45,085171	1024	43,387	0	0	44	
48	0,89838168	50,56994	1025	50,74	1	0	50,337	
56	0,67636275	56,438422	1026	57,598	0	0	55,073	
43	1,43006022	45,92382	1027	44,883	1	1	48	
41	1,14853803	43,103239	1028	43,39	1	0	42,89	
67	1,89315143	72,218278	1029	74,14	1	1	75	
42	0,87041131	41,95975	1030	42,24	1	0	43,758	
45	0,87090651	43,734571	1031	0	0	0	44,78	
52	1,11568193	52,073609	1032	0	1	0	52,345	
54	1,45995851	53,524333	1033	52,22	0	0	52,22	
39	1,31898185	39,710081	1034	40,449	0	0	38,271	
44	0,75779904	45,42616	1035	0	1	0	46,57	
34	1,97888974	36,998162	1036	38,453	1	1	40	
53	1,36723565	52,683581	1037	50,639	0	0	50,923	
46	1,32784386	46,772342	1038	46,43	1	0	46,708	

Figure 5 Example of data in columns BF-BL

The further data on the worksheets are auxiliary data used for calculations by the analysts.