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RADAR

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O.T. 3.2. Databases on Pilot Actions

TA3 ITS - 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
PP	Project Partner
RADAR	Risk Assessment on Danube Area Roads
TA	Thematic Area

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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.

The fifth Work Package of the project aims to give the project partners practical experience in using techniques, information and countermeasures to reduce road casualties. With the help of Pilot Actions (PA), testing of best practice and methodologies become possible. PP3-KTI as a project partner is responsible for the third thematic area, namely ITS and speed-management. Accordingly, Pilot Actions have been carried out by KTI to examine and demonstrate the effects of two selected speed management devices:

i. vehicle activated speed warning signs, and
ii. fixed site speed cameras,

which work as speed reducing tools. The efficacy of the devices has been measured and estimated considering the evidence of the correlation between speed reduction, and reduction in crashes.

The potential effects of vehicle activated speed warning signs and fixed site speed cameras have been determined based on speed measurements at 7 different locations. Speed data have been analysed using mathematical-statistical methods. According to our results, both devices result in the reduction of average and v85 speed of the traffic. Based on this work, Implementation-Ready Road Layout Concept Plans for speed management have been elaborated for 2 locations.

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.

Measurements have been done in July and August of 2020, at weekdays, avoiding peak hours (to avoid distortion of potential congestions).

At each location (5 locations with vehicle activated speed warning signs, 2 locations with FamaLaser III speed camera):

- 9 hours of measurement have been carried out at 3 different weekdays with the speed signs operating / speed camera placed on the roadside;
- 9 hours of measurement have been carried out at 3 different weekdays when the speed signs didn't operate / speed camera was not placed on the roadside.

Vehicles approaching the devices were measured in one half of the measurement period, and vehicles leaving the devices was measured in the other.

We have cooperated with local municipalities and road operators, who arranged the shutdown of the vehicle activated speed warning signs for the duration of the measurements. The measurements were approved by the competent authorities.

For the measurements we used a digital Falcon Plus II intelligent microwave detector with an ARM[1] based computer (self-developed by KTI's subcontractor). 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. Our 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 maximum range of the equipment is 50 meters, but can vary according to weather conditions, colour and size of the measured vehicle, etc. The equipment can detect vehicles almost up to its own location (line), therefore we considered the last measured point 1 meter away from the equipment.

Based on the above consideration and 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 vehicle activated speed warning sign (they were mounted on the same column), or the speed camera.

Due to the operating principle of the equipment, the following difficulties had to be overcome:

- It is not possible to set up the equipment to see only one traffic direction. However, the speeds in different directions are recorded with different signs (arriving vehicles: positive; leaving vehicles: negative). This made it possible to remove unnecessary data measured in the undesired direction.
- In case of different directions, or sufficient following distance between two vehicles in the same direction, the equipment recognizes automatically if it measures a new vehicle. However, it cannot distinguish between vehicles moving close to each other in the same direction. Thus, it records 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 become high due to the large amount of continuously recorded data. As the maximum range of the instrument is 50 meters, data points calculated for a greater distance have been deleted. With this approach (assuming that the difference

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

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 average speed of a vehicle was lower than 40 km/h where the speed limit was 60 km/h, or was lower than 30 km/h if the speed limit was 50 km/h. (These values arose probably from traffic issues and distort the analysis).
- Measurements were deleted if the standard deviation of speed values of a vehicle was higher than 10% of the speed limit. (For some data sets, there was an unrealistic standard deviation due to measurement error).

1.1.1. Speed measurements at vehicle activated speed / speed limit displays

For the evaluation of the effects of vehicle activated speed warning signs, we have carried out speed measurements at 5 different locations. The locations varied according to their characteristics (type of area, reason of being placed), and according to the type of the devices (showing the speed limit, or the speed of the vehicle, colour, etc):

- 9121 Győrszemere, road 83, 63+390 km section (47.5955862, 17.58716091)
- 1038 Budapest, Ezüsthegy street 34-42. (47.600180, 19.046550)
- 1097 Budapest, Határ road 30. (47.458197, 19.118598)
- 2162 Őrbottyán, road 2104, 12+770 km section (47.690259, 19.257157)
- 2162 Őrbottyán, road 2103, 7+980 km section (47.700312, 19.295032)

1.1.2. Speed measurements modelling fixed site speed cameras

For modelling the effects of fixed site speed cameras, we have used a FamaLaser III (VHT-507/DVRM-G) speed camera and carried out measurements at 2 different locations:

- 2330 Dunaharaszti, road 510, 16+850 km section (47.373785, 19.099045)
- 1116 Budapest, Hunyadi Mátyás street 57. (47.448422, 19.024794)

According to our assumptions, the used speed camera placed at a clearly visible place near the road is appropriate for modelling fixed cameras, which are also well known and visible for the drivers, especially for those who travel at the road section regularly. The main reason of this

surrogate was that it made it possible to make speed measurements at the selected road sections also without the device.

1.1.3. Potential effects of implemented Pilot Actions

Pilot Actions have been elaborated at two locations:

- 2700 Cegléd, road 40, 27+320 km section, both directions (47.182424, 19.889272)
- 2462 Martonvásár, road 7, 33+539 km section (towards the city centre) (47.305684, 18.780898)

The potential effects of Pilot Actions have been assessed by the iRAP Star Rating methodology. The Star Rating for Designs Tool has been used to evaluate the Star Rating Score (SRS) of the investigated road sections both before and after the implementation of the Pilot Actions. This tool is capable of taking into account not just the change in speed, but also other parameters affecting road safety (presence of safety barriers, roadside objects, condition of road surface, etc).

At the first Pilot Action (near Cegléd, road 40), the road section has been analysed at a length of 700 meters (road 40; between 27+710 - 27+010 km sections), in 100-meter sections. In case of the second Pilot Action (Martonvásár, road 7), a 500 meter long road section (road 7; between 33+330 - 33+830 km sections) was analysed in 100-meter sections.

2. Database on Pilot Action on TA3 in Hungary

In the following chapters, databases collected by the above described methods are presented in details.

2.1.1. Databases of speed measurements at vehicle activated speed / speed limit displays

Databases of speed measurements at vehicle activated speed / speed limit displays have been uploaded to the following folders in Seafile:

- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Győrszemere, road 83
- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Budapest, Ezüsthegy street 34-42
- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Budapest, Határ road 30
- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Őrbottyán, road 2103

- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Őrbottyán, road 2104

Each folder contains two Excel sheets. In all cases, the Excel file which name starts with the word "BEKAPCSOLT" contains data of speed measurements with the operating status of the vehicle activated display.

Contrarily, the Excel file which name starts with the word "KIKAPCSOLT" contains data of speed measurements with the non-operating status of the vehicle activated display. The structure of both cases are the same as follows.

The first worksheet of the Excel files ("Összes közeledő +") describes data of vehicles approaching the speed / speed limit display.

The second worksheet of the Excel files ("Összes távolodó -") describes data of vehicles leaving the speed / speed limit display.

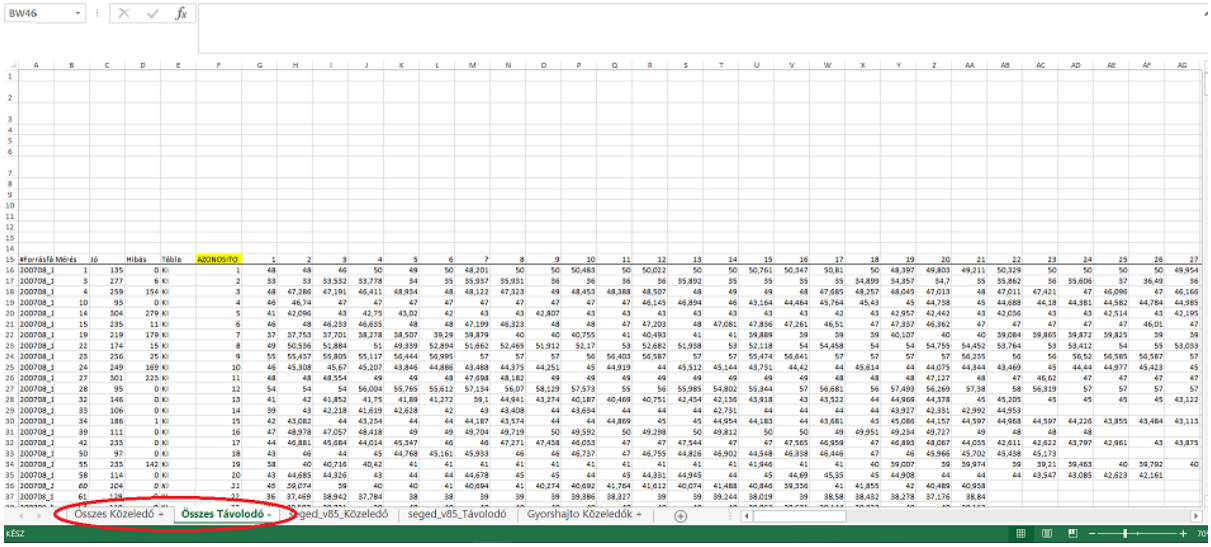

Figure 1 Relevant worksheets in the Excel files

Speed data of individual vehicles are described in the area starting from row 16, between columns A and BJ. 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 16 (row 15 is the heading):

- Column A: Source file of the measurement
- Column B: 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 status of the vehicle activated display (BE meand it was operating, KI means it was not operating)
- Column F: Identifier of the measurement in the examined Excel file

	A	B	C	D	E	F	G
10							
11							
12							
13							
14							
15	#Forrásfáj	Mérés	Jó	Hibás	Tábla	AZONOSITO	-50
16	200708_0	0	112	125	BE	1	49
17	200708_0	1	224	32	BE	2	42
18	200708_0	2	219	0	BE	3	
19	200708_0	3	264	102	BE	4	49,303
20	200708_0	4	133	0	BE	5	
21	200708_0	5	257	494	BE	6	40,122
22	200708_0	7	172	0	BE	7	
23	200708_0	8	71	0	BE	8	
24	200708_0	9	268	161	BE	9	45,879
25	200708_0	17	234	0	BE	10	
26	200708_0	19	173	1243	BE	11	44
27	200708_0	23	235	371	BE	12	36,785
28	200708_0	26	135	1	BE	13	
29	200708_0	27	134	0	BE	14	
30	200708_0	28	119	0	BE	15	
31	200708_0	29	164	1	BE	16	36,959
32	200708_0	30	333	123	BE	17	36,769

Figure 3 Example of data in columns A-F

- Columns G-BD: speed data of the vehicles in different distances from the vehicle activated display (for every integer meter, ranging from -50 to -1 meters in case of approaching vehicles, and from 1 to 50 meters in case of vehicles leaving the device)

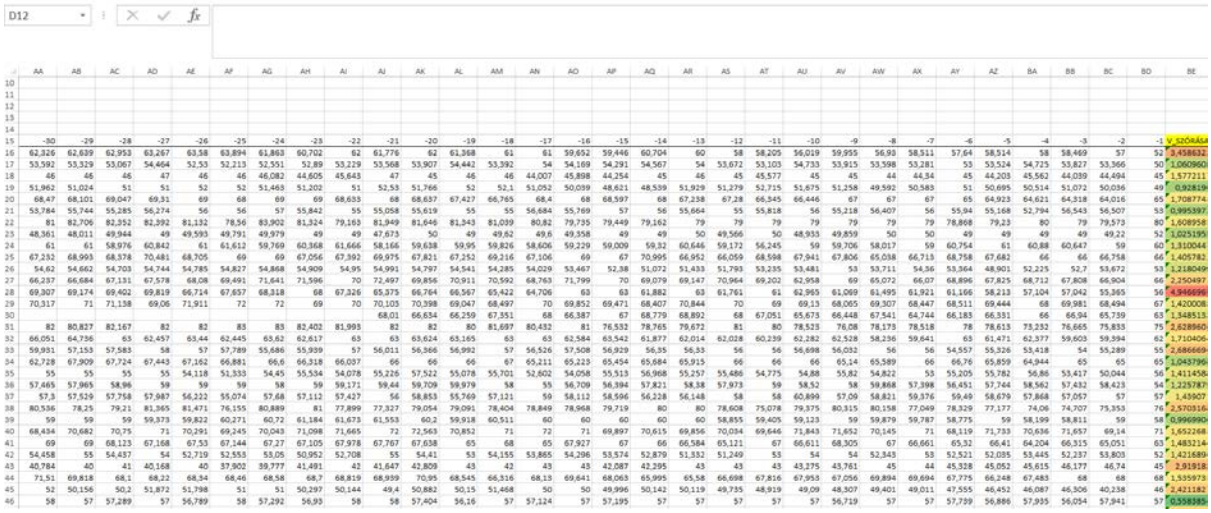

Figure 4 Example of data in columns G-BD

- Column BE: standard deviation of the speed data of the vehicle
- Column BF: average speed of the vehicle
- Column BG: speed of the vehicle 30 meter away from the display
- Column: BH: Indicates if the vehicle decreased speed in case of approaching vehicles, or the vehicle increased speed in case of leaving vehicles, comparing the first and last measurement points of the given vehicle (1- yes, 0 – no)
- Column BI: Indicates if the vehicle decreased speed in case of approaching vehicles, or the vehicle increased speed in case of leaving vehicles, by at least 10% of the speed limit, comparing the first and last measurement points of the given vehicle (1- yes, 0 – no)
- Column BJ: speed of the vehicle at the first measured point of the given vehicle in case of approaching vehicles, and the last measured point in case of leaving vehicles

-2	-1	V_SZÓRÁSA	V_AVG	Sebesség segé	Sebességet csökkent-e?	Sebességet csökkent-e legalább 6-al?	Az első mérési ponton mekkora volt a sebessége
57	52	3,45863222	60,8554	62,326	1	1	70,882
,366	50	1,06096021	53,8227	53,592	1	0	55,955
,494	45	1,57721173	44,8358	46	0	0	42,523
,036	49	0,9281962	51,1508	51,962	1	0	50,15
,016	65	1,70877434	68,1583	68,47	1	0	70,413
,507	53	0,99539724	55,3611	53,784	1	0	55,054
,573	80	1,60895853	80,5986	81	0	0	79,62
9,22	52	1,02519557	49,4089	48,361	0	0	50
59	60	1,31004471	60,4343	61	1	0	61,288
,758	66	1,40578225	67,7012	67,232	1	0	66,535
,672	53	1,21804995	53,8192	54,62	1	0	54,002
,904	66	2,25049717	68,608	66,237	1	0	69,882
,365	56	4,94669655	65,9128	69,307	1	1	69,257
,494	67	1,42000831	70,0964	70,317	1	0	71,646
,739	63	1,34851335	66,7125	0	1	0	68,01
,833	75	2,62896011	80,518	82	1	1	84
,394	62	1,71040649	63,1099	66,051	1	0	66,678
,289	55	2,68666947	58,2374	59,931	1	1	62,849
65	65	1,04379687	66,0046	62,728	1	0	67,562
,044	56	1,41145888	54,537	55	0	0	54,731
,423	54	1,22578792	58,2454	57,465	1	0	56,804
57	57	1,4390715	57,2963	57,3	0	0	54,605
,353	76	2,57031686	76,9784	80,536	0	0	75,729
59	58	0,99699047	59,3894	59	1	0	59,644
9,14	71	1,65226814	70,0573	68,434	0	0	69,286
,051	63	1,48321445	67,3543	69	1	1	70,749
,803	52	1,42168944	53,8637	54,458	1	0	52,009
6,74	45	2,9191822	43,855	40,784	0	0	42,136
68	68	1,53597357	68,6294	71,51	1	0	70,278
,238	46	2,42118277	49,9701	52	1	1	53,036

Figure 5 Example of data in columns BE-BJ

Further uniform data in the worksheets:

- Column BI, row 1: Name of the measurement location
- Column BI, row 2: Measurement direction ("Közeledők" means approaching vehicles, "Távolodók" means leaving vehicles)
- Column BI, row 3: Operating status of the vehicle activated display ("Bekapcsolva" means operating state, "Kikapcsolva" means non-operating state)
- Column BI, row 4: Speed limit at the measurement location

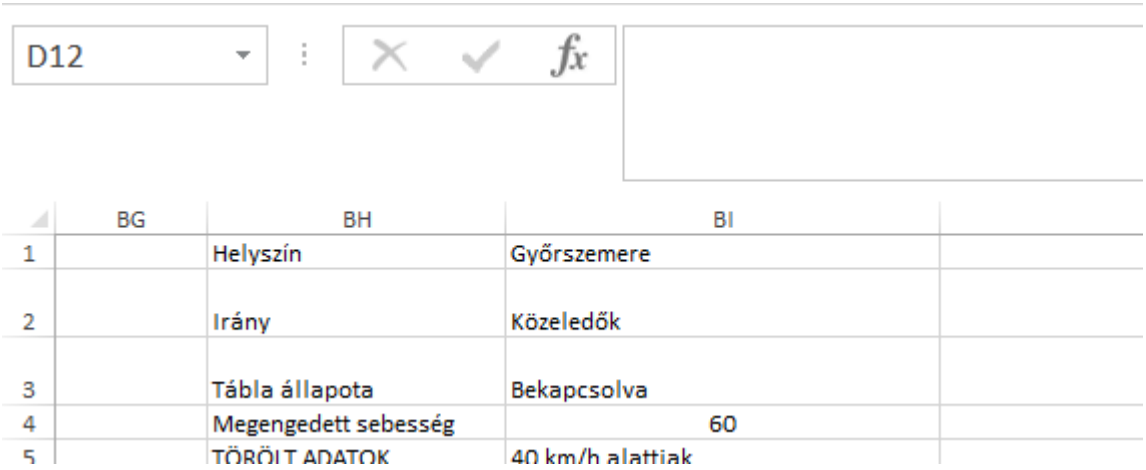

Figure 6 Example of data in column BI between rows 1 and 4

The further data on these worksheets, and the data on other worksheets not described above are auxiliary data used for calculations by the analysts.

2.1.2. Databases of speed measurements modelling fixed site speed cameras

Databases of speed measurements at fixed site speed cameras (modelled by the FamaLaser III speed camera) have been uploaded to the following folders in Seafile:

- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Budapest, Hunyadi Mátyás street 57
- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Speed measurement_Dunaharaszti, road 510

Each folder contains two Excel sheets. In all cases, the Excel file which name starts with the word "BEKAPCSOLT" contains data of speed measurements with the speed camera placed near the road.

Contrarily, the Excel file which name starts with the word "KIKAPCSOLT" contains data of speed measurements without the presence of speed camera near the road.

The first worksheet of the Excel files ("Összes közeledő +") describes data of vehicles approaching the speed camera.

The second worksheet of the Excel files ("Összes távolodó -") describes data of vehicles leaving the speed camera.

The structure of the Excel files are exactly the same as described in the previous chapter.

2.1.3. Databases on the potential effects of implemented Pilot Actions

Databases on the potential effects of implemented Pilot Actions can be found at the following place in Seafile:

- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/Data of Pilot Action1_road 40.xlsx
- 04 RAD_PM/WP5 - Pilots/Act 5.3 Pilot Action TA3 ITS/D5.3.1 Concept Plans/HUNGARY/_Database on Pilot Actions in Hungary/ Data of Pilot Action2_road 7.xlsx

These Excel files contain several worksheets.

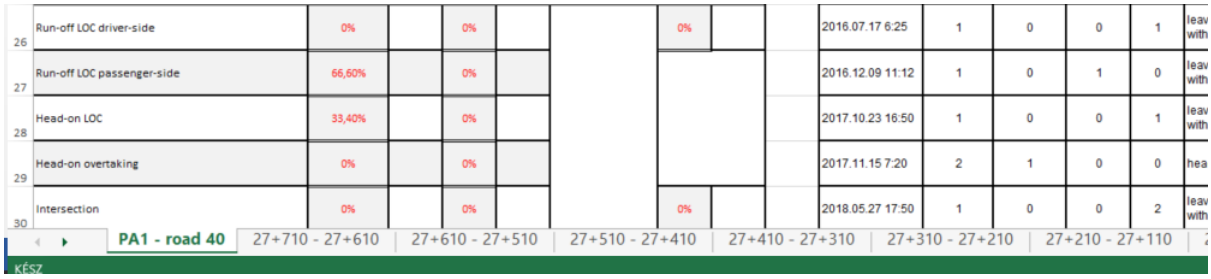

Figure 7 Several worksheets contained by the Excel files on the potential effects of Pilot Actions

The first worksheet in the files ("PA1 – road 40" and "PA2 – road 7") describes the following basic data of the Pilot Actions (label of the data are in column A):

- Location
- GPS
- Type of area
- Affected section
- Current speed limit
- Proposed speed limit
- AADT (vehicle unit/day)
- Operating speed (mean)- before the implementation of the pilot (km/h)
- Operating speed (v85) - before the implementation of the pilot (km/h)
- Expected operating speed (mean)- after the implementation of the pilot (km/h)
- Expected operating speed (v85) - after the implementation of the pilot (km/h)
- Motorcycle percentage
- Pedestrian peak-hour flows (along passenger and driver side of the road and across the road)
- Bicycle peak-hour flow (along the road)

The further worksheets contain the coded attributes for the iRAP Star Rating process, for each 100-meter-long road section. The name of the worksheet identifies the investigated 1000 meter long section. In the worksheets, labels are indicated in column A, Column B and C contain the values of the parameters (Column B – before the implementation, Column C – after the implementation of the Pilot).

The coded attributes were:

- Roadside severity - driver-side distance
- Roadside severity - driver-side object
- Roadside severity - passenger-side distance
- Roadside severity - passenger-side object
- Shoulder rumble strips
- Paved shoulder - driver-side
- Paved shoulder - passenger-side
- Carriageway label
- Upgrade cost
- Median type
- Centreline rumble strips
- Number of lanes
- Lane width
- Curvature
- Quality of curve
- Grade
- Road condition
- Skid resistance / grip
- Delineation

- Street lighting
- Vehicle parking
- Service road
- Roadworks
- Sight distance
- Intersection type
- Intersection channelization
- Intersecting road volume
- Intersection quality
- Property access points
- Vehicle flow (AADT)
- Motorcyclist %
- Pedestrian peak hour flow across the road
- Pedestrian peak hour flow along the road driver-side
- Pedestrian peak hour flow along the road passenger-side
- Bicyclist peak hour flow
- Land use - driver-side
- Land use - passenger-side
- Area type
- Pedestrian crossing facilities - inspected road
- Pedestrian crossing quality
- Pedestrian crossing facilities - intersecting road
- Pedestrian fencing
- Sidewalk - driver-side
- Sidewalk - passenger-side
- Facilities for motorised two wheelers
- Facilities for bicycles
- School zone warning
- School zone crossing supervisor
- Speed limit
- Differential speed limits
- Speed management / traffic calming
- Operating Speed (85th percentile)
- Operating Speed (mean)

A12 | MIDBLOCK ATTRIBUTES

	A	B	C
1	Road	Section	Chainage
2	Road 40	1	0+200 – 0+300
3	Attribute Group	Before	After
4	ROADSIDE ATTRIBUTES		
5	Roadside severity - driver-side distance	1 to 5m	1 to 5m
6	Roadside severity - driver-side object	Downwards slope	Downwards slope
7	Roadside severity - passenger-side distance	1 to 5m	1 to 5m
8	Roadside severity - passenger-side object	Downwards slope	Downwards slope
9	Shoulder rumble strips	Not present	Not present
10	Paved shoulder - driver-side	None	Medium (>=1m to <2.4m)
11	Paved shoulder - passenger-side	None	Medium (>=1m to <2.4m)
12	MIDBLOCK ATTRIBUTES		
13	Carriageway label	Undivided road	Undivided road
14	Upgrade cost	Low	Low
15	Median type	Centre line	Centre line
16	Centreline rumble strips	Not present	Not present
17	Number of lanes	One	One
18	Lane width	Wide (>=3.25m)	Wide (>=3.25m)
19	Curvature	Straight or gently curving	Straight or gently curving
20	Quality of curve	Not applicable	Not applicable
21	Grade	0% to 7.5%	0% to 7.5%
22	Road condition	Medium	Good
23	Skid resistance / grip	Sealed - medium	Sealed - adequate
24	Delineation	Adequate	Adequate
25	Street lighting	Not present	Not present
26	Vehicle parking	None	None
27	Service road	Not present	Not present
28	Roadworks	No road works	No road works
29	Sight distance	Adequate	Adequate

Figure 8 Example of the coded attributes for the iRAP Star Rating process