



STARS Project Report

Intra-Urban Speed Impact Study of a
Two-Way System for Speed Reduction



Munich, July 2011

Oleksandr Savliev & Octavio Jiménez

European Traffic Safety Council
Technische Universität München
Lehrstuhl für Verkehrstechnik
RTB GmbH & Co.



Table of Contents

- Abstract**..... 1
- 1. Project development**..... 1
 - 1.1. Development of the idea..... 1
 - 1.2. RTB Dialog-Display..... 2
 - 1.3. Test site selection..... 2
 - 1.4. Test site equipment..... 6
 - 1.5. Speed measurement and car classification..... 6
 - 1.6. Dialog-Display installation..... 7
 - 1.7. Public interest to the Project..... 10
- 2. Speed data analysis**..... 11
 - 2.1. Concept of the analysis..... 11
 - 2.2. Average speed analysis..... 11
 - 2.3. Statistical analysis..... 16
 - 2.4. Quantiles of drivers violating the speed limit..... 20
- 3. Conclusions**..... 24
- Source of reference**..... 24
- List of Figures**..... 24
- List of Tables**..... 25
- Appendix 1**..... 26
- Appendix 2**..... 27
- Appendix 3**..... 28
- Appendix 4**..... 30

Abstract

In this report, the development process of the STARS project is described mentioning the main project steps, milestones, and stakeholders. A two-way speed reduction system was installed on site in Munich. The system consisted of two Dialog-Displays manufactured by RTB GmbH & Co. A description of the implemented project is given. In the end, an assessment of the effectiveness of the applied speed reduction measure is conducted by means of speed and acceleration analysis before and after the installation of the measure.

1. Project Development

1.1. Development of the Idea

The original idea of installing of an appealing billboard on a rural street around Munich (See Appendix 1) was not feasible due to the specifics in the German law, which does not allow such kind of installation on the roadside due to the driver's distraction reasons. Therefore, after having investigated it was transformed into installation of a speed reduction measure. Particularly, two Dialog-Displays manufactured by RTB GmbH Co. were installed on a street in Munich.

Introduced by Univ.-Prof. Dr.-Ing. Prof. Fritz Busch¹ we were kindly accepted by the president of the RTB Company Mr. Rudolf Broer in his office in Bad Lippspringe. He listened to our idea and by the end of the discussion day it was agreed that all the necessary equipment will be provided and installation costs covered by RTB Company. As a condition for that, and the "payment", we were obliged to perform an acoustic study of the impact of the Dialog-Display on traffic sound emissions, which resulted in a Master's Thesis successfully written on the Chair of Traffic Engineering and Control of the Technical University of Munich (Savliev, 2011).

Additionally, the project was constantly supervised and supported by a representative of RTB Company Dr. Friedrich Maier², by the City Council of Munich (Kreisverwaltungsreferat München) and personally the chief of road transport department of the city of Munich Mr. Norbert Bieling³. He kindly provided his time and support to make the project come true and also facilitated obtaining of all the necessary permissions. Apart from that, the project was supported by Univ.-Prof. Dr.-Ing. Prof. Fritz Busch, the head of the chair of traffic engineering and control of the Technical University of Munich who shared with us his contacts and competency and basically helped to open "locked" doors.

¹Email: fritz.busch@tum.de

²Email: friedrich.maier@gmail.com

³Email: norbert.bieling@muenchen.de

1.2. RTB Dialog-Display

In this report, an impact on speed reduction due to the use of Dialog-Displays is assessed. Dialog-Displays have previously showed its effectiveness on speed reduction (Dittrich, Maier, 2009). The display consists of a shield with two areas: upper area where a motivating picture is printed and a bottom area where a two-line LED display is placed. In case a driver obeys the speed limit, a message “Danke” (Thank you) appears in green letters. Otherwise, it displays “Langsam” (Slow down) in red color (See Figure 1). Additionally, the display has embedded speed radar and data storing unit connected by means of GPRS to the server for downloading and transmission data. This data was used for the analysis of the vehicle speeds.



Figure 1 Example of a Dialog-Display Used for the Study

1.3. Test Site Selection

In order to define a place for the installation of the Dialog-Displays, with the highest utility, it was essential to conduct an analysis of the current situation. Kreisverwaltungsreferat München, and personally Mr. Norbert Bieling as a partner supporting this project, has kindly provided an access to the database of the police speed violation reports. Apart from that, it was decided to consider more relevant streets with changing speed limits over weekends and workdays as well as over the period of a day. Additionally, a presence of the school in the vicinity of the street was set as choosing criteria. Proceeding from that data, eight potential streets in the inner area of the city of Munich were defined. A summary of the results can be found in Table 1.

Table 1 Street pre-chosen for the Potential Installation of Dialog-Displays

Place	Nearest school	Police measurements Total	Total traffic volume, Veh/meas	Total veh. over speed limit Veh/meas	Percentage, %	Average traffic volume, Veh/h
Denninger Straße	Gebelestr.2/ Denninger Str. 1and 3	64	18206	4639	25,48%	284
Blumenauer Straße	Blumenauer Str. 11	326	66655	15679	23,52%	204
Mainau-straße	Reichenau-straße 3	214	41650	8765	21,05%	195
Manzo-straße	Manzostr.79	75	10367	1910	18,42%	138
Flurstraße	Flurstr.4	180	54175	9725	17,95%	301
Oberföh-ringer Straße	Oberföh-ringer Str. 224	255	148638	19968	13,43%	583
Limes-straße	Limesstr. 38	308	171292	18262	10,66%	556
Hugo-Lang-Bogen	Karl-Marx-Ring 63/71 u. Hans-Loehr-Weg u. Hugo-Lang-Bogen 33/35	343	169383	17704	10,45%	494

Having considered the data as well as field observations of the streets, Denningerstraße was chosen for installation and performance of the study. In average 25.48% of all drivers captured by police drove over the speed limit, which made it to be the most problematic street of Munich in terms of speed limit enforcement. The street has a speed limit of 50km/h and a 30km/h speed limitation during workdays from 7am to 7pm. The problem area is represented on Figure 2. A photograph of the street where the installation took place is to be seen on Figure 3. Some more views of the street before the installation are found in Appendix 3. A variable speed limit during different time provides extensive evaluation possibilities of the influence of a speed change. Apart from that, there is a school in the direct vicinity, which makes it especially reasonable to reduce speed on this road as well as sound pollution. This all resulted in a defined study area as shown below on Figure 4



Figure 2 The Area on which the Speed Violations were registered.
Mapsource: Openstreetmap



Figure 3 A View the Denningerstraße during the Potential Test Site Evaluation.
Map source: Openstreetmap



Figure 4 Chosen Study Area at Denninger Straße in Munich.
Map source: Openstreetmap

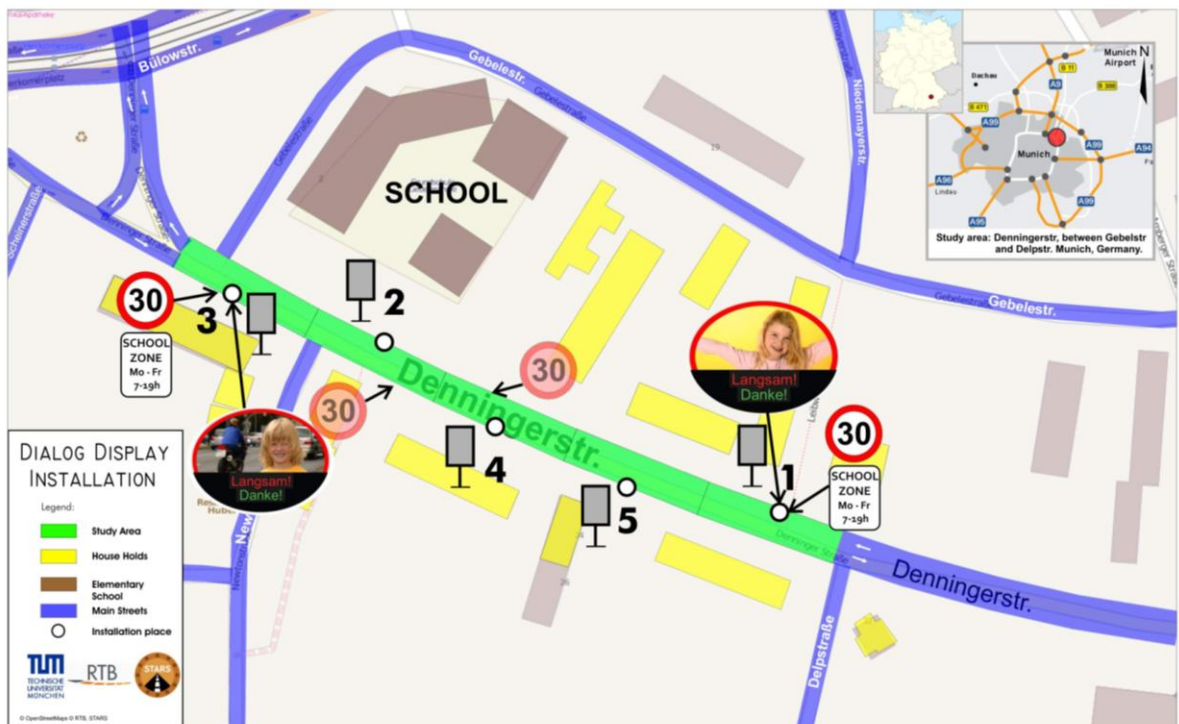


Figure 5 Scheme of the Dialog-Display and the Detectors Placement on the Study Area.
Mapsource: Openstreetmap

1.4. Test Site Equipment

In order to get a reliable dataset on traffic speed as well as vehicle classification before and after the installation of the Dialog-Displays, five speed detectors were installed on the Denningerstraße in Munich. In total, there were installed five masts for mounting of the detectors and Dialog-Displays. A plan of the exact installation places can be seen on Figure 6.

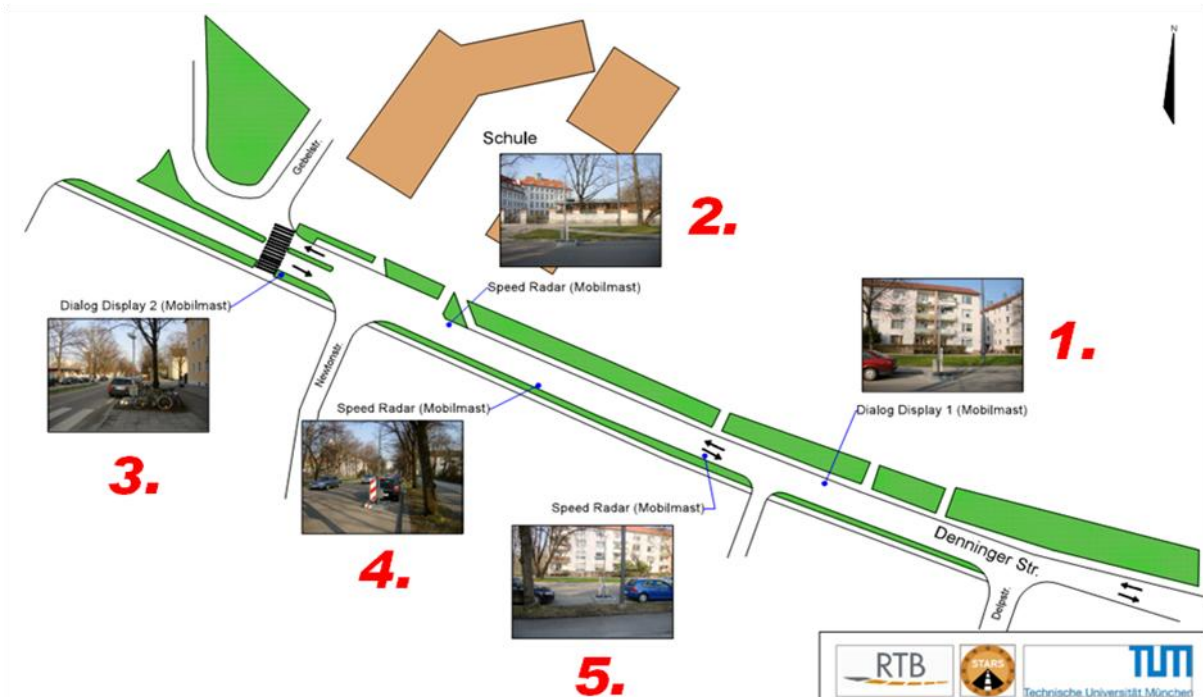


Figure 6 Detectors and Dialog-Display Installation Places

From Figure 6 it can be observed that four poles were installed directly in the area of the parking places, in between the parking area of the road, and one was installed on the grass bed along the road. The reason to place four masts on the road was the existence of parking lane as well as a bicycle lane in both directions, which would have decreased the visibility of the Dialog-Displays and would rise the costs of the mast itself.

1.5. Speed Measurement and Car Classification

The speed measurement as well as count and classification of the vehicles in both directions were made using TOPO.plus detectors from RTB Broer Company. The detectors used measure vehicle speed, length, number of axles and acoustic characteristics of the vehicles (RTB, 2008). TOPO.plus detectors are certified to be used on German road, fulfil BAST⁴ requirements and follow TLS 2002⁵ German technical instructions. In accordance with the aforesaid norm, the vehicles are classified into 8+1 classes. A further description of the vehicle classes is represented in Appendix 2.

⁴ BAST- Bundesanstalt für Straßenwesen

⁵ TLS - Technische Lieferbedingungen für Streckenstationen

Speed and vehicle classification measurements were conducted over the time period of nine days before the installation of the Dialog-Displays as well as nine days after the installation starting from the 29.03.2011 until the 18.04.2011 from five mobile poles as represented on Figure 6. The Dialog-Displays in both directions were installed 8.04.2011 at 10:00. One of the speed measurement devices (spot nr. 2) was distorted by a parking vehicle on the 7.04.2011 and thus provided erroneous speed measurement results until it was verified during the Dialog-Display installation. All the rest of measurements ran through without problems. Five detection devices, on Denningerstraße test site in Munich were battery powered. Therefore, a change of batteries was carried out after one week of measurements. The data from the detectors was transmitted over GPRS connection to the RTB Broer server. At the end of measurements, the raw database looks as represented in Table 2.

Table 2 Raw Database Extract from the Speed Measurements and Vehicle Classification

	A	B	C	D	E	F	G	H
1	DATUM_UHRZEIT	Wochentag	STANDORT_ID	UHRZEIT	LAENGE	V_SR	KLASSE	8+2_TXT
2	29.03.2011 17:15:34	3	2	171534	40	41	1	PKW
3	29.03.2011 17:13:08	3	2	171308	36	30	1	PKW
4	29.03.2011 17:18:02	3	2	171802	37	41	1	PKW
5	29.03.2011 17:17:56	3	2	171756	48	28	1	PKW
6	29.03.2011 17:17:38	3	2	171738	31	20	1	PKW
7	29.03.2011 17:17:02	3	2	171702	39	22	1	PKW
8	29.03.2011 17:16:12	3	2	171612	43	27	1	PKW
9	29.03.2011 17:18:22	3	2	171822	35	25	1	PKW
10	29.03.2011 17:16:08	3	2	171608	37	21	1	PKW
11	29.03.2011 17:19:18	3	2	171918	35	25	1	PKW
12	29.03.2011 17:15:16	3	2	171516	33	22	1	PKW

1.6. Dialog-Display Installation

After the first week of speed measurements of the situation before installation of the devices, the speed reduction system was installed in both directions: Herkomerplatz and Richard-Strauß-Straße (Spot 1 and 3 according to the plan represented on Figure 5). The installation process of the Dialog-Display is represented of Figure 7 below. Figure 8 and Figure 9 represent the installed Speed reduction system as well as the detector system for the assessment of the previous situation. Figure 10 represents three speed detectors used for an assessment of the speed situation behind the speed reduction system in both directions.



Figure 7 Installation of Dialog-Displays on Denningerstraße in Munich (Left direction Richard-Strauß-Straße; Spot 3; Right: direction: Herkomerplatz, Spot 1)



Figure 8 Speed Measurement Detector (left) for the Assessment of the Previous Situation and installed Dialog-Display (right). Direction: Richard-Strauß-Straße. Spot 3



Figure 9 Speed Measurement Detector (left) for the Assessment of the previous Situation and installed Dialog-Display (right). Direction: Herkomerplatz. Spot 3



Figure 10 Speed Measurement Detectors. Spot 2 (left), Spot 4 (middle), Spot 5 (right)

1.7. Public Interest to the Project

There was a constant interest caused by the project from the part of the University with constant support, but also from the public side. Such as the one of the biggest German Newspapers “Süddeutsche Zeitung”, which published an article highlighting the project (See Figure 11). The online version is to be found following the link: [Süddeutsche Zeitung](#)



Figure 11 Süddeutsche Zeitung Article about the Project

2. Speed Data Analysis

2.1. Concept of the Analysis

The speed data analysis was conducted taking data from the field measures; a sample dataset between the dates 04.04.2011-08.04.2011 (Week1) and the dates 11.04.2011-15.04.2011 (Week 2) was examined. This was done due to the fact that these two weeks were the most representatives in terms of recorded data and the easiness of comparisons among them. Similarly, the speed measures were recorded from 7:00 till 19.00 hrs. for every day; later on, they were aggregated for every Week period. In this sense, Week number 1, represents the aggregated values obtained before the installation of the Dialog-Display, while Week number 2 represents the aggregated values obtained after the Dialog-Display installation. Finally, the aggregated sample size n for the Week 1 was 4435 vehicles while for the Week 2 n was 4325 vehicles for the direction Herkomerplatz and for the direction Richard-Strauss-Straße, the samples were, for the Week 1, $n = 6540$ vehicles and for the Week 2, $n = 6370$ vehicles.

Both Weeks were later on compared with the pure propose to visualize the difference between speeds, acceleration and probabilities. In addition, the same procedure was repeated for the weekends; where two weekends were selected out of the total set of records obtained during the experiment. Comparison among the weekends was later carried out, following the same procedure: before and after the Dialog-Display Installation, with the goal to analyse and inspect the performance of the device.

Figure 5 shows the two arrangements for speed detectors and Dialog-Display. One before the installation of the Dialog-Display, and the other one after the installation; the scheme also depicts where the speed detectors were placed along the study section. The analysed direction in this case was towards Herkomerplatz, including the posted limit speed during working days, which is 30 km/h from 7:00 till 19:00 hrs.

2.2. Average Speed Analysis

In Figure 12 the average speed profile is depicted along the observation period. The graph was divided in two segments; the first corresponds to the Spot 1 and the second to the Spot 2. It is noticed how the speed profile has changed along the time and the distance travelled, until partially falls down before reaching the Spot 2. This drastic speed reduction is caused mainly because motorists have to slow down before approaching the zebra crossing; besides, the school sign affected as well their driving behaviour. This was located close to the place where the Spot 2 was installed.

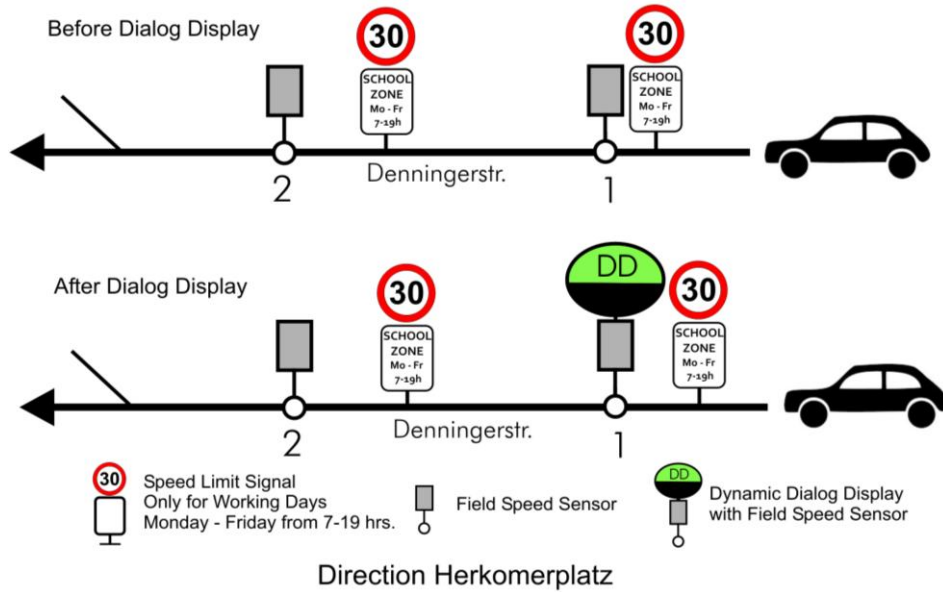


Figure 12 General Layout of Speed Detectors, Disposition and Dialog-Display Installation. Direction Herkomerplatz

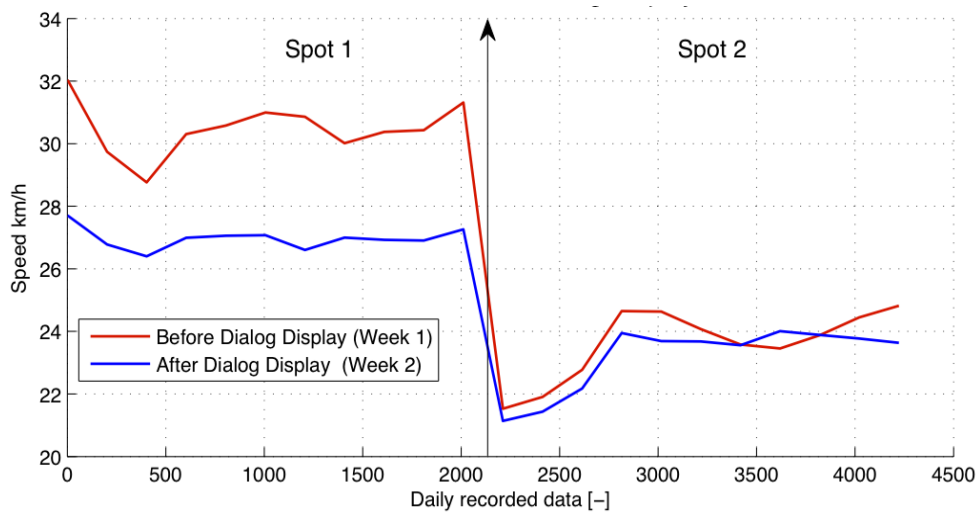


Figure 13 Average Speed Before and After the Dialog-Display Installation for Spots 1 & 2

The red line on Figure 13 depicts the average speed profile analysed based on the sample of the Week 1, while the blue line depicts the average speed profile after the installation of the Dialog-Display, correspondent to the dataset analysed for the sample of the Week 2. It can be seen that the average speed while cars were passing through the Spot 1 was 29 km/h, before the Dialog-Display; after installation the average speed was 25 km/h. Likewise, before the installation, the average speed for Spot 2 was 23 km/h, whereas after the installation, the average speed was 21 km/h.

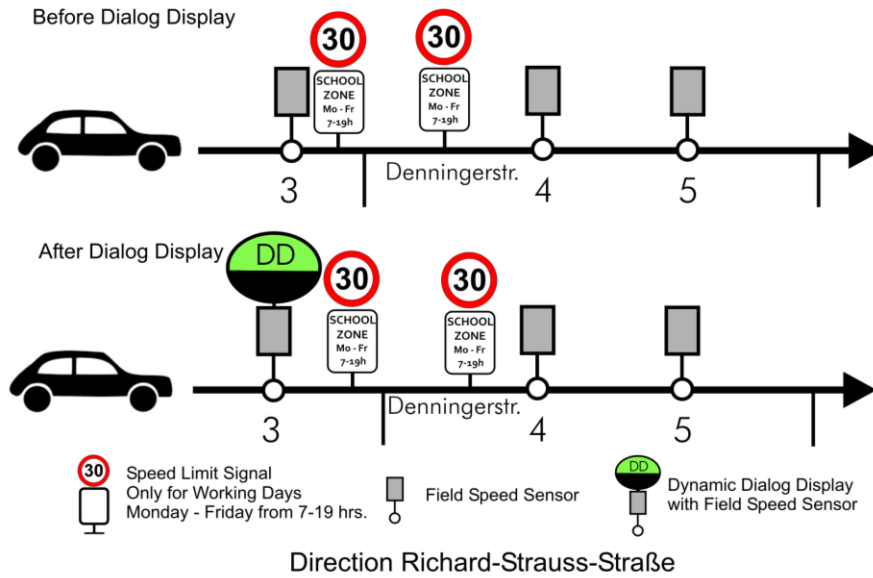


Figure 14 General Layout of Speed Detectors Disposition and Dialog-Display Installation. Direction Richard-Strauss-Straße

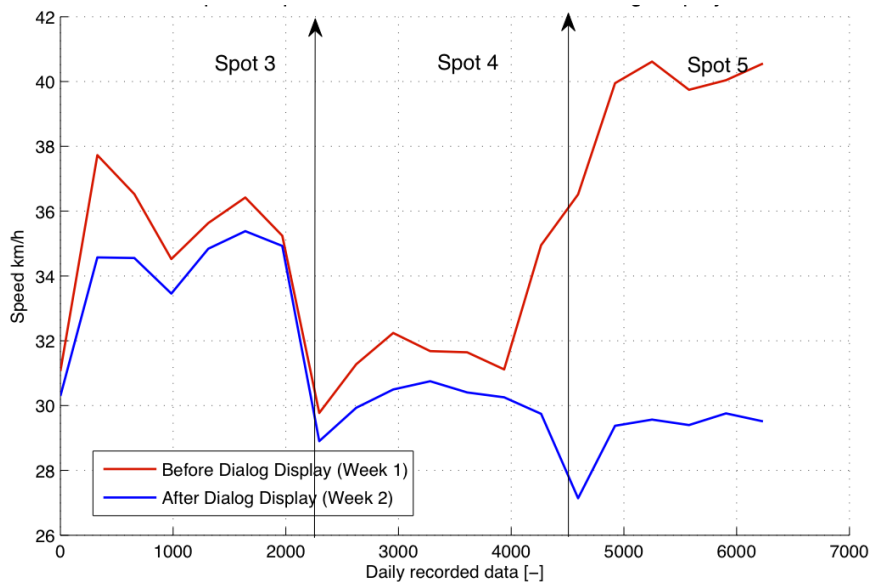


Figure 15 Average Speed Before and After Dialog-Display Installation for Spots 3, 4, & 5

Figure 14 shows the arrangement of the opposite direction towards Richard-Strauss-Straße. The placement of the speed detectors is shown as well as the posted speed limit. The Dialog-Display placement is also illustrated along the study section.

Figure 15 presents the analysis based on the data obtained from the speed detectors. Here the red line represents the average speed profile before the Dialog-Display, showing how the average speed behaved along the section. It is remarkable how just after leaving the Spot 3 (which is located very close to the pedestrian crossing) the motorists began to speed up, regardless the posted speed limit of 30 km/h. After passing through the Spot 4 and reaching the number 5, the speed profile increases constantly and exceeds the speed limit. After the installation of the Display, the reduction of the speed is notorious, as seen in the blue line, which is depicted in the plot. The motorists after leaving the

study area around Spot 5 reduced their average speed significantly in comparison with the situation before the Dialog-Display. The average speed before the Display along the study section was about 36 km/h, while after the installation the average speed calculated was 31 km/h.

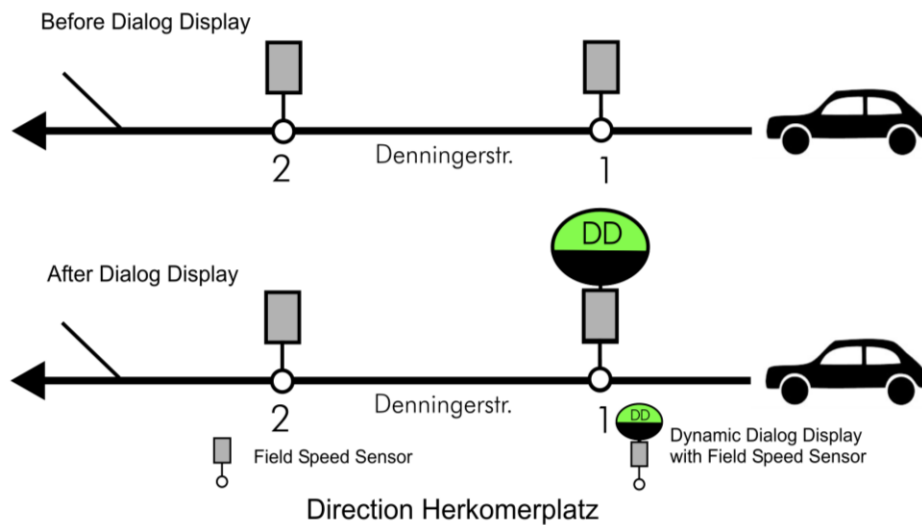


Figure 16 General Layout of Speed Detectors Placement and Dialog-Display Installation. Direction Herkomerplatz (50km/h Speed limit - Weekends)

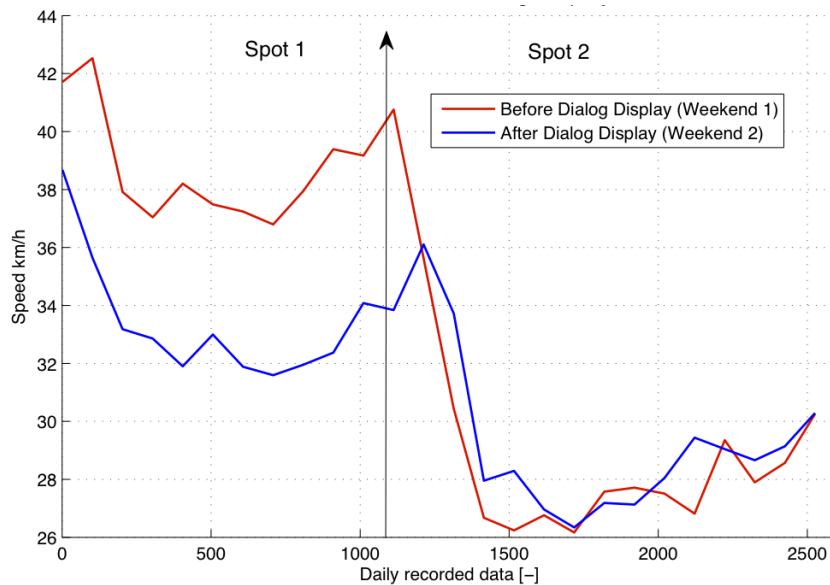


Figure 17 Average Speed Before and After Dialog-Display Installation for Spot 1 & 2 during Weekends

Average Speeds were also analysed during the weekends, where the speed limit is 50 km/h. The dates for the chosen weekends were: 02.04.2011- 03.04.2011 (Weekend 1) and 09.04.2011-10.04.2011 (Weekend 2). In addition, the aggregated sample size for the Weekend 1 n was 2600 vehicles and for the Weekend 2 the sample n was 2700 vehicles for the direction Herkomerplatz, for the direction Richard-Strauss-Straße, the sample n for the Weekend 1 was 4150 vehicles and for the weekend 2 n was 4160 vehicles. The speed measures were recorded from 00:00 till 23:50 hrs. for every day, and later on the values were aggregated into sample Weekends. Figure 16 illustrates the general layout of the placement of the speed detectors and the placement of the Dialog-Display. The travel direction in this case was towards Herkomerplatz. Figure 17 plots the analysed results based on the dataset selected for each weekend.

The red line depicts the average speed profile before the installation of the Display, whereas the blue depicts the average speed after the installation. The average speed before the Display was 41km/h for Spot 1, after the installation, the average speed calculated was 35 km/h at the same Spot. Similarly, for the Spot 2, the average speed before was 32 km/h while, after the Dialog-Display this was 30 km/h.

It is interesting to notice, how the speed profile behaves more or less the same during the working days as during the weekends. Ultimately, it is also clear how the speed dropped after the installation of the device (See blue line), especially along the section where the Spot 1 was installed. It is again remarkable how the Dialog-Display had clear influence on the driving behaviour of the motorists, by reducing their mean speed along the study area.

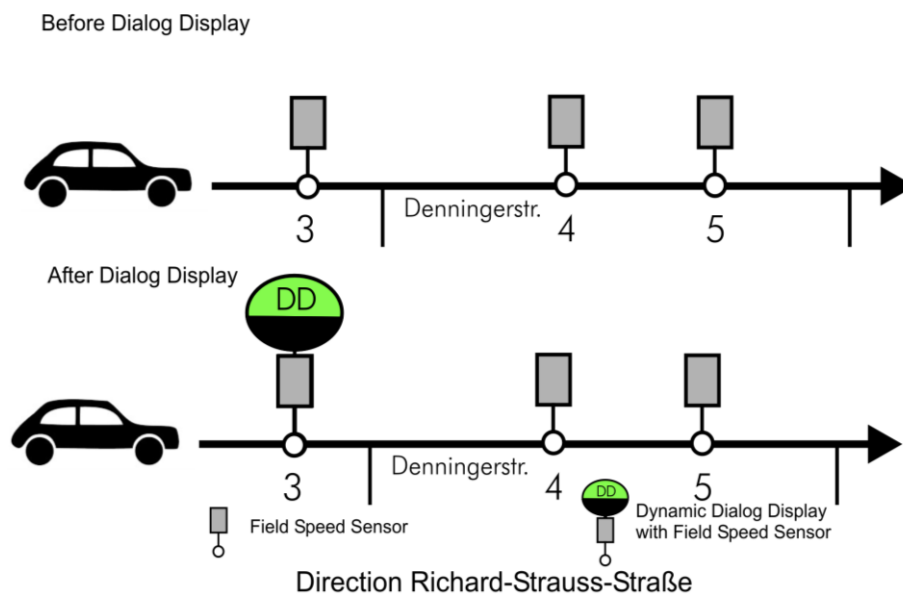


Figure 18 General Layout of Speed Detectors Placement and Dialog-Display Installation. Direction Richard-Strauss-Straße (50 km/h Speed limit - Weekends)

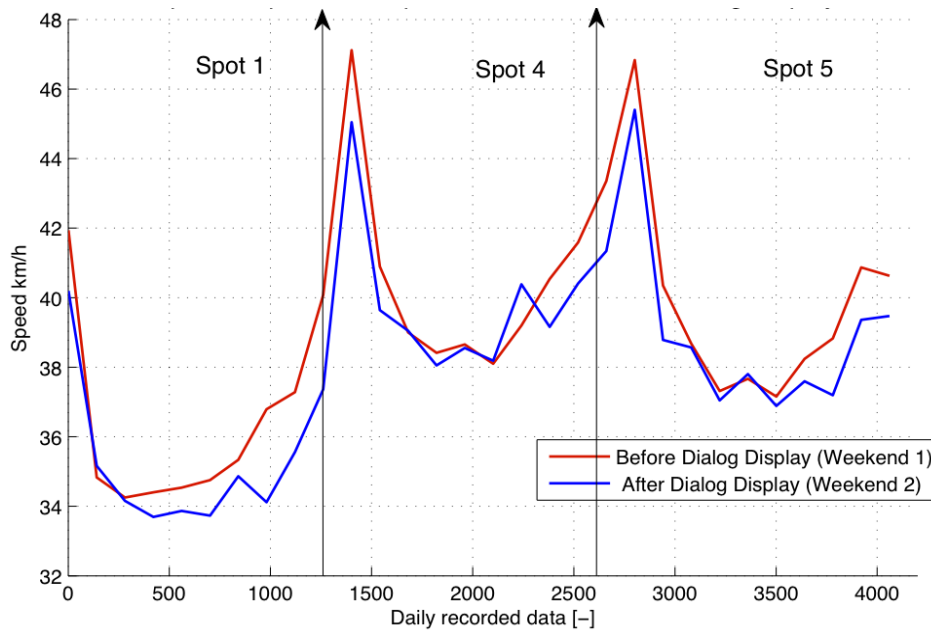


Figure 19 Average Speed Before and After Dialog-Display Installation for Spots 3, 4 & 5 during Weekends

Figure 18 depicts the general layout of the installation devices on the opposite direction towards Richard-Strauss-Straße. Again the speed detectors and the Dialog-Display are shown. Figure 19 presents the average speed profiles along the study area and it is divided in three main segments, where the first segment represents the average speed computed based on the data gathered of the speed detector 3, the next segment represents the average speed obtained from speed detector number 4, and the last segment of the plot represents the average speed computed based on the data of the speed sensor 5. The red lines depict the average speed profile before the implementation of the Dialog-Display, while the blue line depicts the average speed profile after the implementation of the device. The characteristics of both lines are quite similar; however, the effect of the Display is notorious. The average speed before the device reaches about 40 km/h, while after the installation, it reached as much as 39 km/h.

2.3. Statistical Analysis

Other way to represent or measure the effectiveness of the Dialog-Display was by conducting a statistical analysis. During the analysis, the cumulative density of the average speed was computed, as well as the normal distributions for several sample average speeds. In this way, it was easier to identify how much the average speed was reduced after the installation of the device. For conducting the analysis, just one travel direction was analyzed in detail (direction Herkomerplatz). This was done during working days (30 km/h speed posted speed limit), and the sample data was taken from the already chosen Weeks (1& 2).

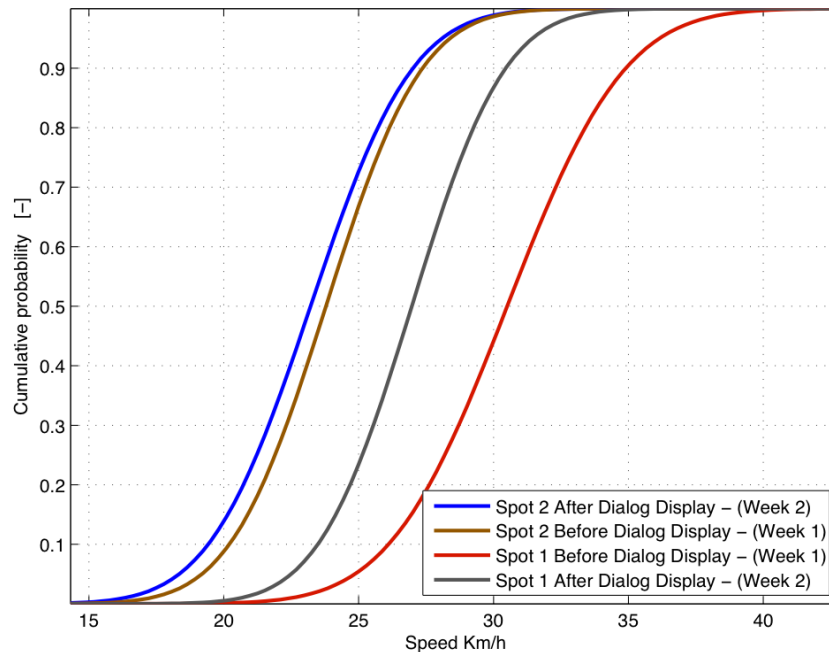


Figure 20 Cumulative Probability of Driving Speed for Spots 1 & 2

Figure 20 depicts the cumulative density of the average speed at the Spot 1 and 2 (entering and leaving the study section), before and after the Dialog-Display installation. It is noticed how the curves shifted to the left after the device installation. This means, for example at the Spot 1, that there was a significant increment of at least 40% (48 - 88% See figure below) of drivers that approached the study section with the appropriate speed limit (30 km/h); however, at the spot 2 the percentage of reduction was minimum due to the fact that the drivers were approaching the School Zone and the pedestrian crossing was just few meters away (See Figure 6). The comparison was done taking as a parameter the posted speed limit of 30km/h. For more statistical analysis concerning cumulative probabilities along the study area, see Appendix 4.

The selected dataset was evaluated, and the data which did not match with the propose of the analysis was excluded. (Data, which was not properly gathered by the speed detectors, was eliminated from the sample). Later on, the data from the Weeks 1 and 2 were plotted, as distributions. Here was noticed that the dataset behaved as normally distributed as it is shown in Figure 21. Before the installation of the device, the recorded data was more towards to the right; meaning that more drivers of drivers exceeded the posted speed limit. After the installation, the amount of observations moved towards to the left. It is notorious again, how a significant amount of drivers has reduced their mean speed after the Dialog-Display as it is shown in Figure 21.

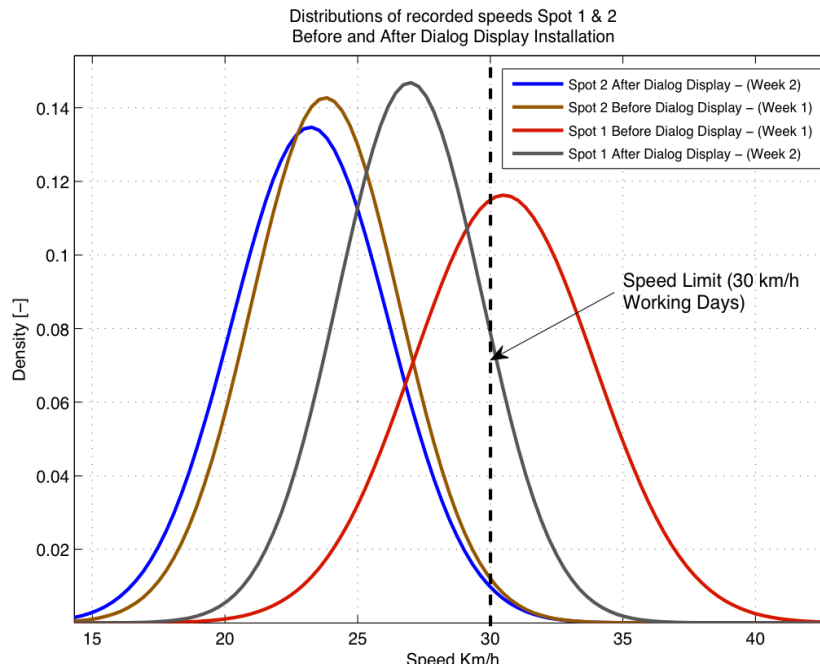


Figure 21 Speed Distribution for Spots 1 & 2 Before and After Dialog-Display

Ultimately, one more method to evaluate if the installation of Dialog-Display worth the efforts was evaluation of mean accelerations of the motorists. In this case, the acceleration was calculated based on the speed already measured by the speed detectors during Working days. This speed was treated as a *Final Velocity (FV km/h)*, and the *Initial Velocity (IV km/h)* was taken as a zero. The time (t sec.) was later on calculated between the two parameters, based on the distance, which was measured from the installation of the speed detector (Spot 1) till the other extreme of the street (312 m approx.), towards Richard-Straus-Straße, exactly where the cars have to stop because of the presence of a traffic light ($IV = 0$).

After being defined the methodology, the mean acceleration was computed before and after the installation of the device. Figure 22 plots this final results, the red line represent the acceleration before the measure; Notice how the acceleration was higher as compared with the acceleration after (blue line). It can be seen as well, how drivers reduced their acceleration before approaching the Dialog-Display, indicating once again the effectiveness of the device.

Figure 23 is regarding the acceleration of drivers, illustrates the normal distribution of the acceleration before and after the device installation. While for instance in the first Week most of the acceleration values fell between the range of 0.6 – 1.2 m/s^2 . After the installation the range was between 0.4 m/s^2 and 1.0 m/s^2 , meaning that less drivers were tempted to accelerate, and in consequence to speed up.

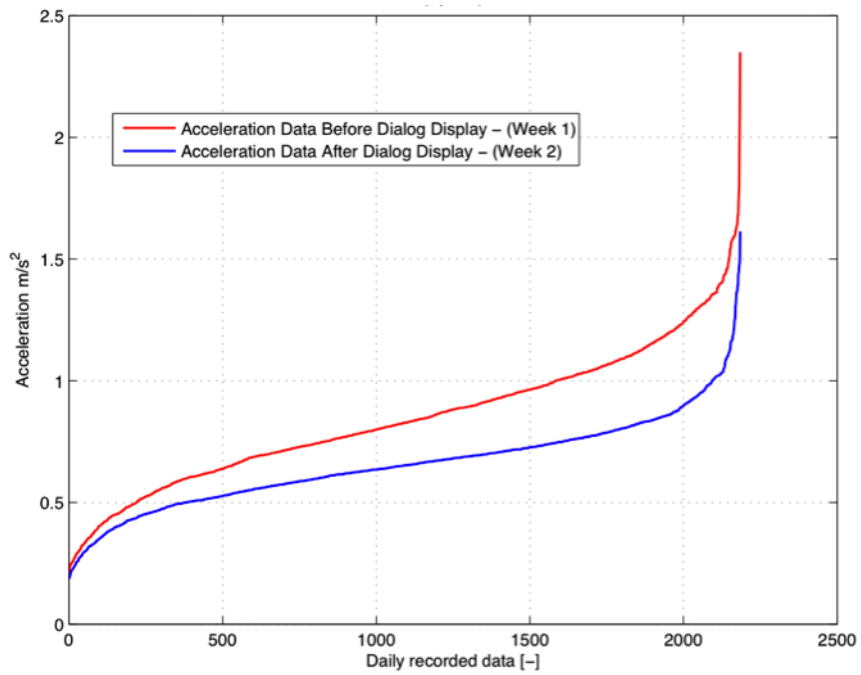


Figure 22 Acceleration data Before and After Dialog-Display

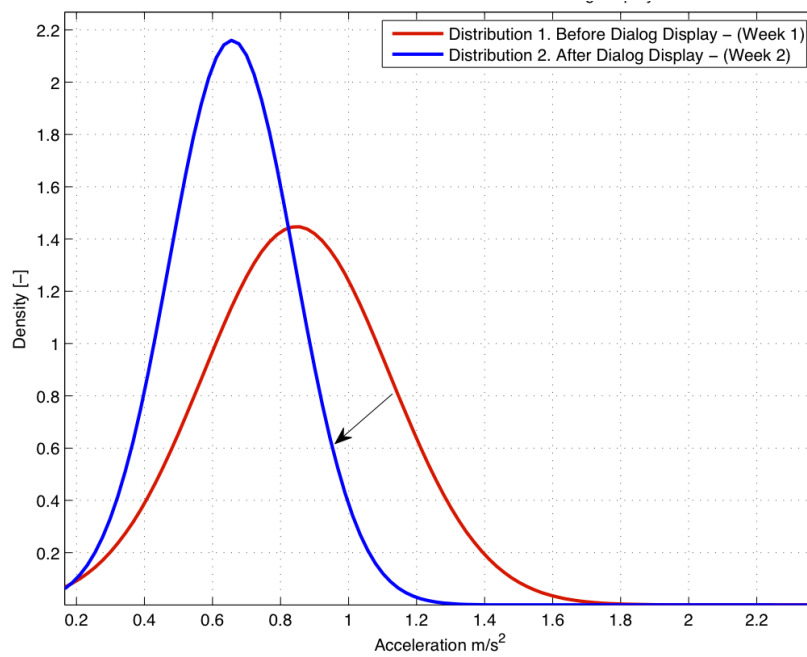


Figure 23 Acceleration Distribution Before and After Dialog-Display for Spot 1 during - Working Days

2.4. Quantiles of Drivers Violating the Speed Limit

Table 3, Table 4, Table 5 and Table 6 represent a summary of the analysis supported by RTB GmbH & Co. in the previous analysis phase. In this case the whole dataset obtained during the speed measurement experiment was considered over the period 29.03.11- 08.04.2011 (before Dialog-Display) and 08.04.2011 - 18.04.2011(after Dialog-Display). It is seen that the percentage of drivers that obey the speed limit increased significantly in both directions at the Dialog-Display installation place, as well as behind of it. For the speed limit 30 km/h the quantity of drivers obeying the speed limit at Dialog-Display in direction Herkomerplatz grew at almost 30 % from 45,9% to 75,6%.

Table 3 Results summary - 30 km/h Speed Limit – Direction Herkomerplatz

SPOT Nr.				Speed Limit 30kmh		
				<= 30	31+	Total
(1)	Analysis phase	Before (without DD)	Amount	8287	9759	18046
			Analysis phase %	45,9%	54,1%	100,0%
		After (with DD)	Amount	9821	3173	12994
			Analysis phase %	75,6%	24,4%	100,0%
(2)	Analysis phase	Before (without DD)	Amount	15917	2465	18382
			Analysis phase %	86,6%	13,4%	100,0%
		After (without DD)	Amount	13110	1288	14398
			Analysis phase %	91,1%	8,9%	100,0%

**Table 4 Results summary - 30 km/h Speed Limit – Direction Richard-Strauss-Straße.
Working Days (7-19hrs)**

SPOT Nr.				Speed limit 30kmh		
				<= 30	31+	Total
(3)	Analysis phase	Before (without DD)	Amount	10380	8780	19160
			Analysis phase %	54,2%	45,8%	100,0%
		After (with DD)	Amount	9417	4631	14048
			Analysis phase %	67,0%	33,0%	100,0%
(4)	Analysis phase	Before (without DD)	Amount	9292	12809	22101
			Analysis phase %	42,0%	58,0%	100,0%
		After (with DD)	Amount	8425	6214	14639
			Analysis phase %	57,6%	42,4%	100,0%
(5)	Analysis phase	Before (without DD)	Amount	8360	9718	18078
			Analysis phase %	46,2%	53,8%	100,0%
		After (with DD)	Amount	7113	6025	13138
			Analysis phase %	54,1%	45,9%	100,0%

Table 5 Results summary - 50km/h Speed Limit – Direction Herkomerplatz. Weekends

SPOT Nr.				Speed limit 50kmh		
				<= 50	51+	Total
(1)	Analysis phase	Before (without DD)	Amount	6409	729	7138
			Analysis phase %	89,8%	10,2%	100,0%
		After (with DD)	Amount	8329	256	8585
			Analysis phase %	97,0%	3,0%	100,0%
(2)	Analysis phase	Before (without DD)	Amount	7227	365	7592
			Analysis phase %	95,2%	4,8%	100,0%
		After (with DD)	Amount	9982	588	10570
			Analysis phase %	94,4%	5,6%	100,0%

Table 6 Results summary - 50 km/h Speed Limit – Direction Richard-Strauss-Straße. Weekends

SPOT Nr.				Speed limit 50kmh		
				<= 50	51+	Gesamt
(3)	Analysis phase	Before (without DD)	Amount	7491	256	7747
			Analysis phase %	96,7%	3,3%	100,0%
		After (with DD)	Amount	9027	303	9330
			Analysis phase %	96,8%	3,2%	100,0%
(4)	Analysis phase	Before (without DD)	Amount	7819	1128	8947
			Analysis phase %	87,4%	12,6%	100,0%
		After (with DD)	Amount	8880	625	9505
			Analysis phase %	93,4%	6,6%	100,0%
(5)	Analysis phase	Before (without DD)	Amount	7153	1073	8226
			Analysis phase %	87,0%	13,0%	100,0%
		After (with DD)	Amount	8813	1047	9860
			Analysis phase %	89,4%	10,6%	100,0%

3. Conclusions

In conclusion, the Dialog-Display represents a feasible option to reduce speed in urban areas. It is also important to remember that an evaluation and assessment of the place where the device could be installed is mandatory. In this way a better performance of the device can be achieved and the possible results may reflect significant speed reductions after the device installation; as it was shown in this study.

After the installation of the Dialog-Display the average speed of drivers approaching the study area was reduced to the amount of 5 km/h in average. Some measurement intervals displayed even bigger reduction. Apart from that, there was a decrease of the speed behind the display. This means that drivers do not immediately accelerate after having passed the speed reduction measure, which is a case for speed bumps, for instance. This proves that a combination between a static appealing image of a child and a dynamic display telling the driver “thank you” or “slow down” has a tremendous impact on the drivers' behavior. Additionally, it was demonstrated that there was at least a 40% increment of drivers that entered with the proper speed limit to the study area after the Dialog-Display Installation, demonstrating by this its efficacy.

Finally, the objective of this study was to prove and evaluate the efficiency and the effects that Dynamic Dialog-Displays (such as the one already investigated) have on drivers. As an alternative to reduce speed, the Dialog-Display has demonstrated its reliability to reduce speed, as it was found in this research. Ultimately, the results presented in this report can be very helpful for any transport authority or planning engineers, or for those who are seeking for alternatives to reduce speed in urban areas.

Source of Reference

- Dittrich C., Maier F. (2009). *Impact of Dialog- Displays on velocities of a rural road*. Lehrstuhl für Verkehrstechnik, Technische Universität München.
- Savliev O. (2011). *Intra-Urban-Acoustic Study of a Two-way system for speed reduction*. Master`s Thesis, Lehrstuhl für Verkehrstechnik, Technische Universität München

List of Figures

Figure 1	Example of a Dialog-Display used for the study.....	2
Figure 2	The area on which the speed violations were register.....	4
Figure 3	A view of the Denningerstraße during the potential test site evaluation.....	4
Figure 4	Chosen study area at Denninger Straße in Munich.....	5
Figure 5	Scheme of the Dialog-Display and the detectors placement on the study area.....	5
Figure 6	Detectors and Dialog-Display installation places.....	6
Figure 7	Installation of Dialog-Displays on Denningerstraße in Munich (Left direction Richard-Strauß-Straße ; Spot 3; Right : direction:Herkomerplatz, Spot 1).....	8
Figure 8	Speed measurement detector (left) for the assessment of the previous situation and installed Dialog-Display (right). Direction: Richard-Strauß-Straße. Spot 3.....	8
Figure 9	Speed measurement detector (left) for the assessment of the previous situation and installed Dialog-Display (right). Direction: Herkomerplatz. Spot 3.....	9
Figure 10	Speed measurement detectors. Spot 2 (left), Spot 4 (middle), Spot 5 (right).....	9
Figure 11	Süddeutsche Zeitung article about the project.....	10
Figure 12	General Layout of speed detectors, Disposition and Dialog-Display.....	12
Figure 13	Average Speed Before and After the Dialog-Display	12
Figure 14	General Layout of speed detectors Disposition Dialog-Display Installation. Direction Richard-Strauss-Straße.....	13
Figure 15	Average Speed Before and After Dialog-Display Installation.....	13
Figure 16	General Layout of speed detectors placement and Dialog-Display.....	14
Figure 17	Average Speed Before and After Dialog-Display Installation for Spot 1& 2 during Weekends.....	14

Figure 18	General Layout of speed detectors placement and Dialog-Display Installation.....	15
Figure 19	Average Speed Before and After Dialog-Display Installation for Spots 3, 4 & 5 during Weekends.....	16
Figure 20	Cumulative Probability of Driving Speed for Spots 1 & 2.....	17
Figure 21	Speed Distribution for Spots 1 & 2 Before and After Dialog-Display.....	18
Figure 22	Acceleration data Before and After Dialog-Display.....	19
Figure 23	Acceleration Distribution Before and After Dialog-Display.....	19

List of Tables

Figure 1	Steet pre-chosen for the potential installation of Dialog-Displays	3
Figure 2	Raw database extract from the speed measurements and vehicle classification.....	7
Figure 3	Results summary - 30 km/h Speed Limit – Direction Herkomerpltz.....	20
Figure 4	Results summary - 30 km/h Speed Limit – Direction Richard-Strauss-Straße.....	21
Figure 5	Results summary - 50km/h Speed Limit – Direction Herkomerpltz. Weekends.....	22
Figure 6	Results summary - 50 km/h Speed Limit – Direction Richard-Strauss-Straße. Weekends.....	22











Appendix 1

STARS Project Original Idea



Appendix 2

RTB Broer TOPO.plus Detector Classification in Accordance with TLS 2002 German Standard. Source: RTB Broer

Code according to TLS 2002	Vehicle class	Symbol	Description	Length
230*	Fahrrad		Bicycle	
235*	Krad		Motorcycle	2535 mm (f.e. Kawasaki VN 2000 classic)
240*	Kleinstwagen		City car	2500 mm (Smart Fortwo Coupe Pure CDI)
1	PKW		Car under 3,5 t z	
4	LKW		Small truck under 7,5 t, f.e. Sprinter MB	
2,3	PKW/A		Car with trailer	
8-12	LKW		Truck over 7,5 t	
32-95	LKW/A		Truck with trailer	
96-119	Sattelzug		Semitrailer truck	
120-125	Bus		Bus with > 16 pass.	
145-255	Reserviert für weitere Klassen			

Appendix 3

Fotographs of the Denningerstraße during the Evaluation of the Installation Place





Appendix 4

Different Cumulative Probabilities for Working Days and Weekends

