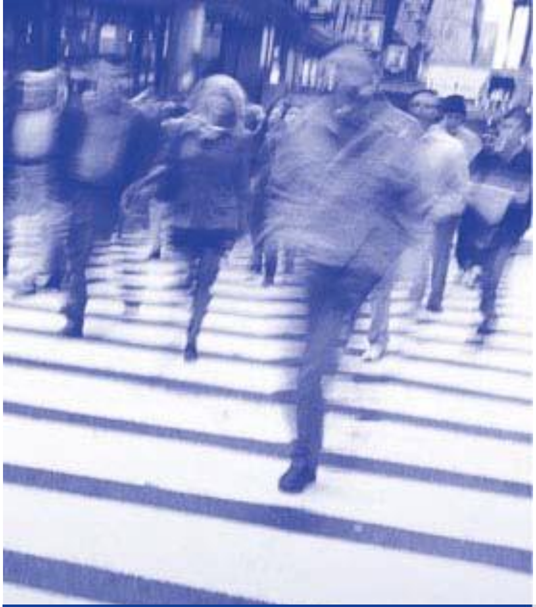

CIVITAS
Cleaner and better transport in cities

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Measure Evaluation Results

TAL 5.1 Improvement of Visibility and Safety of Crosswalks and Cycle Tracks

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Executive Summary

The measure 'Improvement of Visibility and Safety of Crosswalks and Bicycle Tracks' consisted of developing five innovative technical solutions to improve the pedestrians and cyclists safety at crosswalks in Tallinn. The main objectives of the measure are to promote attractive, safe and high quality infrastructures for pedestrians and cyclists and to reduce the number of road accidents involving pedestrians and cyclists.

The measure was implemented in the following stages:

Stage 1: Definition of the most dangerous crosswalks (May 2010 - August 2010) The dangerous crosswalks were identified based on an analysis of traffic accident statistics and survey results. The survey was part of the overall MIMOSA survey and participants were asked about the general traffic safety situation in the city and especially at three of the most dangerous crossings in Tallinn.

Stage 2: Selecting the suitable solutions to improve traffic safety on the crosswalks (September 2010 - March 2011) The solutions were developed and selected by a group of experts composed of MIMOSA Tallinn local evaluation manager, officials from Tallinn Transportation Department and Tallinn Department of Municipal Services during monthly meetings. The selected solutions were: (1) Additional spot-lighted crossing sign above one non-regulated crossing, active during hours of darkness; (2) Pedestrian radar activated LED blinkers on crossing sign poles at one non-regulated crossing, constantly active; (3) Speed-sensitive traffic lights at one regulated crossing, turning traffic light green (from constant red) when approaching car is not exceeding the speed limit, active between 21:00 and 7:00; (4) Speed-sensitive traffic lights at one regulated crossing, turning traffic light red when approaching car is exceeding the speed limit, active between 21:00 and 7:00; (5) Dimmer added to yellow blinking mode of 10 sets of regulated traffic lights, active between 21:45 to 06:30.

Stage 3: Purchasing of the equipment and signs (November 2010 - May 2011) The required equipment to implement suitable solutions were acquired and installed.

Stage 4: Data collection for the impact evaluation before the change (May 2011 – June 2011) The before-study for evaluation was made prior to the implementation of the selected solutions. The study was based on observations on site.

Stage 5: Installation of the equipment and signs (June 2011 - July 2011) The solutions were installed and put into operation at the 14 crosswalks identified as dangerous (the solutions 1 to 4 were implemented at one crosswalk each and the solution 5 on 10 crosswalks).

Stage 6: Data collection and impact evaluation after the change (September 2011 – August 2012) The after-measurements for evaluation were conducted for the five different solutions based on the same principles and indicators as used in the before-study.

Since road safety is a crucial issue of the city policy towards sustainable urban transport, the measure was selected as a focused measure. It was planned to carry out a cost benefit analysis for this measure but, during the process, this proved unfeasible. The impact evaluation of the measure was done using city specific indicators of traffic behaviour, pedestrian accident statistics and awareness of the general public on the situation with regard to using crosswalks.

For each solution implemented, **some key-results** showed the impacts of the measure. For **solution 1**, the driver behaviour has been compared with the before situation and the after situation: the driver behaviour (yielding to pedestrians) had improved by 53%. Nevertheless, the overall driver behaviour (which could be estimated based on trends of accident statistics in Estonia) was worse than from previous trends. With the implementation of **solutions 2, 3 and 4,** the number of cars exceeding the speed limit while approaching the crosswalk was compared with the before and after implementation situation: respectively a reduction by 3%, 7% and 9% were observed. **For solution 5**, it had been observed that the amount of light emitted when using a dimmed traffic light was 40% less than when using a normal traffic light, thus distracting less drivers' attention in poor visibility.

From the process evaluation, some barriers and drivers were identified. **The most important barrier** encountered during the measure was a planning issue. The decision-making process on what would be done in practice demanded time which also caused delays in the entire planning process of the measure. To overcome this barrier, constructive, useful and regular meetings between the measure leader, the evaluator and the city officials were organised. All participants acknowledged these meetings as very useful. **The most important driver** encountered during the measure was that the Estonian Road Administration tested a solution at the beginning of 2011 which was originally planned in the scope of the measure. The testing had demonstrated that it would not be suitable in practice. Thus this activity of the Estonian Road Administration initiative allowed the MIMOSA team to save time and resources by signing a contract with the companies already involved to carry out this solution based on the results of the preliminary testing.

All implemented technical solutions are **replicable in other cities** in accordance with their own road regulations. Nevertheless, in the context of Tallinn the evaluation showed that some solutions were not sufficiently efficient. **It is therefore recommended** to start with simple actions such as repainting erased pedestrian crossing markings prior to implementation of new innovative solutions: innovation takes place through a step by step long-term process.

This MIMOSA measure enabled a test of innovative solutions to improve road safety in Tallinn. The moderate results achieved showed that technical solutions are not as efficient as expected. Nevertheless, by diversifying efforts invested in road safety the innovative technical solution will win in efficiency: Strategy for road safety improvement should be designed in a comprehensive way by a public awareness campaign, enforcement of road code, technical solutions, etc.

A Introduction

A1 Objectives

The measure objectives were:

(A) High level / longer term:

- Improvement of quality of life

(B) Strategic level:

- Promotion of active transport modes usage;
- Promotion of healthy lifestyle;
- Improved safety on crosswalks and bicycle tracks by finding the best marking solution. Pedestrians and cyclists feeling safer in urban traffic;
- Improved safety standards of the infrastructure;
- Promotion of healthier and cleaner mobility patterns e.g. cycling and walking reducing congestion and emission of pollutants.
- Decreased number of accidents between vehicles and pedestrians/cyclists;
- Improved overall traffic culture e.g. obligation to give way by drivers has improved;

(C) Measure level:

(1) Promote an attractive, safe and high quality infrastructure for pedestrians and cyclists;

(2) The most problematic crosswalks have been reshaped;

(3) The number of accidents on redesigned crosswalks has decreased by 25%;

(4) The satisfaction of pedestrians and cyclists has increased by 20%.

A2 Description

The aim of the measure was to find new and innovative approaches for improving traffic safety on crosswalks in Tallinn. For that reason an analysis on traffic accident statistics was done and citizens of Tallinn were asked to point out dangerous crosswalks in a survey. Then five new non-traditional solutions (described below) were selected and implemented in certain suitable locations – the solutions 1-4 all in only one location and the solution 5 in 10 crosswalks along one street section. The selection of solutions was based on a series of meetings of traffic experts from Tallinn City and Tallinn University of Technology. Several solutions were cancelled during the meetings and during preparations for implementing. The locations of the implementations are presented on the **Figure 6**.

While the name of the measure refers also to bicycle tracks, nothing was done specifically for bicycles. The reasons are explained in Chapter D.1 - Deviations from the original plan.

The solutions implemented in the scope of the measure were:

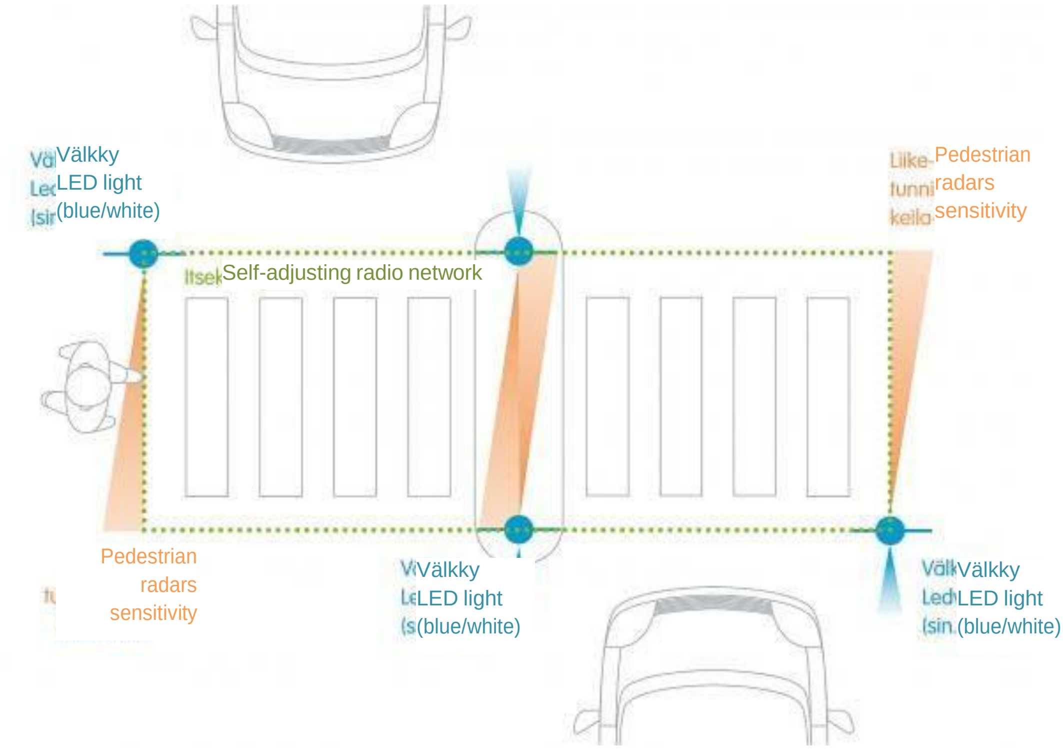
1. A **spot-lighted crosswalk** sign was added above the crosswalk (Figure 1), as the crosswalk signs at street sides were not drawing enough attention in dark. The system functions together with street lighting, i.e. low light or dark conditions.

Figure 1 Additional spot-lighted traffic sign above the crosswalk

2. **LED-equipped blinking reflectors** were added to the crosswalk traffic sign poles. The blue LED-s start blinking (radar-activated) when pedestrians approach the crosswalk, thus drawing the attention of the approaching car drivers. The system functions 24 hours a day.

Figure 2 Pedestrian radar activated blue LED blinking reflectors on crosswalk traffic sign poles

Figure 3 LED lights activated by radio network controlled radars



3. A **speed sensor was added to the traffic lights** of the **pelican crosswalk** (with a push button for pedestrians). The traffic light for car drivers is constantly red and switches to green only if approaching drivers are driving within the speed limit of 50 km/h permitted in the location. The system functions outside peak hours in traffic, i.e. 21:00-07:00 when traffic calming is needed most due to low traffic volumes.

Figure 4 Traffic lights with a speed radar (sensor to the left of the upper traffic light)

4. **A speed sensor was added to the traffic lights** of the pelican crosswalk (regulated crosswalk with a push button for pedestrians). The solution is otherwise same as the solution 3 except that the traffic light is constantly green instead of red and sensor switches it to red if an approaching car is exceeding the speed limit of 70 km/h permitted in the location. The system functions outside peak hours in traffic, i.e. 21:00-07:00 when traffic calming is needed most due to low traffic volumes.

Figure 5 Traffic lights with speed radar (sensor to the right of the upper traffic light)

5. A **traffic light dimmer** was added to 10 traffic lights on pelican crosswalks and intersections (with a push button for pedestrians) on a street section (figure 7 shows a picture from one of the implemented locations). Traffic lights on all pelican crosswalks and many intersections in Tallinn switch to blinking yellow for car traffic at night. The problem is that in low light and darkness the blinking yellow light can be too distracting to drivers drawing attention away from the crosswalk itself. The dimmer functions during the blinking yellow program of the traffic light – from 21:45 to 06:30.

Locations of the implemented solutions are shown on the **Figure 6**.

Figure 6 Location of the implemented solutions in Tallinn

B Measure Implementation

B1 Innovative Aspects

The innovative aspect of the measure was:

- **New physical infrastructure solution –** The innovative aspect of this measure was to test new technical solutions to mark crosswalks to make them safer: new types of signs and reflectors, new sensors and programming principles for traffic lights.

B2 Research and Technology Development

A study was performed to find new solutions to increase traffic safety on crosswalks. The study came up with 6 technical solutions (described in chapter A2) to be implemented on a number of crosswalks.

B3 Situation before CIVITAS

Tallinn has approximately 2300 pedestrian crosswalks (derived from the number of traffic signs) including regulated crosswalks.

The number of pedestrians, cyclists and roller-skaters had been rising in Tallinn together with a growth in traffic volumes. Unless focused, this could have lead to a growth in the number of accidents between cars, pedestrians and cyclists.

Different international studies have shown that, even if the usage of pedestrian and cycling roads increased, cyclists run the biggest risk when crossing streets from car traffic. Accidents happen due to the fact that drivers concentrate on car traffic and do not pay attention to pedestrians and cyclists. These accidents mainly happened at turns and at conventional crosswalks with cycle tracks. The reason for the accidents was mainly due to the low visibility of pedestrians and cyclists on crosswalks as well as the low visibility and the insufficient marking of crosswalks.

The design principles for crosswalks in Tallinn were of a conventional type and design. In the most dangerous non-regulated crosswalks there was a dedicated spot light making people on the road clearly visible and radar activated yellow lights to warn drivers about approaching pedestrians. In less used and low visibility places sign edges were marked with a yellow reflector and the sign post was blue and white striped. On regulated crosswalks a blinking yellow light was used at night time to draw the attention of drivers. However, there is still room for improvement with several smart and innovative solutions not being used in Tallinn or Estonia yet.

B4 Actual Implementation of the Measure

The measure was implemented in the following stages:

Stage 1: Definition of the most dangerous crosswalks *(May 2010 - August 2010)* **–** The dangerous crosswalks were identified based on an analysis of traffic accident statistics and survey results;

Stage 2: Selecting the suitable solutions to improve traffic safety on the crosswalks *(September 2010 - March 2011)* – The solutions were selected by a group of experts during regular meetings;

Stage 3: Purchasing of the equipment and signs: *(November 2010 - May 2011)* – the suitable solutions were acquired and installed;

Stage 4: Data collection for the impact evaluation before the change: (*May 2011 – June 2011*) – the before-study for evaluation was made prior to the solutions being implemented;

Stage 5: Installation of the equipment and signs: (*June 2011 - July 2011*) – The solutions were installed and put into operation;

Stage 6: Data collection and impact evaluation after the change: (*September 2011 – August 2012*) – The after-measurements for evaluation were completed for different solutions and the results were analysed.

B5 Inter-Relationships with Other Measures

The measure is related to other measures as follows:

MIMOSA 4.1 Mobility Management and marketing activities directed at popularising usage of active transport modes – the solutions for measure 5.1 were promoted by several activities of measure 4.1: the Good Traficant's Day and Mobility Cartoons in 2010

C Impact Evaluation Findings

C1 Measurement Methodology

C1.1 Impacts and Indicators

Initially the measure had higher ambitions for improving pedestrian conditions in Tallinn but in the course of planning the measure was changed mainly to testing new innovative solutions for pedestrians on a small number of crosswalks. Evaluation concept followed the changes from initial wide scale impact evaluation based on accident statistics to evaluating traffic behaviour change of drivers and potential impact of solutions in particular locations with implemented solutions. The general statistics analysis was dropped because of the very limited scale of the measure (0,6% of total number of crosswalks in Tallinn were involved in the measure) compared to the total number of crosswalks in Tallinn (approx. 2300). However the original survey questions were retained in the general MIMOSA after-survey as a possibility to evaluate the change in general awareness and acceptance. The detailed selection of indicators is described below.

Table C1.1: Indicators

NO.	EVALU-ATION	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
2	Economy	Costs	Capital Costs	Capital Costs	Cost of installation of technical solutions	€
3	Economy	Costs	Maintenance Costs	Maintenance cost	Running costs and maintenance costs of the technical solutions	€
15	Society	Awareness	Acceptance	Acceptance level	Acceptance level of safety of crosswalks and bicycle tracks in Tallinn	Index, qualitative, collected, survey
21	Transport	Safety	Transport Safety	Accidents, deaths and injuries	Deaths and injuries at the locations where the solutions were implemented	Quantitative, collected
TAL 5.1-1	Transport	Safety	Transport Safety	Yielding to pedestrians, measured four different ways	The percentage of drivers yielding to pedestrians;	Quantitative, measurement
TAL 5.1-2	Transport	Safety	Transport Safety	Approaching speeds to the crosswalk	The percentage of drivers exceeding 61 km/h while approaching the crosswalk.	Quantitative, measurement
TAL 5.1-3	Transport	Safety	Transport Safety	Luminosity difference in between normal and dimmed light	The change in amount of light needed to observe a pedestrian standing next to yellow traffic light, normal and dimmed	Qualitative, measurement

Detailed description of the indicator methodologies:

- **2 Capital costs and 3 maintenance costs –** The cost data was originally planned for use in cost-benefit analysis and later in calculating the benefit-cost ratio of the technical solutions but as the number of accidents was statistically not meaningful, the cost data was never used and no cost-benefit analysis nor benefit-cost ratio calculations carried out.

The cost data was obtained from the contractor. The capital costs were considered to be the installation costs of the technical solutions and as there was no accurate data available the maintenance costs were estimated to be 10% of the installation costs per year (from the experience and recommendation of the contractor).

- **15 Acceptance level** change was evaluated with surveys before and after the implementation of the solutions. The evaluation of change in awareness of the situation regarding safety of crosswalks was based on the general MIMOSA before-phone survey in November 2009 and a separate combined source after-survey in June 2012.

The **general MIMOSA survey** was planned and carried out by a professional market research company OÜ Klaster. Sufficient sample for different MIMOSA measures purposes was calculated to be between 600-800 persons.

The general MIMOSA before-survey was carried out in November 2009 and had a random sample of 1014 people aged between 14 and 75. The survey was based on landline phone interviews and was carried out in Estonian (mother tongue for 53% of the population in Tallinn) and Russian (42%) languages. 25% of the sample was interviewed by mobile phones to retain representability, as the usage of land line phones has decreased rapidly during the past decade. The sample was based on the population registry data and was gathered from all 8 city districts of Tallinn. The quotas of ages and gender were calculated within districts. The quotas for 2 smaller of the 8 districts were above proportional as a minimum 100 respondents were required in every district. This was compensated for by using different weights for different districts when calculating overall city results. The questionnaire was designed to CATI (Computer Assisted Telephone Interviewing) and all interviews were performed using that system. The gathered data was checked in three stages: structural control – the CATI directed the interview to the correct sections with the help of filter questions; formal control – after the survey the errors in open text answers and numerical answers were corrected; cleaning the data – incomplete answers and interrupted interviews were removed in the process of interviewing.

The social profile of a respondent was based on gender, age, nationality, district of residence, car ownership and transportation mode use.

The general phone survey had 4 questions about crosswalks and cycle tracks:

- How many safe crosswalks are there in Tallinn?
- Name 3 dangerous crosswalks in Tallinn.
- How many safe cycle tracks are there in Tallinn?
- Name 3 dangerous cycle tracks in Tallinn.

Only the first question was used in the evaluation of awareness. The results from the second questions were used for the process of selecting suitable solutions and locations for implementation. The last 2 questions were not used as no implementation referring to cycle tracks had taken place.

- **21 Transport safety, accidents, deaths and injuries** – Safety statistics were evaluated on the crosswalks that were included in the measure as before and after the survey. Traffic accident data was obtained from databases of the Estonian Traffic Insurance Fund. The data was collected and analysed by Tallinn University of Technology. The Before-data was taken from 01.2009-06.2011 and the After-data from 07.2011 to 09.2012. Only accidents which happened during the hours of darkness were taken into account for the technical solutions 1-2. Only accidents which happened during the time period 21:00-07.00 were taken into account for the technical solutions 3-4. Accidents between 21:45-06:30 for the technical solution 5. The reason for this was the solutions were all either useful or activated during the listed time periods and thus daytime accidents were not relevant to the implemented technical solutions. An average annual accident rate was calculated for the periods. However, the indicator is not reliable as the occurrence of traffic accidents were of a highly random nature and therefore at least 3-years statistics would be required for both periods to evaluate a change.

- **TAL 5.1-1. Yielding to pedestrians.** The yielding to pedestrians was an indicator of driver behaviour that was directly connected to safety on crosswalks. It was connected to visibility and other design aspects of crosswalks, also drivers' habits. Yielding to pedestrians at crosswalks is compulsory for drivers according to the traffic code. It leads to risk compensation (reduced alertness at crosswalks) by pedestrians who are aware of their right on yielding. Thus in combination with not yielding to pedestrians it creates a higher risk for accidents. The indicator was based on field observations which were doubled with video footage in case of observation problems. The observations took place during dark time on evening when there are very few pedestrians crossing the street, a typical situation with increased accident risk.

The historical annual changes of this indicator in Estonia are presented on figure 17**Fehler! Verweisquelle konnte nicht gefunden werden.**, taken from the Estonian Road Administration annual traffic behaviour monitoring study.

- **TAL 5.1-2. Approaching speed to the crosswalk.** The approaching speed to a crosswalk is again an indicator of driver behaviour that is directly connected to safety on crosswalks. Studies show that the decision of drivers to yield to pedestrians at crosswalks is affected by approaching speed; higher speeds result in lower probability of yielding. The other important factor is the influence of impact speed on the probability of a pedestrian surviving the impact of a car. Any impact taking place at a speed of above 60 km per hour sees a dramatic increase in the probability of a fatality. The approaching speeds were measured by handheld radar from behind so the drivers could not observe the measuring.

The indicator was used for the solutions 2, 3 and 4. All together 24 2-hour observations (both morning and evening) were made for the 3 solutions 8 hours per each solution.

- **TAL 5.1-3. Luminosity difference between normal and dimmed light.** The crosswalk where solution 5 was implemented had very few pedestrian users as the dimmer works only from 21:00 to 07:00. Also, the influence of the solution was expected to be most effective in complicated weather and visibility conditions. Therefore it was not statistically meaningful to use the same indicators as with solutions 1 to 4.

Instead, an experimental indicator was specially developed for the technical solution, measuring the difference in the amount of light emitted by the scenario with a traffic light in normal and dimmed mode. The measurements were made with a normal digital SLR camera taking pictures of the scene with traffic light (figure 7) and setting the exposure level to 0 manually on both normal and dimmed light pictures. The exposure level was set to 0 with an adjusting shutter speed while the yellow traffic light was on. The relative difference in illumination can be seen from the different shutter speeds which were needed for taking the pictures with exposure level 0. The luminosity of the scene is important while a driver approaches the crosswalk. With more light emitted from the traffic light, the human eye adjusts the pupil of the eye to the higher luminosity and reduces the ability to see the less illuminated parts of the scene. The effect is similar to the experience on a motorway at night when it is difficult to see the road ahead while meeting oncoming cars, especially when they have their high beams on. The difference can be important, if it is the difference between noticing and not noticing a pedestrian.

Figure 7 Field work with the indicator TAL

Table C1.2: Indicators that were not used.

NO.	DESCRIPTION	Reason why it has not been measured
29	Transport, Average modal split-vehicles	The scale of the measure was only 14 crosswalks out of approximately 2300 in Tallinn and the safety improvement at the locations was relatively small or questionable. Changes in modal split take more time and larger effort to be measurable.

C1.2 Establishing a Baseline

No baseline was created for the economy-related indicators as the indicators were created only for using in cost-benefit analysis (which was cancelled later). The baselines for transport related indicators were created using the data from the field studies in May and June 2011 before implementation of the measure. The baseline for the acceptance indicator was created from the survey in November 2009.

C1.3 Building the Business-As-Usual Scenario

The BAU scenario for the acceptance could not be estimated as testing the new technical solutions on only 5 crosswalks of approximately 2300 during 1 year (often not noticeable to pedestrians and not always giving clear results of improvement) could not influence the general perception of safety in the whole city.

The BAU scenario of the driver behaviour related indicators was based on trends in traffic safety and driver behaviour during the past 3-5 years. The data for the scenario was extrapolated from the trends. The data on previous trends in driver behaviour on crosswalks (figure 17) was obtained from the annual traffic behaviour monitoring studies made by the Estonian Road Administration since 2001 in 20 locations around Estonia including 10 locations in Tallinn. The trend in driver behaviour at crosswalks is supported by the trend in the overall number of traffic related deaths in Estonia (**Figure 14**).

There were no systematic historical measurements available on the change in driving speeds, so the BAU for driving speeds was based on an assumption, that the driving speeds would have remained the same without implementation of the solutions. The short time period of 6 months between before- and after-measurements supports this assumption.

C2 Measure Results

The results are presented under sub headings corresponding to the areas used for indicators – economy, energy, environment, society and transport.

C2.1 Economy

The costs for the installation of the different technical solutions were as follows:

Table 1 Costs of the technical solutions

Solution no	Solution name	Installation cost, €
1	Spot-lighted crosswalk sign	3 706
2	Blinking LED reflectors	4 703
3	Speed-sensitive traffic light, constant red	8 113
4	Speed-sensitive traffic light, red while exceeding the speed limit	10 471
5	Dimmer on blinking yellow light in 10 locations	5 320
	Sum:	32 313

The exact maintenance costs of the technical solutions were not available but from the experience of the measure partner Signaal AS the maintenance costs for 1 year were estimated at 10% of the installation cost.

C2.2 Energy

Not applicable

C2.3 Environment

Not applicable

C2.4 Transport

The evaluation results of transport related indicators were presented by different solutions explained in detail in the Chapter A2.

Solution 1. The results of monitoring driver behaviour are presented in Table 2. The results are based on 2 hours measurements during the hours of darkness both before and after implementation of the solution - 3 days in April 2011 and 3 days in October 2011. The days were selected as ordinary working days in the middle of a week and with similar visibility conditions.

Indicator no 4 was used for quantifiable results of the solution. It was calculated from the indicators 2 and 3 – percentage of drivers that yielded from the number of drivers who should have yielded. The result of 53% driver behaviour improvement from solution 1 can be considered successful – drivers were more alert and willing to yield to pedestrians.

Table 2 Driver behaviour at the crosswalk of the solution 1

Indicator	Before	After	Difference, after/before
1. No of pedestrians and cyclists using the crosswalk	56	45	-20%
2. Number of drivers that should have yielded (including those that yielded and those that did not)	75	42	-44%
3. Number of drivers that yielded	34	29	-15%
4. Percentage of drivers that yielded	45%	69%	53%
5. Which (first, second, ...) car finally yielded, average	2,2	1,4	-36%
6. No of cases when only one car approached and did not yield	3	4	33%
7. Biggest number of drivers not yielding in one case	6	2	-67%

However, as was brought out by other cities on presentation of solution 1, it would be useful to start improving the crosswalk with a low-tech approach and repaint the zebra-marking on the pavement (see picture in the description of the solution in the Chapter B2). This recommendation was also appropriate for the other solutions according to the pictures. The reason for this was that the beginning of the MIMOSA project happened to coincide with the worst time of the economic downturn and elementary road maintenance suffered as a result. Since then, the situation has improved.

Solution 2. The influence of the solution was evaluated by the approaching speed of cars to the crosswalk. The before and after measurements were made between 05:00-07:00 and 20:00-22:00 during one day in June 2011 (before implementation) and two days in October 2011 (after implementation). The days were selected as ordinary working days in the middle of a week and with similar visibility conditions. The criteria for selecting the time band was to avoid rush hour where the approaching speeds were influenced by the prevailing traffic situation. All together the approaching speeds of 5107 cars were measured. The change in the approaching speeds is presented in the Figure 8 The distribution of approaching speeds is presented in the Figure 9.

Figure 8 The change in approaching speeds to the crosswalk before and after implementation of solution 2, both directions summarised

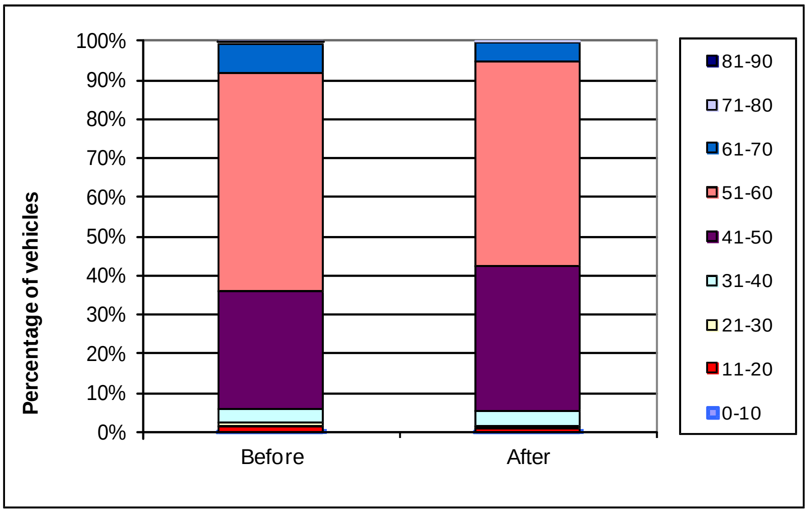
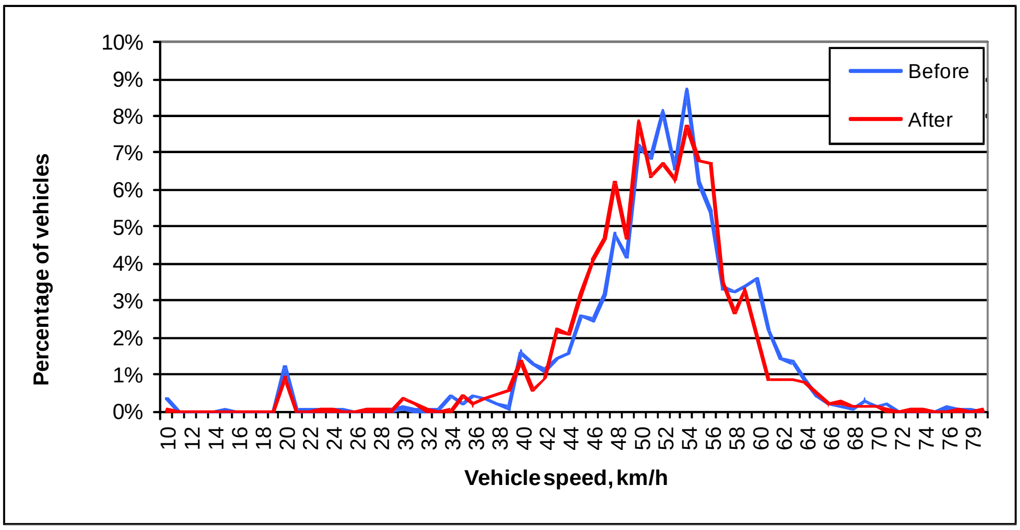


Figure 9 The distribution in approaching speeds to the crosswalk before and after implementation of solution 2, both directions summarised



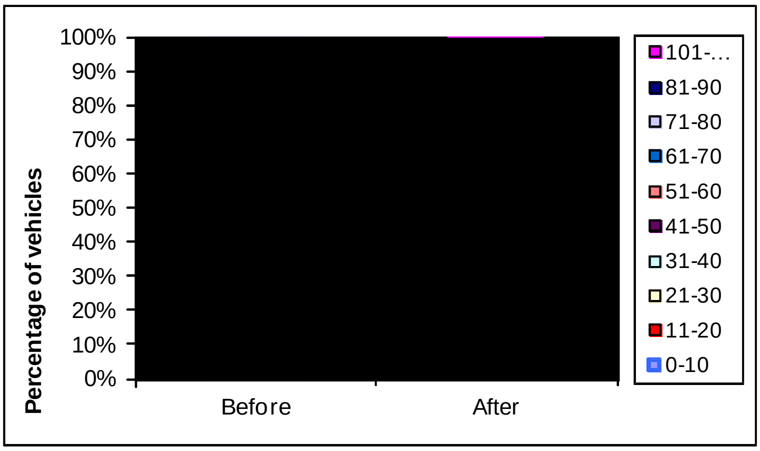
The change in approaching speeds was determined by an average approaching speed and checked by an approaching speed that was not exceeded by 85% of the drivers (V_{85}). The change in average approaching speed was from 51,7 km/h to 51,2 km/h and the change of V_{85} was from 59 km/h to 57 km/h). The result of the reduction in average approaching speed was negligible – 1% and can be caused by other factors. The change of V_{85} was 3,5% and it supports the result that the change was actually positive. The indicator, used for evaluation was the percentage of cars approaching over 60 km/h. This was changed from 9% to 6%.

The result was probably influenced by the malfunction of pedestrian radars, which sometimes caused the blue LED lamps to blink without any pedestrians around and sometimes the LED lamps did not blink even with an adult person crossing the road.

The conclusion was that the solution had an influence on traffic safety but the results were too small to be considered as successful compared to the cost and complexity of the solution.

Solution 3 was similar to solution 2 evaluated by change in approaching speeds. The approaching speeds of 5334 cars were measured, 3117 during before- and 2217 during after-measurements. The change in the speeds is presented on the Figure 8.

Figure 8 The change in approaching speeds to the crosswalk before and after implementation of solution 3, both directions summarised



To confirm that the approaching speeds were reduced as a result of the new solution, not as a result of a change in traffic volumes, the speeds were analysed against traffic volumes (Figure 11 and Figure 10).

Figure 9 Dependence of percentages of exceeders of the speed limit on traffic volumes before implementation of solution 3, both directions summarised

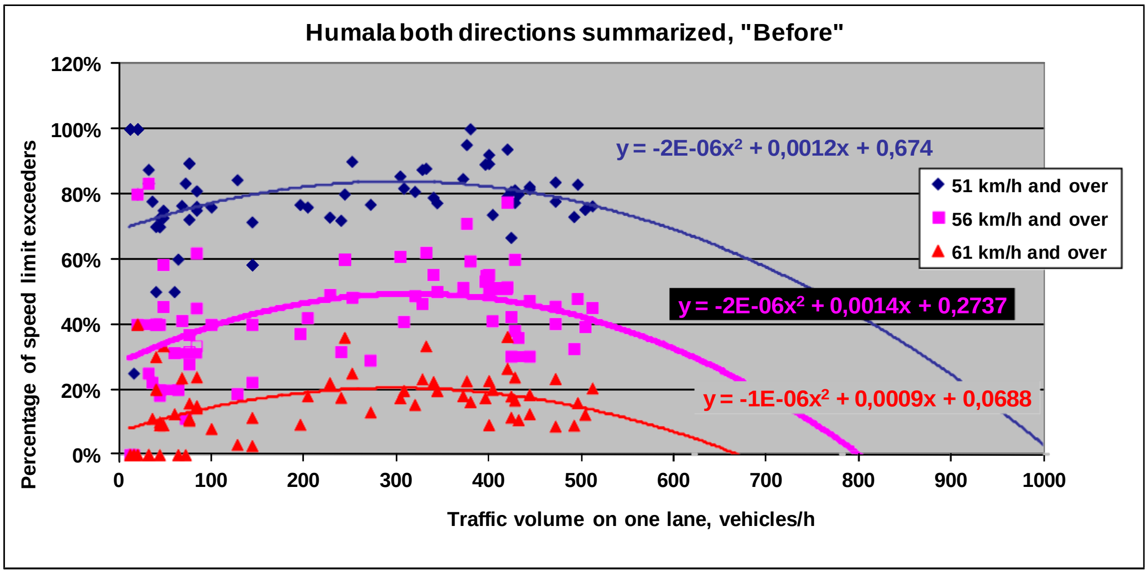
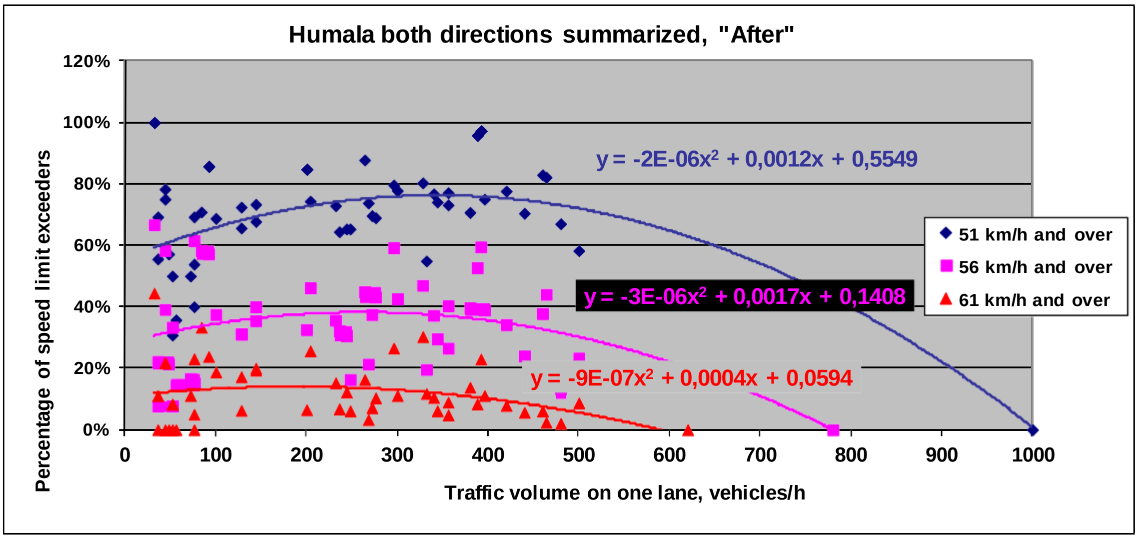


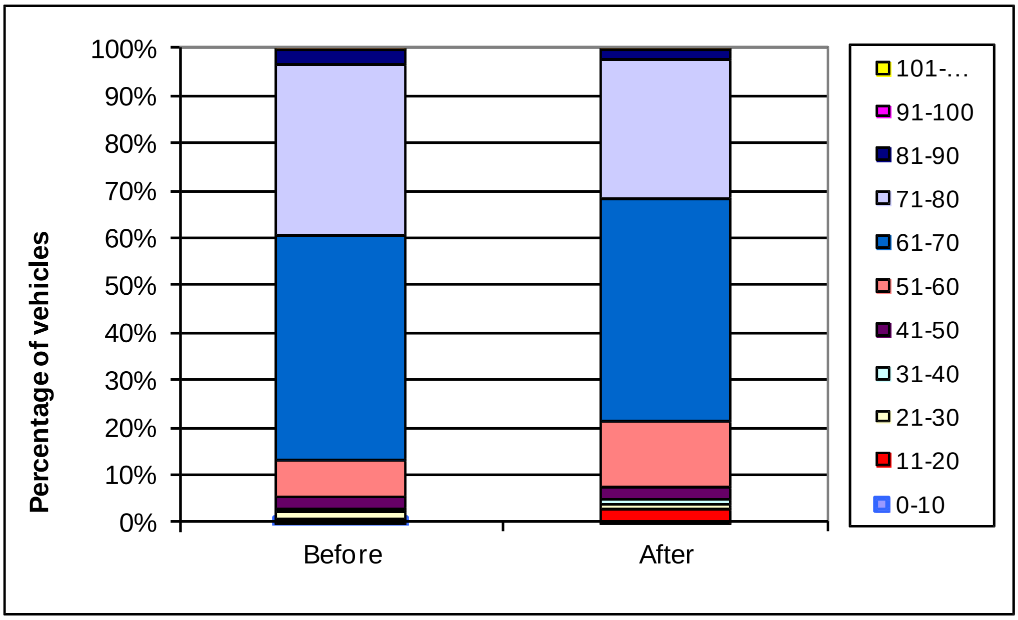
Figure 10 Dependence of percentages of exceeders of the speed limit on traffic volumes after implementation of solution 3, both directions summarised



The conclusion from the evaluation is that the percentage of drivers exceeding the speed limit was reduced noticeably as a result of the measure. The reduction was among cars approaching over 60 km/h, from 18% to 11%, there was practically no change in the percentage of cars approaching from 51 km/h to 61 km/h. The result was supported by the V85 speed, which was changed from 61 km/h to 59 km/h.

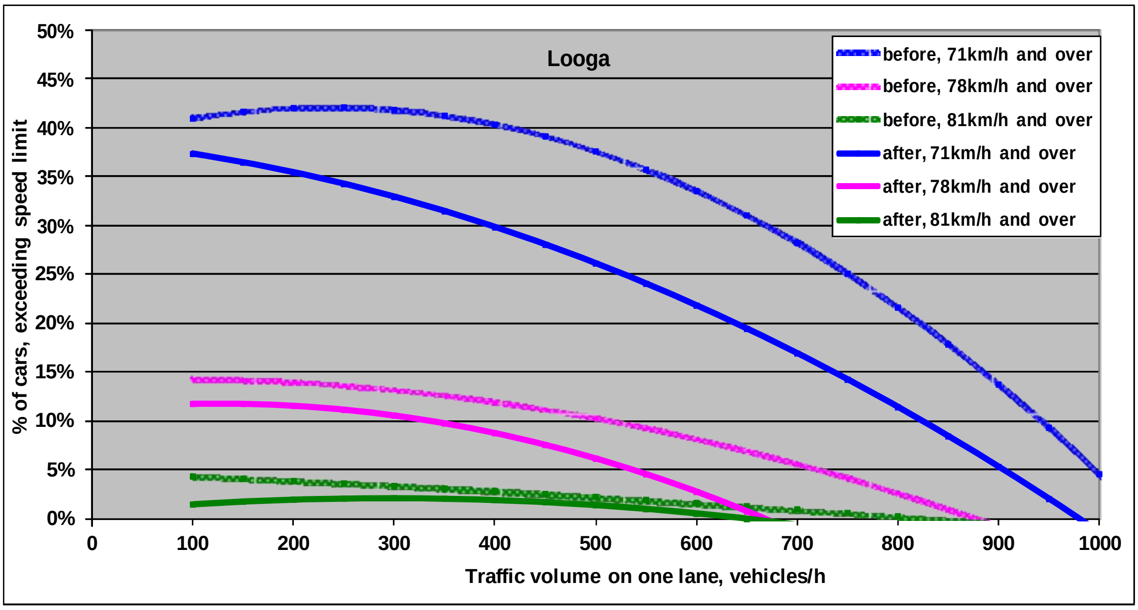
Solution 4. The evaluation of solution 4 was also based on the analysis of approaching speeds of cars to the crosswalk. The analysis was carried out in the same way as solution 3, only fewer details are presented from the results. The approaching speeds of 5234 cars were measured, 3020 during before- and 2214 during after-measurements.

Figure 11 The change in approaching speeds to the crosswalk before and after implementation of solution 4, both directions summarised



To confirm that the approaching speeds were reduced as a result of the new solution, not as a result of a change in traffic volumes, the speeds were analysed against traffic volumes (**Figure 12**).

Figure 12 Dependence of percentages of exceeders of the speed limit on traffic volumes before and after implementation of solution 3, both directions summarised



The conclusion from the evaluation is that the percentage of drivers exceeding the speed limit was reduced noticeably as a result of the measure. The reduction was among cars approaching over the speed limit 70 km/h from 40% to 31%. The V85 speed indicator was insensitive to the change in approaching speeds, it changed from 75 km/h to 74 km/h.

Solution 5. The effect of the traffic light dimmer was evaluated with an experimental indicator, measuring the luminosity of the scene (composition of objects on a picture) containing the traffic light. The comparison between the same scene with a normal traffic light and with a dimmed traffic light is presented in **Figure 13**.

While the determining parameters of the scene are presented in **Figure 13**, other relevant parameters taken from the EXIF information of the images (valid for both images) are:

- ISO sensitivity: 1600
- Focal length: 112mm (35mm equivalent)
- Field of view: 9,6 degrees
- Manual exposure
- Metering mode: Center-weighted average

While the difference between the normal and dimmed light was noticeable, the difference is too small to be noticed by drivers unaware of the dimmer. However, as can be seen from the pictures and exposure times on **Figure 13**, there is clear measurable difference.

Figure 13 Difference between normal and dimmed traffic light in the scene

The background sky is a good example of the effect. The background trees are still distinguishable from the dark blue sky on the right picture. The reason is because of the lower illumination of the dimmed traffic light the whole scene has to be brighter (longer exposure) so that the total exposure of the scene would be 0. The difference would be the same with a pedestrian – distinguishable from the background or not.

The result from the measurements is that the scene with normal traffic light had 40% higher luminosity than the same scene with a dimmed traffic light.

As the cost of the solution was relatively small (an average 530€ per crosswalk), the measure is worth considering but the effect of it is yet to be proven. It is probably more useful in places without street lighting, because in the location of the current measurements the street lighting made pedestrians very distinguishable from the background independently of the luminosity of the traffic light. The difference would probably be greater in darker surroundings.

Table C2.4.1: Measure evaluation results

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After – Before	Difference: After – B-a-U
TAL 5.1-1, Yielding to pedestrians, increase is positive	45% 06.2011	40% 05.2012	69% 05.2012	24%	29%
TAL 5.1-2, solution 2, % of drivers exceeding speed limit, decrease is positive	9% 06.2011	9% 10.2011	6% 10.2011	-3%	-3%
TAL 5.1-2, solution 3, % of drivers exceeding speed limit, decrease is positive	18% 06.2011	18% 10.2011	11% 10.2011	-7%	-7%
TAL 5.1-2, solution 4, % of drivers exceeding speed limit, decrease is positive	40% 06.2011	40% 10.2011	31% 10.2011	-9%	-9%
TAL 5.1-3, Luminosity difference between scenes with normal and dimmed light (measured by exposure time in seconds)	1”	-	0,6”	-	0,4”(-40%)

The results from the Table C2.4.1 show that the safety situation was improved with all technical solutions implemented in the scope of the measure. While the indicators TAL 5.1-1 and TAL 5.1-2 are directly connected to traffic safety and have proven their validity, the experimental indicator TAL 5.1-3 (developed for this measure) has only theoretical connection to traffic safety that is yet to be proven.

C2.4.1. Safety

The safety was evaluated with accident statistics from the crosswalks. The results from the periods before and after implementing the technical solutions are presented in the Table 3. The accident statistics were taken only during hours of darkness for the technical solutions 1 and 2 and from 21:00 to 07:00 or from 21:45 to 06:30 respectively for the other measures. These are the time periods when the solutions are active or visible and are named “valid” in the Table 3.

Table 3 Valid / not valid accidents on all 14 crosswalks

Technical solution no	Technical solution name	2009	2010	2011	2012
1	Spot-lighted crosswalk	**1/0**	**1/0**	0/1	0/1
2	LED-equipped blinking reflector	0	**1/0**	0	0
4	Traffic lights with speed sensor	0	0	**1/0**	0/1
5	Traffic light dimmer	0	0/1	0	0

- Fatal accident

The result shows too small number of accidents (fortunately!) to make any conclusions from the statistics. There were all together 4 "valid" and 4 "non-valid" pedestrian accidents during the whole evaluation period (1.2009-09.2012). Three of the "valid" accidents occurred before the implementation of the measure (06.2011) and resulted in 4 pedestrians being injured. One "valid" accident occurred 3 months after installation of the technical solution 4 and resulted in one pedestrian death. The circumstances of the accident are not fully clear, as the elderly person was already lying on the road when was hit by cars. As a result the connection to the solution (traffic lights with speed sensor) is also unclear.

Accordingly, for the reasons described the results from accident statistics were not used for measure evaluation.

To provide an estimate as to the possible effect of the accident reduction, the estimated values for casualties avoided per case in Estonia were (2008):

- Fatality – 506 880€
- Severe injury – 66 960€
- Slight injury – 4 896€

The information on severity of injuries is not available in Estonian accident statistics.

The overall trend in traffic safety statistics and traffic behaviour has grown worse since the greatest period 2009-2010 (see Figure 14 and Figure 17) and the data from the year 2012 so far (October) has confirmed the trend. Thus the results have been compared with current trends in traffic safety.

Figure 14 Fatalities in traffic in Estonia 2006-2011

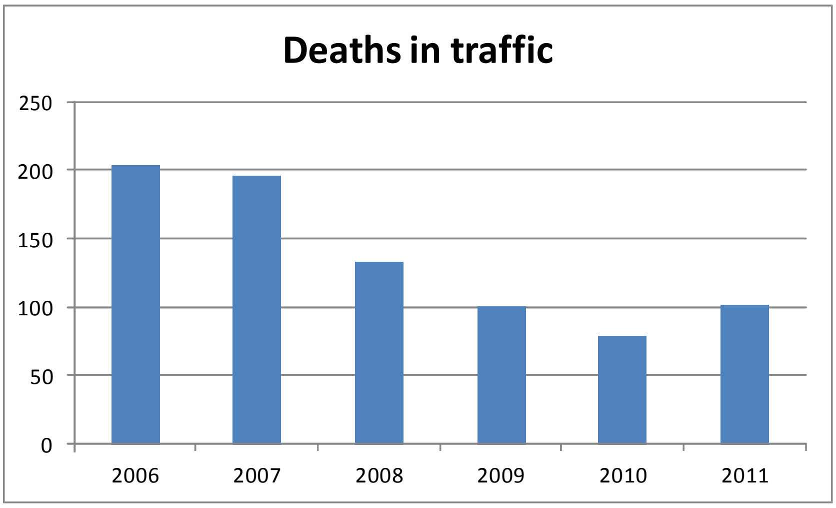
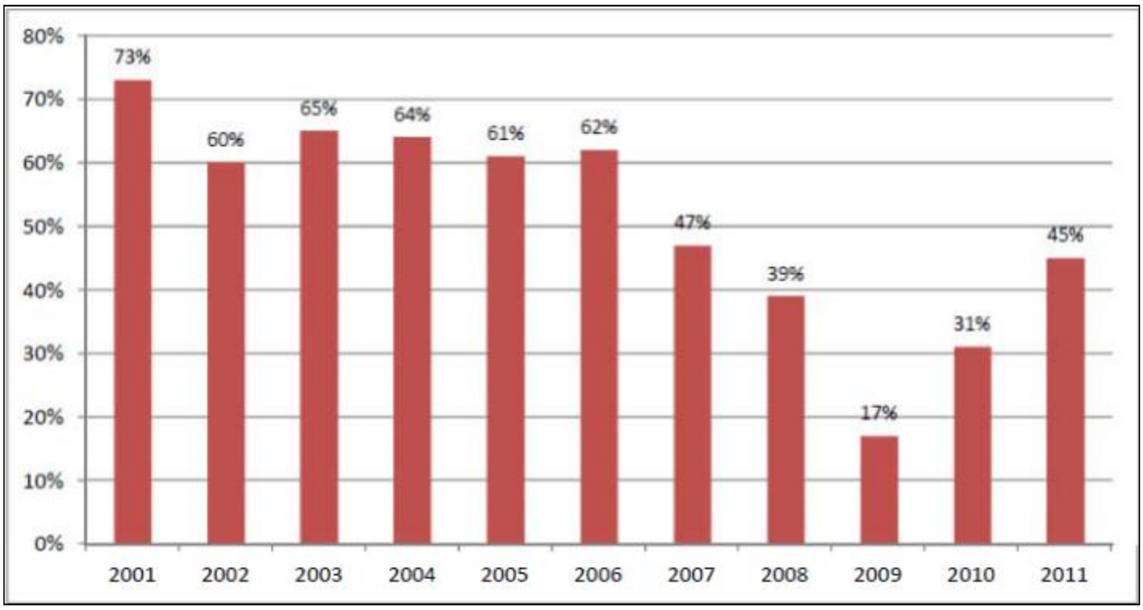


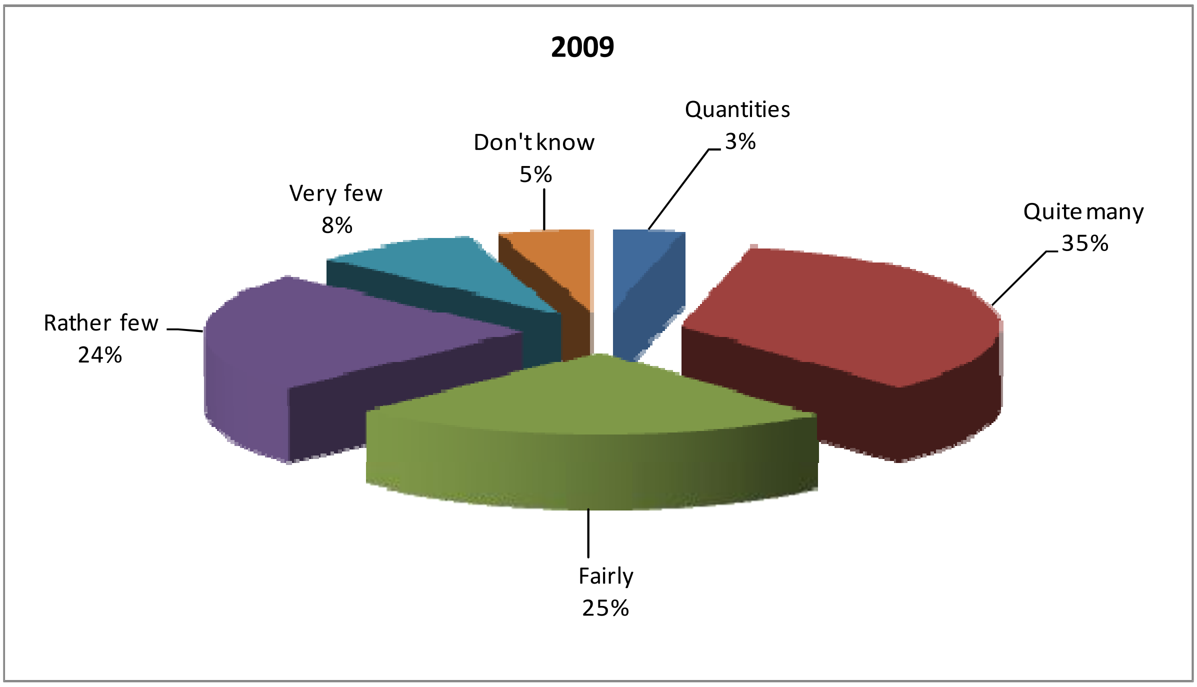
Figure 15 Average percentage of drivers not yielding at crosswalks in 20 locations in Estonia, 2001-2011



C2.5 Society

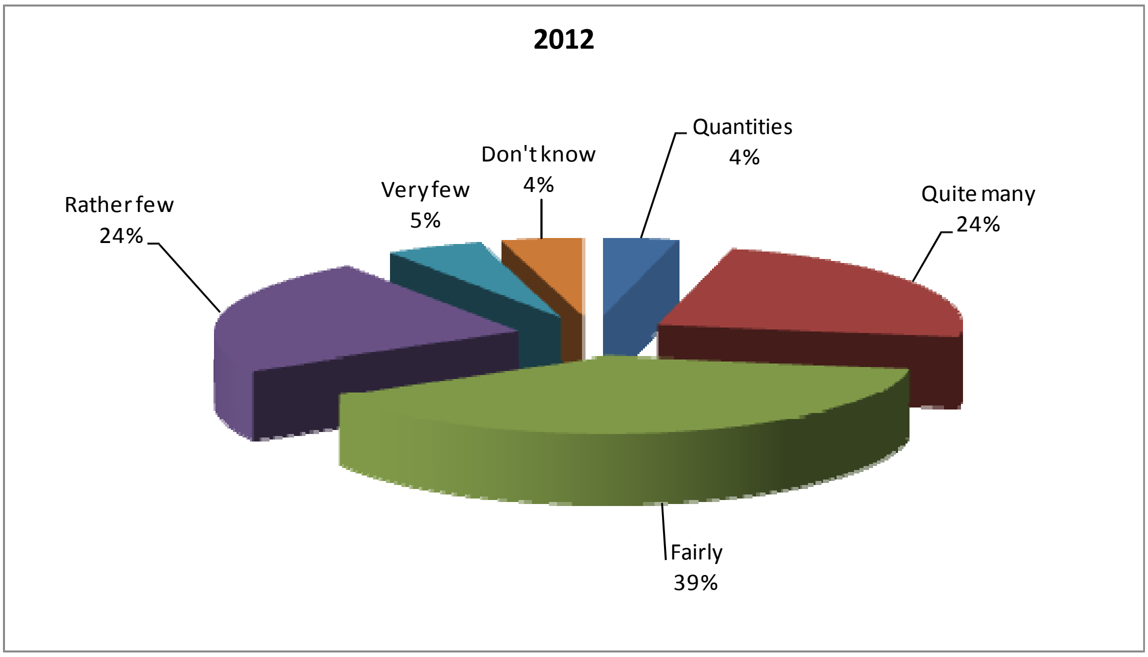
The acceptance of the situation with regard to safety on crosswalks was measured with a survey asking how many safe crosswalks there are in Tallinn. It can be argued if this is awareness of the situation with crosswalks but at the same time is also acceptance of the situation. The result from 2009 is presented in the **Figure 16**.

Figure 16 Acceptance of how many safe crosswalks there are in Tallinn, 2009



The 2012 survey gave mixed results in terms of change (**Figure 17**)

Figure 17 Acceptance of how many safe crosswalks there are in Tallinn, 2012



As a result the positive acceptance ("Quantities" to "Quite many") was reduced by 9%. If we consider the answer "Fairly" also to be positive, the positive acceptance was improved from 63% to 67% but this result has to be taken with reservation – a moderate number of safe crosswalks is not a good objective to aim at. The negative acceptance was reduced by 3% from 2009 to 2012. There can be many factors affecting the acceptance results, including repainting the crosswalk zebras (which was not in the scope of the measure). Also, only 14 of approximately 2300 crosswalks in Tallinn were improved with the measure and the solutions 1, 3, 4 and 5 are not noticeable for pedestrians. Therefore the changes in acceptance cannot be interpreted as a result from the measure.

Table C2.5.1: Awareness of how many safe crosswalks there are in Tallinn

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After –Before	Difference: After – B-a-U
16 Awareness	63% 11-2009	67% 06-2012	67% 06-2012	4%	0%

C3 Achievement of Quantifiable Targets and Objectives

No.	Target	Rating
1	The number of accidents on redesigned crosswalks has decreased 25%	NA
2	The satisfaction of pedestrians and cyclists has increased 20%	O
NA = Not Assessed O = Not Achieved ★ = Substantially achieved (at least 50%) ★★ = Achieved in full ★★★ = Exceeded		

The objectives originally set were not in accordance with the substance and the scope of the measure. The improvements made on the crosswalks were not of a principal type, most of them were not even noticeable to pedestrians or drivers. The results reflect the change:

(1) The change in traffic accident statistics was not statistically meaningful because of too few pedestrian accidents (fortunately!) on the 14 crosswalks during the evaluation period of 3,5 years. Only 4 pedestrian accidents occurred during the hours of darkness (when the solutions were active or made any difference) on all crosswalks during the period, resulting in 4 pedestrians injured and 1 death. The accidents causing injury all occurred before the implementation of the measure and the accident causing death occurred 3 months after the implementation of the solutions. Thus, no meaningful conclusions could be made from accident statistics.

(2) The change of 3% in the satisfaction (acceptance) of pedestrians is not a very clear result as at the same time the clearly positive acceptance was reduced by 10%. Also, the change was probably caused by other factors as only 14 of approximately 2300 crosswalks in Tallinn were improved with solutions often not noticeable to pedestrians nor to drivers. Cyclists were not addressed directly with the solutions. Thus the acceptance change gave expectedly small results and does not provide any useful knowledge.

C4 Up-Scaling of Results

The different solutions of the measure gave different results which can be seen from the evaluation results. The solutions with the best results have a good reason to be repeated in other carefully selected locations so the particular solution would give maximum results.

The main principle of the measure - choosing new solutions for piloting and testing them in use is a method worth using regularly in any city.

Solution 1 gave good results in the chosen location and had a good reason to be repeated in other locations with similar problems. However, if implemented on a wider scale then drivers will get used to paying a higher level of attention to the pedestrians at crosswalks with Solution 1 and accordingly will most probably pay lower attention to the pedestrians at the crosswalks without special solutions.

Solution 2 will most likely not to be implemented on wider scale for several reasons:

- The solution is technically complicated, requires electrical power and has a high cost compared to the effect it achieves;
- There are problems with the reliability of the radar, sometimes creating an adverse effect while blinking the LED-s with no pedestrians around or not blinking when pedestrians are using the crosswalk;
- The blinking LED-s are not always easily observed in the case of lighted and diverse backgrounds;
- If the solution is implemented on a wider scale the drivers will get used to paying a higher level of attention to the pedestrians at crosswalks with blinking LED’s and accordingly will most probably pay lower attention to the pedestrians at the crosswalks without special solutions.

S**olution 3** gave good results by reducing the speed of cars approaching the crosswalk and this is a good reason to use it on a wider scale. If the solution is implemented in many locations around the city, then drivers will get used to the solutions which make them drive within the speed limit and it will probably have an effect on driving habits.

Solution 4 gave fairly good results but as the solution is similar and can be easily reconfigured to solution 4 the latter would be preferred for use in future.

Solution 5 needs to prove its effectiveness before a decision can be made to use it on a wider scale. It was fairly simple to implement at the existing traffic lights but the result of it is yet to be proved. In the case of extra spot lights for pedestrians it is doubtful.

C5 Appraisal of Evaluation Approach

The evaluation with the city specific indicators gave clear results indicating the effectiveness of the solutions. The indicators have been used in Tallinn and Estonia for monitoring drivers' behaviour since 2002 and have also shown the possibility to build up a BAU scenario for one indicator.

The use of the survey to measure the change in acceptance did not give any useful information on what the implemented solutions actually changed. The question was too general for that and also the scale of the measure was negligible to be noticed by a large scale survey. Perhaps a survey with pedestrians and drivers at the exact locations where the solutions were implemented would have provided some indication as to if and how the change was perceived.

The accident statistics were not a suitable indicator for evaluating the impact of the measure. The reason for this was there were too few (fortunately!) pedestrian accidents to make any conclusions and half of them happened in daylight, when the implemented systems were either not in function or have no use.

The use of experimental measuring of the luminosity difference between normal and dimmed light was only introduced after the other indicators and would have resulted in too small a sample in too varied visibility conditions. The result was theoretical but gave an indication on how a human eye can perceive the difference of the situation on a crosswalk with normal and dimmed traffic light.

C6 Summary of Evaluation Results

The key results are as follows:

- **Solution 1 –** The driver behaviour (yielding to pedestrians) was improved by 53% even when the overall driver behaviour could be estimated to be worse from previous trends.
- **Solution 2** – The number of cars exceeding the speed limit while approaching the crosswalk was reduced by 3%.
- **Solution 3 -** The number of cars exceeding the speed limit while approaching the crosswalk was reduced by 7%;
- **Solution 4 -** The number of cars exceeding the speed limit while approaching the crosswalk was reduced by 9%;
- **Solution 5 –** The amount of light emitted by a scene with a dimmed traffic light was 40% smaller than with a normal traffic light, thus aiding the drivers' attention in poor visibility.
- The change in acceptance of the current safety situation with crosswalks in Tallinn was unclear. On the one hand it was improved by 3% when considering the positive and moderate responses together which included the reduction of the negative responses, whereas on the other hand, the number of positive only responses was reduced by

10%. There was also no reason to connect the change in acceptance to the implementation of the measure on only 5 crosswalks.

C7 Future Activities Relating to the Measure

Solution 4 is planned to be changed to the principle of solution 3 – instead of a continuous green traffic light that turns red when a car exceeding the speed limit approaches, the traffic light is continuously red and turns green only when the approaching car has a speed within the speed limit (with little tolerance). The reason for this is that Solution 4 has shown to work better when drivers can understand the connection between their speed and the change of traffic light.

D Process Evaluation Findings

D0 Focused Measure

The reasons for selecting this measure as a focused measure was as follows (listed according to importance):

- The measure fits into the EU policy towards clean urban transport (five pillars of the EU Green Paper)
- The measure fits into the city policy towards sustainable urban transport and / or towards sustainability in general
- The possibility of carrying out a good Cost Benefit Analysis

D1 Deviations from the Original Plan

The deviations from the original plan comprised:

- **Delays in finding technical solutions** – Finding and selecting possible solutions for the measure took longer time than originally planned.
- **Dropping several technical solutions** – Originally 4 additional solutions were considered to be implemented but were omitted in the process of planning and implementation for different reasons:
  - **New traffic arrangement with markings on a roundabout** was considered as one of the solutions. However it was not found to be innovative enough and was cancelled.
  - **Removing traffic light for pedestrians on right turns** of certain suitable junctions. Turning cars have to give way to pedestrians anyway, they drive slowly and often there are no or there are just a few cars turning with each traffic light cycle. If in that case the traffic light is red for pedestrians they start to ignore it, thus compromising traffic safety in general. The solution was not considered to be innovative and when the pedestrian traffic lights were removed from two junctions without getting the evaluators to do the before-survey, it was decided to omit the solution from the measure.
  - **A crosswalk sign with the pedestrian contour on the sign consisting of LED-s** was considered for testing. While considering, the Estonian Road Administration tested the sign independently of the MIMOSA project. The solution was found to be unsuitable, as from a distance the LED-s were not giving any effect to visibility or drawing the attention of drivers. Thus the solution was omitted from the measure.
  - **User-rotatable reflectors** were considered to be installed on crosswalk sign poles. While co-ordinating the solution with the Estonian Road Administration, the answer became negative. Similar rotatable reflectors were used in other regions of Estonia for letting bus drivers know that the passengers at the bus stop want to get on the bus.
- **No cost-benefit analysis for the measure.** Originally a cost benefit analysis was planned as part of evaluation of the measure. It was decided with the Evaluation co-ordinating team that instead of the CBA a benefit-cost ratio was calculated. The reason being there was no sufficient data for the result to be meaningful. Also, the results were based only on 1-years accident statistics (after the implementation) and were not

reliable. After receiving the accident statistics it was clear that even the benefit-cost ratio would not add any meaningful information to the evaluation.

- **Dropping an objective** – The original objective "Build an optimised and user-friendly infrastructure for public transport activities, which will encourage people to use public transport" was dropped. The relation between the objective and the actual measure activities was too small to convey.

D2 Barriers and Drivers

D2.1 Barriers

Preparation phase

- **Planning barrier –** Too long a process in deciding what would actually be done in the scope of the measure. This delayed the process of reaching all objectives and the preliminary study took longer time than expected.
- **Organisational barrier –** Leaving of a city official (key person for the measure) from his role in October 2010. The person was responsible for traffic arrangement in Tallinn and for discussing technical details of the measure. As the barrier occurred prior to the process of preparing the procurement, it delayed the process of reaching all objectives.
- **Financial barrier –** Funds unavailable from Tallinn City budget for arranging the measure procurement in 2010. This delayed the process of reaching all objectives.

Implementation phase

- **Institutional barrier –** A new national traffic regulation law was planned to be introduced originally from 1.01.2011 but due to procedural problems it was postponed to 1.07.2011. The law had many important changes, including new regulations on bicycles crossing roads at crosswalks. Having such an important change during the measure preparation and having it postponed for half a year at the critical phase of the project delayed the process of the measure implementation.
- **Problem related barrier –** National Road Administration did not approve one of the technical solutions planned originally. It was the 'rotating reflective ring' around the pole of the crosswalk that pedestrians could rotate to draw the attention of the car drivers. Similar but non-rotating rings are used in some regions of Estonia at bus stops. Both waiting for the answer from Road administration for 1 month and the refused approval for one measure were experienced as barriers.
- **Communication barrier –** One simple solution in the measure was the removal of traffic lights from separated right hand turns so that pedestrians did not have to wait for a green light while there were no vehicles performing right hand turns. The contractor removed the lights without informing the measure leader or the evaluators, thus the evaluators did not manage to perform the before study at two locations where the traffic lights were removed. It was agreed that physical implementation takes place after evaluators have been informed about finishing the before-studies.

Operation phase

- **Strategic barrier –** With promoting the measure a typical barrier in Tallinn was encountered. In the case of traffic safety and other "soft" measures a general understanding and practice was they have to be carried out with minimal effort and budget instead of maximally contributing to maximise the effect. The practice is general and did not impede promoting the measure in public but the effect of it is thus very limited.

D2.2 Drivers

Overall Drivers

- **Political/strategic driver –** The commitment to share the responsibility for road safety and to carry out activities which would decrease the number of accidents has been set by the City Council in The Tallinn Traffic Safety Development Plan for 2005–2014.
- **Planning driver –** Constructive, useful and regular meetings between measure leader, evaluator and city official. Participants were all satisfied with the usefulness of the meetings, the results were decisions about what would be done in the scope of the measure.
- **Financial driver –** Availability of CIVITAS funds provided the opportunity to reshape some crosswalks in Tallinn.

Implementation phase

- **Technological driver –** Several of the technical solutions needed electricity for operating and solutions were planned according to the needs in particular places. It can be very costly and time consuming to get electricity to some locations. Coincidentally in all places where it was needed the electricity was available. This helped to stay within the budget and time frame for installation of solutions.
- **Problem related driver –** Estonian Road Administration tested a solution at the beginning of 2011 originally planned in the scope of the measure. It was a crosswalk traffic sign with an internally LED-illuminated pedestrian figure. The testing was carried out on an administrations initiative and resulted in the conclusion that it was not suitable for usage. This result was clear prior to making the contract with the installation company so it saved on effort and resources for the measure.

D2.3 Activities

Preparation phase

- **Planning activity –** Constructive, useful and regular meetings between the measure leader, evaluator and city official. Participants were all satisfied with the usefulness of the meetings, the results were decisions about what will be done in the scope of the measure. The activity was caused by the planning barrier in the preparation phase.

Implementation phase

- **Problem related activity –** The result of not approving one technical solution by the Road Administration was grounded and the only possible action was to remove the solution from the measure.
- **Communication activity –** As the solution was finally found not to be according to the principles of the measure (not an innovative nor technical solution), it was just omitted from the measure.

Operation phase

- **Strategic activity –** The change of general practice with promoting traffic safety and other promotional activities was not the only topic for the measure. It required understanding, acceptance and decisions from higher level officials and politicians. As an activity, the topic was brought up in the learning history workshop and was noted by all participants.

D3 Participation

D3.1 Measure Partners

- **Tallinn City Government –** Leading role in the measure organised by the Transportation Department
- **Tallinn University of Technology –** A principal partner, responsible for preliminary studies and evaluation of the measure.
- **Signaal AS -** A principal partner, responsible for the production and installation of the technical solutions

D3.2 Stakeholders

- **General public -** The measure was aimed at all participants in traffic
- **Residents -** As the measure was implemented in Tallinn, it was more directed to local residents;
- **Cycle / walking groups** – The measure was aimed at reducing pedestrian / cycling accidents;
- **Car drivers/motorists** – While aimed at saving pedestrians and cyclists, the solutions were designed to influence the behaviour of car drivers first hand;

D4 Recommendations

D4.1 Recommendations: Measure Replication

- **The measure is replicable –** All implemented technical solutions are replicable in other cities. However as the evaluation has shown, some of them are very clearly inefficient. The process of finding solutions with a wider circle of experts is also replicable and recommendable.
- **Simple things first** – As it was noticed by participants during a general MIMOSA meeting, before implementing new innovative solutions, simple repainting of zebra-markings should have been done first. Worn-out zebra-markings were visible on all pictures of the descriptions of the technical solutions.

D4.2 Recommendations: Process (Related to Barrier-, Driver- and Action Fields)

- **Clear planning is important** – It should be clear from the planning of any measure what are the most important objectives of the measure. It may sound trivial but measure actions should be derived from these objectives, not the other way around. Otherwise it will be difficult in the preparation phase as in the case of the current measure.

RTD Fact Sheet Template

TAL 5.1 Improvement of visibility and safety of crosswalks and bicycle tracks

Reference Measure	TAL 5.1 Improvement of visibility and safety of crosswalks and bicycle tracks
Date of Submission	30/01/2012
Date of Review (ISIS)	04/2012
Date of Approval	04/2012
Author(s)	Marek Rannala
Editor(s)	Loredana Marmora (by ISIS)

Context and Purpose

Number of pedestrians, bicyclists and roller-skaters is rising in Tallinn together with growth of traffic volumes. Unless focused, this can lead to growth of number of accidents between cars, pedestrians and bicyclists.

Different international studies show, that even if usage of pedestrian and cycling roads increases, cyclists run the biggest risk when crossing streets for conventional transport. Accidents happen due to the fact that drivers concentrate on the car traffic, and do not pay attention to bicyclists. These accidents mainly happen on turns and conventional crossings with bicycle tracks. The reasons can be directed to be a low visibility of pedestrians on the crosswalks as well as a low visibility and insufficient marking of crosswalks. The measure is directly aimed on the task of finding new approaches on improving visibility and markings for crossings and crosswalks.

For finding most problematic crosswalks and suitable solutions for implementing a study was performed.

Description of RTD Activity

The study was preceded by series of meetings with traffic arrangement officials of Tallinn Transportation Department. The purpose was to get to understanding, what is needed and what can be done for improving the situation on crosswalks. After analyzing the results of traffic accident statistics a list of possible solutions was created which was again discussed in a series of meetings. The study resulted ultimately in list of locations and solutions to be implemented.

Outputs and Results

The study resulted in list of 7 solutions to be implemented in 1-2 locations each. The solutions were:

1. LED-based experimental lighting of crosswalk signs – 1 location;
2. Redesigning pavement markings on a roundabout to improve the solution to pedestrians– 1 location;
3. Experimental blinking LED lights at crosswalk that start blinking if there are pedestrians approaching – 1 location;
4. Experimental rotatable blinking device on crosswalk sign poles. Pedestrians can rotate a ring around a pole and the ring starts blinking attracting attention of drivers – 2 locations;
5. Speed-sensing red traffic light that turns green light to reed if speed limit is exceeded when approaching the regulated crosswalk – 3 locations;
6. Light-sensitive blinking yellow traffic light. When traffic light is in blinking yellow mode at night the light intensity is reduced automatically for not drawing drivers attention away from

pedestrians – 1 location;

7. Removing traffic lights at separated right hand turns. This removes waiting times for pedestrians and gives them priority 100% of time. The turning speeds are low anyway and drivers attention concentrated before making a turn – 2 locations.

Resulting Decision-making

The list was mostly implemented with few exceptions:

- the solution n. 1 was cancelled due to Road Administration: it did not give permission to implement it
- the solution n. 5 was implemented in 2 locations due to the outcome of procurement (cost higher than expected).

Lessons Learnt

The most useful for the process were regular monthly meetings with officials from Tallinn Transportation Department. The meetings lasted approximately for 1 year and supported the gradual process of finding suitable locations and solutions for implementing. This process enabled to come to well-thought conclusions which resulted in high percentage of implementation of the ideas.
Even if the solutions are carefully planned, unexpected barriers are sometimes possible. Road Administration did not give permit to use experimental solution 1 because of traffic sign standards and missing certification of the solution.

Cost-effectiveness

The study was basis for the whole measure and resulted in high percentage of implementation of the ideas. Thus the results can be considered as effective.

Dissemination and Exploitation

The installation of experimental systems has been published in several newspaper articles and radio interviews. So far (01.2012) there have been no decisions on using the solutions in additional locations. The reason is that the after-studies of impacts of the solutions have not been completed yet and for decision-making it is useful to have at least 1-year testing period because of random nature of traffic accidents. The results from impact evaluation will be available for all interested parties.