BITS
Bicycles and Intelligent Transport Systems

Evaluation report

Safe bike crossing
City of Zwolle

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Project coordinated by Province of Overijssel

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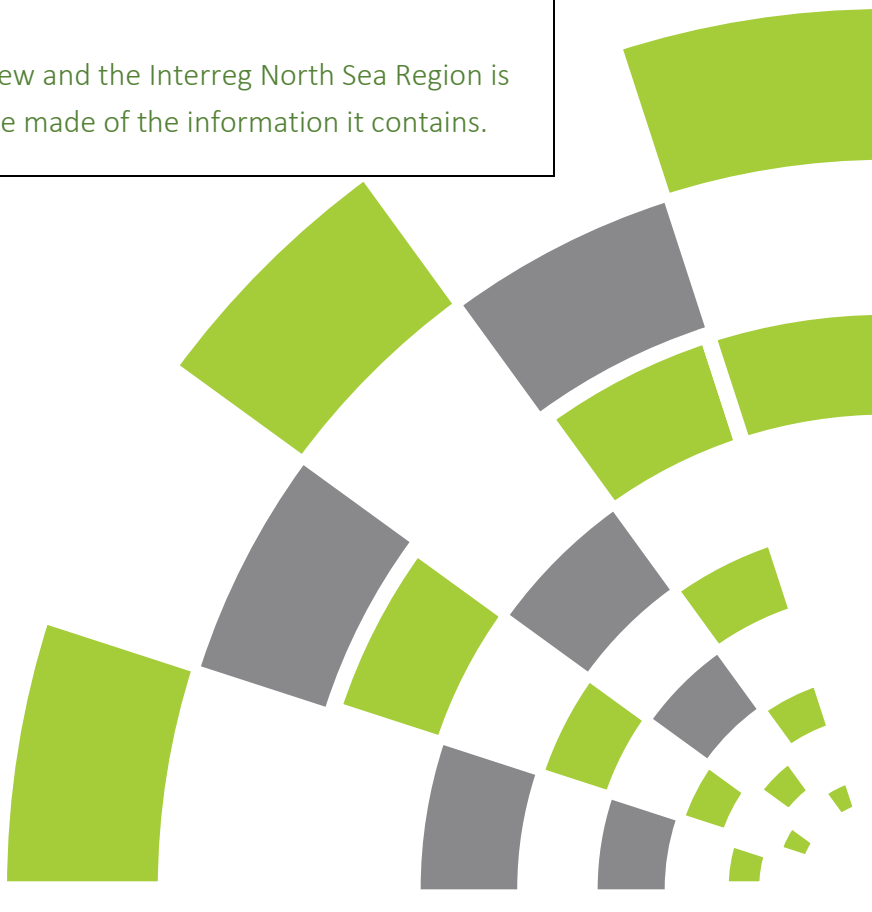


Interreg North Sea Region BITS
European Regional Development Fund

EUROPEAN UNION

Short description

On an intersection in the city of Zwolle ITS solutions were applied to improve the traffic safety. Two types of signs were installed. A classic sign that warns the cyclists of the trough car traffic and a digital speed display to encourage car drivers to lower their speed. To objectively evaluate this intervention a camera system was installed. Comparing a pre- and postintervention conflict analysis should allow to assess the impact the intervention has on the safety at the intersection.

Type of ITS

- Camera system making a conflict analysis before and after the intervention
- Smart digital signs warning cyclists and vehicles for each other

Sysconnect is the company delivering the warning system. Mobycon is responsible for the conflict analysis. Enexis and Siers are local partners responsible for energy and connections. The total cost of this ITS implementation (intervention and pre and post measurement on one location) is approximately €30 000.

Timeline

Between 20 and 26 April 2021 the premeasurement took place at the intersection. Due to several circumstances, the installation of the (digital) signs took place at the end of September 2022. The post measurement of the conflict analysis took place at the beginning of October 2022.

Hypothesis

1. The intervention with the (digital) signs was made to increase safety at the intersection and thus reduce (near) conflicts.
2. The camera system is thought to be a good instrument to objectively evaluate safety at an intersection. By comparing conflict analysis before and after the intervention one can evaluate the impact of the (digital) signs.
3. Ultimately, by making the intersection safer one strives to encourage people to cycle more.

Data sources

- Reports from Mobycon of the pre and post conflict analysis
- Technical reports from Microtraffic of the conflict analysis
- Report of a meeting with the involved project manager from Zwolle to discuss and evaluate the ITS implementation

Analysis

Report of the pilot

This pilot encompasses three phases: in the first phase a pre-measurement was made with cameras investigating traffic behaviour and near accidents. In the second phase, the intervention was executed with the aim to improve safety on the intersection. In the third phase, a post measurement with the cameras followed to evaluate the intervention. These three phases are described below.

Pre measurement conflict analysis

The junction which was subject of this ITS implementation is situated in the centre of Zwolle. It is a crossing of the Burgemeester van Roijensingel, one of the main roads in the city, with the Emmawijk, a smaller street giving access to residential areas and which is also a cycle street (a street in which cyclists have priority).

FIGURE 1: THE INTERSECTION BETWEEN B. VAN ROIJENSINGEL AND THE EMMAWIJK

Source: Mobycon

In the pre-measurement, Mobycon first analysed the intersection on standards following the guidelines of the Dutch government. These guidelines are no legal obligations, but the government stipulates that decent arguments are needed not to follow the guidelines. The analysis by Mobycon showed that this intersection met almost all criteria of 'a priority intersection within the city centre' except for two. Firstly, no crossing for pedestrians is foreseen, however due to a limited amount of pedestrians crossing here and another pedestrian crossing rather close by, this is not necessary. Secondly, due to a bend in the Burgemeester van Roijensingel, the visibility on the intersection for passengers and cyclists coming from the east is limited.

Next to this criteria check, Mobycon made a conflict analysis using cameras. The measurements gave insight in traffic behaviour, near accidents and dangerous situations. During several days and different

moments during the day measurements were made. In total 96 hours of recordings were made. The results give an objective overview of the traffic situation before the interventions made.

The main conflicting situation on this cross road is between vehicles driving on the Burgemeester van Roijensingel with cyclists that are cycling on the Burgermeester van Roijensingel and are turning left to the Emmawijk (as shown in the pictures beneath). The trough car traffic on the Burgemeester van Roijensingel has priority in this situation.

FIGURE 2: TRAFFIC SITUATION CAUSING HIGHEST AMOUNT OF (NEAR) CONFLICTS

Source: Mobycon

In addition, a few conflicts have been observed between turning car traffic towards the Emmawijk versus the straight through bicycle traffic. The bicycle traffic coming from the Emmawijk mainly goes right and continues the road towards the Burgemeester van Roijensingel. Here, the bicycle traffic immediately ends up on a bicycle lane and therefore has no conflict situation with the through car traffic. At this intersection, therefore, no conflicts were observed for bicycle traffic from the Emmawijk.

In comparing the pre- and postintervention conflictanalyses we thus focus strongly on the first traffic situation, namely the cylists driving on the Burgemeester van Roijensingel and turning left to the Emmawijk.

In the table below the amount of conflicts per risk level are shown for this particular angle of the intersection. The risk levels are distinguished based on speed of the vehicle and relative position between vehicle and pedestrian or cyclist. The speed of the vehicle is used to calculate the time needed to reach the pedestrian or cyclist. For a low risk, the time to conflict is less than 5 seconds and the speed of the vehicle is below 15 km/h. In the medium risk category, the time to conflict is less than 3 seconds and the speed of the vehicle is above 15 km/h. For a high risk, the time to conflict is below 2 seconds and the speed of the vehicle is between 35 and 50 km/h. Finally, a critical risk is assigned when the time to conflict is less than 2 seconds and the speed of the vehicle is above 50 km/h.

In the case of this intersection 118 conflict situations were detected during the 96 hours of measurement, of which one with a low risk, 32 with a medium risk, 85 with a high risk and zero with a critical risk. The conflict rate for a high risk is 2,26%, which means that for 2,26% of all cases of passing traffic crossing left turning cyclists on this junction we have a near accident with a high risk. Most conflict situations are registered during morning and evening rush hours. The risk on a high risk near accidents increases during evening hours.

FIGURE 3: TOTAL AMOUNT OF CONFLICT TRAFFIC SITUATION BICYCLE TURNING LEFT TO EMMAWIJK

East-Through Vehicle vs Cyclist on East Crossing (East-through far-side)
@ Emmawijk, 2021-Apr-20 to 2021-Apr-26

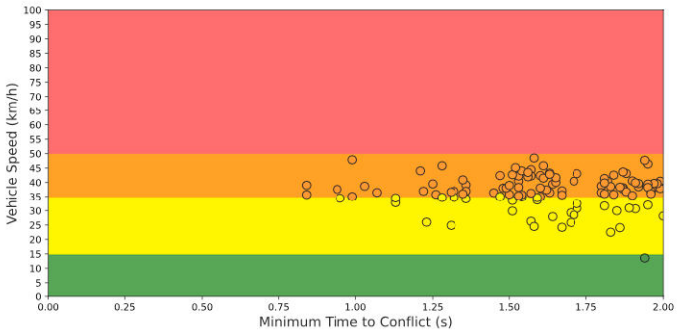
Risk Level	Critical Risk	High Risk	Medium Risk	Low Risk
Measured Frequency	0	85	32	1
Annual Estimate	0	5821	2191	68
Conflict Rate (%)	0.0	2.26	0.85	0.03
Relative Risk	NA	NA	NA	NA

Source: Mobycon

In the total number of conflicts, all conflict situations are included in the analysis. The conflicts are also included in situations where the driving trajectory of the car traffic is beyond the driving route of the turning bicycle traffic (see picture above). In these situations, the cyclist continues to cycle slowly and anticipates until the car has passed and then turns off. This situation is common and is counted as a possible conflict.

The graph below shows the relation between vehicle speed and minimum time to conflict. Conflicts on the left side with a high speed have the highest risk on serious consequences. Most conflicts on this cross road are high risk with a speed between 35 and 50 km/h, with most often a minimum time to conflict above 1 second.

FIGURE 4: RELATION BETWEEN VEHICLE SPEED AND MINIMUM TIME TO CONFLICT



Source: Mobycon

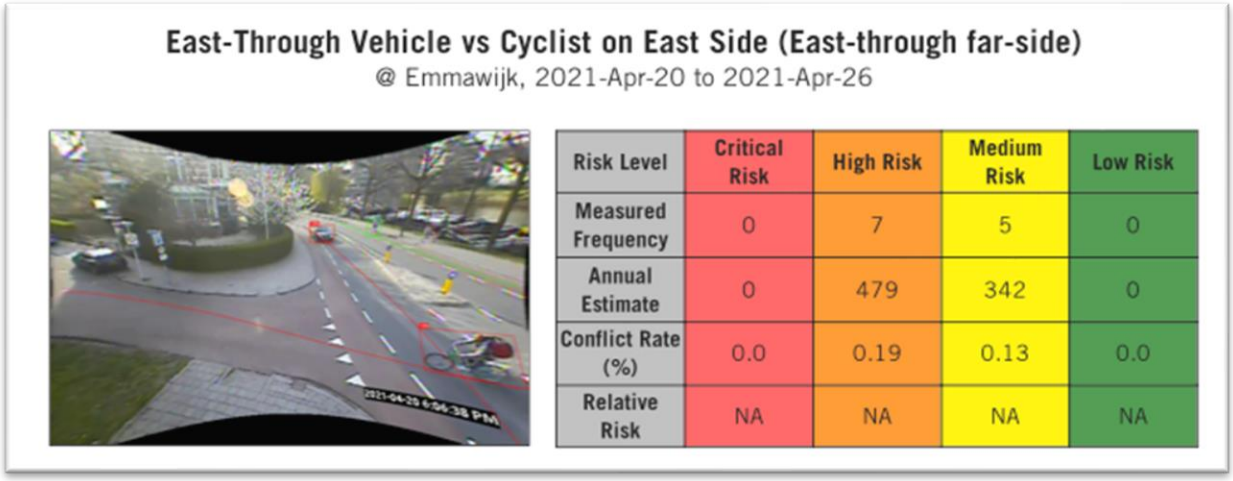
In the total number of conflicts, all conflict situations are included in the analysis. The conflicts are also included in situations where the driving trajectory of the car traffic is beyond the driving route of the turning bicycle traffic (see figure 1). In these situations, the cyclist continues to cycle slowly and anticipates until the car has passed and then turns off. This situation is common and is counted as a possible conflict.

When leaving out this situation (that is not really a conflict situation), the number of conflicts is a lot lower

FIGURE 5: REAL CONFLICT SITUATIONS FOR CYCLISTS TURNING LEFT TOWARDS EMMAWIJK

and in the 0 measurement we see 12 conflicts of which 7 with a high risk and 5 as a medium risk.

FIGURE 6: CONFLICT ANALYSIS FILTERED FOR FALSE CONFLICT SITUATION



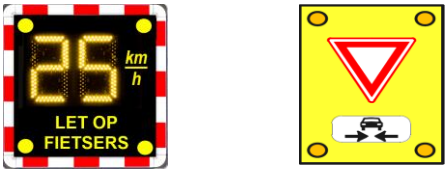
Mobycon also analysed the recordings visually and concluded that the relatively often occurring situation of a high risk near accident is due to the relatively high speed of vehicles driving through on the Burgemeester van Roijensingel. The maximum speed allowed is 50 km/h. 59% of all vehicles drive between 35 and 50 km/h with a percentile 85 of 42 km/h.

Intervention

Using the results of the pre-measurement, the city investigated which interventions would be most suitable. It was decided to use ITS as well, i.e. smart digital signs warning vehicles and cyclists for each other. Cyclists coming from the cycle street Emmawijk were warned with the (yellow) sign below in the case vehicles on the Burgemeester van Roijensingel are approaching. The speed of vehicles driving on the Burgemeester van Roijensingel was measured and shown on a digital screen on the road (see image on the right). Vehicles with an adapted speed receive the message 'thank you'. All vehicles passing through independently of their speed were warned for cyclists although they still have priority on the intersection.

FIGURE 7: PHOTO OF INTERVENTIONS

FIGURE 8: PHOTO OF DIGITAL SIGNS



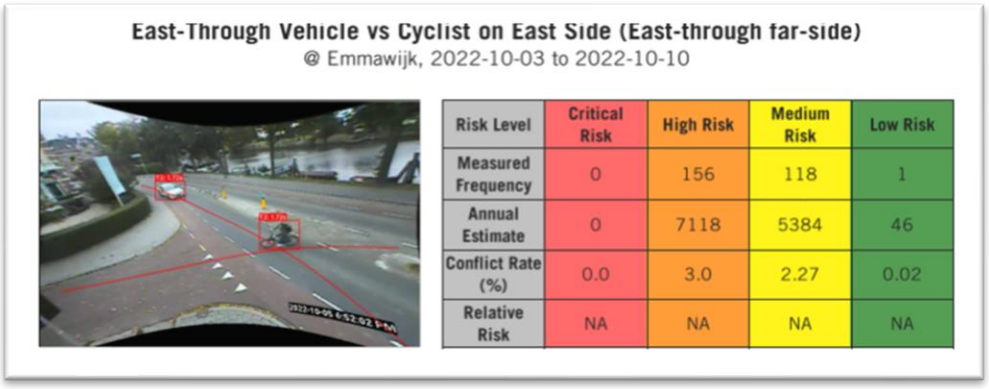
Post measurement conflict analysis

Once the digital signs were installed on the junction, the cameras were installed and the post-measurement took place to evaluate the impact of the intervention. Between the 3th and 10th of October 2022 Mobycon again made a conflict analysis using cameras. The measurements gave insight in traffic behaviour, near accidents and dangerous situations. In total at different moments during the day 96 hours of recordings were made. The results give an objective overview of the traffic situation after the interventions have been made.

In the table beneath, we note an increase in high-risk situation. The post-measurement indicated 156 high risk situations whereas in the pre-measurement we found 85 such cases. The conflict rate is now at 3%. The frequency of medium risk situations equally increased. The conflict rate more than doubled (2,27) as compared to the pre-measurement (0,85). The frequency of the low-risk situations remains the same: only

1 situation has been registered. The conflict rate in this case is lower for the post-measurement (0,02% as compared to 0,03).

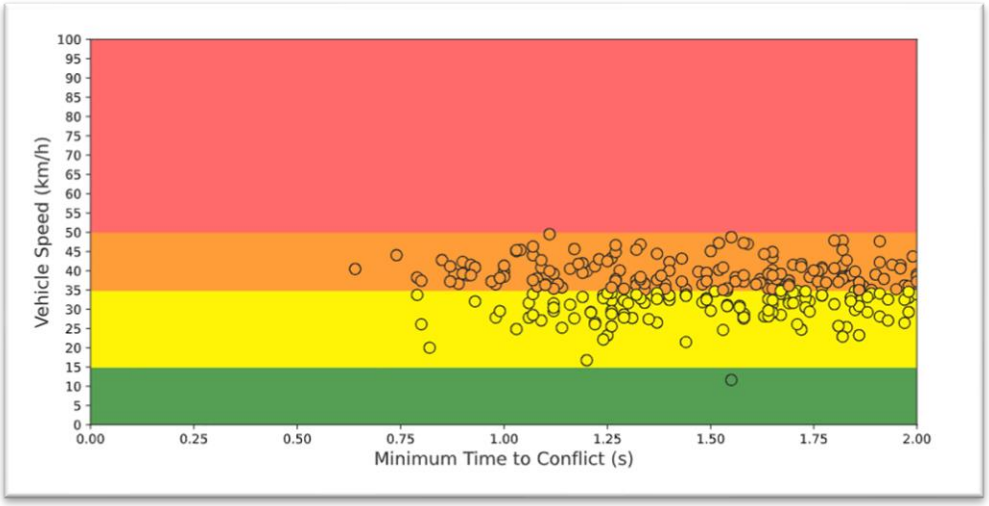
FIGURE 9: CONFLICT ANALYSIS AFTER INTERVENTION CYCLIST TURNING LEFT TO EMMAWIJK



Risk Level	Critical Risk	High Risk	Medium Risk	Low Risk
Measured Frequency	0	156	118	1
Annual Estimate	0	7118	5384	46
Conflict Rate (%)	0.0	3.0	2.27	0.02
Relative Risk	NA	NA	NA	NA

Bron: Mobycon

FIGURE 10: RELATION SPEED AND MINIMUM TIME TO CONFLICT



Source: Mobycon

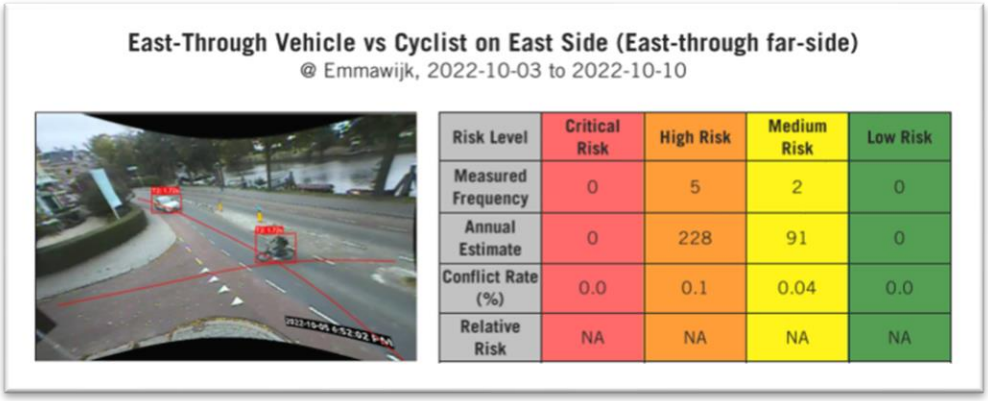
However, this does not necessarily mean that the intersection became less safe as compared to the situation before the interventions were made. There are several reasons for this. The first one concerns the increase in cyclists between the pre- and post-measurement period. For the first period in 2021 1801 cyclists passing at the intersection have been counted. In 2022 we note an increase of 38%: 2489 cyclists have been counted. A higher intensity at the intersection implies a higher risk of near accidents even when the interventions would have made the intersection more safe. We note that the increase in cyclists could possibly be linked to better weather conditions during the post-measurement period. The average maximum temperature was around 18 degrees, whereas in April 2021 it was around 13 degrees. The average minimum temperature was 8, in 2021 it was 0,2. Moreover, while April 2021 was still impacted by

covid-, this was no longer the case in Octobre 2022. No covid-restrictions whatsoever characterized this second measurement period.

The second reason not to conclude that the intersection became less safe after the interventions has to do with the speed of the vehicles. Between both measurement periods, the average speed decreased from 36 km/hour to 33 km/hour indicating a positive evolution toward a safer intersection. A majority of the vehicles (59%) adapted their speed to less than 35 km/hour. In 2021, before the intervention it concerned only 40% of the vehicles.

The third reason concerns a better result on the post intervention conflict analysis when filtering out the so-called 'false' conflict situation. Where before the intervention we noted 479 high risk and 342 medium risk conflict situations, after the intervention in 2022 it were only respectively 228 high risk and 91 medium risk conflicts. The conflict rate dropped significantly after the intervention.

FIGURE 11: POST INTERVENTION CONFLICT ANALYSIS FILTERING OUT 'FALSE' CONFLICT SITUATIONS



Source: Mobycon

Taking into account these three elements, we conclude that the situation for cyclist turning left to the Emmawijk became significantly more secure after the intervention implementing digital warning signs.

Experiences project managers

During the process of this implementation, more than one project manager from the city of Zwolle has been involved. We had a discussion with the latest project manager (Bjorn Blink) to evaluate the pilot from the point of view of the city.

The main advantage for the involved project manager of this ITS implementation is the objectivity. Using the conflict analysis system, the pre- and post-intervention situations are objectively measured and analysed. Regularly, the city adapts streets or cross roads because they believe this is necessary based on their experiences, on statistics of accidents or based on complaints from citizens. This system on the contrary measures traffic safety objectively. Also, this systems measures objectively the impact of the interventions made. Some argue in favour of the digital warning signs, while others don't believe this is a good intervention. The camera system objectively analysed whether the signs made the cross road safer or not.

However, several barriers were met as well during the process of this ITS implementation. A first barrier was the delay during the process. Delay was observed both from the side of the city, as well as due to working together with several partners. Several permissions to install the digital signs were needed and it took time to receive these permissions. Moreover, the cameras are making recordings of passengers so privacy issues need to be taken into account as well. A data protection impact assessment (DPIA) was needed as well and also took the needed time. Thirdly, due to earlier delay in the process, it was necessary to immediately start the post-measurement in order to have an appropriate evaluation within the BITS project. As a consequence, the immediate impact of the digital signs will be measured. We won't however have information on the impact on a longer term. It would have been interesting to measure the impact of the signs after two or three months and to investigate whether the signs still had an impact on traffic safety or whether a potential effect of habituation occurred. Finally, the initial plan of the city was to make an ITS intervention on four intersections roads in the city. The pre-measurement was done on four different locations. Due to different circumstances and due to the conclusions of the pre- measurement, only on one intersections road an intervention was made. One location wasn't suited for these digital signs, a second location wasn't achievable due to time reasons and on the third location the digital signs wouldn't have solved the problem of unsafety and conflict situations.

Conclusion

The project managers argue that the objectives of the pilot have been partially achieved. "We have succeeded in making road safety at intersections measurable and we have succeeded in measuring the effectiveness of one road safety measure", they argue. We consider this Safe Crossing pilot as a successful pilot. In contrast to the project managers we would argue that the objectives are not been reached only partially, but entirely. First, all data considered, the digital signs made de intersection more save. The average speed of the car traffic decreased and the conflict rate concerning the most dangerous situation for cyclists diminished. Secondly, the camera system proved to be a good instrument to evaluate this change based on objective data. Not only allowed the conflict analysis to identify the situations giving way to most (near) conflicts, it allowed equally to assess an improvement of safety at the intersection after the intervention. Thirdly, in regard to the BITS-objective we refer to the relation between safety and the motivation to cycle more that showed in the BITS-survey. A safer crossroad therefore adds to this equation and ultimately supports a decrease in CO_2.

Lessons learned

Some recommendations were made by the project manager. They can be read as lessons learned.

- First, take into account that it can be a time consuming process since several other partners are involved.
- Second, choose the location for the intervention wisely. The pre-measurement showed that at two of the four chosen locations the digital signs could not be installed.
- Third, identify in advance what consequences the intervention will have on the physical public space, so that you will not be faced with surprises with regard to work that must be done for the purpose of the intervention. The installation of the road safety system in Zwolle required

more physical work on the street than previously expected (digging cable ducts, connection to electricity cabinet etc.). Also check this with external parties such as a power supplier.

- Finally, take into account that the privacy aspect requires a lot of attention because cameras are used.