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Method for Pedestrian Crossing Risk Assessment and Safety Level Determination: the Case Study of Tallinn

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SUMMARY

Pedestrians are a part of vulnerable road users which safety requires a special attention. Official statistics in Estonia from the last decade returns the following numbers: around 30 % of all road traffic accidents in the country were accidents with pedestrians, 32 % of all traffic fatalities were finished with pedestrian death.
Pedestrian crossing has the biggest risk level between all kinds of pedestrian facilities, because it includes a direct conflict point between vehicle and pedestrian traffics. The article presents a method to assess risk of pedestrian crossing users and to determine safety level of this road infrastructure element. This approach is based on observation and collection of infrastructural as well as traffic data, which includes: (1) information about each pedestrian crossing facility, its location and state, (2) data about accidents with pedestrians and their features, (3) data from road traffic measurements. The main advantages of the described method are universality and comprehensiveness.
The case study was done in Kristiine district of the city Tallinn, which was chosen as the most typical average district of Estonian capital. Results of this study are also presented in the article.

1. INTRODUCTION

Safety of pedestrians became a very important topic during the last years, especially, in the urban areas. Looking through official statistics, more than 40% of all accidents in Tallinn are accidents with pedestrian. It is clearly presented on the Figure 1: a number of collisions with pedestrians is more than total amount of accidents, where only vehicles participated.
Figures 2 and 3 present distributions of accidents depending on years and on day time, respectively. According to the Figure 2, the most problematic situation was in the year 2012, where the largest amount of accidents was fixed. Distribution by day time shows two critical moments during 24 hours, when situation starts to be risky: these both moments align with traffic peak-hours in the morning (7-9 a.m.) and in the afternoon (16-18 p.m.).
To assess and to improve the situation, experince of neighbour countries must be taken into account primarily because of similar climate conditions and and behaviuors of road users. In case of Estonia the best examples could be provided by Finland and Sweden.

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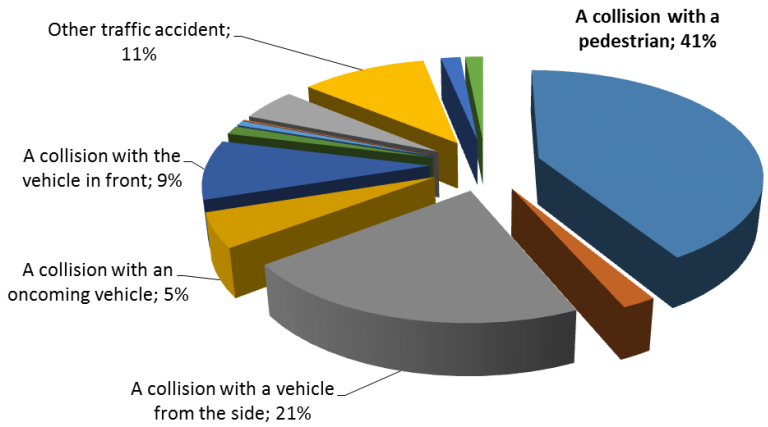

Fig. 1 – Fatal and injury accidents distribution by types

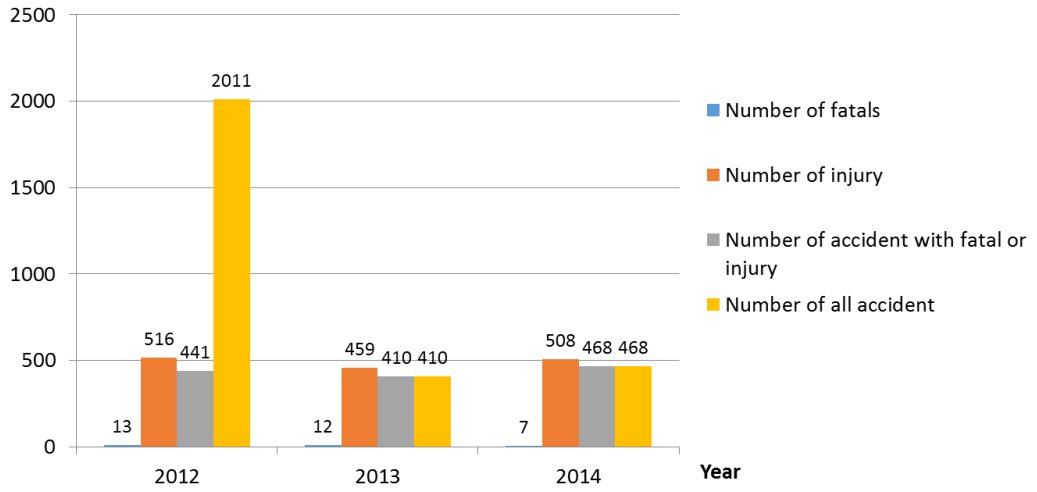

Fig. 2 – Number of accidents in Tallinn by years

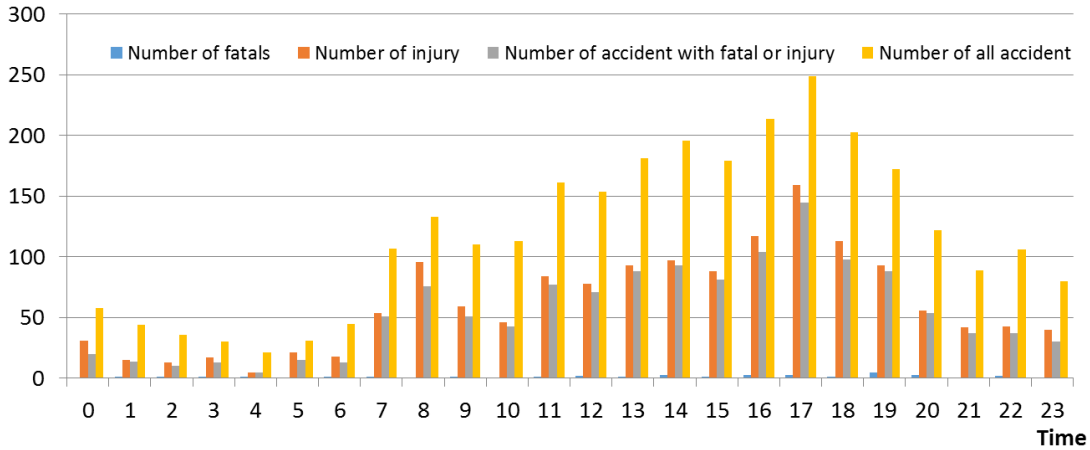

Fig. 3 – Number of accidents in Tallinn by time

Problem of experince transfer is studied during the last decades. View of Swedish research concerning pedestrian safety is shown in the article [3]. Comparison of road safety situations in Finland and Baltic States is presented in the research work [4]. Estonina basic issues in

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this topic are described in the article [5].

2. METHODOLOGY

Pedestrians refer to the most vulnerable road users. To prevent and to reduce accidents with thier participation was and will be one of the priority of road safety policy in Estonia. That is why risk assessment on pedestrian facilities could provided with perfect necessary feedbacks.

Table 1 – Potential risk factors included for pedestrian crossing risk assessment

Unsignalized pedestrian crossing		**Signalized pedestrian crossing**	
I Type			
1	Roadway width	1	Roadway width
2	Number of driving lanes	2	Number of driving lanes
3	Separating strip	3	Separating strip
II Additional risk factors			
4	Road edge with curb	4	Road edge with curb
5	Cycleway along the roadway	5	Lighting
6	Lighting	6	Alignment of crossing
7	Alignment of crossing	7	Children facilities located in the neighborhood
8	Children facilities located in the neighborhood	8	Crossing covers bus stop pocket or turning lane
9	Crossing covers bus stop pocket or turning lane	9	Street signing quality
10	Distance to the nearest intersection and the nearest signalized crossing	10	Distance to the nearest intersection and the nearest signalized crossing
11	Road marking quality	11	Pedestrians cross the road nearby
12	Limited visibility due to traffic control means	12	Traffic lights location and visibility
13	Limited visibility due to parking	13	Other threats
14	Pedestrians cross the road nearby		
15	Traffic signs location and visibility		
16	Other threats		
III: Safety measures introduced			
17	Raised crossing or chicane	14	Single-stage crossing
18	Road humps	15	Average waiting time
19	Colored crossing	16	Crossing with push button
20	Built safety island	17	Built safety island
21	Temporary safety island, introduced traffic sign	18	Temporary safety island, introduced traffic sign
22	Roadway narrowing at crossing	19	Roadway narrowing at crossing
23	Local crossing lighting introduced	20	Local crossing lighting introduced
24	Precaution traffic sign or reflecting background of traffic sign used	21	Displaying time
25	Pedestrian guardrail	22	Pedestrian guardrail
26	Other safety measures	23	Other safety measures
IV: Speed			
27	Real speed	24	Real speed
V: Registered road accidents (injured or killed)			
28	Number of road accidents during the last 36 months	25	Number of road accidents during the last 36 months

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Method for risk assessment at pedestrian crossings was chosen because of 2 reasons:

- Crossings are one of the main hazards to pedestrians
- Selected approach is quite comprehensive and covers different risk aspects.

This method divided all pedestrian crossing into two types: signalized and unsignalized. It based on 5 groups of risk:

1. General type of pedestrian crossings (width, lanes, separating strip)
2. Additional risk factors (deep description of road situation)
3. Existing safety measures
4. Speed
5. Road accident statistics

Detailed description of all risk aspects is in the Table 1. Depending on values of factors, each pedestrian crossing gets its assessment rate, which adds it to particular risk group: 1 – very high risk, 2 – high risk, 3 – average risk, 4 – low risk.

3. KRISTIINE DISTRICT AS A STUDY AREA

Tallinn is the capital of Estonia, which territory covers more than 150 sq.km and population is more than 440 thousands of inhabitants. It is divided into 8 administrative districts, which is shown on the Figure 4.

Fig. 4 – Administrative districts of Tallinn (source: https://www.tallinn.ee/eng/districts)

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Kristiine district was chosen as the most "average" district among existing ones in the perspective of population, area and location. Within the process of research work, information of about 180 pedestrian crossings located in this district was gathered. On the Figure 5 their positions were shown.

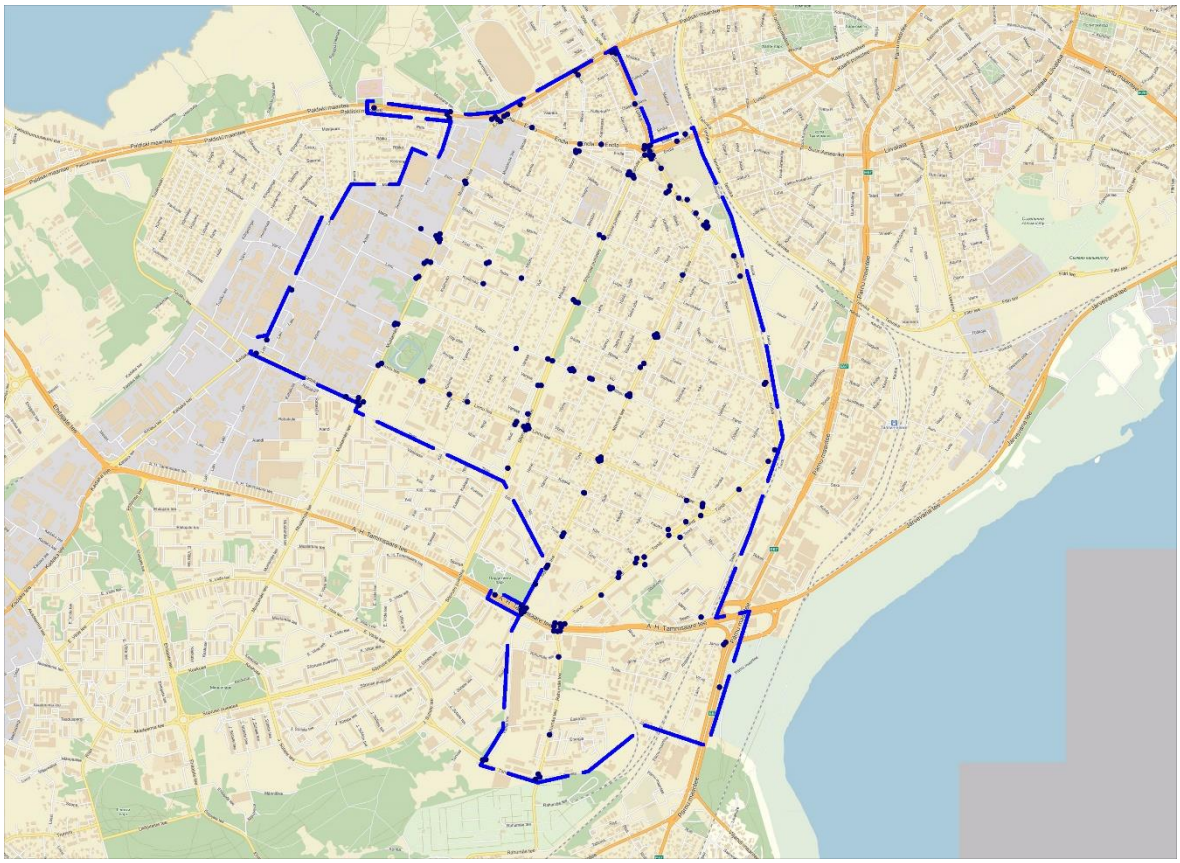

Fig. 5 – Location of all pedestrian crossings in the Kristiine district

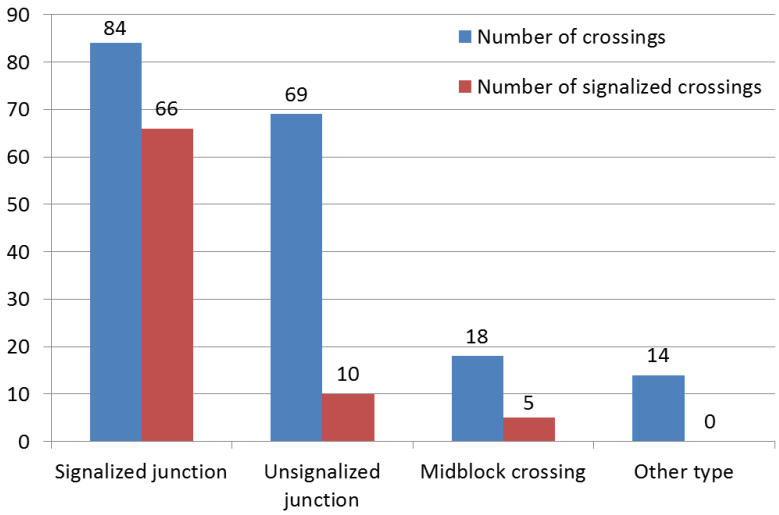

Fig. 6 – Number of crossings in the Kristiine districts by location types

Figure 6 presents the quantitative analysis of pedestrian crossing based on their type and

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location. As it is seen from this diagram, the main part of crossings in the research area are unsignalized and situated on the intersections. Figure 7 shows a topographic map with different type of pedestrian crossings: unsignalized ones are marked with blue color, signalized ones – with green color.

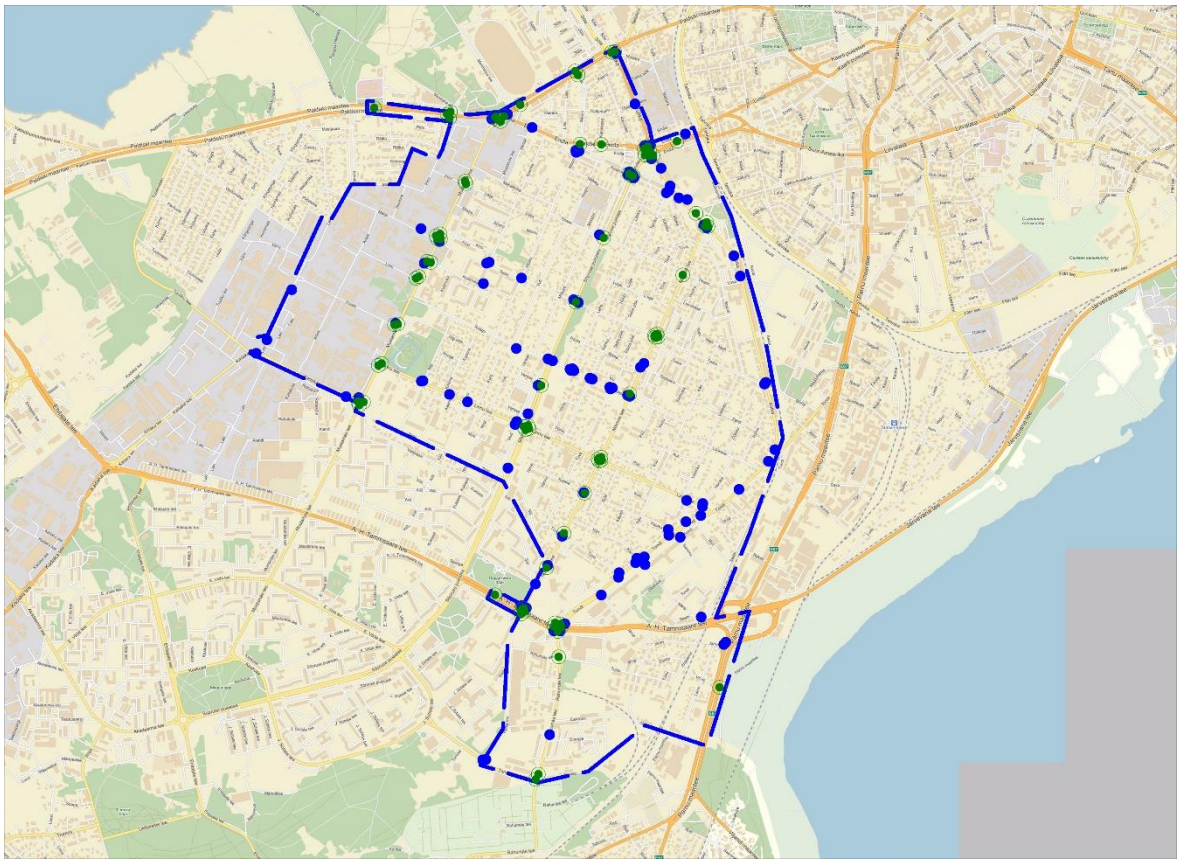

Fig. 7 – Location of signalized and unsignalized pedestrian crossings in the Kristiine district

As it was mentioned above, an amount of data about each selected facility was collected. This data presents mainly characteristics, which is necessary to know of risk calculation. Among them are location in WGS84 coordinate system, length of crossing, number of transport lanes, presence of central dividing strip or median islands, visibility of road users, visibility of road signs and traffic lights, availability of measures for improving pedestrian safety (such as additional lighting, road markings, humps, chicanes and other), etc.

4. ANALYSIS OF STUDY RESULTS

As it was mentioned above, the main aim of a case study was to carry out survey of pedestrian crossings in the Tallinn district and to assess their risks. This study was based on the above-described methodology and included collection and processing of data about regulatory documents and standards in the field of traffic organization, location of pedestrian crossings, its equipment and characteristics, analysis of transport infrastructure, estimation of traffic intensity in the Tallinn, estimation of accident rates on pedestrian crossings,

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calculation of risk rates based on various parameters of crossings. This work was done to get real results, which can help to detect potential "gaps" and problems on pedestrian crossings. Description of pedestrian crossing location was done above. To estimate accident rates, analysis of accident data was done. As a result, topographic map with different type of accident were created (Figure 8).

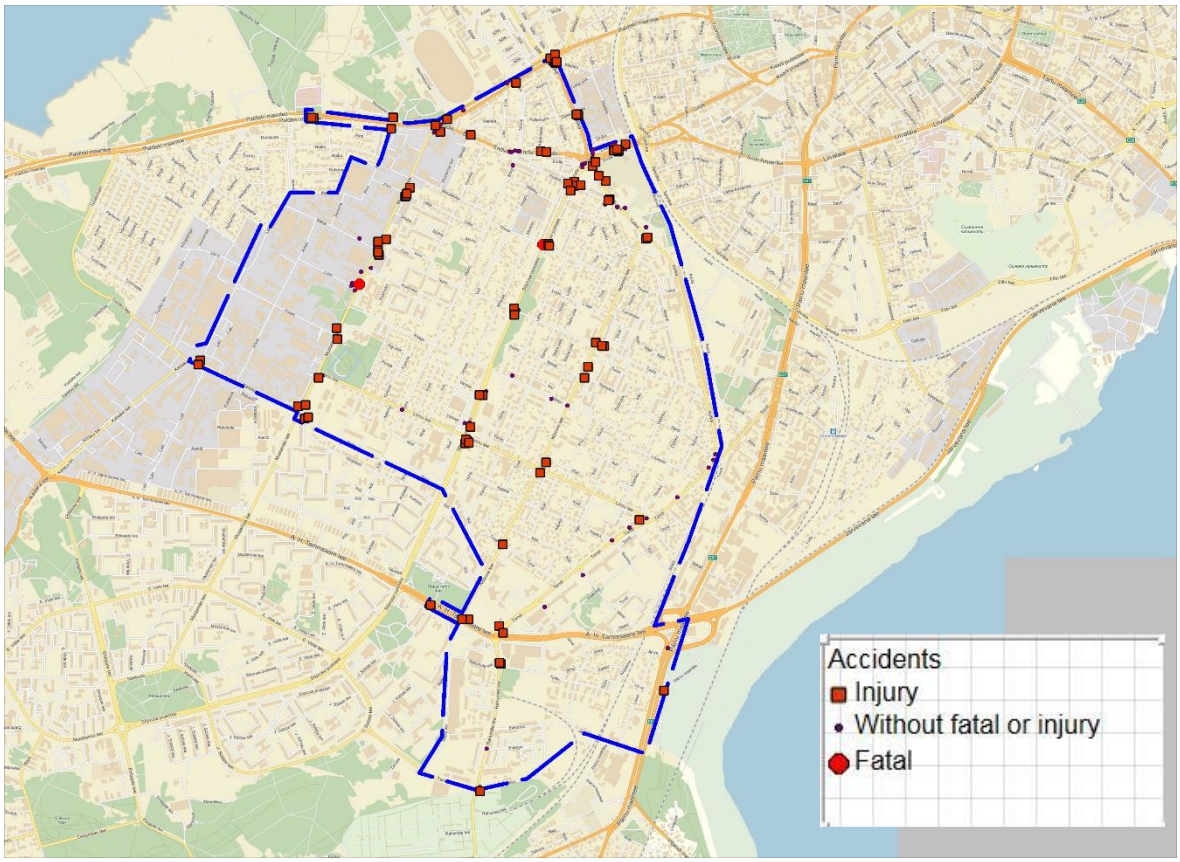

Fig. 8 – Accident rates on pedestrian crossing in the Kristiine district

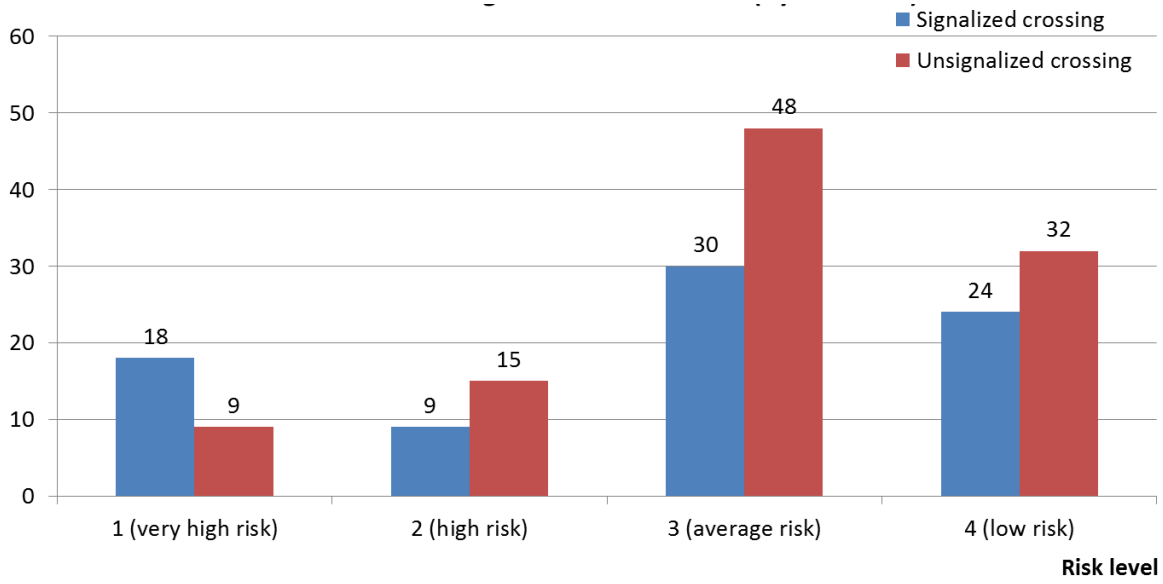

Fig. 9 – Risk levels of pedestrian crossing on Kristiine district

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Using all that data, the risk assessment of pedestrian crossings in the Kristiine district was done. Results of calculation are presented on the Figure 9 in form of risk levels/ safety level. They show quite high amount of pedestrian crossing with average risk level.
On the one hand, the method of risk assessment gives enough good results. On the other hand, such analysis revealed some difficulties in method application and there are possible ways for improving the calculation. For example, intensity of traffic and pedestrian flows is not involved in calculation, but it can have a great value in some cases.

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