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Crime in Lithuanian Cities in Relation to Urban Planning and Design Aspects

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***Abstract* – Crime is a social phenomenon, which is closely related to human behaviour, economics, urban planning and design. The detailed research of six blocks of houses in three Lithuanian cities (Kaunas, Vilnius and Panevezys) with the highest crime rates and the most heterogeneous crimes was performed. Space syntax method, crime prevention through environmental design (CPTED) and correlation analysis were applied. Research results demonstrate that thefts from cars, other thefts, crime against human health, robberies, small-scale hooliganism and intentional damage or destruction of property correlate with particular properties of urban spaces and design elements.**

***Keywords* – Crime, urban planning, urban design.**

Crime is a social issue, which is strongly related to economics and GDP [1], [2], [3], urban planning [4], [5], [6], [7] and urban design [8], [9]. The implementation of urban planning tasks, such as planning of land use can reduce crime. For instance, the inclusion of specialized areas and greenery into dense residential areas would contribute to crime prevention on streets, public lands should be combined with residential dwellings and greenery [10]. Streets with large-scale buildings (primarily commercial) can provoke increase in pickpockets. According to O. Newman [11] it can be expected to have less crime in low density, single use environments with restricted access to strangers. Contrarily, J. Jacobs [12] advocates the opposite: in open and perviously mixed use environments, both, strangers passing through spaces and inhabitants occupying them, form a natural guardianship mechanism which prevents crime. However, various researchers have revealed that different types of anti-social behaviour correlate with different urban spaces [6], [13]. B. Hillier and O. Sahbaz state that such factors as movement, land use and high and low activity patterns are all thought to be linked in a certain way to crime [6]. Abandoned areas are increasing the risk of crime, as they do not attract people. In turn, well-maintained urban spaces contribute to less crime. Crime prevention through environmental design (CPTED) supports and develops great ideas on crime prevention through urban design. For instance, CPTED supports various public art programs, which contribute to city life and use of public places. Lively public areas are considered to bring more natural surveillance by generating human activity and to make these areas safer. According to CPTED, parks are more vulnerable to crime if there is no access to help, if the maintenance and lighting are poor, if the park or some of its spaces are isolated, with confusing layout and poor visibility, if vandalism and abnormal users are present, as well as areas of concealment or ambush points. All these factors of urban design have to be under great attention while planning urban areas.

The criminogenic situation in Lithuanian cities in the context of European and other countries does not look well. According to the United Nations Office on Drugs and Crime [14] data about murders during 1995–2009 and other crimes during 2003–2009, where the average estimates of criminal activities prevalence (per 100 000 inhabitants) have been compared, Lithuania is:

- According to the level of prevalence of murders is the 70th (8.66) among 103 countries in the world context, and the 32nd among 38 European countries.
- According to the level of prevalence of robberies – the 93rd (127.70) among 120 countries in the world context, and the 37th among 43 European countries.
- According to the level of prevalence of thefts – the 75th (796.91) among 118 countries in the world context, and the 16th among 43 European countries.
- According to the level of prevalence of motor vehicle thefts – the 80th (120.29) among 115 countries in the world context, and the 23rd among 43 European countries.

In the research presented in this paper, urban planning is combined with CPTED principles for the analysis of crime. In Lithuania crime analysis is being performed mostly on the statistical data analysis level, without taking into account aspects of surrounding urban environment and design. The results of the research can be used for crime prevention in other cities, despite the fact that the research was based only on some particular urban areas.

I. Research Objects and Methods

Different types of crimes committed in Kaunas, Vilnius and Panevezys cities of Lithuania, were analysed. Six different blocks of houses with the highest crime rates and with the most heterogeneous crimes were selected for the detailed analysis at a micro scale. The three analysed blocks in Kaunas city include: 1) 5 – 9-storey residential buildings with flats where mostly families with juveniles and young families with smalls kids live (Baltijos Street); 2) commercial-industrial buildings with a few one and two family old residential houses (Raudondvario Street); 3) mostly old 5-storey residential buildings with flats built in Soviet times where a lot of old people live, with commercial objects located in the first row from the street (Varniu Street). The two analysed blocks in Vilnius city include: 1) the centre of the city, very lively street always full of pedestrians, cars and public transport, with a lot of commercial objects: cafes, hotels and shops (a part of Gedimino Street); 2) the area around the central bus station and train station, with a lot of pedestrians, private and public transport, a big and important

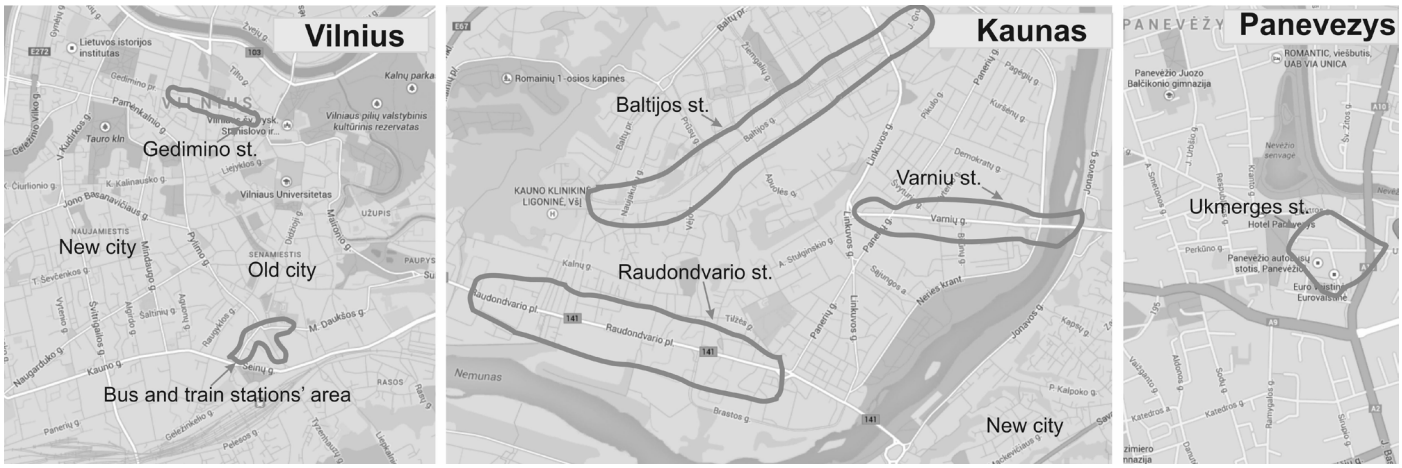

Fig. 1. Research objects in Kaunas, Vilnius and Panevezys cities, Lithuania [pictures: I. Matijošaitienė].

Fig. 2. **Left**: topological depth = 0; **Middle**: topological depth = 1; **Right**: topological depth = 2 [pictures: I. Matijošaitienė].

for the city transport node where a lot of routes intersect, with mostly various commercial and public buildings (Sodu, Pylimo and Bazilijonu Streets). The block analysed in Panevezys city: 1) the area around a big shopping mall IKI with mostly commercial and multi-storey residential houses with flats (a part of Ukmerges Street) (Fig. 1).

For all the research objects the data from registers of criminal acts according to the Code of Criminal (CC) and Administrative Rights Violations Code (ARVC) was selected (the data according to the ARVC is absent for Kaunas city). Amongst a big number of types of crime only crimes which happen in open public spaces more often were selected to be used for this research:

- Crimes against human health (CC);
- Thefts from cars (CC);
- Crimes against human sexual freedom and immunity (ARVC);
- Other thefts (CC);
- Robbery (CC);
- Intentional damage to or destruction of property (ARVC);
- Small-scale hooliganism (ARVC);
- Alcohol in public places and apparition while drunk (ARVC);
- Prostitution or repayable usage of the services (ARVC).

The data on these criminal acts represent the offenses committed during 2010–2011 in the cities under research. The following methods and theories were applied: space syntax, crime prevention through environmental design (CPTED), correlation analysis. The following software was used for the research: DepthMap, AutoCad, SPSS.

For each of the identified research blocks segment maps were prepared according to space syntax method [6]. According to the designed research method, each street segment was analysed at a micro-scale, considering both planning and design factors of the surrounding urban environment. The following factors were taken into account:

- Topological depth from private space to public space. If there is a direct entrance from a building onto the street the topological depth = 0 (Fig. 2). If there is another space (for instance semi-private space, like a mini garden or area with grass) the topological depth = 1 (Fig. 2). If there are two spaces separating the main space (street segment) from the building entrance, then the topological depth = 2. Two separating spaces can also form a case when the spaces are separated by almost or absolutely not transparent fence or hedge or another element (Fig. 2). Space is perceived in the research only in the case when a human standing at any inside corner of the space can see all other corners of this space. The space can be rectangular or multangular. Also, the schemes of topological depth for every street were drawn, where the street segment is presented as a white

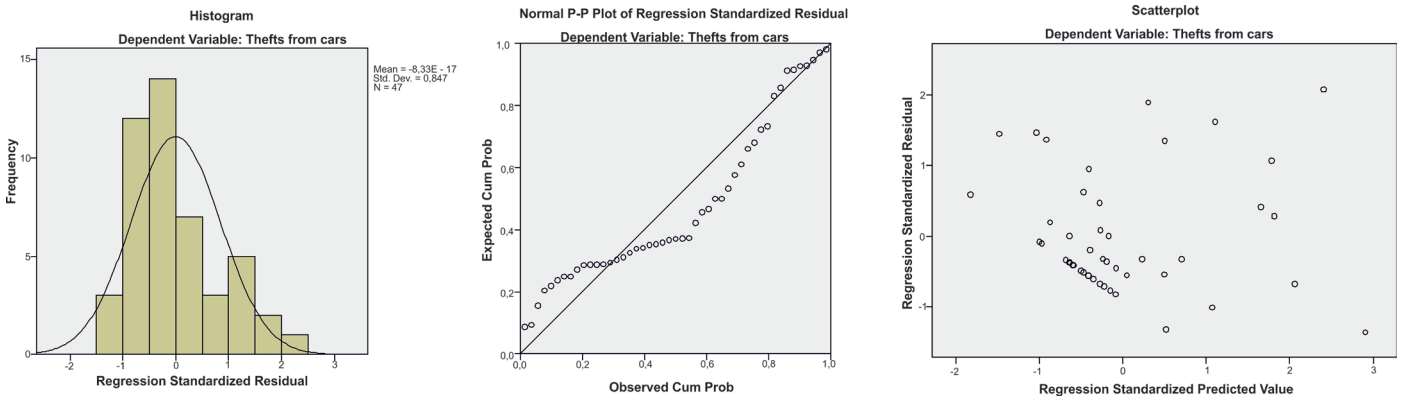

Fig. 3. Left: histogram of the standardized residuals; Middle: diagram of the standardized residuals P-P; Right: diagram of the distribution of standardized residuals – Thefts from cars [diagrams: I. Matijošaitienė].

rectangular, the space separating a building and a street segment is presented as a white circle, and the building is presented as a black dot. Segments, spaces and buildings are related by lines when there is a direct accessibility between them.

- Land use – for every street segment all applicable land uses were registered according to the city's master plan. The following land uses were registered: areas of one and two family houses, areas of block of flats, public use areas, industrial and storage areas, commercial areas, engineering infrastructure areas, common use areas, recreational areas.
- Number of doors and windows was counted. Only the windows and doors that have direct access to the street segment or are separated from the segment by a small grass-plot, were counted. Windows and doors that were more distant from the street segment, were not taken into account. Also, windows and doors were counted separately for residential, commercial, public and industrial buildings.
- Segment accessibility from buildings – a segment can be directly or indirectly accessible. If a street segment is directly accessible from at least one building, the segment is considered to be accessible from the building.
- Segment permeability – street segment can be intervisible or not intervisible according to the number of building entrances and windows that are visible from another side of the street. If there are entrances into the buildings from both sides of the street segment, and if a person standing at the entrance of the building on one side of the street can see the entrance of the building on the other side of the street, the segment is considered to be permeable. The same goes for the windows. Segment permeability for doors and windows is registered separately.
- Blind building walls. The absence or presence of blind walls (walls with no windows and doors) was registered.
- Dense and abandoned greenery. The absence or presence of dense and abandoned greenery on a particular segment was registered.
- Tree alleys on one or both sides of the street. The absence or presence of alleys was registered.
- Lighting. The degrees of lighting of segments were registered as follows: good lighting everywhere; lighting not everywhere; bad or no lighting.
- Objects of small architecture. The absence or presence of the objects of small architecture were registered.
- Graffiti. The absence or presence of graffiti was registered.

II. Results and Discussion

In this research we deal with nominal and scale variables. For scale variables both Spearman and Pearson correlations could be calculated, though for Pearson correlation the condition of normal distribution applies. Therefore, before starting the analysis the normality of the distribution was checked according to these parameters:

- Random errors are normally distributed random variables. The created histogram of the standardized residuals and diagram of the standardized residuals P-P (Fig. 3) show that the distribution of the standardized residuals is not consistent with the standard normal distribution. Also, the visual comparison of both histogram and diagram reveals the same fact. The averages of all random variables are equal to zero. Kolmogorov-Smirnov test (Table I) demonstrates that the compatibility hypothesis is rejected for all types of crime.
- The dispersions of all random variables are equal (homoscedasticity assumption). According to the diagram of the distribution of standardized residuals (Fig. 3) the distribution of the standardized residuals is not consistent with the standard normal distribution.
- All the random variables are independent. According to the analysis all the random variables are independent.
- The data shall not have the outliers. According to the results of the analysis the data does not have any residuals.

As we can see, the distribution is abnormal, therefore, for the correlation analysis of scale variables Spearman's rho correlation coefficient will be applied because if the relation between

TABLE I
ONE-SAMPLE KOLMOGOROV-SMIRNOV TEST [I. MATIJOŠAITIENĖ]

		Number of entrances in commercial buildings	Number of entrances in public buildings	Number of windows in public buildings	Number of entrances in industrial buildings	Number of windows in industrial buildings	Topological depth 0	Topological depth 1	Topological depth 2	Topological depth 3	Topological depth 4
N		47	47	47	47	47	47	47	47	47	47
Normal Parameters [a,b]	Mean	32.8511	0.1702	1.9149	0.3191	5.6596	0.8936	2.0638	1.6383	0.4468	0.0638
	Std. Deviation	47.82940	1.02828	10.66247	1.18149	16.78285	2.04550	2.59937	1.79886	0.99583	0.24709
Most Extreme Differences	Absolute	0.287	0.523	0.529	0.479	0.483	0.371	0.214	0.213	0.439	0.538
	Positive	0.287	0.523	0.529	0.479	0.483	0.371	0.212	0.213	0.439	0.538
	Negative	−0.246	−0.434	−0.429	−0.394	−0.368	−0.331	−0.214	−0.181	−0.327	−0.398
Kolmogorov-Smirnov *Z*		1.966	3.587	3.625	3.283	3.312	2.544	1.464	1.461	3.010	3.689
Asymp. Sig. (2-tailed)		0.001	0.000	0.000	0.000	0.000	0.000	0.027	0.028	0.000	0.000

[a] Test distribution is normal.

[b] Calculated from data.

variables is not linear Pearson correlation coefficient might not be able to define this relation. Spearman's rho correlation coefficient is a non-parametric measure of statistical dependence between two variables. It assesses how well the relationship between the two variables can be described using a monotonic function. If there are no repeated data values, a perfect Spearman correlation of +1 or −1 occurs when each of the variables is a perfect monotone function of the other. For instance, when *X* is increasing, *Y* monotonously increases (not necessarily linearly) or decreases.

The calculated higher correlations (though these are close to moderate, moderate, higher than moderate and high values of correlations) are shown in Table II. Almost all the relations presented in the table are significant at the 0.01 level. From the table we can see, that with the increase of number of topological depth 2 in a certain urban space, the thefts from cars increase too; with the increase of number of topological depth 1, the crimes against human health also increase; the number of other thefts increases with the increase of number of windows in industrial buildings, that surround the certain urban space where the crime is committed; and the number of committed small-scale hooliganism crimes increases with the increase of the number of entrances and doors in commercial buildings, that surround the place of the committed small hooliganism. There are strong correlation values between the damage of property and the number of entrances and windows to residential buildings. That means that with the decrease of number of entrances and windows to residential buildings the number of crimes, when the property is damaged or destructed intentionally, increases, and vice versa. The strongest relations are shown graphically in Fig. 4. Thefts from cars happen more often on the street segments, which have bigger number of topological depth 2. In this case, buildings have no direct entrances to the main street, there are two spaces between the main street and the entrances. Therefore, there is no direct access and surveillance of the main street from building entrances. The same goes for the crimes against human health. They are more common on streets where building entrances are one space away from the main street. Again, here we observe less natural surveillance from the building dwellers, but on the other hand more surveillance from pedestrians walking on the main street. Commercial objects often attract hooligans. That is why the bigger the number of doors and windows in commercial objects faces the higher the rate of hooliganism there. The factor of natural surveillance plays an important role in the case of intentional damage to or destruction of property. A smaller number of windows and doors from residential houses to an urban

TABLE II
SPEARMAN'S RHO CORRELATION COEFFICIENT VALUES [I. MATIJOŠAITIENĖ]

Urban factors ➡ / Crime types ⬇	Topological depth 1	Topological depth 2	Number of windows in industrial buildings	Number of entrances to commercial buildings	Number of windows in commercial buildings	Number of entrances to residential buildings	Number of windows in residential buildings
Thefts from cars		0.531** 0.000					
Crime against human health	0.395** 0.006						
Other thefts			0.416** 0.004				
Small-scale hooliganism				0.535** 0.000	0.466** 0.003		
Intentional damage to or destruction of property						−0.702* 0.016	−0.808** 0.000

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

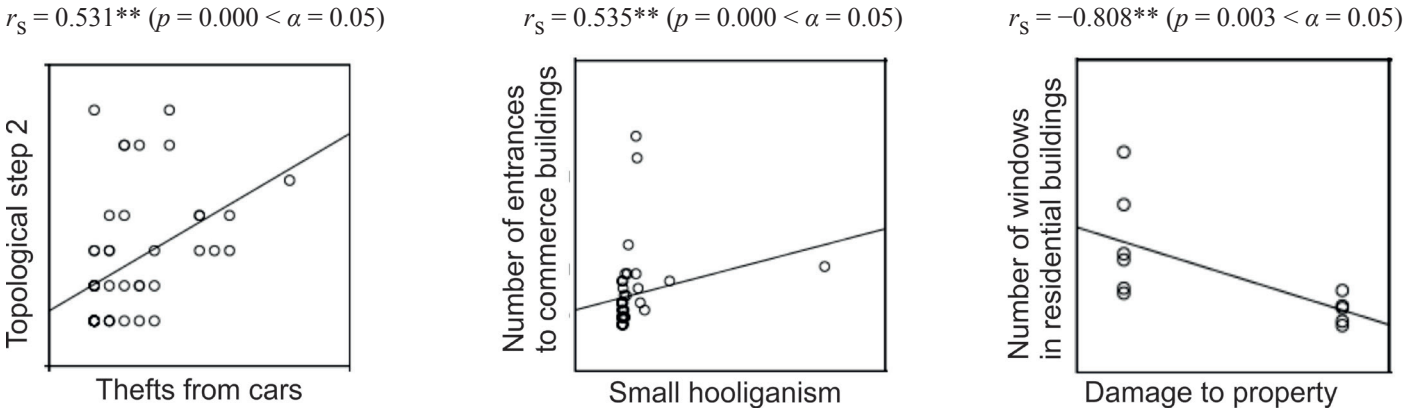

Fig. 4. Scatter plots representing relationships between some types of crime and planning factors of urban environment [diagrams: I.Matijošaitienė].

space means less natural surveillance, and accordingly it means more freedom for the damage to and destruction of property when nobody sees the criminals.

Correlation analysis also reveals that thefts from cars are related to the small-scale hooliganism ($r_S = 0.525^{**}$, $p = 0.000 < \alpha = 0.05$), thefts from cars are related (negative relation) to the crimes against human health ($r_S = -0.499^{**}$, $p = 0.001 < \alpha = 0.05$), and small-scale hooliganism is related to alcohol consumption in public places and apparition while drunk ($r_S = 0.780^{**}$, $p = 0.005 < \alpha = 0.05$).

For the identification of relations between nominal variables (land use, segment intervisibility, design properties of urban spaces) and scale variables (number of types of crime) Eta correlation analysis was applied. A measure of association Eta ranges from 0 to 1, with 0 indicating no association between the row and column variables and values close to 1 indicating a high degree of association. Eta is appropriate for a dependent variable measured on an interval scale (interval and ratio variables are combined in the scale variable in SPSS) and an independent variable with a limited number of categories (for example, residential or commercial land use). Small correlation is being observed at $\eta^2 \sim 0.02$, medium correlation is when $\eta^2 \sim 0.13$, large correlation is when $\eta^2 \sim 0.26$. Only significant correlations ($p < 0.05$) between various types of crime and urban/design properties of spaces are shown in the Table III.

The calculated Eta squared correlation coefficient values (Table III) reveal that on the level of large relations more other type of thefts happen in industrial land use areas, more robberies happen in common use areas (for instance, green areas), and more small-scale hooliganism happens in non-intervisible areas (having in mind intervisibility of doors). On the level of medium relations more crime against human health happens in

TABLE III
ETA Squared Correlation Coefficient Values [I. Matijošaitienė]

	Public land use	Industrial land use	Common use land use	Recreational land use	Intervisibility (doors)	Intervisibility (windows)	Blind walls	Dense abandoned greenery	Trees on one or both sides of street	Small architecture
Crime against human health	0.126 $p = 0.014$			0.094 $p = 0.036$						0.184 $p = 0.003$
Other thefts		0.227 $p = 0.001$	0.149 $p = 0.007$							
Robbery			0.399 $p = 0.000$							
Thefts from cars					0.098 $p = 0.033$		0.147 $p = 0.008$	0.127 $p = 0.014$	0.091 $p = 0.039$	
Small-scale hooliganism					0.243 $p = 0.001$	0.104 $p = 0.045$				

Large correlations

Medium correlations

public areas and close to small architecture objects, more other type of thefts happen in common use areas, more thefts from cars happen in spaces with blind walls and dense abandoned greenery facing these spaces, more small-scale hooliganism happens in non-intervisible areas (having in mind intervisibility of windows). That seems true because people mostly gather and spend their leisure time in common use areas (parks, forests etc.), therefore, the places of their gatherings become good targets for robbers and thieves. Also, people spend a lot of time in public areas and gathering close to the objects of small architecture. That explains why public areas and areas with small architecture are more vulnerable to crime against human health. Spaces with blind walls and dense abandoned greenery attract thefts from cars because these areas are hidden from natural surveillance. According to CPTED, human eyes on the street form natural surveillance. Spaces that are non-intervisible from doors and windows attract small-scale hooligans because they probably are not seen or stopped by observers from the other side of the street while they are committing the crime on the opposite side of the street.

Conclusion and Recommendations

According to the results of the research, major number of crimes depends on urban planning and design properties of urban spaces. Therefore, for each type of crime, which correlates with these properties, recommendations for crime prevention are developed.

Thefts from cars. To reduce or avoid thefts from cars, the number of topological steps 2 from the parking place should be as few as possible, i.e. cars should not be parked on street segments where entrances into the buildings are two spaces away from the parking places (Fig. 5 A). Also, cars should not be parked close to blind walls and dense abandoned greenery. According to CPTED, street art should be used for blind walls in order to reduce or prevent crime (Fig. 5 D). Street art makes areas more pleasant, lively and provide kind of eyes on the street.

Crime against human health. If a person wants to avoid crime against his or her health he or she should not walk on street segments with big number of topological steps 1, i.e., street segments where entrances into the buildings are one space away from the walking path should be avoided (Fig. 5 B). Also, public land use areas and areas with small architecture objects are targets for crime against human health. People cannot avoid using these areas, they just have to be more careful while walking there, especially during dark hours.

Other thefts. The risk of committing other theft is less if more mechanical and natural surveillance is provided in industrial and common use areas. Also according to the research, the number of windows in industrial buildings should be reduced if possible. Probably the presence of industrial buildings by itself contributes to a bigger number of other thefts in the surrounding area.

Robbery. Every day majority of city dwellers and guests occupy common use areas (parks, forests etc.) and make themselves a good target for robbers. To avoid or decrease robberies in common use areas more mechanical, natural and organizational security should be provided.

Small-scale hooliganism. According to the research, areas with commercial objects are vulnerable to small-scale hooliganism. More mechanical and natural security should be provided on doors and windows of commercial objects. Having in mind

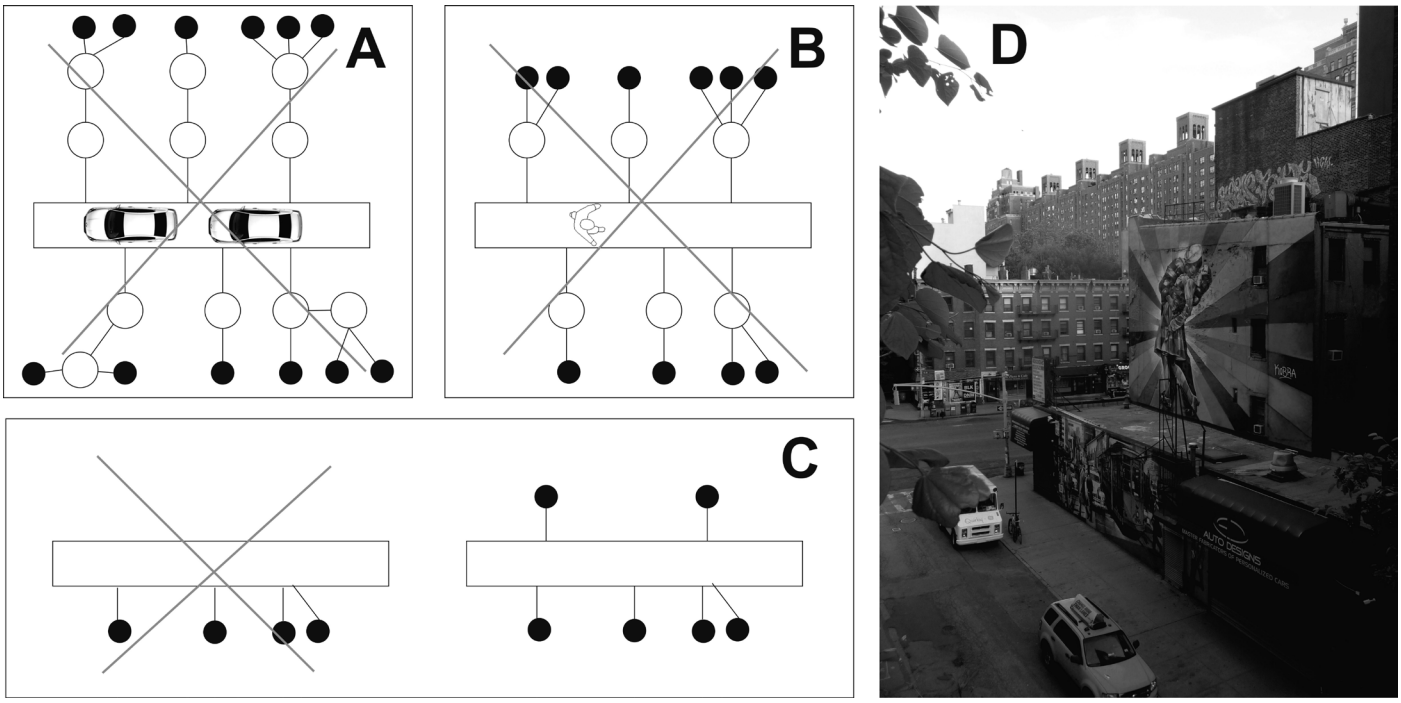

Fig. 5. Recomendations for urban planning for crime prevention: 1) to avoid or reduce thefts from cars, the cars should not be parked on the street segments with big number of topological steps 2; 2) to avoid or reduce crime against human health, pedestrians should avoid walking on street segments with big number of topological steps 1; 3) to avoid or reduce small-scale hooliganism, street segments should be intervisible from doors and/or windows [pictures: I. Matijošaitienė].

all the types of buildings, street segments should be made intervisible from the doors and windows (Fig. 5 C). That would create more natural surveillance in the streets, and accordingly more natural protection.

Intentional damage to or destruction of property. To avoid or reduce intentional damage of property or destruction of it residential buildings should have more windows and doors facing urban spaces. More doors and windows mean more eyes to a space, and more natural surveillance.

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