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Sustainable City – A City without Crime

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Abstract. **The focus of this research is to check if urban crime is related to the social spatial urban structure and to identify the most unsafe territories in the city of Klaipeda from the point of view of crime and urban structure. Space syntax theory and method, as well as correlation analysis have been used for this purpose. The research results have revealed that all types of crimes depend on global integration and global depth: the more integrated and shallow the open public spaces are the more crime incidents in these spaces happen.**

Keywords: **crime, space syntax, urban structure.**

The concept of sustainable development requires using the possibilities and potentials of environment maximally. Contemporary urbanism looks at the social, economic, cultural contents of the city as a primary and urban form and as secondary aspects of city planning. Despite the above-mentioned orientation of planning towards social determinism, the analysis of urban spatial structures plays an important role in understanding and prediction of human behaviour. Human behaviour in open public spaces can be described as movement to and movement through the spaces. The intensity and character of movement, assessed by using the space syntax method, enable us to identify the foreground and background of urban pattern. This stage of the research has also revealed that some public spaces are safer than others. The hypothesis of the research is that *urban crime is closely related to urban structure*. The authors seek to identify how urban spatial pattern correlates and affects urban crime. The objective of the proposed research is formulated while having in mind the alienation of society and bad criminogenic situation in Lithuanian cities. Results of the proposed project will allow implementing the sustainable urban development in Lithuania more effectively, to realise the social spatial reasons of urban crime and identify the earlier urban mistakes.

The research presented in this paper is based on the *space syntax* theory and method [1], [2]. Space syntax is about identifying, representing, and measuring the social spatial relationships in our built environment [3]. Such research of urban crime through the social spatial structure of a city by the application of space syntax method has never been conducted in Lithuania. Though, in the UK (B. Hillier, J. etc.), USA (J. Peponis, A. Carpenter etc.), as well as in Brazil, Turkey, Germany, Holland, Denmark, and Poland, the space syntax method is more frequently used to analyse the urban crime and make forecasts. B. Hillier and O. Sahbaz conducted thorough research of crime and urban structure in London [4]. A. van Nes and M.J.J. López applied this method for the analysis of relation between urban social spatial structure and thefts from cars in some Dutch cities [5], [6]. C. Monteiro and C.P. Iannicelli analysed the relation between robberies and thefts and urban structure of the city of Recife in Brazil [7]. A. Awtuch investigated the dependence of safety in residential blocks and spatial urban structure in Gdansk, Poland [8]. E. Friedrich with colleagues conducted research of anti-social behaviour through the prism of urban configuration [9].

B. Hillier, who is one of the co-founders and developers of space syntax theory and method, proposed using the space syntax model to link crime activity to the patterns of activity and movement in urban structure, and to identify properties of the urban structure, which may have an impact on crime in cities [10]. According to B. Hillier and O. Sahbaz, such factors as movement, land use and high and low activity patterns are to be linked in some way to crime [4]. According to these scholars, urban crime could be reduced by the presence of pedestrians on the streets and the higher number of entrances from residential houses to the streets. From one point of view, this statement could be true since the more people pass the street the more it is controlled. For criminals it would be harder to commit a crime in a public space, which is observed by passengers and inhabitants of surrounding buildings. On the other hand, overcrowded streets can be a good target for pickpockets. Therefore, it is necessary to analyse the effect of urban structure on the different types of crime separately.

The investigation of crime and its prevention in Lithuanian cities are carried out by the Institute of Law and some Lithuanian universities. Most usually they seek to ascertain a statistical situation and tendencies, whereas the territorial coherence is studied more on a level of the whole city or its large territorial parts without linking the research result with spatial properties of a certain territory. Space syntax enables us to investigate relations between urban structure and crime in a city, then to reduce crime by restructuring urban open public spaces. This new approach to urban crime through the prism of urban planning will let us not only analyse the present situation, but also forecast crime reduction/increase in various urban patterns.

I. Research Object and Methods

Klaipėda, the third largest Lithuanian city that is situated on the coast of the Baltic Sea, is the research object. The city occupies the area of 110 km^2, and it has about 161 300 inhabitants. According to the statistical data [11], Klaipėda remains one of the leaders having in mind the number of robberies, thefts, public nuisance and murders in Lithuania. Taking into account the number of all types of crime occurred in Klaipėda during 2008–2010, it has the second-highest crime rate in Lithuania after Vilnius. For the research, the data of 2010–2011 on various types of crime in Klaipeda has been analysed: destruction or damage of property, public nuisance, thefts, crimes against a person, explosives, other crimes.

For the analysis of urban structure of Klaipėda, the *space syntax* method has been applied. According to the method, open public spaces (streets, squares, pedestrian paths, etc.) are crossed by axial lines. Thus, the axial maps need to be prepared. The axial maps consist of the "longest and fewest straight lines that go through all convex spaces and make all axial links" [12], [13]. The axial structure is one-dimensional and it "describes the

TABLE 1

Kendall's Tau_B Correlation Coefficient Values (weak correlations are marked with grey colour)

	Connectivity	**Control**	**Depth**	**Fast choice**	**Global integration**	**Local integration R2**	**Local integration R3**
Destruction or damage of property	0.139**	0.061**	-0.186**	0.095**	0.226**	0.129**	0.134**
Public nuisance	0.138**	0.058**	-0.201**	0.066**	0.235**	0.136**	0.149**
Thefts	0.150**	0.067**	-0.180**	0.087**	0.223**	0.142**	0.145**
Crimes against a person	0.131**	0.064**	-0.188**	0.069**	0.232**	0.123**	0.133**
Explosives	0.088**	0.041*	-0.110**	0.066**	0.146**	0.089**	0.100**
Other crimes	0.137**	0.059**	-0.214**	0.062**	0.244**	0.141**	0.155**
All the crimes	0.126**	0.041*	-0.227**	0.038*	0.283**	0.151**	0.175**

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)

TABLE 2

Spearman's Rho Correlation Coefficient Values (weak correlations are marked with grey colour)

	Connectivity	**Control**	**Depth**	**Fast choice**	**Global integration**	**Local integration R2**	**Local integration R3**
Destruction or damage of property	0.162**	0.078**	-0.242**	0.121**	0.297**	0.164**	0.175**
Public nuisance	0.168**	0.078**	-0.270**	0.088**	0.319**	0.181**	0.202**
Thefts	0.180**	0.088**	-0.240**	0.113**	0.300**	0.187**	0.195**
Crimes against a person	0.155**	0.083**	-0.247**	0.089**	0.310**	0.160**	0.176**
Explosives	0.097**	0.049*	-0.134**	0.079**	0.182**	0.107**	0.124**
Other crimes	0.170**	0.080**	-0.291**	0.082**	0.335**	0.190**	0.212**
All the crimes	0.156**	0.056*	-0.314**	0.051*	0.394**	0.205**	0.243**

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)

degree to which any space extends linearly" [12]. It gives us the information about where we may go in the system. Axiality is more related with movement inside the town. According to the method, connectivity, control, global depth, fast choice, global integration, local integration R2 and local integration R3 maps have to be prepared for the social spatial analysis of urban structure of Klaipėda.

Connectivity is a local characteristic, which enables us to know about the direct connection of spaces. Connectivity is defined as the number of nodes that connect directly to a given node [14].

Control measures the degree of control, when one axis controls the entrance to and from other axes, which are directly linked.

Depth defines the number of steps from any node to any other node [14]. Depth is related to the integration. According to B. Hillier, the integration of axial lines correlates well with the number of pedestrians found to be walking along the axial line [15]. Integration measures how easily accessible a node is from other nodes in the system [14]. Integration can be measured at a global scale – having in mind that a person can reach all the segments in the system (Rn), and at a local scale – when a person has to make one turn to reach the segment (R1), two turns (R2) and so on.

Fast choice shows how many times an axis is used in comparison with all the shortest paths.

To assess the relations and the strength of relations between various types of crimes and urban structure of Klaipėda, the correlation analysis has been applied. The variables describing the number of crimes on the streets and social spatial characteristics of urban structure (connectivity, control, depth, etc.) are scale. Therefore, Kendall's tau_b and Spearman's rho correlation coefficients have been calculated. Kendall's tau-b correlation coefficient is used to measure the association between two measured quantities. Kendall's tau-b, unlike tau-a, makes adjustments for ties and is suitable for square tables. In our case, we have 7x7 table (according to the number of variables), thereby the table is square. Values of Kendall's tau_b range from –1 to +1. Spearman's correlation coefficient (Spearman's rho) is a non-parametric measure of statistical dependence between two variables. It assesses how well the relationship between two variables can be described using a monotonic function. If

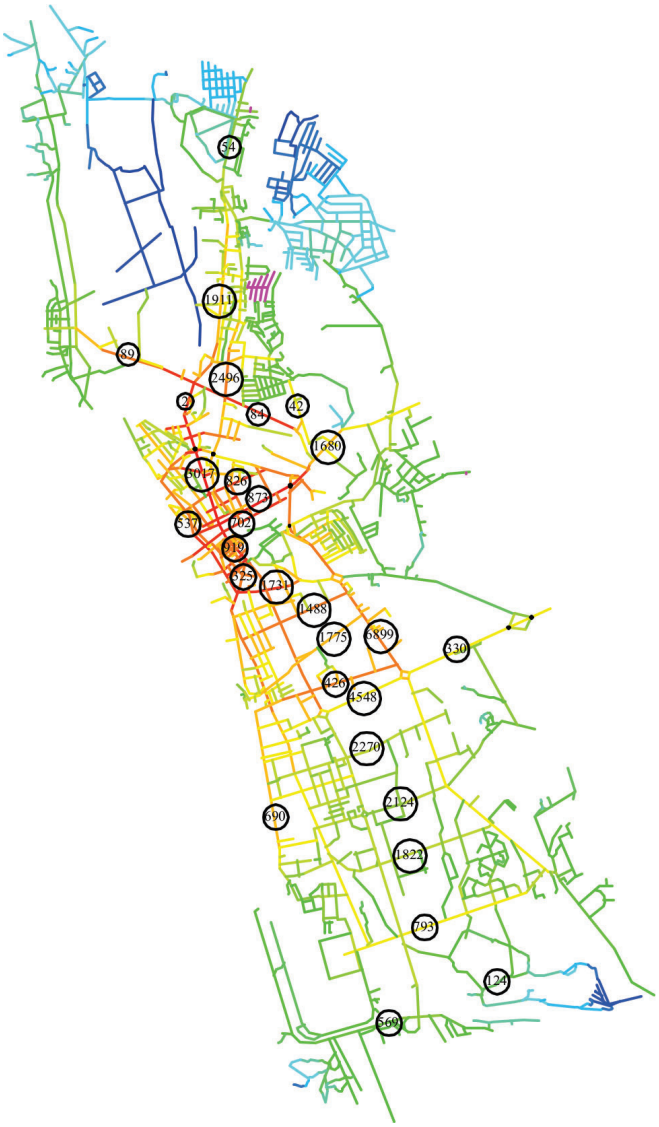


Fig. 1. Global integration of Klaipėda

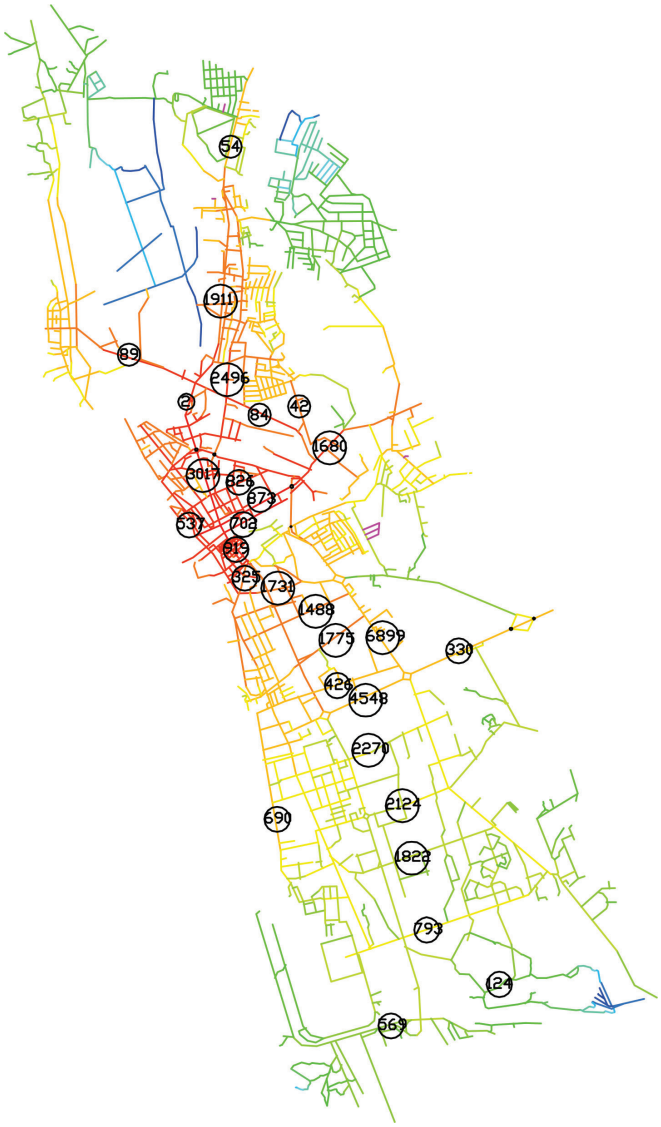


Fig. 2. Global depth of Klaipėda

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 increases, Y monotonously increases (not necessarily linearly) or decreases. For the both correlation coefficients, the correlation can be:

- very strong, when the value is –1 or +1,
- strong, when the value is from –1 to –0.7 or from +1 to +0.7,
- moderate, when the value is from –0.7 to –0.5 or from +0.7 to +0.5,
- weak, when the value is from –0.5 to –0.2 or from +0.5 to +0.2 and
- very weak, when the value is from –0.2 to 0 or from +0.2 to 0.

A value of 0 indicates the absence of relation.

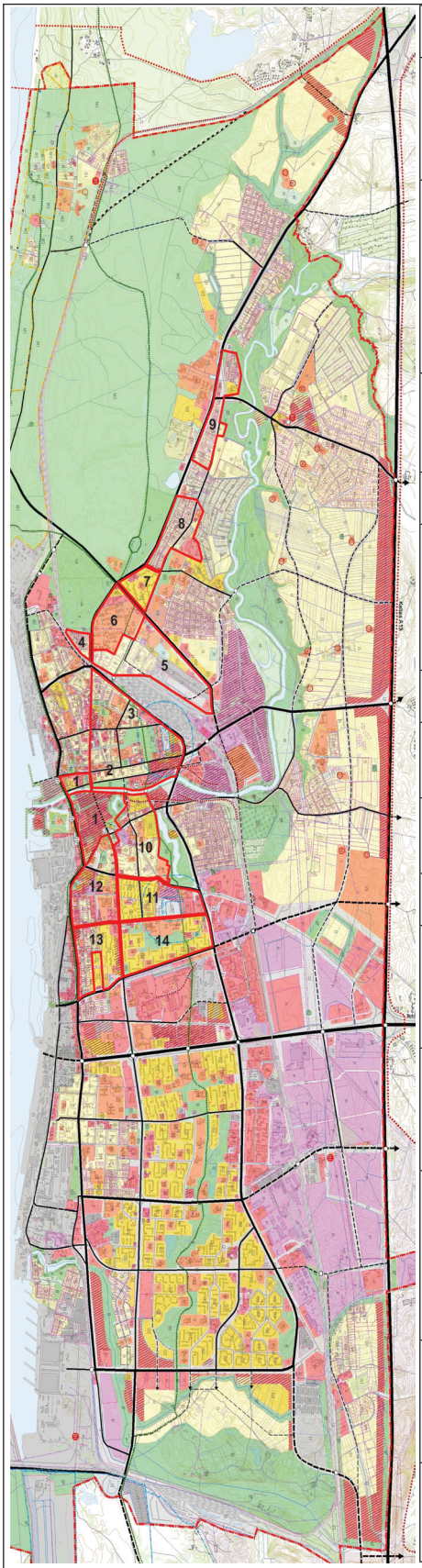
II. Results and Discussion

The axial maps of Klaipėda have been prepared and analysed: connectivity, control, global depth, fast choice, global integration, local integration R2 and local integration R3. Then the axial maps have been covered with the maps of the data on the number and location of various types of crime.

Calculation results on Kendall's tau_b correlation coefficient values (Table I) demonstrate that there is a weak relation between all the types of crime, except explosives, and global integration. Also there is a weak negative relation between public nuisance and depth r_{tau_b}=-0.201 (p=0.000<α=0.05), other crimes and depth r_{tau_b}=-0.214 (p=0.000<α=0.05). The calculation results of Spearman's rho correlation coefficient (Table II) reveal weak negative relations between all the types of crimes, except explosives, and depth. Also there are weak relations between all the types of crimes, except explosives, and global integration. According to Kendall's tau_b and Spearman's rho correlation coefficients, there are very weak relations between connectivity, control, fast choice, global integration, local integration R2, local integration R3, and all the analysed types of crimes.

The prepared maps of global integration (Figure 1) and global depth (Figure 2) of Klaipėda reveal potentially the most and the least dangerous open public spaces from the point of view of crime and urban structure. Hot colours (red, orange, and yellow)

TABLE 3
COMPARATIVE ANALYSIS OF THE MOST UNSAFE PARTS OF KLAIPĖDA



Name and number of city part	Land use	Detailed description
Old Town (1)	Commercial Public Green areas Residential (very few) Infrastructural (very few)	Commercial lands occupy the most part of this area
New Town (2)	Residential (blocks of flats and private houses) Commercial Public Green areas Recreational Industrial Infrastructural	Mixed land use. There are very few private houses
Lietuvninkai (3)	Residential Public Commercial Green areas	Blocks of houses and commercial buildings occupy the most part of this area
Pušynas (4)	Residential (blocks of flats)	Private residential houses and 2-3 storey residential houses
Kretinga (5)	Residential (blocks of flats and private houses) Public Infrastructural Commercial (very few) Green areas (very few)	Blocks of houses occupy the most part of this area. There are very few private houses. In general, it is a mixed land use area
Universitetas (6)	Public	Public lands occupy the most part of this area
Miškas (7)	Residential (private houses) Commercial (very few) Public (very few)	It is a prestigious part of Klaipėda. 5-12 storey residential houses dominate here
Mažasis kaimelis (8)	Residential (blocks of flats) Commercial (very few) Public (very few)	One of the most prestigious parts of Klaipėda city. Luxurious private houses dominate here
Liepoja (9)	Residential (blocks of flats) Commercial (very few)	1-3 storey residential houses dominate
Baltikalnė (10)	Residential (private houses and blocks of flats) Public Commercial Industrial	Block of flats occupy the most part of this area
Rumpiškė (11)	Residential (private houses) Commercial Industrial Infrastructural Public (very few)	In the Western part 5- and some 9-storey blocks of flats are situated. In the Eastern part of Rumpiškė commercial, idunstrial and infrastructural areas dominate
Birutė (12)	Residential (private houses and blocks of flats) Commercial Industrial Public Infrastructural Green areas	In the Easthern part 5-storey blocks of flats dominate. In the Western part there are mixed land use areas and various buildings: 2-3 storey residential houses, storehouses, garages, scholastic institutions and various companies
Vėtrungė (13)	Residential (private houses and blocks of flats) Commercial Public Infrastructural (very few)	Residential lands occupy the most part of this area
Kaunas (14)	Residential (private houses) Green areas Public Commercial	Private houses occupy the most part of this area

Fig. 3. Master plan of Klaipėda [16]

mean very integrated spaces on the global integration map, as well as shallow spaces on the global depth map – in other words, the foreground network of high-activity linked centres. According to the correlation analysis, these spaces have the highest crime rates: the more a space is integrated and shallow the more accidents happen there. Cold colours (blue, dark green, etc.) mean low integrated or disintegrated spaces on the global integration map, as well as deep spaces on the global depth map, i.e., the background network of lower activity spaces. These spaces have the lowest crime rates according to the correlation analysis. The number of crime incidents is presented in the circles for some streets.

The research has revealed the foreground network of spaces with more people activity and movement (marked with hot colours on both maps), which have the highest crime rate and, accordingly, are unsafe for inhabitants and passengers. In the case of Klaipėda, these dangerous city parts are the Old and New Towns, Lietuvninkai, Pušynas, Kretinga, Universitetas, Miškas, Mažasis kaimelis, Liepoja, Baltikalnė, Rumpiškė, Birutė, Vėtrungė and Kaunas districts, Šiaurės and Šilutės avenues, as well as Liepojos, Mokyklos, Kauno and Dubysos streets. The comparable analysis of these city parts is proposed in Table III. These urban parts and streets have evolved into very integrating and shallow open public spaces. It may be the reason of their unsafety. However, other factors, such as land use, street segment length and angle they intersect with each other, etc., may also affect the urban crime. The analysis of these factors is the objective of our further research.

The analysed Šiaurės and Šilutės avenues, as well as Liepojos, Mokyklos and Dubysos streets are B category streets, and Kauno street is C category street. There is very intensive traffic on these streets.

It is worth mentioning that not the whole area of the above-mentioned parts of Klaipėda are dangerous. Unsafe areas are layered by the foreground of global integration and global depth maps. Despite the fact that almost all the most unsafe parts of Klaipėda include residential, public and commercial land use, we can not conclude that the land use increases the rate of urban crime. It is logical that residential, public and commercial lands attrack more people – inhabitants and passengers. As we may know, the more people pass the space the more accidents may happen in this space. On the other hand, in the space with more eyewitnesses it becomes more difficult to commit a crime. Hereby, for the more detailed analysis and identification of urban factors, which influence crime incidents in cities, we need more detailed data on the urban crime and existing urban structure.

Conclusions

According to the research results, all types of crime depend on such spatial characteristics of urban structure as global integration and global depth. Therefore, for the further research of urban safety through urban structure we should use the maps of global integration and global depth.

The correlation analysis has revealed that the more integrated and shallow the open public spaces are the more crime incidents in these spaces happen, i.e., the foreground network of the city is more dangerous from the point of view of all the analysed types of crime, and background network is more safe.

The parts of Klaipėda that have potentially high crime rates are the Old and New Towns, Lietuvninkai, Pušynas, Kretinga, Universitetas, Miškas, Mažasis kaimelis, Liepoja, Baltikalnė, Rumpiškė, Birutė, Vėtrungė and Kaunas districts, Šiaurės and Šilutės avenues, as well as Liepojos, Mokyklos, Kauno and Dubysos streets.

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