TOWARDS A STRATEGY FOR SAFETY-ORIENTED URBAN STRUCTURE

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Abstract

The paper represents analysis and modelling of urban spaces through their topological properties in order to make them safer in terms of robberies, larceny and motor vehicle thefts, stolen properties, weapons and drugs. The research is performed on a macro-scale in the city of New Haven, Connecticut, USA. The topological properties of streets were calculated and analyzed by the application of space syntax method and DepthMap software, GIS and SPSS. The results are explained in the terms of people movement and presence on the main streets which are on the natural search paths of possible criminals, and which on the other hand have been assigned to a greater surveillance effect from movement.

Keywords: Crime, GIS, space syntax, urban space, urban structure

Introduction

The technique of strategic planning has been applied to manage various human activities in cities. Strategic urban planning is strongly related to the city dwellers, where the main goal is to enhance their life quality and satisfy their needs and requirements (Mirza, 2010). Urban crime is the well-known factor which reduces life quality of city dwellers. Therefore, the important task of crime prevention is highlighted in strategic planning of many cities all over the world.

In environmental criminology it is widely established that the crime is closely related to the urban environment in which it happens. In environmental criminology greater attention is paid to the places where the crime was committed. As the experience on crime investigations shows criminals are most likely to commit a crime near their living place or on the paths which connect major activities places (shopping, leisure etc. places). For instance, as the results of M. Lopez's and A. van Nes's (van Nes & Lopez, 2010) research show, "most residential burglaries took place in the most segregated and unconstituted streets that lay within a radius of 2.1 km from a burglar's home address". Australian institute of criminology resource says that "most burglars (77%) travelled away from their home suburb to do their work, travelling an average of five kilometers to their target" (Ratcliffe, 2003). According to B. Hillier and O. Sahbaz (2009), "picking pockets is easier in crowded high streets, street robbery is easier when victims come one at a time, burglary is helped by secluded access, and so on". The above stated facts shows that the location of committed crimes is related to a certain place. Understanding the relation between the place and the crime can help us analyze, forecast and predict the crime, and therefore, to make the right decisions in a strategic planning of the city.

The research of various groups of crime on a macro-scale is being implemented in New Haven (Connecticut, United States of America). Research at a macro-scale means taking into account the distribution of crimes and the topological features of street network in the whole city. Crime data registered by the Police Department of New Haven during the last five years (since 2009) (New …, 2013) was used for the research. The following topological features of street network were taken into account: robberies, larceny thefts, motor vehicle thefts, stolen property, weapons and drugs were analyzed on a macro-scale. Robberies amount 1.18% of all crimes committed in New Haven during the last five years, larceny thefts amount 6.91% of all crimes, motor vehicle thefts amount 5.78% of all crimes, stolen properties amount 2.29% of all crimes, weapons amount 1.05% of all crimes, drugs amount 2.73% of all crimes. New Haven is the second largest city in the state of Connecticut, with the population about 130,741 (according to Census Bureau data of July 1, 2012) and the area of 52.1 km^2. A large part of the city is built up with Yale University buildings, laboratories, offices and dormitories.

I.
Methodology

Space syntax method with the combination of Geographical Information Systems (GIS), as well as Statistical Package for the Social Sciences (SPSS) were used for the implementation of this research. First, segment map of New Haven City was prepared for the analysis using the DepthMap software (Varoudis, 2012). Segment is the shortest path which uses the least number of streets (actually the least number of "interjunction" stretches of street) to get to your destination (Turner, 2008). Second, the segment map was associated with crime map, and then compared to the syntactic characteristics of urban spaces (for that purpose correlation analysis was applied): global and local (at different radii) integration, choice, connectivity, depth from the most important and intensively used urban space in the city. It was identified that Elm street segment which lays between Broadway and York streets was the most important and mostly chosen route (Fig. 1). This street segment is in the Downtown of New Haven connecting many important routes within and outside the city, with boutiques, bars, apartments above them, on both sides of the segment, also a grocery shop in a distance of a couple of steps on the next street segment, that definitely attract people. In this case, topological depth from this segment of Elm street to all other segments was calculated.

Fig. 1. Elm street segment is identified as the most important and intensively used urban space in New Haven

Integration is related to “to-movement” and the accessibility of spaces, it is about deciding where to go. “Integration says us how close each segment is to all others under different types of distance and at different scale. Integration describes how easy it is to get to one segment from all other segments. In practical terms this would mean that pedestrians would end up to such a space more often and with less effort” (Hillier & Iida, 2005). Global integration (with a radius n) shows how accessible a segment is from all the others, id est. how it is integrated in the scale of the whole city. More integrated spaces are used more as nearby destinations than more segregated spaces. Local integration (with radii 2, 3, 4 etc.) shows how integrated the local area is in the relationship of its surroundings. In this case study for the analysis of local integration topological and angular radii starting R2 and ending R10 were tested.

Choice is related to the choice of path on the way to the destination or so-called “through-movement”. “Choice describes how likely you are to pass through the segment on trips, and so it’s potential as a route, from all segments to all others” (Hillier & Iida, 2005). For the analysis of choice global radius Rn as well as local topological and angular radii starting R2 and ending R10 were tested.

Connectivity shows with how many segments each segment is connected by its both ends.

Depth defines the number of steps from any segment to any other segment (Raford & Ragland, 2004). Deeper spaces are accessed more hardly, therefore, they are less used. For the analysis of depth global radius Rn and various local radii R2-R10 were tested.

The GIS data for the research was provided by the city of New Haven, IT Department (maps of streets and their center lines, with sites and buildings) (City …, 2014), and by the Police Department of the New Haven (all crime types committed in New Haven in 2009-2013, with all crimes being geocoded) (New …, 2013). The DepthMap software (Varoudis, 2012) is used for the calculation of the topological characteristics of urban spaces such as connectivity, global and local integration, global and local choice, global and local depth, as well as topological step depth from the main space in the city. The ArcMap software was used to combine the calculated topological characteristics with the city map and crimes.

Results

According to the above described methodology the segment map was created for the city of New Haven. It was layered by the map with exact locations of analyzed crime groups, then certain crimes were assigned to certain street segments, after that the correlation analysis identifying the relations between crime groups and topological properties of street segments was performed. The research results show that some urban spaces are more vulnerable to some crime than others. The bigger and significant relations between various groups of crime and some spatial characteristics of urban spaces are shown in the Table 1.

	Connectivity	Choice R2	Choice R3	Choice Rn	Depth R2	Depth R3	Depth R4	Depth Rn	Integration R2	Integration Rn
Robberies	.415**	.408**	.354**	.078**	.346**	.395**	.345**	-.293**	-.188**	.310**
Larceny thefts	.512**	.502**	.506**	.022*	.509**	.524**	.527**	-.343**	-.279**	.366**
Motor vehicle thefts	.517	.527**	.499**	-	.512**	.516**	.511**	-.295**	-.296**	.319**
Stolen property	.429**	.420**	.420**	.042**	.423**	.426**	.426**	-.294**	-.212**	.312**
Weapons	.375**	.365**	.356**	-	.362**	.361**	.355**	-.234**	-.178**	.247**
Drugs	.426**	.416**	.404**	.031**	.413**	.413**	.409**	-.268**	-.218**	.285**

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

Table 1. Spearman's rho correlations between crime groups and topological features of street segments (grey color means higher correlations. For all represented correlations $p=0.000<\alpha=0.05$)

The results demonstrate that the correlation on a local scale between choice and robbery decreases with the increase of radius achieving the highest value at R_{sp_rho}=0.408** (*p*=0.000<α=0.05) at a local scale (R2), and the lowest value at R_{sp_rho}=0.078** (*p*=0.000<α=0.05) at a global choice (R=n). Also with the increase of radius on a local scale correlation between depth and robbery decreases achieving the highest value at R_{sp_rho}=0.395** (*p*=0.000<α=0.05) at a local depth R3, and the lowest value at R_{sp_rho}=-0.293** (*p*=0.000<α=0.05) at a global depth (R=n).

The larceny theft together with motor vehicle theft have the highest correlations between crime and connectivity, local choice (R2 and R3), local depth (R2, R3 and R4). The highest relation between larceny theft and choice is observed at a local topological radius R3 step: R_{sp_rho}=0.506** (*p*=0.000<α=0.05). Also with the increase of radius correlation between choice and larceny theft decreases achieving the lowest value at R_{sp_rho}=0.022** (*p*=0.000<α=0.05) at a global choice (R=n). Beyond connectivity and choice R2 motor vehicle theft is also related to integration, but it is a weak relation, with a bit stronger relations on larger radii (R10, R9).

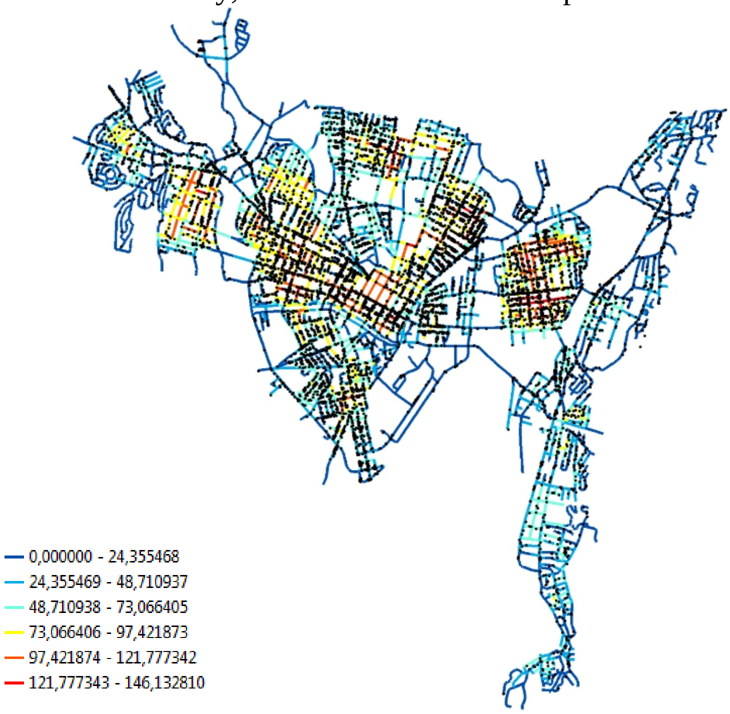
For stolen properties the highest correlation value is observed for connectivity R_{sp_rho}=0.429** (*p*=0.000<α=0.05) and local depth R3 as well as R4 R_{sp_rho}=0.426** (*p*=0.000<α=0.05).

For weapons and drugs results are very similar: the highest correlation value is for connectivity, local choice R2, and local depth R2 and R3.

For all analyzed groups of crime depth on a global scale has negative relation with crime, and positive relations with the depth on a local scale for all radii R2-R10 with the highest values at local radii R2-R4. It could mean that analysis of these groups of crime through depth is effective only on a local scale (neighborhoods, city parts etc.) with the radius up to R4, and not at a global scale (the whole city). That looks like a logic outcome, because these topological features are related to pedestrian movement, and pedestrians usually move within the radius of 2.4 km that is equal to 30 minutes walk.

Integration on small local scales (R2-R4) has negative relations with all groups of crime, and positive relations on a global scale Rn. Though, both local and global integrations have weak relations with crime, therefore, they are not very suitable for the further analysis and prediction of crime.

Due to the highest correlation values the most accurate analysis and prediction of crime can be done for larceny thefts taking into account global depth R4 or R3 or R2, or connectivity, or global choice R3 or R2. The same could be done for motor vehicle thefts taking into account global choice R2, or connectivity, or global depth R3 or R2 or R4. Figure 2 demonstrates how some of the above mentioned topological features (that have the highest correlations for larceny theft and motor vehicle theft) are visually related to the locations and density of crimes. From the Fig. 2 we can see that more larceny thefts concentrate on the streets with higher values of depth R4 (streets marked with hot colors – red, orange and yellow), it means that on the local scale the more shallow is the street from the main streets the more larceny theft happens on it. Shallow streets are used more often and accessed more easily, that factors might attract a possible thief. The same regularity is for the motor vehicle thefts. Also more motor vehicle theft concentrate on the streets with higher values of choice R2 (streets marked with hot colors – red, orange and yellow), it means that on the local scale the more chosen is the street by pedestrians walking from the point of origin to the point of destination, the more motor vehicle theft happens there. The same regularity is for the larceny thefts. Well-chosen streets serve as natural search paths for a possible thief. On the over hand, well-chosen paths can have a greater surveillance effect from movement. Though, this movement can be only transit and rapid, not concentrating attention at possible thefts. To achieve the most effective strategic planning for the City of New Haven streets should be planned in order to reduce crime. In this case larceny and motor vehicle thefts can be reduced (or at least controlled) by the regulation of streets' connectivity, local choice and local depth.



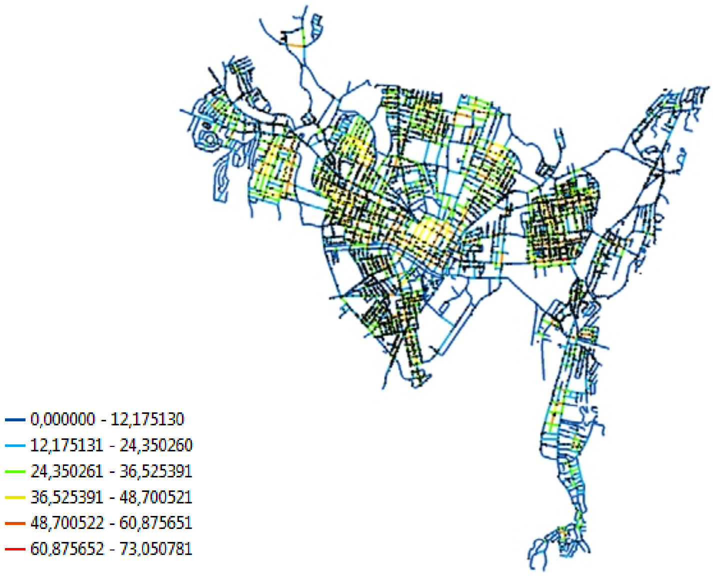


Fig. 2. Larceny theft and depth R4 (left). Motor vehicle theft and choice R2 (right)

Conclusion

For all the analyzed crime groups the highest correlation values are observed for connectivity, local choice and local depth. Though, the most accurate and reliable are correlation values for larceny and motor vehicle thefts with connectivity, local choice R2-R3 and local depth R2-R4. According to the research results more larceny and motor vehicle thefts happen on the streets with high connectivity, local choice and local depth values. In other words, it means that well-connected streets attracting more movement, shallow streets that are used more often and accessed more easily, and well-chosen streets attract more thieves. For the smart strategic planning of New Haven more surveillance by the police and local residents within the neighborhoods should be proposed for these vulnerable to crime streets. Also the proper urban planning could be employed that would make streets hardly accessible and a bad target for a possible thief. The strategy for the safety-oriented urban structure in New Haven could be addressed to larceny thefts and motor vehicle thefts only, as they have high enough and significant correlations with topological properties of urban spaces. The strategy should include regulations for urban spaces on not making spaces shallow from the main streets, connected with other spaces and chosen by pedestrians. It could be done by re-planning urban spaces, closing of some pedestrian routes and directing them to other paths. If the above mentioned actions are impossible or hard to implement, then organizational (security guards, police), mechanical (CCTV, alarms) or natural (local residents watching surroundings, strong communities) security tools could be added.

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