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## THE USE OF THE B. HILLIER'S METHOD FOR THE SIGNIFICANT CITY PUBLIC SPACE ANALYSIS

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**Abstract.** The article covers the subject of professor Bill Hillier's methodology for the analysis of urban spaces. This technique for research of the structures, that are differently ordered and have different purposes, is adaptive and applied to review city public spaces as independent system as well as the city structure element of the highest order.

**Key words:** the structure of the city, methodology for the analysis of urban spaces, public space

### 1. Introduction

Socioeconomic changes in Ukraine has promoted the urbanization process. Increase of the urban land by using a density factor which also embraces urban public spaces is the most distinctive feature. Unfortunately existing approaches in urban design, particularly in the organization of the city environment, were they used to be efficient in the past, nowadays have become inapplicable or non-operated in new market conditions.

The research of the modern techniques in urban design causes to consider the studies in related fields or to investigate objects which have similar principles of operation.

B. Hillier's method is one that can be useful for the research of the public spaces of the city. Bill Hillier is the Professor of Architectural and Urban Morphology in the University of London, Chairman of the Bartlett School of Graduate Studies and Director of the Space Syntax Laboratory at University College of London.

As the original pioneer of the methods for the analysis of spatial patterns known as 'space syntax', he is the author of *The Social Logic of Space* (Cambridge University Press (CUP), 1984, 1990) which presents a general theory of how people relate to space in built environments, *Space is the Machine* (CUP, 1996), which reports a substantial body of research built on that theory, and a large number of articles concerned with different aspects of space and how it works (Space Syntax Limited, 2017).

The B. Hilliers investigative approach of the street network could be generally reflected as the theoretically methodologic foundation in the urban structures foundation. Urbanist A. Gutnov based the urban structure investigation value, in particular when it is about the carcass element. According to him, the intersection of the highways, consolidated with the functionally important objects, are the knots tying mechanisms. This is about the space that formed as the community centers of the planning areas. According to Gutnov, these are territories of the consistency of high intensity development and transport high accessibility, which are optimal conditions for the business development nowadays. As knot tying mechanisms that take the main role in urban structure, these territories "become the most sustainable through the time, relatively constant parts of the urban planning system" (Gutnov, 1986).

Well-known K. Lynch's book *The Image of the City*, published in 1960, displays that people consider city space as five-elements structure. The first are the connections, streets, sidewalks. The second are different kinds of barriers, obstacles, fences, buildings. The third are areas, city districts that are relatively big parts of the city that distinct from their identity or nature. The fourth are the knots – centers. The last one – the fifth part of the city space are spatial orientations – objects, that are easily identified.

Different ways of grouping city space objects or features can be indicated as fixative parts. "The unity of the territories with close or related features ...with purpose to gain new territory features ... may occur as the cluster" (Kryvoruchko Y., Kryvoruchko O., Petryszyn H., 2013).

Researchers also considered the mechanisms of city structure conduct as part of the scientific reports. In particular composite aspects of the city formation and consolidation of its knot elements are introduced in Y. Idak's monography (Idak, 2011).

O. Panchenko's researches of urban fabric symmetryzation could be also interpreted as approximate to the B. Hilliers methods. In complicated system, which is city, "symmetry serves as group forming way" and helps the city with its development "aspiring to ideal" (Panchenko, 2012). City districts designed with use of symmetry are more sustainable to further planning changes. Scilicet existing local symmetric structures acting in further planning changes may become knot tying mechanisms in the city carcass.

**Purpose of the article is** to present possible use of the Hillier's method in the urban practice and his theoretical research of the urban structures and networks, especially of the city public space network.

**Research methods.** The basis of the research is transferring the cartographic material – mapping of the city – into cartogram, using binary code. As in sociologic research, specifically in the questionnaire method, explication of the results, their interpretation and verification are important.

## 2. Presentation of basic material

For a long time Bill Hillier researches syntax that means construction and order of making city networks. He published scientific works, dedicated to the urban structures and methodology of their analysis (Hillier, 1989, 1996, 2004). As a functional outcome some parts of the city may distinct – streets, spaces, that have perspective to disseminate their features on the adjacent territory. The scientist outlines them as ones that have "moving potential" or "priority spaces". This is new theoretic knowledge of the city viewed as a system that organises itself depending on the city network geometry.

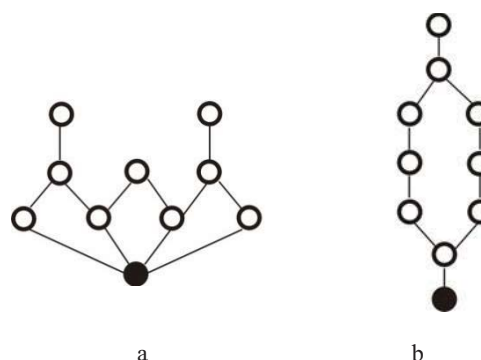
In the research, except physical parametres of the urban space, outlined function and features of its user, there may also be considered description of the position of each space in relation to all the others – "relations that take into account other relations".

This layout is interpreted as integrated (Fig. 1a) or as segregated (Fig. 1b) element in urban space network.

Considering amount of integration connections of separated layout we can mathematically place the whole space into the scale from integration to segregation. Accordingly, we gain the integration scheme of the urban spaces.

Although integration criteria in Hillier's method don't have the outlined parameters and this technique is considered to be auxiliary and subjective, it reveals the possibility of cross-analysis. Thus, based on integration city space schemes we can explore, for example, regional housing culture or interconnection of public spaces.

The author of the method considers two ways of structure-functional relations "space –society". The first one, according to Hillier, is conservative (reproductive). The organization of such space represents social vision of situation, within it, amplifies it or reproduces. That is the primary function of the object and the space ensures



**Fig. 1.** Model of the variance of urban space functioning in relation to other spaces, Hillier, 2004

the functioning of the facility. These are the conditions of the space in the public facilities, agreed according to Ukrainian DBN 360-92 \*\* "Urban development. Planning and development of urban and rural settlements."

In fact, it is the same type of the parameters, function and conduct in these spaces, that you can design using method of templates or other term – patterns. This design method was developed by K. Aleksander.

However, according to B. Hillier, city is more complicated organism, that is self-organised, so that it can't contain only the typical templates. The problem of the space syntax is that city territories with the same purpose or statements – as size of the housing group, open area ratio etc – are very similar. So that, K. Aleksander's method of templates has to be restituted.

The second way of the structural-functional relations is "space – society". That is if space creates new opportunities of the social cooperation, encourages the user to action. With the changes in the economy and the changing in nature of society new models of urban space are created and, in accordance, new ways of behavior. However, implementation of the same models of space (for example, area near typical shopping mall) in cities that differ by culture and morphology will happen in different ways. This space-conduct differences may be one of the city identity criteria.

According to B. Hillier, cities are "large collections of buildings held together by a network of space: the street network. The network is the largest thing in the city. It is what holds it all together". By analysis of city street network we can see the difference of the network density. There are cities, whose road network has a bit of continuous lines and numerous short stretches of street intersections, contiguity, dead-end passages.

The main part of analysis, by Hillier, is section of the street between intersections. We analyze the correlation between segment of the street between two intersections and adjacent segments. The analysis is to transfer image data in a binary system. More specifically, the distance between the center of the selected section of the street and the center of the adjacent segment is set to "1" if there is a change in direction between the selected segment and the adjacent segment, and is set to "0" if there is a change of direction. Accordingly, the direct connection is arranged – 0-character line that is a sequence of 0-evaluated connections. This is how the linear structure of the city is marked.

The next step is to calculate the syntactical integration of street network elements, or mathematical proximity which measures how close each segment is in relation to others. The length of distance between elements is being calculated, minimizing the path between each pair of segments. As follows how a system with the least amount of turns on the map is being found. Standard dimension of search system with the least amount of turns is performed for the territory within a radius of 2 km. For the sake of clarity, performed measurements are remarked with coloured symbols (or by gradations from white to black). The most stable network with the fewest turns is marked in red, the most segmented sections – in blue. This method essentially determines the potential for the development of space, as one of the criteria of space quality.

Thus, part of the network indicated in blue are blind: they have no potential for direction development. They can be regarded as fragments of the urban network of exhausted possibilities for further urban density. This data fragments of the city are not able to accept additional functional load or take planning complications.

The network marked in yellow can be interpreted as a logical structure that controls content in a structural order of surrounding urban areas. This network has stocks of resources to be consolidated with new features and buildings.

The network marked in red can be interpreted as a framework to develop the capacity for both of the structures – frame of the city, and its fabric and functional content.

Study of the real movements in the city revealed, that people move, perceiving the geometry of the space by angle fracture of the street axis, but not the actual metric distances. Thereby, if the distance between A and B is larger than between C and D although bends of the street or space are smaller, so the majority – up to 80 % according to B. Hilliers research – will choose the trajectory with the smallest angle of changing path.

Processing B. Hilliers method we conducted it on mapping the Lviv city. Analysis of the Lviv city street network is done by measuring the average distance from each other space to all of them (metric

means depth). It is defined that the criteria for “priority space” by B. Hillier in Lviv is the rectangular network of streets at the Market Square and the area around it (Fig. 2, a, b). As well as the space, that has the potential to develop, highways of the city importance are distinguished. That was expected to radial city (Fig. 3). Areas of apartment buildings of 60s-80s are the “patches” in the structure of the city with more resources to development and complications (Fig. 4). This definition is confirmed by the density of these areas with new buildings, especially with new functions. So that Sykhiv, Levandivka, Shchurata streets have had the built-of shopping centres, markets for fifteen years. The first floors of residential buildings have completely been passed into the various types of business. In addition, density of areas usage in these regions has increased, also mainly because of open-typed trading facilities and cafes. In general, the nature of the network of “priority spaces” in Lviv has the patch nature, combined with the centre with the use of radial directions (Fig. 5).



**Fig. 2.** Street network of the central part of Lviv city: a – a common network, b – identified as “prior spaces” according to the B. Hilliers method. Source: the author analysis



**Fig. 3.** Preferred fragments of the city street network. Source: analysis of the author.



**Fig. 4.** Areas of the city, that have received impetus to the high-quality development despite the priority of Lviv street network pieces. Source: analysis of the author.





**Fig. 5.** Territories that will rapidly develop on the basis of street network potential by B. Hillier's theory. Source: analysis of the author

Monitoring the event activity in the city also confirms the B. Hilliers theory about priority spaces of the city and their dependence on the geometry of the street network. The most significant events in the city, both of cultural and commercial nature, and social actions are held in spaces along the streets with the lowest angles of rotation as well as with the nearby streets of the smallest grinding.

Indirectly B. Hilliers theory is consistent with the K. Lynch's investigations regarding the perception of urban space during movement of people (Lynch, 1960). Because of the lack of composition in some of the territories, overall perception of the city deforms. An appropriate formulation was obtained by K. Lynch – if “direction of movement has the lack of recognition, then the whole image of the city remains unclear”.

Analysis of urban structures, made by the Hillier's method, is based on decisions of planning acceptance. For example, we can use it in the election of the distribution direction for central functions of the city and public space of the city center. As downtown of many cities have exhausted their capacity of critical operating space per indicators for pedestrians density and density functions per unit area (Panchenko, 2012), a question arises in what direction the city center should be developed.

There are two city districts that are suitable for Lviv to solve the task of development of the centre functions using the criteria of “continuity” as the qualitative structural unite according to the graphical analysis. They are the Chornovil's Avenue with surrounding neighborhoods and the territory between Shevchenko Avenue, Stefanik street and Doroshenko street. With some breaks in the structural grid, the second section goes on through the Ivan Franko Park and covers the area between the streets of Bandera and Metropolitan Andrey to Horodotska street. The quality of the section, the axis of which is the Kopernik street, it is said in the research of potential formation of art city clusters of Lviv. The authors of the research distinguish this territory as the one with the most number of art and cultural functions and attractions (Kryvoruchko Y., Kryvoruchko O., Petryszyn H., 2013). As the second district has a hilly relief, the Chornovil's Avenue has the priority in development of the city-wide functions, as it is said by the urbanists of several generations (O. Nowakowsky, O. Pidlisnyy, M. Habrel).

According to the Polish researcher Dorota Wantuch-Matla “public spaces of the new suburbs operate in isolation from the traditional multi-functional city space systems. In addition, they are separated from them with communication thread” (Wantuch-Matla, 2016). Otherwise, transport and pedestrian network can be the only one combining element between the local public spaces.

Thereafter, we can talk about the interchangeability between pieces of lower order network, which can be the urban space network, and the elements from higher hierarchical network. In our case, higher hierarchical network is the network that is more completed and structural with no gaps – the transport network. City structures as street network, pedestrian links and public spaces of the city are interconnected. By laying new public spaces or modernization the existing ones can be achieved the ‘healing’ of the urban structures, that were separated due to the urbanization or flawed planning decisions (Wantuch-Matla, 2016).

Appropriately, the results that concern the functional hierarchy of street network by Hillier's method can be the foundation for further research of the other urban structures or separated structure elements: public spaces, landscaped areas, forming local urban communities.

With feedback and multiplier effects – once one shop appears, others follow – this is the fundamental ‘city creating process’ by which cities evolves from collections of buildings to living cities, with busy and quiet

zones, often in close juxtaposition, and with differentiation of areas according to the detail of how they are embedded in the larger scale grid.

City networks conducts are similar. Based on this statement, B. Hillier's theory of the structure conduct is important in urban public space researches. Assuming that street structure forms movement flow even at a certain distance as well as patterns of land use, then such statements must be sought in the network of public spaces. There is a network of public spaces that has the potential to progress in other parts of the city where this typological unit does not exist. In other words, if qualitative public spaces are formed in the city center, then patterns of these spaces will be taken over by adjacent districts. Appropriately, urban districts, which had lower environmental quality, will take patterns from better-organized spaces. Therefore, these spaces will become both economically and socially more effective.

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## ВИКОРИСТАННЯ МЕТОДУ Б. ГІЛЛЬЄ (B. HILLIER'S) ДЛЯ АНАЛІЗУ ГРОМАДСЬКОГО ПРОСТОРУ ЗНАЧНІШОГО МІСТА

**Анотація:** Методика дослідження міських структур різного порядку і функцій Білла Хіллера є адаптивною і прикладною у розгляді громадських просторів міста, як самостійної системи так і елементу міської структури вищого порядку. В результаті застосування методу можна виділити ділянки міста – вулиці, простори, що мають потенціал до поширення своїх характеристик на сусідні території. Б. Хіллер окреслює їх як такі, що мають “потенціал руху” або “пріоритетні простори”. Це нове теоретичне розуміння міста як системи, що самоорганізується в залежності від геометрії міських мереж.

Найбільш структурованою і сталою в місті можна вважати вуличну мережу. Згідно методики Б. Хіллера, з точки зору розподілу довжини лінії у вуличній мережі, найменший відтинок приймається за масштабний модуль. Основний елемент аналізу – відрізок вулиці між перехрестями. Аналізується співвідношення відрізка вулиці між двома перехрестями чи примиканням і сусідніми відрізками. Аналіз полягає в розрахунку математичної близькості, яка вимірює, наскільки близько кожен відрізок знаходиться по відношенню до інших, зводячи до мінімуму шлях між кожною парою відрізків. Таким чином знаходимо систему з найменшою кількістю поворотів та безсистемних примикань у вуличній мережі, яка, згідно Б. Хіллера, має найвищий потенціал до подальшого розвитку міської тканини.

Опрацювання методу Б. Хіллера проводилося на топозйомці м. Львів. Визначено, що критерієм “пріоритетного простру” за Б. Хіллером у Львові відповідає прямокутна мережа вулиць площі Ринок і ділянки докола неї та магістралі загальноміського значення, що було очікувано для радіального міста. Загалом, характер мережі “пріоритетних просторів” у Львові має характер плям, поєднаних з центром радіальними напрямками.

Отримані результати можуть бути основою для досліджень міських структур чи окремих структурних елементів, таких як громадських просторів, ландшафтних територій, локальних міських обцин.

**Ключові слова:** структура міста, методика дослідження міських структур, публічний простір