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PEDESTRIAN MOVEMENT AND SPACE SYNTAX MEASURES. EXAMPLE OF THE CITY CENTRE IN ŁÓDŹ, POLAND

RUCH PIESZY I SKŁADNIA PRZESTRZENI. PRZYKŁAD CENTRUM ŁODZI

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ABSTRACT: In accordance with the assumptions of space syntax, spatial configuration shapes spatial patterns of pedestrian traffic. The influence of configuration (spatial relations) on, for instance, pedestrian route choice causes further consequences, making an impact on the land use pattern or providing opportunities to form social relations. The identification of the configurational features of space may, therefore, play a crucial role in the processes of urban planning and renewal. The goal of the study is to verify the assumed relations between the theoretical measures of space syntax and the actual pedestrian traffic. The study proves that theoretical indices are strongly connected to the real pedestrian traffic intensity. This fact confirms the value of space syntax methodology in the studies on the relations between the society and the built environment.

KEY WORDS: space syntax, pedestrian movement, built environment, street network, agency of space

ABSTRAKT: W myśl założeń teorii składni przestrzeni, konfiguracja przestrzeni kształtuje przestrzenne wzorce ruchu pieszego. Wpływ konfiguracji (przestrzennych relacji) np. na decyzje o wyborze trasy przemieszczania się, rodzi dalsze konsekwencje takie jak obciążenie ciągów komunikacyjnych, możliwość nawiązywania relacji społecznych lub sposób użytkowania ziemi. Rozpoznanie konfiguracyjnych cech przestrzeni może zatem ogrywać istotną rolę w procesie planowania lub reorganizacji i odnowy struktur miejskich. Celem prezentowanych badań była weryfikacja zakładanych związków pomiędzy teoretycznymi miarami składni przestrzeni, a rzeczywistym ruchem pieszym. Wykazano, że wskaźniki teoretyczne pozostają w silnym związku z realnym natężeniem ruchu pieszego. Potwierdza to wartość metod składni przestrzeni w badaniach relacji pomiędzy społeczeństwem i środowiskiem zbudowanym.

SŁOWA KLUCZOWE: składnia przestrzeni, ruch pieszy, środowisko zbudowane, sieć uliczna, sprawczość przestrzeni

Introduction. Research goal

A city space devoid of meanings and functions assigned to it by the society is a purely relational structure, conditioned by the existence of material objects. However, even

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such space actively influences its users. This happens because acting in accordance with certain geometric rules is as natural for humans as is the ability to speak. To paraphrase Alfred Gell, the author of one of the first concepts of the agency of things (1998), space is characterised by agency, that is the ability to initiate causal occurrences in the vicinity of an agent. In the relation described herein, man, an intentional being, is the primary agent, while the relational structure of space is a secondary agent, always functioning as an extension of man's will.

From the social perspective, dividing and re-merging space gives it new values and functions necessary to its users (Godelier 2012). Thus the places of encounters, copresence and coawareness are created (Peponis and Wineman 2002). In reality, regulating space amounts to regulating the relations between people (Hillier and Hanson 1984). Actions such as sleeping, eating, working, resting, participating in social meetings, and shopping are performed in various places that can be linked to form predictable relations (Leach 2010). In this way the social logic of space is shaped (Hillier and Hanson 1984).

Space syntax is one of the research currents where the agency of space, understood as a relation between spaces that make up a given structure, is the main research subject. This theory has been developed since the 1970s by Bill Hillier and his colleagues at The Bartlett, University College London, and it makes it possible to assess the influence of a specific spatial configuration on the functioning of societies. In space syntax theory, the proportion of urban pedestrian movement determined by the urban grid configuration is known as the natural movement. Pedestrian movement is also influenced by attractors – buildings or urban features having the potential of generating the trips to and from those built forms. Yet, it is configuration that "is the primary generator, and without understanding it we cannot understand either urban pedestrian movement, or the distribution of attractors or indeed the morphology of the urban grid itself" (Hillier et al, 1993, p. 32).

Research on space syntax indicates that the spatial patterns of human activities are largely shaped by spatial configuration (Hillier et al. 1993, Sharmin and Kamruzzaman 2018, Turner and Penn 2002). It has been shown that the topology of a street network plays a unique role in explaining people's collective behaviours. It is still being proven that studies conducted in the field of space syntax are able to predict people's collective activities (Ma et al. 2018). Therefore, space syntax is believed to make it possible to assess urban space and single out places with varying levels of social activities (and, therefore, with varying consequences). The assessment is possible not only ex post, but also ex ante, i.e. before the agency of a designed spatial structure (e.g. urban layout) begins. Space syntax studies also contribute to the research on spatial accessibility, understood as the relative ease by which the locations of activities can be reached from a given location (Luo and Wang 2003, p. 865). The way of spatial configuration can be considered a special case of accessibility (Ståhle et al. 2005). In this theory, accessibility and distance are associated with junctions (points), instead of the usual streets (lines) (Batty 2004).

The achievements of space syntax are crucial in the studies on socio-economic processes related to the presence of people in urban space, such as spatial patterns of criminal behaviours, the search for an optimal location of retail and service facilities, the optimisation of city traffic, etc. (Kim and Sohn 2002, Lerman and Omer 2013, Ozbil, Peponis and Stone 2011, Penn et al. 1998, Van Nes and López 2010).

In Poland, studies utilising the achievements of space syntax are relatively rare. The authors base their work on theoretical assumptions, without making attempts to verify them on the basis of real behaviours of societies in Polish cities (Kocki and Kwiatkowski 2016, Książkiewicz 2015, Nassery and Dudek 2015, Saeid and Masztalski 2009).

The purpose of the research presented in the article is to assess the correlation between the real intensity of pedestrian traffic within a city space and the theoretical measures developed in the field of space syntax. The results of field observations refer to selected configurational indices calculated on the basis of three various models of urban space, developed in accordance with the premises of space syntax. It is, possibly, one of the first, if not the first, Polish attempt to confirm the selected data developed in the field of space syntax.

The long-term purpose of the presented verification of the assumptions of space syntax is to develop the theoretical bases for the research on the diversification of socio-economic processes in the context of the agency of urban structures.

Models of urban space[1]

The model of urban space is a basis for the analyses conducted as part of space syntax. So far, several methods of constructing such a model were developed. Their purpose is to transform a two-dimensional plan (of a city, a district, etc.) into a graph which would make it possible to conduct a quantitative analysis as the next step. Depending on the method adopted, the model is constructed from the so-called axial lines, natural streets or new axial lines.

Each model is made of lines representing spaces that enable pedestrian traffic in the analysed structure. During line construction it is usually assumed that a pedestrian walks along pedestrian routes (avenues, boulevards, pavements). It is also assumed that a line represents all of the space seen by the pedestrian, therefore one line is constructed per street, instead of two lines representing two pedestrian traffic routes on both sides of the street.

The model made up of axial lines is the oldest. The lines are straight, usually drawn by hand in such a way so as to cover all spaces of the analysed structure. The least numerous set of the longest axial lines that meets this assumption is called an axial map. An axial line symbolises a space in which pedestrian traffic may occur, but it is also a sight

[1] The presented reflections regard solely the research on pedestrian traffic on the urban scale and the selected methods of space syntax based on axial lines.

line (Hillier and Hanson 1984). Moving along this theoretical line, a pedestrian can see the space it represents. However, the field of vision and the movement possibilities not always go hand in hand, for instance, due to the presence of ground-level barriers. Therefore, it is reasonable to verify the model in the field.

The growing access to databases with vector cartographic data, such as Open Street Map, resulted in a new method of building a city model. The fact that building a traditional axial map is really time-consuming and researchers may struggle to remain objective during its construction is also not without significance. The new model was based on street axes (central lines of streets), commonly used on vector maps. Segments of such axes (that is the sections from one intersection to another) are automatically combined into routes. These, in the context of human perceptive mechanisms, are convenient traffic routes known as natural streets (Jiang, Zhao and Yin 2008). They are formed from segments that fit best in terms of angles and, in contrast to the axial lines, are usually curved. This concept is based on the principle of good continuity known from the achievements of Gestalt psychology.

The third of the mentioned models is constructed on the basis of natural streets. Those can be treated as a hint to draw a set of straight axial lines (Liu and Jiang 2012). To differentiate, the resulting lines are known as new axial lines. The process of constructing them has been automated. Similarly, it is also possible to automatically create axial lines in the first model mentioned.

Each of the enumerated models enables building a dual graph that illustrates the topological structure of the space of the researched layout. In this graph the spaces (e.g. streets) are represented by vertices, and their connections (e.g. intersections) by the edges of the graph (Fig. 1). A graph makes it possible to obtain a number of rational data about each space that makes up a given structure. The data is objective, which means it depends on the city plan and not on the researcher or, for example, the respondent users of space (or, the individual cognitive or motor capabilities, etc.). Each space (vertex of the graph) is analysed in the context of the configuration of the whole layout or the neighbourhood adopted for the research (e.g. covering the area within three topological steps).

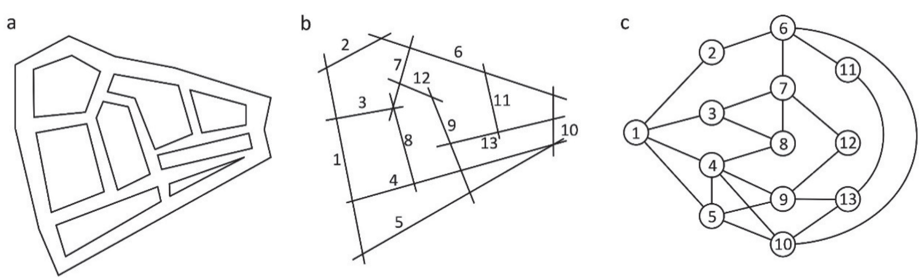

Fig. 1. Transformation of a city plan into a graph: a – fictional urban layout, b – axial map, c – connectivity graph

Source: Jiang and Claramunt, 2002.

The perception of spaces that make up a given urban structure from a configurational angle (i.e. taking into account the relations between each space and all others) is typical of space syntax. It is emphasised that even a small, local change in structure (e.g. closing off a street) has global consequences, since it changes the configuration of the whole layout. Therefore, the level of attractiveness of a place is determined not only by the local context (e.g. the quality of its development), but also the overall configurational context. Configuration is of fundamental significance, since it constitutes a somewhat hard-to-modify framework of social and economic life. Relatively permanent physical objects modify the behaviours of societies in space and create relations that impose upon them a given set of available spatial choices. The method of structure configuration determines, among other aspects, the peripherality or centrality of individual places. In this way, configuration influences numerous social and economic activities, for instance locations of social gatherings or service facilities. Therefore, it is crucial to identify the predispositions of a given spatial structure in order to optimise the use of places that make it up, not only in terms of the requirements and needs of their users, but also from the angle of the nature of the layout itself.

The course of the research

The research was conducted in two stages. The first stage involved the preparation of three graphic models of the research area, enabling a quantitative analysis. The research area in question was the centre of Łódź, within the borders of the Historic Urban Core, together with a 400-metre-wide zone surrounding it (more than 2200 ha in total).

The axial map was made manually, on the basis of the city plan. The map of natural streets was automatically generated on the basis of the central lines in the Georeference Database of Topographic Objects created by the Regional Surveying and Cartographic Documentation Centre in Łódź. The map of new axial lines was generated automatically on the basis of natural streets. Some new axial lines, representing long, winding, natural streets, required manual corrections. Then, selected configurational measures were calculated on the basis of models. The AutoCAD Civil 3D (2020), DepthmapX (2017), ArcMap (ESRI 2015), and Axwoman (Jiang 2015) software was used for this purpose.

Field observations were conducted in the second stage to record the actual presence of pedestrians. Observations were preceded by marking out street segments (from one intersection to another) in such a way, so as to include a set of real streets – representatives of a whole set in terms of integration, one of the key measures of space syntax (illustrated in Fig. 2 on the example of natural streets).

At the same time, the aspiration was for the segments observed to form closed loops long enough to make it possible to conduct cyclical observations. As a result, 165 street segments were studied, making up approx. 60-70 axial lines/natural streets/new axial lines (Fig. 3).

The method of conducting observations was based on similar research conducted in London (Hillier et al. 1993). The studies were conducted on a working day and with

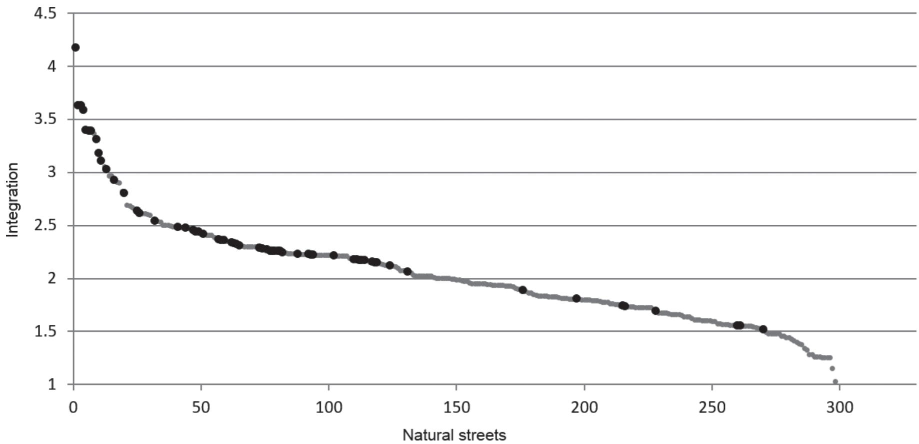

Fig. 2. Arrangement of the values of the global integration of natural streets in the centre of Łódź. Grey dots stand for values of all natural streets, black dots stand for streets whose segments were under observation. Streets with the lowest integration values are under-represented in the observations. It is the result of conducting observations outside of the zone surrounding the Historic Urban Core to limit the so-called edge effect.

Source: personal elaboration.

the participation of 60 observers[2] recording pedestrian traffic along selected routes (Fig. 3). The observers moved at the speed of approx. 5.5 km/h, along six routes, each one approx. 5.5 km-long in such a way so as to observe the studied route again after an hour. Observation was conducted between 8 a.m. and 6 p.m.

During the process, they recorded passersby, noted down their gender, approximate age (child, adult, senior) and behaviour (in motion/motionless – e.g. waiting for the arrival of public transportation). They also recorded the observed traffic intensity[3], i.e. the number of people observed per 100 m of the segment, correlated with selected configurational measures.

Selected configurational measures and the actual pedestrian traffic

Among many measures used in the field of space syntax, four were subjected to correlation analysis: total depth, global integration, local integration, and control value. Defining the notions of symmetry and depth is necessary to understand these measures.

A symmetric relation of two spaces, for example A and B, occurs when the relation of A to B is the same as the relation of B to A and their relations to other spaces in the layout are also the same, for instance A to C and B to C (Fig. 4a). When paths from A to C and from B to C differ (Fig. 4b), the relation is asymmetric.

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[2] The observers were students of spatial economy, Faculty of Geographical Sciences at the University of Łódź.

[3] When calculating traffic intensity, children under the care of adults were omitted, since it was assumed that their routes were most likely chosen by their guardians.

Fig. 3. Observation routes against the street network in the centre of Łódź. Roman numerals stand for the numbers of subsequent routes (as in table 1). The dash-dotted line marks the area of the Historic Urban Core of Łódź, the dotted line marks the 400-metre-wide zone surrounding it

Source: personal elaboration.

Depth expresses a topological distance between spaces. For instance, it takes one topological step to cross from space A to space B, and two steps to cross from space A to C (Fig. 4b). Therefore, it can be said that in the layout in question, space B is the most shallow, because the distance between it and the remaining spaces in the layout is the shortest. This affects the whole system. Closing off space B would prevent the system from functioning, while the results of closing off A or C would be less negative.

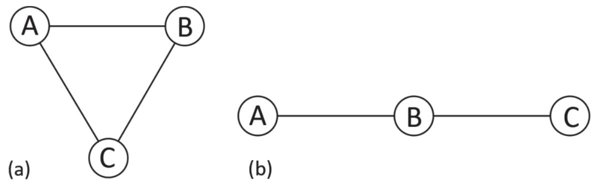

Fig. 4. Symmetric and asymmetric relations between spaces
Source: elaboration on the basis of Hillier and Hanson 1988.

Total depth is a global measure dependent on the size of the whole system. It shows how deep each space is in the analysed structure. Its value determines the number of topological steps to be taken from a given space to reach all other spaces. Therefore, for example, due to transit costs, it is better to choose shallow spaces throughout the whole layout, since they are closer to all others, over spaces that are deeply rooted in the system. It should be emphasised that the notion of topological distance is not synonymous to metric distance. For instance, spaces with high depth values may be located both on the outskirts and in the centre of the analysed structure.

The results of field observations show a statistically important, reverse correlation between the total depth values calculated for the studied spaces in the centre of Łódź and the real traffic intensity (Table 1). That means that traffic intensity is higher on streets that are topologically shallower, while streets with a larger depth have lower pedestrian intensity Therefore, this facet of the configuration of urban structures not only illustrates their inner, topological diversity, but also influences the presence of users in space.

Table 1

Values of correlation* between the selected topological measures of space syntax and the intensity of pedestrian traffic in the centre of Łódź

Model**	Total Depth	Global Integration	Local Integration (R2)***	Control value	P-value
Axial lines	–0.5885	0.6664	0.6132	0.6025	$p < 0.001$
Natural streets	–0.6178	0.7240	0.6635	0.6433	$p < 0.001$
New axial lines	–0.6174	0.6884	0.6466	0.6012	$p < 0.001$

* Pearson's linear correlation coefficient

** Each time, without five observations that drastically upset the result of the correlation of global integration. Those were, for example, spaces with high integration values observed along extremely short route segments where a relatively low traffic intensity was observed or streets with low integration values located in the vicinity of busy trade squares.

*** Calculated for the neighbouring area within two topological steps.

Source: personal elaboration.

The comparison between the real depth of the system seen from a given space and its depth or theoretical shallowness (the lowest when all spaces are direct neighbours of a given space, as in fig. 4a, and the highest when all spaces form a linear sequence starting with the space in question, as is the case with space A in fig. 4b) makes it possible to calculate relative asymmetry. The calculation of relative asymmetry of a given space is based on the mean depth of the system from the perspective of the analysed space and related to the number of spaces that make up the whole system (2). This leads to a normalisation of depth to fit values within the range [0, 1] (Al Sayed et al. 2014).

$$MD_i(\text{Mean Depth}) = \frac{D_i}{n-1}; \quad (1)$$

$$RA_i(\text{Relative Asymmetry}) = \frac{2(MD_i - 1)}{n-2}; \quad (2)$$

where:

$$D_i(\text{Total Depth}) = \sum_{j=1}^{n-1} d_{ij}$$

n – number of vertices in a graph (a space in the analysed layout),
d – topological step,
i – analysed space (vertex in a graph).

To calculate a normalised value of RA (3), it needs to be divided by D_{value} (4). This makes it possible to calculate global integration (5) or local integration (in a given neighbourhood of spaces and defined by a number of topological steps):

$$RRA_i(\text{Real Relative Asymmetry}) = \frac{RA_i}{D_{value}} \quad (3)$$

$$D_{value} = \frac{2\left\{n\left[\log_2\left(\frac{n+2}{3}\right) - 1\right] + 1\right\}}{(n-1)(n-2)} \quad (4)$$

$$INT_i = \frac{1}{RRA_i}; \quad (5)$$

Spaces that integrate the studied system show high integration values, while spaces segregated from the system show low integration values. Integration is a global measure, since it considers the relations between space and every other space in the system (Hillier and Hanson 1988). It should be emphasised that integration is considered a crucial measure of space syntax, as it helps understand the relations between the users of space and space itself. The existence of significant relationships between the integration value and the presence of pedestrians in space was proven on multiple occasions. It is believed that the integration value also corresponds with the indices of social interaction and trade activity (Hillier 1996). As a result, integration is often considered a measure of the quality of urban space, additionally providing information about the potential of a given space.

The results of observations confirm a high positive correlation between the integration value and pedestrian traffic. The correlation is slightly higher with global integration than with local one, but it always approaches or exceeds the level of 0.7, which proves the existence of a significant relation (coexistence) of the analysed features.

The correlation is proven by the scatter plots prepared for each analysed model (Fig. 5). Each time, the R^2 coefficient informs that the observed intensity of pedestrian traffic is determined in 45-50% by the level of integration of the street network. Therefore, the configuration of street space in the centre of Łódź can be considered an important determinant of pedestrian traffic within the city space.

The diagrams also depict the special position of Piotrkowska Street (rightmost point). The street has both the highest integration value and the lowest depth in the studied structure. It also has the highest control level (described further on). This space is the centre of the Historic Urban Core not only topologically, but also functionally, representationally and symbolically. In its considerable, almost 2 km section vehicle traffic is highly restricted and pedestrians have right of way. It is also space with intense trade and service activity; maintaining its centrality in the city is part of the policy of Łódź authorities.

It should be mentioned that out of both calculated integration measures, global integration is slightly better correlated. This may result from the features of observation areas and the traits of its users. City centres have a higher percentage of destinations with a significant range of influence (specialised functions within the city range or beyond). Still, a major percentage of people using these services comes from outside the city centre. Possibly, these people (including tourists) create different spatial movement patterns (in comparison with those created by the residents of the city centre). The diversity may stem from the readiness to cross longer distances by foot (searching for the way, aiming to reach multiple destinations en route, sightseeing).

The control measure is, on the other hand, a local measure, based on relations between space and immediately neighbouring spaces. Control value measures the degree to which a given spaces controls access to the immediately neighbouring spaces (6) (Osman and Suliman 1994).

$$C_{Value} = \sum_{C(i,j)=1} \frac{1}{Val(i)} \tag{6}$$

where:

C(a,b) represents the connectivity between the immediately neighbouring graph vertices i and j,

Val(i) is the number of direct connections for vertex (i).

If k stands for the number of immediate neighbours of a given space, then each neighbour has a control 'strength' of 1/k. The total value of 1/k for each space determines the strength of its control. Spaces with the total value exceeding 1 have strong control, while those with the value lower than 1 have weak control (Fig. 6).

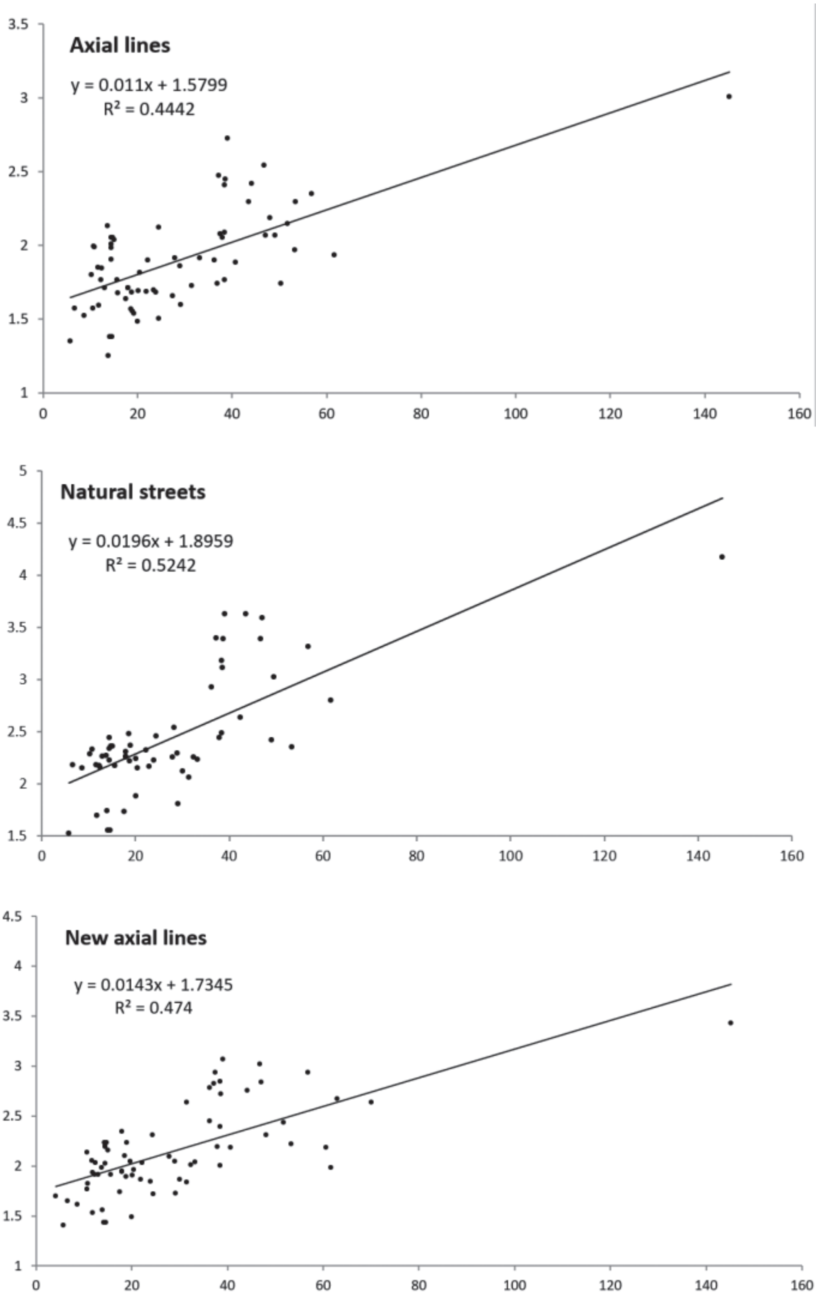

Fig. 5. Relation between the intensity of pedestrian traffic (persons per 100 m) (horizontal axis) and the integration value (vertical axis) in the studied models

Source: personal elaboration.

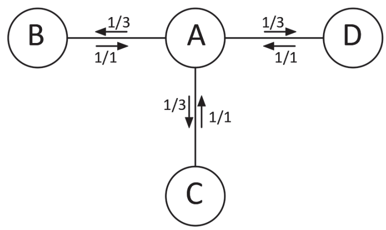

Fig. 6. Method of calculating control values. Space A is the only neighbour of spaces A, B and C, therefore it fully controls access to them. It 'receives' 1/k, that is 1/1, from each of them. Access to space A depends equally on the passability of three spaces B, C, and D, therefore each one has the value of 1/3. Thus the control values for spaces in this layout are A=3, B=0.33, C=0.33, D=0.33

Source: personal elaboration.

Also in this case field observations have shown the existence of a significant positive correlation between the intensity of pedestrian traffic and the level of control. In each analysed model the correlation value either reaches or exceeds 0.6.

The same parameters, total depth, global integration, local integration and control value, were calculated separately for each of the six routes observed (Table 2). The results yet again confirmed a high correlation between the theoretical measures and the actual intensity of pedestrian traffic, although with local exceptions to the observed regularities.

Observations conducted at routes II-V indicate a stronger correlation of observed features; the results for route VI are close to the average values; observations conducted at route I, encompassing the Old Town area, have a higher divergence from the theoretical model.

Table 2

Values of correlation between the intensity of pedestrian traffic and the selected configuration measures, in accordance with observation routes

Model	Total Depth	Global Integration	Local Integration (R2)	Control
I				
Axial lines	–0.3528	0.2981	0.5339	0.5195
Natural streets	–0.5843	0.4897	0.5700	0.3553
New axial lines	–0.4484	0.3805	0.4796	0.5180
II				
Axial lines	–0.6774	0.7857	0.6884	0.7312
Natural streets	–0.6220	0.7831	0.6410	0.8358
New axial lines	–0.7034	0.8242	0.6878	0.7751

Table 2 contd.

Model	Total Depth	Global Integration	Local Integration (R2)	Control
III				
Axial lines	–0.7270	0.8055	0.6935	0.8495
Natural streets	–0.7807	0.8696	0.8003	0.8353
New axial lines	–0.7737	0.8621	0.8020	0.9111
IV				
Axial lines	–0.6050	0.7508	0.6007	0.7226
Natural streets	–0.6732	0.8267	0.6754	0.9388
New axial lines	–0.5497	0.6778	0.5639	0.7525
V				
Axial lines	–0.7915	0.8790	0.7209	0.8159
Natural streets	–0.7156	0.7818	0.6759	0.6336
New axial lines	–0.7151	0.7784	0.7185	0.7632
VI				
Axial lines	–0.5826	0.6714	0.5187	0.6129
Natural streets	–0.5710	0.6537	0.5359	0.5758
New axial lines	–0.5684	0.6392	0.5113	0.5838

Source: personal elaboration.

A detailed data analysis has shown that several streets with higher than predicted pedestrian traffic intensity are responsible for the low correlation visible in the last case. These were, among others, parts of Lutomierska and Bazarowa streets, near the busy Zachodnia street as well as streets in the vicinity of the Bałucki Market. It is possible that the divergence between the observations and the model was caused by local movement 'generators' in the form of the concentration of sources and destinations (accumulation of public transport stops, shopping centres, etc.). This would also validate the high intensity of pedestrian traffic on Piotrkowska street, which is significantly higher than on other streets of Łódź with similar global integration values (Fig. 6).

Discussion

The goal of the research is to assess the accuracy of theoretical space syntax measures in predicting the intensity of pedestrian traffic in urban space. These measures were calculated on the basis of three models used in the field of space syntax and representing real spatial structures. It is necessary to point out that both the measures calculated on the basis of presented models and the models themselves are based solely on the topological properties of spatial structures.

The prediction capabilities of the models are applicable to mass behaviours, not individuals. Additionally, it cannot be assumed that a spatial configuration model will fully match pedestrian traffic, since models omit elements such as the nature of building development and its intensity, the presence of traffic sources or destination points. There is also a certain simplification to the spatial behaviours – for instance, it is assumed that people take the shortest paths possible. The characteristics of societies are also omitted (e.g. age or lifestyle which have an effect on the tendency to walk).

The research results indicate that all analysed models similarly evaluate the structure of urban space. Generally, the conformity of each model to the observed pedestrian traffic is both quite high and statistically significant (Table 1). In each of the analysed parameters, the model based on natural streets has the highest conformity, yet the divergence of the levels of correlation between the models is small. The analysis of partial observations (by routes) indicates a similar, strong or even very strong correlation between the calculated measures and the real intensity of pedestrian traffic. In this case, it is hard to assess which model has the highest conformity. The best correlations usually occur in the model based on axial lines and natural streets. Therefore, the predictive properties of models are similar, and the choice between them may depend more on the researcher's preferences or software availability than their properties.

The analysis of individual routes has shown significant differences on the level of correlation between theoretical measures and empirical observations on the local scale. However, for most routes, the correlations obtained were high or very high, exceeding the correlation calculated for all routes in total.

It should be emphasised that observations were frequently conducted in relatively short street segments and later generalised to match the whole length of the theoretical lines representing them. Therefore, the observations did not fully consider the possible changeability of traffic throughout the whole length of analysed spaces. Moreover, the observations were short (one working day), which could have influenced the level of conformity of a model to the actual situation in downtown Łódź. Yet, the conducted analysis has doubtlessly shown strong and statistically significant relations between the actual pedestrian traffic intensity in Łódź and the theoretical measures developed in the field of space syntax. Therefore, it is possible to assume that conclusions drawn on the basis of theoretical measures of space syntax are reflected in the real socio-economic processes (structures of cities and societies that use them).

Without question, the locations of attractors that influence pedestrian movement patterns should be considered in the analyses. They can have a major influence on the basic pattern established by configuration, which has been confirmed by prior research (Hillier et al. 1993). Although the distribution of attractors is related to the configuration of space, the relation is not straightforward. For instance, various types of economic activities occur in places with characteristic centrality levels (Porta et al., 2010). Yet it is a notion that requires further, separate research.

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