Index Keys Method for Analyses of Urban Public Spaces

Methodological assumptions

Małgorzata Hanzl

Institute of Architecture and Town Planning
Lodz University of Technology
Lodz, Poland
e-mail: mhanzl@p.lodz.pl

Abstract— **The paper proposes the index keys methodology of analysis of urban structures. Few hypotheses are formulated concerning the relation between the crowd of people representing a given culture and the urban settings, which constitute their habitus. The geometrical analyses of public spaces, including the examination of urban closures cross-sections and urban silhouettes, draw upon the writings of Kazimierz Wejchert, widely recognised for his contribution to the theory of urbanism in Poland. Quantitative parameters describing the form of space are introduced, including: central angle, corrugation and regularity. Cultural aspects of given settings, as proved by the results of preliminary descriptive analysis of the former Jewish district in Lodz, require developing methods of description of public spaces.**

Keywords-urban design; public spaces; urban morphology.

I. INTRODUCTION

When looking for the relation between urban structures and the culture of space usage, there are three main issues, which should be considered: (1) physical features, including distribution, shape and size of forms defining the space, (2) the distribution and behaviour of the space's users, which reflect a social order and (3) the flow of human movement, which finds its reflection in the sociometric layout of a given place. Flows are connected with movement/traffic and are related to space, following the definition by Yi Fu Tuan [31]. Concentrations enable contact and communication processes. They are static rather than dynamic, thus place related. Both types are closely interrelated, they inseparably interpenetrate each other. Whenever the human flow stops for a moment concentration occurs, though interrelations require more comfortable conditions to take place, among others: time and spatial arrangement. According to the theory formulated by Lynch [22], flows may be approached as paths and concentrations as nodes. Concentrations tend to a static form, while flows serve mainly as a means of getting to some destination. Taking into consideration mostly their static behaviour, the distribution of people in public spaces reflects social order. Cultural aspects of everyday space usage are reflected first of all by its internal organisation and arrangement.

The paper is organised as follows: after the introduction, which points out at the anthropological understanding of situation and the definition of *habitus*, the main methodological assumptions are presented, with an emphasis on the explanation of index keys concept. Further the case study is discussed, which provides explanation for the development of methodology for detailed description of outdoor spaces. Section IV discusses analytical methodology, introducing several parameters intended for description of urban enclosures. Section V provides conclusions from the paper and presents further steps, which are to be taken in order to verify the presented methodology of analyses.

A. Anthropological concept of situation

In anthropology situation is defined as a theatre of human activities [24]. Goffman [10, p.18] refers to a situation as to *"the full spatial environment anywhere within which an entering person becomes a member of the gathering that is (or does then become) present"*. Anthropologists developed elaborated theory on ways in which a site is converted into a meaningful 'place', by inscribing human activities into the surroundings. The relationship between people and sites encompasses both: attaching meaning to space and *"recognition and cultural elaboration of perceived properties of environments in mutually constituting ways through narrative and praxis"* [20, p.14]. Schumacher [28] states that the role of architecture is to frame social communication [28, p.414]. Thomas, who introduced the concept of situation in the 1920s, defined it as a *"constellation of the factors determining the behaviour"* [30, p.8] after [28, p.420].

B. The definition of habitus

The morphological approach [23] refers the above concept to the urban structure introducing the notion of *habitus*. The set of identifiable cues, which may be qualified as culture-specific [25, pp.106-107], and referring to spaces, includes features like: *"quality, size, shape, enclosing elements, paving, barriers, and links, etc."*, requires examination with regard to the distribution of human flows and concentrations and their intensities, and consequently occasions for contacts. Both Gehl [9] and Whyte [34] point at similar rules of use of outside spaces. The territorial distribution and exchange of nonverbal cues serves the communication purpose and usually certain semantics may be attributed to it [10]. The behaviour of a given human group in concentrations reflects its culture. The movement component tends to be more universal and less culture dependent, as Hillier and Hansen [18] claim. The thesis is

made that the rules, which govern the non-verbal communication component of the human group behaviour are the same ones, which govern the distribution of buildings. They represent the same culture of space usage.

II. METHODOLOGICAL ASSUMPTIONS

A proposal of the methodology for the analysis of public spaces is presented, based on the writings of Wejchert [32], widely recognised for his contribution to the theory of urbanism. Forgoing morphological descriptions of urban structures based on the analyses of plans, i.e., Conzenian school of urban morphology [33], and on the diachronic characteristics of constructions, i.e., Muratori's tradition [2], do not allow for considerations of this kind. The actual, practice-based approach engages the definition of genius loci, notably in rehabilitation projects. The research tries to develop existing descriptions of urban spaces [8] by applying the anthropological approach as presented by Levi-Strauss [21] to the description of cities and urban structures, following and developing the methodology proposed, among others, by Rapoport [25, pp.106], who defined a comprehensive set of features allowing for drawing characteristics of physical structures, including the culture related ones. Hillier and Hansen [18, p.224] ponder on the method of investigating of encounters as morphic languages, concluding that the aim is to establish, how encounter systems acquire differential properties, which would have different manifestations in space.

A. Theory of seeing – index keys concept

Like in the paintings of Van Gogh, seeing is concentrated around few key points, which define, how a scene is perceived [29]. The analyses should provide observation of processes: flows and forces, and concentrate on their key points. Situations, which are the most important for the definition of cultural character, i.e., the moments of human interactions, particularly attract researchers' attention [15] – they are static rather than dynamic. The methodology of key points, analogue to the anthropological method of making photographs by native observers, who are able to notice the clue activities important for their cultures and often unnoticeable for foreigners, allows for observation of socially meaningful activities, responsible for the formation of a cultural specific environment.

The application of the 'key points' methodology assumes the choice of the most obvious perspectives when observing the environment. In the case of urban spaces, it means choosing these view axes, which provide cross-sections perpendicular to the main axe of a given path. The analyses of the cross-section and of the silhouettes may use, among others, the highly efficient methodology proposed by Gal & Doytsher [7], which allows to replace the Line of Sight (LOS) methodology of extracting silhouettes of groups of buildings. In the proposed methodology the simplest way to extract cross-sections and silhouettes is used, based on orthogonal projection. Although as Gestalt psychology proves in the perception of distant buildings the distances are shortened. Further methodology development should also take into consideration these processes as well as the way in which humans perceive environment, e.g., including perception of meaningful entities [12].

III. THE CASE STUDY

The case study pertains to the former Jewish district in Lodz, in the 19th century, the district served as a habitat of the multiethnic society, in which Jews constituted a majority [16], [17]. These settings were commonly described as possessing a special 'Jewish' character. This notion is evoked by the form of public spaces, different than in other parts of the city. The study refers mainly to the areas of the Old Town and of the central part of Nowe Bałuty. An attempt has been made to define a certain set of features proper to the area, describing its morphological structure and referring mostly to the shape of public spaces, which is repeated in most Polish towns and neighbourhoods formerly populated by Jews [5]. The examination of the character of public spaces as they are perceived by observers, in the case of scapes, which do not exist in their original form, is based mainly on the analysis of archival photographs. The subject of analysis is first the shape of the public realm itself, in the 2D plan view, the cross-section and street silhouette. Moreover the sequences of views in time and the character of buildings itself should be analysed.

A. Shape of public spaces, sequential analysis - General features

The essential features of the outdoor space, characteristic for the given area refer to the issues of scale and dimensions. The narrowness of streets and presence of numerous slight turns and directional differentiation, providing the notion of concavity, and therefore closing the perspective and assuring perceived and felt closure, are factors favouring direct physical interaction. Gehl [9] points at small dimensions of spaces as favourable for establishing relations. The irregularity of enclosures of streets, their broken line, the apparent lack of precise form, which enlarged the amount of border space, where people stop more willingly than in the centre of an open area, facilitates transactions, presentation of goods, etc. The abundance of such spaces enabled the location of numerous outdoor, commercial furniture. Attracting passers-by, was fostered by the presence of numerous small size elements in the outdoor space, providing sham shelter: stalls, kiosks, stands and presentations encouraging buying. Cullen [3, p.103] describes this phenomenon using the example of a street „cross", the main function of which was to stop pedestrians.

Whyte [34] defines the set of features of outdoor space fostering relations pointing at the location inside of the human flow. Gehl [9, p.150] underlines the role of the corrugation of the edge of space (through the presence of elements of urban equipment and the shape of walls themselves) as important for enhancing communal life.

B. The ubiquity of commerce

The basic character of the area of concern may be defined as the 'ubiquity of commerce'. The space of commerce was not restricted to the main square, it was

present in the neighbouring streets and passages. Frequent protrusions of buildings, especially of commercial and service use (restaurants, etc) additionally influenced the presence of service in the public sphere, and thus improved the effectiveness of sale. Very rational management of space, lack of space without prescribed use, frequent overlapping and synergy of different uses of the same space completed the above picture. Jews often chose the settlement location in the direct proximity of commercial places. After settling, they usually redeveloped their environment introducing enhancements with regard to the requirements of commerce.

C. Issues related to proxemics

The proxemics approach, presented by Hall [15] and his successors, examines the relation between spatial patterns of space usage in different cultures and the material environment. The differences between morphological structures representing various cultures are particularly apparent in cities, which like Lodz had become a melting pot of many cultures. Hall [15] identifies direct relationships between interpersonal distances and other characteristics of individuals and communities and the way they shape their own physical environment. Hillier and Hanson [18, p.27] refer to the usage of space and the patterns of behaviour appropriate for different communities and ethnic groups as the determinants of the final shape of urban structures. According to Hillier [19] city is seen as a system of visual distances, strongly influenced by both perception and personal distances.

In social groups, whose members are accustomed to residing in small spaces, social distances are usually smaller than in other groups. Assessment based on the descriptions of the crowd in literature or photos of the Ashkenazi Jewish population, which once used to live in Lodz, corresponds to that characteristic. The limited scale of outdoor spaces, narrowness of the passages and nooks, often even narrowed by the introduction of additional trade facilities, typical for most of former Jewish towns and districts, also fit into this profile. The analyses of crowd with the use of archival photographs, allow to distinguish apparent clusters of people, who grouped also when moving; thus the narrowness of sidewalks.

D. Perception as a factor influencing the creation of space

Strzemiński [29] pointed at the evolution of visual awareness along with the development of civilisation. Visual awareness was transformed together with the changes of socio-cultural settings. He noticed the result of economic and technical factors as well as the social structure proper to a given group of people, in the defined historical context. The notion of visual awareness, understood as the *"cooperation of seeing and thinking"* emphasises the role of cognitive absorption of perceived visual stimuli. Strzemiński [29] identifies two ways of development of visual awareness. In the rural cultures, it is the observation of the interior of an object, which finds its expression in the studies of nature. The second form was a silhouette vision, which developed from the primitive contour observation in economies based

on hunting and breeding animals, that is in tribes accustomed to vast open spaces.

The derivative of the silhouette vision was the perspective of simple parallel projection, and, in the further stage, the development of rhythm, including architectural rhythmisation, as a consequence of inclusion of the afterimage phenomena, natural for the perception processes taking place in vast open spaces. Another form of seeing, which was particularly apparent in communities, whose main occupation was commerce was seeing concentrated on ware attributes, with emphasis on the texture and weight of objects, usually devoid of larger perspective. The preserved iconography, mainly paintings by Jewish artists contemporary to the development of the *'shtetl'* culture, confirms the assumption on their belonging to this group. The shape of urban settings analysed above also confirms the thesis about concentration on the content rather than on external appearance of activities and environment itself.

Adorno [1, p.5] points at the role of artworks as medium reflecting the unconscious aspects of culture: *"Artworks are afterimages of empirical life insofar as they help the latter to what is denied them outside their own sphere and thereby free it from that to which they are condemned by reified external experience."* The same refers to the urban settings, which perceived by a group of users answer their needs, including the aesthetic criteria.

IV. THE ANALYTICAL METHODOLOGY

A. Convex - definition

Hillier and Hanson [18] defined a series of rules governing the spatial order of analysed settlements. They noticed that the definition of the basic spatial unit for analyses, which would be distinguishable in the geometrical way, is essential for further considerations. Referring to their theoretical apparatus such basic spatial unit, which may serve for description of public spaces, is a convex. A *"fully convex fat space"* is defined as *"a part of a space, which represents the maximum extension of the point in the second dimension given the first dimension"* [18, p.91]. In Hillier logic of space, the implicit assumption is made that all the cells, representing spaces, are similar units, both in size and in shape. It doesn't describe the actual form of urban closures and the spatial edges are lacking. The critique concerns lack of geometrical description of buildings, which form urban settings, including their size, shape and distribution (e.g., [26]).

Spaces, which are not defined spatially but by the presence of some other edges – like property borders, remain problematic. A more complete picture, which may serve to describe reality in a reliable way, requires introduction of the shape and size parameter(s) and multiplying them by three dimensions. Studies in human perception show a trend to generalise objects to wholes, if only the compounds are located close to each other, have similar attributes, may be described with the same contour line and their meaning, recognised from former experience, remains similar.
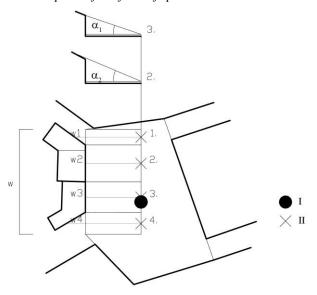
B. Description of the form of space

Figure 1.   Index points and cross-sections definition. I – geometrical central point, II – index key points, α_n – central angles for each cross-sections, w_n – widths of each unique part of wall

The way in which an observer perceives space in the urban interior depends on the parameters of cross-section. Wejchert [32]. The basic features important for describing convex spaces are cross-section and walls silhouettes. The analysis of a wall silhouette allows for identification of required index points, which may further on serve for creation of cross-sections. Cross-sections may be created for any cue point of any unique physical form of objects surrounding the space change, i.e., the height and the shape of buildings.

Each index point is referred by one cross-section, various cross-sections require association with distinguished index points. The starting point for each cross-section is located on the line, which is parallel to the wall and goes through the geometrical centre of the given convex; see Fig. 2. Cross-sections are by definition perpendicular to the convex wall. In case of buildings or other constructions, which are set back from the convex edge and not perpendicular to it, the middle point of a building/construction is the location of an index point. Similar situation occurs in the case of buildings, which are located behind other buildings but their height exceeds the height of the front building.

The method may also serve for the description of some concavity closures. Yet, as their perception as one spatial unit is more the result of tradition than of their geometrical attributes, these shapes should be defined manually, i.e., divided into two or more basic convexes and then reconsidered as one whole. An example of a concavity space widely recognised as single urban interior is the L-shaped Piazza della Signoria in Florence.

C. Central angle

One of the most important parameters describing cross-sections is the central angle. The central angle is an angle

between a horizontal plane parallel to the floor at the height of 1,5m (the medium level of sight for humans) and a line going through the highest point of the building defining the closure in a given index point. The point belongs both to the silhouette line and to the cross-section.

Wejchert [32] provides general rules for classification of closures basing on the description of heritage sites which are widely recognised as beautiful for their great proportions. The central angle values in most of the discussed squares range from 25° to 30°, e.g., Piazza Saint Marco in Venice - 28° to 30°, Old Market in Warsaw - 30°. The angle smaller than 10° refers to closures, which are feebly read in space. Either the plan dimensions are too vast or the vertical dimension is not adequate to provide the proper definition of space.

The closures of central angle parameter higher than 60° rarely serve as public piazzas. An important feature for their evaluation are lighting conditions proper for a given climate. The general attitude towards more densely built spaces has changed recently, their values being widely recognised after a break of Modernism. The former pejorative connotation of terms such as "canyon" or "well" [32] lost their previous importance along with common scarcity of defined spaces and dispersion of development. The central angle analysis is made for each of the cross-sections created at each of the index-points of the distinguished walls, and then combined for the walls forming the convexes, using the following formula (1), where α_1, α_2, α_3, α_n are values of central angles of each of the defined cross-sections, n is the number of index points for each wall, w_n is the width of a piece of a wall represented by a given index point and w is the length of the whole wall.

$$\alpha = \alpha_1 \times \frac{w_1}{w} + \alpha_2 \times \frac{w_2}{w} + \alpha_n \times \frac{w_n}{w} = \sum \left(\alpha_n \times \frac{w_n}{w} \right) (1)$$

D. Corrugation and size

The urban spaces must be also measured using metric values. Humans, as Gehl asserts in the interview in a documentary film 'Urbanized' by Gary Hustwit *"remain a small walking animal"* and require spaces of human scale. The spaces, which are too large seam undefined. Gehl recognises a distance of 100m as a maximum, which allows the observer for proper reception of the environment. The assumed research methodology refers to the width of half of the closure, thus the distance shouldn't exceed 50m. The actual dimensions of physical spaces reflect also the requirements defined by proxemics. The differences in personal distances influence both the perception of space and its production [13], [15] which means that we may assume that the size of space is perceived and designed differently by people of various cultural background. Continuing this thread the analysis of dimensions of public spaces proves that they remain culture specific.

The definition of space may be either precise or haze. In the first case walls form clearly cut edges, in the second one buildings and other objects are scattered, forming a kind of

fuzzy boundary. As Wejchert [32] argues, the sight tends towards forms, which are 'strong' – which means: clearly defined - and towards layouts, which are concise. Parts or whole of the observed constructions may be hidden behind other objects, which occurs both in the vertical as in the horizontal plane. In case of breaks in the structure - i.e., openings in the walls, the closest object closing the perspective visible in the silhouette view is taken into consideration. Similarly a higher building located in the background should be taken into account as, constituting a part of a silhouette, it influences the actual central angle parameter. The index points, where there are no visible constructions are described with central angle value 0.

In a situation, where buildings are set back from the line of frontages, the method allows for the description of an angle in the way similar to other cases. Variations of buildings' set back are another parameter important for the definition of the space character. The line of frontages may be located in the edge of a given convex or set back, the set back may be regular or irregular, any of these attributes influence the perception of the space (Fig. 2).
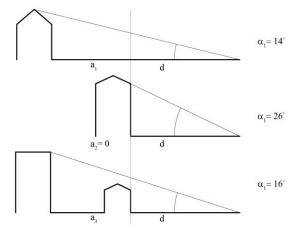

Figure 2.   Corrugation of the wall, a_n- set back or behind of a part of a wall, d – a distance of the wall from the central point of the cross-section.

Corrugation may be defined using the formula (2), where φ symbolises corrugation value of the wall and γ - set back of a single part of the wall. The possibilities of comparison of different situations are enabled thanks to the normalisation of set back values as in the formula (3), where a represents the set back in metric units and d – the distance of the wall from the central point of the cross-section. In case of some elements, set behind the lines of frontages shift should be provided as positive numbers.

$$\varphi = \frac{\sum \gamma_n}{n} \qquad (2)$$

$$\gamma_n = \frac{a_n}{d} \qquad (3)$$

E.   Distribution of index points

Further analyses include the distribution of index points, which reflects the distribution of buildings – each point belongs to a single building and the points are located in the middle of the facade. Such an analysis allows for easy detection of rhythms, repetitions, symmetries, axial layouts, etc. Distribution of index points may be described as clustered, spaced or scattered. It should be noticed that similar words are applied to the characteristics of the groups of people forming a crowd [6].

When analysing the index points distribution the parameter of regularity may be defined referring to an ideal pattern, which for each case would mean equal distribution of the number of points defined for a given wall (Fig 3). Any shift from the point resulting from an equal division should be measured and normalised by the width of the wall represented by each index point. The sum of all shifts divided by the number of index points describes the value of regularity for each wall. The regularity of the whole closure is described by the average value. The regularity may be described with the use of the formula (4), where τ is the regularity parameter, r represents a single shift, w – width of a piece of a wall represented by a given index point and n is the number of index points for a given wall (5).
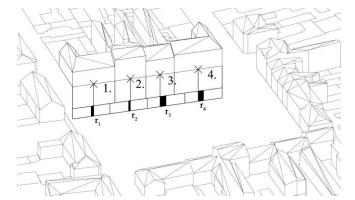

Figure 3.   Regularity of the wall – method of description.

$$\tau = \frac{\sum \tau_n}{n} \qquad (4)$$

$$\tau_n = \frac{r_n}{w_n} \qquad (5)$$

V.   CONCLUSIONS AND FUTURE RESEARCH

The challenge defined by Hall [14, p.55] that in a globalising world man must find out how *"basic cultural systems such as time and space are used to organise behaviour"* starts to influence contemporary urban design thought as numerous studies show [28]. The thread of cultural studies imports viable content to the proposal of

ontology for urban design, which is being developed e.g., by Duarte et al. [4]. The requirement to define the methodology of description of public space character has been recognised. The studies of urban morphology go through a period of intensive revival after a break associated with the activities of modernists [27] and attract the attention of numerous researchers all over the world, as Gauthier and Gilliland [8] describe in their comprehensive résumé.

An extensive set of culture dependent features was defined by Rapoport [25]. The current study provides assumptions to the quantitative description of public spaces basing on the theory by Wejchert [32]. The concept of index points is introduced which enables examination of physical form of urban settings with the use of geometrical description. Basic values are defined, including the parameters of central angle, regularity and corrugation of the walls of the closure. Further development of the current theory is envisaged, including different approaches to the analyses of urban silhouettes and cross-sections, as well as its verification for the description of the assumed case study.

The current research is an ongoing one. The further steps include validation of the proposed methodology in the experimental way and comparison of various urban environments. This may help to understand the diachronic aspects of urban development. The first step assumes exploratory modeling of various urban environments with the use of available software, including: (1) Google SketchUp; (2) CityEngine; (3) Rhino and comparison of results with the two-dimensional analysis explained hitherto.

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