6  Spatial-Social Readability of a Cityscape and Some Additional Insights into Modernistic Urban Transformations

6.1 Limits of angular segment analysis including proposed MMM models and additional perspective of the graph of public spaces

At the beginning of chapter 5, it was mentioned, that axial space syntax analysis focusses on the visually perceived axes as a background for the modelling of the movement of people in urban structures. Later on, with introduction of the segment analysis, the above mentioned axes were chopped into segments and replaced by the central street lines as more appropriate for modelling of human orientation in a city. Despite the good results of application of segment space syntax models, it is impossible to neglect the importance of visual perception in some situations, e.g. we can have two street segments of the same length with identical syntactic values, but one represents a very wide street while the other one – narrow passage. It would be logical to expect that both segments will be perceived and will affect urban network differently. Such a premise looks even more convincing if we remember the statement by Bill Hillier that space is not a territory and not an emptiness, but a container of various social contents. This statement could be expanded into the following one: each culture or period, or society has a specific public life scenario realized in space with the help of architectural measures. Such a statement could be supported by the idea of M.Cole about outer collective consciousness made out of cultural artefacts which as cultural creation have both material and ideal side. On the base of it, we can say that architectural space because of specific configurations and connections is at least catalyzing or supporting specific ways of its usage. Few historical examples could be mentioned:

– The medieval Islamic city as a labyrinth of narrow streets which aimed at the maximal separation between public and private spaces, catalyzation of social

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603 Bill Hillier [et all], “Creating Life: Or, Does Architecture Determine Anything?” in: Architecture et Comportement /Architecture and Behaviour, Lausanne, 1987, Nr. 3 (3) 233 – 250. p.237.

604 Michael Cole, Cultural Psychology: A Once and Future Discipline, Harvard: The Belknap Press, 2003.

Kęstutis Zaleckis, Kaunas University of Technology, Faculty of Civil Engineering and Architecture
contacts in narrow streets, concentrations of business activities at specific zones, etc.\textsuperscript{605} Medieval Gothic city with narrow street spaces, regular even structure, pointed out vertical dimensions and closeness of all spaces including market square. It defensive wall, according to Le Goff performed not only military but as well very important symbolic function – the border between safe urban are and in all meanings unsafe outer realm\textsuperscript{606}. According to Mumford, it was a city of religious processions, where narrow spaces transformed every observer into a participant of an event \textsuperscript{607}. Regular street network without dominant axial space and, in comparison to Islamic cities, open building facades assures closer interaction between public and private spaces and even structure in terms of commercial potential what is essential to the Western openness to the economic initiatives according to Max Weber\textsuperscript{608}. Three equal dominants in a form of cathedral, castle and town hall reflect the balance of political powers, etc.

The cities of classicism reflect completely different values and scenarios of space usage. Versailles could be taken as a good example. According to Mumford, it is a city which concentrates around the palace and reflects the life of a court \textsuperscript{609}. Wide alleys are suitable to the usage of horse transportations; the main street leads to the palace; residential squares create a kind of parking and representative space in front of houses of wealthy citizens thus copying life scenarios in the palace; commercial squares are placed away from the main streets; etc.

A lot more similar examples could be found in urban history and contemporary situations. They all demonstrate importance of spatial urban structure as a collection of cultural artefacts which allows speaking about readability of a cityscape. The spatial visually perceived features, which are essential for making a cityscape readable in a specific common way, should make a background of its identity, thus this topic is worth of investigation in the presented research in order deepen understanding how the “traditional” and modernistic cityscapes function in terms of readability. Here, before going to presentation of the methodological background is worth to make a distinction between two terms – intelligibility and readability. If the analogy with a written text is employed, then intelligibility means just legibility of

\textsuperscript{605} Amira K. Bennison, Alison L. Gascoigne (editors), \textit{Cities in the Pre-Modern Islamic World: The urban impact of religion, state and society}, London and New York: Routlage, Taylor & Francis, 2007, 231p.
\textsuperscript{606} Jacques Le Goff, \textit{The Medieval World}, London: Collins & Brown, 1997, 392p.
\textsuperscript{607} Lewis Mumford, \textit{The City in History: Its Origins, Its Transformations, and Its Prospects}, San Diego New York London: A Harvest Book Harcourt Inc., 1989, 657p.
\textsuperscript{608} Simon Parker, \textit{Urban Theory and the Urban Experience: Encountering the City}, London and New York: Routledge Taylor & Francis Group, 2004. P15-19
\textsuperscript{609} Lewis Mumford, \textit{The City in History: Its Origins, Its Transformations, and Its Prospects}, San Diego New York London: A Harvest Book Harcourt Inc., 1989, 657p.
spatial configurations, while readability is related to much deeper interaction with the observer – it could be related to recognizability of possible usage scenarios, meaning and functions of spaces, etc. In a case of text intelligibility means just that letters are clear and recognizable while readability means that text makes sense for a reader, is interesting and involving. Thus, in this chapter we will make an attempt to look at visually perceived aspects of urban genotypes and compare those of modernistic urban models with the other examples.

6.2 Theoretical background of spatial-social readability and its normalization proposal

Is spatial readability directly or indirectly already addressed by some theoretical models and could it be investigated while using quantitative approach? In the review, we will focus on models which in essence are related to human visual perception even if the term “readability” is not used.

The fundamental concept of secular pilgrimage by Benjamin Walter, which speaks about relations between urban spatial environment and its observer, should be mention in the beginning. According to it, city, because of its specific spatial structure which brings together people, activities, objects and creates conditions for unique complex experiences, becomes an object of pilgrimage – pilgrimage which aims at discovery and better understanding of self on the base unpredictable connotations, associations, memories, experiences, etc.610 Benjamin Walter does not speak about the readability of cityscape but spatial urban environment, together with its contents, is seen as an important text.

Environmental psychology has offered a concept of a preferred environment. It is such an environment which is chosen to stay if the possibility of choice exists 611. According to the authors of this concept, long term stays in not preferred environment can cause various psychological problems. The four essential features of the preferred environment are named as follows:

- Coherence. In coherent environment, all elements are perceived as parts of an integral whole.
- Complexity. There is a certain diversity of pars or elements in complex environment.
- Mysteriousness. Environment could be considered mysterious if it is each perceived as a little different or renewed, thus creating an interest to rediscover it

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610 Walter Benjamin, *The Arcades Project*, Cambridge, Massachusetts, and London: The Belknap Press of Harvard University Press, 1999. 545p.
611 Rachel Kaplan, Stephen Kaplan, Terry Brow, “Environmental Preference: A Comparison of Four Domains of Predictors”, in: *Environment and Behavior*, Vol.21 No.5, September 1989, p.509-530
again and again. It is important to note, that from perspective of urban planning, the higher degree of mysteriousness could be achieved in different ways, e.g.: by creating urban spaces which attract all people thus, each time their different activities or people could be observed of joined; by creating a spatial labyrinth where traveller can easily be lost and discover something new; by integrating nature into urban environment as it might look different depending on season or time of a day; etc.

- Legibility. Legible environment is an environment in which spatial configurations are intelligible or understandable. Legibility could be seen as a background for expression of the above mentioned three features.

There are some investigations where the model of the preferred environment is used in natural landscape analysis with employment of such quantitative indicators as a number of objects in visual field, ration between sizes of objects, density of objects, etc. Similar approach in principle is possible in manmade environment as well.

The mental city image model by Kevin Lynch is well known by architects and urban planners since the 70s of the 20th century. There are elements of a conceptually perceived city image named in the model: paths, nodes, landmarks, boundaries and districts. They could be seen as archetypical structural elements which create cityscape-text and make it readable. The successful usage of the city image model for the analysis of the role of urban green structure in assurance of more preferred urban environment in Kaunas confirms its potential relations with legibility and readability of a cityscape.

The concept of serial vision by Gordon Cullen investigates how human consciousness perceives and structuralizes cityscape from within while moving in it. According to Cullen, the character of a cityscape is determined by the relation between “here” and “there”. Here is described as space where an observer is at the precise moment; there – space which is neighbouring with here and where an observer will move soon. Here is always known and perceivable, there could be either known or unknown. A number of architectural measures, tools or elements can help to make there known or unknown; how boundaries of here are identified; how attention from here is drawn to there, etc. It is possible to think that relation between here and there make an effect on bigger or smaller intelligibility or even readability of a cityscape.

612 Åsa Ode, Mari S. Tveit, Gary Fry, “Capturing Landscape Visual Character Using Indicators: Touching Base with Landscape Aesthetic Theory” in: Landscape Research, Vol. 33, No. 1, February 2008, p.89-117
613 Kevin Lynch, The Image of the City, Cambridge MA: MIT Press, 1960, 194p
614 Kęstutis Zaleckis, “Role of the green structure in creation of preferred urban environment” in: Green structure and urban planning: final report of COST action C11, Luxembourg, COST Office, 2005, p. 249-255.
615 Gordon Cullen, Concise Townscape, London, Routledge, 2015, p17.
The concept of the line of life by Cullen could be seen as well as functional and visually readable backbone of urban structure. Relations between it and Lynch’s city image paths or some of Alexanders patterns\(^{616}\) could be found.

Bill Hillier offers a syntactic measure of intelligibility of spatial structure. It is described as correlations between the most important local syntactic features as connectivity or degree centrality and local integration as described in chapter 5, and global integration \(^{617}\). A bigger correlation means that the most reachable by pedestrian areas or streets with the biggest number of crossroads, which are the most important for visual perception of another street, coincide with the most reachable or central areas of a whole city. Because of the pedestrian reachability reflected in this model, in essence it could be further developed into readability. The problem which appears if such decision would be taken is following:

- intelligibility is calculated for the axial space syntax model, which is less precise and a little outdated if compared with the segment model which was used for the research described in chapter 5 of this book;
- both axial and segment models are focused just on the axial representation of public spaces without possibility to address their width.

Nikos A. Salingaros formulated three laws of architecture grounded in the analysis of integrity and optimality for visual perceptions of architectural patterns\(^{618}\). The first law states that integrity of architectural composition and the lowest hierarchical level is assured by tension between contradictions or controversies, e.g. black vs white, closed vs open, low vs high, etc. If this law would be applied not on facades of buildings, but on urban structure, then some analogy with Cullens’s here and there could be found. The second law states that a similarity assures integrity of architectural compositions at the higher hierarchical levels and between different levels. It could be similarity of colours, forms, volumes, etc. At the same time, so irregularity is seen as favourable in order to make pattern more attractive and interesting. The third law states that differences in sizes of neighbouring scales in an architectural composition should be equal to a number \(e\) –or 2.7. The three laws are accompanied and supported by the statement that functional and compositional focus of an architectural form should be the same in order to make a pattern of a whole structure more intelligible. The index for optimality of architectural patterns in terms of perception is proposed by Salingaros on the base of the three laws of architecture. Despite its quantitative

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\(^{616}\) Christopher Alexander [et all], *A Pattern Language: Towns, Buildings, Construction*, New York: Oxford University Press, 1977, p. 58-62.

\(^{617}\) Bill Hillier, *Space is the Machine: A configurational theory of architecture*, London, Independent Publishing Platform, 2015, p.92-102.

\(^{618}\) Nikos A. Salingaros, *A Theory of Architecture*, Vajra Books, 2016, p.26-65.
nature, this model is oriented towards analysis of building facades and could not be used directly for cityscape analysis.

In 2012 Joh Peponis created the model of cognitive frame which he used for analysis of a number of building plans. This model could be seen as the most appropriate for the intelligibility and readability modelling because it looks at an architectural space in the most complex way, reflects two types of architectural space users – transit travellers and “stayers”; is based on quantitative indicators and allows quite high resolution of analysis results. The model could be directly applied in urban scale as well. This model is based on the space syntax visual analysis approach. According to it, as well as in a case of a whole space syntax theory, space is seen as a container of various social cultural and economic processes. Spaces make a continuous network and a functional potential of a precise space is on a large scale affected by its position in a network. Mathematically a network is represented by a mathematical graph model which was discussed and explained in the 5th chapter of this book. A segment of a street becomes a node in a graph in the case of angular segment analysis. Visual graph is created in a different way: all visually perceivable space (e.g. all public spaces in a city or all interior spaces in a building) is divided into equal size cells. Each cell becomes a node of a graph. If from one cell or node the other one could be seen they are considered as connected by a common graph edge. John Peponis offered to connect to nodes only if a visual direct connection between them exists and there is a possibility to move straight from one node to the other one. Such an approach offered a simple yet elegant solution in such case as glass wall in buildings, o boundaries between public and private space in a city which is not marked by visually impenetrable walls.

Four indicators as a part of cognitive frame model were offered by John Peponis:
- **direct purview or area of visible and by movement accessible space.** It is calculated on the base of the following formula: \( DP(x) = (\sum n+1) \cdot m^2 \), where \( \sum n \) is a sum of all nodes which are visible and accessible by a straight movement from the node \( x \); \( m^2 \) – area of one cell or node of visual graph. In a case of building layout analysis are of a cell is proposed to be equal to 0.49 m\(^2\) as the smallest area occupied by one man. Size of the visually observed field definitely is related to a possible function of space thus it could be seen as an important indicator of both intelligibility and readability.
- **Path elongation** is described by formula \( PE(x) = \sum \frac{(l-l_0)}{l_0} \). It is equal to a sum of ratios between a real shortest distance between \( x \) and all the nodes in the graph in meters (\( l \)) and the straight distance between the same nodes (\( l_0 \)) and the straight distance (\( l_0 \)). A bigger path elongation value shows a more labyrinth like structure. This indicator is important for perception and reading of cityscape.

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619 John Peponis, “Building layouts as cognitive data: purview and purview interface” in: Cognitive Critique 6, 2012. p. 11-52.
while moving in it. We can easily imagine that bigger path elongation creates completely different serial vision and „here-there“ experience if compared to a straight line, thus it is without doubt related to intelligibility and readability.

- Mean turn number represents the mean number of turns which traveller should take from a counted nod x to all the rest nodes of the graph. It is described by the formula $MT(x) = \Sigma t/(n-1)$ where $\Sigma t$ is a sum of turns from the calculated node x to the rest of the graph and n is the node number. In essence, this indicator is a little similar to path elongation, but it allows to measure distance in turns as more essential elements of distance felt by humans thus relating it to cityscape readability.

- Path length per turn is counted by the formula: $PLT(x) = \Sigma l/MT$. $\Sigma l$ marks a sum of all straight paths in meters which cross the node x, MT – is a mean number of turns from the node x as counted in the previous formula described in a text above. It is easy to imagine that in the labyrinth like the structure of the medieval Islamic city this indicator will be very low while in classicistic city as Versailles it will be significantly bigger. The presented example and the fact that path or route is one of the archetypical spatial elements as explained by Mircia Eliade in the description of a Roman town creation ritual$^{620}$, allows seeing these indicators as a part of cityscape intelligibility and readability formants.

In conclusion it could be stated that the cognitive frame model suites quite well for the intelligibility and, may be, readability analysis as it could be practically directly applied at urban scale, offers high enough modelling precision and is based on a similar mathematical graph as already used space syntax model and is following the same theoretical approach: space as a container. As models need some further development in order to address readability aspects and allow direct comparison between various cities, some other reviewed ideas could be employed as well.

### 6.3 Readability of a cityscape

While making an attempt to apply the cognitive frame model by John Peponis in various urban settings at urban scale the two problems were met:

- It is impossible to compare directly numerical values between cities or investigated urban areas of different sizes. The normalization of numerical values is needed.
- Four indicators are difficult to generalize and need to be combined without losing the complexity of the model.

While the second problem was addressed, the two new indicators, based on the concept of semiotic of space that the essence of architecture is demonstration

$^{620}$ Mircea Eliade, *The Sacred and the Profane the Nature of Religion*, Harcourt, Inc. 1987 p. 47.
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and hiding of space, were proposed. The dynamic and static demonstration. Both together these indicators were named readability of cityscape, having in mind a fact that they have to indicate not only intelligibility, but also readability of space as container of social processes. These two indicators are described by the following formulas:

\[
DD = MT \times PE \\
DS = DP \times PLT
\]

Where DD and DS means dynamic and static demonstration, MT, PE, DP and PLT correspond to the indicators described in chapter 6.2. On the base of the formulas, it is easy to understand that the lowest numerical values of DD indicate the areas of cityscapes that are reachable from all locations of the graph by the smallest number of changed movement directions and the smallest elongations of a straight line between all graph nodes. The biggest values of DS indicate spaces which have the biggest visually perceived and accessible area and are crossed by the longest straight aces.

When the essential for this research possibility to compare the readability of different urban structures was addressed, there were different attempts to normalize DD and DS numerical values made. The first idea was to compare DD and DS with possible maximum and minimum values, e.g. the maximal possible number of turns in a labyrinth or maximal length of a straight axe fitted in the investigated territory. In order to check normalization procedure calculations with around twenty historical cities, which represent various urban spatial-social genotypes in the clearest possible form: Tunis, Damascus, Fez, Sfax as medieval Islamic cities which demonstrate narrow socially integrating spaces and labyrinth like structure; Vilnius, Krakow, Berlin, Norwich and Kaunas as an examples of medieval European towns; Zamosc, Palmanova, Nove Zamky and Sabionetta as Renaissance cities; Versailles, Edinburg New Town, Kaunas New Town and Wren's London plan as an examples of classicistic cities; Plan Voisin, Brasilia, Kalnieci and Silainiai in Kaunas, Elektrenai and Visaginas as examples of modernistic town planning. After a series of calculations and analysis of the results, it was concluded that the first idea of normalization of readability is not enough sensitive to the differences between investigated cities, the numeric scale is too close to zero and hard to read, and, what is the most important, it does not cover social dimension of a space, e.g. wide and long street configuration is well intelligible, but, when certain dimensions are reached, a space becomes too big to be perceived as a container of social content. Moreover, if the same territory was investigated within slightly different borders then the results of normalized DD and DS values were different as borders made an effect possible maximal reference values, e.g. the possible longest axe within configuration.

621 Piero Pellegrino, “Semiotics of Architecture” In: Oxford, Elsevier, Keith Brown, (Editor-in-Chief), Encyclopedia of Language & Linguistics, Second Edition, 2006, volume 11, pp. 212-216.
The second idea of normalization was based on a comparison of DD and DS values to the chosen reference existing or at least planned urban structures: Fez as the most labyrinth like and closed urban structure, and Plan Voisin as the most open, regular modernistic city was chosen. Again it was discovered that boundaries and size of investigated territory make a significant impact as in order to be able to compare, the investigated and standard territory should be made equal in size. The social spatial dimension was not addressed directly during the normalization procedure and there always existed a possibility to find an example which better than a chosen standard represents a specific urban genotype.

The third proposal of normalization is focussed on certain limits of humans to perceive social content and interact accordingly (e.g. on the base of personal or social dimensions), and offers to normalize each of four indicators (DP, MT, PLT, PE) separately. In this case, 137 meters were chosen as a limit of social distance\textsuperscript{622} while normalizing DP. The same distance was used for PLT normalization just in this case, the Cullen's here and there formula was used while seeing 137 meters as here distance if no other obstacles exist. PLT normalization was based on the finding that people do not feel elongation if a straight path is prolonged up to 20 per cent\textsuperscript{623}. For normalization of MT a number of three turns was taken as, according to Hillier, the most often met distance for allocation of local urban centres of other important objects in organically evolving urban structures\textsuperscript{624}. The scales of four normalized indicators in the investigated cases fluctuate between 0 and 30 where 0-1 part identifies readable spaces. In the future, while continuing investigation the upper border of a scale could be limited, e.g. on a base of limits of visual perception, etc. The following formulas were used for normalization:

- $DP_{\text{norm}}$ for a precise node of a graph $x$ is equal to ratio between DP and DP with metric radius 137. It could be written in a such way: $DP_{\text{norm}} = \frac{DP}{DP_{137}}$. In a more simple way, it could be explained as a ration between all visually perceived are from point $x$ and are within 137 meters distance.

- PLT normalization is counted while dividing PLT, which is calculated according to John Peponis proposal, by $137m \times 4$ or 548 meters. Number 4 represents „here“ distance to both sides form a calculated node $x$ and two additional „there“ distance. The formula is the following: $PLT_{\text{norm}} = \frac{PLT}{137 \times 4}$.

- PE normalized value is calculated just by multiplying it by 1.2 as it could be seen as already normalized. The formula is following: $PE_{\text{norm}} = PE \times 1.2$.

\textsuperscript{622} Hans Blumenfeld, *The Modern Metropolis: Its Origins, Growth, Characteristics and Planning*, Cambridge: MIT Press, 1967, 377p.

\textsuperscript{623} Mahsan Mohsenin, Andres Sevtsuk, “*The impact of street properties on cognitive maps*” in: *Journal of Architecture and Urbanism*, 2013, Volume 37(Issue 4) 301–309.

\textsuperscript{624} Bill Hillier, *Space is the machine: A Configurational Theory of Architecture*, London, Independent Publishing Platform, 2015, p.99.
MT normalization as well is conducted in a simple way – by dividing it by 3: \( MT_{\text{norm}} = MT/3 \).

Before moving to DD and DS normalization, which in essence is very simple, it is worth again to discuss the essence of demonstration concept and how it is related to the chosen cognitive frame model and its normalization. Space semioticians describe architecture as an art to de monstrate or kill a monster of chaos\(^{625}\) by segregating spaces and making some of them more visible than others. The process of demonstration could be described in pairs of perceived spatial oppositions\(^{626}\) which help us to structure an environment:

- **Open vs Closed.** It could be said that visual graph and connectivity of its nodes are constructed on the base of this pair. In the case of DP, it could be expanded by adding a pair accessible vs not accessible. The proposed normalization procedure sets a limit to a degree of openness and accessibility which are too big to be perceived in a structured way. Normalized DP values as well allow to speak about more social or more official nature of urban spaces and correspondingly – scenarios of its usage, e.g. if normalized value of DP is equal to 1 then it means that space could be felt as a big social space (e.g. public square); if values is equal to 0.1 than a space is perceived as almost private. It is logical to predict that people will act accordingly to the proposed by space scenarios.

- **Here vs There** based on Cullen' concept as a fundamental pair for serial vision\(^{627}\) structuring. Normalization again introduces limits to unlimited openness of urban axes. It is important to note, that the concept of serial vision and PLT indicator as well correspond to the archetypical model of road or path, which is one of the few basic elements in Lynch's city image.

- **Static vs Dynamic.** This pair reflects different ways to interact with urban environment either by staying in a place and looking around or moving in a space. DP and PLT represent two aspects of static perception while combining perceived area and degree of axiality of visual space. PE and MT represent the dynamic element of the presented pair and are normalized as it was described earlier in this chapter. Both together MT and PE combined two types of perception of distance, which might be both actual depending on situations: in some case metric distance could be felt better while in some – angular distance is more important. In any case, if combined they can make a more precise representation of human psyche relation to movement distances. Static vs Dynamic opposition pair as well forms a background for calculation of two demonstration types.

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625 Piere Pellegrino, “Semiotics of Architecture” In: Oxford, Elsevier, Keith Brown, (Editor-in-Chief), *Encyclopedia of Language & Linguistics*, Second Edition, 2006, volume 11, pp. 212-216.

626 Pairs of oppositions, according to semiotics, make a background of any semantic structure.

627 Gordon Cullen, *The Concise Townscape*, London: Architectural press, 2009, p.17.
– Demonstrated vs Hidden or Illegible vs not illegible. In essence, two demonstrations, based on four normalized indicators, in a complex way describe investigated cityscape as a special-social structure based on these oppositions. It is worth to note that the par Demonstrated vs Hidden creates a background for various cultural-social scenarios and messages, e.g. by the type of the most demonstrated spaces or objects in a city we can relatively easily determine ideals of a precise culture; ways of presentation could be identified as more democratic, or more autocratic, etc.

So, the normalized cognitive frame values describe a cityscape in a quite complex way and prelate space with potential spatial or cultural context.

The final normalized formulas of static and dynamic demonstrations could be written in the following manner:

\[
DD_{\text{norm}} = MT_{\text{norm}} \times PE_{\text{norm}} \\
DS_{\text{norm}} = DP_{\text{norm}} \times PLT_{\text{norm}}
\]

Normalized dynamic demonstration could be described as showing those public urban spaces which are reachable from a rest of a spatial network by less than 3 turns and 20 percent of a straight line path elongation. Such spaces could be seen as potential allocations of the most important objects and the most intensive public use.

Normalized static demonstration identifies spaces which are perceived as most suitable for social activities because of the area and limited length of streets. In case of numbers, it means radius up to 137 meters and axe up to 548 meters.

While having in mind that a smaller part of public spaces in a city could be related to more intensive public usage or street culture, the third indicator besides DD and DS was offered – Intensity of usage of public spaces. It would be logical to conclude that more intensively used spaces, and places of a cityscape will be more clearly readable as asocial and cultural containers not only because of spatial configurations, but because of presence of both direct and indirect marks of its usage, e.g.: people, remaining various objects of small architecture, etc. Intensity is calculated by dividing an area of public spaces by an area of a whole investigated territory.

The above described methodology of normalization of cognitive frame values and three newly introduced indicators were successfully tested and used for the analysis of around twenty historical urban examples in order to see the modernistic urbanism in a wider cultural context and better understand its peculiarities and possible effect on human behaviour in public spaces. The results of investigation are presented in the next sub-chapter.
6.4 Readability investigation of the historical cities with a wider perspective on the peculiarities of modernistic urbanism

The proposed normalization model for four cognitive frame components and three new suggested indicators was applied in two stages. The first stage aimed at the initial test of the model while analyzing two completely different in terms of street culture urban structures. The first example was chosen medieval European city with the introvert structure of even in terms of functioning, narrow street spaces functioning as intensive locations of various forms of street culture, exchange of information and both cultural and social interactions – it is presented by the 13th century Berlin plan. Modernistic urbanism with extravert spatial structure, separation of pedestrian and car traffic, main streets replaced by roads, eliminated private space and offering lot of choices for terms of spatial locations for a public space users was chosen as the second case and the iconic Plan Voisin, which was offered as a model for Paris center renovation in 1925, was chosen as its example.

What information about two cities were revealed on the base of conducted normalized calculations and do it corresponds to general knowledge about the functioning of these two urban spatial-social genotypes?

In the case of Berlin, we see very social spatial structure: DP$_{\text{norm}}$ mean values fluctuate around 0.3 and only single maximal values reach 1.2 in the most open crossroads of the gothic plan. If the medieval organic plan were investigated, the max numbers would be significantly lower because of curved street lines. It would be suitable to remind here that in the normalized scale one marks the boundary between more introverted, social space and more extraverted, logistic, may be representative space. Closeness to zero, in this case, demonstrates existence of more private or even intimate public spaces. In this case mean 0.3 value demonstrates very social spaces, but, in comparison to the medieval Islamic cities, where even smaller spaces performed a role of catalyzation of social contact and separation of private from public spaces, these numbers should be higher. PE$_{\text{norm}}$ even max values do not exceed 1 (0.98) and it is logical in an even, regular gothic plan. If we look a little further and check similar indicator of the Islamic cities with a tree like street structure, then we will find both max and mean values which exceed those from Berlin. Functional and compositional axes of the city (PLT$_{\text{norm}}$) variate between 0.12 and 0.38 thus demonstrating not only well perceivable “here and there” structure, but two additional things:

- Relatively small size and as a whole closed structure of the city what is true in the investigated case. It could be explained like this because the size and borders of the investigated area affect max PLT values in a regular structure with straight streets as the gothic one. In the future such a sensitivity to a structure size could be eliminated by adding max visual perception distance as a limit for calculations, but at the moment it might be even useful to be able to identify a city or its regular structure islands size just by numbers.
On the other hand, smaller PLT values can show some de-regularization of an initially regular gothic plan. It is true in the case of Berlin as city is divided by a river and some de-regularization of street network might be noted on the plan (Fig. 6.1.).

MT\textsubscript{norm\textsuperscript{norm}} mean values reach 0.9 while max is equal to 1.9. It means that in general majority of spaces are reachable from each other up to 3 turns what corresponds, according to Hillier\textsuperscript{628}, to good local or pedestrian reachability. 1.9 value of MT max means that there are some tree type segments with possibly dead end street in the city plan and in such areas could be seen in the medieval city plan. While looking and the maps with normalized 4 values (DP, MT, PE, PLT) in figure 6.1. some general remarks could be made as well. In the DP map the dominance of small normalized values could be noted with a little bigger size of spaces reflected in some squares and wider streets. MT values are a little higher at the periphery of the city where its street network loses some regularity. In terms of PE the dominant majority of city is very well reachable. The biggest PLT values are seen in the straight streets and the main squares, but, those do not exceed social dimensions as the reviewed numerical values confirm.

\textbf{Fig. 6.1.} DP\textsubscript{norm\textsuperscript{norm}}, PLT\textsubscript{norm\textsuperscript{norm}}, MT\textsubscript{norm\textsuperscript{norm}} and PE\textsubscript{norm\textsuperscript{norm}} values in the 13\textsuperscript{th} century Berlin. Blue colour shows the lowest numerical values.

\textsuperscript{628} Bill Hillier, Space is the machine: A configurational theory of architecture, London, Independent Publishing Platform, 2015, p.99.
The DD$_{\text{norm}}$ and DS$_{\text{norm}}$ maps (Fig. 6.2., 6.3.) show a more generalized image which could not be so easily created from just above discusses four indicators. DD map demonstrates that in essence all city is very well reachable except some dead end streets. DS map shows

**Fig. 6.2.** DD$_{\text{norm}}$ in the 13$^{th}$ century Berlin. Blue colour shows the lowest numerical values.

**Fig. 6.3.** DS$_{\text{norm}}$ in the 13$^{th}$ century Berlin. Blue colour shows the lowest numerical values.
How do Plan Voisin calculations look like? DP \textsubscript{norm} mean values reach 7.3. If compare to Berlin, it looks like a huge number and exceeds a value of 1 by 7 times, thus allowing to state that area is perceived as a field rather than as an urban structure. PLT \textsubscript{norm} mean values reach 1.518, max -2.086. Number is much higher if compared to Berlin and, we guess, are not bigger just because of the relatively small investigated area, but
even in this case, mean values show asocial length of the axes. Both $MT_{\text{norm}}$ and $PE_{\text{norm}}$ demonstrate the values which are significantly lower than in Berlin and close to zero. In terms of dynamic demonstration, it could be said that Plan Voisin has “no secrets” or no hidden spaces thus again acting as an empty field. This reveals a paradox of this iconic modernistic urban structure: dynamically all spaces are exposed, but statically there practically is no social spaces or places if the terminology of You Fu Tuan is used\textsuperscript{629}. The evenness of the all four indicators $DD_{\text{norm}}$ and $DS_{\text{norm}}$ in the territory is clearly seen in figures 6.4., 6.5., 6.6.

Fig. 6.6. $DS_{\text{norm}}$ in Plan Voisin. Blue colour shows the lowest numerical values.

The intensity values finalize the comparison of two cities: in Berlin, it is equal to 0.25 while in Plan Voisin – 0.9. It could be generalized that the normalized model revealed two essentially different urban spatial-social genotypes:

– The first one made of spaces of social dimensions, with all of them dynamically well reachable but separated at the same time, intensively used. It all allows to speak about democratic, horizontal and functionally clearly, but not too much divided, potentially multifunctional or with evenly spread specializations network of public spaces in Berlin.

\textsuperscript{629} Yi-Fu Tuan, *Space and Place the Perspective of Experience*, Minneapolis, London: University of Minnessota Press, 2001, p. 67-85.
In the second case, we can see very extensively used, asocial continues spaces what corresponds to the initial ideas of modernistic urbanism – to have green area with some free standing buildings freely allocated in it.

While comparing those two cities, the idea from calculation of optimality of architectural pattern for perception by Nikos A. Salingaros could be borrowed for some additional interpretation of the received results. According to Salingaros, the most optimal pattern should reach a balance between simplicity or so called attractiveness and complication. In our case DD norm, if it’s numerical values are too low or all spaces are very well demonstrated, it creates, as in case of visual pattern perception, too many possibilities which are hard to combine into commonly perceivable, readable and in the same way usable structure. Thus, in terms of Eliade, undivided and not structured enough urban space reminds the “initial chaos” from which city had to escape while using planning tools as division of space into private and public, structuring public space by created moving paths, by making some spaces more reachable or demonstrated than others, etc. It is impossible at the moment to present the optimal in terms of readability model, but it could be stated at least, that the 13th century Berlin is much closer to it if compared to Plan Voisin.

The normalized model worked quite well in the initial test. Will it show subtle differences if more urban models will be analyzed? The calculated numerical values of 29 urban samples, including the 13th century Berlin and Plan Voisin, are presented in table 6.1. The date besides the plan name (e.g. Kaunas 1789) shows just a year of the map, but do not represent the historical period of a city plan: in case of Kaunas the map from 1789 is the first reliable map, but it reflects unchanged medieval structure of the city.

In order to make a general tendency of changes of DD norm, DS norm and Intensity, these three indicators are presented in scatterplots in figures 6.7, 6.8, 6.9. The sequence of samples in the table and in the scatterplots is made according to:

- chronological order: middle ages, renaissance, classicism, modernism;
- increased openness of public spaces: Islamic city as the most closed one, medieval European city, Renaissance, Classicism and modernistic urbanism.

While looking at the presented numerical data certain clear groups of the investigated cities could be identified which in essence correspond to the historical acknowledge urban planning styles or systems.

The first group is made out of medieval Islamic cities: Fez, Damascus, Tunis, and Sfax. They all could be described as labyrinth like structures which are hard to navigate for outsiders; which demonstrate extremely narrow spaces and tend to segregate as much as possible private from public realms and public commercial from

630 Nikos A. Salingaros, A Theory of Architecture, Vajra Books, 2016, p.122-152.
public in housing areas. The following essential finding on the base of normalized calculations of readability was made:

- Much lower $\text{DP}_{\text{norm}}$ mean numerical values than in European cities of the same period. In the first group, they fluctuated between 0.1 and 0.2 while in Europe between 0.3 and 0.6. It should be noted that in Damascus and Tunis max DP values are quite high – 1.65 and 2.74 correspondingly. Such numbers are close to some examples from medieval Europe, but in the case of Damascus it could be explained by the rudiments of Hellenistic regular city plan. In the case of Tunis, the high max numbers appear because of the wide unbuilt space along the city wall.

- $\text{PLT}_{\text{norm}}$ is much lower if compared to Europe as well. The mean values change between 0.09 and 0.18 (0.18 and 0.33 in European medieval cities). Damascus makes a special case in this group because of the mentioned regular plan rudiments: PLT mean values there are close to some European examples, but min values are much lower thus reflecting peculiarities of this group.

- $\text{MT}_{\text{norm}}$ mean values are very similar in all four cities: 2.0, 2.1, 2.4, 2.6. A similar indicator is seen only in European cities with more organic plans with max values still significantly higher in this group. From one side it shows very segregated public space network, but from another perspective, this mean value could be seen as a still functional maximum which allows for a system not to fall apart in terms of readability.

- $\text{PE}_{\text{norm}}$ does not demonstrate significant differences if compared to Europe: form one side the mean values are higher here – 0.02 -0.56 (In Europe 0.17-0.26), but initially it was expected to have a higher difference. May be, as in case with $\text{MT}_{\text{norm}}$ mean, it shows that even in organic or labyrinth like structures, in order to function properly, a system of public spaces should be rational enough, unless, with a higher PE values it might be transformed into real labyrinth which would be significantly less functional as a city plan.

- $\text{DD}_{\text{norm}}$ (Fig. 6.7.) and $\text{DS}_{\text{norm}}$ values summarize and generalize the four indicators and show very well, statically readable and less well dynamically readable cities. If we look at the scatterplots (Fig. 6.7,6.8.) we can see the group of Islamic cities as having the highest DD and the lowest DS values with some exceptions which will be discussed later. Intensity of space usage is similar as in medieval Europe, but, while looking at the plans, it might be predicted that in the Islamic cities the highest intensity will be around business are while in Europe it should be more or less evenly spread around a whole city. More detail investigation could be performed in the future by dividing all city into equal cells and calculating intensity for each of them separately.
Fig. 6.7. Scatterplot of DD norm values of the investigated cities.

Fig. 6.8. Scatterplot of DS norm values of the investigated cities.

Fig. 6.9. Scatterplot of Intensity values of the investigated cities.
Table 6.1. Normalized values of the calculated indicators of the visual graph analysis.

| City          | DP Max | Mean | Min | PLT Max | Mean | Min | PE Max | Mean | Min | MT Max | Mean | Min |
|---------------|--------|------|-----|---------|------|-----|--------|------|-----|--------|------|-----|
| Visaginas     | 14,45  | 2.52 | 0.009 | 2.07 | 1.05 | 0.35 | 0.179 | 0.028 | 0.014 | 2.20 | 0.633 | 0.372 |
| Elektrenai    | 6.45   | 1.52 | 0.02 | 1.21 | 0.73 | 0.39 | 0.24 | 0.05 | 0.02 | 1.07 | 0.57 | 0.35 |
| Kalnieciao    | 3.07   | 0.96 | 0.02 | 0.84 | 0.45 | 0.21 | 0.27 | 0.08 | 0.03 | 1.17 | 0.57 | 0.37 |
| Silainiai     | 4.24   | 0.91 | 0.02 | 0.89 | 0.55 | 0.34 | 0.26 | 0.05 | 0.03 | 1.39 | 0.59 | 0.37 |
| Brasilia 2    | 28,71  | 4.50 | 0.08 | 1.87 | 1.20 | 0.50 | 0.12 | 0.05 | 0.03 | 1.08 | 0.49 | 0.29 |
| Brasilia 1    | 47,49  | 12.83 | 0.06 | 3.40 | 2.08 | 0.80 | 0.29 | 0.02 | 0.01 | 0.91 | 0.34 | 0.22 |
| Plan Voisin   | 12,19  | 7.32 | 0.03 | 2.09 | 1.52 | 0.70 | 0.20 | 0.03 | 0.02 | 0.56 | 0.26 | 0.22 |
| Kaunas NM 1990| 5,21   | 0.60 | 0.00 | 0.94 | 0.52 | 0.25 | 0.32 | 0.12 | 0.06 | 2.27 | 1.14 | 0.64 |
| Kaunas NM 1939| 6,27  | 1.64 | 0.06 | 1.15 | 0.716 | 0.35 | 0.40 | 0.21 | 0.12 | 2.12 | 0.93 | 0.57 |
| London Wren's | 6,67   | 1.76 | 0.02 | 1.89 | 0.918 | 0.335 | 0.26 | 0.12 | 0.05 | 1.63 | 0.74 | 0.38 |
| Edinbug NT 1774 | 9,03   | 1.87 | 0.02 | 0.991 | 0.572 | 0.238 | 1.31 | 0.25 | 0.09 | 2.18 | 0.80 | 0.44 |
| Berlin 1688   | 2,12   | 0.44 | 0.01 | 0.483 | 0.293 | 0.182 | 0.99 | 0.33 | 0.18 | 2.11 | 1.34 | 0.80 |
| Versailles 1795 | 11,85  | 2.93 | 0.09 | 1.70 | 0.918 | 0.32 | 0.562 | 0.208 | 0.077 | 1.63 | 0.638 | 0.328 |
| Palamanna 1851 | 0,91   | 0.22 | 0.02 | 0.38 | 0.21 | 0.13 | 0.25 | 0.15 | 0.09 | 1.28 | 0.77 | 0.37 |
| Sabionetta 1848 | 1,13  | 0.29 | 0.04 | 0.409 | 0.229 | 0.128 | 0.90 | 0.29 | 0.15 | 1.64 | 0.81 | 0.44 |
| Nove Zamky 1680 | 0,41  | 0.14 | 0.02 | 0.318 | 0.173 | 0.118 | 0.47 | 0.14 | 0.08 | 0.69 | 0.43 | 0.25 |
| Zamosc 1694   | 1,44   | 0.428 | 0.01 | 0.446 | 0.268 | 0.16 | 1.67 | 0.285 | 0.104 | 1.44 | 0.624 | 0.353 |
| Venice 1838   | 4,59   | 0.376 | 0.003 | 0.257 | 0.189 | 0.138 | 1.90 | 0.761 | 0.334 | 12,46 | 8.01 | 5.10 |
| Kaunas Senamiestis 2016 | 2,19 | 0.403 | 0.003 | 0.474 | 0.284 | 0.125 | 0.528 | 0.176 | 0.071 | 3,09 | 1,21 | 0.677 |
| Kaunas Senamiestis 1990 | 1,70 | 0.30 | 0.00 | 0.47 | 0.28 | 0.15 | 0.47 | 0.13 | 0.06 | 2,61 | 1,19 | 0.68 |
| Kaunas Senamiestis 1939 | 2,48 | 0.611 | 0.026 | 0.462 | 0.333 | 0.202 | 0.418 | 0.171 | 0.079 | 1,76 | 1,07 | 0.636 |
| Kaunas 1798   | 2,63   | 0.537 | 0.029 | 0.46 | 0.31 | 0.20 | 0.531 | 0.191 | 0.078 | 2,29 | 1,15 | 0.631 |
| Krakow 1837   | 1,76   | 0.48 | 0.03 | 0.63 | 0.35 | 0.20 | 0.66 | 0.19 | 0.12 | 2,22 | 0,81 | 0,45 |
| Vilnius 1737   | 1,13   | 0.315 | 0.012 | 0.27 | 0.18 | 0.10 | 0.634 | 0.25 | 0.132 | 2,86 | 1,62 | 0,939 |
| Berlin 13     | 1,20   | 0.30 | 0.01 | 0.38 | 0.23 | 0.12 | 0.98 | 0.26 | 0.17 | 1,89 | 0,91 | 0.52 |
| Fez           | 0,96   | 0,18 | 0.00 | 0.14 | 0.09 | 0.04 | 2.08 | 0.56 | 0.21 | 6,09 | 2,39 | 1,40 |
| Sfax          | 0,464  | 0,073 | 0.002 | 0.14 | 0.09 | 0.06 | 0.603 | 0.282 | 0.156 | 3,38 | 2,00 | 1,23 |
| Damascus      | 1,65   | 0,198 | 0.003 | 0.43 | 0.22 | 0.09 | 0.675 | 0.289 | 0.18 | 5,47 | 2,13 | 1,18 |
| Tunis         | 2,74   | 0,219 | 0.004 | 0.27 | 0.16 | 0.10 | 0.445 | 0.203 | 0.095 | 5,25 | 2,59 | 1,81 |
|                  | Max   | Mean  | Min   | Max   | Mean  | Min   | VG area      | All area      | Int  |
|------------------|-------|-------|-------|-------|-------|-------|--------------|---------------|------|
| **DD**           |       |       |       |       |       |       |              |               |      |
| Visaginas        | 0,343 | 0,019 | 0,006 | 34,85 | 2,86  | 0,006 | 2438600,00   | 2761228,00   | 0,883 |
| Elektrenai       | 0,19  | 0,03  | 0,01  | 7,06  | 1,17  | 0,01  | 934300,00    | 1078187,00   | 0,87  |
| Kalniecijai      | 0,29  | 0,05  | 0,01  | 2,51  | 0,34  | 0,00  | 427500,00    | 540973,00    | 0,79  |
| Silainai         | 0,24  | 0,03  | 0,01  | 3,63  | 0,53  | 0,01  | 669200,00    | 803958,00    | 0,83  |
| Brasilia 2       | 0,10  | 0,03  | 0,01  | 50,10 | 6,02  | 0,06  | 2514000,00   | 3058743,00   | 0,82  |
| Brasilia 1       | 0,14  | 0,01  | 0,00  | 143,68| 28,55 | 0,06  | 3727600,00   | 4324357,00   | 0,86  |
| Plan Voisin      | 0,09  | 0,01  | 0,00  | 22,75 | 11,36 | 0,34  | 1291658,00   | 1434600,00   | 0,90  |
| Kaunas NM 1990   | 0,65  | 0,14  | 0,05  | 4,69  | 0,35  | 0,00  | 1110925,00   | 2022105,00   | 0,55  |
| Kaunas NM 1939   | 0,76  | 0,19  | 0,09  | 6,68  | 1,23  | 0,022 | 503400,00    | 2022105,00   | 0,24  |
| London Wren's    | 0,30  | 0,09  | 0,03  | 10,39 | 1,59  | 0,008 | 907038,00    | 2821767,00   | 0,32  |
| Edinburg NT 1774 | 2,76  | 0,26  | 0,05  | 6,23  | 1,17  | 0,004 | 399276,00    | 1010593,00   | 0,40  |
| Berlin 1688      | 1,57  | 0,45  | 0,18  | 0,816 | 0,137 | 0,004 | 240300,00    | 696704,00    | 0,35  |
| Versailles 1795  | 0,727 | 0,136 | 0,029 | 13,15 | 2,98  | 0,046 | 747400,00    | 1876117,00   | 0,40  |
| Palmonicova 1851 | 0,25  | 0,12  | 0,05  | 0,33  | 0,05  | 0,00  | 84114,00     | 207516,00    | 0,40  |
| Sablonetta 1848  | 1,06  | 0,25  | 0,07  | 0,437 | 0,072 | 0,006 | 38128,00     | 214654,00    | 0,18  |
| Nove Zamky 1680  | 0,33  | 0,06  | 0,02  | 0,129 | 0,025 | 0,003 | 21980,00     | 44618,00     | 0,49  |
| Zamoc 1694       | 1,86  | 0,201 | 0,048 | 0,543 | 0,123 | 0,002 | 70794,00     | 220501,00    | 0,32  |
| Venice 1838      | 19,40 | 6,31  | 2,07  | 0,805 | 0,074 | 0,0006| 1811120,00   | 7812498,00   | 0,232 |
| Kaunas Senamiestis 2016 | 1,22 | 0,218 | 0,078 | 0,885 | 0,127 | 0,0004| 275463,00 | 844515,00 | 0,326 |
| Kaunas Senamiestis 1990 | 0,81 | 0,16  | 0,06  | 0,79  | 0,10  | 0,00  | 393648,00 | 844515,00 | 0,47  |
| Kaunas Senamiestis 1939 | 0,554 | 0,183 | 0,076 | 1,10  | 0,212 | 0,006 | 169936,00   | 844515,00    | 0,20  |
| Kaunas 1798      | 1,12  | 0,226 | 0,085 | 0,81  | 0,18  | 0,01  | 139050,00    | 707756,00    | 0,20  |
| Krakow 1837      | 0,84  | 0,16  | 0,06  | 0,99  | 0,18  | 0,01  | 149150,00    | 641346,00    | 0,23  |
| Vilnius 1737     | 1,23  | 0,415 | 0,13  | 0,27  | 0,06  | 0,00  | 87066,00     | 618278,00    | 0,14  |
| Berlin 13        | 1,18  | 0,24  | 0,10  | 0,44  | 0,07  | 0,00  | 71757        | 288756,00    | 0,25  |
| Fez              | 12,23 | 1,44  | 0,32  | 0,13  | 0,02  | 0,00  | 30521,00     | 175898,00    | 0,17  |
| Sfax             | 1,98  | 0,14  | 0,261 | 0,06  | 0,01  | 0,00  | 43788,00     | 176198,00    | 0,25  |
| Damascus         | 2,86  | 0,627 | 0,229 | 0,56  | 0,05  | 0,00  | 175490,00    | 1257175,00   | 0,14  |
| Tunis            | 1,56  | 0,526 | 0,235 | 0,71  | 0,04  | 0,00  | 202905,00    | 957723,00    | 0,21  |
While concluding it should be pointed out that all four cities of this group, as well as the rest of investigated cases, were modelled on the base of historical maps except Fez, for which a precise map was used. Despite some possible errors, as increase of spaces on a map, the general tendencies and differences are quite clear.

![Fig. 6.10. DD norm maps of the medieval Islamic cities](image)

The second group is made out of medieval European cities: Berlin in the 13th century, Kaunas, Vilnius and Krakow. The results of the calculations are close to already discusses case of Berlin:

- **DP** <sub>norm</sub> values are in general higher than in the first group. Mean values change from 0.30 to 0.611 show more spacier, but very well socially-spatially readable urban structure. Some variety inside the group could be related to the differences in the width of the streets, e.g. in Kaunas, according to the map and available GIS data they are much wider.
- **PLT** <sub>norm</sub> mean changes around 0.25 and is higher than in the first group except Vilnius (0.18) which demonstrates the organic medieval city plan.
- **PE** <sub>norm</sub> and **MT** <sub>norm</sub> mean fluctuates around 0.17 and 1.0 and show spatial structure where spaces are better reachable from each other in terms of meters and turns if compared to the Islamic cities. A little higher mean values are found in Vilnius and Berlin. The first case could be explained by already mentioned organic plan, the second one – by division of a city by river with limited number of bridges.
- Intensity is similar as in the first group and fluctuates around 0.20
Interesting results are observed while comparing Kaunas Old town in 1798 and 1939. From the first glance, urban structures are the same, but in 1939 DP and PLT values are higher thus reflecting some hardly notable changes introduced in the 19th century, as some new market squares of a prolonged and widened street segment in front of governor’s palace.

In summary, it could be stated that the investigated medieval European towns represent a little better dynamically and well statically readable spaces. Two subgroups were identified: cities with regular gothic plan and organic plan. DD norm maps of this group are presented in figure 6.11.

Fig. 6.11. DD norm maps of the medieval European cities.

The third group – cities of classicism and based on classicism ideas: Versailles, Edinburg New Town, Wren’s London plan, Kaunas New Town. They demonstrate the following results:

- DP norm mean values change from 1.64 to 2.93 while max reaches 11.85! If we compare classicism with the first and the second group, the DP results demonstrate not a step by step evolution, but revolution of urban structure: some of the spaces of classism cities, according to the graph model, loose earlier social dimensions and are transformed into fields. Could it be seen as true? Yes, classicism which appears with development of absolutism, radically changed a city model by introducing wide alleys surrounded by tree, huge representative squares, separation of pedestrian and horse transportation, etc. By observation in situ, it could be confirmed that the new wide and straight streets of Versailles start to act not as social integrators, but as separators or borders between pedestrian walks.
- PLT<sub>norm</sub> mean values here are increased to 0.78 from 0.27 in the Middle Ages. The max reaches 1.90. It corresponds quite well to the increased geometrization of city plans and appearance of some very long streets while keeping the background spaces, in terms of generic city model, shorter and at more social scale – it is quite well seen in Versailles and Edinburg plans (Fig. 6.12.). Such a specialization of streets is proved by much bigger differences between DP<sub>max</sub> norm and mean values if compared to the earlier described groups, as well. Relatively small max indicators could be caused by a small area of the cities of this period as well, or, explained by an applied concept of visual relations between the main points of urban attraction as palaces, churches, monuments.

- PE<sub>norm</sub> varies depending on the street plan of the investigated city (e.g.: if the secondary approaches to land plot are planned PE is bigger), but in essence is very similar as one found in the gothic plan cities. This similarity is logical, as in both cases, we have very similar regular structures. The exception is demonstrated just by Wren’s London, where two regular networks obliquely placed on each other managed to decrease PE values. The same situation is repeated by MT<sub>norm</sub>.

For a summary it could be said, that DD<sub>norm</sub> (Fig. 6.12.) and DS<sub>norm</sub> describe a city of classicism as dynamically more or less readable in the same way as all regular plans, but, in this dynamically well readable structure appear some statically not readable as social spaces, which, as we know from urban history, performed a representative and logistic function. The intensity of urban structure as well decreased radically in this period from around 0.2 to 0.4, thus demonstrating possible less intensively used street culture spaces. The lower intensity may indicate the increased specialization of public spaces as well and it is true in the investigated group: during the classicism period specialized market squares appeared, commercial activities were pushed away from the main representative squares, residential squares appeared, pedestrian was separated from horse transportation in the main streets, etc.

The fourth group with very distinguishable normalized indicators is represented by modernistic urbanism samples: Plan Voisin as an icon of the movement, Brasilia, Visaginas as new town built in Soviet Lithuania besides the nuclear power plant, Kalniecīai and Silainiai as two modernistic areas in Kaunas and Elektrenai as another newly built city besides coal power plant in Lithuania. According to the results of calculation two clearly different sub-groups could be identified:

The first sub-group is made of Plan Voisin and two samples from Brasilia. They demonstrate huge DP<sub>norm</sub> mean values which vary from 4.5 to 12.8. PLT<sub>norm</sub> mean, in comparison to the other cities is big as well – 1.2-2.1. DS<sub>norm</sub> practically shows an empty field with a few possibilities to find spaces of socially acceptable size. The same is confirmed by DD<sub>norm</sub> and its components: MT<sub>norm</sub> mean varies from 0.26 to 0.49, PE<sub>norm</sub> mean fluctuates between 0.02 and 0.05. Intensity reaches 0.90 thus showing that huge open space is potentially functionally divided and fragmented. In general, while looking at DD<sub>norm</sub> and DS<sub>norm</sub> scatterplots (Fig. 6.7.,6.8.) it could be
clearly seen that the samples of this subgroup demonstrate the most dynamically readable and socially –statically commonly not readable spaces thus creating a good situation for individual, fragmented, accidental interpretations and understanding of urban space. It could be noted as well, that modernistic urbanism continues to the extremes tendencies which started in classicism. It offers a new and worth of further exploration view on urban history. If the idea borrowed from Salingaros regarding some balance between readability and complication of urban structure, which means that demonstrations are possible when something is hidden only, is re-called, here again, it is logical to state that modernist samples represent the most imbalanced situation. Is it good or bad? The answer depends on the point of view. If we agree that city as commonly used spatial structure should bring people and activities together and spatial readability could be one of the tools to do it, then modernistic urbanism is separating people and activities by creating in essence commonly not readable spatial structure and quite well destroying the essence of cities.

The second sub-group is made of Silainiai, Kalnieciai, Visaginas and Elektrenai. They all reflect the same tendencies of modernist urbanism but demonstrate more moderate normalized features thus corresponding to the attempt to incorporate local urban character. In this case Visaginas, which was planned by an urban planner from Soviet Union, demonstrate bigger numerical values and could be seen as an interim position between the first and the second sub-groups. Visaginas DP\_norm mean is equal to 2.52 and PLT\_norm mean = 1.05. Kalnieciai and Silainiai in Kaunas reach just 0.91-0.96 and 0.43-0.45 values accordingly. With the main spaces in modernistic parts of Kaunas still having asocial character (DP norm 14.45 and PLT norm 2.07), the mean values show more social and readable character of the inside block places, and it
could be named as a local peculiarity or transformations of modernistic urbanism in Lithuania. In terms of dynamical readability, these areas stick together with the rest of modernistic examples: $\text{PE}_{\text{norm}} \text{mean} = 0.04$, $\text{MT}_{\text{norm}} \text{mean} = 0.59$.

The renaissance cities as Palamanova and Sabionetta in Italy, Zamosc in Poland, Nove Zamky in Serbia and Sabionetta do not demonstrate very clearly distinguishing features in terms of normalized readability values and could be connected into the fifth group. If we look more thoroughly the following interesting peculiarities of this group are noted:

- Normalized values of the Renaissance cities are very close to the ones found in medieval cities.
- Slightly increased, if compared to middle ages, the $\text{DP}_{\text{norm}} \text{max}$ values could be noted. It could be explained by reflection of beginning of the appearance of the representative spaces (e.g. plazas in front of palaces) and widening of streets.
- The intensity changes are quite notable: they decrease from 0.2 in earlier period to 0.4 here. It quite well corresponds to the beginning of the specialization of public urban spaces.

In summary, we can conclude that Renaissance examples demonstrate some slight shift from medial structure to Classicism and maximal values of the indicators are limited by relatively very small size of all investigated towns. This finding allows to think about one more improvement of the applied methodology in order to reveal a potential of an investigated urban structures: repetition of a sample structure in
space, if it is not reaching certain size limits, might be considered as an additional procedure. Generally, conclusion could be seen as an illustration of confirmation of Mumford’s statement that Renaissance urbanism presents just seed of the features which were fully developed during Baroque and Classicism⁶³¹. The DD\textsubscript{norm} of the investigated cities is presented in figure 6.14.

![DD norm maps of the Renaissance cities.](image)

Two investigated samples could not be assigned to any of the five groups – Venice 1834 (Fig. 6.15.) and Berlin 1688 (Fig. 6.16.) with expansion around Unter den Linden. In the case of Venice is distinguishing character is caused by the unique plan which does not show the routes of gondolas’ movement. While looking at the DD\textsubscript{norm} map of Venice, it is interesting to note that two functional city centers as San Marco Square and Fishmarket are located in very well dynamically demonstrated zones close to the border between well readable and less readable city parts. In Berlin the classicistic expansion is “outnumbered” by the size of the old, more medieval part.

⁶³¹ Lewis Mumford, *The City in History: Its Origins, Its Transformations, and Its Prospects*, San Diego New York London: A Harvest Book Harcourt Inc., 1989.
For the finalization of the analysis of normalized readability models, once again let’s look at the changes in both Old Town and New Town in Kaunas in 1939 and 1990 (Fig. 6.17.) The essential change, besides widening and straightening of some streets in these areas during the Soviet period, was the cancellation of private land property and transformation of formally private land into semi-public or public spaces. How it
affected spatial readability? Despite the fact that formal perimetric structure of house placement was kept intact, the normalize readability indexes were changed thus indicating the shift in social – cultural potential of urban system:

- \(DP_{\text{norm}}\) mean values decreased from 1.64 in 1939 to 0.60 in 1990, thus showing essential transformations of classicistic spatial pattern because of appearance of public spaces of completely different character inside traditional blocks. Max values at the same time remain not changed much.

- The labyrinth like, accidental new urban structures inside perimetric blocks increase according to MT norm and PR norm mean values: from 0.93 till 1.14 and from 0.12 till 0.21.

- Intensity of public space usage decreases dramatically from 0.24 to 0.55, thus saying that traditional 19th century street spaces are losing part of everyday functions for the benefit of newly appeared semi-public courtyards.

It could be summarized, that according to readability calculation the central part of Kaunas, and probably the other cities of Soviet Lithuania, even without the creation of a new wide street or mass renovation is Plan Voisin style, have face revolutionary but not evolutionary changes. Even if it looks like some spaces of more socially readable character were introduced there with keeping the main street structure intact, but it created more evident segregation between the foreground and foreground structures of these areas in a similar way as it was done in modernistic housing areas.

Fig. 6.17. \(DD_{\text{norm}}\) maps of Old Town (left) and New Town (right) in Kaunas in 1939 and 1990.
6.5 Summary and conclusions of chapter 6

Of course, 29 investigated cities are not a big number, and the received results could be treated just as preliminary, but they already allow further interpretations and more detailed understanding of urban transformations which were identified while using space syntax segment models in chapter 5.

The proposed normalized model, in essence, reflects quite well the general features of urban social-spatial genotypes while remaining sensitive to very specific peculiarities of the investigated samples. It could be seen as a background for decryption of probable scenarios of urban space usage in terms of optimal reachability and size, e.g. too close or less than 3 turns/20 percent elongation of straight line distance might mean that space has very fuzzy boundary’s thus not allowing it to be perceived as a clear place for co-presence activities; if space is too far, then it acts more as a segregator of users and uses; if space is too big it is perceived just as a transit space of field but not as co-activities place; size of a space within socially acceptable limits might affect its choice for common use by as smaller or bigger number of city inhabitants, etc. Modernistic urbanism, in this case, could be described as urbanism with very little number of places for social co-presence activities in comparison to the other investigated periods.

The analysis results open interesting and promising in terms of new interpretations point of view on urban history in general. If speaking about modernist transformations, they demonstrate appearance of very well or even too much dynamically readable space, thus destroying their boundaries, and statically not readable spatial structure in the modernistic areas of the investigated cities. It could be demonstrated by the potentially decreased role of the main streets as places of everyday street culture in the traditional 19th century areas. In general id corresponds to the earlier described fragmentation of the social-spatial body of a city because of modernistic urbanism interventions, but describes this process in more details and with added specific peculiarities to new and old city parts. From another point, modernistic urbanism could be seen as a maximal peak of the urban spatial features that started to appear in Renaissance and were fortified by Baroque and Classicism urbanism.

The local features of modernistic urbanism in Soviet Lithuania were identified with a clear presentation of more modernistic foreground and more social background, in terms of the generic city concept, made of public courtyards and other spaces inside housing blocks.

In general, if the short investigated segment of urban history from Middle Ages to Classicism could be seen as an evolution, then modernistic urbanism could be named as a significant revolution in terms of social-spatial readability of a cityscape.