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Chapter 1

URBAN SUBSTRUCTURES AS A WAY TO BUILD A BALANCED SPATIAL AND FUNCTIONAL STRUCTURE OF CITIES

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ABSTRACT

According to the tenets of sustainable development, the spatial structure of a city should be designed to enable satisfying the residents' needs in the most effective and egalitarian way while saving its resources. These conditions are fulfilled by an urban spatial structure based on urban substructures. The term 'urban substructure' defines certain intra-urban, functional wholes operating according to the model of a nodal region. Morphologically, the substructure is composed of a core (sub-centre), concentrating goods and services meeting daily needs of inhabitants and the area of its influence. Built from substructures, an urban spatial and functional structure is polycentric, condensed around each sub-centre, demonstrating at the same time certain features of dispersion. The article aims to present the theoretical assumptions of the conception of urban

substructures, historical examples of such substructures (jurydyki – former settlements in Poland outside a royal city, or beguinages, etc.) and also the benefits resulting from the creation of the spatial form of the city composed of substructures. The article is theoretical in character and relates to numerous theories and spatial development conceptions, including the conception of polycentricity. A polycentric spatial structure in various spatial scales has many advantages. There is still lack of approaches that would refer to the local scale of a city. Filling this gap is one of the purposes of this publication.

Keywords: urban substructures, urban spatial form, polycentrism, sustainable urban development, nodal region, compact city

1. INTRODUCTION

A spatial structure, also called an urban form, plays a crucial role in the sustainable development of a city. In general, one can distinguish a compact and dispersed form. Each of them has both advantages and disadvantages. Therefore, an optimal solution would be maximising the benefits of both while avoiding the weaknesses. The creation of a polycentric, more dispersed spatial city structure, where the architecture is compact, diversified and multifunctional around each sub-centre, seems to serve this purpose. Such a sub-centre (core), concentrating various types of functions, being the place of meeting daily needs of a local community, together with the area of its influence, can be called an urban substructure (Mierzejewska 2017a, b). Created from such substructures, a polycentric spatial urban structure should be more conducive to the implementation of sustainable development assumptions than a monocentric one (Jenks and Jones 2010, Litman 2016 et al.). This conception concerns mainly large and medium-sized cities in which the distance between the place of residence and places where objectives are to be achieved exceeds the walking abilities of an average citizen. In this study it is assumed that relations created by people are the basis for the distinction of an urban substructure, and the substructure itself is morphologically (a clear core and the area of its influence) and functionally (different functions fulfilled by the core, ensuring the provision

of daily services to the residents of the immediate neighbourhood) similar to a nodal region, but on a smaller scale. At the same time, what is adopted is the systemic conception of both the city as a whole and the urban substructure, treated as a compound, functional whole and, simultaneously, as an element (sub-system) of a larger and more complex system which is the city (Bunge 1979, Chojnicki 1989 et al.).

This chapter presents the theoretical assumptions of the conception of urban substructures highlighting their morphological and functional features, ways leading to the creation of substructures and methods of their delimitations. The historical examples of such substructures (jurydyki, beguinages, etc.) will be presented as well as the benefits resulting from the creation of the spatial polycentric form of the city composed of substructures. The article is theoretical in character and relates to numerous theories and development conceptions, including the conception of polycentricity in the first place.

2. METHODOLOGY

Owing to the nature of the study, the main research method adopted is the analysis of literature dedicated to various theories and conceptions related primarily to the systemic understanding of the city, the spatial structure of cities, sustainable development, a nodal region and polycentricity. The conception of urban substructures and also the identification of benefits resulting from the existence and functioning of substructures in the city space will rest on the presented theoretical premises.

3. BASIC RESEARCH PREMISES

3.1. A City as a System

The concept of a system relates to a large class of objects and is used in various meanings. This results from the certain universality of this term

which is in the way it is understood. In real terms, a system can be a specific unit composed of other units constituting its elements which are linked together so that they form a whole which is possible to be separated from surroundings (Bunge 1981, Chojnicki 1989). What is therefore assumed is a certain degree of cohesion, a system closure in which the internal relations of a binding nature are stronger than the relations with the surroundings. Scientific cognition requires the knowledge of both the elements, surroundings and the structure of systems and also their history and scientific laws governing them (Chojnicki 1989).

One of the important features of systems is that they can form multilevel patterns. This means that there are systems of specific levels as well as subsystems and supra-systems. A subsystem is an element of the system which is also a system (Chojnicki 1989).

In geographical research, since the first formulations developed by Berry (1964), it has been common to see the city as a system. It is then perceived as a functional, spatial whole, composed of various types of elements which usually include an urban population, private and public capital resources, and natural resources of the city. Relations in the city system are thus reduced to economic, socio-cultural, political and administrative processes, although different authors present different viewpoints on the matter (Parysek 2015). However, the city is such a complex system that it embraces various types of subsystems. These are, for the most part, an urban subsystem as well as social, economic, transport, financial one, etc. Also an urban substructure, due to its complexity, cohesion and functionality can be treated as a subsystem of the city and can be viewed as a separate system, consisting of many inter-related elements (residents, economic entities, etc.), functioning within the city system with which it has numerous relations (relations with the surroundings).

3.2. Urban Spatial Structure

The spatial structure of human settlements has always been and still is a topic of great interest among many researchers from various fields. At larger

spatial scales, one should mention the works of Christaller (1933), Lösch (1954) or Isard (1965), dedicated mostly to structures of settlement patterns or the theory of regions. In deliberations on smaller spatial scales attention is paid mainly to the spatial structure of cities which is discussed in the traditional works of such authors as Park (1925), Burgess (1925), Berry (1958), Alonso (1964), Muth (1969), Mills (1967) and others. The specificity of urban spatial development results from dynamical urbanisation processes as a consequence of which not only cities are subject to transformation but also their immediate and distant surroundings.

A spatial structure in geographical research is understood mostly as patterns of economic or social units distributed in an organised way as well as economic and spatial links between the units constituting these patterns (Kuciński 1996). The term structure denotes then a set of objects and relations between those objects which may be vector (interactions) or scalar relations (Parysek 1982, Mierzejewska and Parysek 2019). The urban spatial structure is formed by a set of overlapping patterns (of workplaces, housing, shopping, leisure, social contacts and others) corresponding to the basic spheres of life and human activity (Korcelli 1974). The analysis of this structure consists of the description of the existing distribution of social and economic elements present in the city space or the description of spatial and functional relations between them (Maik 1997, Słodczyk 2003). The spatial structure understood in this way is also called a spatial-functional or an intra-urban structure and is closely related to the concept of a city form. The latter should be read as both the architecture of the city expressed by the arrangement of solids and its internal and external space (Sumień 1992). The form of the city comprises, among other things, its size and shape, the arrangement and distribution of open spaces (including green ones), transport infrastructure features, etc. (Jenks and Colin 2010).

Pioneers of research on the spatial-functional city structure, however, were not geographers but sociologists. Thus, in theories or models of the internal structure of cities two basic approaches, although somewhat different, can be distinguished: sociological and geographical. The first one refers to the achievements of the so-called Chicago school, within which

Park, Burgess and Hoyt developed the concentric and sector models; the second – to the multiple nuclei model of Harris and Ullman.

The concentric model, presented for the first time by Burgess in 1923, was prepared on the basis of the analysis of the spatial structure of American cities which were developing very dynamically at the beginning of the 20th century as a result of intense migration movements in the conditions of a free-market economy. This theory holds that cities develop radially, from a core to periphery, and there are five zones (rings) around the centre, which differ in development, especially when it comes to housing and residents who settle in a given zone. The character of the zones changes with the distance from the core (Korcelli 1974).

Hoyt (1939) presented a somewhat different viewpoint on the spatial urban structure, according to which a basic factor that forms this structure is not the distance from the core, but the direction. In the sector model he prepared (also called the wedge model), the factor determining the spatial structure of the city is the layout of the transport network with wedges along them, different in terms of land development and settlement. These wedges expand from the centre towards the city's peripheries and are similar across their entire surface. According to the assumptions of this model, the types of land-use which remind rays of a star, initially formed close to the city core, spread to the outside over the course of time (Korcelli 1974).

On the other hand, the geographers CH. D. Harris and E. L. Ullman (1945) developed a model in which cities are perceived as mosaic patterns, called the multiple nuclei model (Korcelli 1974). The authors of this concept claim that this pattern is formed as a result of synergetic interaction of various factors, among which they distinguished: (1) different location requirements of various economic entities (e.g., shopping and service centre must be easily accessible, whereas industrial plants need vast areas and good transport accessibility), (2) mutual attraction or repulsion of some types of economic activity whereby attracting entities which create closely cooperating separate groups can initiate new centres, and (3) differences in land prices depending on location which means that not all kinds of economic activity are profitable enough to operate in areas where land prices are the highest (Korcelli 1974, Domański 2002). In the multiple nuclei

model it is assumed that although in many cities there was originally one core, however, over time, in the development process these cities created other, separate centres (subcentres).

The above-mentioned models show certain similarities, but also differences. In general, Burgess and Hoyt identify a monocentric spatial structure of a city, whereas Harris and Ullman – a polycentric one. What they have in common, however, is the distinction of homogeneous areas in terms of a specific feature or a set of features in the city space which falls within the concept of a region. The region is then an area of any size, uniform from the point of view of certain criteria, different from the neighbouring areas in terms of a set of spatially related features (James 1959). The basic conditions for recognising a given area as a region include: (1) uniformity in terms of strictly defined criteria for delimiting this area, (2) the importance of criteria from the point of view of a solved problem, and the fact that (3) these criteria must relate to the coexistence of some set of features among which causal links develop (James 1959, Whittlesey 1954, Chojnicki and Czyż 1992).

The wide interpretation of the concept of a region became the basis for distinguishing its two categories: homogeneous regions, having the same nature throughout the whole area and nodal ones, uniform in terms of their internal structure or organisation. The important elements of this structure are a core (or cores) and its surrounding area linked with it by circulation lines (Whittlesey 1954).

In the models of Burgess and Hoyt or Harris and Ullman, similar areas have been distinguished in a city in terms of both the social features of the population residing in a given area and a comparable way of land use (areas with similar functions), which can be identified with homogeneous regions where the relations are scalar in character. The research approach presented in those models, however, does not exhaust the possibility of spatial and structural studies on cities, particularly large ones. This is so because in the city space it is also possible to distinguish uniform areas due to the way of functioning, where the relations are of a vector nature, which until now have been the subject of interest only to a limited extent. These are areas which, due to the organisation, structure and way of functioning, can be identify

with nodal regions, although on a much smaller spatial scale. These types of areas can be called urban substructures. Treating the urban substructure as a specific nodal region requires the identification of its characteristics.

3.3. Characteristic Features of Nodal Regions

A nodal region (also called a region of connections, a vector one) is defined as a set of spatial units, connected by a network of various mutual interactions and reactions with the main core the boundaries of which are delimited by the ranges of these connections. Such regions are uniform due to their internal structure or organisation (Chojnicki and Czyż 1992).

Based on the literature, the elementary features of a nodal region include (Mierzejewska 2017a):

- economic character – such a region is a separate part of socio-economic space (Dziewoński 1967),
- the nature of its component parts (including spatial structures) and spatial relations create a certain coherent, homogeneous whole which can be separated from the surroundings by specific criteria. One of them is the compactness of a structure determined by the existence of interdependent fields of human activity in the studied area (Domański 2002),
- it has one or more centres (cores) which are focal points of its organisation, connected to the area around them (impact zone) by the exchange of people, goods, services and information, primarily through commuting to school and work, or through commerce and services (Kosiński 1958, Domański 2002),
- it consists of both a human community with its socio-economic activity as well as the specific area on earth. Each region has then a defined material form and content (people and their activity) (Dziewoński 1967),
- over the course of time, the new content creates not only new, but also fills old spatial forms. Therefore, the significant features of an

urban region include certain durability accompanied by changeability over time (Dziewoński 1967),

- regional awareness of people, which translates into a sense of regional identity. This awareness is understood as a set of views, beliefs and attitudes of people towards a region which is the place of their residence and activity (Chojnicki 1996, 1999).

A territorial organisation has such a nodal system in different spatial scales, which should be identified by the following elements: 1) the formation of the nodal structure of a settlement pattern, 2) a high level of social, economic and cultural integration, 3) a high level of self-organisation, 4) the character of closure and boundaries (Chojnicki and Czyż 1992). In view of the fact that one of the features of nodal regions is their horizontal and vertical dimension, which is reflected in the stratified (hierarchical) structure, the delimitation of regions can be reduced to: 1) the determination of the hierarchical pattern of links, that is the role of particular nodes in the link pattern and, 2) checking the degree of their closure through the analysis of internal links which should be stronger than external ones (Chojnicki and Czyż 1992).

Therefore, in order to treat urban substructures as nodal units, albeit lower than tier regions, it ought to be shown that they represent features attributed to such regions. Their functioning in the city space should, however, at the same time be consistent with the objectives of the sustainable development paradigm accepted today.

3.4. Urban Spatial Structure in the Light of Sustainable Development

The interest in research on the spatial-functional structure of cities and changes occurring in this field results from several reasons.

It is mainly a matter of concern about: (1) economic efficiency – assuming that this efficiency can be increased by the proper spatial organisation of economic activity, (2) social justice – assuming that a spatial pattern of demographic groups reflects both the structure and diversification of availability of goods and services offered by a city, and (3) environmental protection – assuming that good organisation in the human activity space can influence the quality and integrity of the natural environment (Knaap et al. 2016). Therefore, these are the issues that fall within the sustainable development idea (Knaap et al. 2016).

Sustainable development consists in the proper and conscious formation of relations between economic growth, concern for the environment (mainly natural) and meeting various types of human needs that determine to a great extent the quality of life (Petrișor and Petrișor 2013). The requirement of meeting "needs" translates into such social goals as improving living conditions and the level of service for residents which must include economic and ecological aspects. The main principles of sustainable development also cover inter-generational equity, social justice (intra-generational equity) and trans-frontier responsibility (Haughton and Hunter 1994). On this basis, three main dimensions of equity are distinguished: time, social and spatial (De Sousa Vale 2008). Moreover, the issues of sustainable development are related to the need for creation of places where people want to spend time, live and work now and in the future (ODPM, 2006, Petrișor and Petrișor 2013). The development of such places requires social participation in planning processes, which means taking into account needs and rights of all interested parties (Olazabal et al. 2007).

Hence, the structure of the city should be planned in such a way as to effectively facilitate meeting the needs of its inhabitants and ensure the most egalitarian access to goods and services offered by the city while preserving a high quality of the natural environment. However, the adoption of specific solutions regarding the creation of this structure is not obvious due to, among other things, difficulties in the choice between often competitive objectives of sustainable development (Knaap et al. 2016).

3.5. Compact vs Dispersed Urban Spatial Structure

In the literature on sustainable urban development, two spatial forms are generally contrasted: compact and dispersed. Despite the fact that each of them has both advantages and disadvantages, it is commonly assumed that a compact form is more conducive to sustainable development (Table 1). Its advantages usually include meeting the residents' needs better, energy saving, protection of suburban areas against urbanisation processes, possibility of ensuring effective pubic transport and waste management, etc. (Frey 1999, Mierzejewska 2015 et al.). One can also agree with the statement that a compact form, measured with density, diversity of uses and a proper urban design oriented towards pedestrians, influences transport needs and creates more balanced transport patterns (Cervero 1998). Simultaneously, however, high development density can lead, among other things, to exceeding the social capacity of areas (Wiliams et al. 1999), an excessive population density (Jałowiecki and Szczepański 2002), a greater traffic volume (Burton 2000), a deterioration of the life quality of residents, especially the poorer ones (Burton 2000), an escalation of conflicts, a greater competitiveness of places and a loss of the potential of open intra-urban areas, often those environmentally valuable. This can result in a smaller biodiversity and limitations on services provided by the natural environment (e.g., water, drainage) and also a decrease in the area of urban greenery, important from the social and ecological points of view (Jenks and Jones 2010).

However, a dispersed form has also some advantages. This applies to the reduction of an urban heat island, better access to green areas, the possibility of greater retention of precipitation or the introduction of equipment for obtaining renewable energy. What is also emphasised are economic (food production), recreational and ecological functions of house gardens (Mierzejewska 2009), and meeting social expectations as to the forms of land development (Mierzejewska and Parysek 2005).

From the point of view of sustainable development objectives, the most desirable spatial structure should then comprise the favourable features of

both these urban forms while limiting their negative results. Therefore, it ought to represent both compactness and dispersion.

Table 1. Comparison of compact and dispersed city models

Criterion	Compact city	Dispersed city
thermal energy use	lower	greater
fuel consumption	lower	higher
need for development areas	lower	greater
water retention	lower	greater
efficiency in public transport organisation	greater	lower
pollution reduction	greater	lower
reduction of heat island effect	lower	greater
access to green areas	more limited	less limited
possibility of using equipment for obtaining renewable energy	more limited	less limited
density effect	stronger	weaker
access to technical and social infrastructure	less limited	more limited

Source: Own study based on L. Mierzejewska (2015).

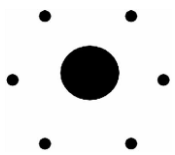
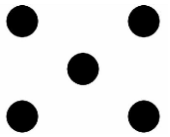
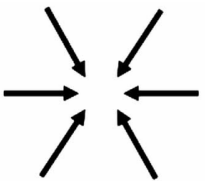
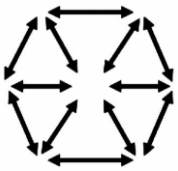
3.6. Polycentricity as a Feature of 21st Century Cities

One of the conceptions which fits in with the assumptions of sustainable development promoting equally economic growth, social justice and environmental protection is the conception of polycentricity (Knaap et al. 2016). This idea is developed at various spatial scales and also at the scale of the city. Polycentric urban development is the issue of interest discussed in both scientific works and documents on European policy (Szabó et al. 2014). One can even risk a statement that at the end of the 20th century, a previously dominating model of a monocentric city was replaced by its polycentric form (Champion 2001, Hall 1993, 2009).

The term "polycentricity" means literally that a spatial unit is composed of many centres. It does not explain, however, what kinds of centres are the matters of interest (transport network centres, housing, some types of business activity, such as retail, industry, etc.). For this reason, different ways of understanding polycentricity as well as different viewpoints on it and various features can be distinguished. The concept of polycentricity can be interpreted at least in the following four dimensions (Intra-metropolitan polycentricity 2010):

1. analytical-descriptive – description, measurement and characteristics of the existing state of a spatial unit and the analysis of a degree to which it exhibits polycentric features,
2. normative – which can help, e.g., to organise a spatial configuration of a given unit (for promoting and developing polycentricity or maintaining and using the advantages of the already established polycentric structure),
3. spatial – which refers to the discussed spatial scope (e.g., the level of a city, city-region, a regional, even national or transnational level),
4. morphological-functional – related to the perception of subcentres in terms of their specific morphological forms (such as the structure of urban fabric) of from the point of view of their functional links (mutual relations) (Figure 1).

The distinction between morphological and functional aspects should be made very carefully because they are often interdependent. A clear distinction between an analytical-descriptive and a normative understanding of polycentricity is also difficult due to mutual relations between them, with the former providing the basis for distinguishing the latter (Intra-metropolitan polycentricity 2010).

ASPECT	Monocentric	Polycentric
Morphological		
Functional		

Source: Budger and Meijers (2010).

Figure 1. Aspects of monocentric and polycentric spatial structures.

The multidimensionality mentioned causes difficulties in the perception of what polycentricity is (or polycentric development) or what it can be (Davoudi 2003). In the case of such rich, multifaceted and historically contextualised spatial units as cities, this multidimensionality embraces almost every aspect of social life. This basically means that in their case polycentricity can relate to almost every space of human activity (Kloosterman and Musterd 2001). Such a viewpoint justifies the reference of polycentricity not only to the city-region scale, which most often takes place, but also to the city within administrative borders.

The reasons for the polycentric development of cities are multidimensional and have different impact range. They primarily include changes occurring in transport means, changes in mobile behaviour of labour, transition from manufacturing goods to providing services in developed economies, but also contemporary urbanisation processes bringing about changes in demographic structures in the city-region pattern (Bontje 2001, Bontje and Kepsu 2013, Szabó et al. 2014).

The emergence of polycentric urban structures is treated at the same time as the product of three overlapping factors, namely population growth,

an increase in commuting costs and a decrease in the transport expenses of firms between decentralised locations and central business districts (CBD) thanks to the development of information and communication technologies (ICT) (Szabó et al. 2014).

What functions in the literature is the opinion that "a polycentric city" reflects the specific conditions of urban-planning development. It is then an urban form which is the product of existing institutional, political (including the transport policy) determinants and the manifestation of the authority exercised in a given social system (Szabó et al. 2014). Changes taking place in cities and urban agglomerations are often called "post-suburbanisation" (Szabó et al. 2014). They are observed in various parts of the world characterised by different cultures and political systems. Economists, geographers and planners documented the emergence of polycentric urban forms in the post-industrial societies of the USA (Bogart and Ferry 1999, Arribas-Bel and Sanz-Gracia 2014), the European Union (Cismas et al. 2010) and Japan (Nishimura and Okamuro 2011), and also in developing economies, such as China (Chou et al. 2011, He et al. 2011). A little less attention is paid to this issue in post-socialist countries (Maier 2009, Dövényi and Kovács 2006, Finka 2009, Pichler-Milanović 2014 et al.), although the literature on urbanisation processes is extensive.

As a result of the occurring changes, it can be stated that polycentrism has become the main characteristics of the urban landscape worldwide (Anas et al. 1998). The process of transforming monocentric structures into polycentric ones manifests itself primarily in the decentralisation of jobs and households in cities (Legras and Cavailhès 2012). A polycentric structure based on the existence of secondary urban areas turns out attractive for both companies and consumers (Volgmann 2012, Szabó et al. 2014). The implementation of the assumptions of Transit Oriented Development (TOD), recommended as compliant with sustainable development principles, also helps to shape it. This conception holds that the city space should consist of transport centres around which the area is intensely developed, densely populated with mixed development forms (Bevilacqua et al. 2013, Chan et al. 2016). The development intensity should lessen with the distance from such a centre. The implementation of these assumptions

leads practically to the formation of the polycentric form of a city with good access to services, including transport ones. This form can be recognised as balanced, although it is not compact. Similar results are obtained by the commonly used practice of shaping more compact and intensely developed areas along main transport routes, though there are significant differences between this practice and the assumptions of TOD (Jenks and Colin 2010). It is worth emphasising here that the role of transport in building the urban spatial structure was highlighted by Hoyt in the sector model. Also, in the UN report *Our Common Future* attention was paid to the "concentrated-decentralised" settlement model as the most favourable from the point of view of the reduction of pressure on the natural environment by growing urban agglomerations (Brundtland 1987).

However, it must be mentioned that in the literature polycentricity of cities refers primarily to agglomerations and metropolitan areas in which, mainly due to advancing suburbanisation processes, subcentres develop in the suburban zone. Nevertheless, this conception can also apply to a city within administrative borders.

3.7. Advantages of Polycentricity

Many studies show that polycentricity generates numerous advantages, primarily economic ones (Cavailhès et al. 2007). Moreover, polycentric centres serve decentralisation and social integration; they generate less traffic, serve to improve accessibility and diminish territorial disproportion (Pokhrel et al. 2018).

Furthermore, polycentricity at the scale of the city may serve (Intra-metropolitan polycentricity 2010):

- to form more effective and balanced urban settlements,
- to combat uncontrolled urban sprawl,
- to react positively to the observed, advancing climate change,
- to support economic competitiveness,

- to support the division of work among subcentres regarding specific objectives.

In this context, through the decentralisation of economic activity, polycentricity can also support the reconciliation of competitiveness and territorial cohesion policies while minimising the unfavourable effects of agglomeration (such as traffic volumes and high land rents) (Intra-metropolitan polycentricity 2010).

The effectiveness of the polycentric structure is basically determined by three key aspects (Intra-metropolitan polycentricity 2010):

1. high development density around particular and carefully selected subcentres, conducive to the protection of the city's green infrastructure (polycentric compactness),
2. an increase in the density of subcentres related to an increase in the number of functions they perform (e.g., in terms of urban facilities, job opportunities),
3. preparation of a polycentric transport system as a kind of spatial frame regarding the distribution of subcentres.

It is also worth noting that there is no critical research verifying the numerous benefits of the polycentric city (Knaap et al. 2016). What is more, however, no studies can be found on the basis of which one can answer the question whether the degree of polycentricity of a given area is connected to the level of its balance (and if so, to what degree). This is particularly important as not only polycentricity determines the level of this sustainability, but mainly land development and functions of subcentres. Therefore, what is desirable are both theoretical and empirical research aiming, among other things, at the analysis of relations between urban development pattern and access of inhabitants to goods and services, and determining the strength of these relations (Legras and Cavailhès 2012).

4. CONCEPTION OF URBAN SUBSTRUCTURES

Demographic changes, economic growth and technological progress contributed to the formation of a new spatial order which differs markedly from classical mono-centric models of the structure and urban functions (Knaap et al. 2016). The transformation of a monocentric city into a polycentric one should involve, among other things, the development of such areas which enable the daily life of residents independent of the city centre (Volgmann 2012, Szabó et al. 2014). These areas, functioning similarly to a nodal region and being part of the polycentric structure of a city, can be identified as urban substructures.

4.1. The Understanding of Substructures, their Main Aspects and Features

Such a whole which can be distinguished in the spatial structure of a city, or is autonomous and functionally cohesive, and spatial relations generated by people are the basis for its distinction can be called an urban substructure. It shows a close resemblance to a nodal region, however, at a much smaller scale.

Urban substructures should not be identified with the city's functional areas which are separated as part of the classic spatial-functional structure of the city (residential, transport, industrial, green areas, etc.). This is so, because an important feature of the substructure is that it covers an inhabited territory, united by spatial relations regarding meeting daily needs. Thus, the residents and specifically their decisions about where they will satisfy their everyday needs determine whether a particular substructure can be distinguished in a given area or not (Mierzejewska 2017a).

Similarly, as in the case of a nodal region, the morphological and functional aspects of the substructure can be discussed.

4.1.1. Morphological Aspect

The morphological aspect is related to the more or less clearly visible "separation" of a given substructure in the city space. From the morphological point of view, an urban substructure is composed of a core and an area of its influence. The core is a place (usually a market, a square, a street or its part) where trade and service, as well as administrative, educational, productive, cultural and recreational activities are concentrated. In this place the residents of the surrounding areas most often shop, use various types of services (hairdressing, beauty, restaurant, cafeteria, insurance, postal, banking etc.) meet, make social contacts (Mierzejewska 2017b).

As the substructure is assumed to contribute to the implementations of sustainable development, its core should be within the walking distance of pedestrians, that is up to a maximum of 0.8-1.0 km from the place of residence (Doxiadis 1970, Duany et al. 2000, Mierzejewska 2008, Mierzejewska 2017b). If the distance is larger, the inhabitants choose other means of transport to meet their needs, e.g., a passenger car. In practice, satisfying the conditions of the maximum distance from the place of residence to the core of a substructure can contribute to reducing the need for other, less environmentally friendly forms of transport, which is conducive to saving energy while maintaining a high level of services and brings additional health benefits (walking or cycling). Thus, it can be assumed that the distance mentioned above (0.8-1.0 km) indicates an essential diameter of the impact of the core, its spatial scope and also allows determining an approximate, desirable distance between the cores of neighbouring substructures. Then, this theoretical distance is about 1.6 up to a maximum of 2 km in areas with compact development. However, due to the fact that substructures can only develop in residential areas, it should be assumed that this is the minimum distance between their cores. In order to ensure the economic efficiency of the services concentrated in the core, this sub-centre should be at the same time the place with intensive housing development, the intensity of which decreases with the distance from it.

4.1.2. Functional Aspect

The functional aspect of a substructure embraces the spatial relations mentioned above, generated by people and determining the cohesion and a relatively autonomous character of such a substructure in the city area. Within the identified substructures basic needs of residents are met, which particularly include daily shopping, basic services, education, work, recreation, leisure, religious practices, and also social contacts (Mierzejewska 2017a). It should be emphasised here that this is primary a matter of basic, general social needs of the residents of a given area since more individual or higher ones are usually satisfied in the city centre. This is so, because substructures, like nodal regions, are characterised by a hierarchic system.

4.1.3. Systemic Aspect

A substructure is supposed to be a functional and structural whole (system), but it is undoubtedly a part of the greater whole, superior to the substructure, which is the city system. Owing to that fact, it should be properly developed and organised (a system with a certain level of self-sufficiency), but also linked to other areas in the city (an element of the city system), including other cores (sub-centres). This is about integrating it with the technical infrastructure network, and its core with the public transport network. It is extremely important for public transport to be organised within subcentres (Knapp et al. 2016). What is crucial here is also certain complementarity of functions performed by neighbouring substructures (e.g., school, health centre, recreational areas) determining the possibility of becoming more self-sufficient and independent from the city centre which is superior to its substructures.

It is worth emphasising that certain independence of inhabitants from city centres and services located there (administration, insurance, banking, and specialised services) follows as the result of the advancement of IC technologies. When using them, one can obtain various goods and services at home (e-services, e-administration, etc.), which can strengthen the importance of local cores (sub-centres) situated near the place of residence.

4.1.4. Relations of Inhabitants to the Area of Residence (Substructure)

Substructures display some features of territoriality, although usually no autonomous power functions there. The inhabitants, however, following the pattern of regional identity, demonstrate certain emotional closeness to the area of residence where they often work, run business activity, satisfy various kinds of needs or spend their free time (a sense of identity with the substructure). A pattern is therefore adopted whereby residents can easily identify themselves with the inhabited territory, which means the rejection of the thesis that a city is only the space of flows and its inhabitants are constantly on the move (Jałowiecki 2014). This identity originates and in some situations is reborn due to an increasingly popular opinion that a life in metropolis would be unbearable without the identification with small centres (Kubicki 2010, Lisiecki and Kubera 2015). Such a standpoint is compliant with the provisions of the Leipzig Charter according to which a city (an area of residence) based on civic ties is treated as one of the pillars of sustainable development (Billert 2012).

It is also desirable that the inhabitants of a substructure create a community which can decide for itself at least to a limited scope. It requires, however, among other things, a proper formation of public and semi-public spaces, conducive to building social bonds, first of all between neighbours.

4.1.5. Dynamic Character

A crucial feature of substructures is their dynamic character. Like the structure of the entire city, they are also subject to succession processes. This means that they originate, develop, function, but they can also disappear together with the transformations of the city's spatial-functional structure, socio-economic changes, changes in life styles and consumption models or technology. The demographic and social structure of inhabitants as well as the forms of economic activity are changing over time. A building pattern and development are more stable elements of the substructure, although there are some changes in this respect (so-called infill development, construction of new and expansion of existing housing estates) (Mierzejewska 2017a).

4.2. Ways of Establishing Substructures

Urban substructures can be created in several ways. Among the most important are: (1) inclusion of the already formed spatial structural patterns in the city borders, (2) completing the infrastructure of the existing estates, and (3) implementation of the holistic investment projects (Mierzejewska 2017a).

One of the ways of urban spatial development is the inclusion of the spatially and functionally cohesive rural areas, estates or cities, formed earlier during the historical process, in the administrative borders of the city. This inclusion takes place on the basis of administrative decisions, often as a result of the suburbanisation process or the will to secure the development needs of a city. It is worth mentioning here that numerous European cities were created by joining the adjacent rural, semi-rural or urban areas to a former, medieval centre. The names of districts in many cities and their certain differences prove a "long existence" of this former settlement structures which are often an element of the everyday experience of the residents of the whole city. In Poland, it is particularly visible in Cracow or Poznań where the names of streets and estates correspond with villages, towns and estates subsequently absorbed by the city (Kubicki 2010, Lisiecki and Kubera 2015).

Another way to form a substructure can be completing the infrastructure of the existing estates fulfilling mainly housing functions (bedrooms) with trade and service areas (squares, streets, commercial zones, etc.) allowing meeting the basic, daily needs of the inhabitants of a given estate or adjacent estates (Mierzejewska 2017a). These types of substructures often develop in the areas of large blocks of flats in the cities of post-socialist countries.

Urban substructures can be also formed as a result of properly planned and realised investments made by the city authorities or private investors (mainly developers). This includes the implementation of holistic conceptions and the construction of multifunctional estates fulfilling basic needs of their residents (e.g., the so-called city in a city).

Substructures can develop then as a result of "bottom-up" or "top-down" activities (Mierzejewska 2017a).

One can talk about a "bottom-up" way if the cores of substructures are formed in the already existing estates where trade and service infrastructure necessary for everyday life of inhabitants was not initially planned or it was planned but not fully realised (Mierzejewska 2017a). Bottom-up initiatives, undertaken by residents, managements of housing cooperatives or estate self-governments, fill this gap. Such a situation often arises in block estates in post-socialist countries having one shopping centre with one store and several service points (usually a library, a restaurant and a cinema) operating over the decades. Over the course of time, what often started to develop in their neighbourhood was multifunctional markets or shopping arcades, as these estates, under market economy conditions, did not fully meet the growing requirements of residents concerning the availability of various elements of urban infrastructure.

In the case of a "top-down" activity, one can talk primarily about different administrative decisions. They regulate the inclusion of the spatial structures already functionally formed into the administrative borders of a city, where they are further transformed, or are subject to various investment plans, including developers' investments, or those of the managements of housing cooperatives.

4.3. Factors behind the Formation of Substructures

Various factors, often mutually related, can lead to the formation of substructures. They mainly include (Mierzejewska 2017a):

- demand generated by the residents of a given area,
- a tendency to minimise distance and costs,
- a tendency for various types of activity to concentrate,
- administrative decisions.

Under market economy conditions, demand plays a decisive role in the location of specific business entities in a given place and viability of the undertaken economic activity. The demand generated by the residents

results from the need to satisfy daily, general social requirements considering, among other things, a tendency to minimise distance and related costs. This demand depends on the population potential in a given area, hence a high population density near cores of substructures is a prerequisite for their functioning.

The distance between the place of residence and work, shops, services, meeting spots, etc. can be measured in terms of spatial, economic (costs of covering the distance), temporal categories as well as those relating to the effort required to cover it. The observed trend to minimise the distance leads to the deconcentration of workplaces and other destinations (Korcelli 1974). This can result in a polycentric spatial structure of a city.

The concentration of many economic entities in a given area decides about its attractiveness as a place for running a business activity and often as a place of residence. The positive effects of this process, called economies of agglomeration, go with an increase in population density, which was noticed by A. Marshall as early as in 1890 (Harasimowicz 2015). They were also noted by Harris and Ullman in their polycentric urban model, stating that different types of business activities which attract one another can start new centres. The trend towards the concentration of various kinds of activities in a small area regarding favourable cooperation in the best possible place in terms of spatial and temporal accessibility can be recognised as one of the most important factors behind the formation of urban substructures.

Substructures can be also established by administrative decisions, which was mentioned earlier.

4.4. Delimitation of the Boundaries of Substructures

In theoretical terms, the boundaries of urban substructures, similarly to nodal regions, should indicate where the place loses its relations with a given core in favour of another, neighbouring core. This is so, because a substructure is characterised by the domination of internal relations generating the cohesion of a substructure over external ones.

In practice, however, it is sometimes very difficult to define the delimitation of the spatial scopes of substructures. This is because both the boundary of a substructure can be more or less blurred and there is no proper data needed for the identification of internal links. The boundaries of substructures can be clearly visible in the case of villages incorporated into the city in the recent past, the functional-spatial substructure of which has not been fully integrated with the city yet, thus maintaining their individual character. The boundaries are less clear in settlements, towns or villages which have been going through "urban-making" processes for a long time, the primary spatial structures of which were worn away as a result of the realisation of urban investments, or which have been still developing as part of the existing internal structure of a city. However, it can be assumed in a certain simplification that the identification of a core which generates various types of spatial relations connected to the functioning of households and which concentrates the daily life of the residents of an area shows that more or less clearly developed substructure exists there (Mierzejewska 2017a).

A basic method for the delimitation of a substructure is then an analysis of spatial relations connected to the functioning of households and meeting the basic needs of the population. Such data can be obtained primarily by using a survey method. The analysis of development method and the intensity of building pattern as well as the population density might be also of relevance. This is so, because in the core of a substructure the density of both development and a population should be higher than in more distant areas.

Formed of urban substructures, an urban spatial structure is then simultaneously concentrated and deconcentrated which seemingly contradicts each other. However, the notion of a concentrated-deconcentrated spatial pattern functions in the literature (Korcelli 1982, Faludi and Van der Valk 1994) and it seems that that is what a balanced urban spatial structure is supposed to look like. Deconcentration is related to the polycentricity of an urban spatial structure built of substructures, whereas the places of concentration in this structure can be substructures, including first of all cores (sub-centres).

4.5. Examples of Substructures

From the historical point of view, the establishment and functioning of certain substructures were determined by various reasons, hence several examples. They include such urban functional units as jurydyki, beguinages or some housing estates. Substructures can be also, and often are, villages, estates, military zones, prisons, some multifunctional university campuses, etc., contained within a city.

4.5.1. Jurydyki

Settlement units, independent of the city in terms of a system, legislation, administration and treasury, called jurydyki developed as early as in the 17th and 18th century in the vicinity of large cities, already called "urban complexes." Although these enclaves emerged rather randomly, their spatial structure was carefully planned. Their owners had powers enabling them to make rational land division according to the urban project. Such a project included a plan for each plot containing a detailed architectural design of the building (Putkowska 1991, Gzell 2004). As cities developed, jurydyki were included into their structures through the network of streets and squares, which is reflected in their contemporary spatial-functional pattern (Gzell 2004).

Jurydyka can be perceived as a formally and organisationally separated spatial unit which can have the character of a "small-town" urban district (Bogdanowski 1984). It should have rich content, a beautiful form, be functional, properly linked to the surroundings, with a clear centre in which buildings and social life concentrate. These features are, to a large extent, typical of a historical small town, but with regard to contemporary standards and user requirements (Gzell 2004). At the same time, these are the conditions set for urban substructures, for which jurydyki can be largely considered.

4.5.2. Beguinages

Beguinages were originally a kind of convent. They were created primarily in the Middle Ages and were mainly homes to beguines –

unmarried women, members of lay religious orders, but also men (beghards). This form of religious life comes probably from the Crusades, as a result of which many women in Western Europe became widows or were forced to live alone. These women could find their place and way of life. They had to, however, devote themselves to religious life and charity. Moreover, they cultivated a common garden placed in the courtyard of a beguinage, took care of the sick and poor and taught children. Beghards were mainly occupied with craft. The communities of beguines were autonomous and have their own laws, specific to a given society, have their house superior and lived off their own work, shared money, buildings (beguinages), eat together and held joint services. Beguinages can be most often found in northern and north-eastern France, Belgium, Holland as well as in western and north-western Germany. The best-known beguinages had quite often thousands of members.

The space where the community lived (beguinage) was developed in a characteristic way, connecting the architecture of buildings (prophanum) with religion (sacrum). A settlement was usually composed of single houses (rarely two rows of houses) built around the internal courtyard (garden) with an adjacent chapel or a small church as well as rooms for common work and a hospital. This garden was the basis for the entire spatial development pattern and was a place of worship (a contact with transcendence) and work for the benefit of the whole community (Cisek 2011). Beguinages also consisted of: an isolation room for the sick with infectious diseases, a stable, a hen house, a brewery, gardens and meadow (Cisek 2011).

A beguinage was surrounded by the wall in which there was one gate or more connecting it to the city. Thus, it was a unique element, a kind of ecosystem in the city space, a form that dominated over the surroundings. The yards of beguinages had the shape of an irregular quadrilateral (sometimes a triangle or rectangular) which merged with the city fabric forming a hierarchic construction (Cisek 2011).

Initially, beguinages grew outside the city walls, but after the Council of Trent, the church advised that they should be included within the city boundaries. In this way they became a cohesive, largely self-sufficient, functional whole in the city structure, which can be treated as a substructure.

4.5.3. Workers' Colonies

The conception of flats for industry workers, and then the development of estates attached to factories (so-called colonies) was created in England, France and Germany almost simultaneously. It demonstrated the ideas for improving housing conditions of the new social strata – workers of modern industry in order to attract disciplined, specialised employees, devoted to a company and completely subject to the rhythm of work. Such estates were not necessarily situated in the proximity of a factory, but were administratively connected with it (Juzwa and Sulimowska-Ociepka 2004).

The space of workers' colony was organised, geometric and hierarchised. It was often constructed in such a way that houses stood along the main axis of the estate, leading to the factory. Workers' houses were the actual colony, equipped with most basic urban functions such as shops, a school, a church, a hospital, often a park. Houses of office workers were loosely located, on larger, often fenced plots, outside the proper urban pattern. These types of estates became the beginning of many urbanised areas in Europe's industrial regions (Juzwa and Sulimowska-Ociepka 2004). With the collapse of traditional industry, these areas were degraded and became the subject of revitalisation activities in Western Europe.

Workers' colonies, fulfilling two basic functions, namely a workplace (mines, steelworks, factories and surrounding areas) and a place of residence (housing estate) started a polycentric spatial structure of urban agglomerations. An example of such a settlement, or a colony, in Poland, in the Upper Silesia agglomeration, is the Bobrek estate in Bytom, the Piaskowa Colony in Zabrze, or the colonies of Nikiszowiec and Giszowiec in Katowice (Juzwa and Sulimowska-Ociepka 2004).

4.6. Benefits from the Functioning of Substructures

On the basis of the literature it can be assumed that an urban spatial pattern built of substructures will represent features and benefits attributed to polycentricity and a balanced city form.

In the context of polycentricity, the following advantages can be listed:

- decentralisation of workplaces, not concentrated only in the central district (CBD) but also in the cores of substructures, which leads to more balanced access of inhabitants to workplaces, goods and services,
- increased investment attractiveness of the substructure core and the whole substructure as a place of residence owing to the concentration of business entities in the sub-centre (the core of a substructure),
- reduced distance between a place of residence and a workplace and other destinations, the effect of which is a decreased demand for transport and lower commuting costs,
- improved access to public transport which makes it possible to limit travelling by private cars and related inconveniences to the city and inhabitants,
- greater possibility of meeting daily needs on foot, which is conducive to health, the air quality and is crucial for persons who do not hold a driving licence (mainly children, adolescents, the elderly and others),
- greater social integration and the sense of identity of inhabitants with the residence area due to the availability of public spaces conducive to establishing social contacts which leads to the emergence of communities undertaking bottom-up activities.

Moreover, the deconcentration of the urban spatial structure, and specifically the occurrence of empty areas between particular substructures means that such a structure will represent benefits associated with a dispersed urban form, such as greater water retention in building-free areas (mainly those between substructures), the reduction of the heat island effect, greater availability of greenery or the reduction of the overcrowding effect. Due to high development intensity in the core, a substructure will represent at the same time benefits associated with compact cities. This is because it helps to reduce energy consumption, including gases, pollution; the pressure on open areas, also those environmentally valuable, is weaker; it is

conducive to the effective organisation of public transport, more equal access to goods and services and to technical and social infrastructure.

In the context of sustainable development, an urban spatial structure composed of substructures combines advantages attributed to compact and dispersed cities. It also serves to accomplish such basic sustainable development objectives as meeting social needs considering the principle of social justice manifested by more egalitarian access of inhabitants to infrastructure fulfilling their basic, daily needs. In this way it achieves sustainable development objectives both on the local and supra-local (city-region and even larger) urban scale.

However, in order to fit in with the assumptions of sustainable development, substructures need:

- appropriate spatial development (including the use of modern solutions enabling sustainable development),
- proper management of a polycentric city structure (co-governance),
- adoption of relevant policies promoting intra-urban polycentricity (spatial, investment, regeneration, transport, education policy etc.),

At the same time their inhabitants need to have an adequate level of awareness (e.g., environmental) and the sense of responsibility for the sub-local environment of life.

CONCLUSION

A spatial structure of cities and its proper, effective formation is a traditional, but still topical subject of interest for the representatives of various fields of science. In the present conditions the main focus is on achieving sustainable development objectives which include primarily the need to meet social needs while ensuring equal access of city inhabitants to goods and services and concern for the quality of the natural environment. This chapter was devoted to preparing the conception of such a structure. The conducted research shows that it can be an urban spatial form composed

of u5.rban substructures. It is a polycentric form which can be identified with the concept understood as the deconcentrated concentration. The study aimed mainly to present the theoretical assumptions of the conception of urban substructures and show the benefits resulting from the formation of an urban spatial structure based on substructures.

City substructures are understood as functionally cohesive urban areas, operating according to a nodal region model, which are mainly distinguished by spatial relations generated by people.

Substructures should consist of a sub-centre and the area of its influence. The sub-centre ought to concentrate buildings and various types of socio-economic activities, be a place where local residents usually shop, use different types of services (hairdressing, beauty, restaurant, cafeteria, insurance, postal, banking etc.) meet and make social contacts at the same time.

The impact range of a core determines the spatial scope of a substructure to some extent, although this scope is largely dependent on compactness of buildings and development. However, it can be assumed in a certain simplification that the identification of a core in a city structure proves the existence of a specific substructure (Mierzejewska 2017a).

Due to its organisation, structure and functioning, a substructure should be treated as a system which is a sub-system of its superior – a city system. It is a territorial system the inhabitants of which should form a community and be able to decide, at least to a limited degree, about the further development of the substructure.

The urban spatial-functional structure composed of substructures brings many advantages in terms of sustainable development. This is because it contributes to more equal access of residents to goods and services, satisfying better their needs, especially the basic ones. Thus, it fits the implementation of the time, social and spatial equity conception. Moreover, it is conducive to the reduction of transport needs, an increase in job offers near the place of residence, social development, the establishment of social contacts, the formation of civic society, etc. These benefits, however, are not always noticeable by both inhabitants and other entities as well as city authorities, hence the need for their promotion.

Polycentricity, however, is not merely a spatial conception. It also involves the need for the effective management of this type of structure, the proper methods of which have not been developed yet. It is also necessary to understand better market mechanisms that lead to the formation of polycentric spatial patterns and potential territorial effects of these mechanisms. This is so, despite the fact that polycentric development is currently perceived as the common aim of public policy in many European metropolitan areas due to its numerous benefits (Intra-metropolitan polycentricity, 2010).

One of the problems, or even challenges related to the management of a polycentric urban spatial structure is the need for the proper coordination of activities, crucial between various entities and caused by multi-level interactions. In this regard it is important to identify subjects (local leaders, urban movements, managements of housing cooperatives, associations, etc.) which are of key significance for the successful implementation of the polycentricity conception. No less important is also the issue of organisational abilities and available instruments serving to promote polycentric spatial structures. This is both about formal (administrative) and informal ones. One of the basic tools is certainly communication involving the organisation of debates, moderating meetings of various interested parties and other methods aiming to identify certain problems and find ways to overcome them. It was noticed, however, that the implementation of specific projects, the use of incentives, etc. are often beneficial for only several centres (not all), which can provoke conflicts.

Although these types of issues were not investigated in this study, they certainly deserve consideration and remain open to further research into urban substructures.

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