

Jerzy Dzieciuchowicz

2. VALORIZATION AND SPATIAL TYPOLOGY OF ŁÓDŹ'S RESIDENTIAL RESOURCES DURING THE TRANSFORMATION PERIOD

2.1. Introduction

A specific spatial structure of Łódź's residential resources was distinguished in Łódź in the age of political transformation. Different features of these resources (336,1 thousand apartments in 2008) create different spatial patterns, which are usually highly variable. A synthetic approach is justified in this case, as this issue was not frequently subject to independent study.

The object of this study is valorization and spatial typology of Łódź's residential resources in conditions typical for the transformation period. The multivariable analysis of these resources involves distribution and intensity of residential development, its dynamics (in years 1988–2002), its age, types of ownership, as well as size of buildings and apartments, technical facilities in the apartments and population density in the apartments. Specific features of residential resources were investigated according to data from 2002 national census. The city was divided into 61 housing estate units. During the valorization of residential resources, a synthetic variable, being the function of 13 diagnostic features which are the stimulants of residential standard, was used. In order to elaborate the spatial typology of residential resources, the *K-mean* method was used, as one of the most effective iterative optimization methods used in numerical taxonomy. There were 19 typological features distinguished.

2.2. Distribution and intensity of residential development

The 2002 national census data indicates, that the spatial pattern of the number of apartments in Łódź, in relation to the housing estate units, is

skewed positively ($A^3 = 1.98$). This confirms the dominance of housing estates with fewer apartments, comparing to an average unit. This is linked to a strong leptokurtosis ($K = 4.13$) and variation ($V = 147.2\%$) of the analyzed distribution. In 25% of all housing estates, the number of apartments does not exceed 165 and in 75% it is below 7 035. It is noteworthy, that the size of residential resources in housing estates is correlated with their size ($r = 0.021$) and is highly dependent on the intensity of residential development ($r = 0.802$) and average building size measured with number of apartments ($r = 0.794$) and their usable floor space ($r = 0.701$).

The spatial pattern of Łódź's residential resources is close to concentric-sectoral (fig. 1). A central zone, closed within the boundaries of ring railroad, can be clearly distinguished. This zone contains apartments located mostly in pre-war, tenement buildings and older, post-war, multi-family blocks. The highest amount of apartments in this zone (nearly 34.2 thousand) is located in the housing estate of Stare Miasto – Bałuty. Other sectors of post-war, multi-family housing estates expand away from the central zone in different directions. These are located in both transitional and peripheral zones. Within those sectors there are five units, containing the largest housing estates in Łódź, namely Retkinia (31.3 thousand apartments), Teofilów (19.1 thousand), Radogoszcz (16.1 thousand), Widzew-Wschód (17.3 thousand) and Chojny Zatorze (11.9 thousand). Outside the aforementioned sectors, most peripherally situated housing estates, with single-family and rural development, do not exceed 1 000 apartments. In case of 11 units, the number of apartments does not even reach 100.

The intensity of residential development, measured with the ratio of usable floor space size of the apartments and the total area size, creates a concentric-sectoral spatial pattern, which is a derivative of apartments' layout. A slight, negative correlation between the level of intensity and the area of housing estate units can be observed ($r = -0.251$). At the same time, the intensity is highly correlated with the amount of apartments ($r = 0.801$), average amount of apartments in a building ($r = 0.794$) and its usable floor space ($r = 0.830$). The highest values of the intensity indicator, usually exceeding 0.06, can be observed in the central zone and in the outer sectors of multi-family housing developments. In the inter-sector areas, dominated by dispersed single-family housing development, the intensity indicators frequently drop below 0.01.

³ The following symbols were used in the article: V – classic coefficient of variation, A – classic skewers coefficient, K – classic kurtosis coefficient, r – Pearson correlation coefficient. These measures were calculated with the aid of SPSS software.

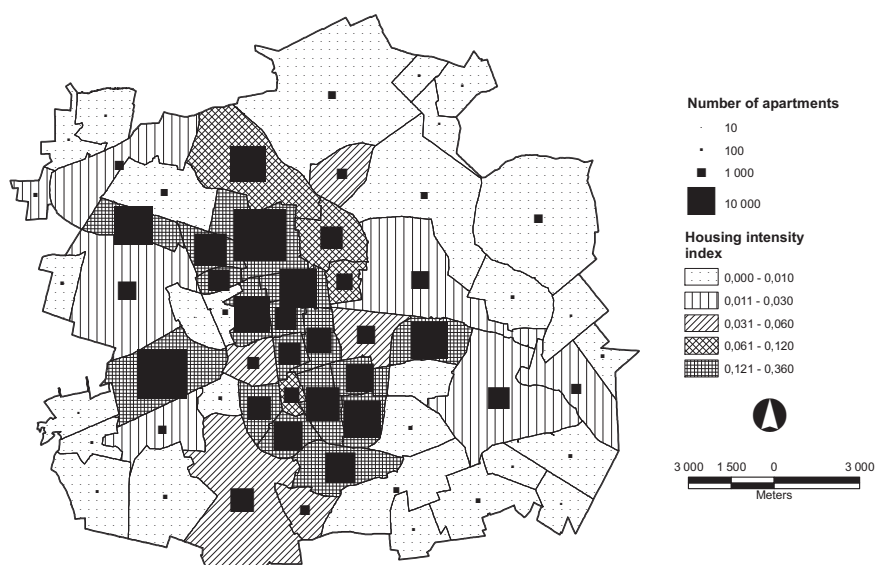


Fig. 1. Distribution and intensity of housing development in Łódź

Source: 2002 national census; author's own elaboration

In years 1988–2002, Łódź witnessed a decrease in residential resources. It concerned mainly central areas with large, used up residential resources, as well as industrial and warehouse districts located in transitional and peripheral zones and other areas with low intensity of residential development, which do not attract new residential investments. The aforementioned parts of the city witnessed the decline of 10% of their residential resources, as a result of demolition or closure of buildings. It is noteworthy, that these areas are also undergoing depopulation. On the other hand, a dynamic increase in residential resources was observed mainly in a peripheral zone, where attractive building plots were located, with easy access to green areas and technical infrastructure. Three housing estate units can be given as an example: Olechów, Romanów and Ustronna, where the amount of apartments tripled. This reflects the tendency of Łódź's inhabitants' migration from overpopulated, ecologically impaired areas to suburban areas, with proximity of nature.

2.3. Valorization of residential resources

The comprehensive evaluation of residential resources for the 61 studied housing estate units in Łódź was performed, based on data from the last national census. A synthetic variable, being the function of all the 13

diagnostic features, describing different, important aspects of residential resources in housing estate units, was used to make this measurement. The following input features were recognized:

- 1) intensity of residential development,
- 2) index of dynamics of residential resources in years 1988–2002,
- 3) percentage of apartments built after 1944,
- 4) percentage of apartments belonging to natural persons,
- 5) number of apartments per 1 residential building,
- 6) number of rooms per 1 apartment,
- 7) percentage of apartments connected to water main,
- 8) percentage of apartments connected to gas main,
- 9) percentage of apartments with central heating,
- 10) number of people per 1 room,
- 11) number of people per 1 apartment,
- 12) usable floor space per 1 person,
- 13) number of households per 100 apartments.

Before a synthetic variable was calculated, the set of diagnostic features was unified, in order to contain only the stimulants, i.e. variables positively correlated with the standard of residential resources. That is why some input features (1, 5, 10, 11, 13) underwent algebraic transformation. The values of synthetic variable for different housing estate units were calculated as a sum of relative deviations of each stimulant's value from its maximum score (Bartosiewiczowa 1976, p. 3–37). This enables different variables to keep their diverse variance, which gives them specific weights.

The distribution of a synthetic variable, determining the standard of residential resources in Łódź's housing estate units resembles a normal distribution (fig. 2). It is related to a slight negative skewness ($A = -0.252$) and platokurtosis ($K = -0.525$) of the studied distribution. A very low variation is also observed ($V = 13.72\%$), which is related to a very narrow empirical range of the synthetic variable's variation ranging from 5.75 to 10.55. The average value of this variable (8.4) reflects its central tendency, although in this case a slightly higher median value (8.66) would be a better measure of centrality. Moreover, it was determined that for 25% of all housing estate units, the synthetic variable does not exceed 7.52, while in 75% of them it is lower than 9.19. Considering the typical variance range, determined on the basis of the mentioned quartiles, the housing estate units with exceptional low standards are the ones with synthetic variable of below 7.83. The units with particularly favourable residential conditions are those with a synthetic variable of 9.5 and above. The units with typical synthetic variable range (7.83 – 9.5) are the most common type of residential standard in the city.

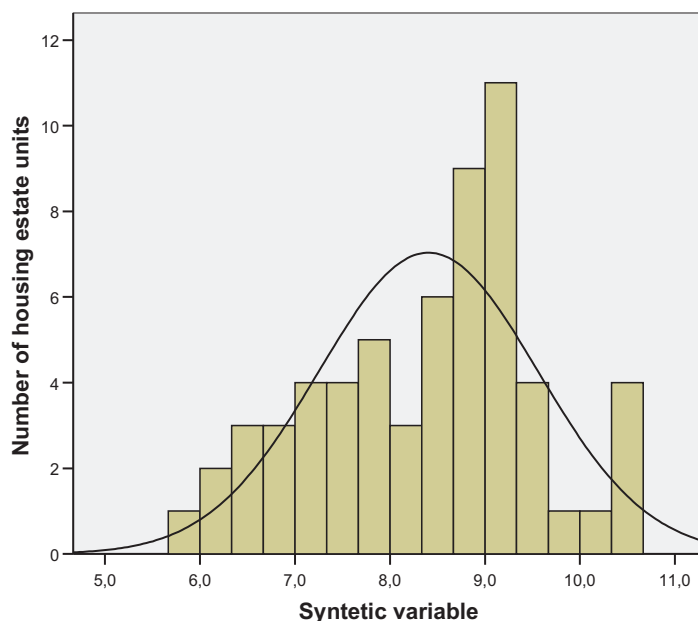


Fig. 2. Distribution of the synthetic variable of residential standard in Łódź (the curve represents a normal distribution)

Source: 2002 national census; author's own elaboration

In order to spatially visualize the synthetic variable of residential resources' standard, a cartogram was created (fig. 3), where 7 natural ranges of residential standards were established: 1) exceptionally low (5.75 – 6.72), 2) very low (6.73 – 7.41), 3) low (7.42 – 8.03), 4) average (8.04 – 8.74), 5) high (8.75 – 9.15), 6) very high (9.16 – 9.69) and 7) exceptionally high (9.70 – 10.55).

The exceptionally low and very low standard is found in residential resources of the central zone and in older housing estates located in its direct vicinity (Górny Rynek, Dąbrowa Zachodnia, Kurak, Stare Miasto, Nowe Rokicie) and in some industrial and warehouse districts (Teofilów Przemysłowy, Nowe Sady). Many high-rise housing estates, usually located away from the city centre, are categorized as a low residential standard (Chojny Zatorze, Widzew-Zachód, Doły, Zarzew, Koziny, Dąbrowa, Żubardź, Widzew-Wschód). An average standard of residential resources is typical for peripherally located, large, multi-family housing estate clusters (Retkinia, Teofilów) and some clusters of non-homogeneous, single-family housing (Feliksin, Ustronna, Ruda, Mileszki, Nowe Moskule, Stoki, Romanów and Sokołów). As a contrast, new multi-family (Akademicka,

Radogoszcz, Olechów) and single-family (Zimna Woda, Nowy Imielnik, Sąciczno, Łaskowice, Wilanów, Andrzejów) housing developments represent a high standard. The residential resources with very high and exceptionally high standards are only found in the peripheral and marginal zones, where the newest single-family housing development is located, such as Wiskitno, Wiskitno Las, Nowosolna, Marysin-Rogi and Jagodnica.

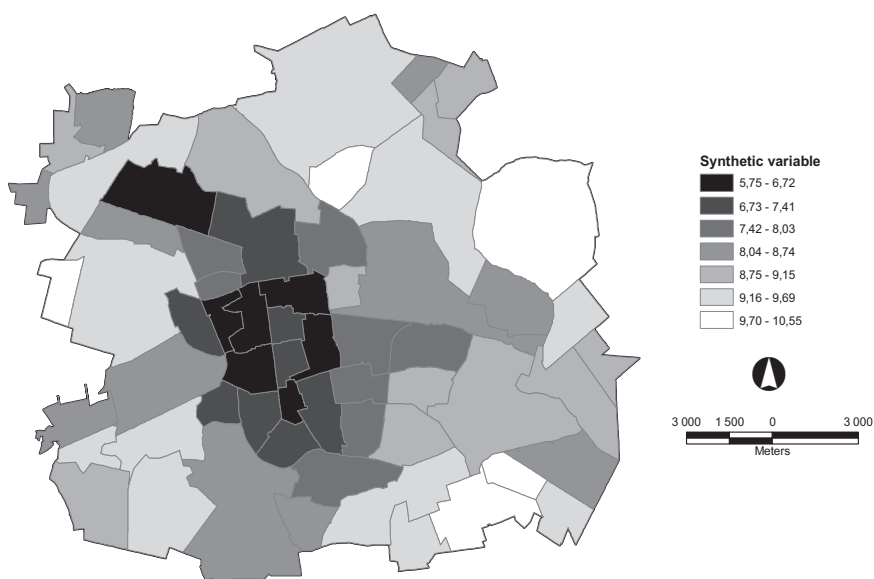


Fig. 3. Valorization of Łódź's residential resources

Source: 2002 national census; author's own elaboration

Generally speaking, the discussed residential standard has a pattern similar to concentric-sectoral, with a general increase of the residential standard in the outward direction. A similar pattern has been determined during the study on living standards of Łódź's urbanistic units (112) in 1988 (Dzieciuchowicz 2002). This proves that the transformation period did not bring significant changes in the quality of urban, residential space⁴.

When comparing the abovementioned spatial pattern of the synthetic variable of residential resources' standard with the spatial typology of Łódź's

⁴ The first comprehensive, spatial study of Łódź's residential conditions in 1970 showed conditions completely different from what is observed nowadays (Dzieciuchowicz 1980). Areas with good and average residential conditions were located centrally. The city centre was surrounded with areas of both good and bad conditions, while the peripheral zone comprised average and bad conditions. All the distinguished areas of residential conditions formed a concentric-sectoral pattern.

inhabitants, based on 18 demographic-social features (Dzieciuchowicz 2009), it is worth to underline the striking correlation between the distribution of housing estate units of significantly low residential conditions with type 8, which is mainly related to high spatial density of people and relatively high unemployment rate. At the same time, areas with the best residential conditions are mainly correlated with types 3 and 9, which are related to people with high level of education and self-employed.

2.4. Spatial typology of residential resources

The choice of typological features is one of the most important and most controversial issues in every typology, as it mainly determines the results. That choice in conducted spatial typology of Łódź's residential resources was based on three groups of criteria: content-related, formal and statistical (Grabiński 1992). The main content-related criteria are:

- comprehensive formulation of the main traits of analyzed services, instead of secondary traits,
- clear, unambiguous and precise definition of variables,
- logical link between the variables and possibility of control of variables, through the knowledge of their mutual relation,
- conformity of proportions between the number of variables representing a particular aspect of the studied services and their content-related significance.

The formal criteria include:

- measurability of the features,
- existence of trustworthy and easily accessible statistical data,
- completeness of data for all spatial units,
- continuity, enabling mutual comparability of spatial units.

As far as statistical criteria are concerned, two of them were taken into account:

- high discrimination capacity of spatial units, resulting from high spatial variation of diagnostic features,
- lack of strong, mutual correlation between the diagnostic features.

In order to elaborate the spatial typology of residential resources, a set of 19 easily accessible and trustworthy diagnostic features, describing particularly vital features of the studied residential substance, was used:

- 1) number of apartments,
- 2) intensity of the residential development,
- 3) residential resources dynamics index in years 1988–2002,
- 4) percentage of apartments built before 1944,
- 5) percentage of communal apartments,

- 6) percentage of apartments belonging to natural persons,
- 7) percentage of apartments belonging to State Treasury,
- 8) percentage of apartments belonging to housing co-operatives,
- 9) percentage of apartments in buildings being a common property,
- 10) percentage of apartments belonging to a work place,
- 11) number of apartments in a building,
- 12) number of rooms in an apartment,
- 13) percentage of apartments connected to water main,
- 14) percentage of apartments connected to gas main,
- 15) percentage of apartments equipped with central heating,
- 16) number of people per 1 room,
- 17) number of people per 1 apartment,
- 18) usable floor space of apartments per 1 person,
- 19) number of households per 100 apartments.

All of the abovementioned features except three of them (13, 16, 19) show moderate or high variance, which indicates a large load of information about residential resources of housing estate units. It proves their high usefulness for typological studies. The spatial distributions of most of the analyzed features are asymmetrical and their kurtosis is usually far from a normal level. It is also noteworthy, that 50% of all studied variables have more than one modal value. Looking at the correlation between different diagnostic features, it was determined that only two pairs of variables were mutually strongly dependent. Therefore, it can be assumed, that the set of diagnostic features used, meets all the most important statistical criteria for typological purposes.

The types of studied territorial units were determined with the use of *K-mean* method, successfully used in taxonomy in many earlier studies (Anderberg 1973; Sparks 1973; Grabiński, Wydymus, Zeliaś 1989; Grabiński 1992; Kolenda 2006). A variant of this method, used in this study, was proposed by D. N. Sparks, who utilized the SPSS statistical software. It enables to distinguish relatively homogeneous cluster of objects in terms of chosen features, with minimal variance of objects within one cluster and maximum variance between different clusters. A particular object is assigned to a class, whose centroid is in the closest Euclidean distance. This type of clustering is usually performed in three stages, such as:

1. determining (K) objects comprising initial clusters,
2. assigning subsequent objects to the nearest cluster,
3. relocation of objects between the clusters, until the quality of the division is improved.

The use of this method required prior standardization of the empirical values of the proposed diagnostic features⁵. It was determined, that the best

⁵ Standardization was made according to the following formula:

separateness can be provided by establishing 7 clusters, treated as counterparts of housing estate unit types (fig. 4). Each of them represents specific combinations of mean values of the standardized diagnostic features and their separate spatial pattern. The names of different types were derived from the most predominant features of their residential resources.



Fig. 4. Spatial typology of residential resources

Source: 2002 national census; author's own elaboration

Type 1 – high dynamics of housing development, with a large share of co-operative apartments in single-family and multi-family housing

This type is only found in 3 housing estate units, located peripherally (Olechów, Ustronna, Romanów). It is characterized by large dynamics of housing development in years 1988–2002. Its entire residential resources are dominated by post war housing. The percentage of co-operative apartments and apartments located in commonly owned buildings is also relatively high. A negative phenomenon of low independence of apartment use by households occurs.

Type 2 – high share of apartments belonging to State Treasury and high population density in apartments in single-family housing with a blend of multi-family housing

$x_{ij}^t = (x_{ij} - m_{1i}) / S_{xi}$, where x_{ij} – empirical value of the feature i in unit j , m_{1i} – arithmetical mean of the feature i , S_{xi} – standard deviation.

It is assigned only to one housing estate unit, namely Mileszki. It is characterized in particular by a high percentage of state-owned apartments and a very favourable room structure of the apartments, convergent with their high population density. Moreover, in this case we are looking at scarce residential resources, low intensity of housing and a high share of post-war apartments.

Type 3 – strong dominance of single-family housing, with a low level of population density in the apartments and high level of their technical infrastructure

This is one of the most frequent types found in urban space (15 housing estate units), located mainly in the direct vicinity of the central zone and dominated by low intensity of single-family housing of varied standard. The main features of this type include: large usable floor space of the apartments per 1 person, large share of apartments with central heating, low room population density and favourable apartment structure in terms of room number.

Type 4 – dominance of single-family and rural housing, with high population density in the apartments and low independence of apartment use by households

It occurs mainly within city's borders, similarly to type 3, creating a number of isolated areas dominated by privately owned single-family houses and homesteads in the marginal zone. The predominant features include high number of people per 1 apartment and high number of households per 100 apartments. Scarce residential resources, low housing intensity and low percentage of apartments connected to gas and water mains are also frequent for this type.

Type 5 – relative surplus of privately owned apartments in a pre-war, single-family housing with low population density

It is a rather rare type, which can be found in areas with limited resources of privately-owned, pre-war apartments in a single-family housing of low intensity (Park Ludowy, Zarzew Przemysłowy). It is also characterized by low apartment and room population density, with a large usable floor space per 1 person and insufficient access to sanitary-technical facilities.

Type 6 – relative dominance of pre-war tenement buildings with high share of communal apartments

The housing estate units, which belong to this type, are the main part of Łódź's urbanistic city centre, with the exception of Śródmiejska Dzielnica Mieszkaniowa, but including Górny Rynek and Teofilów Przemysłowy. The main features of this type include relative dominance of pre-war, multi-family housing with a high share of communal apartments, large residential resources and high intensity of housing. At the same time, lack of central heating, dominance of small rooms and high population density is observed in the apartments.

Type 7 – dominance of intensive block development with large residential resources

This type is the most common for housing estate units with block development (17), which create a direct surrounding of Łódź's city centre. We are dealing here with a high intensity of housing, which is related not only to large residential resources but also to a high vertical intensity. It is characterized by a high percentage of co-operative apartments with low population density, reflected in both, number of people per 1 room and 1 apartment, as well as usable floor space per 1 person and number of households per 100 apartments.

It is also noteworthy that types 6 and 7, with housing estate units comprising tenement buildings and blocks of flats, are characterized by a general low residential standard. In contrast, types 3 and 4, dominated by single-family housing, have a standard above average. In all other types, the residential standard is usually varied.

The discussed typology, independently from differences in the assumed methods, partly reflects the typology of residential standard of Łódź's urbanistic units (112) as per 1988 (Dzieciuchowicz 2002). Additionally, it is explained by the aforementioned statement about limited range of spatial transformation of Łódź's residential environment during the transformation years.

Moreover, a comparison of spatial typology of residential substance with the typology of people (Dzieciuchowicz 2009) brought interesting results. It showed, that types 6 and 7 of the housing estate units, comprising multi-family housing, are frequently accompanied by demographic-social type 8 of housing estates, characterized by a high concentration of people and a relatively high unemployment rate. In contrast, type 3 of housing estate units, with dominance of single-family houses, is frequently accompanied by demographic-social type 2, with a relative high percentage of self-employed people with large households. The correlation between type 4 of territorial units (single-family and rural housing development), with demographic-social type 3 (people working in agricultural sector) is also visible.

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STRESZCZENIE

WALORYZACJA I TYPOLOGIA PRZESTRZENNA ZASOBÓW MIESZKANIOWYCH ŁODZI W OKRESIE TRANSFORMACJI

Przedmiotem tego opracowania jest waloryzacja i typologia przestrzenna zasobów mieszkaniowych Łodzi w warunkach charakterystycznych dla okresu transformacji. Wielozmienna analiza tych zasobów obejmuje rozmieszczenie i intensywność zabudowy mieszkaniowej, jej dynamikę (w latach 1988–2002), wiek oraz formy własności, a także wielkość budynków i mieszkań, wyposażenie lokali mieszkalnych w instalacje sanitarno-techniczne oraz zaludnienie mieszkań. Określone cechy zasobów mieszkaniowych były rozpatrywane według stanu ustalonego w momencie krytycznym NSP z 2002 r., przy przyjęciu podziału miasta na 61 jednostek osiedlowych. W waloryzacji zasobów mieszkaniowych posłużono się zmienną syntetyczną będącą funkcją 13 cech diagnostycznych, stanowiących stymulanty standardu mieszkaniowego. Natomiast do opracowania typologii przestrzennej zasobów mieszkaniowych wykorzystano metodę *K-średnich*, zaliczaną do najbardziej efektywnych metod iteracyjno- optymalizacyjnych stosowanych w taksonomii numerycznej, posługując się zbiorem 19 cech typologicznych.

Standard mieszkaniowy ma układ przestrzenny zbliżony do koncentryczno-sektorowego, przy ogólnym wzroście tego standardu w kierunku odśrodkowym. Podobny układ stwierdzono w badaniach standardu mieszkaniowego jednostek urbanistycznych Łodzi w 1988 r., dowodząc tym samym, że okres transformacji nie doprowadził do zasadniczych, jakościowych przekształceń przestrzeni mieszkaniowej miasta.

Zastosowanie metody *K-średnich* pozwoliło na wydzielenie siedmiu skupień, traktowanych jako odpowiedniki typów jednostek osiedlowych. Poszczególnym typom nadano następujące nazwy pochodzące od najbardziej wyróżniających cech ich zasobów mieszkaniowych: typ 1 – wysoka dynamika budownictwa mieszkaniowego.

wego, przy dużym udziale mieszkań spółdzielczych w zabudowie jednorodzinnej i wielorodzinnej; typ 2 – wysoki udział mieszkań należących do Skarbu Państwa i duże zaludnienie mieszkań w zabudowie jednorodzinnej z domieszką wielorodzinnej; typ 3 – silna dominacja zabudowy jednorodzinnej, przy niskim stopniu zaludnienia mieszkań i wysokim poziomie ich wyposażenia w instalacje sanitarno-techniczne; typ 4 – dominacja zabudowy jednorodzinnej i zagrodowej, przy wysokim stopniu zaludnienia mieszkań i niskiej samodzielności użytkowania mieszkań przez gospodarstwa domowe; typ 5 – względna nadwyżka prywatnych mieszkań w przedwojennej zabudowie jednorodzinnej o niskim zaludnieniu; typ 6 – względna dominacja przedwojennych kamienic czynszowych, w połączeniu z wysokim udziałem mieszkań komunalnych; typ 7 – dominacja intensywnej zabudowy blokowej o bardzo dużych zasobach mieszkaniowych.