Land Use Policy 61 (2017) 511–525

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Rating engineering of real estate markets as the condition of urban areas assessment

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ARTICLE INFO

Article history:
Received 7 May 2016
Received in revised form
30 November 2016
Accepted 30 November 2016

Keywords:
Real estate market
Rating system
Urban areas condition
Urban development

ABSTRACT

The real estate market is closely linked with the condition of the area (e.g.: quality of both technical and social infrastructure, function of urban area – residential, commercial, industrial, recreational; characteristics and state of the environment, spatial barriers and obstacles, etc.) and it is determined by the diverse needs and requirements of space users. Cities and regions which want to achieve a dominant position in the network via their policy try to attract as many entities and types of activity as possible. The link between real estate markets and the potential of urban development is becoming increasingly visible and highlighted in many studies. Real estate markets play an increasingly important role in the global economy and attract a growing number of international investors. Consequently, the demand for reliable classification and scoring systems will continue to grow and become an essential tool in the process of investment planning.

The aim of this research is to develop a methodology which could be used to evaluate the state (related to rating levels such as: investment, development, stagnant, crisis; see Appendix A, Table A1) and the condition (related to the components described in the rating scale table, such as: economic situation, quality of life, spatial potential of development, flexible reaction of the market, behavioral factors, etc.; see Appendix A, Table A1) of the real estate market in a form of rating. The established rating classification provides a current, reliable and comparable view of the conditions of cities that can be useful in investment decision-making process. The authors used "Rating Engineering" to highlight the application of mathematics and practical knowledge (regarding the needs of participants) in order to develop an innovative tool for decision-making on the real estate market. The proposed rating system procedure is versatile and can be implemented in any domain, especially when the analysis concerns imprecise and vague data. The study shows that the ratings developed by the authors indicate on a significant correlation with future events in the real estate market, which have a key influence on the development of the real estate market and an assessment of its condition. The received results confirmed that the developed methodology allows to obtain reliable view of the state and condition of residential property market.

1. Introduction

Real estate is the kind of goods that depends, among other things, on the place where they are located. Real estate, especially residential properties, is according to the needs hierarchy of Abraham Maslow, one of the most important factors which meets the basic biological needs of a man (Kotler et al., 1993). In the hierarchy of the importance of needs, the need for housing takes one of the main places. Real estate is an integral and indispensable element of meeting needs virtually in every sphere of human life: in the sphere of security needs (sense of stability), social needs (home, meeting place), needs for recognition and respect (a sign of prestige, highlighting social position), and the need for self-realization (proof of independence).

Fulfilling a number of functions related to meeting human needs, real estate provides timely, important, and even necessary area for an interdisciplinary research. From this point of view, the real estate market should be the subject of studies that not only take into account the impact on the value of the so-called physical

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http://dx.doi.org/10.1016/j.landusepol.2016.11.040
0264-8377/

aspects of real estate in the micro-local conditions, but it should also be studied in terms of macroeconomic and global aspects, in relation to the information strictly linked to the market and the factors that define the quality of the space in which they are located. This widely recognized range of information allows diagnosis of the quality of life of a given society regarding the economics, political, social and behavioral terms in their micro-, macro- and global aspects.

Decision-making on the real estate market is complicated from the point of view of the needs that the property is supposed to satisfy. The difficulty also lies in the diversity and imprecision of space attributes, a large and multidimensional scope of data to be analyzed, the sensitivity of properties to environmental or economic changes and fashion, as well as heterogeneity with respect to nature and type of individual objects. All of those aspects increase volatility and in this context they create problems with the reliability and effectiveness of the analyses.

The universality of the topic and its practicality increase the number of scientific studies on real estate markets classification. Most of the analyses focus, however, on the division, classification or segmentation of real estate markets, and not on the assessment of its condition, which is very important in the process of increasing the efficiency of decision-making and the rationalization of decision-making situations for every participants of the real estate market.

Guided by these assumptions, the authors proposed the development of a complementary and unified scoring system that allows for the assessment of residential real estate markets condition. The conducted study should be considered as an important methodical element. The results will enable market participants to make decisions in a more conscious and well organized manner. The access to continuously updated information about the rating may certainly affect the increase of informational efficiency in the decision making process, especially in case of private and public investors, developers, appraisers, tax assessors, urban planners, designers and architects, land administrators, local authorities and other real estate market participants, such as, mortgage lenders and insurers etc. Additionally, the objectified information will be more accessible, which will influence the level of knowledge among market participants, and thus will be helpful in meeting their needs in the sphere of information.

The conducted research is also important from the point of view of assessing the state of urban development (residential aspect) of the spatial settlement units (e.g. cities). Cities and regions want to achieve a dominant position in the network via their policy and try to attract as many entities and types of activity as possible. When examining the structure and the character of the surrounding space, it is possible to determine whether there are attractive prospects, and whether there is a growth potential in the analyzed area. Each property market is closed in a specific and unique space. The ratings (a dynamic assessment of the state of area development) enable the current assessment of individual spatial units and the identification of threats (e.g.: decreasing investor interest, high migration of population, rising unemployment, deteriorating condition of technical and social infrastructure, decreasing quality of life, emergence of spatial and social conflicts, and occurrence of spatial, environmental and legal barriers) in the functioning of these units in the context of their location of the real estate market.

The paper is structured in the following way. First, explanation of the reason to choosing the rating classification are described in Section 2. Section 3 presents methodology of the research and Section 4 presents the procedure of the real estate market rating. Section 5 includes a Discussion and the analysis of the rating results. Section 6 presents Conclusions.

2. Related research

In the literature, the real estate market is often (in fact, even mostly) assessed for its value and in order to define the value-creating factors. A Real Estate Guide (2015) indicates that "to appraise means the act or process of developing an opinion of value". Additionally, A Real Estate Guide (2015) and Kaklauskas et al. (2015) pointed out that the appraisers must be exceptionally careful to accurately assess the true forces affecting value. The authors mentioned above indicate the particular significance of the following factors: utility, size, corner influence, shape, thoroughfare conditions, exposure, plottage or assemblage, topography and character of soil, obsolescence, building restrictions and zones, tract layouts, directional growth ("the city directional growth"), location, environmental, social ideals, character of business climate, economic condition etc. The link between real estate markets and the potential of urban growth was revealed a long time ago (e.g. D'Arcy and Keogh, 1999; Leung, 2004). Real estate markets play an increasingly important role in the global economy and attract a growing number of international investors. Consequently, the demand for reliable classification and scoring systems will continue to grow and become an essential tool in the process of investment planning.

The heterogeneity of real estate affects the complexity of the market, the difficulty of its analysis and the credible inference in the decision-making processes. The consideration of the general condition of a spatial unit (the real estate market) is increasingly discussed in theoretical and practical aspects. In order to make the information more comprehensible, various types of classifications and segmentations are used. Market classifications can be divided into two main categories. The first category is related to the markets sharing depending on the subject, object or condition of the property – this is the context used in the process of property valuation (usually in terms of the local market). In this context, specific real estate markets are usually classified on the basis of property type, location, income-producing, potential, typical investors characteristics, typical tenant characteristics, or other attributes recognized by those participating in the exchange of real property (Razzak, 2015). For instance, Dubin and Goodman (1982) proposed methods for analyzing non-nested submarkets. Bourassa et al. (2007) involved spatial dependences in the prediction of house price. Goetzmann and Spiegel (1997) examined how neighborhood amenities influence house prices using zip code districts to determine housing submarkets. The idea to identify housing submarket boundaries by developing and estimating the parameters of a hierarchical model for house prices was proposed by Goodman and Thibodeau (1998). Additionally, Floyd and Allen (2002) proposed segmentation of real estate markets due to real estate space and the asset of transactions. The second way involves a classification of real estate markets allowing for a mutual review of individual markets, their quantitative and qualitative comparison in terms of hyper-local and/or global approach. In this group the following classifications can be made:

1. ranking classification – excluding the elements of the comparative assessment of the market,
2. rating classification – including the elements of the comparative assessment and the diagnosis of market condition.

The second classification of the market is the subject of this study. Rating allows for an interpretation of the states and it is an attempt to conduct the comparative assessment. The potential and power of classifying the real estate market in the rating form was indicated by European Property and Market Rating (2003), Research on Property and Market Rating in China based on Basel II (2008), Kalberer (2012), Renigier-Biłozor et al. (2014), Maszczyk (2014), Kaklauskas et al. (2015). The European Property and Market

Rating (2003) and Kalberer (2012) defined 'Property and Market Rating' as a versatile instrument for assessing the quality of property. However, these authors recommend the use of a developed procedure to assess individual properties risks for securitization rather than for markets in general. Other authors find real estate market ratings a useful tools for developing portfolio investment strategies (Anglin and Yanmin, 2011; Collett et al., 2003) or formulating long-short portfolio strategies on housing indices for more risky and less risky assets characterized by low liquidity (Beracha and Skiba, 2011). The aim of such studies includes, among other things, the attempts to eliminate or at least reduce the impact of speculative phenomena on the real estate market and to increase the effectiveness and objectivity of the decisions.

In the context of the analysis, the following question – Are there any factors which might stimulate or harm the development of property market? – has become common. Therefore, various housing market indicators make an effort to establish the existing housing situation. For example, to determine "hidden clues to future economic trends and investment opportunities", Baumohl (2005) analyzed the existing home sales, sale price of existing homes, the housing affordability index, new homes sold and for sale, total construction spending, total housing units started and the housing market index. Lu and So (2005) underline that it is indispensable to analyze the life cycle of a crisis in the real estate sector in a complex fashion involving the following aspects: demographic, economic, social, legal, religious, managerial, educational, psychological, institutional, cultural, ethical, political, technical, emotional. Moreover, Kaklauskas et al., 2015 indicated that economic and technological triumphs alone cannot determine how to overcome a crisis and pursue advancement in the property markets area – true advancement also encompasses elements of values. For this reason, researchers and practitioners are interested in the classification of real estate markets as the tools supporting decision-making processes and providing additional (often critical) information on and for the real estate market – especially important in the face of all kinds of crises, local and global ones. The above-mentioned systems employ various models, methods and indicators. One of them is the warning systems for property markets. They have been considered by numerous authors (Ho et al., 2012; Lind, 2009, Agnello and Schuknecht, 2011; Hui and Wang, 2014; Kaklauskas et al., 2015). Kaklauskas et al. (2015) proposed the "model of crisis thermometer" for national/domestic housing market recommendations and indicated that "temperature" of a housing market in Lithuanian has a strong uphill linear relationship with the housing price to income ratio, buyer income, construction works and investments in the construction sector. Appraisers, analytics, researchers are constantly concerned with the conditions and prospects of the local economy, area growth potential, environmental conditions of space because the value of local real estate is largely determined by "the health of the community" A Real Estate Guide (2015).

However, it can be asked how to elaborate, classify, measure and diverse the condition of real estate markets which consist in many aspects defined as the quality of location considering opportunities for employment, economic condition, quality of local government, civic and social conditions, demand for goods and services, transportation and living conditions, opportunities for education and personal improvement, access to natural and anthropogenic amenities, urban investments of the area, conditions of neighborhood etc. With reference to the above-mentioned question, the authors elaborated on the supportive rating – decision systems that would increase the effectiveness of market analyses and make them a source of objective knowledge. In the light of the research, the authors proposed the development of "ratings of real estate market" as a modern tool that can be used in analyses and predictions of urban area potential.

3. Research methodology

The research of the article involves developing a rating system of residential real estate markets. For this purpose, it is necessary to specify the scope and methods of the research, but also to define its subject. According to the authors, the real estate market is a set of interacting elements (i.e. the subject, object, their properties and the relationships between them) which are closely connected with space (location) they are in and conditioned by social, economic, political, legislative and behavioral aspects (Brzezicka and Wisniewski, 2016). The real estate market is not only the system operating under local conditions, but also an important element of the economic organism of a country, even of the world.

Housing is an important aspect of a quality of life in any community (Renigier-Biłozor et al., 2015). The residential real estate market is a subsystem in real estate market system. It is the causative factor for many evolutionary phenomena when determining the development of a given area. The good condition of the residential real estate market attracts new inhabitants and it is the driving power for its residents. The housing market determines the development of technical and social infrastructure, creates business environment and investment climate. It is now a strong sector of the economy of any country affecting the perception and image, as well as the development of a spatial unit. The real estate market (its state and condition) is thus both a driving force of area evolution and the result of this phenomenon in a certain time interval.

The aim of this research is to develop a methodology for valuation of the housing market condition. The research is thought to show the way to assess the potential and possibilities of reaching a certain stage of development by the market considering the state and condition of the area. Furthermore, the research aims at enabling an assessment of the flexibility to changes in both the demand and the supply of the analyzed real estate market. According to the authors, the condition of the housing market should be determined and assessed in a separated administrative area, which is a separate space ensuring a certain quality in the field of meeting the needs and requirements of the space users and participants in the housing market.

The condition of this market should be considered regarding the following factors:

1. different fields of activity of market participants
2. various forms of social life
3. factors relating to the safety of investments (social and capital)
4. market ability of self-regulation in response to the evolution of the real market conditions and,
5. needs of the real estate users

For the purposes of this research, authors defined rating as a kind of a market classification carried out using the methodology of comparative valuation of the analyzed phenomenon. Rating, as the methodology of the comparative assessment, requires the use of rating scales. These scales must permit an assessment of the condition of real estate markets and allow for a comparable market assessment. The prepared scales are shown in Appendix A (Table A1).

In the research, the method of comparative results, which include the condition of market comparability based on an established criterion e.g. city size, population, population density, strategic and administrative functions etc., was used. In addition, due to the complexity of the real estate market, it was necessary to define the key phenomena (key indicators) that could play the

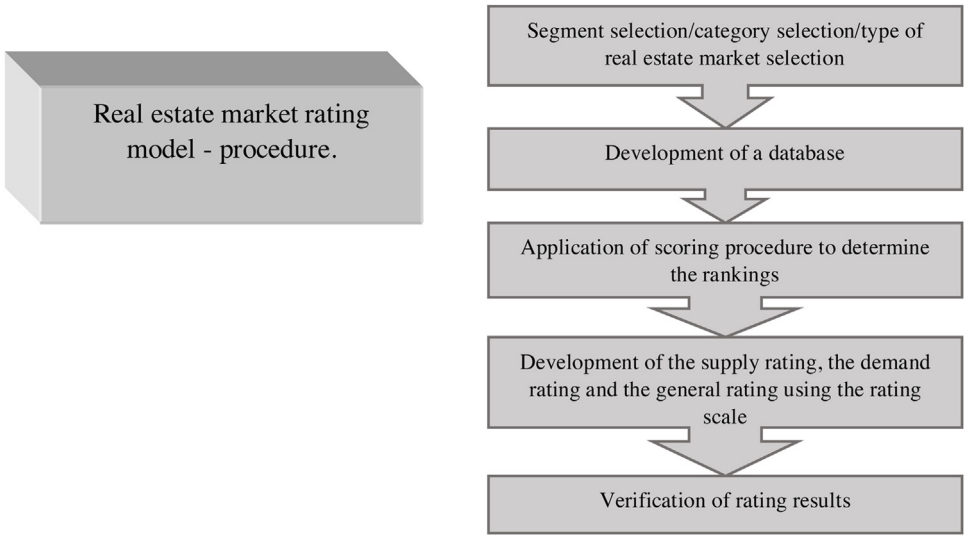

Fig. 1. A model of the real estate market rating – procedure.

Source: Own study.

role of a test results verifier. In this case, it was assumed that these phenomena would directly reflect the scale of the evolution of the two main areas of the market i.e. the supply (in terms of a number of properties that can be traded) and the demand (expressed in the number of transactions).

Rating engineering of the real estate market developed in the article is shown in Fig. 1. The determination of the rating score for real estate markets was prepared in the form of a procedure aimed at obtaining significant elements supporting decision-making in the market.

The procedure consisted of several stages that were methodologically opened. It contained the definition of the rating subject that was established as a set of information to be evaluated, a methodological and analytical part enabling objectifying the research results and the final part consisting in the verification of the results that would be obtained on the basis of future market data.

4. Procedure of the real estate market rating – a case study

4.1. Data description

In the first stage of the research a database including a set of factors that could affect the condition of the real estate market was developed. The database was developed for the period of the preceding two years in relation to the rating year, assuming the valuation methodology of real estate, for the years 2011, 2012 and 2013 (the rating year). When choosing the time range of the research, the possibility of obtaining data was also considered, including: the access to the main databases, updated information and the assumptions arising from the necessity to carry out the verification of the test results. In order to properly verify the results of the research, some of the variables identified as crucial (key indicators) from the point of view of the market definition were also developed for the year 2014.

The study was conducted on the basis of 16 provincial markets. All the proposed provincial cities constitute the most important space of impact onto other regions and they are the best point of reference – they represent the region and they give a complete access to data.

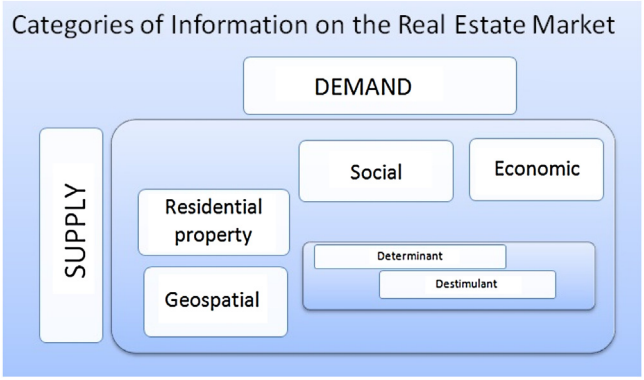

Fig. 2. Description of factors regarded in evaluating the condition of the real estate market.

Source: Own study.

4.2. Scope of data analysis

To choose variables for the scoring rating model, numerous publications and solutions were considered (Agnello and Schuknecht, 2011; Anglin and Yanmin, 2011; Ball and Wood, 1999; Baumohl et al., 2010; Belej and Cellmer, 2014; Case and Shiller, 1990; European Standards of Valuation, 2012; Global Real Estate Transparency Index, 2014; Goodman and Thibodeau, 2003; Ho et al., 2012; Hui and Wang, 2014; International Standards of Valuation, 2011; Irwin, 1993; Jaffe and Sirmans, 1989; Kaklauskas, 2015; Kaklauskas et al., 2015; Kucharska-Stasiak and Źróbek, 2015; Lind, 2009; Li et al., 2009; McCue and Belsky, 2007; Residential Real Estate Investment and Business Guide for Foreigners, 2010; Źróbek et al., 2014; Xiaoling, 2007). On this basis, a database called the "rating toolkit" was developed (Appendix A Table A2). It was assumed that the variables collected in the prepared database allowed for multi-parameter and comprehensive analysis of the condition and potential of the residential real estate markets. The variables of the first phase of the study were divided into two sets representing two factors: the supply and the demand. Such a division was proposed due to the diversity of the target group for these two market phenomena. The range of factors was divided into four subcategories: social, economic, geospatial and residential property (Fig. 2). These are the most common factors which basically influence the

overall valuation of the residential property market. Each of the mentioned realms represents a different range of information that has an influence on decisions concerning buying, renting or selling of residential real estate. Additionally, in each of the set categories, the criterion of indicators determining (det.) or destimulating (des.) the supply or the demand were distinguished. The database called the "rating toolkit" contains 124 indicators, which are divided into the supply and the demand, the mentioned subcategories, and criteria (Appendix A Table A2).

4.3. Preparation of the database

4.3.1. Verification of data quality

The next step was the preparation of the database where the preliminary verification of data quality was made. For this purpose, the substantive verification was made (using expert method, relying on the Delphi method in conjunction with the Estimate-Talk-Estimate method (ETE)). The variables were diversified for determining and destimulating in relation to the studied phenomenon. The determinants positively influence the features that shape the housing real estate market condition while the destimulants have a negative influence on them. In the next step, the statistical verification analyzing the results of the correlation of the particular indicators (variables) with the so-called key indicators in both subsets (supply- number of completed and offered apartments and demand – number and value of property transactions) was made. The analysis (Table 1) confirmed the adopted assumptions, because those variables that were significantly correlated with the key indicators (indicators 19 and 41) coincided with the essentially assumed determinants and destimulants.

4.3.2. Removing redundant variables

The construction of decision rules, or classifiers, is closely connected with the problem of the selection of features, i.e. a number of explanatory (independent) variables. Redundant attributes, as well as attributes which have no connection to the phenomena, increase the cost of the decision-making process. Moreover, introducing useless and superfluous information (noise) causes the loss of the degrees of freedom, which makes the interpretation more difficult and influences its quality. Several classification methods have been proposed in the literature, such as: wrapped methods, embedded methods and filter methods. For the classification methods, the procedure for feature selection used by the author can be considered as a combination of the ranking and wrapped methods, because it uses both these types where the number of selected features is optimized by the sensitivity analysis based on the maximal correlation with the outcome (dependent – key indicators) variable and the minimal correlation with other classifiers. Due to this assumption, the multivariate correlation analysis (MCA) was made. During the analysis, the variables that were highly correlated, the ones with the correlation coefficient over 0.90 and those that were less correlated to the key variables for the supply (the number of completed apartments – indicator 19 and the number of property offers – indicator 41) and for the demand (the number of property transactions – indicator 94 and value of property transactions – indicator 95) were removed (Table 2). For example, indicators 2 and 3 were correlated over the assumed critical level of 0.90 (i.e. 0.93), while indicator 2 was correlated with indicator 18–0.41 and indicator 41–0.42, which gave better results than indicator 3, which was correlated with indicator 18–0.31 and indicator 41–0.46. Therefore, indicator 3 was removed from the further analysis, as it was regarded less significant.

Due to the analysis, the indicators number: 3, 34, 40, 48, 53, 73, 74, 77, 82, 84, 85, 86, 90, 105, 114 were removed. The applied method allows to control and supervise the reduction of variables and prevents removing significant information for the analysis.

4.3.3. Data normalization

In this stage of the procedure, the set of database was normalized. The aim of the normalization was to transform multidimensional space of the collected diagnosing variables into a one-dimensional space (objectively comparable). In the case of classical unitarisation, parameters of normalization take the following values:

$$p = 1; \quad a = \begin{cases} 0, \\ \max\limits_{i}\{x_{ij}\}; \\ \min\limits_{i}\{x_{ij}\}. \end{cases} \quad b = \max_{i}\{x_{ij}\} - \min_{i}\{x_{ij}\}, \tag{1}$$

As a result of the normalization formula (A Real Estate Guide, 2015), the received variables had the values from the interval [0; 1]. In the presented procedure, certain modifications to the classic assumptions and the normalization of data (Table 3) were made using the following formulas:

– for determinant

$$Z_j = \frac{X_j - X_j^{\min}}{X_j^{\max} - X_j^{\min}} \tag{2}$$

– for destimulant

$$Z_j = \frac{X_j^{\max} - X_j}{X_j^{\max} - X_j^{\min}} \tag{3}$$

where:

Z_j – value of indicator after normalization, X_J – value of indicator before normalization, X_j^{max}; X_j^{min} – minimum and maximum of indicator value in 3 years.

The conducted normalization allowed to gain more objective results of the analysis in the adopted term and more dynamic test procedure. This was important in the context of the change dynamics of the analyzed phenomenon engaged in various business cycles, phase delay etc.

4.3.4. The significance of the data with the use of entropy

The next stage of the procedure consisted in the selection and diversification of variables/indicators in terms of their relevance and importance from the point of view of the purpose of the analysis. This phase was very difficult due to the lack of final factor (dependent variable) owing to which the significance could be determined. The authors were searching for various solutions. Consequently, it was assumed that the relevance of variables would be determined based on the weight of variables fixed using the measures of entropy. This approach allowed to take into account the diversity, merit and usefulness of the information. In the presented spin of entropy, a measure of '*disorder, chaos and randomness of certain information*' (Shannon and Weaver, 1964), was used as a differentiating factor. According to different theories, entropy is perceived differently. In thermodynamics, it is an averaged characteristics describing the state of a balanced system. In the theory of information, entropy should be equated with the amount of information and its value. Statistical theory operates with the concept of entropy as a measure of uncertainty taking into account the probability of occurrence of events, and thus determine the informativeness. There is therefore a justification for the use of this measure in the real estate market, where the indeterminacy and randomness are its inherent characteristics. In this simulation, a measure of entropy (weight vector determined by entropy)

Table 1
The example of verification of the assumed destimulants and determinants for supply.

Significant indicators for correlation with indicator 41	4	15	22	27	10	45	
Correlation with indicator 41	0.5259	0.6636	0.4992	−0.4985	0.6890	0.8688	
Significance of statistic t student for $t_{k.}$ = 2,14	2.3135	3.3191	2.1557	2.1523	3.5573	6.5679	
Significant indicators for correlation with indicator 19	4	15	16	18	20	27	43
Correlation with indicator 19	0.5365	0.6397	0.7725	0.7268	0.9694	−0.5185	0.5139
Significance of statistic t student for $t_{k.}$ = 2,14	2.3789	3.1145	4.5518	3.9604	14.7857	2.2523	2.2418

Source: Own calculation.

Table 2
Reduction of redundant indicators – example.

	indicators	correlation	correlation with indicator 18	correlation with indicator 41		indicators	correlation	correlation with indicator 93	correlation with indicator 94
	2	0.93	0.41	0.42	del	48	0.95	0.20	0.25
del*	3		0.31	0.46		49		0.33	0.43

Source: Own calculation.
* del – deleted indicators.

Table 3
Normalization of indicators – example for Gdansk.

		An example of normalization for supply variables					
		Indicator 1 – determinants		Indicator 2 – determinants		Indicator 5 – destimulants	
		Min. value – absolute	1	Min. value among 3 years	6.62	Min. value among 3 years	1.9
		Max. value – absolute	100	Max. value among 3 years	13.24	Max. value among 3 years	2.7
No.	markets	Original	After normalization	Original	After normalization	Original	After normalization
1	Gdansk	44.0	0.4343	9.58	0.4470	2.30	0.5000

Source: Own calculation.

was calculated for factors in the individual subcategories of rating information according to the formula:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{4}$$

where:
w_j – weight vector for particular criteria
d_j – degree of internal rating variance

$$d_j = 1 - E_j, \tag{5}$$

$$E_j\text{–entropy}, E_j = -K\sum_{i=1}^{m} n_{i,j} \ln n_{i,j}; \mathrm{K} = 1/\ln \mathrm{m}; \mathrm{i} = 1, \ldots, \mathrm{m}; = 1, \ldots, \mathrm{n} \tag{6}$$

$$\text{m–number of states in particular criterion} \tag{7}$$

The example of the weight vector for social sub-criterion in supply sphere was shown in Table 4.

The presented research showed that the smaller the value of entropy, which was a smaller variation in the analyzed information, the greater the weight of a given factor, and hence the greater the significance of the impact of the information on the outcome of the rating classification.

4.4. Development of ranking for information categories

In the next step, the level of partial ranking was specified using the following formula:

$$Sr_j = \sum_{i=1}^{m} Z_j \times w_j \tag{8}$$

where:

Sr_j – level of partial ranking; Z_j – normalized indicator; w_j – weight vector (see formula No. 4).

The developed level of partial ranking, for example for Gdansk social subcategories for the supply realm, was shown in Table 5.

Having applied the above-mentioned procedure, partial ranking level for all subcategories in the supply and the demand was obtained. The example of the results was shown in Table 6.

4.5. Local rating for subcategories

The next step in applying the procedure was determining local real estate market rating for particular categories set – LRS. At first, LRS was elaborated assuming that the measure of arithmetic mean calculated for each subcategory based on partial ranking corresponded to the average level for the rating scale (Appendix A Table A1).

It was assumed that the rating represented 30 assessment levels and the average level was between BB + and B- (15 and 16 level). Assuming that the average was placed in the middle of the considered range, the remaining levels of the rating were determined in a proportion to the number of category 'above' (15) and 'below' (15) the rating categories. A model LRS analysis for social within the supply was shown in Table 7.

The assumption of the rating classification for the analyzed property markets (for the subcategory) allowed for diversification and determination of the rating level on the basis of a median value expressing the average level of market development. It assumed 3-year dynamics of the phenomena included in the "rating toolkit". As part of the detailed analysis, a rating for all subcategories was established with the use of the adopted assumptions (Table 8). These analyses allowed to carry out a more detailed assessment of the real estate market condition taking into account a given rating category. LRS for the rest of subcategories from the "rating toolkit" was established in the context of the proposed solutions (Table 8).

Table 4
The weight vector for social subcategories in the supply domain.

Supply – social subcategories				
indicators	1	2	4	5
Ej	0.9902	0.9960	0.9987	0.9940
dj	0.0098	0.0040	0.0013	0.0060
wj	0.4632	0.1902	0.0631	0.2835

Source: Own calculation.

Table 5
Partial ranking level for social subcategories within the supply domain.

Supply – social subcategory						
No	Markets	1	2	4	5	Sr_j – partial ranking level
1	Gdansk	0.2012	0.0850	0.0177	0.1418	0.4457

Source: Own calculation.

Table 6
Partial ranking level for all subcategories within the supply and the demand.

No.	Markets	Partial ranking levels for subcategories in supply				Partial ranking levels for subcategories in demand			
		Social	Economic	Residential property	Geospatial	Social	Economic	Residential property	Geospatial
1	Gdansk	0.4457	0.4637	0.5439	0.4194	0.3695	0.2631	0.6931	0.2243
2	Olsztyn	0.3542	0.3550	0.3575	0.1604	0.3077	0.1779	0.6789	0.2163
3	Szczecin	0.3704	0.5359	0.3245	0.1908	0.2688	0.2248	0.5064	0.2097
4	Bydgoszcz	0.2695	0.1786	0.2190	0.1163	0.1644	0.1862	0.4881	0.2473
5	Bialystok	0.3278	0.2383	0.2973	0.1730	0.2581	0.1672	0.4555	0.2855
6	Poznan	0.4647	0.1913	0.3552	0.2986	0.3205	0.3103	0.6525	0.2597
7	Warsaw	0.6186	0.3563	0.5985	0.7641	0.4765	0.5888	0.6041	0.2979
8	Lodz	0.5623	0.3890	0.2532	0.1129	0.1341	0.1899	0.4397	0.2025
9	Wroclaw	0.5657	0.4299	0.5232	0.4093	0.3555	0.2663	0.5445	0.2433
10	Lublin	0.3527	0.2804	0.2717	0.1939	0.2300	0.1617	0.4713	0.2173
11	Cracow	0.4247	0.2549	0.4037	0.3409	0.4561	0.2586	0.5206	0.2303
12	Rzeszow	0.2354	0.3474	0.3851	0.2314	0.5792	0.2050	0.3820	0.2412
13	Zielona Gora	0.2802	0.2413	0.3286	0.2091	0.3639	0.2055	0.5455	0.1770
14	Kielce	0.2834	0.2072	0.2365	0.1255	0.1975	0.1846	0.4025	0.1933
15	Katowice	0.5670	0.3306	0.2788	0.3539	0.2974	0.3444	0.5317	0.2728
16	Opole	0.4224	0.3319	0.2677	0.2325	0.3058	0.2534	0.5250	0.1583

Source: Own calculation.

Table 7
Local rating for subcategories – social subcategory within the supply.

No.	Categories of rating		Markets	Social level or rankings	LRS
1	AAA +	0.969–1.000	Gdansk	0.446	BB-
2	AAA	0.929–0.968	Olsztyn	0.354	B-
3	AAA –	0.889–0.928	Szczecin	0.370	B
4	AA+	0.849–0.888	Bydgoszcz	0.269	CCC-
5	AA	0.809–0.848	Bialystok	0.328	CCC+
6	AA-	0.769–0.808	Poznan	0.465	BB
7	A+	0.729–0.768	Warsaw	0.619	BBB+
8	A	0.689–0.728	Lodz	0.562	BBB-
9	A-	0.649–0.688	Wroclaw	0.566	BBB-
10	BBB+	0.609–0.648	Lublin	0.353	B-
11	BBB	0.569–0.608	Cracow	0.425	BB-
12	BBB-	0.529–0.568	Rzeszow	0.235	CC+
13	BB+	0.489–0.528	Zielona Gora	0.280	CCC
14	BB	0.449–0.488	Kielce	0.283	CCC
15	BB-	0.409–0.448	Katowice	0.567	BBB-
16	B+	0.383–0.408	Opole	0.422	BB-
17	B	0.357–0.382	Arithmetic mean	0.409	BB-/B+
18	B-	0.331–0.356			
19	CCC+	0.305–0.330			
20	CCC	0.279–0.304			
21	CCC-	0.253–0.278			
22	CC+	0.227–0.252			
23	CC	0.201–0.226			
24	CC-	0.175–0.200			
25	C+	0.149–0.174			
26	C	0.123–0.148			
27	C-	0.097–0.122			
28	D+	0.071–0.096			
29	D	0.045–0.700			
30	D-	0.000–0.044			

Source: Own calculation.

Table 8
LRS for all categories.

No.	Markets	LRS for supply				LRS for demand			
		Social	Economic	Residential Property	Geospatial	Social	Economic	Residential Property	Geospatial
1	Gdansk	BB–	BBB–	BBB	BBB–	BB	BB–	BBB+	B+
2	Olsztyn	B–	BB–	BB–	CC+	B+	CCC	BBB+	B+
3	Szczecin	B	BBB	B	CCC	B–	B	B+	B
4	Bydgoszcz	CCC–	CC+	CCC	CC–	CC	CCC+	B	BB–
5	Bialystok	CCC+	CCC+	B	CCC–	B–	CCC–	B–	BB
6	Poznan	BB	CC+	BB–	BB–	BB–	BB	BBB–	BB–
7	Warsaw	BBB+	BB–	BBB+	AA	BBB–	A–	BB+	BB
8	Lodz	BBB–	BB	CCC	CC–	CC–	CCC+	B–	B
9	Wroclaw	BBB–	BB+	BBB-	BB+	BB–	BB–	BB–	BB–
10	Lublin	B–	CCC	CCC+	CCC	CCC	CCC–	B	B+
11	Cracow	BB–	CCC+	BB	BB	BBB–	BB–	B+	BB–
12	Rzeszow	CC+	BB-	BB-	B-	BBB+	B–	CCC	BB–
13	Zielona Gora	CCC	CCC+	B	CCC+	BB	B–	BB–	CCC+
14	Kielce	CCC	CCC–	CCC–	CC–	CCC–	CCC	CCC+	B–
15	Katowice	BBB–	BB–	CCC+	BB	B	BB+	BB–	BB–
16	Opole	BB–	BB–	CCC+	B-	B+	BB-	B+	CCC

Source: Own calculation.

Table 9
Global rating and final global rating for real estate markets.

		Sum of partial rankings		Sum of supply and demand partial rankings – LRSsum	Final rating		Global Rating (GR)
No.	Markets	Supply	Demand		Supply (FRs)	Demand (FRd)	
1	2	3	4	5	6	7	8
1	Gdansk	1.8727	1.5500	3.4227	BB+	BB	BB+
2	Olsztyn	1.2272	1.3808	2.6080	B	BB-	B+
3	Szczecin	1.4217	1.2097	2.6314	BB–	B	B+
4	Bydgoszcz	0.7833	1.0860	1.8693	CC+	B–	CCC
5	Bialystok	1.0363	1.1663	2.2026	CCC+	B	B-
6	Poznan	1.3098	1.5430	2.8528	B+	BB	BB–
7	Warsaw	2.3375	1.9674	4.3049	BBB+	BBB–	BBB
8	Lodz	1.3173	0.9661	2.2834	B+	CCC	B–
9	Wroclaw	1.9281	1.4096	3.3377	BBB–	BB–	BB+
10	Lublin	1.0987	1.0803	2.1790	B–	B–	B-
11	Cracow	1.4242	1.4657	2.8899	BB–	BB–	BB–
12	Rzeszow	1.1993	1.4073	2.6066	B–	BB–	B+
13	Zielona Gora	1.0592	1.2919	2.3511	CCC+	B+	B
14	Kielce	0.8525	0.9780	1.8305	CCC–	CCC	CCC-
15	Katowice	1.5303	1.4462	2.9765	BB	BB–	BB–
16	Opole	1.2545	1.2426	2.4971	B–	B+	B
Arithmetic mean		1.3533	1.3244	2.6777			

Source: Own calculation.

4.6. Final rating and global rating

The further stage allowed to determine the final rating for the demand (FRd) and the supply (FRs), as well as for the global rating (GR). When fixing FRd and FRs (Table 9), the sum of the different ranking levels was used separately for the supply and the demand. The aim of adding the LRS values for the categories characterizing respectively the demand (Table 9, col. 3) and the supply (Table 9, col. 4), in the context of the whole group of the analyzed markets was to:

- include the contributions of particular rating categories in a given market – the contributions resulting from the value determined for a given category should be identified with the importance of this category in the ranking of the market – a higher value of contribution indicates a greater impact, and vice versa.
- create a space that can be used for market comparisons – category structure, which is the basis on which the sum of the LRS was established for individual markets, is the same.

Adding the LRS values allows for the comparison of market value because it takes into account the contributions of each category (they may be different), depending on the situation prevailing on the market, while ensuring comparability resulting from the internal structure of the added values.

In the next step, average values were calculated for a number of the added LRS values, respectively for the supply and the demand. These values were used to determine the ratings of FRs and FRd, according to the method applied for determining the LRS (subsection: Local rating for subcategories).

Designated ratings for the demand (FRs – col. 7) and the supply (FRs – col. 6) were compiled in Table 9.

In the last step, in order to obtain a general mapping of the condition of the analyzed real estate markets, Global Rating was designated (GR). In the first phase, the values of LRS for the supply and the demand were summed up and the LRSsum value was created – the results of this operation were shown in column 5 of Table 9. Then the mean of the respective values of LRSsum was calculated. The average value was used to create GR (Table 9, col. 8). When creating GR, the method used in determining the LRS was applied (subsection: Local rating for subcategories).

4.7. Verification of the rating results

In order to verify the results of the research and highlight the relevance, and applicability of the rating procedure, the method

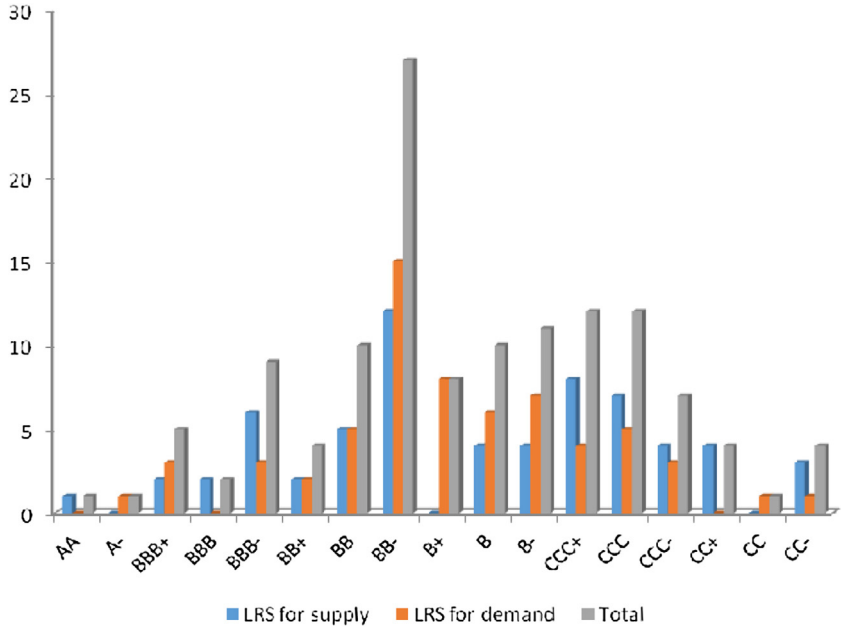

Fig. 3. Comparison of LRS for the supply and the demand for particular rating levels.

Source: Own study.

of checking the rating classification was developed for diagnosing the condition of the residential real estate markets in the future. From the point of view of the research carried out for the data from years 2011–2013, the year 2014 represented the future. The year 2014 was assumed to serve for the verification of the research methodology. This enabled checking the obtained results not only to determine the potential and the development qualification of the real estate market in the analyzed term, but also to predict its condition in the future.

4.7.1. Correlation results for key indicators and LRS, FRs and FRd

According to the definition of the property market condition and according to the assessment of its development prospect, **key indicators** are the information and factors that can verify the results of the research (i.e.: for the supply – indicator 19 and 41, for the demand – indicator 94 and 95). For this purpose, the analysis of the correlation was made including the category division for the supply and the demand. The correlation was determined between indicator 19, 41 and indicator 94, 95 and between GR, FRs and FRd. In the first phase, the analysis of the correlations between rating results and future variables was conducted (Table 10).

The presented studies prove that the results are satisfactory, and basing on the assumption that critical value of t-student statistics 2.14, each result seems to be significant. Market condition was subjected to valuation based on the aggregated information that represents LRS and FRd (Table 10).

4.7.2. Correlation results for key synthetic indicators and LRS, FRs, FRd, GR

Certain correlations between aggregates (LRS and FRd) and the value of individual variables (categories) were checked using a different method. This method assumes that the correlations are determined between aggregates (LRS and FRd) and synthetic variables. Synthetic variables have such advantage that, being specific aggregates, they reflect the correlations in a better way. For this purpose, synthetic variables were determined with the use of the maximum likelihood method within the method of factor analysis (Appendix A Table A3). The results were determined based on the formula below:

$$X_i = a_{11}F_1 + a_{12}F_2 + ... + a_{1k}F_k + b_1U_1$$
$$X_i = a_{11}F_1 + a_{12}F_2 + ... + a_{1k}F_k + b_1U_1 \Rightarrow X_i = A \bullet F + BU_1 \quad (9)$$
$$X_i = a_{11}F_1 + a_{12}F_2 + ... + a_{1k}F_k + b_1U_1$$

where:

X_i – vector of variables, $A = \left(a_{ij}\right)$ – matrix of linear combination coefficient called factors loadings, F– vector of mutual factors, U – vector of specific factors, B – matrix of diagonal factors loadings for specific factors.

The goodness of fit test was conducted for all new variables and the research indicated a high degree of reliability of the new features (Appendix A Table A3).

Then the correlation between the designated synthetic indicators and the results of the rating were examined (Table 11).

The results showed that LRS indicators for subcategories of residential markets, FRs, FRd and GR indicated significant correlative interdependence on the future phenomena and they had a key impact on the diagnosis of property market growth and the assessment of its condition. It is visible that Global Rating (GR), which generalizes phenomena in the market, proves a high correlation with the image of the synthetic key factors.

5. Discussion

This study developed methodologies for assessing the state and condition of the housing market in the form of the rating. The rating was elaborated for 16 markets (Table 9). LRS ratings, elaborated separately for particular category of the assessment, enabled to determine the state of the market within the selected categories. LRS for the supply and the demand was determined for social, economic, residential property and geospatial variables. The comparison of LRS for the supply and the demand for particular rating categories was presented in Fig. 3. Regardless of LRS type, the highest score of categories was awarded for the level BB-, then for CCC and CCC + categories, then for B-, BB and B. For groups, most major

Table 10
Correlation results between future indicators and ratings results.

Pearson's correlation for supply			Pearson's correlation for demand		
	indicator 41–2014 y.	indicator 19- 2014 y.		indicator 94–2014 y.	indicator 95–2014 y.
LRS for residential markets subcategories	0.66	0.75	LRS for residential markets subcategories	0.56	0.60
FRs	0.62	0.57	FRd	0.71	0.53
Significance ofstatistic t student fort $_{k.}$ = 2.14	3.31	4.28	Significance ofstatistic t student fort $_{k.}$ = 2.14	2.95	2.60
	2.97	2.57		3.75	2.33

Source: Own calculation.

Table 11
Correlation results between synthetic indicators and ratings results.

Pearson's correlation					
	Synthetic indicator (19 and 41) for supply		Synthetic indicator (94 and 95) for demand		Synthetic indicator (94, 95 and 19,41) for demand and supply
LRS for residential markets subcategories	0.7694	LRS for residential markets subcategories	0.6785	GR	0.7850
FRs	0.6180	FRd	0.6719		
Significance of statistic t student for t $_{k.}$ = 2.14	4.5068	Significance of statistic t student for t $_{k.}$ = 2.14	3.4559	Significance of statistic t student for t $_{k.}$ = 2.14	4.7418
	2.9416		3.3943		

Source: Own calculation.

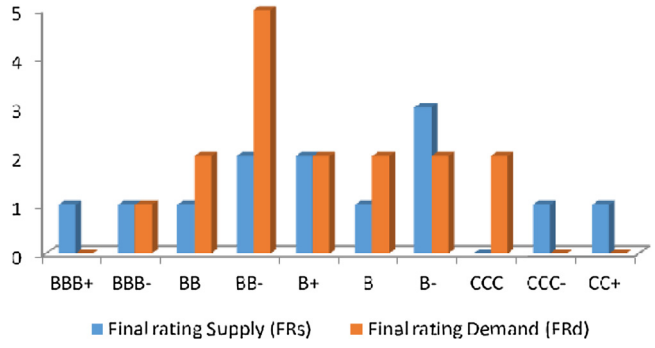

Fig. 4. Comparison of FRs and FRd for particular rating levels.
Source: Own study.

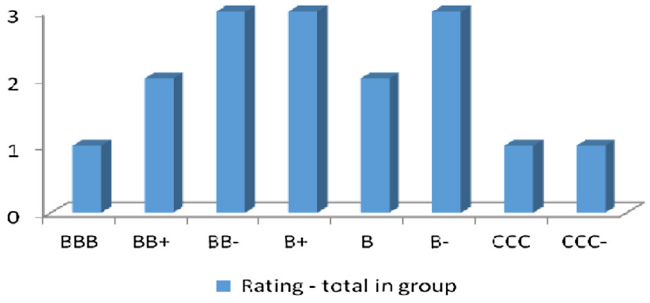

Fig. 5. The comparison of GR for particular rating levels.
Source: Own study.

categories were awarded to the level BB, followed by CCC, B and BBB.

The final rating for the supply (FRs) and the demand (FRd) was made in order to determine the state and condition of residential property market, separately for the demand and the supply. The comparison of FRs and FRd ratings for particular rating categories was presented in Fig. 4. Most categories were awarded to the level of BB- for the demand, then for B- for the supply, then to B + for the demand and the supply, and BB, B, B-, CCC for the demand and BB- for the supply.

The results that were obtained having applied the developed methodology for Global Rating (GR) were shown in Table 12 and Fig. 5. The state and condition of the 16 analyzed markets were assigned to 8 out of 30 rating levels. The highest rating was admitted to Warsaw (BBB), Gdansk and Wroclaw ranked in the second rating group (BB +), Poznan, Cracow and Katowice went into the third group (BB-). In the penultimate group (CCC) and the last group (CCC-) were Bydgoszcz and Kielce.

The results obtained for Global Rating confirm the general social feeling related to the assessment of the state and condition of the housing market in Poland. The fact was confirmed by the calculated coefficient of the correlation for GR (on the basis of the LRSsum) and transaction prices for existing stock market (4th quarter 2013), which value is 0.7791. The indicator showed a significant correlative interdependence between rating and the level of transaction prices in the fourth quarter of 2013 in the secondary market.

The comparison of "the sum of the supply and the demand partial rankings (LRSsum)" (see Table 10) being the basis for constructing GR and 'Transaction prices for existing stock market (4th quarter 2013) were divided by 1000' (NBP 2013) and shown in Fig. 6. By dividing the price by 1000 it was possible to show the values within one graph. By analyzing the graph, it is evident that GR rating is well reflecting the state of the market, which, in this case, is represented by transaction prices. The relationships are not strict. However, a certain general relationship can be seen. Additionally, it is confirmed by the fact that GR rating is well reflecting the state and condition of residential property market.

6. Conclusions

The methodology of the unified scoring system proposed by the authors allows for the assessment of the condition of residential property markets in the form of rating. It is a significant element of market analysis and the system supporting the process of decision-making by the participants of property market.

Classification and assessment of property market condition are very important elements of both the analysis of property market

Table 12
The comparison of GR for particular rating levels.

Rating	Rating – total in group	Markets in each group		
BBB	1	Warsaw		
BB+	2	Gdansk	Wroclaw	
BB-	3	Poznan	Cracow	Katowice
B+	3	Olsztyn	Szczecin	Rzeszow
B	2	Zielona Gora	Opole	
B-	3	Bialystok	Lodz	Lublin
CCC	1	Bydgoszcz		
CCC-	1	Kielce		

Source: Own calculation.

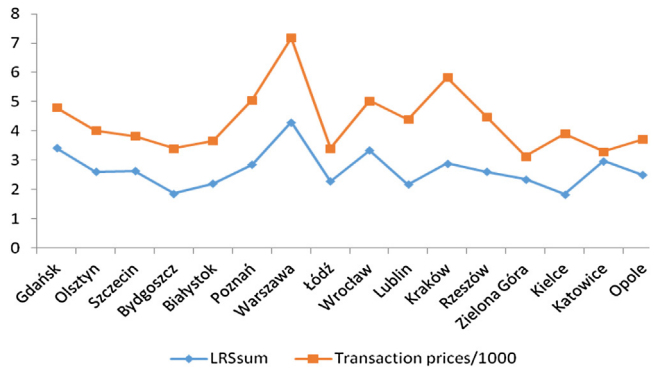

Fig. 6. Comparison of the LRSsum and Transaction prices/1000.
Source: Own study.

and the state of the economy of a given country. In the era of intensive business fluctuations, reduction of capitalization rates stops in residential resources and increases in significance of comparative analyses in property market, the following needs are increasingly perceived: quality of location of the market concerning conditions and prospects of the local economy, area growth potential, environmental conditions of space, social conditions and ideals, character of business climate in determining the value of real estate and real estate market analysis.

Therefore, various ways of segmentation and classification of real estate markets are proposed in the reference. They were developed in the form of decision-support systems. However, there is a gap in the area of providing the information involving the assessment of the condition of the real estate markets developed in the form of the substantive methodology as well as simulation, and analytical methodology. There is no comparative assessments i.e. ratings of real estate markets.

The methodology of the unified scoring system that allows for the assessment of the residential property market condition in the form of rating, which was proposed by the authors, is a significant element of market analysis and it is the system supporting decision-making process among participants of property market. Considering the connotation between property market rating and classical ranking, it is at the same time significant information related to the potential credit reliability of market participants depending on conditioning, potential and development of a given urban area.

The research conducted by the authors and the suggested solutions make an essential element of research methodology of the condition assessment of real estate markets and urban areas. This solution is utilitarian and it can effectively be applied in foreign markets and other fields of studies, especially when the research units are highly heterogeneous.

Acknowledgement

The paper is financed by the Polish National Science Centre under Grant No. UMO-2014/13/B/HS4/00171.

Appendix A.

Table A1
Rating scale for classifying condition of real estate markets.

Group	Description of market characteristics	Rating scale	
Investment level (A category)1.1.1.1.1	"High" High return on investments; Positive market outlook; High market growth potential; High potential for economic and spatial growth; Self-regulatory capacity, Flexible response to economic changes; The situation on the real estate market fosters positive social change; Satisfactory price-cost relationship; Stable behavior of real estate market actors; Low threats to the growth of the real estate market; The situation on real estate market fosters positive social change.	AAA + > AAA > AAA –	1
		AA+ > AA >–AA– A+ > A > A–	2 3
Development level (B category)	"Moderate" Moderate return on investments; Moderate market outlook; Certain threats to market growth potential; Moderate potential for economic and spatial growth; Lower self-regulatory capacity, less flexible response to economic changes; The situation on the real estate market fosters moderately positive social change; Greater discrepancies between the cost and prices of real estate; Less predictable behavior of real estate market actors; Moderate threats to the growth of the real estate market; The situation on the real estate market fosters moderately positive social change.	BBB+ > BBB > BBB–	4
		BB+ > BB > BB– B+ > B > B–	5 6
Stagnant level (C category)	"Low" Low return on investments; Negative market outlook; High threats to market growth potential (supply and demand on the real estate market); Low potential for economic and spatial growth; Low self-regulatory capacity, significantly less flexible response to economic changes; The situation on the real estate market does not foster positive social change; High discrepancies between the cost and prices of real estate; The behavior of real estate market actors is likely to be unpredictable; High threats to the growth of the real estate market; The situation the real estate market does not foster positive social change.	CCC+ > CCC > CCC–	7
		CC+ > CC > CC– C+ > C > C–	8 9
Crisis level (D category)	"Lack"/"deficit" No returns on investments; The market is stagnant with no prospects for growth; No potential for economic or spatial growth; The market is undergoing reorganization. The price-cost relationship cannot be determined; The behavior of market participants cannot be predicted; Very high threats to the growth of the real estate market; The situation on the real estate market drives negative social change.	D+ > D > D–	10

Source: own study basing on.

Table A2
Rating toolkit for the residential property market.

Group I – supply-side indicators:	
a) social set	1 – ranking of quality of life for "quality of local government" (max 100 p.) determinants
	2 – number of deaths of those older than 50 (per 1000 residents) determinants 3 – contribution of individuals in the post-productive age (percentage) determinants 4 – usable dwelling space (per resident) determinants
	5 – the average number of individuals in apartment destimulants
b) economic set	6 – fuel prices per litre destimulants
	7 – number of new registered businesses in industry and construction (per 10,000 residents) determinants
	8 – local government spending on public utilities and environmental protection (per resident) determinants
	9 – local government spending on investments (per resident) determinants
	10 – local government spending on housing policy *(per residents)* determinants
c) residential property set	11 – vacancy rate for office properties destimulants
	12 – vacancy rate for retail properties destimulants
	13 – vacancy rate for warehouses properties destimulants
	14 – average number of rooms in a dwelling determinants
	15 – value of new mortgage agreement (per resident) determinants
	16 – total number of issued construction permits (per 10,000 residents) determinants
	17 – number of issued construction permits – individual (per 10,000 residents) determinants
	18 – number of apartments with started constructions (per 10,000 residents) determinants
	19 – number of completed apartments (per 10,000 residents) determinants
	20 – number of completed rooms (per 10,000 residents) determinants
	21 – the average number of rooms in completed apartments determinants
	22 – the average area of a room (per m^2) determinants
	23 – number of developers on the local market (per 10,000 residents) determinants
	24 – number of property transactions (per 10,000 residents) determinants
	25 – value of property transactions (per 1000 residents) determinants
	26 – affordability of rental housing (number of square meters that can be financed from an average local salary (per month) determinants
	27 – difference in the structure of (<=40) supply of usable area per transaction and offers on the primary market (percentage) destimulants
	28 – difference in the structure of (40; 60) supply of usable area per transaction and offers on the primary market (percentage) destimulants
	29 – difference in the structure of (60; 80) supply of usable area per transaction and offers on the primary market (percentage) destimulants
	30 – difference in the structure of (>80) supply of usable area per transaction and offers on the primary market (percentage) destimulants
	31 – structure of (>80) supply of usable area per transaction on the primary market (percentage) determinants
	32 – structure of (>80) usable area supply for offers/quotation on the primary market (percentage) destimulants
	33 – balance of supply and demand for apartments below or equal to 50 m^2 on the primary market (percentage) determinants
	34 – balance of supply and demand for apartments of over to 50 m^2 on the primary market (percentage) determinants
	35 – difference in the structure of (<=40) supply of usable area per transaction and offers on the secondary market (percentage) destimulants
	36 – difference in the structure of (40; 60) supply of usable area per transaction and offers on the secondary market (percentage)destimulants
	37 – difference in the structure of (60; 80) supply of usable area per transaction and offers on the secondary market (percentage) destimulants
	38– difference in the structure of (>80) supply of usable area per transaction and offers on the secondary market (percentage) destimulants
	39 – structure of (>80) supply of usable area per transaction on the secondary market (percentage) determinants
	40– structure of (>80) supply of usable area per transaction per offers on the secondary market (percentage) destimulants
	41 – number of property offers – average from the most popular websites (per 1000 residents) determinants
d) geospatial set	42 – number of apartments (per 1000 residents) determinants
	43 – percent of land covered by zoning plans determinants
	44 – level of retail area (m^2/1000 residents) determinants
	45 – supply of office area (m^2/1000 residents) determinants
	46 – supply of warehouse area (m^2/1000 residents) determinants
	47 – population density (per km^2) determinants
Group II – demand-side indicators:	
a) social set	48 – forecasting of population number for 2020 (percentage in comparison with 2013). determinants
	49 – forecasting of population number for 2035 (percentage in comparison with 2013) determinants
	50 – number of private cars (per 10 residents). determinants
	51 – ranking of quality of life for health (max 100 p.). determinants
	52 – ranking of quality of life for satisfaction with life (max 100 p.). determinants 51 –– ranking of quality of life for safety (max 100 p.) determinants
	53 – unemployment rate destimulants
	54 – unemployment rate (average from last 5 years) destimulants
	55 – difference between regional and local unemployment rate determinants.
	56 – population growth. (per 1000 residents) determinants
	57 – net migration rate (per 1000 residents) determinants
	58 – number of marriages (per 1000 residents) determinants
	59 – number of students (per 1000 residents) determinants
	60 – contribution of individuals in the productive age determinants (percentage)
	61 – contribution of individuals in the pre-productive age group (percentage) determinants
	62 – contribution of individuals in the post-productive age (percentage) destimulants
	63 – number of sports clubs (per 10,000 residents) determinants
	64 – number of cultural centres (per 100,000 residents) determinants
	65 – number of cinemas (per 100,000 residents) determinants
	66 – number of hypermarkets (per 100,000 residents) determinants
	67– the average number of individuals in apartment determinants

Table A2 (*Continued*)

b) economic set	68 – average rent in a new shopping centre (affordability per average local salary – m^2) destimulants
	69 – average rent in the office blocks (affordability per average local salary – zl/m^2) destimulants
	70 – number of science and technology parks determinants
	71 – fuel prices (per litre) destimulants
	72 – number of suspended business activities (per 1000 residents) destimulants
	73 – number of new businesses (per 1000 residents) determinants
	74 – number of self-employed individuals (per 1000 residents) determinants
	75 – number of businesses employing 0–9 workers (per 10,000 individuals in the productive age) destimulants
	76 – number of businesses employing 10–49 workers (per 10,000 individuals in the productive age) destimulants
	77 – number of businesses employing 50–249 workers (per 10,000 individuals in the productive age) determinants
	78 – number of businesses employing 250 and more workers (per 10,000 individuals in the productive age) determinants
	79 – number of businesses with foreign capital (per 10,000 residents) determinants
	80 – Gross Domestic Product (Poland = 100p.) determinants
	81 – local government income (per resident) determinants
	82 – local government spending (per resident) determinants
	83 – difference between the national average salary and the average salary on the local market (percentage) determinants
c) residential property set	84 – availability of apartments on the primary market in terms of average salary (m^2) determinants
	85 – availability of apartments on the secondary market in terms of average salary (m^2) determinants
	86 – offered purchasing power on the local housing market (average salary on the local market/average price per 1 m^2 of property on the local market) determinants
	87 – transaction purchasing power on the local housing market (average salary on the local market/average price per 1 m^2 of property on the local market) determinants
	88 – availability of mortgages in terms of m^2 (average property price/average credit rating of a family or individual)determinants
	89 – availability of mortgages on the secondary market in terms of PLN credit (m^2) determinants
	90 – availability of mortgages on the primary market in terms of PLN credit (m^2) determinants
	91 – value of new mortgages (per resident) determinants
	92 – number of real estate agents on the local market (per 10,000 residents) determinants
	93 – number of real estate appraisers on the local market (per 10,000 residents) determinants
	94 – number of property transactions (per 10,000 residents) determinants
	95– value of property transactions (per 1000 residents) determinants
	96 – average time on the secondary market (in days) destimulants
	97 – difference between the average offered and transaction price of m^2 the real estate on the primary market (PLN) destimulants
	98 – difference between the average offered and transaction price of m^2 the real estate on the secondary market (PLN) destimulants
	99 – changes in local property offered prices (per cent) determinants
	100 – changes in local property transaction prices (per cent) determinants
	101 – difference between changes in offered and transaction prices on the secondary market (percentage) destimulants
	102 – difference between changes in offered and transaction prices on the primary market (percentage) destimulants
	103 – affordability of rental housing on the secondary market (number of square meters that can be financed from an average local salary per month) determinants
	104 – difference between the minimum and maximum transaction prices on the primary market (PLN/m^2)determinants
	105 – balance of supply and demand for apartments below or equal to 50 m^2 (percentage) determinants
	106 – balance of supply and demand for apartments of over to 50 m^2 (percentage) determinants
	107 – difference between the minimum and maximum transaction prices on the secondary market (PLN/m^2) determinants
	108 – difference between offered and transaction prices for low standard (PLN/m^2) destimulants
	109 – difference between offered and transaction prices for medium standard (PLN/m^2) destimulants
	110 – difference between offered and transaction prices for high standard (PLN/m^2) destimulants
	111 – difference between low and high standard for offered prices (PLN/m^2) determinants
	112 – difference between low and high standard for transaction prices (PLN/m^2) determinants
	113 – ratio of replacement value per 1 m^2 of property to the transaction price (per cent) determinants
	114 – ratio of replacement value per 1 m^2 of property to the offered price (per cent) determinants
d) geospatial set	115 – number of apartments (per 1000 residents) destimulants
	116 – per cent of green areas (per cent) determinants
	117 – cycle path (per 10,000. residents) determinants
	118 – length of bus-lane (km) determinants
	119 – roads with hard surface (km per 10,000 residents) determinants
	120 – roads with hard surface (km per km^2 of city) determinants
	121 – number of green parks in the region determinants
	122 – population density (per km^2) determinants
	123 – number of buses (per 1000 residents) determinants
	124 – number of high schools (per 100,000 residents) determinants

Source: Own study with using the following sources of information: databases of public institutions (databases of the Central Statistical Office, etc.), commercial databases (databases of real estate agencies, etc.), geoportal, municipals spatial information systems, cadastral information systems, the local zoning plans, data register of land and buildings.

*det – determinats. des. – destymulants.

Table A3
Synthetic indicators.

	synthetic indicator (18 and 41) for supply	synthetic indicator (93 and 94) for demand	synthetic indicator (93 and 94 and 18 and 41) for demand and supply
	0.6396	0.9913	−0.9173
	−0.6368	0.8829	−0.2658
	−0.7793	−0.1130	0.4055
	0.0167	0.6266	−0.5073
	−0.4625	−0.1924	0.3788
	−0.0573	0.1517	−0.0560
	1.8194	2.3642	−2.5281
	−1.2942	−1.3310	1.4570
	1.2712	1.2419	−1.4170
	−0.8179	−0.2909	0.5582
	2.0931	−0.9135	−0.4163
	0.1973	−1.0806	0.7148
	0.0887	−0.4083	0.2690
	−0.3664	−1.0996	0.9628
	−0.6774	−0.2379	0.4877
	−1.0343	−0.5915	0.8743
test of fit goodness – R2	0.8306	0.9144	0.7170

Source: Own study.

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