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Developing Methodology and Algorithm for Estimating Comfortability and Classifying Residential Property

Metodología de desarrollo y algoritmo para estimar la comodidad y clasificar la propiedad residencial

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Content

ABSTRACT:

The article researches methodological and methodic problems of estimating and assigning a class to residential property according to the level of its comfortability. Special attention is paid to considering the notion "residential property" as an object of the material world that has a multi-level hierarchical structure. The structure of spatial environment and real property within it were described and shown. The level of the consumer's impact on the comfortability of the spatial living environment was defined. The system of criteria that characterize consumer features and requirements to residential property was formed. On the basis of these features it is possible to get an integral estimate of the comfortability of every specified level. Basic provisions of the methodology on estimating the comfortability and classifying residential property were developed. Basic stages of implementing methodology, as well as the algorithm of estimating the property comfortability were offered.

Keywords. Residential property, comfortability, spatial living environment, consumer characteristics, methodology to estimate comfortability, classification of

RESUMEN:

El artículo investiga problemas metodológicos y metodológicos para estimar y asignar una clase a una propiedad residencial de acuerdo con el nivel de comodidad. Se presta especial atención a considerar la noción de "propiedad residencial" como un objeto del mundo material que tiene una estructura jerárquica multinivel. Se describió y mostró la estructura del entorno espacial y la propiedad real dentro de ella. Se definió el nivel de impacto del consumidor en la confortabilidad del ambiente de vida espacial. Se formó el sistema de criterios que caracterizan las características de los consumidores y los requisitos para la propiedad residencial. Sobre la base de estas características es posible obtener una estimación integral de la comodidad de cada nivel especificado. Se desarrollaron las disposiciones básicas de la metodología para estimar la comodidad y clasificar la propiedad residencial. Se ofrecieron las etapas básicas de la metodología de implementación, así como el algoritmo de estimación de la comodidad de la propiedad.

Palabras clave. Propiedad residencial, confortabilidad,

objects, differentiation of objects, levels of comfortability, criteria of comfortability.

entorno de vida espacial, características del consumidor, metodología para estimar la confortabilidad, clasificación de objetos, diferenciación de objetos, niveles de comodidad, criterios de confortabilidad.

1. Introduction

Over the recent years researchers, analysts, representatives of the state power bodies have considered the "residential area comfortability" and "characteristic of residential conditions of the population" as the most important aspects in implementing the stable society development concept. It is stipulated, above all, by the social and economic role of residence for a separate person and spatial residential environment for the society as a whole. Special attention is paid to methodological and methodic problems of estimating and assigning a class to the residential property according to the degree of its comfortability. A number of works and researches on this issue say about it ((Aivazian 2012; Generalov and Generalova 2015; Housing statistics – 2015; Elizarova and Hrustalev 2014; Residential Terms and Conditions" Better Life Index; Koshcheev and Taranuha 2012; Kuzmin and Yusin 2011; Larionov and Larionova 2014; Novikov, n. d.; Sarchenko 2012; Sarchenko 2014). In this article the authors offer a properly developed variant of the methodology to estimate the comfortability of the residential property and algorithm to assign a class to the residential property according to the degree of its comfortability. It is based on differentiating zones (levels) of forming comfortability in the system of residential property.

According to the authors, the problem of estimating the residential property according to the level of its comfortability is above all stipulated both by the complexity of the notion "residential property" itself (that must be simultaneously considered both as an object of civil rights and as an object of the material world) and unambiguity of defining the degree of the comfortability of the residential property as a comparative characteristic of coziness, convenience, and satisfaction determined by the aggregate of positive physiological and psychological feelings of the person in a specific external environment. That is why, it is necessary to deal first of all with the detailed characterization of the notion "residential property" before stating basic provisions of the authors' methodology to estimate the degree of the residential property comfortability and its classification based on this criterion.

As an object of civil rights, the residential property is a property complex that contains a building or its part meant for permanent living of people, with the finished construction, and accepted into service according to the legislatively established procedure, related to the land, and having boundaries subject to cadaster and technical record-keeping (inventory), including living accommodation, housekeeping areas and other auxiliary premises, equipment, constructions, and elements of the engineering infrastructure that service the living accommodation. This property complex is owned by specific individuals or legal entities that dispose of it on the basis of their own interests related to meeting residential or other needs, for example, earning an income from using the residential property by other people.

As an object of the material world, the residential property is a spatial environment with a multi-level hierarchical structure that is characterized by the consistency (Figure 1). The essence of "consistency" is expressed in the fact that all processes, phenomena, things in the objective world are universally connected and interact as relatively isolated objects that have a qualitative and quantitative parts and change in time and space. We will emphasize three characteristics of the "consistency": universal connection of all processes and phenomena is the connection of relatively isolated objects and things; relative isolation and independence of objects, things and phenomena are expressed in the fact that they have qualitative and quantitative parts; and relatively isolated objects, things and phenomena interact with one another.

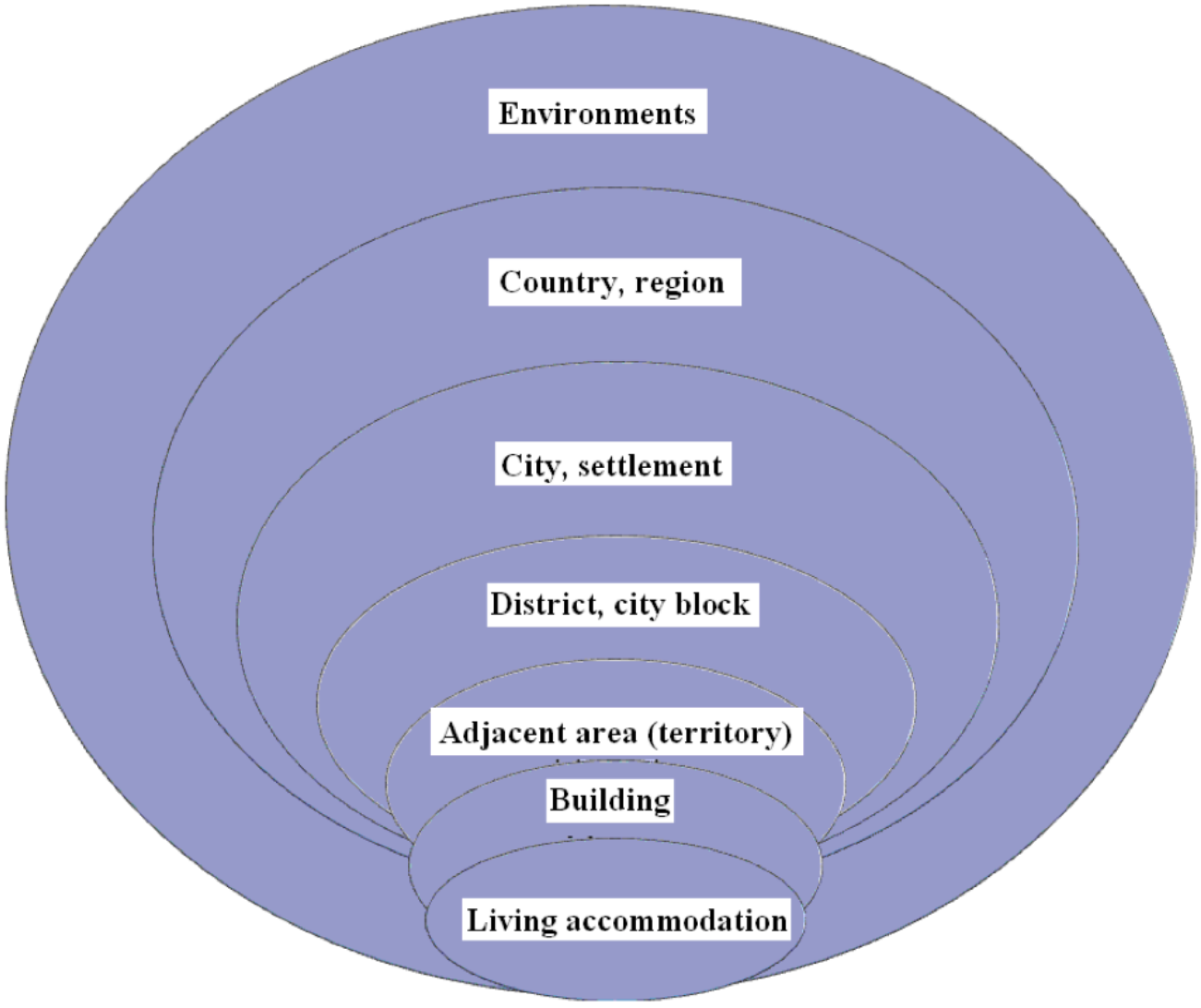

Figure 1. Hierarchical Structure of Living Spatial Environment

We will note that "comfort of the spatial environment" is such objective state and subjective perception that corresponds to the system of needs, values, ethnic norms and cultural traditions that exist at the specific time in a specific place in a specific society and form the idea of what elements and features of the spatial environment are required for the adequate life of the person" (Housing statistics – 2015; Elizarova and Hrustalev 2014; Larionov and Larionova, 2014). Herewith, the objective state of the spatial environment can be differently estimated by various people, and if characteristics of the spatial environment comply with the consumer needs, it is possible to observe the state of satisfaction by conditions of living the person believes to be comfortable.

The above hierarchical structure of the residential property in the spatial environment at the stage of creation is regulated by city construction and building standards and rules whose comfortability and possibility to accommodate when using allows to single out the following levels. Each level has a specific value and zone of responsibility for the person and society as a whole:

- Living accommodation (room, apartment, and individual residential house (residential building)) gives the opportunity to individually accommodate the space for the person and a separate family, forms close inter-personal contacts of close people; zone of responsibility of a separate family,
- Apartment block (apartment building) allows to jointly with neighbors take decisions and specific actions on accommodating "own" house, defines conditions for the personal communication of people; zone of responsibility of all owners of apartments,
- Adjacent territory of the apartment building or a complex of apartment buildings allows to take decisions and specific actions on accommodating "own" territory, defines conditions for the personal communication of people; zone of responsibility of both owners and municipal bodies of power,
- City block, district form a social spatial infrastructure and impersonal close contacts of communication, it has an impact on the level of citizens' satisfaction by conditions of living; zone of responsibility of municipal bodies of power, and

- Settlement, city, country, region make up the level of the spatial accommodation that like the previous one can only have an impact on the person's satisfaction by the quality of life, as a whole; it depends on nature and climate conditions and the policy in the social area pursued by the state.

Structuring of the spatial environment allows to form the criteria of consumer characteristics of every level the person is regulated when selecting the place of residence and living conditions. The basis of this system is a building as an object of capital development created when improving the land. It is necessary to note that construction technologies allow to create the residential property forming a different degree of comfort of the spatial environment, even in living accommodations of the same building. The authors think that the degree of comfort of the spatial environment whose basis is made by the residential property is the determining factor in estimating the comfortability of the residential property itself. According to A.M. Elizarova and E.Yu. Khrustalev, "comfortability of the residential property, accommodation can be a generalizing indicator of the consumer features, consumer requirements to the quality of the property to criterion of its estimation" (Elizarova and Hrustalev, 2014). Based on the above, we define that it is necessary to interpret comfortability of the residential property as the comfortability of the spatial living environment formed by it. The living environment is defined both by the quality of the residential property itself, and consumer features of the created spatial environment that in the aggregate make up a generalizing criterion of the estimation of the degree of this spatial environment.

2. Methods

The above facts about the levels of comfortability and value of the residential spatial environment enabled the authors to develop the basic provisions of the methodology to estimate comfortability and classify the residential property based on this criterion. Some provisions of this methodology were stated earlier in our works (Saenko and Chepeleva 2016; Chepeleva and Saenko 2016).

At the first stage it was necessary to define the levels of forming the conformability of the residential property when using it, on the basis of distinguishing zones of impact on internal and external factors that form the comfortability of the spatial environment. The following levels were singled out:

- Living accommodations in the building, as a rule, an apartment,
- Building,
- Adjacent territory of the living building or a complex of living buildings,
- Other superior levels defined in the above hierarchical structure of the real estate in the spatial environment (Figure 1), which we will conditionally call the external environment.

Such distinguishing is reasonable because it complies with the subsequence of the person's conscious selection of the residence from selecting the region for residence to selecting a specific apartment and/or room in a specific building or a complex of buildings with the adjacent territory. We will note that when selecting a residence, the person is limited by his own financial opportunities. That is why the formed levels enable him to understand how he can participate in forming the parameters of comfort of his residential conditions in accordance with the existing residential need supported by the financial opportunity (Table 1).

Table 1. Degrees of the Consumer's Impact on Comfortability of the Spatial Living Environment

Levels of comfortability	Degree of impact
Living accommodation	Maximum
Apartment building	Medium
Adjacent territory of the apartment building or a	Medium

complex of apartment buildings	
External environment	Minimum

On the “living accommodation” level the consumer has the opportunity to participate in forming the comfort of the spatial residential environment and managing it. It is stipulated by the circumstance that this is the property he directly disposes of as the owner or a renter meeting the existing residential need.

On the level of “living building” and “adjacent territory of the living building or a complex of living buildings”, the consumer has a medium opportunity to participate in forming the degree of comfort of the spatial environment. It is stipulated by the following circumstances:

- A great number of owners in one building or buildings that are located near each other and forming a single complex whose social statuses considerably differ,
- Ambiguity of objects of the capital building according to various characteristics that form consumer features of the building as a whole and separate premises, including residential accommodation,
- A great number of commercial facilities in buildings used by individuals (owners),
- Peculiarities of the adjacent territory of the living building or a complex that form differences in the possibility to accommodate them,
- Owners’ passive attitude in managing the collective property, and
- High probability of conflict situations related to accommodating the joint spatial residential environment.

Besides, the level of “adjacent territory of the living building or a complex of living buildings” is also within the zone of responsibility of municipal bodies of power that solve the following issues within settlements:

- Organizational and legal provision of the improvement of the system related to managing the city construction policy,
- Defining territories for the comprehensive reclamation for residential construction,
- Developing and implementing the engineering preparation of territories meant for constructing, creating conditions for the residential and social and cultural construction in accordance with the current legislation of the Russian Federation, and
- Organizing the development and approving of local standards of the city construction design.

On the “external environment” level the consumer has a small opportunity to participate in forming the comfort of the environment because the environment is influenced above all by the nature and climate conditions, a number of political, economic, socio-cultural and technological factors, as well as in general by the residential policy of the state focused on creating social perspectives of improving the residential conditions for all groups of population.

At the second stage we formed a system of criteria that characterize consumer features and requirements to the residential property and the spatial environment formed by it. Based on them, it is possible to give an integral estimation of comfortability of every distinguished level (Li.).

Table 2 shows a list of criteria of comfortability for every level (Cij). It was compiled by the authors on the basis of researhcing the statutory base in the area of constructino and cost estimation of the residential propery and amended taking into acocunt their own ideas in this subject area.

Table 2. System of Criteria to Estimate Comfortability of Residential Property and the Spatial Environment Formed by It

Internal environment			External environment
		Adjacent territory of	

Living accommodation	Apartment building	the apartment building or a complex of apartment buildings	
- Comfortability of volume-planning solutions, - Protectability of accommodation from radon, - Natural illumination, - Artificial illumination, - Air and thermal comfort, - Light comfort, - Acoustic comfort, and - Quality of interior decor.	- State of the object, - Quality of the architectural treatment of the building, - Quality of public zones within the building, - Control and management of systems related to engineering support of the building, - Beautifying the building, - Entrance control and providing people with safety, - Control over and management of the air environment, and - Quality of sanitary protection.	- Type of the residential zone, - Location of the object in the settlement, - Transportation accessibility, - Surroundings, - Accessibility of public transport, - Accessibility of social objects, - Provision of the adjacent territory with health and fitness sports facilities and playgrounds, - Beautifying of the territory, - Insolation of the adjacent territory, - Protectability of the adjacent territory from ionisable and magnetic radiation, - Nearness of the water environment and visual comfort, - Availability of parking for cars, and - Availability of ecological transport.	Environment quality: - Provision of the residence per person, - Availability of modern formats of consumption, - Level of roads loading, - Level of criminality, - City illumination, - External transportation accessibility, - Level of the city accomplishment, - Level of usefulness of natural conditions, and - Level of ecological pollution. Cost of life: - Possibility to buy own residential property, - Possibility to rent 1-room apartment, - Level of expenses for consuming, - Level of expenses for paying for services of the housing and public utilities, and - Purchasing power of the population.

Source: Compiled by Authors on the basis of (The Unified Methodology of Classifying New-Built Real Estate Accoridng to the Consumer Quality Class; 100 Largest Cities of Russia Integral Rating; Order of the Ministry for Regional Development of the Russian Federation No. 371; Architectural and Design Solutions of Multi-Apartment Real Estate; Urban Construction. Design and Building in Urban and Rural Settlements; Multi-Apartment Real Estate; STO NOSTROY 2.35.4-2011)

At the third stage it was necessary to define particular indicators (Qij) that characterize every distinguished level of comfortability and to offer a variant to estimate them. Indicators of the comfortability criteria must be estimated according to the measured and steadily differing qualitative and quantitative features that characterize every level of the spatial environment formed by the residential property and including the characteristic of the external environment. The indicators are measured in the units that are specific for every feature. The metrological, expert and analytical methods can be used for measuring.

To our mind, the supposition about the number, composition, and characteristic features (indicators Qij) of the residential property and external environment can be corrected in the

future focusing on results of the research and technical and socio-economic development of the production and the society as a whole, and separate regions.

At the fourth stage it was necessary to define the algorithm of the unifying transformation to compare various features of the residential property and the external environment measures in various range and size scales.

In order to do it, we offer the Cij estimate to be a relative dimensionless indicator that reflects the level of approximation of the absolute indicator of the Q_{ij} feature to the maximum Q_{max} and minimum Q_{min} to indicators for every specific criterion of comfortability. The relative indicator is described by the constraint:

$$C_{ij} = f(Q_{\min},\ldots,Q_{ij},\ldots Q_{\max}), \quad (1)$$

All indicators Q_{ij} selected to estimate the degree of comfort can be referred to one of the two groups:

1) If the peculiar indicator Qij is related to the analyzed integral feature Li of the comfort degree by the monotonously increasing constraint (i.e. the higher the value Qij, the higher the comfort degree), the value of the relevant unified variable Cij is calculated using the following formula:

$$C_{ij} = \frac{Q_{ij} - Q_{\min}}{Q_{\max} - Q_{\min}}, \quad (2)$$

where Q_{ij} is an absolute indicator of the feature,
Q_{max} is a maximum indicator of the feature, and
Q_{imin} is a minimum indoctaor of the feature.

2) If the peculiar indicator Qij is related to the analyzed integral feature Li of the comfort degree by the monotonously decreasing constraint (i.e. the higher the value Qij, the lower the comfort degree), the value of the relevant unified variable Cij is calculated using the following formula:

$$C_{ij} = 1 - \frac{Q_{ij} - Q_{\min}}{Q_{\max} - Q_{\min}}, \quad (3)$$

where $Q_{ij}, Q_{max}, Q_{imin}$ are the same as in (2).

The recommended level of features indicators both minimum and maximum must be defined in accordance with the established normative requirements set in standards, GOSTs, codes of practice, and official methodologies based on the principle of usefulness and rationality when a further change of the indicator does not bear an important increase in the comfort degree.

Some comfortability parameters can be characterized only by discrete "yes/no" values based on the availability/lack of the required material object or compliance/non-compliance with the set requirement. Such values in and of themselves are boundary. In this case values in relation to the Cij indicator become equal to one or zero, respectively.

At the fifth stage it is necessary to define the weight index of every comfortability criterion Gij in the integral estimate of the comfortability level of every distinguished level of comfortability Yi. The value of weighing indices is defined by using a variety of expert and analytical methods.

Table 3 shows the example of estimating one of the comfortability criterion defined by the authors.

Table 3. Example of Estimating "Comfortability of Volume-Planning Solutions" Criterion

Criterion	Indicators	Qmin	Qmax	Gij
Comfortability of	Height of accommodations not less than, m	3	4	0.08

volume-planning solutions				
	Index of the width and depth correlation of 60% of accommodations	1.5	2	0.05
	Area of apartments, m2: 1-room 2-rooms 3-rooms 4-rooms 5-rooms	28 44 56 70 84	60 80 120 250 350	0.11
	Kitchen area	8	20	0.08
	Open plan	No	Yes	0.08
Statutory framework of the parameter: SP 42.13330; SP 54.13330 Methods of defining: analysis of planning documentation, linear and areas measuring, visual defining				

At the sixth stage we define the integral estimation of the degree of comfortability of every level Li . It can be defined by using the following formula:

$$Cc = \sum_{i=1}^{n} C_i G_i, \quad (4)$$

Where C_{ij} is a relative indicator of the feature,
Gij is a weight index of the feature, herewith $0 < Gij_i < 1$, and the sum of weights is one.

At the seventh stage in accordance with the obtained result of the integral estimation of the comfortability degree, we refer the considered level of the spatial environment Li formed by the residential property and factors of the external environment to one of the possible, to our mind, four classes of the residential property according to the level of comfortability. For this purpose we single out the following:

- Minimum level or economy comfort (C),
- Extra comfort (EC),
- Business comfort (BC), and
- Premium comfort (PC) (Table 4).

Table 4. Classifying Residential Property and Spatial Environment Formed by it According to the Comfortability Degree

Level of comfort	Economy comfort	Extra comfort	Business comfort	Premium comfort
Living accommodation	0 – 0.25	0.25 – 0.5	0.5 – 0.75	0.75 – 1
Apartment building	0 – 0.25	0.25 – 0.5	0.5 – 0.75	0.75 – 1

Adjacent territory of the apartment building or a complex of apartment buildings	0 – 0.25	0.25 – 0.5	0.5 – 0.75	0.75 – 1
External environment	0 – 0.25	0.25 – 0.5	0.5 – 0.75	0.75 – 1

3. Results

For clarity, it is offered to use the graphic representation of the obtained results in the form of a "rainbow" where layers are levels of the estimation of the residential property comfortability and the spatial environment Yi formed by it (a living accommodation, an apartment building, an adjacent territory of the apartment building or a complex of buildings, external environment). The colors are indicators of quality in terms of the comfort degree (Figure 2).

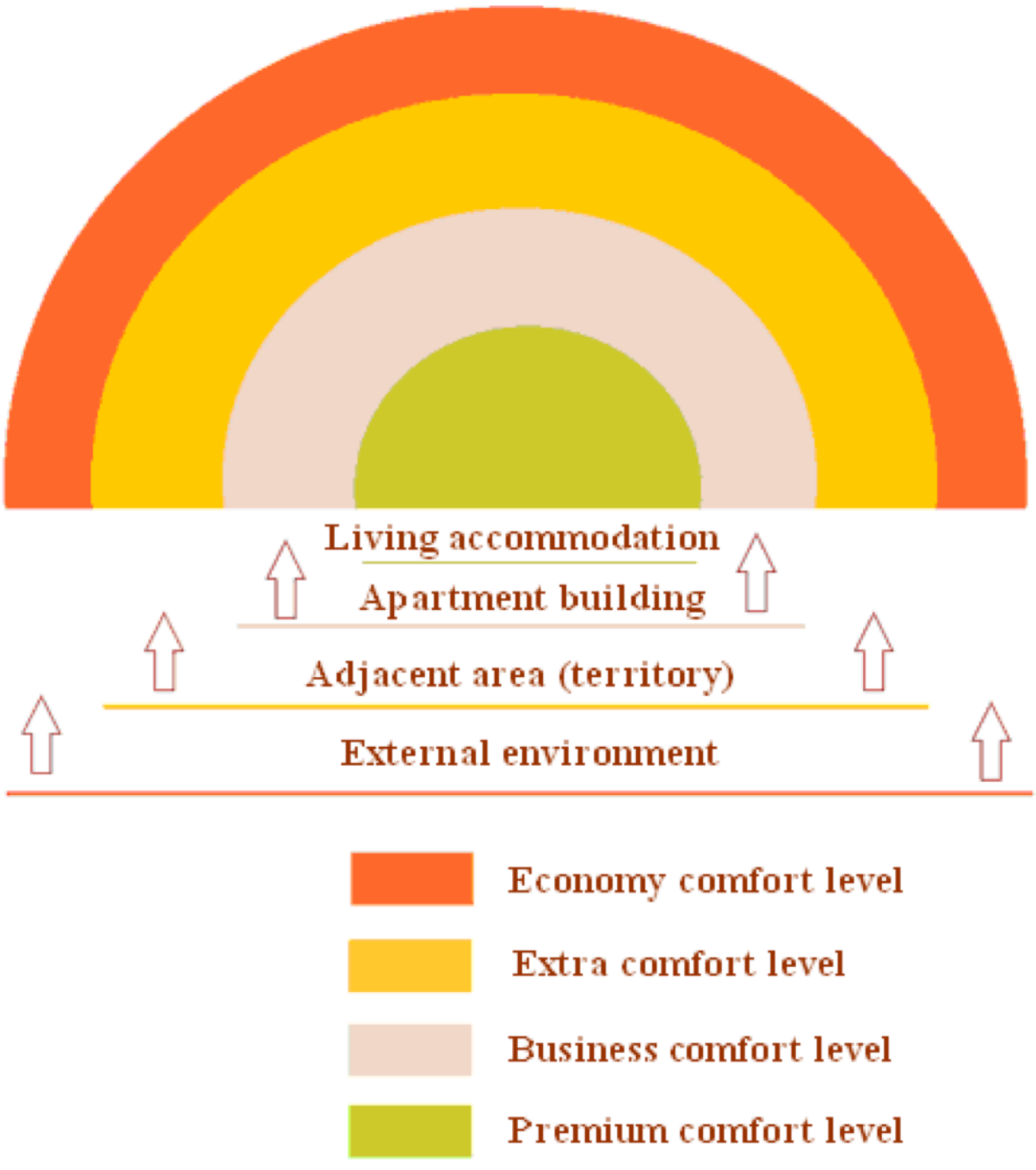

Figure 2. Visual Representation of the Estimation of the Level of Residential Property Comfortability and Spatial Environment Formed by It

The division into layers according to the scale of impact and the range of colors from bright orange (the worst level) to forest green (the best) must be intuitively understandable. To our mind, such illustrative reflection will enable every person and society as a whole to form the idea about comfortability of the residential property.

The following provisions can be used as the basis of developing the methodology of classifying the residential property according to the level of comfortability:

- It is necessary to distinguish zones of impact of various factors that form the comfortability of the residential property (Figure 1). Herewith, every zone of impact has a set of specific criteria, aggregate of parameters whose values must be estimated. It is necessary to distinguish them according to zones of responsibility in order to have the possibility to specifically consider the factors that form the comfortability of living conditions related to the apartment, building or its surrounding.
- The point estimation of indicators that form every zone of impact of factors defining the comfortability of the residential property is the most rational. It is supposed to assign points on the basis of applying the provisions of the above classifications by making all necessary corrections and amendments.
- In accordance with the number of the points obtained for every zone of responsibility, it is possible to assign classes of the residential property according to the level (degree) of comfortability. For this purpose, it is necessary to single out the minimal level or economy comfort (C), extra comfort (EC), business comfort (BC) and premium comfort (PC).

Then it is necessary to consider the algorithm of estimating the comfortability of the residential property that can be used by professional members of the real estate market.

Stage 1. Collecting initial data.

At this stage data according to four levels (Qij system is formed) is collected:

- Living accommodation,
- Apartment building,
- Adjacent territory of the apartment building or a complex of apartment buildings, and
- External environment.

Stage 2. Analyzing and processing of data.

At this stage on the basis of the initial data, at the beginning we define Cij, and then, taking into account Gij, we calculate the degree of comfortability of every level of the spatial environment Li.

Stage 3. Estimating the degree of comfortability of the spatial environment and residential property.

This stage supposes that the calculated indicator of the comfortability degree allows to refer every level of the spatial environment and the residential property to one of the specific classes: economy comfort, extra comfort, business comfort and elite comfort.

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4. Discussion

The complexity of the problem on estimating the comfort of the spatial environment and thereby the comfortability of the residential property is defined by the following aspects:

a) Plurality and diversity of consumers, because every person needs a place of residence and sets different requirements to consumer characteristics of the environment he or she thinks to be comfortable for himself/herself,

b) A lot of indicators that characterize the consumer features and requirements to the quality of the residential property measured in scales that differ according to the range and size, and

c) Changeability of indicators that define the level of comfortability over time.

When developing the Methodology of estimating comfortability and classifying residential property, the authors used the following assumptions:

- Comfortability is a generalized aggregated (integral) characteristic of the level of comfort of the spatial environment,
- Comfort is an aggregate of only those features of the real property or the spatial environment formed by it that are related to the result achieved with its aid – the degree of comfortability - but

not with the expenses incurred at that,

- All features that form the comfortability of the residential environment make up the hierarchical structure as a tree of features. The undermost layer of this tree (tree root) is the most complicated feature, i.e. the final indicator – the degree of comfortability, and branches of the upper layer represent simple and quasi-simple features, and
- When defining the comfortability of residential conditions, the consumer complexly focuses on all consumer features of the spatial environment formed by objects of the residential property system.

5. Conclusion

The developed methodology will allow to solve the problem on the lack of the unified typological criterion that integrates the impact of all factors on the comfortability of a residential object. In practice they apply several criteria that give a stipulated idea about the real estate object. However, it is necessary to understand that the real estate market is developed in accordance with the needs of its members rather than in compliance with the classification. That is why objects of mixed formats always occur, and some objects only partially comply with the classical definitions.

The offered methodology and algorithm of estimating the comfortability and classifying residential property will enable professional members of the real estate market to better focus consumers when meeting their residential need, as well as to be a tool of the cost estimation of the residential property.

One of the strategic goals of "Strategy 2020: New Model of Growth – New Social Policy" is to form social perspectives to improve residential conditions for various groups of population. The offered methodology can considerably change the needs in the residential construction, development and modernization of objects, use of architectural and design solutions and construction technologies subordinated to the city planning. In a new and more balanced mode it will define the spatial structure that is convenient and comfortable for the people's life. This methodology acquires a special urgency in the context of transferring to a new procedure of calculating the property tax in 2020. At the present time estimators use the comparative approach, in particular the method of typical object. It often does not take into account consumer parameters of the residence quality – comfortability of the residential property.

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