Housing classification as the basis for developing an economic strategy for developer

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Abstract. There are 5 types of housing in this article which are consistent with generally accepted classification of residential real estate. It has been implemented a segmentation of the new buildings market by types of availability based on discriminant analysis. This type of the analysis is a statistical method, which allows to research differences between 2 or more object groups simultaneously on several variables and also gives an opportunity to classify objects according to the principle of maximum similarity. According to the samples, some rules have been obtained which later make it possible to determine the class of new objects. The discriminant functions and distribution graphs of objects by type of accessibility have been built, classification method has been graphically presented. Data base of 102 objects has been formed and 12 factors that characterize types of housing availability have been chosen. It has been determined that 5-element classification of objects is the basis for formation of market positions and development of economic strategy for developer in the housing market.

1. Introduction

In modern economic conditions, when the developer losses in case of accepting wrong strategy are significant, increased attention to strategic planning of quality and cost parameters of construction products is required. There is a specificity of housing construction, namely: significant terms of facility construction (the average period of construction from obtaining construction conditions to commissioning of facilities is 3 years), high price, extended period of sale of individual living quarters, inertia of decision making, complicated organizational and management structure [1-8]. Lack of reaction on long-termed market tendencies may lead to lack of demand on premises what is often observed in already built objects. It may have critical effects for developer in form of insufficient solvency and economic non-viability.

Purpose of the article is the development of methodology for identifying the actual class of built facilities, based on statistically significant results of the discriminant analysis of building residential buildings under construction in different regions. Applying this methodology in practice will help developers to make more informed strategic decisions.

2. Analysis of the latest researches and publications

Relevance of improving the applied tools of formation of economic strategy of developer in the housing construction market, its importance for science and practice are confirmed by significant number of works by leading scientists. Among them it is worth to note works of Asaul A., Astafiev S, Zapiechna
Yu, Lancaster,K., Levi,D., Li,S., Murphy A., Pesotskaya, E Scheiber,A., Svetnik T, Tsyfra T, Yakubovsky A, Young, T, and etc. [1, 11-17], which include proposals for solving the range of problems of strategic development for construction enterprises.

Works of the listed scientists have determined the theoretical basis for the current research, and analysis of showed problematic questions convinces that in present time an important and priority need of developers, which work in housing construction sphere, is providing the stable and solvent demand in long-term perspective. Tasks of generalizing of the existing toolkit and creation new one that will help to choose reasonably the strategetical demanded parameters of residential properties, implement the forming of stable demand according to accessibility of housing for different segments of population do not have an ultimate methodological and practical solution, which determines the relevance of the described research.

3. Statement of the main research material
In works [1, 9, 10, 15] for choosing market sector and segmentation in the market of housing construction the simulation modeling, factor analysis, fuzzy sets have been used. Concept of «housing availability» - possibility to provide satisfaction of people’s needs with various levels of incomes in construction (purchase) of housing taking into account criteria of comfortability, environmentally friendliness, profitability [1] has become a basis for our approach.

The assigned task may be solved by using of statistical and classification methods (discriminant analysis) which require an availability of an input sample for the distribution of new buildings into groups, depending on the needs of the population and opportunities of developer enterprises [1, 9, 10, 14, 18]. In practice, collection of such information is a quite a laborious process.

Establishment of the boundaries of housing accessibility is implementing on the basis of its 5-component classification which is widespread in Russia: «social housing» - «comfort class» - «business class» - «prestige» - «elite» [11, 13, 19].

Preliminary selection is carried out on the basis of content-analysis of sites information about property for sale: cian.ru, domofond.ru, avito.ru, realty.yandex.ru, domclick.ru, mirkvartir.ru, and final – on the basis of the discriminant analysis of methodology, which is shown in detail in works [4, 5, 7, 20]. From 96 factors, which are found in literary sources, it has been chosen 12 factors, which research expediency is justified by us.

The hypothesis that «comfortable», «ecological» and «economic» indicators of the listed 5 groups of residential buildings will significantly differ from each other, has been proposed.

Table 1. Initial data for determining «comfortable», «ecological» and «economic» indicators for various types of accessibility (fragment).

| Object number | X1    | X2    | X3    | X4    | X5    | X6    | X7    | X8    | X9    | X10   | X11   | X12   |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1             | 63.61 | 2.00  | 2.75  | 1.5   | 1     | 1     | 7     | 67    | 0.65  | 4     | 15700 | 1.06  |
| 2             | 59.69 | 1.33  | 2.7   | 2.75  | 0.5   | 1     | 4     | 100   | 0.50  | 5     | 12795 | 0.87  |
| 3             | 58.63 | 1.67  | 3     | 2.5   | 1     | 1     | 6     | 82    | 0.50  | 4     | 18700 | 1.26  |
| 4             | 109.68| 1.67  | 2.7   | 2.25  | 0.5   | 1     | 3     | 105   | 0.50  | 5     | 19725 | 1.33  |
| 5             | 34.00 | 2.00  | 3     | 2.75  | 1     | 1     | 6     | 110   | 0.25  | 5     | 39120 | 2.20  |
| 6             | 66.82 | 1.33  | 2.8   | 2.25  | 0.5   | 1     | 5     | 110   | 0.60  | 4     | 15913 | 1.08  |
| 7             | 65.83 | 1.67  | 2.7   | 2.25  | 1     | 1     | 10    | 110   | 0.40  | 3     | 19103 | 1.29  |
| 8             | 56.63 | 1.67  | 2.7   | 2     | 0.5   | 1     | 4     | 110   | 0.50  | 3     | 16165 | 1.09  |
| 9             | 57.97 | 1.67  | 2.7   | 1.5   | 0.5   | 1     | 4     | 120   | 0.25  | 3     | 20050 | 1.36  |
| 10            | 72.51 | 1.33  | 3     | 2.75  | 1     | 1     | 5     | 75    | 0.50  | 4     | 19800 | 1.34  |
| 11            | 32.99 | 2.00  | 3.2   | 3     | 0.5   | 1     | 10    | 120   | 0.50  | 5     | 83000 | 1.60  |
| 12            | 52.30 | 1.67  | 2.7   | 2.5   | 1     | 1     | 2.1   | 87    | 0.50  | 5     | 72190 | 1.39  |
Using Discriminant analysis in program «Statistica 13» a step-by-step discriminant analysis aimed to identification the characteristic classification features of each segment has been implemented. Based on the data of 102 objects of various classes which are being built in Russia (table 1), the system of discriminant classification function has been proposed which allow a potential customer to be convinced that quality, consumer, cost characteristics of building housing category match to the category which declared by developer to object.

The independence of factors from each other has been checked based on the values of paired correlation coefficients (table 2). Ultimately chosen indicators in model must be independent from each other. Choosing of coefficients for creation the equation is implements by exception from further analysis aimed to identification the characteristic classification features of each segment has been implemented.

| 13 | 39,15 | 1,67 | 2,7 | 2 | 1 | 1 | 2.2 | 87 | 0.5 | 3 | 88500 | 1,71 |
| 14 | 40,87 | 2,00 | 3 | 2.5 | 1 | 1 | 8 | 110 | 0,25 | 4 | 52292 | 1,01 |
| 15 | 49,56 | 1,67 | 2,7 | 2 | 1 | 1 | 3,4 | 120 | 0,25 | 4 | 46970 | 0,91 |
| 16 | 46,34 | 1,33 | 3 | 2,75 | 1 | 1 | 3,4 | 65 | 0,25 | 4 | 46500 | 0,90 |
| 17 | 48,87 | 1,00 | 2,7 | 2,5 | 1 | 1 | 3,4 | 120 | 0,25 | 5 | 44108 | 0,85 |
| 18 | 58,55 | 1,67 | 3 | 2,5 | 1 | 1 | 5,4 | 135 | 0,25 | 5 | 49228 | 0,95 |
| 19 | 47,69 | 1,33 | 2,8 | 2,5 | 1 | 1 | 5,4 | 50 | 1,00 | 5 | 61040 | 1,18 |
| 20 | 51,44 | 1,00 | 3 | 3 | 1 | 1 | 2,4 | 105 | 1,25 | 5 | 73260 | 1,42 |
| 21 | 35,66 | 1,33 | 3 | 1,75 | 0,5 | 1 | 2,4 | 25 | 1,00 | 5 | 64184 | 1,24 |
| 22 | 33,98 | 1,00 | 3 | 1,5 | 0,5 | 1 | 6 | 28 | 1,00 | 5 | 58650 | 1,13 |
| 23 | 31,87 | 1,00 | 3 | 1,5 | 0,5 | 1 | 2,4 | 25 | 1,00 | 5 | 62690 | 1,21 |
| 24 | 63,61 | 2,00 | 2,75 | 1,5 | 1 | 1 | 7 | 67 | 0,65 | 4 | 15700 | 1,06 |
| 25 | 59,69 | 1,33 | 2,7 | 2,75 | 0,5 | 1 | 4 | 100 | 0,50 | 5 | 12795 | 0,87 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 99 | 63,20 | 0,33 | 2,8 | 1 | 0,75 | 1 | 0 | 65 | 1,00 | 5 | 10200 | 0,70 |
| 100 | 65,00 | 0,33 | 2,7 | 1,5 | 0,75 | 1 | 0 | 65 | 1,00 | 5 | 8800 | 0,60 |
| 101 | 112,50 | 2,00 | 3 | 3 | 0,5 | 1 | 10 | 65 | 1,25 | 5 | 36400 | 2,49 |
| 102 | 60,00 | 0,33 | 2,7 | 2 | 1 | 1 | 0 | 65 | 1,00 | 5 | 11240 | 0,77 |

«Comfortable», «ecological» and «economic» indicators of the listed 5 groups of residential buildings in Russia will significantly differ from each other:

- **X1** – housing area, per person, m²;
- **X2** – security level, (taking into account presence of an intercom, fire and burglar alarms), point;
- **X3** – height of a typical floor of new buildings, m;
- **X4** – availability of infrastructure of new buildings (parking, shops, restaurants, personal services, availability of educational institutions), point;
- **X5** – availability of «smart home» elements, point;
- **X6** – availability of ecological construction materials, point;
- **X7** – availability of terrace, veranda, «green zone» indoors, point;
- **X8** – the degree of insolation of adjacent territory, %;
- **X9** – indicator of buildings compactness (the ration of the useful building area to the area of the outer shell 1.0-1.2 or more), point;
- **X10** – accessibility of ponds, forest, point;
- **X11** – price 1 m², rubbles;
- **X12** – housing cost coefficient (the ratio of the cost of one m² of an object to the average cost of one m² in the region).
analysis one of the interconnected factors (r>0.5), value of which is the least (value of lambda quotient is the least).

Table 2. Matrix of paired correlation coefficients.

| Indicator | Paired correlation coefficients |
|-----------|---------------------------------|
|           | X1     | X2     | X3     | X4     | X5     | X6     | X7     | X8     | X9     | X10    | X11    | X12    |
| X1        | 1,00   | 0,29   | 0,19   | 0,13   | 0,23   | 0,03   | 0,11   | 0,01   | 0,07   | 0,21   | -0,13  | 0,13   |
| X2        | 0,29   | 1,00   | 0,19   | 0,45   | 0,43   | 0,19   | 0,30   | 0,18   | 0,05   | 0,23   | 0,30   | 0,02   |
| X3        | 0,19   | 0,19   | 1,00   | 0,28   | 0,23   | 0,16   | 0,08   | 0,05   | 0,15   | 0,29   | 0,29   | 0,02   |
| X4        | 0,13   | 0,45   | 0,28   | 1,00   | 0,46   | 0,28   | 0,21   | 0,33   | 0,02   | 0,36   | 0,25   | 0,02   |
| X5        | 0,23   | 0,43   | 0,23   | 0,46   | 1,00   | 0,45   | 0,01   | 0,34   | -0,12  | 0,49   | 0,31   | -0,11  |
| X6        | 0,03   | 0,19   | 0,16   | 0,28   | 0,45   | 1,00   | 0,03   | 0,30   | -0,14  | 0,44   | 0,21   | -0,19  |
| X7        | 0,11   | 0,30   | 0,08   | 0,21   | 0,01   | 0,03   | 1,00   | 0,12   | -0,14  | -0,09  | -0,16  | 0,05   |
| X8        | 0,01   | 0,18   | 0,05   | 0,33   | 0,34   | 0,30   | 0,12   | 1,00   | -0,36  | 0,21   | 0,01   | -0,20  |
| X9        | 0,07   | 0,05   | 0,15   | 0,02   | -0,12  | -0,14  | -0,14  | -0,36  | 1,00   | 0,21   | 0,09   | 0,14   |
| X10       | 0,21   | 0,23   | 0,29   | 0,36   | 0,49   | 0,44   | -0,09  | 0,21   | 0,21   | 1,00   | 0,27   | 0,04   |
| X11       | -0,13  | 0,30   | 0,29   | 0,25   | 0,31   | 0,21   | -0,16  | 0,01   | 0,09   | 0,27   | 1,00   | -0,20  |
| X12       | 0,13   | 0,02   | 0,02   | 0,02   | -0,11  | -0,19  | 0,05   | 0,20   | 0,14   | 0,04   | -0,20  | 1,00   |

Table 3. Classification functions for establishing the compliance of actual characteristics of object with the nominal criteria for the class of housing declared by developer.

| Group         | Number of observations | Classification function for the integral indicator |
|---------------|------------------------|-----------------------------------------------|
| Social housing| 34                     | Y1 = 29,0097X12 + 0,3849X7 + 0,001X11 - 0,0713X4 + 1,6639X5 + 0,1124X8 + 1,1489X10 + 0,2797X2-17,7005 |
| Comfort class | 25                     | Y2 = -39,2793X12 + 1,1584X7 + 0,0002X11 -0,2168X4 -1,0658X5 + 0,1505X8 + 1,3432X10 -0,8604X2-29,8412 |
| Business class| 24                     | Y3 = 45,7557X12 + 2,2663X7 + 0,0002X11-1,1907X4 + 0,9553X5 + 0,1468X9 + 1,9244X10-2,7046X24,3565 |
| Prestige      | 9                      | Y4 = 54,1769X12 + 1,3023X7 + 0,0003X11 + 1,5118X4+ 2,6150X5 + 0,1760X8 + 1,39825X10-1,9704X2-53,9032 |
| Elite         | 10                     | Y5 = 80,221X12 + 2,288X7 + 0,0001X11 + 0,715X4 + 0,717X5 +0,232X8 + 0,873X10-3,311X2-106,916 |

The resulting models are suitable for classification of new objects, because they have an acceptable level of discrimination, high percent of correctly classified cases (table 3).

By using created models, it is possible to accurately predict possibility of accordance of new buildings to population’s needs and form strategies for works implementation by developer enterprises. Social housing will belong to that group, for which received significance level will have a maximum value (table 4).

Table 4. Criteria for assessment of the created models.

| Number of observations | Number of model steps | Lambda Wilkes (λ) | F-criteria | p – significance level of F-criteria | Percentage of correctly classified cases |
|------------------------|-----------------------|------------------|------------|-------------------------------------|----------------------------------------|
| 102                    | 8                     | 0,0592908        | 11,99967   | <0,0001                            | 90,19608                                |
Wilkes coefficient is lower in first function and indicates about its high efficiency because it allows to clearly divide new building into classes. Also, the higher order of the first function is evidenced by large indicators of its own value in comparison with the other. So, the first discriminant function in all calculated indicators better classifies the object of the research – accessibility and importance of new buildings’ population needs in comparison with the second function (table 5).

It is possible to make a conclusion that indicators-factors: Х2, X4, X5, X7, X8, X10, X11, X12 allow to clearly divide new building into groups by using criteria «social housing – comfort – business class – prestige – elite».

| Variable | G_1:1   | G_2:2   | G_3:3   | G_4:4   | G_5:5   |
|---------|---------|---------|---------|---------|---------|
| X12     | 29,0097 | 39,2793 | 45,7557 | 54,1769 | 80,221  |
| X7      | 0.3849  | 1.1584  | 2.2663  | 1.3023  | 2.288   |
| X11     | 0.0001  | 0.0002  | 0.0002  | 0.0003  | 0.0001  |
| X4      | -0.0713 | -0.2168 | -1.1907 | 1.5118  | 0.715   |
| X5      | 1.6639  | -1.0658 | 0.9553  | -2.6150 | 0.717   |
| X8      | 0.1124  | 0.1505  | 0.1468  | 0.1760  | 0.232   |
| X10     | 1.1489  | 1.3432  | 1.9244  | 1.3982  | 0.873   |
| X1      | 0.2797  | -0.8604 | -2.7046 | -1.9704 | -3.311  |
| Constant| -17,7005| 29,8412 | -43,3565| -53,9032| -106,916|

In figure 1 it is shown the dividing of enterprises into groups. Numbers of groups: №1 – social housing, №2 – comfort housing, №3 – business class, № 4 – prestige, № 5 – elite.

**Figure 1.** Scatter diagram of canonical values for new buildings of 1-5 groups.

From the figure 1 it is possible to notice that residential buildings of 1st and 5th groups are clearly divided into 2 different complexes, but at the same time in groups 2, 3 and 4 (comfort housing, business class, prestige) there is a mutual intersection.

4. Conclusions
It has been developed an methodology that identifies the factual class of constructing objects with developer which is nominal determined in project documentation. This methodology is based on statistically determined results of discriminant analysis of constructing residential buildings in different
regions. It will allow to adapt the system of housing classification assessment from position of its accessibility. During the research it have been determined 5 types of housing accessibility which match with the generally recognized classification of residential properties objects. According to the proposed approach, it have been determined coefficients of various types of housing accessibility for further monitoring of efficiency of strategic plans realization. It has been determined that 5-element classification of objects is the base for formation of the market positions and development of economic strategy of developer in the housing market.

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