

Analysis of the impact of quantitative and qualitative price-setting attributes on a market of real estate intended for the purpose of the transformer stations on the example of Krakow

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Abstract. Based on appraisal reports, obtained from the City Office of Krakow, there were formulated base of real estate properties on which is situated the building of transformer station or which are intended for such purpose. The base consists of 90 properties located in the administrative boundaries of the city of Krakow. Most of these properties are the plots of very small areas, mainly in the range from 30 to 70 square meters. Based on the completed database, there were conducted a statistical analysis of the relevant market the property. In order to determine the relationship between the attributes and the price of real estate, there were calculated coefficients of the Pearson complete correlation and coefficients of the Spearman correlation. The analysis showed significant differences between quantitative and qualitative correlation coefficients for some variables. In order to improve the consistency of the database, using statistical methods eliminated property turned out. Finally, the analysis considered two bases, numbering respectively 90 and 77 real estates. In the following values, there were defined standardized regression coefficients (scale β), the partial correlation coefficients for the dependent variable (price) relative to the rest of variables and coefficients of determination. On the basis of calculations and analysis, there have been drawn conclusions on the impact of each attribute on the market prices of these unusual properties.

Keywords: real estate appraisal, transformer stations, statistical analysis

Conference topic: Technologies of Geodesy and Cadastre

Introduction

In everyday practice of real estate appraiser, beyond valuations of the typical real estate, which are generally flat or houses, there are also ones whose purpose is to determine the value of less standard objects. These include the land properties or parts thereof, on which transformer stations are situated. The need for the valuation of such property is usually for the purpose of determining the remuneration for the establishment of transmission easement or compensation for non-contractual use of property (Butryn, Preweda 2016).

Property appraiser, whose task is to estimate the market value of the property, is obliged to make a prior analysis of the market, which will enable the selection of the price-setting attributes of similar properties – in case the use of a comparative approach, or features that differentiate the potential rent rates – in case the use of the income approach (RRM 2004).

Land properties on which transformer stations are situated undoubtedly represent the unusual segment of real estate market. Their specificity consists of a combination of factors, both physical, and legal, which will be presented in the text of this document. In combination with the relatively small number of transactional data, they affect the difficulty of the characteristics of the market for valuation purposes.

In this study was defined the set of potential price-setting attributes for the real estate market, as well as determined the quantitative impact of selected attributes of real estate on prices of plots with transformer stations in Krakow.

Reasons of taking an issue

Introduced in August 2008, the institution of transmission easement created another task for a property appraisers - determination of the remuneration for the establishment of transmission easement and estimating the amount of compensation for non-contractual use of the property. The first of the objectives is associated mainly with devices that have yet to be constructed on the property. The second one refers to a situation in which transmission facilities are sited on the property for some time, and the transmission entrepreneur has used the property without legal title. Currently, the issue of establishing transmission easement is discussed in many publications (Butryn, Preweda 2016; Wójciak 2015; Zamroch 2015).

In practice, there are many types of transmission facilities, typical of the type of transmission network. The objects of this study are the transformer stations, which are devices related to electricity transmission networks. The transformer station is a facility where there is a separation of electricity at different voltage levels equipped with transformers or converters for AC to DC and back.



Fig. 1. Examples of transformer stations in the area of Krakow
(Source: own materials)

Transformer stations are objects often associated with power lines of the transmission. Usually, for their foundation they are secreted separate cadastral plot/parcel (or group of parcels), in whole or the majority of stations built facility. As a result, real estate property which is the subject of the valuation is made up of cadastral parcel with a relatively small surface area, fitted out in a certain way. It can therefore be assumed that properties on which transformer stations are situated create a specific real estate market. The aim of this study is to analyze the factors affecting the price level in the market of land, on which are situated transformer stations. Geographical range of the analyzed market is an area of the city of Krakow.

Description of data, research methodology

The basis for the study is a set of properties, on which are situated transformer station or designated for their construction. The data was obtained from the resources of the City Hall of Krakow. They were made available in the form of extracts of appraisal reports. Therefore, it should be noted that the analysis covers the value of property, not transaction prices.

The database consists of 90 properties located in the administrative boundaries of the city of Krakow. For each of them there is given designation of the property (cadastral unit, precinct, parcel number). Each real estate was described by 10 attributes, characterized below (as a convenience to the recording attributes also determined the letter's abbreviations):

Table 1. Characteristics of the local real estate market
(Source: own studies)

Abbreviation	Attribute name	Description features	Range of scales
a	Zone of the city	Location of the property expressed by a concentric model - the zone of the city	4 - central zone 3 - downtown zone 2 - intermediate zone 1 - peripheral zone
b	Planning conditions	Zoning, the parameters of possible construction, the potential and limitations, conditions the neighborhood	10 - parks, green spaces, recreation 20 - low housing 25 - high housing 30 - municipal housing 35 - trade construction 40 - services construction 50 - industry construction
c	Availability of public transport	Access to a public road, public transport (bus and tram)	2 - very good 1 - good 0 - average -1 - difficult
d	Plot surface area [m ²]	The surface area of the plot expressed in [m ²]	-

e	The density of construction and environmental influences	The density of buildings in the immediate vicinity of the property, the nature of the environment (land built / unbuilt)	2 - very beneficial 1 - beneficial 0 - average -1 - unfavorable
f	The shape of the plot and topography	The shape of the plot (regular / irregular), lay of the land plot (flat terrain / a varied terrain)	2 - very beneficial 1 - beneficial 0 - average -1 - unfavorable
g	The attractiveness of the location	The attractiveness of a location on the local market in the context of the use of the property	5 - the most attractive 3 - very attractive 1 - attractive 0 - average -1 - unattractive
h	The armament of land	Technical infrastructure situated on the plot or in its neighborhood	The number of networks from 0 to 6 (energy, water, gas, sewage, heating, telecommunications)
i	Valuation date	Date on which was estimated market value of the property	-
j	Value	The estimated market value of the property, expressed in full PLN	-

Below is a database of real estate with the unit scale attribute values, which will be analyzed further below:

Table 2. Real estate database - the basis of analyzes
(Source: own studies)

Ordinal	Cadastral unit	Precinct	Number of parcel/parcels	a	b	c	d	e	f	g	h	i	j
1.	Krowodrza	15	43/4,	1	10	0	85	-1	0	0	1	20.09.2015	3 300
2.	Krowodrza	15	18/3, 18/5, 18/6	1	10	0	86	-1	0	0	1	20.09.2015	3 784
3.	Podgórze	29	53/4	2	50	1	69	1	1	1	5	16.07.2014	13 400
4.	Podgórze	68	528/46	2	40	1	79	1	1	1	1	18.10.2015	9 316
5.	Podgórze	49	423/13, 423/32	2	25	1	50	1	1	3	4	10.06.2015	10 638
6.	Podgórze	57	216/12,	2	25	1	59	1	1	1	5	10.06.2015	5 907
7.	Podgórze	49	645/34	2	25	-1	49	1	1	1	4	07.06.2015	10 261
8.	Podgórze	49	427/11	2	25	-1	125	1	1	1	4	12.06.2015	26 039
9.	Nowa Huta	10	315	2	25	1	49	1	1	0	5	29.07.2015	4 520
10.	Podgórze	53	522/2	2	20	1	91	1	1	1	4	10.06.2015	17 001
11.	Podgórze	61	1/7	2	10	-1	49	1	1	0	5	12.06.2015	7 513
12.	Podgórze	57	29/27	2	25	1	68	1	1	0	5	10.06.2015	6 607
13.	Podgórze	31	182/40	2	25	-1	60	1	1	3	0	23.12.2014	12 820
14.	Podgórze	44	67/27	2	40	-1	151	2	1	1	5	19.06.2015	11 949
15.	Podgórze	84	131/4	2	10	0	255	0	1	0	2	15.05.2013	16 575
16.	Krowodrza	14	83/8,	3	20	0	39	1	1	1	1	20.09.2015	7 332
17.	Śródmieście	16	160/1	3	20	1	76	2	1	1	5	19.09.2015	16 009
18.	Podgórze	49	537/19	2	25	1	50	2	1	3	4	01.07.2015	10 506
19.	Podgórze	36	74/4,	2	10	-1	75	0	0	0	0	23.12.2014	2 060
20.	Krowodrza	43	431	1	25	-1	60	1	1	0	1	20.09.2015	11 160
21.	Podgórze	44	167/2	2	25	-1	59	2	1	3	6	14.06.2015	11 895
22.	Nowa Huta	5	114/60	2	25	1	50	2	1	3	1	21.09.2014	12 012
23.	Podgórze	55	208/5	2	25	1	51	2	1	1	1	11.07.2014	6 120
24.	Śródmieście	1	355/2	4	20	-1	162	2	1	5	6	03.04.2014	529 902
25.	Podgórze	63	167/16	2	25	-1	93	2	1	1	1	17.05.2014	15 069
26.	Krowodrza	31	50/1,	3	50	1	99	0	0	3	1	26.03.2014	12 120
27.	Nowa Huta	18	1/38	1	20	-1	39	-1	0	-1	0	31.07.2014	1 365
28.	Nowa Huta	7	46/1,	1	25	1	71	0	1	1	0	23.12.2014	16 330
29.	Podgórze	49	736/4, 736/19	2	25	-1	84	2	0	0	0	22.07.2015	19 246
30.	Podgórze	19	286/12	2	40	1	56	1	1	0	6	25.07.2015	6 552
31.	Podgórze	13	571/4	1	10	1	51	-1	1	-1	1	25.09.2015	5 661
32.	Podgórze	47	57/139	1	25	0	60	2	0	1	1	25.09.2015	10 200

33.	Podgórze	55	351/32	2	35	1	49	0	1	3	6	04.11.2015	12 149
34.	Podgórze	69	263/346	2	20	1	61	1	0	0	1	13.06.2014	7 442
35.	Krowodrza	11	379/3	2	20	1	45	2	1	3	5	23.09.2015	5 649
36.	Krowodrza	43	957	2	25	1	78	2	2	1	5	23.09.2015	13 371
37.	Śródmieście	4	207/9	3	4	1	67	2	2	1	5	06.05.2013	17 000
38.	Nowa Huta	2	28/141	2	25	1	123	2	1	-1	5	06.05.2013	18 000
39.	Nowa Huta	10	847	2	25	2	93	1	0	-1	5	06.05.2013	8 800
40.	Nowa Huta	8	28	2	40	2	42	1	1	-1	5	06.05.2013	6 300
41.	Śródmieście	22	512	3	25	2	51	2	1	1	5	07.07.2013	11 985
42.	Nowa Huta	48	11, 12/3, 12/7	2	40	1	134	1	0	-1	5	07.07.2013	24 120
43.	Nowa Huta	51	44	2	40	1	41	0	0	-1	5	11.11.2015	14 564
44.	Nowa Huta	2	74/10	2	25	0	53	2	1	0	5	15.12.2015	4 656
45.	Nowa Huta	51	42	2	40	0	79	2	1	0	5	11.11.2015	28 062
46.	Nowa Huta	10	330	2	25	1	69	0	0	0	5	11.11.2015	7 500
47.	Podgórze	58	59/8,	2	25	0	32	1	2	0	5	06.05.2013	3 200
48.	Nowa Huta	52	31	2	10	0	122	0	0	0	5	06.05.2013	24 000
49.	Nowa Huta	10	205	2	25	0	37	-1	0	-1	5	11.09.2015	3 630
50.	Nowa Huta	53	285/3	2	40	0	78	1	1	0	5	11.09.2015	14 270
51.	Nowa Huta	10	881	2	20	2	136	1	1	-1	5	25.11.2015	52 300
52.	Nowa Huta	2	113/16, 116/14	2	25	2	60	1	2	0	1	09.03.2013	3 420
53.	Nowa Huta	45	150/3, 157/1	2	40	0	36	1	1	0	5	12.09.2012	13 559
54.	Nowa Huta	5	114/33	2	25	0	52	1	2	0	1	14.10.2012	5 900
55.	Nowa Huta	5	114/21	2	25	0	47	1	2	0	1	17.10.2012	5 290
56.	Nowa Huta	5	114/52	2	10	0	49	1	2	0	1	11.10.2012	4 500
57.	Nowa Huta	5	114/46	2	25	0	83	1	2	0	1	10.03.2013	7 885
58.	Nowa Huta	44	234/2	2	40	1	65	0	1	0	1	15.12.2012	2 454
59.	Nowa Huta	11	251/1	1	20	-1	80	1	0	-1	1	19.04.2013	3 000
60.	Podgórze	102	219/5	2	10	2	29	0	1	0	4	24.11.2012	1 463
61.	Podgórze	40	56/53	2	20	0	25	0	0	0	2	24.07.2014	2 250
62.	Podgórze	12	431/1	2	40	1	66	0	1	0	2	15.03.2014	7 688
63.	Podgórze	41	20/3	2	20	-1	36	0	1	0	1	16.08.2013	3 240
64.	Nowa Huta	7	46/1	2	40	0	71	-1	-1	-1	1	10.12.2014	16 330
65.	Podgórze	101	146/1	2	40	1	24	1	1	0	4	08.11.2012	1 438
66.	Podgórze	62	99/14	2	20	0	50	1	0	0	4	22.11.2012	4 350
67.	Krowodrza	14	407/2	2	40	2	35	1	1	0	5	06.07.2013	23 400
68.	Krowodrza	41	508/2	2	20	-1	17	2	1	0	1	20.03.2013	2 210
69.	Krowodrza	40	524/3, 524/5	2	10	1	16	-1	0	-1	4	09.11.2012	656
70.	Śródmieście	4	202/49	3	40	2	112	2	2	3	5	15.04.2012	24 987
71.	Śródmieście	5	432/2	3	40	0	58	1	1	3	1	18.07.2014	37 549
72.	Śródmieście	1	539/7	3	10	1	60	0	1	3	3	10.12.2014	60 000
73.	Śródmieście	22	11	3	10	1	74	1	1	1	5	26.11.2014	24 916
74.	Śródmieście	4	459/19	3	20	1	38	1	1	3	2	14.12.2014	9 500
75.	Śródmieście	5	414/17, 414/21	3	25	0	55	2	2	3	5	07.12.2014	20 625
76.	Krowodrza	8	133/4	2	40	2	73	1	1	1	5	23.12.2014	24 700
77.	Krowodrza	20	60/13	2	20	1	45	1	1	0	3	04.07.2015	5 677
78.	Nowa Huta	11	534/7	2	20	0	90	1	1	-1	4	10.12.2014	8 100
79.	Nowa Huta	5	19/190	2	25	2	37	0	1	0	3	29.10.2014	6 650
80.	Nowa Huta	5	114/81	2	25	2	60	1	1	-1	4	12.06.2015	7 848
81.	Nowa Huta	54	216/25	1	40	0	51	0	1	-1	3	23.12.2015	8 303
82.	Nowa Huta	5	114/60	2	25	2	50	1	1	-1	4	21.10.2014	12 012
83.	Nowa Huta	18	1/38	1	20	0	39	-1	0	-1	1	31.07.2014	1 365
84.	Krowodrza	52	231/3	2	10	2	44	0	1	0	1	02.05.2013	2 500
85.	Krowodrza	9	231/7	2	40	2	139	1	2	3	4	27.11.2013	20 926
86.	Krowodrza	14	122/3	2	25	1	23	0	1	0	5	06.10.2011	3 003
87.	Krowodrza	4	762/3	2	40	0	32	1	1	0	6	06.06.2014	6 400
88.	Nowa Huta	5	114/27	2	25	2	62	2	1	-1	5	10.03.2012	6 820
89.	Nowa Huta	5	114/29	2	25	2	55	2	1	-1	5	15.03.2012	5 949
90.	Nowa Huta	5	114/41	2	25	0	52	1	1	-1	3	12.03.2012	3 740

The bulk of the property is characterized by a very small surface, in the range of 30 to 70 m². Based on the assembled base, it was carried out statistical analysis considered the real estate market.

In order to determine the relationship between the attributes and the price of real estate, Pearson complete correlation coefficients and Spearman correlation coefficients were calculated (Czaja, Preweda 2000; Jasińska 2012).

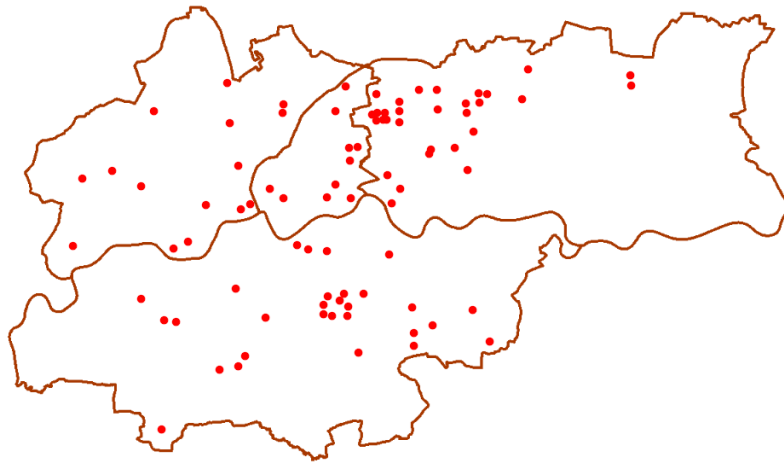


Fig. 2. Location of the properties in relation to the boundaries of Krakow (Source: own studies)

The analysis showed significant differences between quantitative and qualitative correlation coefficients for some variables. In order to improve the consistency of the database, using statistical methods (Preweda 2013) outliers were eliminated. Finally, the analysis considered two bases, numbering respectively 90 and 77 properties. In the following, there were defined: the value of standardized regression coefficients (β weights), partial correlation coefficients for the dependent variable (price) with respect to other variables and the coefficients of determination. On the basis of calculations and analyz, conclusions on the impact of each attribute on the market prices of these unusual properties were drawn.

Results

The analysis of the database began with the designation for each attribute: Pearson complete correlation coefficients and Spearman correlation coefficients. Selected results of the calculations are presented in Figure 3 and in Tables 4 and 3 below.

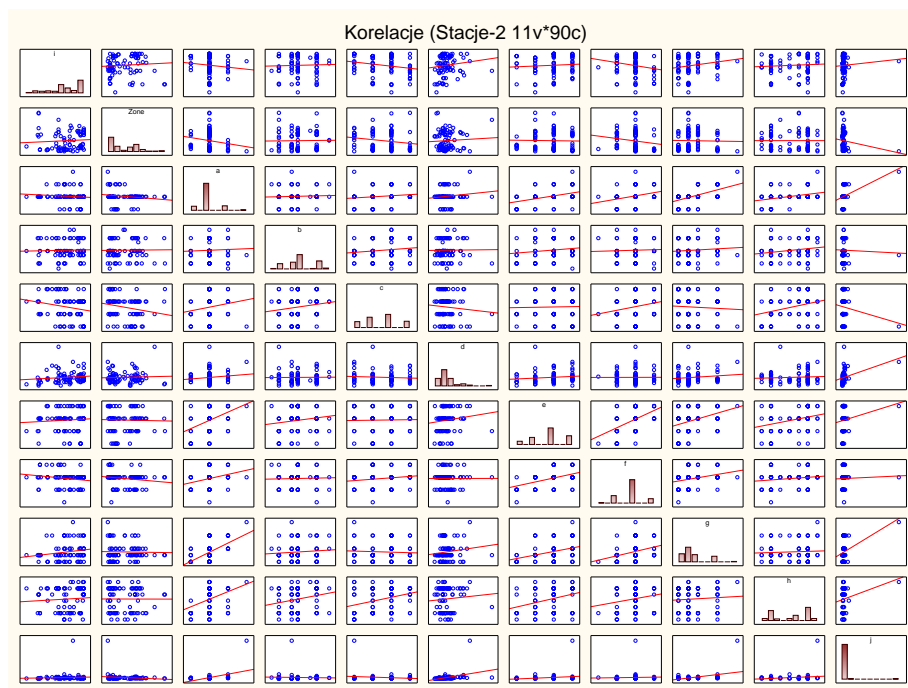


Fig. 3. Correlation matrix graph (base of 90 properties) (Source: own studies)

Table 3. The results of calculations - Pearson complete correlation coefficients (base of 90 properties)
(Source: own studies)

Attribute	a	b	c	d	e	f	g	h	i	j
Zone of the city (a)	1,00	0,05	0,16	0,14	0,39	0,29	0,54	0,33	-0,02	0,52
Planning conditions (b)	0,05	1,00	0,16	0,01	0,15	0,04	0,09	0,14	-0,01	0,02
Availability of public transport (c)	0,16	0,16	1,00	-0,08	0,02	0,18	-0,06	0,27	-0,03	-0,12
Plot surface area [m ²] (d)	0,14	0,01	-0,08	1,00	0,13	0,00	0,14	0,06	0,14	0,23
The density of construction and env. influences (e)	0,39	0,15	0,02	0,13	1,00	0,47	0,35	0,32	0,1	0,18
The shape of the plot and topography (f)	0,29	0,04	0,18	0,00	0,47	1,00	0,30	0,23	-0,16	0,06
The attractiveness of the location (g)	0,54	0,09	-0,06	0,14	0,35	0,30	1,00	0,15	0,09	0,48
The armament of land (h)	0,33	0,14	0,27	0,06	0,32	0,23	0,15	1,00	0,17	0,21
Valuation date (i)	-0,02	-0,01	-0,03	0,14	0,1	-0,16	0,09	0,17	1,00	0,02
Value (j)	0,52	0,02	-0,12	0,23	0,18	0,06	0,48	0,21	0,02	1,00

Table 4. The results of calculations – Beta weights, partial correlations and coefficients of determination (base of 90 properties)
(Source: own studies)

Attribute	Beta weight	Partial correlation	R ²
Zone of the city (a)	0,38	0,35	0,41
Planning conditions (b)	0,00	0,00	0,07
Availability of public transport (c)	-0,17	-0,19	0,17
Plot surface area [m ²] (d)	0,14	0,17	0,06
The density of construction and env. influences (e)	-0,06	-0,07	0,37
The shape of the plot and topography (f)	-0,11	-0,12	0,33
The attractiveness of the location (g)	0,28	0,28	0,37
The armament of land (h)	0,14	0,15	0,24
Valuation date (i)	-0,06	-0,07	0,14

Based on the results of calculations listed above, it can be stated, that the proposed potential price-setting attributes do not explain the estimated market value of real estate for the transformer stations in the city of Krakow.

The calculation procedure was repeated after eliminating outliers. As a criterion for the elimination of outliers was adopted twice the standard deviation determined on the basis of multiple regression.

Finally, it was obtained the base of 77 properties. Within the base was repeated calculation procedure carried out earlier. The results obtained are given below in Tables 5 and 6 and Figure 4:

Table 5. The results of calculations - Pearson complete correlation coefficients (base of 77 properties)
(Source: own studies)

Attribute	a	b	c	d	e	f	g	h	i	j
Zone of the city (a)	1,00	0,24	0,29	0,08	0,40	0,25	0,33	0,33	-0,07	0,29
Planning conditions (b)	0,24	1,00	0,17	0,23	0,18	0,12	0,22	0,19	0,02	0,32
Availability of public transport (c)	0,29	0,17	1,00	0,01	0,06	0,21	0,00	0,31	-0,05	0,03
Plot surface area [m ²] (d)	0,08	0,23	0,01	1,00	0,20	-0,03	0,12	0,06	0,28	0,15
The density of construction and env. influences (e)	0,40	0,18	0,06	0,20	1,00	0,45	0,35	0,26	0,08	0,38
The shape of the plot and topography (f)	0,25	0,12	0,21	-0,03	0,45	1,00	0,27	0,18	-0,19	0,13
The attractiveness of the location (g)	0,33	0,22	0,00	0,12	0,35	0,27	1,00	0,11	0,11	0,49
The armament of land (h)	0,33	0,19	0,31	0,06	0,26	0,18	0,11	1,00	0,20	0,23
Valuation date (i)	-0,07	0,02	-0,05	0,28	0,08	-0,19	0,11	0,20	1,00	0,35
Value (j)	0,29	0,32	0,03	0,15	0,38	0,13	0,49	0,23	0,35	1,00

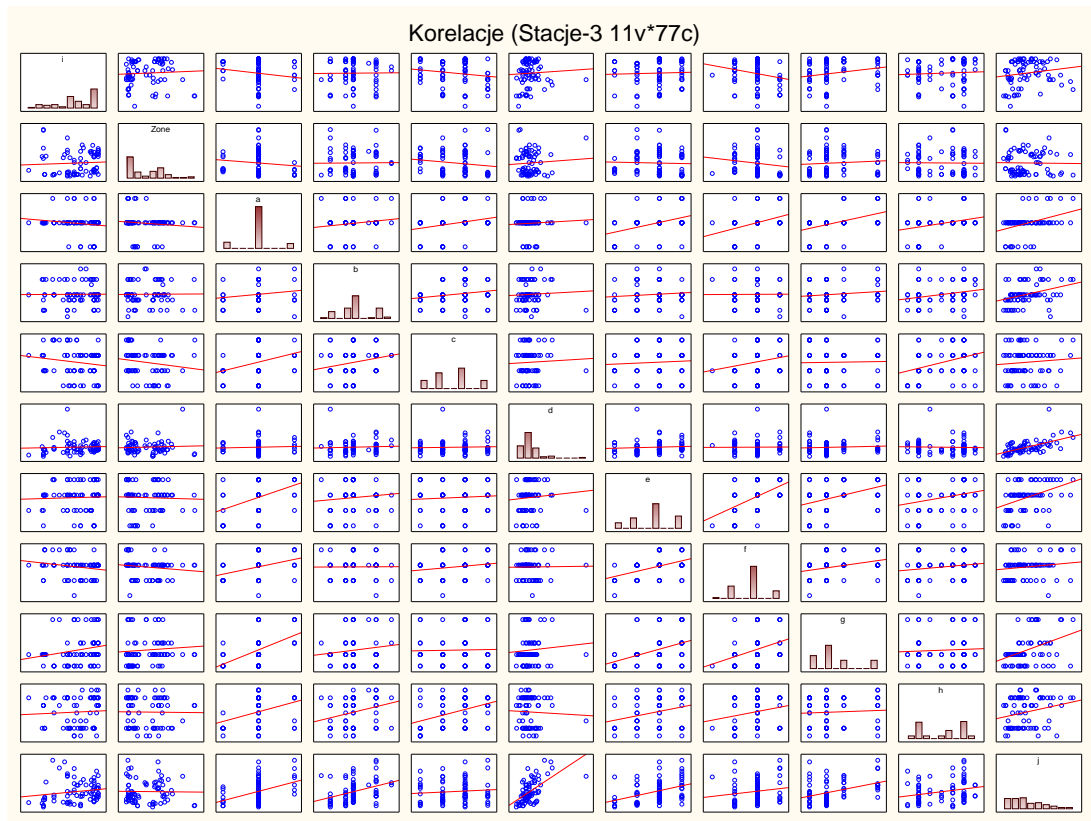


Fig. 4. Correlation matrix graph – after eliminating outliers
(Source: own studies)

Table 6. The results of calculations – Beta weights, partial correlations and coefficients of determination (base of 77 properties)
(Source: own studies)

Attribute	Beta weight	Partial correlation	R ²
Zone of the city (a)	0,09	0,09	0,33
Planning conditions (b)	0,20	0,23	0,14
Availability of public transport (c)	-0,03	-0,04	0,20
Plot surface area [m ²] (d)	-0,06	-0,08	0,15
The density of construction and env. influences (e)	0,19	0,20	0,37
The shape of the plot and topography (f)	-0,04	-0,04	0,31
The attractiveness of the location (g)	0,33	0,35	0,23
The armament of land (h)	0,04	0,05	0,24
Valuation date (i)	0,30	0,33	0,21

Summary

Based on the analysis of Pearson complete correlation coefficients, Spearman correlation ranks, beta weights and partial correlations calculated for the analyzed database of real estate, it can be stated that the estimated market value of land designated for the transformer stations do not follow the standard attributes of the property. It is not possible to estimate their value based on a common database developed for the city of Krakow. There was no significant relationship between the attributes of the property and its value. After eliminating outliers, coefficient of determination was only 0.64. It is necessary to search for a different methodology to determine the actual nature affecting the value of these unusual properties. It was pre-noted that the important role is played by planning conditions. When analyzing only the real estate designated for construction services and industry, the coefficient of determination reached $R^2 = 0.79$, and considering only the real estate used for low housing coefficient was about $R^2 = 0.92$. The same value of R^2 were obtained taking into account only the transformer stations located in areas of parks, green areas and recreational facilities. But for the real estate intended exclusively for housing high coefficient of determination was only 0.66. These considerations are a reliable basis for further research in the field.

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