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How Does a Change in the Development Intensity Index Affect Land Value?

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Abstract:

Purpose: *This study aims to determine the market value of land when the development intensity changes due to planning regulations. This issue is particularly relevant in situations where direct comparative analysis is limited due to an incomplete or restricted real estate market.*
Design/Methodology/Approach: *The study employs a literature review, case study, and valuation methods, including: (1) analysis of planning conditions before and after regulation changes; (2) collection of comparable land transaction prices; (3) market analysis of land use and development intensity; (4) comparative approach for the after changes scenario; (5) Tiemann's formula for the before changes scenario; (6) validation with market data.*
Findings: *A change in planning regulations that reduces the permissible development intensity also reduces land value. In the analysed case, the property's value dropped by almost 40%. The study confirms that higher development intensity corresponds to higher land values and demonstrates that the adopted methodology yields results consistent with observable market prices.*
Practical Implications: *The proposed valuation method is applicable in markets with limited transaction data, enabling more accurate estimation of land value under changing planning conditions. It supports property valuers, municipal authorities, developers, and policymakers in assessing the financial implications of zoning changes and making informed investment or compensation decisions.*
Originality/Value: *The paper presents a method for valuing land in restricted markets by combining comparative approaches with Tiemann's intensity adjustment. This method addresses its underuse and provides a replicable solution for similar contexts.*

Keywords: *Land value, development intensity, building height, planning guidelines, restricted market.*

JEL codes: *M12, J40, L26, O31, O35.*

Paper type: *Research paper.*

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1. Introduction

The development of areas, and consequently the transformation of space along with the resulting economic needs, generates a range of formal and legal activities that depend on land value. This is a well-known issue in market economies.

English researchers emphasise (Dale and Mc Laughlin, 1999) that land management and administration involve, among other things, regulating property development, land use and protection, generating revenues from sales, leases and taxes, and resolving conflicts concerning property rights and usage rules.

Land value is an inherent part of land management and directly influences many investment decisions. All of these activities rely on the need to determine the market value of land, which is not a new issue (Krajewska, 2017; Rącka and Szarafińska, 2018). However, in conditions of a limited market, combined with changing planning regulations, difficulties arise in the valuation procedure.

Authorities of countries that are members of the United Nations Economic Commission for Europe (UNECE) regulate possible methods of land use and development through provisions in spatial development plans. Translating these regulations to the property valuation context, it should be emphasised that determining the purpose of a property and the possibilities for its development is the first step in land valuation and the most fundamental criterion in selecting comparable properties (Ratterman, 2020, p. 231), as well as the basis for comparative analysis (TEGOVA, 2025; IVSC, 2005).

When valuing a property, in addition to establishing its purpose, it is also necessary to determine the development potential of the land, for example by specifying the development intensity index. This issue is particularly significant when valuing land intended for multi-family residential development, as for developers it is the primary factor influencing investment decisions regarding land acquisition and price negotiation.

Since the role of a property valuer in the valuation process is to reflect the behaviour of market participants, considering the development intensity index for this market segment is crucial.

The issue of selecting comparable properties for valuation naturally does not arise in a well-developed market with a sufficient number of transactions. The problem occurs in areas with limited market activity.

The aim of this article is to indicate a methodology for determining land value under planning regulations that incorporate different development intensity indices, in a market with an insufficient number of transactions. The authors' discussion is

supported by an example of a land valuation conducted under conditions of a limited market.

2. Literature Review

The issue of the impact of planning conditions on land value is nothing new. The problem of determining land value for the purposes of spatial management has been addressed in various scientific disciplines by numerous researchers.

Źróbek and Bełej (2000) discussed the role of the comparative approach in valuation. Hełdak (2010) and Herman (2013) examined spatial development patterns in urban areas, demonstrating how planning instruments shape land value. Cellmer (2014) and Cymerman and Cieślak (2007) focused on spatial modelling and changes in land value during investment processes, whereas Foryś and Putek-Szeląg (2015) provided empirical evidence that planning decisions directly affect local land prices.

Rącka and Szarafińska (2018) showed that location within zones with different development opportunities, including differences in the permissible development intensity, affects the value of land designated for multi-family housing. The influence of planning conditions on land prices appears obvious. It is a feature recognised by participants in the property market, yet the exact extent of this influence has not been fully identified.

In many market analyses, the aspect of permissible development intensity indices is not sufficiently taken into account. This may be due to the fact that the market areas selected by researchers are not differentiated in this respect, with all analysed plots having a similar index (Krajewska, Szopińska and Dittmann, 2014). As a result, the markets studied are homogeneous, and the issue of planning conditions does not arise.

This is also the case in many European countries where spatial development is based on clearly defined development conditions. For example, in Slovenia (Krajewska, Źróbek, Šubic-Kovač, 2014, pp. 52–66), the selection of comparable properties does not present difficulties, and land valuation is carried out on the basis of market data. In another case, reference may be made to the German valuation school (Tiemann, 1976), as emphasised in the reflections of Kłopociński (1995).

German research and valuation practice consistently indicate that development intensity is one of the key determinants of the unit value of land in urban areas. This is systemically addressed by the amended ImmoWertV Act (2021), which standardises data, including development intensity ratios, as well as their application in property valuation (Kleiber, 2023).

From comprehensive market knowledge and analysis, it follows that there is no doubt that development intensity affects price and, consequently, land value.

Development intensity (I) is measured as the ratio of the total building area (TA) to the land area (LA), with the total footprint area (TfA) defined as:

$$TA = TfA \cdot f \tag{1}$$

where: TfA – building area; f – number of storeys.

Thus:

$$I = \frac{TA}{LA} = \frac{TfA \cdot f}{LA} = \frac{TA}{LA} = \frac{TfA \cdot f}{LA} \tag{2}$$

If development intensity influences land value, the number of storeys also plays a role.

However, this relationship is not proportional, since for example:

- part of the costs are incurred independently of the number of storeys,
- construction costs of upper floors are higher,
- foundation costs do not increase proportionally.

Research in this field, and the literature on the subject, including Tiemann (1976), describe this relationship with the following formula:

$$wi = 0{,}6 \cdot \sqrt{I} + 0{,}2 \cdot I + 0{,}2 \tag{3}$$

where: wi – coefficient determining the impact of building density on land price, assuming that wi = 1 for I = 1.

Knowing the land value A (MV_A) at a given intensity I_a, it is therefore possible to calculate the land value B (MA_B) at a different intensity I_B, and vice versa, using the following relationship:

$$\frac{MV_b}{MV_a} = \frac{0{,}6 \cdot \sqrt{I_b} + 0{,}2 \cdot I_b + 0{,}2}{0{,}6 \cdot \sqrt{I_a} + 0{,}2 \cdot I_a + 0{,}2} \tag{4}$$

thus

$$MV_b = MV_a \cdot \frac{0{,}6 \cdot \sqrt{I_b} + 0{,}2 \cdot I_b + 0{,}2}{0{,}6 \cdot \sqrt{I_a} + 0{,}2 \cdot I_a + 0{,}2} \tag{5}$$

$$MV_a = MV_b \cdot \frac{0{,}6 \cdot \sqrt{I_a} + 0{,}2 \cdot I_a + 0{,}2}{0{,}6 \cdot \sqrt{I_b} + 0{,}2 \cdot I_b + 0{,}2} \tag{6}$$

The problem of valuing land with different permissible development intensity ratios frequently arises in Poland, particularly in suburban areas experiencing dynamic suburbanisation processes, where local spatial development plans are enacted or amended.

3. Materials and Methods

For the purposes of the valuation of the analysed land, planning conditions were examined both prior to (situation 1) and following (situation 2) the introduction of planning amendments.

Subsequently, data on transaction prices of investment land were collected from notarial deeds, and a property market analysis was carried out with particular consideration of land use function and the permissible development intensity ratio. Site inspections of both the appraised land and the comparable properties were also conducted.

Using the comparative approach, the valuation of the land was then performed under the new, lower development intensity ratio (MV_2) – direct data could be obtained for this market. For this purpose, transaction prices of land obtained from notarial deeds were applied, i.e. historical market evidence collected through individual data acquisition. In order to obtain a homogeneous market, the collected data were verified, selected, and grouped using Walor, a valuation software package developed by ProNet.

A set of comparable properties was established for the valuation of land after the change of land use designation, and it was determined that this market segment was transparent and active. In turn, in the absence of sufficient transactions for the analysis and valuation of land at the original, higher development intensity ratio, the land value (MV_1) was determined using formulae (1–6) (Tiemann, 1976) described above.

This was considered justified, as in the analysed area only one transaction was recorded in which the object of sale was land with a similar (higher) development intensity ratio.

3.1 Research Objectives

The determination of land value was carried out for a selected property subject to planning provisions which were adversely altered through the adoption of the Local Spatial Development Plan (2020) – a new, lower development intensity ratio was introduced.

According to Polish legislation (Act of 2003, Article 36(1)), if, as a result of the adoption or amendment of a local plan, the use of a property or part thereof in its

existing manner or in accordance with its previous designation becomes impossible or significantly restricted, the owner may demand compensation from the municipality for the actual damage suffered.

Consequently, it is necessary to establish whether the value of the property has decreased, and if so – by what amount.

This requires conducting property value analyses under two different planning guidelines for the land:

1. before the adoption of the local spatial development plan, with the possibility of constructing multi-family residential buildings up to five above-ground storeys (Photo 1);

2. after the adoption of the local spatial development plan, with the possibility of constructing multi-family residential buildings up to two above-ground storeys (Photo 2).

Photo 1. *Visualisation of possible residential development up to five above-ground storeys*

Source: *Materials received from the investor.*

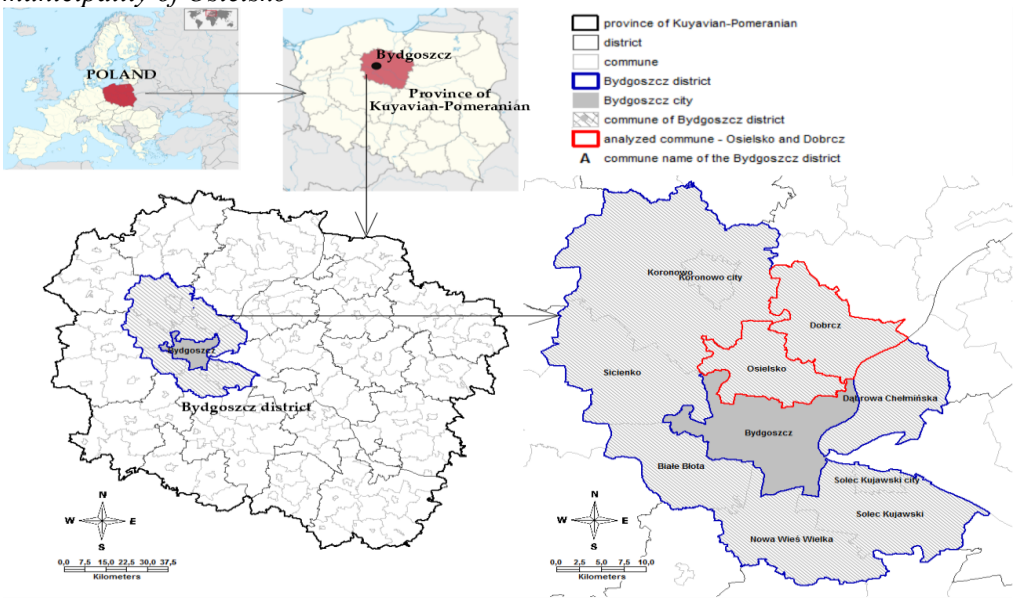
The research object is an investment land plot with an area of 3,149 m², located in the suburban zone of an agglomeration in Central Europe: Poland, Kuyavian-Pomeranian Voivodeship, Bydgoszcz County, Osielsko Municipality – the suburban zone of the city of Bydgoszcz (Figure 1).

In this area, there are well-developed zones of single-family and multi-family housing up to two storeys. Multi-family residential buildings up to five storeys occur only sporadically – in this market segment the number of comparable properties is limited.

***Photo 2**. Visualisation of possible residential development up to two above-ground storeys*

***Source:** Materials received from the investor.*

***Figure 1.** Location of the suburban zone of the city of Bydgoszcz and the analysed municipality of Osielsko*



***Source:** Own study.*

3.2 Planning Conditions for the Land

In the context of the valuation objective and the applicable legal provisions, it is necessary to examine how the property could have been developed prior to the adoption of the local spatial development plan, including a comparison between the use of the property in accordance with the previously issued development conditions and the use resulting from the newly adopted local plan.

Therefore, the planning guidelines arising from two planning documents were examined:

1. Decision of the Mayor of Osielsko Municipality establishing the development conditions for the construction of two multi-family residential buildings on the subject plot, defining the land use prior to the adoption of the local plan;

2. Local Spatial Development Plan for the area between Koperkowa and Chabrowa Streets in Osielsko, Osielsko Municipality, adopted by Resolution No. VII/58/2020 of the Osielsko Municipal Council of 15 September 2020 (published in the Official Journal of the Kuyavian-Pomeranian Voivodeship, 2020, item 4448), defining the new land use (post-change situation).

The provisions of these documents for the analysed area are presented in Table 1.

Table 1. *Planning status of the analysed land*

No.	**Intended use before changes** based on the decision on development conditions	**Intended use after changes** based on the Local Spatial Development Plan of 15 September 2020	Effects of the change
1.	**MW** – two multi-family residential buildings **up to five storeys,** with basements,	**2 MW** – multi-family residential development **up to two storeys,**	The function of the area has not been changed, but the characteristics and parameters of the development have been significantly altered, and the height of the building has been reduced by three storeys
2.	**Building footprint area** up to 630 m2, i.e. a total of max. 1260 m² (buildings designed with a total footprint area of 1257.40 m²)	**Building area** up to 70% of the plot, i.e. max. 2205.7 m2; however, in order to comply with other recommendations, a building with a total footprint = 1237.9 m2 was designed.	Insignificant change in the development area
3.	**Number of residential units: 56**	**Number of residential units: 14**	Change in the functional programme of the building – the number of residential units decreased by 42
4.	**Biologically active area – min. 20%**	**Biologically active area – min. 30%**	A larger biologically active area must be maintained

5.	**Number of parking spaces** **- 1 parking space per unit**	**Number of parking spaces** **- 1.5 parking spaces per unit**	More parking spaces must be designed
6.	**Building setback –** 6m from the plot boundary	**Building setback –** 8m from the plot boundary	Buildings must be set further away from Topolowa Street.
7.	**Provisions regarding servicing in terms of technical infrastructure and transport:** -ee (electricity): on the terms and conditions of the network operator, -w (water): until the municipal water supply system is built, water may be taken from a private intake, - k (sewage): until the municipal sewerage system is built, wastewater may be discharged to a domestic treatment plant or a sealed tank, - c.o. (central heating) and g (gas): not specified; - access to the municipal road (currently called Topolowa Street)	**Provisions regarding servicing in terms of technical infrastructure and transport:** -ee (electricity): on the terms and conditions of the network operator, -w (water): to the municipal water supply system, - k (sewage): to the municipal sewerage system, - c.o. (central heating): not specified; - g (gas) not specified - access to the municipal road KD-Z (currently called Topolowa Street)	No significant modifications in terms of technical infrastructure and transport servicing.

Source: *Authors' research.*

It was established that, on the analysed plot, prior to the adoption of the local spatial development plan, it was possible to construct two multi-family residential buildings with five storeys, with a usable area UA = 4985.6 m2 and TfA = 1257.40 m2, containing 56 residential units (as determined on the basis of the architectural design and the decision on development conditions).

After the adoption of the local spatial development plan, it is possible to construct multi-family residential buildings with two storeys, with a usable area UA = 1993.57 m2 and TfA = 1237.9 m2, containing 14 residential units (as determined on the basis of the construction design and the local plan).

It was concluded that the use of the property in accordance with its previous designation has become significantly restricted through the reduction in the number of building storeys, and consequently in the usable floor area, development

intensity, and number of residential units, which may result in a change in the value of this property.

4. Results

4.1 Land Value under the New Development Intensity Index

An analysis of the local real estate market in the municipality of Osielsko showed that, for the condition of the property after the adoption of the local spatial development plan, the market for land designated for concentrated residential development up to two storeys – terraced and semi-detached housing – is active, and prices in this segment range from approximately PLN 194/m2 to PLN 400/m2.

Lower prices, below PLN 190/m2, were also recorded, mainly for land located in other villages of the municipality of Osielsko. Higher prices were noted for land designated for detached single-family residential development, with an area of about 0.1 ha, at the level of PLN 400–530/m2. It should be emphasised that the municipality of Osielsko sold land at auction for detached single-family housing at prices ranging from PLN 270–303/m2.

The presented set of sixteen transactions of comparable properties in Table 2 reflects the confirmed condition of the real estate market (data obtained from notarial deeds).

Table 2. *Set of comparable properties – land with the possibility of developing residential buildings in concentrated housing, up to two storeys.*

Transaction date	County	Municipality	Cadastral district	Area (m²)	Price (PLN)	Price per m² (PLN)
Mar 25	Bydgoski	Osielsko	Niemcz	1833	355000	193.67
Mar 25	Bydgoski	Osielsko	Niemcz	2618	600000	229.18
Apr 24	Bydgoski	Osielsko	Niemcz	1120	300000	267.86
Dec 23	Bydgoski	Osielsko	Niemcz	1374	375393.5	272.96
Nov 23	Bydgoski	Osielsko	Osielsko	1534	335000	218.37
Dec 23	Bydgoski	Osielsko	Osielsko	1681	497000	295.66
Sep 23	Bydgoski	Osielsko	Osielsko	1069	321318.9	300.62
Oct 23	Bydgoski	Osielsko	Osielsko	1335	400000	299.63
Apr 24	Bydgoski	Osielsko	Osielsko	1234	400000	324.15
Dec 23	Bydgoski	Osielsko	Osielsko	1510	528500	350
Mar 24	Bydgoski	Osielsko	Osielsko	2564	900000	351
Dec 23	Bydgoski	Osielsko	Niemcz	1494	538160	360.27
Oct 23	Bydgoski	Osielsko	Niemcz	1998	718560	359.65
Dec 23	Bydgoski	Osielsko	Osielsko	1600	600000	375
Nov23	Bydgoski	Osielsko	Osielsko	957	336000	351.51
Mar 24	Bydgoski	Osielsko	Niemcz	1326	530000	399.7
Nov 23	Bydgoski	Osielsko	Osielsko	2031	812000	399.9

Source: *Authors' research based on notary deeds.*

In summary, based on the analysis of the market for undeveloped land in the Osielsko municipality, acquired for concentrated residential development up to two storeys, the following price range, in which the number of transactions is the highest, has been adopted:

Minimum unit price (Pmin)	→	193.67 PLN/m^2
Maximum unit price (Pmax)	→	399.80 PLN/m^2
Range of unit prices (DP)	→	206.13 PLN/m^2
Average unit price (Pavg.)	→	320.81 PLN/m^2

Range of the sum of correction coefficients:

Pmin/ Pavg. = 0.60;
Pmax/ Pavg. = 1.25.

Based on the above market data, applying the comparative approach and the average price correction method, the market value of the property – investment land, as the subject of ownership rights, was determined in relation to 1 m² of land designated for residential use up to two storeys at the level of 376.95 PLN/m^2.

The market value of the investment land with an area of 3149 m² after the adoption of the local zoning plan:

MV_2 = 3149 m^2 × 376.95 PLN/m^2 ×1.0 = PLN 1187015.50
K= 1.0 – correction coefficient within the range (0.9; 1.1).

Adopted: **MV_2 = 1,187,000 PLN**

4.2 Land Value under the Old Development Intensity Index

The analysis of the local real estate market in the Osielsko municipality showed that, for the condition of the property prior to the adoption of the zoning plan – that is, land with the possibility of developing a building up to five storeys – this market is very limited, with only one transaction recorded at approximately 625 PLN/m².

In view of the above, it was decided that in the process of estimating the market value of land with the possibility of development up to five storeys, Tiemann's dependency, which takes into account the impact of development intensity on land value, would be applied – formula (6), which in this case takes the form:

$$MV_1 = MV_2 \cdot \frac{0{,}6 \cdot \sqrt{I_1} + 0{,}2 \cdot I_1 + 0{,}2}{0{,}6 \cdot \sqrt{I_2} + 0{,}2 \cdot I_2 + 0{,}2} \tag{7}$$

Data for the calculation of value:

1/ after the adoption of the zoning plan:

→ MV_2 = PLN 1187000
→ TfA = 1237.9 m², two storeys f=2, plot area LA = 3149 m²
→ $I_2 = 2 \cdot 1237{,}9 : 3149 = 0{,}8$

2/ before the adoption of the zoning plan:

→ TfA = 1,257.4 m², five storeys, f = 5, plot area LA = 3,149 m²
→ $I_1 = 5 \cdot 1237{,}9 : 3149 = 2$

By substituting into formula (7), we obtain:

$$MV_1 = MV_2 \cdot \frac{0.6 \cdot \sqrt{I_1} + 0.2 \cdot I_1 + 0.2}{0.6 \cdot \sqrt{I_2} + 0.2 \cdot I_2 + 0.2} = 1{,}187{,}000 \cdot \frac{0{,}6 \cdot \sqrt{2} + 0.2 \cdot 2 + 0.2}{0{,}6 \cdot \sqrt{0.8} + 0.2 \cdot 0.8 + 0.2} = 1{,}917{,}572 \quad \text{(PLN)}$$

Adopted: **MV_1 = PLN 1,918,000**

5. Discussion

Theoretical and empirical studies on the impact of development intensity restrictions on land prices are a good point of reference for the thesis that lower intensity reduces land value (Moon and Ahn 2022). Estimates of the impact of regulatory restrictiveness in the housing sector on land prices in the U.S. market show the effects of a regulatory mechanism that influences land value (Gyourko and Krimmel, 2021).

It is worth noting the economic effects of spatial planning regulations on real estate prices, which may be useful for outlining methodological disputes and assessing changes in the budgets of local government units (Śleszyński *et al.,* 2021).

As a result of the analyses of land value at different development intensity indices, it was found that, following the adoption of the zoning plan permitting development up to two storeys, the value of the land decreased in relation to the earlier planning guidelines (development up to five storeys) by the amount of:

ΔMV = MV2 – MV1 = PLN 1,187,000 – PLN 1,918,000 = PLN –731,000

The market value of the land, as the subject of ownership rights, for the function of multi-family residential use up to two storeys was determined using the comparative approach, the average price correction method. The valuation process took into account the legal and functional status of the property under appraisal, as well as data on achieved transaction prices of comparable properties obtained in the years 2023–2025 in the Osielsko municipality.

The market value of the land, as the subject of ownership rights, for the function of multi-family residential use up to five storeys was determined on the basis of the relationship and coefficient reflecting the impact of development intensity on land value.

The obtained land values fall within the range of transaction prices achieved for comparable properties – the analysis showed that they are as follows:

→ for multi-family residential use up to two storeys: 194 PLN/m² to 400 PLN/m², with the estimated value of 376.95 PLN/m²;
→ for multi-family residential use up to five storeys: 625 PLN/m² (in the study area only one transaction was recorded for land with the possibility of development higher than two storeys), with the estimated value of 609.08 PLN/m².

This confirms that the assumptions adopted for the valuation are correct, and the determined values are probable

The result of the study, showing an approximately 40% decrease in the value of the analysed land after the reduction of allowable intensity (from 5 to 2 storeys), is consistent with the literature indicating that development intensity restrictions reduce the residual value of land.

Both theoretical and empirical approaches point to a positive relationship between allowable intensity and land price; in partial equilibrium models the effect operates through an increase in land rent at higher development intensity.

The application of Tiemann's formula to determine value under conditions of a limited market is methodologically justified when there are insufficient transactions for higher intensities, provided that the results are verified against market observations. Such a procedure reflects the developer's way of thinking (residual land value), in which every reduction in usable floor area, at constant fixed/marginal costs, directly reduces the bid price for land (TEGOVA 2025, IVSC 2025).

From the perspective of Polish realities, it is important that a zoning change which may "significantly restrict" previously permissible development possibilities, in addition to affecting value, triggers the compensation regime under Article 36 of the Planning and Spatial Development Act.

The results of the study therefore provide an empirical basis for estimating the financial implications of such changes. At the same time, domestic literature indicates that the effects of plans (both positive and negative) are economically measurable and should be considered systemically.

The limitations of the study result mainly from:

- the small number of observations for the "high" intensity market (sample selection risk),

- potential endogeneity – locations where greater intensity is allowed usually also have other advantages (infrastructure, transport accessibility),

- the assumptions adopted regarding the sensitivity parameter of value to intensity in Tiemann's model. In practical terms, the obtained results reinforce the recommendation that valuation reports should consistently treat the intensity index as a key market characteristic when selecting comparable properties, or – in case of insufficient data – use a hybrid approach (comparative + Tiemann method) with verification against transaction data.

6. Conclusions

The development intensity index is a very important characteristic considered by developers when making decisions about the purchase of land for multi-family residential development. It is certainly reflected in land price – the higher the development intensity index, the higher the price.

Since this factor is so important for the buyer, it must also be taken into account in the valuation process. Unfortunately, the authors' experience allows the conclusion that in Poland this feature is not sufficiently considered in many valuation reports.

This may perhaps result from the lack of reliable data on the characteristics of properties traded on the market. The methodology applied for determining land value with consideration of different development intensity indices may be used wherever the land market is incomplete and non-transparent, that is, under the conditions of a limited market.

However, the estimated values require verification against transaction prices, which means that the valuation process cannot be "detached" from the market. There is therefore a continuous need to study the interdependencies between planning conditions and land prices in order to make informed investment decisions and, when determining market value, to correctly select comparable properties and justify their selection.

The results of this study are both cognitive and applicative in nature – they may serve as guidance for practical solutions, supporting property valuers, decision-makers, and other real estate market participants in making sound decisions regarding spatial form and the consequences of planning decisions.

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