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Index of Development and its Impact on Private Sector

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Abstract. Development of nowadays cities takes place in both the peripheral and central zones. In the peripheral zones, cities grow to the width and in the central zones, cities grow to the height. Cities and their development is complex for both main city zones: peripheral and central, development of any part of the city has consequences for different parts of the city. There are tools for sustainable development of the cities as the city plan and another city planning documentation, however, development can be slowed down by many features which have influence on the structure development. A primary problem can be a poor city plan which does not meet current requirements of the city. A collision of the city plan and other limits set by the authorities can also appear. One of the most serious problems is collision of the city plan and flood zones. The aim of this paper is the adjustment of the equation for the Index of Development for the use of private sector as a development of the research. This paper is based on city of Brno case study. The main objective of this paper is development of residential zones and analysis of the land intended for residential buildings as well as its limits.

1. Introduction

Society manages primary development aimed at people (inhabitants). The most of developed indexes for evaluation are aimed at poverty and human development as mentioned by Amate-Fortes et al. in their article called Economic and Social Determinants of Human Development: A New Perspective. Their aim was the assessment of the impact of fight against poverty, provision of basic infrastructure, and investment in greater democracy. [1] They used Human Development Index developed by the United Nations, first published at the Second United Nations Conference on Human Settlements (Habitat II), [2] inflation and its rate and openness which means openness to trade and investment which gives the percentage of gross investment against the GDP of every observed country. This study tried to determine the factors which affect development. However, not only economic development, but also development connected with inhabitants and social effects on the affected people [1].

An index closely connected to the growth of the city is a Household-Based Human Development Index mentioned by Harttgen and Klasen in their paper called A Household-Based Human Development Index. This index was partially derived from Human Development Index of the United Nations [2] but they draw attention to the inequality in the Human Development Index. Their paper provides a method which estimates a Human Development Index in case of the household level. Their analysis identifies countries where inequality in the Human Development Index is a massive problem [3].

However such studies, approaches and development outputs do not respond to the issue of urban planning mentioned above.



A green view on the city is actual in case of the city development. For example, there is a Green Township Index, which has 86 indicators across three main dimensions: people, planet and prosperity. All of these are based on the assessment of townships with three award levels: platinum, gold and silver. This index is usable for evaluation of sustainability of built townships as is described and used in the paper called Green Township Index: Malaysia's sustainable township rating tool [4].

However this index is aimed at individual buildings and not at the city as a complex. Much attention has not been paid to the indexes and methodologies aimed at urban planning and development of cities.

It is necessary to learn how to evaluate development of cities for the purpose of the future urban planning and for the planning of investments. These two issues are important for both private and public sectors and are not the strait objective of the method mentioned above. Current research is aimed especially at the development of cities and the limits of the city plan.

Objective of the research described in this paper is the adjustment of the Index of Development. The original Index of Development misses one important part of evaluation of public sector which is the importance of the built-up state of the plots (input data for the equations).

Adjustment of the index of development usable more for the public sector is presented in this paper as the public sector has primarily been searching for free sites for construction projects. The original methodology of this research is presented in Chapter 3.

2. Literature Review

A few methodologies which are close to the topic of evaluation of the city development exist, but they are mostly aimed at a bit different objective. For example, the paper by Gyenizse et al. was focused on the urban development in case of the landscape shape index; however it is too much concerned with the historical evolution of the cities [5].

There are also many approaches aimed at sustainable development of the cities, for example Park et al. wrote a paper dealing with the approach to the urban growth and sustainability. It was based on comparison of the land suitability index, geographic information system, frequency ration, analytical hierarchy process, logistic regression and artificial neural network. The outcome of the approach was the prediction of the urban land-use changes [6].

Many limits to the city development were also mentioned. Since Brno has the worst flood limit, which makes it difficult to build and design buildings with primary function on the building site. It is caused by contradiction of the Brno city plan and the individual limits of flood zones. [7] However there are more limitations to the city plans as:

- Protected areas of usable resources,
- Protected areas of nature, landscapes and greenery,
- Protection of monuments and cultural values,
- Protection zones of the main routes of utility networks,
- Protection of special interests,
- Underground structures,
- Others.

All these limits have their impact on the development of the city. In some cases, cities can manage or mitigate some limits and they can make the designed zones usable in the range of the city plan. Cities have always been built in varied environments, however not all cities can manage it. There are flood management approaches to the risk of floods. These approaches include measures taken for the mitigation of the flood risk and they include procedures how to manage it. These approaches were described in the paper called Flood management: lesson from a US city, which used the experience from the cities of the United Kingdom and the United States [8].

3. Methodology

Original methodology of the research is based on the areas of the limits to design zones (design zones = zones planned for future construction in the city plan). The limits were sorted by the level of the impact into three classes, which are mentioned in Table 1. [9].

Table 1. Limit levels [9].

Limits	Flood zone	Contamination zone	Bio-corridors	Regulation	Underground structures	Combination	Without limit
Level of limit	3	3	3	2	2	3	1

Limit levels were derived from the best practice of the project management in the case study of the city of Brno [9].

The limited areas represent basic incomes for the Index of Development, which were developed for the evaluation of the city development level. For this reason, an approach with the highest equation has been developed in Equation 1: [9]

$$IoD = IoD_{ce} \times IoD_{pe} \quad (1)$$

This equation represents the main Index of Development and the partial Indexes of the Development of the central zones of the city (IoD_{ce}) and the peripheral zones of the city (IoD_{pe}). The index is usable in the partial execution for evaluation of the central or peripheral zones of the city. The best value of the index is 1.0 [9].

3.1. Index of Development – central zone

This level of the equation is aimed at the central zone of the city (index IoD_{ce}), which is mostly the part of city around the city centre, unlike the peripheral zones, which are located on the outskirts of the city. The expression for the Index of Development for the central zone is given in Equation 2:

$$IoD_{ce} = IoD_r \times IoD_c \times IoD_i \times IoD_m \quad (2)$$

The Equation 2 is partially composed of the Indexes of Development based on functional zones from the city plan. These partial indexes are focused on residential (index “r”), commercial (index “c”), industrial (index “i”) and multifunction (index “m”). The incomes for every of the partial indexes result from the limited design zones assessed according to the Equations 3–6 [9].

$$IoD_r = \frac{A_{rL1}}{A_r} \times (1 - \frac{A_{rL2}}{A_r}) \times (1 - \frac{A_{rL3}}{A_r}) \quad (3)$$

$$IoD_c = \frac{A_{cL1}}{A_c} \times (1 - \frac{A_{cL2}}{A_c}) \times (1 - \frac{A_{cL3}}{A_c}) \quad (4)$$

$$IoD_i = \frac{A_{iL1}}{A_i} \times (1 - \frac{A_{iL2}}{A_i}) \times (1 - \frac{A_{iL3}}{A_i}) \quad (5)$$

$$IoD_m = \frac{A_{mL1}}{A_m} \times (1 - \frac{A_{mL2}}{A_m}) \times (1 - \frac{A_{mL3}}{A_m}) \quad (6)$$

The incomes for the Equations 3–6 are based on the total design area for the specific design zone, and the total design area divided between every limit level (L_1 , L_2 and L_3).

The best value for every equation is 1.00 [9].

$$IoD_{pe} = IoD_r \times IoD_c \times IoD_i \times IoD_m \quad (7)$$

Index of Development for peripheral zones (IoD_{pe}) assessed according to Equation 7 has been similar to the Index of Development for central zones (IoD_{ce}). However, this paper was aimed only at the residential Index of Development for central zone.

The original methodology is usable both for private and public sectors, however, for private sector it is really important if the design zones are free sites, or already built up ones.

In the case mentioned above, the aim was to adapt the equation to the assessment, based on if the evaluated zones were free sites or not.

The case study used the same city central zone as in the previous research. The residential design zones of Brno were set for the city parts: Staré Brno, Štýřice, Stránice, Veverří, Brno-město, Černá pole, Zábřovice, Trnitá and Pisárky as displayed in Figure 1.

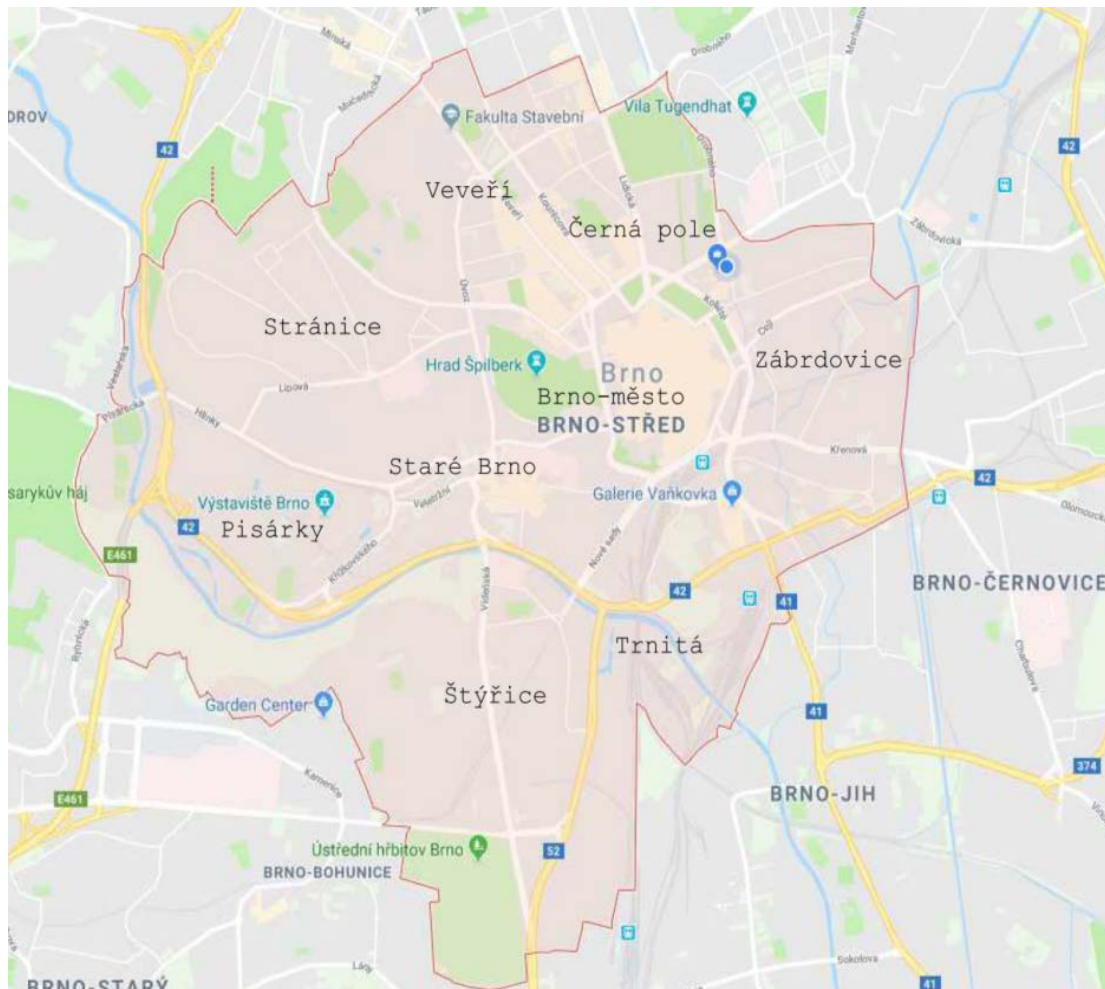


Figure 1. Centre of the Brno city [9].

The principle of this upgrade of the Index of Development is in the additional empirical count of the areas already built. Three levels of evaluation, which describe the level of the built-up plots by its level of built-up, based on the logical level of this coefficient (1-0) were mentioned in Table 2:

Table 2. Built-up plots.

Numeric stamp	1	0.5	0
Text description	Built-up plot	Partially built-up plot	Free site

The numeric stamp has been used for every design zone and its area which means that the level of the built-up plots has been set as a ratio of proportional areas.

The inputs for the evaluation of the level of the built-up plots were obtained from online maps and visual evaluation showing if the design zone is fully built-up, partially built-up or if it is free site. Publicly available map systems were used for this evaluation. The maps used were from 2016.

Consequently there was an option to combine the Index of Development [9] and the coefficient of the built-up area. The combination is represented by the Equation 8:

$$IoD_{BuA} = IoD_{xx} \times k_{BuA_x} \quad (8)$$

The IoD_{BuA} represents the Index of Development improved by the coefficient of the built-up plots. This improvement is usable for every level of the equation of the Index of Development (residential, commercial, industrial, multifunctional or total). Every level of IoD equation has its own coefficient of built-up areas. For example, the Index of Development of the central zone of the city has the improved Equation 9:

$$IoD_{ce} = (IoD_r \times k_{BuA_r}) \times (IoD_c \times k_{BuA_c}) \times (IoD_i \times k_{BuA_i}) \times (IoD_m \times k_{BuA_m}) \quad (9)$$

4. Results

As a result of this research of the built-up level of design zones of the Brno city plan, the built-up coefficient for the residential design zones of the centre of the Brno city with a value of 0.475 has been developed which means that 47.5% of the residential design zone areas for the centre of the Brno city have already been built up.

Inputs were gathered for the evaluation of the level of the built-up areas from the online maps and visual evaluation showing if the design zone is fully built-up, partially built-up or if it is a free site.

The final Index of Development improved by coefficient of the built-up areas represents the value of the development level. The improved Index of Development value is 0.145.

This result represents the potential of the development of the city for the residential construction. The value is quite low, however the inputs for this index were varied, and the situation in the city of Brno is complicated which has been known from the common practice of the preparations of construction projects in Brno.

5. Conclusion

This paper is aimed at the development of the city, in this case the city of Brno, which is the second biggest city in the Czech Republic. This paper was aimed at the residential design zones of the city of Brno. The research has shown that the options for the construction of the residential buildings are at the wrong level. This research shows that there is not only a low level of the index of development, but there are also only a few free sites out of the design zones.

The value of the improved Index of Development is relatively low (0.145 out of the best value 1.000) which represents a difficult situation with a city plan of the city of Brno. The city had a city plan from 1994 which is really long time and it signifies that the city plan cannot react to the actual need for the growth and development of the city.

The results of this paper represent only the first (second) step of the research, it is necessary to continue in the research and gathering of the data. It is also important to make the indexation for more

cities to get more data for setting the good level of the improved index and the bad level of improved index.

There is also an option not to make one number out of the coefficient of the built-up area and Index of Development, but make the table with a scale for some levels of the Index of Development and the coefficient of the built-up area. This table could represent the good range and the bad range of the combination of these indexations.

The results of the research described in this paper are usable for both public and private sector. Private sector can use it for the decision making process about the investments in the cities. Thus the options for the investments can be analysed before they enter the market of the city estates.

Public sector can use results of this research for preparation of a new city planning strategy. The indexation and the coefficient of the built-up areas can be used for setting of the city plan and for making the city plan more efficient which can help to the general development of the city.

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