

Evaluation of Economic Efficiency of Territory Development

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Abstract. *The article deals with the analysis of background resources for the evaluation of socio-economic impact methodology elaboration of the territory development in the field of commercial, service and residential properties, mixed constructions and multifunctional buildings in the first phase of their life cycle. The research team investigated the possibilities of using the information and procedures for the evaluation of socio-economic impacts of the territory development. Relevant data for the evaluation was identified and analysed on the research sample of 12 major urban districts of the city of Brno. Technical and social parameters that appeared relevant for the economic evaluation of the surveyed location development were identified based on the available data on individual territories. The first identification step was their description. Subsequently, suitable metrics for their evaluation were examined. Findings about what socio-economic impacts these locations create in the field of interest and whether these impacts are efficient in terms of their functioning represent the output of the paper. This includes determining the overall economic efficiency of the implementation phase of their life cycle. This output then forms base for the future research focusing on the possibility of including other variables that shall focus on the operational phase of the life cycle and extend the assessment to a wider timeframe.*

Keywords: *Territory Development, Socio-Economic Evaluation, Multicriteria Analysis.*

1 Introduction

The method of assessing the economic efficiency of the territory development depends on the extent and specifications of the technical determination of the change in the current situation. From the development point of view, it can be a specific large-scale development project, for which the basic project documentation has already been elaborated at the architectural study level; furthermore, one of the stages of the project documentation can be processed for a particular sub-project. At the level of information provided by the specific technical documentation, it is possible to evaluate their economic efficiency with a certain amount of experience and knowledge, e.g. using the CBA method (projects of road and highway sections, railway corridors, waterways, specific buildings for civil or commercial purposes (Guide, 2014)). The authors of this article focus on a more general view of the territory development and its future potential use, already at the land use plan level. At this level, no specific

development projects are defined, however the territory is being prepared for a specific use or combination of uses. The land use plan sets out the urban concept, the concept of landscape arrangement and the concept of public infrastructure, it defines the built-up area, areas and corridors and sets the conditions for the use of these areas.

The research is aimed at finding suitable criteria that can be used to assess the socio-economic efficiency of the territories that are defined as areas or sets of areas, or parts of areas, defined on the basis of the prevailing character. The individual areas constituting the territory may be areas for housing, recreation, civic amenities, mixed residential, transport infrastructure, technical infrastructure, production and storage, mixed production, public areas, green areas, water and water management, agricultural, forest, natural, mixed undeveloped areas, mineral extraction and specific. The research question is whether the territories formed by the combination of the above-mentioned areas can be expressed by economic quantity that would prove their efficiency level. The municipality, in which cadastral the territory is located has to incur certain expenditures on preparation for its intended use. The question is whether there may be any revenues and/or socio-economic benefits that the new territory can bring to the municipality/society.

2 Analysis of the Current Situation

Urban sustainability is a multi-dimensional concept that includes environmental, economic, social and political dimensions (Huang *et al.*, 2009; Olewiler, 2006). The strategic plan towards sustainable development is fundamentally based on knowledge of the local economic opportunities, the local environmental conditions, and cultural and social characteristics (Scipioni *et al.*, 2009). Many authors describe the territory in various detail views. Moussiopoulos (2010) develops this concept in a framework of 13 discrete thematic areas, namely: (I) Economy–Population, (II) Land and Urban Planning, (III) Energy, (IV) Transportation, (V) Agriculture–Livestock–Fishery, (VI) Industry, (VII) Tourism, (VIII) Air Pollution–Climate Change, (IX) Water Resources and Sea Environment, (X) Solid Waste, (XI) Biodiversity, (XII) Health, (XIII) Education–Research and Technology.

(Nijkamp, 1995) sets main criteria and sub-criteria following A. Functional restructuring of the area (residential, tertiary and cultural function), B. Economic valorisation of the area (property value of real estate, commercial value, socio-economic value), C. Common utility (public recreational and supporting services) and D. Historic – environmental value (conservation and restoration value, aesthetic aspect of urban assets, integration with the historical city center).

For deciding on effective activities in the area it is sometimes necessary to quantify these variables. Research of the authors in the first phase focused only on a part of economic and socio-economic aspects, where it was able to define technical and socio-economic input variables, create their aggregation and produce relevant outputs.

3 Methodology

Changing the location purpose from the current prevailing use to another entails certain costs that the municipality has to incur in order to implement the new use of the location. These are mainly requirements for the construction of roads and backbone networks. At the same time, changes in the use of locations, depending on their character of the usable areas, can bring a

certain capacity of new residents and new jobs.

In order to work effectively with the technical-economic data, the characteristics of the locations were primarily defined. The basic attribute for their determination was the structure of the layout of the individual areas of the location, which may be residential (r), compact (c), empty (e), construction limited (l) or zoned (z). Average lengths of roads and backbone networks in m/ha were determined for each structure. Furthermore, possible incremental capacities of permanent residents and incremental capacities of new jobs were determined for each location. These data, which create important inputs into analysis presented in this paper, were taken from the results of the relevant scientific research oriented on evaluation of development opportunities prepared and proposed for the land use plan.

Based on the average length of roads and backbone networks in m/ha (water, sewerage, gas, electricity, central heating), including their average technical parameters together and their average unit prices according to national price databases, the cost in €/ha was determined for each location and the cost in €/m² was derived from them. The total cost of the change in the use of the location (Criterion K1) is the sum of the costs of the areas that the location contains.

$$K1 = \sum_{i=1}^n CA_i \quad (1)$$

Where

K1... Total costs of the location in €

CA... Cost of i-th area in €

n... Number of areas in the location

Based on the incremental capacity of residents and the tax revenues of the municipality per capita, the potential revenue of the municipality (Criterion K2) can be determined according to the following relation:

$$K2 = I \times R_T \quad (2)$$

Where

K2... Total revenue of the location in €

I... Incremental capacity of residents

R_T... Tax revenue of the municipality per capita in €/cap.

The potential social benefit (Criterion K3) was determined on the basis of the incremental capacity of the new jobs in the location, where the unit of benefit is the socio-economic benefit arising for the company in creating one new job.

$$K3 = L \times B_j \quad (3)$$

Where

K3... Total socio-economic benefits of the site in €

L... Incremental capacity of jobs

B_J... Benefit of the society from one created job in €/job

The output of the economic model is the determination of the overall location efficiency (E), which is defined as the sum of the product of the location classification values in a given criterion (K) and its weight (w).

$$E = \sum_{i=1}^n K_i \times w_i \quad (4)$$

The rating scale for each criterion values are listed below. The criteria weights were expertly chosen as follows:

Criterion K1 weight $w_1 = 0.60$,

Criterion K2 weight $w_2 = 0.20$,

Criterion K3 weight $w_3 = 0.20$.

According to the fact that this is a “yield” criterion, higher value of overall efficiency E represents higher efficiency of the territory.

4 Results

Interim research results are presented on a case study. The case study includes the evaluation of 12 locations boroughs of the Statutory City of Brno.

4.1 Values of Input Variables

Based on the above-mentioned procedure, the costs for backbone networks were determined for individual representatives of the location structures. The values are given in Table 1.

Table 1. Model costs of the backbone network in €/ha.

Type of structure	Cost of Water [€/ha]	Cost of Sewerage [€/ha]	Cost of Gas [€/ha]	Cost of Electricity [€/ha]	Cost of Central Heating [€/ha]
r	141,438	100,836	67,140	36,633	391,744
c	118,206	84,273	56,112	30,616	327,397
e	157,267	112,120	74,653	40,733	435,583
l	61,882	44,118	29,375	16,028	171,396
z	120,436	85,863	57,170	31,194	333,575

The costs of roads by length per hectare were further divided into groups according to the

assumed width of the road, considering the widths of 8, 12 and 24 m. The values obtained are shown in Table 2.

Table 2. Model costs of roads in the territory according to their widths in €/ha.

Type of structure	Width 8 m [€/ha]	Width 12 m [€/ha]	Width 24 m [€/ha]
r	228,275	342,413	684,826
c	190,779	286,169	572,338
e	253,821	380,732	761,464
l	99,875	149,813	299,625
z	194,379	291,569	583,137

The value of revenue per capita used is based on the statistical data of the set municipality, in the case of the mentioned case study - the final account of the Statutory City of Brno (SCB, 2018) in the current value of € 1,020/resident.

The average value of a socio-economic benefit arising for a society in creating one job without considering specific job positions is assumed for the Czech Republic at the current value of € 12,401/job (SEI, 2019).

4.2 Values of the Individual Criteria

The case study deals with 12 considered locations located in the cadastral territories of the individual city districts of the Statutory City of Brno. The location is described in the Table 3 below.

Table 3. Values of criteria K1, K2, K3 v €/m².

Location in the cadastral area	Area ha	Incremental capacity of residents	Incremental capacity of jobs	K1 - costs €/m ²	K2 - revenues €/ m ²	K3 – benefits €/ m ²
Prizrenice 1	62.52207	2,736	3,871	55.47	106.88	76.80
Prizrenice 2	58.32664	3,215	4,272	57.70	125.59	90.82
Cernovice 1	39.97897	458	4,668	65.20	1.17	144.80
Bosonohy 1	39.72692	1,407	874	45.00	3.63	27.27
Reckovice	38.96985	4,033	1,959	55.63	10.55	62.34
Styřice	38.76289	883	674	87.77	10.86	261.56
Bosonohy 2	34.87699	28	2,030	53.32	5.43	187.89
Komin	32.67942	982	573	47.34	3.09	21.76
Bohunice	31.46935	3,031	1,966	59.61	9.84	77.46
Dolní Herspice	30.93395	90	1,807	55.31	0.31	72.46
Prizrenice 3	30.68411	3,612	944	61.33	12.03	38.16
Cernovice 2	28.72383	380	3,191	62.42	1.37	137.77

4.3 Description of Classification Grades to Calculate the Overall Location Efficiency

For all the above-mentioned evaluation criteria, the following tables show the methods of their evaluation based on the classification according to the selected categorisation.

Criterion K1 – classification scale for cost value intervals per m²

In terms of their cost per m², the assessed locations were divided into 5 classification grades (1 - least expensive, 5 - most expensive) according to the cost intervals given in the following Table 4.

Table 4. Classification grades for the cost interval per m² of the designed location area.

Cost interval per m ² [€/m ²]	Descriptor	Classification grade
< 39.06	Low cost	1
39.06 – 58.58	Lower cost	2
58.59 – 78.13	Average cost	3
78.14 – 97.66	Highest cost	4
> 97.66	High cost	5

Criterion K2 – classification scale for revenue value intervals per m²

In terms of their revenue per m², the assessed locations were divided into 5 classification grades (I - highest revenue, V - lowest revenue) according to the revenue intervals given in the Table 5.

Table 5. Classification grades for the revenue interval per m² of the designed location area.

Revenue interval per m ² [€/m ²]	Descriptor	Classification grade
> 23.44	High revenue	I
20.35 – 23.44	Higher revenue	II
9.78 – 20.34	Average revenue	III
3.91 – 9.77	Lower revenue	IV
< 3.91	Low revenue	V

Note: For the calculation of the overall efficiency for this yield criterion, the classification grade “I” = 5 points, the classification grade “V” = 1 point (higher revenue is preferred).

Classification scale for the social benefits value interval

The assessed locations were divided into 5 classification grades (A to E, A - highest social benefit, E - lowest social benefit) according to their societal benefit intervals given in Table 6.

Table 6. Classification scale for social benefits interval per m² of the designed location area.

Social benefit interval per m ² €/m ²	Descriptor	Classification grade
> 97.66	High benefit	A
58.65 – 97.66	Higher benefit	B
19.54 – 58.64	Average benefit	C
3.90 – 19.53	Lower benefit	D
< 3.90	Low benefit	E

Note: For the calculation of the overall efficiency for this yield criterion, the classification grade “A” = 5 points, the classification grade “E” = 1 point (higher benefit is preferred).

4.4 Resulting Ranking of the Locations According to Overall Efficiency

Table 7 shows the evaluation of locations according to individual classification grades and the overall efficiency of the location E according to the above-listed relation is determined as the sum of the products of the classification grade values in the relevant criterion and its weight.

Table 7. Overall efficiency of the locations, sorted by the value of the overall efficiency E descending.

Location in the cadastral area	K1 (cost per m2)	K2 (revenue per m2)	K3 (benefit per m2)	E (overall efficiency)
Prizrenice 1	4	V	A	4.20
Prizrenice 2	4	III	C	4.20
Cernovice 1	4	III	A	3.60
Bosonohy 1	3	V	A	3.40
Reckovice	3	V	A	3.20
Styrice	3	V	B	2,60
Bosonohy 2	2	I	B	2.40
Komin	2	V	C	2.40
Bohunice	2	III	B	2.40
Dolni Herspice	2	V	C	2.20
Prizrenice 3	2	I	B	2.20
Cernovice 2	2	V	B	2.00

Locations are sorted according to values of efficiency, according to the values of individual criteria is also clear how the individual criteria for overall efficiency involved. The overall efficiency ranges from 2 to 4.2 points of the 5-point scale.

5 Conclusion

The article deals with determination of the procedure for the evaluation of the economic efficiency of designed locations. The economic evaluation is made to compare the extent of economic intensity, potential revenue and socio-economic benefit of individual development

locations among themselves and to determine the possible succession for their implementation - a change in their use. For this reason, an economic model of costs, revenues and benefits related to the transformation of the current location into its proposed use was developed. The economic model is designed for the basic economic awareness of the costs, revenues and benefits of the areas under consideration at the level of detailed technical data that are part of the land use plan. For this reason, it works with the average values of the territory representatives. Value analysis procedures were chosen for comparison of designed locations. Future research will focus on another part of the life cycle of the municipal property thus created, namely the cost of repairing and maintaining in the operational phase, where it will be necessary, among others, to examine its average lifetime.

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References

- Huang, S. L., Yen, C. T., Budd, W. and Chen, L. L. (2009). *A Sensitivity Model (SM) approach to analyze urban development in Taiwan based on sustainability indicators*. *Environ. Impact Asses. Rev.* 29(2), 116–125.
- Olewiler, N. (2006) *Environmental sustainability for urban areas: the role of natural capital indicators*. *Cities* 23(3), 184–195.
- Scipioni, A., Mazzi, A., Mason, M. and Manzardo, A. (2009). *The dashboard of sustainability to measure the local urban sustainable development: the case study of Padua Municipality*. *Ecol. Indic.* 9(2), 364–380.
- Nijkamp, P. and Artuso, L. (1995). *Methodology and Application of Sustainable Environment Concepts for the Built Environment*, *Cerie Research Memoranda*, 1995-48, VRIJE Universiteit, Amsterdam.
- Moussiopoulou, N., Achillasa, Ch., Vlachokostasa, Ch., Spyridia D. and Nikolaou, K. (2010). *Environmental, social and economic information management for the evaluation of sustainability in urban areas: A system of indicators for Thessaloniki, Greece*, *Cities*, Volume 27, Issue 5, October 2010, Pages 377-384. <https://doi.org/10.1016/j.cities.2010.06.001>
- Statutory City of Brno (SCB, 2018). *The final account of the Statutory City of Brno*, Brno City Hall, Budget and Finance Department.
- Database of socio - economic impacts of OPEI (SEI, 2019). Available from <https://www.agentura-api.org/cs/metodika/ekonomicke-hodnoceni/>
- Guide to Cost-Benefit Analysis of Investment Projects (Guide, 2014). *Economic Appraisal Tool for Cohesion Policy 2014-2020*, European Commission, Directorate-General for Regional and Urban Policy.