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CALCULATION OF IMPACT OF CONSTRUCTION INVESTMENT TO THE PUBLIC INFRASTRUCTURE

Abstract

The paper shortly introduces and describes a computational model that illustrates the impact of land development construction investment in the form of creating new needs for public infrastructure and community facilities in the territory. New construction investment may also initiate other construction investment, which also increases the demands on ensuring the capacity of public infrastructure. For public administration (local and regional), the created model can facilitate preparation, decision-making and management of public investment in the territory while respecting the 3E principle.

Keywords

Land development, community facilities, urban planning, investments, computational model.

1 INTRODUCTION

Current changes in the population structure and changes in socioeconomic areas require attention dealing with problems in the direction of investments and financing activities from public sources. Many cities undergo transformation of economic sectors, mainly from industrial companies to companies offering services, which is affected by the processes of globalization, suburbanization, population decline and changes in the demographic structure. It is in the interests of municipalities and regions to invest in the territories while respecting the 3E principle (effectively, efficiently and economically) and thereby reduce the impact of new economic risks (Mace, 2006). Investments in the territory create added value in the form of the territory facilities even in the event of additional costs that have to be considered. Territorially – development investments (construction) bring about additional induced effects, which can create further incentives to invest in the area (induced investments in the area of the public infrastructure, such as not only need to ensure the capacity of the technical and transport infrastructure, but also e.g. ensuring supporting civic amenities). Complex community facilities can then include general services, medical facilities, educational institutions, facilities for sport and recreation, police and fire facilities, and many others (Association, A. P., 2006).

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2 CURRENT STATUS OF THE ISSUE

For effective implementation of investment projects whose impact is, in many cases, given by a wide range of specifics of the target area, it is necessary to have a tool that can correctly and objectively evaluate the impact of these projects on specific areas determined by specific territorial disparities. At present, there is already a wide range of territory development models that prognosticate development trends (Dlask, 2007) or follow deficiencies in the territory facilities (Beran & Dlask, 2007). The solved calculation model, however, focuses on calculating the needs of the planned investment.

At EU level, there is a guide prepared by the European Commission, procedures for evaluating – TIA (Territorial Impact Assessment). Procedures for impact assessment have also been elaborated by certain individual countries at national level (e.g. the Netherlands, Slovenia). Such approaches and methodologies aim to provide decision-making bodies with a basis for their activity based on qualitative and, if possible, also quantitative evaluation of impacts on a particular specific area formed by territorial differentiation and specific problems. These procedures are often based on counterfactual methods of evaluation. In the case of ex-ante assessment, it is unrealistic to obtain statistical data regarding the future status after realization of the investment; therefore, one of the main conditions of using counterfactual evaluation methods is not met. For the purposes of visualization of investment impacts, quantitative evaluation methods were chosen.

Implementation of the computational model follows up on the methodology of the project "Determination of Necessity for Public Investment in Areas with an Emphasis on Effectiveness, Efficiency and Economy" TACR (Technology Agency of the Czech Republic) (TD020202). The methodology focuses on the evaluation of the necessity and effectiveness of investments in the territory within the socioeconomic aspect and respects the principle of 3E (Efficiency, Effectiveness, Economy), whose essence is consideration of three basic questions during planning, preparation and realization of investments (projects, etc.) and spending public means. The principle is to minimize costs while maintaining the required investment objectives (profitability), realization of the investment, which covers the need that generated the investment (purposefulness), and achieving the best possible outcomes (effectiveness).

3 METHODOLOGY AND METHODS

Effects of the needs of new territory facilities are difficult to measure and any prediction often becomes only a professional estimate due to the lack of adequate data. Monitoring the impact of capital construction in the area is also distorted by the number of factors that may influence the effects in the area, which was not estimated in advance. It is not only the case of the technical, economic and demographic factors, but also, for example, psychological, aesthetic factors, and the like. Also, it is not possible to separate the time factor of the impact and planning that gives the models another computational dimension (Vanier & Danylo, 1998).

To solve the model, localized urban indicators reflecting the need for the territory facilities for residents were used. These indicators are based on typological, demographic and technical parameters. The problem is their territorial applicability, which cannot generally be extended to any other territory of another country, and their problematic topicality. In the Czech Republic, these indicators were compiled in the 1980s (VUVA - Research Institute of Construction and Architecture, 1983). Because of the sophistication of this data and the absence of new data on a similar level, this data can be used in current considerations of spatial development planning. In combination with standard computing of the needs for different types of infrastructure, these indicators provide a good starting base for the solved calculation model.

4 MODEL CREATION

The model of the impact of investments is created in MS Excel and the programming language Visual Basic for Applications (VBA). It is linear deterministic quantitative computational model. The user interface provides simple procedures for calculating and plotting the diagram of the development of related investments. The input parameters are data on the initiating investment and the required volumes, e.g. the size of the built-up space and the number of residents served. All scenarios are editable.

The initiation (initial, primary model) investment causes subsequent (secondary) induced investments and costs of public infrastructure facilities of the area (Fig. 1). These induced secondary investments may cause other affiliated investments (tertiary) that respond to these changes in the status of the territory. Affiliated (secondary) investments can ultimately increase demands on providing the area with other technical infrastructure (in other stages).

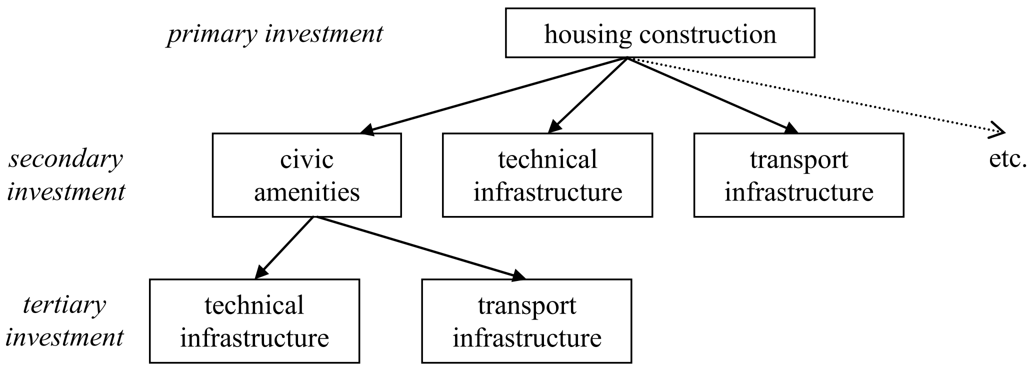

Fig.1: Diagram of the development of induced investments

The cycle algorithm performs a calculation for the secondary and tertiary levels of impact investments. Other levels are not relevant due to increased errors of estimation and unpredictability of the effects of other factors.

The algorithm is based on the matrix of relationships of possible model investment. In this matrix, representative objects of public infrastructure from public facilities to transport and technical infrastructure are represented. Links between these objects are made of three types of determination:

1. calculation based on the legislation or standard
2. determination according to urban indicators
3. expert estimate of priority importance.

In the first case, the link between the initiation and induced investment is formed by calculation. Housing construction, for example, generates the need for drinking water supply and these volumes are given by the particular regulation per resident. However, due to the complexity of the problem, these calculations are simplified to the basic most common condition of the possible case. Calculations are based on current legislation and standards of the Czech Republic.

In the latter case, the links are determined by urban indicators. These include the recommended amounts of amenities for residents, etc. However, these figures come from outdated documents, still frequently used, or the comparison of data from foreign sources (Association & Staff, 2006).

The third case of links consists in an expert estimate based on logical considerations of the possible occurrence of links. These links cannot be quantified by calculation or spreadsheets findings, and it can only be concluded that the initiation investments may also cause these additional links and impacts. The first and second case are quantifiable, the third case is shown only as an option.

The links are determined by the matrix of elements of investment and the identifier of calculation according to its type (Tab. 1). Calculation of the link consists in the type of determination and calculation units. If the result of the calculation is negligible, it is not indicated in the diagram.

Tab.1: Matrix representation of investment elements relation

Element:	COLLECTIVE HOUSING	FAMILY HOUSES	PRESCHOOLS	ELEMENTARY SCHOOLS	HIGH SCHOOLS	RECREATIONAL FACILITY	CULTURAL FACILITY	etc …
COLLECTIVE HOUSING			r1	r2	r3	r4	r5	
FAMILY HOUSES			r1	r2	r3	r4	r5	
PRESCHOOLS								
ELEMENTARY SCHOOLS						r6		
HIGH SCHOOLS						r7		
RECREATIONAL FACILITY								
CULTURAL FACILITY								
etc …								

where:

r1-r7 – formula identifier.

Example (Tab. 1):

Collective housing units induct needs of preschools. Calculation formula is identified with *r1* identifier (Eq. 1).

$$P = \frac{I}{1000} \cdot k \tag{1}$$

where:

P – number of required seats in preschools,

I – number of new collective housing inhabitants,

k – number of seats in preschools per 1000 inhabitants, $k = 40$.

The logic of calculation is based on the considerations of cumulative needs and combining the same kind of investment into one group. It is the case of, e.g. increasing demands on the capacity of the water reservoir due to the construction of a high number of housing units; this amount inevitably calls for the construction of kindergartens, schools and other amenities. Each of these elements also increases the demands on the capacity of the water reservoir. These demands are combined with the prospect of other land-development stages.

4.1 Computational Relationships

Elements relationships are determined by calculations based on directives, regulations and standards. These relations are marked with the *r* letter and index (Tab. 1). Each relationship is determined by own computational formula (e.g. water consumption) and own data inputs (Fig. 2). Input data are mainly volumetric, e.g. number of residents and water consumption per person. The calculation output shows required facility dimension and its implementation costs. The calculated need is then compared with the current capacity of solved element (Eq. 2).

$$C_{req} = C_c - C_p \tag{2}$$

where:

C_{req} – means required capacity of community facility element [solved capacity units],

C_c – means calculated capacity of community facility element [solved capacity units],

C_p – means current capacity of community facility element [solved capacity units].

If $C_{req} < 0$ then target capacity of the element increases and potential investment realization is assessed. Assessment price lists are implemented in model and these lists could be modified by user. Partial assessments are cumulated in final price of overall investment impact.

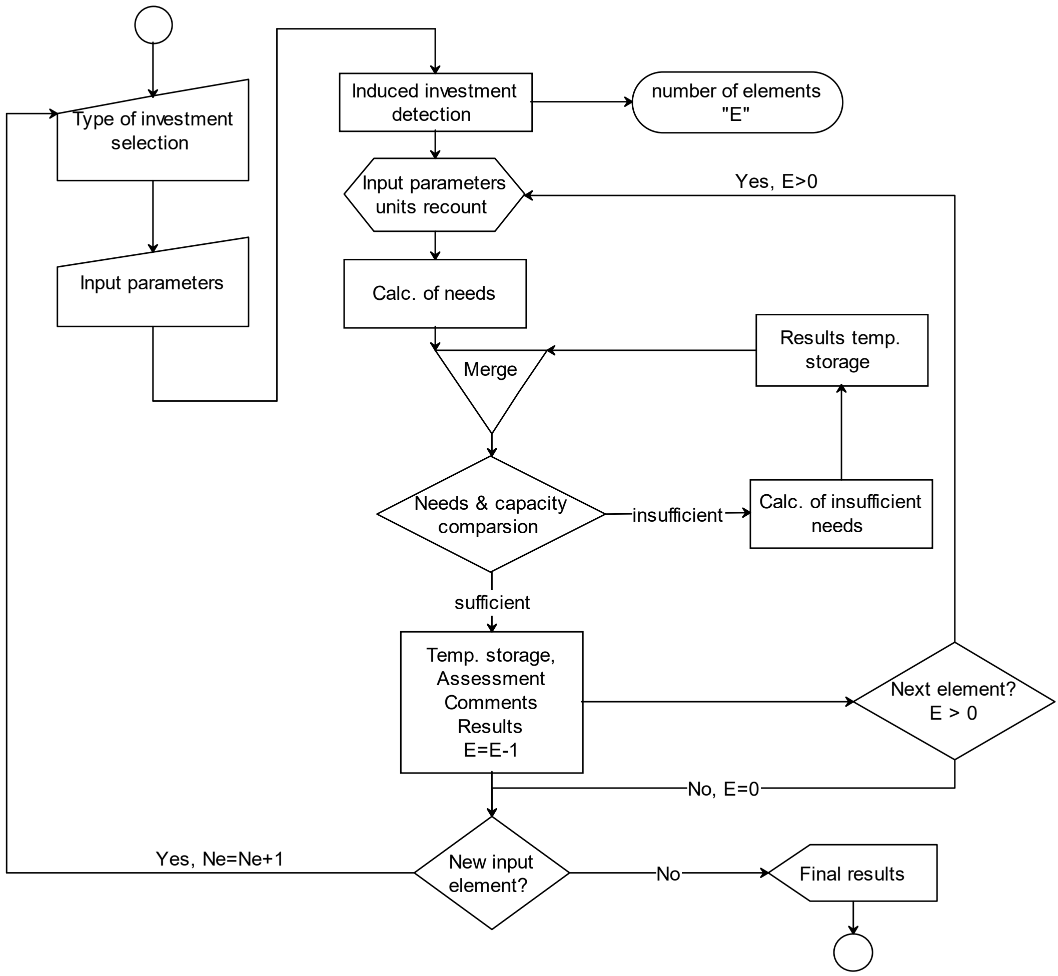

Fig.2: Algorithm Diagram

where:

E – number of inducted elements,

Ne – number of new generated elements.

More complex cases with multiple computational links can generate chain calculation cycles (Fig. 2) that represent number of new generated elements (Ne). The outcome of the calculation is a graphical diagram, exportable into a metafile image format. The application is in a bilingual user interface in Czech and in English; it is available on the web: homen.vsb.cz/~fer031/inv.xls.

5 OTHER SOLUTIONS

The application is editable and it can be complemented with other types of investments, adding links, calculations and adjusting scenarios. The user can refine the calculation at his/her discretion. In the next stages of the application development, compatibility with later versions of MS Excel is solved. The theme is also the incorporation of a time component of the prediction of needs and the estimate of the gross costs of investments in the territory. In addition, a case study will be carried out comparing tables and real values.

6 CONCLUSIONS

The model of the investment impact brings a new practical tool for the decision-making level of municipalities. Based on these results, it is possible to think about the efficiency of the territorial development investment and the impact on other necessary territory facilities. Idealized results must be considered as a vision of the needs in the territory according to the recommended values. The computational model can reveal current and future capacity deficiencies in the public infrastructure, and it is advisable to discuss these results with respect to the intentions of investing in the area. The application is further developed in cooperation with entities that are engaged in the development of the area and provide a valuable stimulus to more accurate calculations.

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