

# Basic effects types of logistic infrastructural investments - theoretical approach

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**Abstract.** The study aims to determine the basic effects catalog of logistic infrastructural investments. The catalog proposes eight criteria for the division: the way the effects are impacted, the measurability of effects, the range of impact effects, the distribution of effects in time, types of effects, effects impacts, channels of impact effects and sustainability impacts. Each criterion was characterized. The result is a catalog of epistemological and pragmatic meaning.

## 1. Introduction

Planning the macro-logistics infrastructure is a complex, challenging and extremely responsible process. First of all, the type, size, and functional scope of the infrastructure investment should be determined. To do this well, you need to demonstrate the legitimacy of the investment and accurately assess what will be the demand for the planned infrastructure. For this purpose, it is necessary to analyze the dynamics of demand for both direct and indirect users of the future infrastructure. The basic decision at the planning stage of the logistics infrastructure is the selection of the location. Financial issues are also raised, mainly concerning sources of investment financing as well as the method and schedule of spending funds. Planning also includes the definition and analysis of effects that are considered in the category of benefits, as positive (desirable) effects, and as unfavorable (undesirable) effects. The effects should be presented in an evidential way, which means that they should be associated with an event occurring at a given time and in a given space.

The study aims to determine the basic effects catalog of logistic infrastructural investments. The catalog was built mainly based on a literature review but also includes a proprietary view. It has epistemological and pragmatic meaning.

## 2. Discussion

About the logistics infrastructure of the economy, the effects of investment can be considered in various classification sections. The most important classification criteria can be included (Table 1) [1] [2] [3] [4] [5]: the effect of effects, measurability of effects, range of impact effects, distribution of effects in time, areas where effects occur, who they influence effects, channels of impact effects, durability of effects.

The visible effects of logistic infrastructure investments are objectively stated and have an economic nature. In turn, visible and irrational effects are attributed to subjectivism and are usually classified in the group of socio-economic effects, and the effects of environmental protection and security referred to in the literature as external effects.

**Table 1.** Effects classification of logistic infrastructure investments

<b>Classification criterion</b>	<b>The division results</b>
The way the effects are affected	<ul style="list-style-type: none"> <li>• Positive effects: benefits, savings</li> <li>• Negative effects: disadvantages, losses</li> </ul>
Measurable effects	<ul style="list-style-type: none"> <li>• Measurable effects</li> <li>• The effects are difficult to measure</li> <li>• Immeasurable effects</li> </ul>
The range of impact effects	<ul style="list-style-type: none"> <li>• The effects felt local, regionally, in the country on an international scale</li> <li>• The effects affecting the entire economy, the effects acting on selected sectors of the economy</li> </ul>
Distribution of effects over time	<ul style="list-style-type: none"> <li>• Short-term, medium-term and long-term effects</li> </ul>
Types of effects	<ul style="list-style-type: none"> <li>• Economic, social, environmental (external) effects</li> <li>• Demand and supply effects</li> </ul>
Entities impact	<ul style="list-style-type: none"> <li>• Effects felt by TSL enterprises, enterprises from other industries</li> <li>• External effects (felt by the environment)</li> </ul>
Effects channels	<ul style="list-style-type: none"> <li>• Direct effects</li> <li>• Indirect effects</li> </ul>
Durability of effects	<ul style="list-style-type: none"> <li>• Constant effects</li> <li>• Temporary effects</li> </ul>

Source: own study based on [1] [2] [3] [4] [5].

In a large group of effects generated by the macro-logistic infrastructure, it seems to be superior to positive and negative ones. The positive effects of logistic infrastructure investments are manifested in the form of benefits and savings, although sometimes the indication of a clear border between these forms is challenging. The benefits of the logistics infrastructure of the economy are related to its impact on the functioning and development of the economy, recognized as both a structural and functional whole, as well as a division structure. This means that the benefits created by logistic infrastructure may arise at the micro, meso and macroeconomic levels and are a function of its impact on revenue growth, employment growth, investment growth, increase in commodity exchange, etc.

A well-developed macro-logistics infrastructure does not necessarily have to bring only benefits. One should also identify negative effects, which mainly include effects of the impact on the natural environment. Because this issue is the subject of further chapters, hence the detailed characteristics of the negative impact of construction, development, modernization, and operation of the logistics infrastructure on the natural environment will find its place there.

Benefits derived from logistic infrastructure investments can be quantifiable (measurable) or hard to quantify. Rational benefits include, above all:

a) regarding road infrastructure:

- an increase in the speed of travel (among others due to better quality and technical parameters of the road), leading to indirect benefits in the form of shortening the delivery time, reducing the value of inventory in transit, increasing the efficiency of transport means;
- reduction of effective operational costs of transport - among others reducing fuel consumption, reducing repair costs;
- increased transport accessibility, resulting in a shorter route, shorter transport times, lower transport costs;
- increased traffic safety translating into lower accident rates, and indirectly - reduction of losses and damage to cargo, means of transport as well as infrastructure itself;
- reduction or elimination of congestion, which is reflected in the time and cost of transport;
- reduction of transport costs in the total cost of logistics processes;

b) regarding logistic centers:

- reduction of service time thanks to modern technical and organizational solutions;

- reduction of employment due to mechanization and automation of warehouse and handling processes;
- reduction of service costs (including transport costs), which results from dependencies defined as cost concessions;
- reduction in the level of inventories, and what is related to this, and inventory costs, in distribution channels by reducing or eliminating intermediate links and introducing deconsolidation and consolidation reloadings, i.e., cross-docking;
- increase in the outsourcing of warehouse functions leading to a reduction in storage costs in the total cost accounting of logistics processes;
- centralization of logistics services provided by logistics service centers, resulting in lower total costs of logistics processes.

One should remember about the synergistic effects [6] resulting not only from the complementary relations of individual elements of the logistics infrastructure of the economy but also from the recognition of them as an integrated structural and functional coplanar of the implementation of logistics processes (network). The synergy will, therefore, result in the benefits gained as a result of the development of the logistic infrastructure multiplied. It can also trigger completely new effects that will not occur in the case of investments of individual elements of the logistics infrastructure carried out independently of each other. One can, in particular, mean the coherence of a logistics system, e.g., a supply chain, which is one of the basic conditions of its efficiency.

When it comes to the hard-to-come benefits of infrastructure investments, their precise definition causes some problems, and therefore, they are usually established based on estimates. As an example: social savings resulting from the reduction of the number of accident victims on the used transport infrastructure, reducing the level of external costs through a smaller impact on the natural environment, increasing the added value in goods and services as a result of extending the network of cooperative links between business entities, increased revenues as a result of expanding sales markets, improving the flow of goods between regions, increased revenues of transport companies due to better development opportunities for transit transport.

In the literature mentioning measurable and hard-to-measurable effects of transport infrastructural investments, the non-measurable effects are omitted. Undoubtedly, they should be included, because the development of logistics infrastructure brings not only effects that can be expressed using numbers, but also those that can not be measured or counted. Such effects include aesthetic feelings caused by changes in the environment as a result of the construction or expansion of the logistics infrastructure. More specifically, the aesthetic evaluation may concern elements of logistic infrastructure as well as the landscape in which particular infrastructure elements are integrated. In the first case, one may ask whether users, in addition to functionality, expect from some roads or logistic centers also some aesthetic impressions and what would have to consist of them because they are the largest group of evaluators. In the second case, the group of potential assessors consists primarily of members of the local community and tourists who want to use the aesthetic qualities of a given landscape.

The issues of shaping and protecting the aesthetic values of the logistics space of infrastructural investments are still insufficiently appreciated in Poland. It is also visible in the technical field because few authors deal with this subject [7] [8]. In the case of logistic infrastructure investments, however, the highest priority is given to technical, legal, functional, or ecological issues. The reasons for this state should be found in the legal system regulating spatial development issues because these problems are not identified in Polish legislation. There is the problem of methods for assessing aesthetic impressions, even for the simple reason that their reception is always subjective and depends on many factors, such as education, sex, age, whether or mood of the recipient. It is also known that human perception is inherently multisensory, although in a particular situation it can be compelled to be dominated by one sense, e.g., in the situation of excessive noise. In the case of landscape, beside the dominant visual stimuli, sound and smell stimuli play an especially important role in perception. Beautiful patterns regarding, for example, engineering structures or storage centers prevailing in the eighties of the twentieth century are difficult to compare to current standards.

The significant logistical effects of infrastructure investments can also include satisfaction when using the logistic infrastructure obtained due to the quality of the road surface, road network density, convenient connections in the road network, spatial availability of logistics centers, logistics centers, etc. Analyzing the phenomenon of satisfaction, usually, the states are accented positive, such as, for example, joy, a feeling of pleasure, but you can also be interested in negative states such as stress, effort or tension. However, in both cases, there are no clearly defined measures to measure these states. Another substantial effect of the development of logistics infrastructure is the improvement of the region's image, which is manifested by the increase of investment attractiveness.

The effects of logistic infrastructural investments can be felt locally, regionally, nationally or internationally. The range of radiation effects depends primarily on the size and function of the logistics infrastructure. Logistics service centers located in seaports will generate effects on an international scale, while the effects of the cross-docking center's functioning can be felt within the limits of the regions served. It is important that some effects may occur in parallel on several scales. It is difficult to delimit local and regional effects, and if we take into account Euroregions separated from abroad (e.g. Euroregion Pomerania, Euroregion Meuse-Rhine, Euroregion Szeszupa), then it is challenging to distinguish regional effects from international ones.

The time-based criterion allows distinguishing the effects of logistics infrastructure development on short, medium, and long-term. In terms of short-term impact, the effects of logistic infrastructural investments are related to the period of investment implementation and result from the involvement of production factors (labor resources, raw materials, machinery, etc.) in the construction process. The medium and long-term effects that appear after the end of the construction phase of infrastructure facilities are of key importance and are associated with the greater attractiveness of the area for functioning enterprises and potential investors. The most important medium- and long-term effects, involving business entities operating in an environment with favorable infrastructure potential, include the increase in productivity of resources used by the company, streamlining logistics processes related to supply, production and customer service, reducing the company's costs.

The effects of logistic infrastructure investments can be analyzed as demand and supply [9]. Demand effects result from short-term development impulses, directly related to the implementation of the investment. They concern creating demand for work and materials (resources).

The effects generated by the logistics infrastructure are the participation of various entities. In the simplest terms, they will be operators from the TFL sector and cargo holders that are entities using logistic services offered by the TFL sector and entities that independently implement logistics processes, have their fleet or own warehouse. Looking more broadly, the entire national economy will contribute to the emergence of the functioning of the logistics infrastructure. Therefore, the effects of logistic infrastructure investments can be seen in the category of impacts of logistics infrastructure on management processes implemented on the micro-, meso- and macroeconomic scale.

J.G. Heggie [10] divided the effects of transport investments on direct and indirect. One can use this division and refer it to logistic infrastructure investments, seeing as direct costs of capital and periodic costs of investment maintenance, value of travel time or storage of cargo, accidents costs, noise costs, and impact on real estate or land value, increased demand for transport or storage, impact on the environment as indirect effects.

In the works of such authors as F. Rietveld [11] [12], F. Bruinsma [12], T.R. Lakshmanan, P. Nijkamp, E.T. Verhoef [13] effects of transport infrastructural investments are characterized in terms of infrastructure projects appearing at various stages of the cycle, simultaneously taking into account the duration of impacts. Based on these criteria, they have distinguished temporary and permanent effects. About logistic infrastructure investments, temporary effects will be generated at the construction stage, and they will be demanding effects of a direct and indirect nature. In addition, there will be temporary external effects, such as noise or other environmental impacts when carrying out construction works. In turn, the permanent effects of logistic infrastructural investments are visible in the operation phase and occur for as long as the use of the logistic facility continues. It is therefore obvious that the permanent effects of logistics infrastructure development may imply logistic solutions based on the more intensive use of transport, such as on-time delivery, various small quantities of goods, cross-docking, warehouse

function outsourcing as well as multi-variant reconfigurations supply chains made at various geographical levels..

The permanent effects of the development of logistic infrastructural investments identified at the operational stage are also noticeable on the macroeconomic scale. For example, in the long-term perspective, assuming the slow pace of changes, permanent effects will be visible in the size of employment or GDP. During the operation of the logistics infrastructure, external effects will also arise. However, noise, which will be the source of infrastructure users, accidents, or air pollutants, will constantly be, but with varying intensity. The original landscape aesthetics will be permanently disturbed.

### 3. Conclusions

Considerations on the effects of logistic infrastructural investments lead to the belief that all empirical analyses should be made in a multifaceted way, using the matrix relations that occur between special effects. Also, the effects of logistic infrastructure investments can be subject to ex-ante and ex-post analysis. In the first case, the anticipated effects serve as a justification for the commencement of an infrastructural undertaking. On the other hand, ex-post analyses - apart from the cognitive value - show which effects should be intensified and which should be limited or eliminated.

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