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METHODOLOGY OF ASSESSMENT AND SELECTION OF ECONOMIC FACTORS CONDITIONING THE OPERATION OF INTEGRATED LOGISTICS CENTRES

Summary. The article addresses the overall body of problems pertaining to economic factors conditioning the construction and operation of integrated logistics centres (ILCs). These problems are among the most fundamental decision-making dilemmas related to such investments. The authors of the article have discussed the methodology of assessment and selection of economic factors for the cost-effective construction and operation of ILCs by taking the perspective of entities involved in the construction and functioning of these centres into consideration. Model ILCs are understood as facilities of a specific spatial and functional nature, along with all the infrastructure and organization, where logistics services are rendered in the scope of receipt, storage, distribution and release of goods, supported by auxiliary services provided by businesses independent of forwarders or recipients [3]. From the perspective assumed in the article, logistics centres are considered as projects implemented by both privately owned and public entities, which are open to participation with different economic entities representing the ILC sector, as well as other industries performing their logistics operations on the centre's premises and

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using its infrastructure. The article draws from the authors' own experience, research and insights.

Keywords: logistics centres; investments; development; financing; economic factors.

1. INTRODUCTION

The problem of identifying economic factors for the construction and operation of integrated logistics centres (ILCs) is one of the most fundamental decision-making dilemmas related to implementation of such investments. The authors of this article have attempted to discuss the methodology of assessment and selection of the economic factors underlying the efficient construction and operation of ILCs by taking the perspective of businesses directly and indirectly involved in the development and functioning of ILCs into consideration.

The main problems involved in deciding on the development of an ILC should be solved while planning the construction and operation of the ILC, as per the following five-point algorithm proposed in this paper.

1. Demand analysis, comprising the assessment of both current and future demand for logistics services, size of the logistics market, consumption level, labour market and economic growth.
2. Location analysis, comprising problems in the structure of individual transport branches, availability of transport infrastructure and investment sites, attitude of local authorities, and assessment of potential conflicts and threats.
3. Feasibility analysis, comprising economic and financial analysis, risk analysis, environmental risk analysis, and assessment of social and economic effects.
4. Decision-making analysis, concerning the choice of an implementation variant, organization variant, functional variant, ownership and capital structure, as well as growth strategy.
5. General implementation planning, comprising the determination of final ILC size, project schedule, investment financing instruments and ways to ensure that tenants occupy the investment premises.

In order to analyse these aspects for the sake of evaluating alternative solutions, one must consider diverse aspects, including economic, technical, social, legal and environmental ones, and, at the same time, the frequently and inherently contradictory interests of different parties. The most common interest groups involved in development of ILCs are: investors, capital owners, ILC management, ILC tenants and their clients, employees, public authorities on different levels and local communities. The expectations and needs of all or some of the aforementioned parties must be satisfied to a larger or smaller extent. Faced with such issues, one will hardly ever resort to the classical and obsolete understanding of optimality, since it is virtually impossible to produce optimum outcomes (solutions) perceived as the best ones by those representing all points of view. What seems to be far more significant under such circumstances is the concept of a compromise solution, which also takes the interests of different parties, as well as the analysis of potential trade-offs, into consideration.

2. FACTORS INVOLVED IN INTEGRATED LOGISTICS CENTRE CONSTRUCTION AND OPERATION

In the authors' opinion, the factors conditioning the construction and operation of ILCs include those that determine the effectiveness of ILCs' development and functioning, such as the following:

- determination of the ILC size, depending on the demand for the services to be rendered by the ILC and its nature and assumed features, taking its future growth and the availability of land into account [4]
- determination of the ILC's range of functions
- choice of location for the ILC, depending on the demand for the services to be rendered by the ILC being designed, the level of infrastructural connections with the surroundings, accessibility of utilities etc.
- land acquisition procedure (purchase, lease, consolidation)
- choice of the ILC construction financing structure, which particularly applies to cases when such potential funding sources as private and public funds are to be included
- planning of individual investment stages, depending on the assumed general concept of the ILC growth
- choice of the policy to be pursued with regard to prices of logistics and auxiliary services to be rendered by the ILC, as well as lease prices for the ILC's buildings and land

The above description of the most significant factors considered in the construction of an ILC clearly shows that they depend on a number of conditions and that they matter for different entities directly or indirectly interested in meeting these conditions. Moreover, the fact that ILC investment planning requires numerous decisions to be made at the same time, and that each of them may lead to more than two solutions, means that the number of alternative variants for the construction and operation of the given ILC is relatively high. Such characterization of the related problems implies how complex it is to choose the most adequate solutions.

Businesses whose economic and financial standing is most highly dependent on the development and subsequent functioning of the ILC include the following:

- Investors - Direct investor, i.e., the enterprise owning the ILC, accumulates capital and develops the ILC infrastructure. Indirect investors - direct investor's shareholders (manufacturers, distributors, developers, financial institutions, local government bodies, individuals etc.).
- Service purchasers - ILC tenants, i.e., businesses making use of the ILC infrastructure upon payment, which organize and perform logistics processes as part of the ILC's operations (logistics operators, production companies, distributors, service providers).
- Recipients of ILC's services - businesses using the logistics services delivered directly by the ILC or by the ILC tenants upon payment.
- Public institutions - local government bodies highly interested in creating new jobs and stimulating the region's economic growth.

The aforementioned entities, representing major participants in the ILC construction venture, exert the largest influence on the prospects of financial efficiency and cost-effectiveness of the ILC development project. For the sake of assessing the economic and financial factors of the ILC construction project, the model shown in Figure 1 is proposed, as it enables the assessment of the foregoing factors from the perspective of the satisfaction

of the ILC tenants' needs related to minimizing the costs of the services being purchased, as well as the investor's needs oriented towards profit maximization.

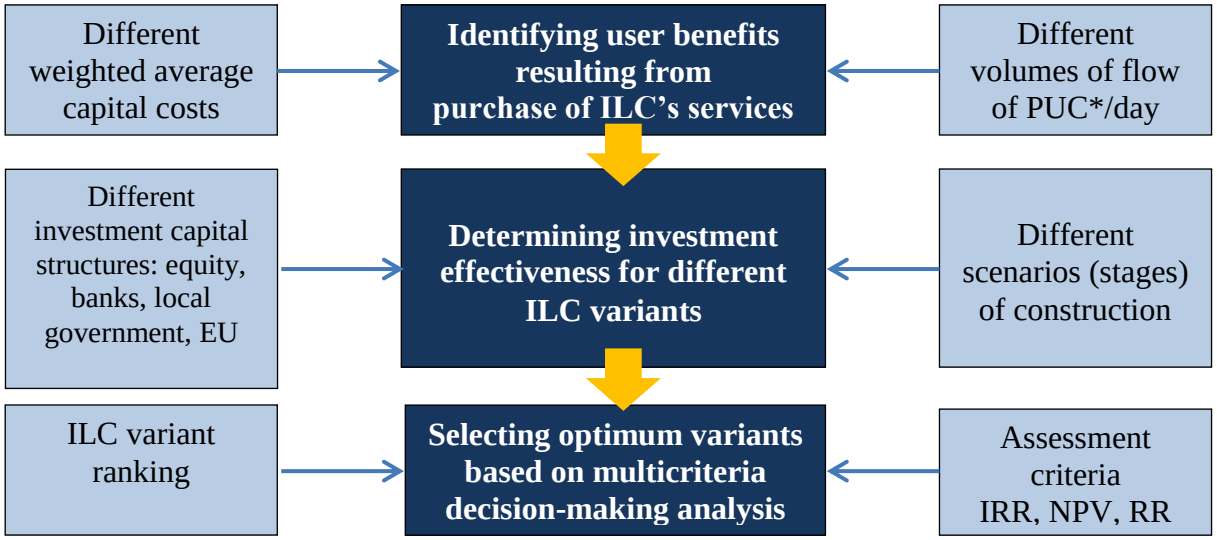

Fig. 1. Model for the assessment of economic ILC construction factors with regard to investor and user needs
Source: author's own materials

According to the model, the first stage consists of establishing total (constant and variable) unit costs of logistics operations for the potential purchaser of the services rendered by the ILC/tenant, which affect the total unit cost of the former's product or service. Establishing the level of these costs, based on rational and objective economic premises, and comparing them with prices of the services rendered by the ILC will make it possible to assess whether it is substantial to use services offered by the ILC as an alternative to the construction and/or use of one's own logistics resources.

2.1. Identifying user benefits resulting from the purchase of the integrated logistics centre's services

The first stage of this methodology assumes that unit costs of logistics operations (warehouse management operations have been considered for the purposes of this elaboration) for potential ILC tenants will depend on the following:

- production levels and consequential daily volumes of the warehouse flow of cargo units
- scenarios of construction and operation of one's own warehouse (stage-wise nature of investment)
- storage technologies in use
- weighted average cost of capital acquisition
- pre-assumed indices of effectiveness of construction and functioning of one's own warehouse

Having calculated the cost indices of logistics operations for potential purchasers of the ILC's services as above, one can establish price levels for the services to be rendered by the ILC, making sure that the ILC tenants' expectations will be satisfied, thus creating demand for these services (price level-relative demand curves).

2.2. Determining investment effectiveness for different integrated logistics centre construction variants

With reference to the demand thus established, economic and financial effectiveness prospects of construction and operation are identified for an ILC investor with regard to different:

- investment capital structures
- demand distributions depending on the price levels of the ILC's services
- ILC construction scenarios (stage-wise nature of investment)

2.3. Selecting optimum variants based on multicriteria decision-making analysis

Stage three consists of ranking the best variants of the ILC construction and operation based on multicriteria decision-making analysis, bearing in mind the perspectives of major decision makers and based on the criteria assumed for the assessment of individual investment variants.

3. GOALS UNDERPINNING THE DEVELOPMENT OF A MODEL INTEGRATED LOGISTICS CENTRE AND FACTORS OF ITS CONSTRUCTION AND OPERATION

The most fundamental socio-economic goals underpinning the construction of a model ILC are as follows:

- functional enhancement of the supply chain (logistics networks)
- shifting demand from road transport towards rail transport
- increasing interoperability of transport networks
- optimized use of national and international transport networks
- stimulation of local and national economic activity by rendering services that support production, distribution and logistics

Pursuing the above goals exerts a direct impact on the scope of tasks and functions that ILCs should perform, the most important of which are:

- organization and coordination of cargo transport services
- matching different modes of transport together and organization of their co-functioning
- sharing infrastructure and creating conditions for the activity of logistics operators
- matching supply of and demand for logistics services
- creating conditions that favour increasing value added in logistics services
- creating a milieu for fair competition and free market price setting

The opportunities for the construction, functioning and growth of ILCs also depend on socio-economic conditions, the most important of which are connected with the key parties involved in the project, including public investors (authorities and local organizations) and public investors, as well as with attracting ILC clients (tenants) in a sufficient number.

4. CHARACTERISTICS OF THE MODEL INTEGRATED LOGISTICS CENTRE

The model ILC assumed for the purposes of further analysis was characterized by the following features:

- regional and international character of the ILC's operations
- regional service coverage within the radius of 150 km
- international service coverage - 60-h customer service span
- two modes of transport combined: road and rail transport
- road and rail container terminal functioning along with trans-shipment equipment
- convenient access to road and rail infrastructure ensuring the efficient handling of combined transport
- land utilities (internal roads, utilities) enabling business activity for entities operating on the ILC's premises
- ILC's facilities: warehouses, storage yards, office buildings, parking areas for heavy goods vehicles, petrol station, heavy vehicle service garage, hotel, electronic information and transaction platform

For purposes of the research experiment, it was assumed that the following main location and siting requirements affecting the operating efficiency of the logistics centre would be satisfied for the model ILC:

- high economic potential of the region and the related high demand for logistics services within the ILC's reach
- close proximity of highly developed road and rail transport network
- availability of integrated investment areas of sufficient sizes
- access to utilities
- availability of highly qualified workforce with relatively low labour cost
- good transport connections with regional business centres

The model ILC was assumed to be developed in stages with the dense spatial arrangement of technological and organizational features, with the following five domains of activity at the core:

- road and rail container terminal featuring trans-shipment machines, capable of servicing intermodal shipments
- buildings and other built features for lease: warehouses, storage yards, parking areas tailored to specific tenants' needs and requirements
- land for lease
- integrated information and transaction system
- diverse services rendered by the ILC tenants, including: logistics services delivered by businesses representing the ILC sector, and auxiliary services, such as the servicing of heavy goods vehicles, hospitality and customs clearance

Having analysed examples of the spatial development of ILCs built in Western European countries and drawing on their own experience, the authors have devised a model structure of ILC land development. The model proposed applies to logistics centres with an area of about 100 ha [2]. One of the assumptions behind this solution is that 70% of the area intended for the given ILC land development option is to be offered to external investors willing to invest in the development of their in-house storage facilities and office buildings.

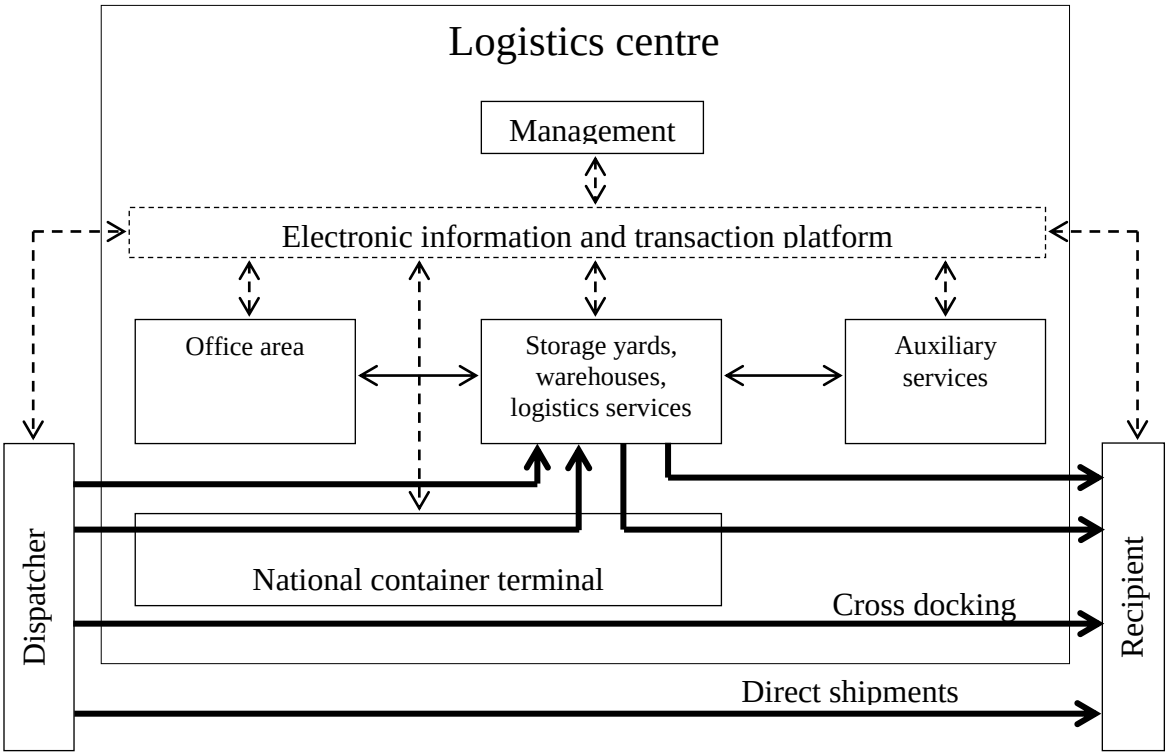

Fig. 2. Diagram of the functional and organizational features of the model ILC

The range of services provided by the model ILC will comprise those to be delivered by the ILC managing company (operator) in relation to rendering the infrastructure available, assuming their high quality and competitive prices, as well as services offered by businesses, i.e., the ILC tenants, comprising typical logistics services and prerequisite auxiliary services.

The basic services to be rendered directly by the ILC include the following:

- cargo trans-shipment at the container terminal
- rendering of warehouse space and storage yard area available upon payment
- lease of land for logistics investments

The services to be rendered by the ILC tenants as a means to support logistics processes include the following:

- basic logistics services
- transport services
- storage services
- freight forwarding
- order and stock management
- packing
- picking and dispatching

Table 1

Indicator-based structure of the model ILC land development

Land development option	**Area [ha] (external investors)**	**Share [%]**
Total area	100	100
Storage buildings	12.5 (70% - 8.75)	12.5
Auxiliary facilities of storage buildings (vehicle circulation and parking areas)	6 (70% - 4.2)	6
Office buildings	0.6 (70% - 0.4)	0,6
Pallet and crate storage yards	4.3	4.3
Container terminal	11.4	11.4
Parking areas	2.7	2.7
Access roads, vehicle circulation areas	27	27
Accessory buildings (petrol station, washing station, service garages, processing facilities etc.)	12 (100% - 12)	12
Green areas	23.5	23.5
Utilities	**Length [rm]**	**Network density [rm/m² thous.]**
Storm water drainage	22,000	22
Storm sewer	1,600	
Electrical network	8,300	8.3
Water supply and sewage disposal system	7,800	7.8
Main sewer	1,600	
Gas network	2,600	

Source: author‘s own materials

Auxiliary services:

- insurance for trade in goods
- customs clearance
- banking services
- technical vehicle servicing
- container rental, storage and repair
- sales of fuels and automotive accessories
- hotel and catering services
- parking services
- cargo surveying and inspection
- information services and IT support
- marketing and advertising services
- legal counselling
- accounting and financial services

5. PRICING POLICY ASSUMED FOR THE MODEL INTEGRATED LOGISTICS CENTRE

The pricing policy assumed for the model ILC should consider the need for profit maximization for the sake of a quick return on investment, which theoretically boils down to reaching a demand and supply balance with prices set at a level ensuring the full utilization of the ILC’s resources.

In accordance with the classical price and demand principle, it has been assumed that the level of ILC utilization will depend on the economic conditions of the tenants’ logistics

operations managed at the ILC, with special emphasis on the level of prices offered for the services rendered. The aforementioned implies that the problem involved in analysing different options of economically sound levels of calculated unit prices, which would ensure, on the one hand, realizing financial indicators satisfactory to investors and, on the other hand, a high level of benefits attained by the ILC tenants, becomes the key element in the analysis of factors, which condition the effective functioning of the model ILC.

In order to solve this problem, one must ensure the base calculated unit prices for typical services rendered by the ILC, ensuring that the ILC's services are favourable to those that buy them, which means that they are equivalent to comparable adequate unit costs for the construction and operation of their own warehousing infrastructure.

To this extent, in order to determine the impact of the adopted pricing policy on investment effectiveness, specific curves of demand for the ILC's services have been assumed, making the degree of utilization of the ILC's resources conditional upon the level of prices defined against the base calculated prices. Three pricing options have been taken into consideration with regard to provision of the ILC's services.

- OPTION 1 - Prices of the ILC's services set at 20% less than the base calculated prices. This option, providing high benefits to service purchasers, should ultimately ensure full (90% - warehouses, 85% - container terminal) utilization of the ILC's resources.
- OPTION 2 - Prices of the ILC's services set at 10% less than the base calculated prices. This option should ensure moderate (80% - warehouses, 77% - container terminal) utilization of the ILC's resources.
- OPTION 3 - Prices of the ILC's services set at a level equal to the base calculated prices. This option assumes that potential purchasers will make use of the ILC's services for non-economic reasons, for instance, good connections with the transport network or access to a wide range of logistics services. It is further assumed that this option should ultimately ensure minimum (70% - warehouses and container terminal) utilization of the ILC's resources.

With regard to the ILC's pricing policy thus defined, it is necessary to define the base calculated prices that have been calculated with reference to the original methodology for warehousing services, while, for other services (terminal handling, lease of land), they have been calculated based on market surveys and conducted using data available on the Internet.

6. INTEGRATED LOGISTICS CENTRE AREA DEVELOPMENT PLAN

The model ILC area development plan, as depicted in Figure 3, has been prepared with reference to the pre-assumed land development structure, the spatial development analysis of European logistics centres and the authors' own experience. The layout plan defines locations of enclosed structures and surface facilities covered by a two-stage ILC development variant, as well as the infrastructure of access roads. The site development plan covers a parcel that is 600 m in width and from 1,400 to 1,700 m in length, equating to an overall area of about 100 ha.

The plan has been drafted by taking the following technological and economic assumptions into consideration:

- enabling provision of the assumed basic and auxiliary services
- optimization of investment costs

- effective utilization of the entire investment area as per the projected demand for the ILC's services
- ensuring access to road and rail infrastructure in response to the ILC's needs
- construction of infrastructure and enclosed structures as per the investment schedule assumed to be implemented in stages
- modularity of building development, enabling the flexible organization of functions and entities
- purchasing all the land in the first investment stage in order to avoid any further actions of speculative nature

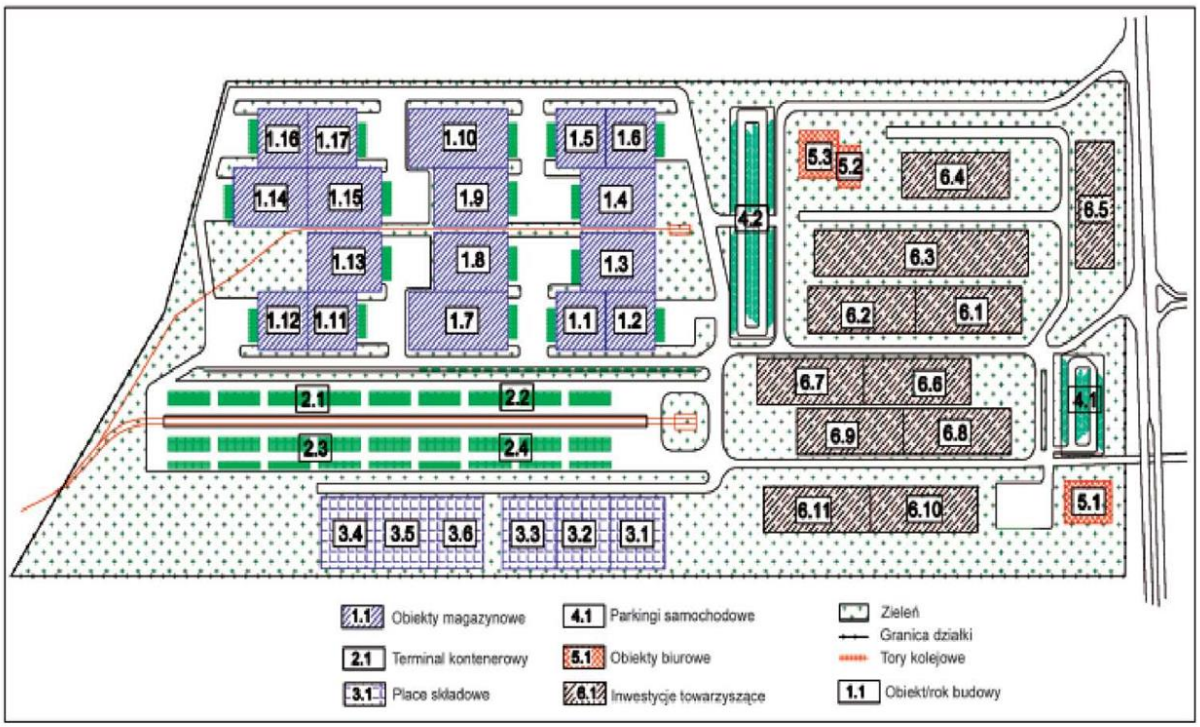

Fig. 3. Model ILC land development plan
Source: author's own materials

Based on the land development plan, in subsequent stages of the investment, one can produce detailed technical and technological designs as well as building plans and specifications for the ILC infrastructure, which, however, have not been required for the purposes of this study.

Parameters of all buildings and facilities to be sited on the ILC's premises are collated in Table 2, broken down into successive years of operation, from the first to the 15th year. The values provided therein are based on the target performance of individual facilities in handling cargo streams.

Table 2

Structure of the ICL area development

Warehouses	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	Total
Area [m^2]	6,000	6,000	8,500	8,500	6,000	6,000	11,250	6,000	6,000	11,250	6,000	6,000	8,500	8,500	8,500	6,000	6,000	125,000
Capacity [palettes]	7,228	7,228	10,240	10,240	7,228	7,228	13,554	7,228	7,228	13,554	7,228	7,228	10,240	10,240	10,240	7,228	7,228	150,589
Daily deliveries [palettes]	289	289	409	409	289	289	542	289	289	542	289	289	409	409	409	289	289	6,019
Daily dispatches [palettes]	289	289	409	409	289	289	542	289	289	542	289	289	409	409	409	289	289	6,019

Container terminal	2.1	2.2	2.3	2.4	Total
Total area [m^2]	28,500	28,500	28,500	28,500	11,4000
Storage area	4,250	4,250	4,250	4,250	17,000
Capacity [TEU]	648	648	648	648	2,592
Daily deliveries + dispatches	123	123	123	123	492

Storage yard	3.1	3.2	3.3	3.4	3.5	3.6	Total
Area [no.]	7,200	7,200	7,200	7,200	7,200	7,200	43,200
Capacity [palettes]	4,800	4,800	4,800	4,800	4,800	4,800	28,800
Palettes delivered per day	160	160	160	160	160	160	960
Palettes dispatched per day	160	160	160	160	160	160	960

Parking area	4.1	4.2	Total
Area	7,000	20,000	27,000
No. of parking bays	84	210	294

Office buildings	5.1	5.2	5.3	Total
Area	1,600	1,600	3,200	6,400

Investment land	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	6.10	6.11	Total
Area	10,000	10,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	120,000

Green areas	253,000
Roads and vehicle circulation areas	330,000
Logistics centre's surface area	1,010,215

Source: author's own materials

7. INVESTMENT SCHEDULE

The schedule assumed for the model ILC construction investment is based on two fundamental premises, the first being an intent to start operation of a part of the ILC as soon as possible, and secondly, that consecutively commissioned ILC components are built in a sequence, which corresponds to the needs of future tenants. The former premise will be fulfilled by completing the investment in stages, while the latter will be fulfilled by rendering the services that the ILC's customers expect the most. In accordance with the results of the survey conducted among potential recipients of the ILC's services, these include the following:

- freight forwarding and transport services (performed by ILC tenants)
- warehousing and storage in yards
- combined transport handling (road and rail trans-shipment terminal)
- parking services
- hotel and catering services
- customs clearance
- technical servicing of vehicles

The proposed modular nature of the investment (see the ILC land development plan) and the investment schedule, which assumes that individual modules will be completed in stages, have a positive influence on limiting financial risk and increase the capacity to win clients and partners for the project.

The schedule defined for the model ILC construction investment has been prepared with regard to three options of stage-wise construction. Such an assumption has been made by considering the general experience related to the construction of similar logistics centres in EU countries, as well as the need to assess the impact of the stage-wise ILC construction on the investment effectiveness. Consequently, it has been assumed that the ILC construction cost-effectiveness is to be assessed from the perspective of the stage-wise character of the project, as well as the choice of the best of the following options:

- Option A - project completed in two stages
- Option B - project completed in three stages
- Option C - project completed in four stages

The first stage of construction works is intended for the completion of the most important and capital-intensive ILC components required to attain the target size of the logistics centre, including the construction works to be performed by local authorities and the PKP (Polish National Railways):

- providing utilities on the ILC premises
- extending access roads and tracks to the ILC premises
- completion of individual ILC components by investors, as defined under the investment stages, including: container terminal, enclosed warehouses and storage yards, internal roads and vehicle circulation areas, separated customs clearance zone, technical backup facilities of the vehicle service garage, and office buildings

The scope of investment to be completed by investors in the first stage of the ILC construction will comprise the following:

- purchase of all land parcels planned for the investment - 100 ha
- development of internal utilities for purposes of the operations to be conducted on the premises subject to the given investment stage, including: access roads and vehicle circulation areas, rail docks and track, parking area for heavy goods vehicles, water supply and sewage disposal system, power and gas supply network, telecoms and IT network.

The construction of the enclosed building infrastructure is divided into three main parts:

- warehouses intended for area lease
- unroofed goods storage yards

- office buildings intended for logistics operators and providers of banking and postal services etc.
- construction of the container terminal, including a container trans-shipment and storage yard

Besides the aforementioned investments, part of the ILC land will be available for lease and intended for the construction of buildings and facilities to be financed by external investors not directly related to the ILC, including:

- storage facilities
- petrol station for heavy goods vehicles and passenger vehicles
- service garage for heavy goods vehicles
- hotel

The entire ILC construction in stages has been planned for completion within 12 years, where the actual construction works will proceed between the second and 12th years of the investment, while the first year is to be consumed with design works, land purchase and preparations before the commencement of the actual construction works.

The land development plan assumes that about 25% of the total ILC area will be rendered available to external investors for the purposes of their own projects. The fact that 49% of all the land has been intended for non-production areas (greens, roads, vehicle circulation) implies that half of the total production area will be used for facilities financed by external investors.

It should be noted that the value of the land will increase considerably once it has been developed to ensure access to utilities and connected with transport infrastructure (container terminal). As time passes and interest in the project grows among further investors, one may expect the value to rise even higher.

The schedule of land preparation by the ILC for leasing to external investors assumes that all works required to complete the respective stage of the ILC construction will be completed within the first year of the given stage.

8. CONCLUSIONS

As a result of the research experiment conducted by applying the methodology developed for the sake of assessing the economic factors underlying the construction of an ILC, the following conclusions have been drawn:

- Businesses that generate the low-volume flow of cargo units incur high unit costs of warehousing operations, which should incline them to use the ILC's services.
- None of the investment variants taken into consideration with regard to the ILC construction guarantees a satisfactory return on investment in relation to the ILC construction within a 15-year time span, the evidence of which can be found in the negative NPV indices (NPV for total capital).
- Investing in the ILC seems profitable if one considers the cash flows connected with the project financing, as evidenced by additional NPV indices for equity, as well as residual values of investment.
- The factor of decisive influence on the cost-effectiveness of the ILC construction and operation is the structure of investment capital. The impact of service prices, as well as the stage-wise nature of the ILC construction project, is of secondary importance.

- It has been established that a compromise solution, which would satisfy entities representing both the public and the private sectors, whose preferences are essentially disparate, can indeed be found.

The factors that determine the cost-effectiveness of the investment, which encompasses both the construction and the operation of the ILC, are as follows:

- public-private partnership in terms of investment capital
- using financial aid and public capital to complete the investment
- low prices of the services to be rendered by the ILC, conditioning the high utilization rate for resources and employment maximization

To recapitulate on the above, it should be noted that the multicriteria decision-making support methodology has proved efficient as a tool for solving decision-making problems in relation to the ILC construction.

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