Methods for Calculating the Efficiency of Logistics Centres

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Abstract

Changes in the organization of the transport system, such as building a logistics centre, bring them uncertainties linked with the risk of investments failure. One of the first steps of creating such a logistics centre is carrying out a thorough economic analysis. Localization and organizational analysis and then the assessment of the functioning of the future centre is possible mainly thanks to the economic effectiveness calculation, which takes into account the expenditure, the operating costs, and benefits of creating a logistics centre in a selected place and gives the answer concerning the reasonableness of organizing such a centre. The article describes various types of the economic effectiveness calculations. As a result of the analysis performed a formula has been suggested, which can be used in the case of estimating the rationality of organizing a sample Logistic Centre consisting of four infrastructural elements. All of the described above simple and complex methods for calculating economic efficiency are the starting point for a discussion on the use of REE calculation for Logistic Centre in Southern Podlasie.

1. Introduction

In view of the problems besetting Polish transport system and inhibiting its development and the ongoing technological changes, there is a need to consolidate the haulage effort in a specific location (transport hub) and the necessity for cooperation of all the transport process participants, including the transport modes, in that said hub, which is the logistics centre. The logistics centre, by definition, coordinates the work of the various

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modes of transport. This means including, in the transport operation, all of the resources that are necessary to ensure its success, i.e. to meet the transport need.

The Classic logistics centre is defined as a spatial object together with the infrastructure and organization, in which the logistics services are being provided, related to receiving, storage, distribution and despatching of goods as well as the ancillary services provided by independent entities, in relation to the sender or the recipient.

In Western Europe, the modern logistics centres were built back in the 70 - ies of XX century. They are equipped with infrastructure capable of handling several modes of transport, computer and telematic centre, warehouses, along with specialized cargo handling equipment, enabling fast handling of goods. The development of such terminals and centres is strongly associated with the development of modern multimodal technologies.

Poland has favourable conditions for the development of this type of logistics centres in the transport corridors, because it is a transit country, through which run large streams of goods from the East to the West of Europe and vice versa. In view of the increase in trade is expected that the exchange of goods will increase, which will result in an increase in the stream of haulage. The fact of the Polish presence in the European Union is not without significance here and the participation of our country in a common EU transport policy. The idea behind the development of modern, European transport policy is creation of a sustainable transport system, and thus a return to, so-called, Modal Split. It is this concept that necessitates in the development of logistics centres, in which there will be collaboration of various modes of transport and strongly supports the concepts of using combined transport.

The evaluation of economic efficiency of the organization of the logistics centre (CL), whose measure is the result of economic efficiency calculation (REE), aims to facilitate making decisions on the profitability of the creating, organizing and functioning of such a centre in the future, it sets objectives, for the organizers and the centre users to strive towards and outlines ways to achieve them. Such an evaluation is essential when applying for an additional source of financing such investment (funds from the European Union, credits and bank guarantees, etc.). With a well-conducted analysis it is possible to plan in detail future actions and predict whether or when we will make profit and when the expected payback period of the expenditures incurred for the creation and organization of the CL, will take place. It's easier also to see the need to change strategy before starting a business, being able to avoid future costly mistakes.

Starting a business requires proper preparation. The result of the economic analysis is the result of REE. Properly interpreted, it sets objectives for a given project and determines methods of its implementation, and also facilitates functioning of the market. REE is helpful especially prior to commencing business activities; it assists in its financing and management. There are no rules as to the volume of REE, for a large project, it should, however, take into account many different factors.

There are many definitions of economic efficiency calculation. They state, among other things that:

- it is the primary instrument of the investment purposefulness analysis. With the proven methods of this calculation there is an objective, accessible to all test of the right economic decision-making [2)3];
- it is the method of calculating the inputs and outputs at different alternatives of shaping costs and prices. Also in this sense it is a procedure that allows to achieve a maximum degree of achievement of the original objective with a given inputs or minimizing capital expenditures at a given stage of fulfilling the objective;
- comparing the expenditures associated with the actions taken and the intended effects it makes it easier to select a procedure variant, which allows you to achieve maximum benefit , e.g.:
  - ➢ option I - the principle of greatest effect / highest efficiency (if the measures are known, to maximize the objective),
  - ➢ option II - the principle of smallest input / cost-saving of measures (if the goal is known, to minimize inputs);
- in other words it is confronting the results achieved (outcomes) with the expenditure incurred on them, expressed in monetary units, enabling their comparability;
- it answers the questions: what? , how? , how much? and when? to produce and is the basis for determining the production programs, guidelines and terms of sale, adapted to market conditions;
- it is a set of methods and measures enabling to make the best, i.e. the optimal decision, on the allocation and use of resources and measures to achieve the best results in line with the social rationality of economic activities;
- it reveals the strengths and weaknesses of the project, verifies its reality, helps contractors meet the set out target;
- it applies to the investment and development projects which, analysed in their preparation phase (pre-investment studies) are called investment projects.

It is widely recognized that the best criterion of the economic activity evaluation at microeconomic level is profit. [10] Therefore as a profitable venture is seen one that ensures a profit. The choice of the most effective options is to maximize profit for the capital involved. However, the application of only profit measure for the evaluation of investment projects is insufficient. This criterion does not account adequately for such the factors such as „time" and therefore the "risk".

The risk factor is strongly related to investment activities and in time of its realization. For the short-term decisions the risk is low but it increases dramatically when it comes to long-term decisions. There is therefore a need to take into account the risk factor in REE of the given project. Also, the time factor is linked with the distribution, in the coming years, of the input costs for the implementation of certain projects and effects achieved by them. Both the inputs and the effects are not equally valuable because of the time they occur. The later the expenditure is incurred and the earlier the results are obtained, the higher is the effectiveness of the project being implemented. The time factor differentiates therefore the profitability of the projects with profit realized at different times.

Profit maximization as a basic criterion in decisions for short-term investment decisions can only be an auxiliary criterion. The time and risk factors would suggest to take as a criterion for assessing the organization project rather profit optimization which will ensure the development of the project in the long run, which leads to the maximization of its value. Determination of an appropriate criterion for assessing the project and applying proper economic efficiency calculation methods allows to set out the correct directions of development of the project, ensuring the maximization of its value.

Taking into account the specifics of the creation and development of the logistics centre one needs to consider REE for project and not for the venture. In this case, there are two trends that should be considered when making an investment decision:

- ongoing evaluation trend,
- long-term trend evaluation.

In this particular case of the future logistics centre in Małaszewicze [1] the ongoing evaluation may be related to the functioning of the existing components of the proposed centre, after ensuring managerial coordination of their operation. However, the long-term evaluation applies to investments undertaken that make up the final form of the proposed logistics centre.

2. Methods for the REE evaluation

Among the methods of economic calculation, likely to be used in the calculation of the investment efficiency of the Logistics Centre (CL) type, there can be absolute and relative methods distinguished of assessing the profitability of investment projects:

- absolute methods - evaluate individual project of the business enterprise,
- relative methods - are to select from a variety of possible options for the implementation of the project, the one which is the most efficient and cost-effective.

Another division of the REE method distinguishes simple and complex methods (discount) which appear in the literature under different, often confusing names. Taking into account the specifics of REE for CL, which is due to the scale of investment must account for in the algorithm the variability of money value over time, risk and scope of profitability evaluation carried out, the appropriate will be especially complex REE methods.

Simple methods do not include the variability of the money value over time and are based on the profit as the measure of the net gain [6]. Therefore, they are used mainly for small investments, the short term, where the capital commitment is relatively low. These methods do not require detailed data and quickly provide information on comparable projects. The annual figures used in these methods are nominal values, undiscounted at the time of the assessment, which leads to a balanced treating of effects and expenditures, regardless of the actual time of their occurrence. Since these methods do not take into account changes in the value of money over time they are burdened with a great risk [8].

For the use of simple methods for the absolute profitability assessment speaks their uncomplicated nature and affordability. Using these methods and interpretation of the results obtained by using them does not require a deep knowledge of economic theories and conducting tedious computational processes. There are many divisions of simple methods. The authors used here the division proposed by W. Rogowski [8], according to which the most important simple methods are payback period methods:

1) simple rates of return:
   - ✓ simple rate of return on investment (Return on Investment – ROI),
   - ✓ simple rate of return on equity (Return on Equity - ROE);
2) simple payback period (Payback Period - PP);
   - ✓ accounting rate of return,
   - ✓ break-even analysis, also called investment break-even or sensitivity analysis.

2.1. Payback period methods

The payback period methods allow to choose from a variety of investment projects variant allowing the fastest possible recovery of investments incurred. The payback period is a number of years, during which the investment outlays incurred will pay for themselves in the form of the economic effects of these investments. The advantage of the payback period methods is its simplicity and communicativeness of the message, and the disadvantages - lack of objective decision-making criteria, lack of accounting for the value of money over time, not taking into account the effects after the payback period and taking into account the results of accounting results rather than cash in-flows.

2.1.1. Simple rates of return

Simple rates of return are a relative measure of the absolute profitability of investment projects and express their relationship of the net benefits to the size of the of capital involved:

$$R = \frac{K}{I} 100\% \ ,$$

where:
K – net gain expressed by profit,
I – investment outlays.

There are two types of simple rate of return i.e. a simple rate of return on investment (ROI), in which the operating profit is divided by total investment outlays:

$$ROI = \frac{Z_o}{I_c} \times 100\% \ ,$$

where:
Z_o – operating profit,
I_c – total investment outlays;

and the simple rate of return on equity (ROE), in which the net profit is divided by total capital expenditures financed with equity:

$$ROE = \frac{Z_n}{I_{kp}} \times 100\% \ ,$$

where:
Z_n - net profit,
I_{kp} – total investment outlays financed with equity x 100 %.

Simple rate of return on equity is estimated only for the owner and is the ratio of capital expenditures financed with equity and a measure of net benefits. In addition, simple rates of return are not synthetic methods, but the annual (one period).

Based on simple rates of return methods one can not build objective decision criteria. Therefore, as decision criterion is only accepted the principle of maximizing their value and to achieving a value greater than the rate limit. Determining the method of constructing a rate limit is, however, subjective in its nature [8] [13].

2.1.2. Simple payback period (PP)

The payback period (T) is the expected number of years required for obtaining complete return on investments. The main question to which we get an answer is, how long will take to repay the investment outlays?

In principle, a simple payback period is the ratio of investment outlays (I) and average net cash in-flows (average annual cash in-flow) from the project, which represent the sum of the annual net profit and annual amortization.

$$T = \frac{I}{W_p} \ ,$$

where:
T - payback period,
I – investment expenditure,
Wp – average cash in-flows defined as income + annual amortization.

According to W. Rogowski the simple payback period method estimates the length of time it takes to recoup the capital expenditure incurred for the implementation of the investment project, by net benefits generated by the project. Therefore:

$$T = \frac{I}{K_n} \ ,$$

where:
T – simple payback period,

I – investment expenditure,

K_n – net benefit.

The differences in the recording investment outlays and net benefits make that there are many variants of the simple payback period. Discrepancies in determining the payback

period complicate the use of PP method in practice, because in extreme cases, the use of different algorithms for the same investment project may lead to contradictory results.

Based on the simple payback period method one can not build an objective decision-making criterion but only to formulate a subjective criterion, where the payback period of the given project is compared to a threshold value called payback period limit. The absolute decision criterion based on the simple return method may be generally presented as follows:

- if n < ngr then this investment project is viable and can be accepted,
- if n > ngr then this investment project is not viable and should be rejected,
- if n = ngr then whether to accept or reject an investment project should decide other factors not included in this method [8].

Another formula calculating the payback period compares expenditures with cumulative positive cash in-flows and observes when the amount will be 0. In this case:

$$T = t + \frac{N_o}{Pt},$$

where:

T - payback period,

t – number of full years before the end of full payback,

N_o – not paid back outlay at the beginning of the year, during which the full payback of the investment will take place (absolute value),

Pt – planned positive flow at the end of the financial year during which the full payback of the investment will take place.

Another definition says that the payback period (T) – is the time that is necessary to offset the revenue expenditures:

$$T = \frac{t + N_o}{Pt},$$

where:

T - payback period,

t - the last year, at the end of which the expenditures are not returned (the number of full years before the full repayment),

N_o - expenses not repaid at the end of year t,

Pt - net income in the following year.

2.1.3. Accounting rate of return

The Accounting Rates of Return (ARR) method defines the relationship between the annual profit generated during the operation of the project and the value of investment outlays. Accounting rate of return method is also referred to sometimes as the average accounting return (AAR). Accounting rate of return (profit) is the ratio of the expected annual project net profit to the so-called average investment, which is the book value of the

asset at the mid point of its operation. This method does not take into account amortisation, which, together with a profit represents cash flows. As the criterion for the selection of the investment project based on the accounting rate, is regarded its maximum value or greater (equal to) the rate adopted as the limit for similar projects. There are many ways to calculate the accounting rate of return. In contrast to the simple rate of return it uses average values rather than annual ones:

$$ARR = \frac{K_{śr}}{I_{śr}} \ ,$$

where:
$K_{śr}$ – the average accounting net benefit,
$I_{śr}$ – the average accounting value of the investment outlays.

The economic interpretation of the accounting rate of return is contained in the statement: how much of the average net gains expressed in net profit is attributable to one ZLOTY of the average value of investment outlays. The ARR method informs then about the average profitability of the investment undertaking.

Another definition says that it is the ratio of annual net profits to the opening and closing capital involved:

$$ARR = \frac{Z_n}{\dfrac{K_{pk} + K_{kk}}{2}} \times 100\% \ ,$$

where:
Z_n- annual net profit,
K_{pk} - initial capital invested,
K_{kk} - final capital involved.

The main advantage of the rate of return measures calculated based on the average values is the fact that they take into account in an indirect way the entire period of the analysed enterprises.

2.1.4. Break-even analysis

Break-even analysis is a method of financial evaluation of a different nature than the other simple methods. It concerns the sensitivity of the project to the changes of the factors determining the profitability of its realization. In this study, it is possible to take into account the variation of a single factor (e.g. price) with others unchanged or simultaneous change of several factors. By selecting out only the „pessimistic changes" it is also possible to determine so called viability of the given project in the worst possible operating conditions. Changes of the individual factors causes shifting of the break-even point. Therefore, the starting point of the analysis is to determine what level it will reach if there are changes of e.g. variable unit costs or fixed costs.

For example, limit price level can be calculated by the formula:

$$C_{\min} = \frac{Kz \times P_x + Ks}{P_x},$$

where:

$C_{\min}$ – limit level of the unit price of the product,

P_x – assumed sales volume of the product,

Kz – variable unit costs,

Ks – fixed costs.

They may therefore be only as an auxiliary tool for the evaluation. The final decision on the implementation or rejection of specific investment projects should be preceded by REE based on complex methods (discounting). REE of creating and functioning of the CL will be characterized by the time span of the project, and thus the degree of risk (However, risk level in case of establishing the logistics centre is quite different from investing in the financial markets (e.g. stock exchanges). Hence, the risk will not be in this case so important). [10] Therefore more appropriate in the case of the REE use for CL will be complex methods of evaluating investment projects taking into account the time factor and the associated risk.

2.2. Complex (discount) methods of evaluating the REE results

All monetary issues of the investment project are carried out within a specified period of time and are of cash flow character. The value of money changes over time, therefore complex investment appraisal methods include the time factor [12], taking into account the volatility of the money value over time and capture the net benefit in the context of the net cash flow. The time factor exists in REE, e.g. in the form of: frozen funds at the time the implementing of the investment. during use of the fixed assets resulting from the investment, payback time, which is a synthetic initial indicator of the effectiveness of the investment.

From an investor's perspective, all of the funds involved in the new venture, such as a logistics centre, bringing initially negative cash flows. Once the profitability threshold is exceeded, positive cash flows should not be immediately paid out as dividends, but should be used to strengthen the financial balance. The cash will return to the investors at the time of their leaving the investment. Since the cash flows will take place over a number of years, must be discounted, that is, calculated by reference to the present moment (the calculation of interest and accrued interest). The discount factor can be calculated using the following formula:

$$D = \frac{1}{(1+r)^T},$$

where:

D - discount factor,

r = discount rate as a percentage,

T = the year in which the cash flow takes place.

The most commonly used in the practice discounting methods of economic calculation are:

- discounted payback period,
- Net Present Value (current) - NPV,
- Internal Rate of Return - IRR.

2.2.1. Discounted payback period

The discount is the amount by which the expected future value of capital has to be reduced to obtain the current value. This amount represents the change in the value of money over time. The ratio between the discount to the value of the future capital represents a discount rate:

$$PV = FV - D ,$$

therefore:

$$r_d = \frac{D}{FV} ,$$

where:
PV - present value of the capital,
FV - future value of the capital,
D – discount,
r_d - discount rate.

The method of discounted payback period, only in one point, differs from the traditional payback period, namely we are comparing the expenditures with the discounted proceeds, which is expressed in the present value of the cash flow. Under this assumption, it becomes important to determine the interest rate (discount rate) necessary to determine the discount factors. This method, like its predecessor, focuses only on the part of the cash in-flows required to repay the investment outlays. Still, part of the projects is no evaluated throughout their implementation period.

Based only on the payback period method it is impossible to build an objective criterion for decision-making. The payback period of the given venture (T) is thus compared to a threshold value - the payback limit period (Tgr), i.e. the average period of return on similar projects in the same industry. Where:

T< Tgr - profitable investment,
T > Tgr - investment unprofitable,
T = Tgr - about the rejection or acceptance should determine other factors.

2.2.2. Net present value - NPV

Another complex method to evaluate investment project is the method of the Net present value. NPV method is mathematically expressed as the sum of all net gains (net cash in-flow) achieved throughout the entire economic life cycle of the investment venture, which are discounted prior to the summing up, i.e. reduced to a single point in time in order to harmonize their monetary value.

To determine the NPV it is necessary to:

- estimate the value of net cash flow throughout the entire economic cycle of the investment venture,
- estimate the discounted value for every net cash in-flow,
- sum up the discounted net cash in-flows.

The result of summing up is treated as a cumulative net benefit from the given investment venture i.e. NPV.

Another definition says that the method is based on the methodology of discounted (operational) cash flows, on the calculation of the account throughout the duration of the entire investment project (t = 0, 1 , ... n -1, n), and on adopting a prudent assumption concerning a discount rate, which is usually accepted at the level of the cost of obtaining capital for the realization of the project (average weighted capital cost). The economic rationality requires that the cost of capital was lower than the rate of return expected by investors.

The principle of the NPV calculation is as follows. First, it is necessary to discount and then sum up all the cash flows related to the investment project (including positive and negative ones). The project selection criterion used is clear, i.e. accept are only projects with NPV > 0 Others get rejected. If we are to choose one of two projects with positive NPV, then choose a project worth more. It is worth noting that the decision to choose a particular project is correct for a given interest rate. However, one should not use simple analogies with the conclusions regarding other interest rates. It is best to conduct again the NPV calculation.

To calculate the NPV the following formula is used:

$$NPV = \sum_{t=0}^{n} NCF_t \times CO_t ,$$

where:
NCF_t – net cash flows in subsequent years of the calculation period,
CO_t – present value factor (discount rate) for the subsequent years of the calculation period (proper for accepted interest rate),
t = 0, 1, 2,…, n – subsequent year of the calculation period.

If the total expenditure incurred in year t = 0, this formula can be represented as follows:

$$NPV = \sum_{t=0}^{n} \frac{D_t}{(1+i)^t} - I ,$$

where:
D_t – net cash flows associated with the current operation of the venture (excluding capital outlays) in subsequent years of the calculation period,
I_t - capital expenditures in subsequent years of the calculation period,
i – annual interest rate,
t = 0, 1, 2, …, n – another year of the calculation period.

In the case of the application of this criterion, we accept only projects with NPV . A positive NPV value implies that the rate of return of this venture is higher than the rate

limit, defined by the interest rate approved for the calculation. Each investment characterized by NPV > 0 can be realized, as it will produce financial benefits to the venture.

K. Leszczynski recognizes that unequivocal social criterion in the economic calculation in the long run (in the discount formula) is maximizing the net present value (NPV = max $\geq$ 0), provided of course that it will be properly calculated [6]. This criterion is the sum of updated pure profits in the discount period. The fulfilment of this criterion means that any new entity resulting from the investment project will find itself in the dynamic equilibrium economics. Achieving NPV = max $\geq$ 0, indicates that the selected project investment is optimal (economically viable), for every PLN (the first and last one) of the investment outlay will ensure each year of the discount period gain of not less (greater than or in an extreme case, equal) than the threshold rate of return – r.

NPV method can be used for the fixed cash flows, such as investment tranches in the long run.

2.2.3. Index of internal rate of return - IRR

Another complex method is the internal rate of return method (IRR). It is the second after NPV, most commonly discount method used in practice. IRR shows directly rate of return of the investigated ventures. A single investment project is profitable if its internal rate of return is higher than the rate limit, which is the lowest possible acceptable to the investor's rate of return.

In other words, the internal rate of return is the interest rate at which the discounted sum of all positive and negative cash flows is zero. Most calculators and spreadsheets have a function for calculating the IRR, for example, in the Excel it is the function IRR. The internal rate of return can also be calculated "by hand". IRR indicates the exact rate of return of the project, because to determine it is necessary to calculate such a discount rate i = r, for which the NPV = 0, which is the threshold rate of return.

Another definition says that the internal rate of return is the discount rate at which present value of expected cash flows equates with the present value of the expected costs. The similarities between the IRR and NPV method are obvious. There is however one major difference: the discount rate in the IRR method is an equivalent to the expected rate of return, and not the cost of capital. IRR calculating method is similar to the NPV method. The difference is that the value sought is the discount rate, called the IRR and not NPV, which assuming that the discounted investments align with the proceeds, equals to 0.

The procedure for determining the IRR involves several steps. In practice, the internal rate of return is determined using computer programs (such as the already mentioned Excel spreadsheet) or a financial calculator. First, determined is the value of the net cash flows in the subsequent years of the project realization, like in the calculation of NPV. Then, by successive approximations, selected are two values of interest rate (i_1 and i_2), those where:

- NPV calculated based on i_1 is close to 0, but positive, and determined in this manner NPV level is designated as PV;
- NPV calculated based on i_2 is close to 0, but negative, and determined in this manner NPV level is designated as NV.

With these values we calculate the internal rate of return of the investigated venture:

$$IRR = i_1 + \frac{PV \times (i_2 - i_1)}{PV + NV},$$

where:

i_1 – level of the interest rate at which NPV>0;

i_2 – level of the interest rate at which NPV<0;

PV – NPV level calculated from i_1;

NV – NPV level calculated from i_2.

In the presented IRR method, particularly important is the difference between the level i_1 and level i_2. This difference should not be substantially greater than 1 %. For in reality relationship between the level of interest rates and the level of NPV is non- linear, assumed by the present formula.

All of the described above simple and complex methods for calculating economic efficiency are the starting point for a discussion on the use of REE calculation for CL in Małaszewicze at Southern Podlasie[1].

2.3. The method used to carry out REE for CL

While conducting REE for the sample CL [1] a formula including the time factor based on the discount method, was used. To sum up, the current economic efficiency calculation has been taken from the work of Michał Kalecki [4], as well as the paper by Tadeusz Dorosiewicz [3] and has the form of the following ratio:

$$E = \frac{I + I_q n + K_e n}{\sum\limits_0^n P_n},$$

where:

E – efficiency ratio;

I - investment outlays (direct, accompanying and indirect investment) incurred within the specified time, mean the total investment expenditures incurred for the design, construction and commissioning of the logistics centre;

$I_q n$ – interest on the investment outlays (such as bank loan) over n period (amortisation i.e. the part of the expense related to the operation of the asset);

q - interest derived from statistical tables or average interest rate of several examples of banks;

$K_e n$ – operating costs (direct, associated with and indirect costs) over n period (they do not include depreciation contained in I and $I_q n$);

$\sum\limits_o^n P$ - production volume or value of production throughout the entire period of the logistics centre operation (production or services effects of the investment are expressed in natural meter such as the number of transported tons or tonne-kilometres).

This formula assumes a simplified model of organizing the logistics centre. According to this model the construction of facilities is instantaneous (so there is no problem of freeze outlays in the construction). The project has a standard durability period, say 20 years (so there is no problem of different periods of operation), and finally the production and the costs are fixed for the life of objects operation (so there is no problem of the production dispersion and the cost over time). In this simplified model what remains is only a matter of additional permissible investment outlays I which bring lowering of the operating costs - K , in the compared investment properties, which is determined by the limit payback time T. The T value should be chosen to be conducive with maximizing production growth using the entire investment measures. Because in the economy there are ample opportunities to reduce costs by replacing old appliances with new ones, and by their modernization or mechanization of work, at relatively low investment outlays with the payback time T of less than six years, then making additional cost savings at the expense of the investment outlays that exceed this limit would be a waste of investment funds.

Prerequisite of choosing a better option of the two comparable variants, giving the same production, can be expressed as follows:

$$I_2 - I_1 \triangleleft (K_1 - K_2)T \text{ or } \frac{I_2}{T} + K_2 \triangleleft \frac{I_1}{T} + K_1 .$$

The comparison, therefore, concerned two solutions where:

I_1 – current variant,

I_2 – target variant,

K_1 - operating costs of the current variant,

K_2 - operating costs of the target variant,

T - pay-back period on investment outlays.

In other words, the better option is one for which the formula:

$$E = \frac{I \frac{1}{T} + K}{P} ,$$

where:

E- effectiveness of investment, the investment is more efficient the smaller the E value,

T – normative investment outlays payback time, taken initially as six years (excluding amortization deductions in costs) or eight years (with amortization deductions); has a smaller value.

However, this is the simplest form of the formula for the economic efficiency of investment, because the costs relate to the one-year period. So the investment outlays are reduced to a one-year period by multiplying them by the inverse of normative return time on investment outlays.

This formula is the starting point for the formula cited at the beginning of the reasoning:

$$E = \frac{I + I_{qn} + K_n}{\sum\limits_{0}^{n} P_n} \, ,$$

where $q = (\frac{1}{T}) - (\frac{1}{n})$.

At present we assume that this formula is true only for the standard n_s period (say, 20 years). For other periods it requires appropriate amendments.

In conclusion, and emphasizing the time factor, the formula for the efficiency calculation of the logistics centre functioning, consisting of a minimum of four elements we begin to develop in the following way:

$$E = \frac{\sum P_{1,2,3,4}}{\sum I_{1,2,3,4} + \sum K_{1,2,3,4}} \, ,$$

where each of the elements of CL (e.g. airports), will have to however be subject to a separate calculation.

Conducting a calculation of the economic efficiency of the creation of a logistics centre is aimed at comparing it with the economic efficiency calculation of the existing transport coordination system. In this case, therefore, the comparison is with another variant of the solution. It is therefore a relative REE.

The construction of the logistics centre will pay dividends when the economic efficiency calculation of the operation of the logistics centre will be better than the economic efficiency calculation of the existing transport coordination system (DSKP).

First, then it is necessary to make the economic efficiency calculation for the logistics centre:

Logistics Centre – CL = E_{CL}.

Next, make the economic efficiency calculation for the existing transport coordination system:

Existing transport coordination system - DSKP = E_{DSKP}.

The next step should be to compare the results of both of these calculations. After deduction from the result of the economic efficiency calculation for the existing transport coordination system, the economic efficiency calculation for the logistics centre we will receive the difference:

E_{DSKP}- E_{CL}=Δ,

where: Δ = resulting difference.

If the difference is greater than zero, it will mean that the existing transport coordination system is less efficient (cost-effective) than the solution of the logistics centre:

E_{DSKP}- E_{CL}>0.

If the difference will be close or equal to zero, which means that the existing transport coordination system is equally efficient (cost-effective) as a logistics centre solution:

$$E_{DSKP} - E_{CL} \geq 0.$$

It should then be considered whether there are perhaps other non-economic benefits demonstrating the superiority of the logistics centre over the existing transport coordination system.

If the difference is less than zero it means that the construction of the logistics centre is unprofitable:

$$E_{DSKP} - E_{CL} < 0,$$

in other words:

$$\frac{E_{DSKP}}{E_{CL}} \lhd 0.$$

Based on a concise calculation, that is encompassing global efficiency calculation and so-called, profitability period, the choice of investment solution is conditional on:

$$E \lhd E_b, E_1, E_2, E_3, ..., E_n,$$

where:

E – indicator of the solution accepted,

E_b - comparative base indicator,

E_1, E_2, E_3, E_n – indicators of other possible solutions.

Concise calculation based on the above indicator allows to select investment solution, ensuring the achievement of certain production tasks or services, with minimal expenditures. The indicator becomes more favourable with the minimization of the total expenditures, i.e. investment outlays and operating costs.

The effectiveness of the investment outlays can be looked at from the update of the flow of the logistics services production conditions in different periods or points in time, on any chosen moment (e.g., the expected completion of the investment).

The today's value of PLN received for t years is:

$$\alpha = \frac{1}{(1+i)^t},$$

where:

α – discount rate,

i - interest rate,

t - year in which the flow of money takes place.

This is the discount factor, tabulated for economic calculations.

Updating future annual income at each end of the year 1, 2 , 3, ..., t are of interest (equal here for simplicity). The value of this income is:

$$\alpha = \frac{1 - \dfrac{1}{(1+i)^t}}{i} = \frac{(1+i)^t - 1}{(1+i)^t i}.$$

This is called, factor updating future annual incomes. It allows to derive a general formula for the efficiency of the investment outlay [11]:

$$1 \leq \sum_{\tau}^{T_0} \frac{P_t - R_t}{(1+i)^t} \; ,$$

where:

τ - period of the investment maturing (reaching the expected volume of production, e.g. services),

T_0 – operating period of the investment,

P_t – revenue (takings, sale of assets) in the time t,

R_t – outflows (investment expenditure, cost, taxes, insurances) in the period t,

i – updates rate (discount).

The P. Sulmicki formula can be converted according to Kalecki formula:

$$1 \leq \sum_{\tau}^{T_0} \frac{P_t - R_t}{(1+i)^t} \quad \text{or otherwise} \quad I \leq \sum_{\tau}^{T_0} \frac{P_t - K_e}{(1+i)^t} \; .$$

If $i = \bar{i}$, that is, the update rate is equal to the desired profit rate, then we compare the cost of the investment outlay m_0 with its value w_0, defined as the sum of updated at the end of the year future incomes attributable to this outlay, i.e. instalments of the amortisation deductions U_t and net profit S_t:

$$m_0 \leq w_0 = \frac{U_1 + S_1}{1 + \bar{i}} + \dots\dots + \frac{U_{T_0} + S_{T_0}}{(1 + \bar{i})} \; ,$$

If this condition is met, the outlay is effective.

Reversing the formula of Kalecki and Sulmicki, i.e. putting the production in the numerator and dividing by the capital expenditures and costs, we obtain capital intensity of the investment concerned.

Capital intensity is the ratio of the value of the fixed assets involved in the production to the value of production obtained using them. Capital intensity ratio is the amount of investment outlays needed to achieve the given effect of the production.

$$Z = \frac{S_t}{\sum_{0}^{n} P} \; ,$$

where:

Z = capital intensity,

S_t – fixed asset,

$\sum_{o}^{n} P$ - volume of production or the value of production obtained by fixed assets throughout the entire period of operation.

Suppose that at any given time the logistics operators have specific investment opportunities (not just only operators but e.g. carriers, retail chains, manufacturers of goods). They will look for allocation that will bring them profit. For the logistics centre which holds a variety of aspects and consists of various infrastructural elements these will be individual locations – places of the best and worst conditions (WOC, „dry railway port", airport and road infrastructure). It necessary to carry out the selection of localization argumented by the calculation:

$$t = t_0$$

$$\frac{E_n}{K_n} = e_n$$

$$\frac{E_1}{K_1} = e_1$$

$$\frac{E_4}{K_4} = e_4$$

$$\frac{E_3}{K_3} = e_3$$

$$\frac{E_2}{K_2} = e_2$$
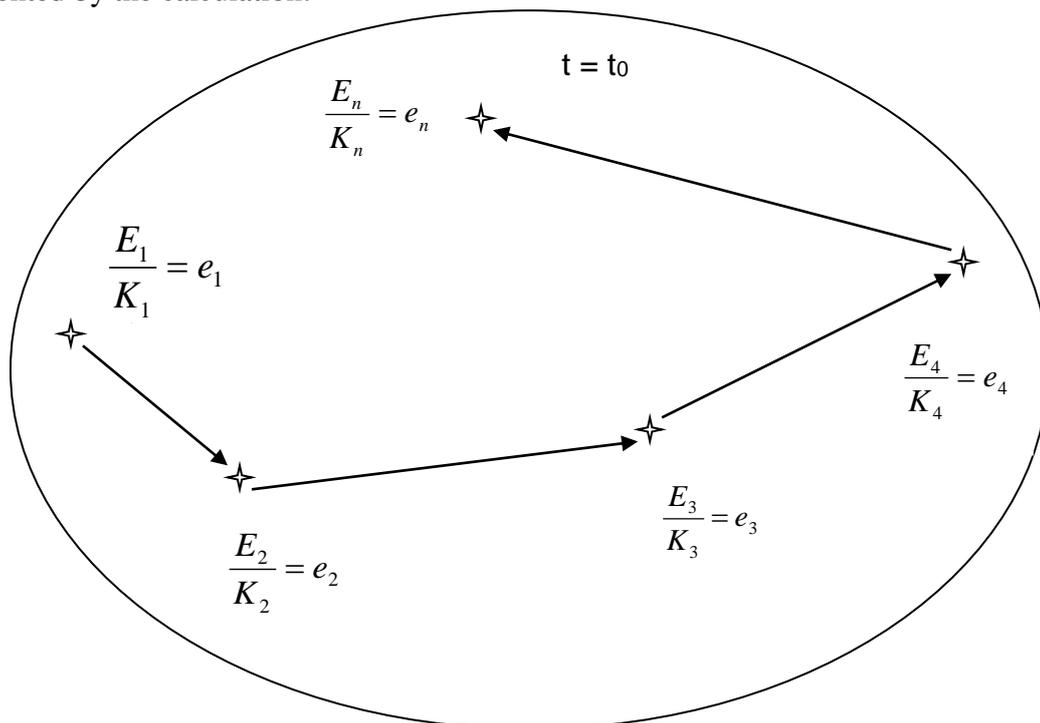
Fig. 1. Logistics centre of several elements

where:
$E_1, \ldots, E_n$ – effect magnitude;
$K_1, \ldots, K_n$ – cost magnitude;
$e_1, \ldots, e_n$ – spatial conditions of efficiency.

The hierarchy of the next localization selections, for example Logistic Centre in Southern Podlasie (CL Małaszewicze) investors will be shaped according to the logic of economic calculation carried out:

$$e_1 > e_2 > e_3 > e_4 > \ldots > e_n$$

Whoever manages the logistics centre must be prepared for use the calculation arguments while convincing potential investors and CL Małaszewicze users about specific location decisions.

3. Conclusions

The presented method of conducting economic efficiency calculation of creating intermodal, multi-component logistics centre combines the existing methods of investment projects evaluation, and also refers to the risk, time and space factors. In the business practice dominate the simplest methods, least time-consuming. This understandable approach, however, requires complementing and expanding in the situation of analysing the economic impact of complex infrastructural and spatial projects. It turns out that such methodological extension is possible based on the achievements of famous Polish economists - Michal Kalecki and Paul Sulmicki, as suggested earlier by Tadeusz Dorosiewicz and others. It is not, in any conflict with the pragmatics of conducting the efficiency calculation of investments in accordance with the guidelines of the European Union, and even, quite the contrary – it contributes to the quality of performed calculations. In connection with the development of transport and logistics infrastructure in Poland it may therefore have utilitarian significance for many investment ventures.

The calculation method presented in the article has been used by the authors for the calculations of the Economic Efficiency Account (REE) for the proposed Logistics Centre (CL) in the South Podlasie region [1]. The authors, as the first ones in Poland, carried out REE calculations for the sample multi modal logistics centre, located in a particular place, i.e. the Southern Podlasie region in eastern Poland. The integrated calculation has been conducted, for this location comprising several elements (and thus dispersed) and an uncoordinated, for the first time to such an extent.

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