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CHAPTER 14
RATIONALE FOR INVESTMENT RELIABILITY

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INTRODUCTION

Transformation processes in the national economy have significantly changed the economic, legal and social environment of the construction sector. Currently, further development of the construction industry requires the involvement of significant investment resources, especially in the case of economic entities that are directly involved in the investment process. After all, the investment activity of the enterprise determines the prospects for its development, the level of competitiveness and renewal and growth of production resources, which, of course, affects the efficiency of its activity.

One of the relevant problems in the activity of construction companies is the problem of taking into account the potential negative consequences of adverse environmental effects and the associated uncertainties and risks that affect the reliability of the entire investment process. And since the implementation of investment of construction companies takes a long time and involves a large number of contractors and various resources, the likelihood of negative effect is increasing significantly compared to other sectors of the economy, which causes a substantive deviation of the real indicators from the planned, and reduces the reliability of investment.

The problems related to the peculiarities of the development of construction enterprises were dealt with: V.I. Anin, N.I. Verkhohlyadova, V.T. Vecherov, V.V. Herasymov, V.F. Zalunin, Y.B. Kaluhin, V.L. Konashchuk, H.N. Lapin, V.R. Mlodets′kyy, Y.V. Orlovska, A.V. Radkevych, V.D. Rayzer, Y.I. Sedykh, V.I. Torkatyuk, R.B. Tyan, L.M. Shutenko and others. Significant contribution to solving the problems of investment activity of enterprises, strategies for investment development of economic systems and the associated risk have made by: M.V. Hrachova, P.H. Hrabovoy, V.V. Vitlinskyy, S.A. Koshechkin, A.O. Nedosyekin, L.N. Tepman, N.V. Khokhlov, R.A. Fatkhudynov and others.

However, there are a number of unresolved issues related to the quantitative characterization of the reliability of the final indicators of investment performance and consideration of those in the economic rationale of investment reliability. In most cases, alternative methods of investing today are not comparable in terms of reliability. In some cases, the economic justification for the reliability of investing is not made at all, in others – the probabilistic nature of the environmental parameters is not taken into account.

The paper discusses the methodological approach to the economic justification of the reliability of investing at variant modeling of possible combinations of cash flow parameters using the method of sequential substitutions. The economic indicators characterizing the efficiency of investments are considered. The influence of individual factors on the economic efficiency of investment of the construction investment project is determined.

14.1. Rationale for investment reliability based on the discrete-state method

Low reliability of investment decisions has a number of negative consequences for both the enterprise itself and its associates (investors, contractors, suppliers), which can lead to the company defaulting on its obligations, its bankruptcy or reorganization.

This applies to businesses in any industry, but construction industry is the most affected by uncertainty. This industry is one of the most capital intensive and is a multiplier of investment stability and attractiveness of other sectors of the national economy. The economic justification of the reliability of investment is one of the conditions for the renewal of investment activity in the construction industry, which determines its economic sustainability, competitiveness and potential in the effective realization of economic interests of all participants of the investment process.

The proposed methodological approach to the economic justification of investment reliability is based on the discrete-state method.

As you know, cash flow consists of two parts – investment cost (I) and positive, which characterizes the return on investment (CF). Also important is the discount rate (r). If we consider each of these parameters from the standpoint of the scenario method, it is logical to enter in the calculation the values corresponding to optimistic (I_O, CF_O, r_O), pessimistic ($I_П$, $CF_П$, $r_П$) and most probable (average) (I_{CP}, CF_{CP}, r_{CP}) scenario of realization of investments. Using optimistic, pessimistic and average values of cash flow parameters, and the method of combination analysis we determine the number of possible combinations and make $3^3 = 27$ variants of combinations or discrete states, for each of which it is calculated a system of indicators characterizing the investment performance – NPV, IRR, RI [1][2].

The calculation of performance indicators for different discrete states allows to determine the regularity of their change $RIf(NPV)$, $IRRf(NPV)$, $RIf(IRR)$, by constructing mathematical regression models. MS Excel Regression tool is used to set parameter values and estimate the quality of the regression model. Establishing functional interdependencies will allow moving to continuous analysis and appropriate calculation of both performance indicators and cash flow.

Next it is set the investor-acceptable performance ranges. Estimation of investor expectations of the investment's performance provides an opportunity to establish whether the performance indicators are balanced according to the terms of the implementation, otherwise the investor is invited to adjust the range of stated performance indicators. If the investor leaves the acceptable indicators unchanged, adjustments require input boundary parameters, namely finding alternative cheaper sources of financing and managing the cost of investment by changing the intensity of their distribution by stages of construction.

For the estimated net present value, corresponding to different combinations of cash flow parameters, the parameters of normal distribution are calculated and the reliability function is built and the required level of reliability of obtaining expected performance indicators (N) from realization of investments is established.

Based on the interdependence functions, the values of the RI and IRR parameters corresponding to the NPV at the established reliability level are calculated and it is determined whether the $NPV_{(N)}; IRR_{(N)}; RI_{(N)}$ indicators are within the acceptable range. If not, the investor is invited to lower the established level of reliability or revisit the range of acceptable values or input limit parameters. However, if the metrics ($NPV_{(N)}; IRR_{(N)}; RI_{(N)}$) are within the acceptable range, then cash flow parameters are determined to ensure that obtained performance data is at the set level of reliability (N). The last stage of the proposed algorithm of

[1] Hoiko A.F. (1999). Metody otsinky efektyvnosti investytsii ta priorytetni napriamy yikh realizatsii: monohrafiia [Methods of estimation of investment efficiency and priority directions of their realization: monograph]. Kyiv: VIRA, 320 p.

[2] Zdrenyk V.S. (2014). Sutnist finansovykh investytsii yak obiektu obliku: problemy ta shliakhy yikh rozviazannia [The essence of financial investment as an accounting object: problems and ways to solve them]. *Ukrainska nauka: mynule, suchasne, maibutnie.* Ch. 1, vyp. 19, pp. 51-59.

economic justification for investment reliability is the investment implementation itself.

For practical calculations according to the methodical approach considered, we will use the following values of flows and their parameters in the optimistic, pessimistic and average implementation scenario (Tables 1, 2, 3).

Table 1

Basic cash flow options

Values	Timeline, years				
	1	2	3	4	5
Optimistic embodiment					
Investment (I)	-100	-100			
Net operating income (CF)			200	200	200
r, %	15				
Cash flow	-100	-100	200	200	200
Discount rate	0,870	0,756	0,658	0,572	0,497
Discounted cash flow	-87,0	-75,6	131,5	114,4	99,4
NPV	182,7				
IRR	57,85				
RI	2,12				

Table 2

Basic cash flow options

Values	Timeline, years				
	1	2	3	4	5
Average embodiment					
Investment (I)	-125	-125			
Net operating income (CF)			190	190	190
r, %	17,5				
Cash flow	-125	-125	190	190	190
Discount rate	0,851	0,724	0,616	0,525	0,446
Discounted cash flow	-106,4	-90,5	117,1	99,7	84,8
NPV	104,7				
IRR	40,30				
RI	1,53				

Table 3

Basic cash flow options

Values	Timeline, years				
	1	2	3	4	5
Pessimistic embodiment					
Investment (I)	-150	-150			
Net operating income (CF)			180	180	180
r, %	20				
Cash flow	-150	-150	180	180	180
Discount rate	0,833	0,694	0,579	0,482	0,40 2
Discounted cash flow	-125,0	-104,2	104,2	86,8	72,3
NPV	34,1				
IRR	27,10				
RI	1,15				

Next, we calculate the performance figures of 27 combinations of cash flow parameters. Summary of these calculations at different discount rates, which are ordered by increasing value of the net present value (NPV) is presented in tables 4-6.

Table 4

Summary of the results of calculating performance figures for different combinations of cash flow parameters (discrete states) at r = 20%

Values	Combinations of cash flow parameters								
	Iп;CFп;rп	Iп;CFср;rп	Iп;CFо;rп	Iср;CFп;rп	Iср;CFср;rп	Iср;CFо;rп	Iо;CFп;rп	Iо;CFср;rп	Iо;CFо;rп
NPV	34,14	48,77	63,40	72,34	86,97	101,59	110,53	125,16	139,79
RI	1,15	1,21	1,28	1,38	1,46	1,53	1,72	1,82	1,91
IRR	27,1	30	32,8	37,2	40,3	43,4	50,8	54,4	57,8
r	20	20	20	20	20	20	20	20	20

Table 5

Summary of the results of calculating performance figures for different combinations of cash flow parameters (discrete states) at r = 17,5%

Values	Combinations of cash flow parameters								
	Iп;CFп;rcp	Iп;CFcp;rcp	Iп;CFo;rcp	Icp;CFп;rcp	Icp;CFcp;rcp	Icp;CFo;rcp	Io;CFп;rcp	Io;CFcp;rcp	Io;CFo;rcp
NPV	49,45	65,33	81,20	88,84	104,71	120,59	128,22	144,10	159,97
RI	1,21	1,28	1,34	1,45	1,53	1,61	1,81	1,91	2,02
IRR	27,1	30	32,8	37,2	40,3	43,4	50,8	54,4	57,8
r	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5	17,5

Table 6

Summary of the results of calculating performance figures for different combinations of cash flow parameters (discrete states) at r = 15%

Values	Combinations of cash flow parameters								
	Iп;CFп;ro	Iп;CFcp;ro	Iп;CFo;ro	Icp;CFп;ro	Icp;CFcp;ro	Icp;CFo;ro	Io;CFп;ro	Io;CFcp;ro	Io;CFo;ro
NPV	66,90	84,17	101,43	107,55	124,81	142,08	148,19	165,45	182,72
RI	1,27	1,35	1,42	1,53	1,61	1,70	1,91	2,02	2,12
IRR	27	30	32,8	37,2	40,3	43,5	50,8	54,4	57,8
r	15	15	15	15	15	15	15	15	15

Next, we define regression models of the performance figures for each of the discount rates you set. The obtained interdependencies are presented in table 7.

Table 7

Functions of performance indicators interdependence

Function	Functional dependence (r=15%)	Functional dependence (r=17,5%)	Functional dependence (r=20%)
$RI\ f(NPV)$	$RI = 0{,}0078 \cdot NPV + 0{,}6877$	$RI = 0{,}0077 \cdot NPV + 0{,}7681$	$RI = 0{,}0076 \cdot NPV + 0{,}8339$
$IRR\ f(NPV)$	$IRR = 0{,}2825 \cdot NPV + 6{,}2771$	$IRR = 0{,}2938 \cdot NPV + 10{,}765$	$IRR = 0{,}3057 \cdot NPV + 14{,}946$
$RI\ f(IRR)$	$RI = 0{,}0276 \cdot IRR + 0{,}5113$	$RI = 0{,}0263 \cdot IRR + 0{,}4832$	$RI = 0{,}025 \cdot IRR + 0{,}4591$

The quality of the obtained mathematical regression models can be estimated by a number of criteria.

The obtained mathematical model will be qualitative if there is a close correlation between the actual values of the resultant characteristic y_i and the corresponding theoretical values, which can be estimated by the pair correlation coefficient, which is determined by the statistical MS Excel function CORREL. In the CORREL function dialog box, the Array 1 contains the range of cells in which the resultant elements are located, and the Array 2 contains the range of cells in which the calculated values $\bar{Y}xi$ are presented [3].

If the value of the correlation coefficient is close to 1, then the quality of the model is high.

The coefficient of determination (1) is used as an indicator of the bond intensity[4]:

$$R^2 = \sigma^2_{\bar{Y}_X} / \sigma^2_y, \tag{1}$$

where σ^2_y is the general variance (sample variance) that characterizes the variation of the y values of the observed feature near its mean value;

$\sigma^2_{\bar{Y}_X}$ the variance caused by the regression $\bar{Y}_x$, that is, the part of the values dispersal of the effective feature y under the influence of the factor(s).

This coefficient shows the fraction of effective feature variation in the influence of factor X. In the absence of correlation, the empirical coefficient of determination is 0, and in the case of strong functional correlation it is 1 (all observation data are on the regression line).

In addition, to evaluate the quality of the obtained regression models, we estimate the statistical significance of the regression equations as a whole and by its individual parameters. The estimation of the statistical significance of the regression equation is entirely performed using the F – Fisher test. The calculated value of the F criterion is determined by the formula (2):

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[3] Baraz V.R. (2005). Korreliatsyonno-rehressyonnyi analyz sviazy pokazatelei kommercheskoi deiatelnosty s yspolzovanyem prohrammy Excel: uchebnoe posobye [Correlation and regression analysis of the relationship between indicators of commercial activity using the Excel program: a training manual]. Ekaterynburh: HOU VPO «UHTU–UPY», 102 p.

[4] Hmurman V.E. (2000). Teoryia veroiatnosty y matematycheskaia statystyka [Theory and Mathematical Statistics]. Moskva: Vysshaia shkola, 479 p.

$$F_{РАСЧ} = \frac{R^2 \cdot (n-k-1)}{(1-R^2) \cdot k}, \qquad (2)$$

where R^2 – is a coefficient of determination;

n – sample volume;

k – the number of factor traits of the linear regression model and the number of nonlinear regression model parameters related to the factorial feature.

Critical value F of Fisher criterion is determined using the statistical MS Excel function FINV by a given significance level α and the number of degrees of freedom: m1 = k; m2 = n – k – 1. It is usually accepted that α = 0,05. If $F_{РАСЧ} > F$, the regression equation as a whole is statistically significant, that is it has good agreement with the observation data.

To evaluate the statistical significance of the parameters of the a_j regression model is to determine whether the factor x_j in the total population has a significant effect on the resultant characteristic y, that is, whether the parameter of the regression model can be equal to zero. To estimate the statistical significance of the parameters of the regression equations, we use the Student's t-test. We determine the critical value of t-statistics using the MS Excel statistical function TINV by the value of α = 0.05 and the number of degrees of freedom m = n – k – 1.

The estimated value of the t-statistics can be obtained using the MS Excel Regression tool. If $t_{РАСЧ} > t$, the parameter is considered statistically significant.

Held calculations of the quality of the regression models, which reflect the dependencies, separately for each of the discount rates, confirmed that all regression equations (Table 7) and model parameters are statistically significant. The interdependencies thus obtained can be used for prediction.

Next, we set the investor-friendly performance values, which are presented as a range (Table 8):

$$NPV_{(П)} \in \lfloor NPV \min;\ NPV \max \rfloor;$$

$$IRR_{(П)} \in \lfloor IRR \min;\ IRR \max \rfloor;$$

$$RI_{(П)} \in \lfloor RI \min;\ RI \max \rfloor.$$

Table 8

Range of acceptable for an investor performance values

Indicator	Range of acceptable performance values	
r=15 %	min	max
NPV c.u.	60	110
RI	1,25	1,5
IRR %	30	40

With the help of the established functional interdependencies of performance indicators (Table 7), we assess the investor's expectations in accordance with the implementation of investments.

The calculation is done by successive changes of the input data. For example, we will evaluate the investor's expectations for the implementation of the investment, provided that acceptable NPV values are set as input.

1. Estimated value range for RI:

$$RI_{\min} = 0{,}0078 \cdot 60 + 0{,}6877 = 1{,}15$$

$$RI_{\max} = 0{,}0078 \cdot 110 + 0{,}6877 = 1{,}54$$

2. Estimated value range for IRR:

$$IRR_{\min} = 0{,}2825 \cdot 60 + 6{,}2771 = 23{,}23$$

$$IRR_{\max} = 0{,}2825 \cdot 110 + 6{,}2771 = 37{,}35$$

Based on the above, it is clear that the calculated values of RI and IRR exceed the acceptable values set by the investor, so requires some adjustments to the range of declared values of performance indicators.

In order to establish the required level of reliability of obtaining the expected performance indicators (N) from the investment implementation, we carry out the probability distribution of each of the calculated twenty-seven scenarios of implementation of investments. To do so, it was suggested to use the basic rules of probability theory for a normal distribution law. Table 9 shows the defined distribution parameters. The values of the normal distribution function $F_{m,\delta}$(NPV) with parameters m, σ are calculated by the formula (3)[5]:

[5] Semenov V.A. (2013). Teoryia veroiatnosty y matematycheskaia statystyka: Uchebnoe posobye. Standart treteho pokolenyia [Probability Theory and Mathematical Statistics: A Training Manual. Third generation standard]. Sankt-Peterburh: Pyter, 192 p.

$$F_{m,\delta} = F\left(\frac{NPV - m}{\delta}\right) \quad (3)$$

where m – is mathematical probabilistic mean;
δ – is mean root square deviation.

Table 9

Calculation of parameters for the distribution of performance indicators for discrete states

№	Indicator	Value	Distribution parameters			
			m	δ	$F_{m,\delta}$(NPV)	N
1	NPV ($I_п$; $CF_п$; $r_п$)	34,1			3,00	0,9987
2	NPV ($I_п$; $CF_{ср}$; $r_п$)	48,77			2,41	0,992
3	NPV ($I_п$; $CF_п$; $r_{ср}$)	49,45			2,38	0,9913
4	NPV($I_п$; CF_O; $r_п$)	63,40			1,82	0,9656
5	NPV ($I_п$; $CF_{ср}$; $r_{ср}$)	65,33			1,74	0,9591
6	NPV ($I_п$; $CF_п$; r_O)	66,90			1,68	0,9635
7	NPV ($I_{ср}$; $CF_п$; $r_п$)	72,34			1,46	0,9279
8	NPV($I_п$; CF_O; $r_{ср}$)	81,20			1,10	0,8643
9	NPV ($I_п$; $CF_{ср}$; r_O)	84,17			0,98	0,8365
10	NPV ($I_{ср}$; $CF_{ср}$; $r_п$)	86,97			0,87	0,8078
11	NPV ($I_{ср}$; $CF_п$; $r_{ср}$)	88,84			0,79	0,7852
12	NPV ($I_п$; CF_O; r_O)	101,43			0,28	0,6103
13	NPV($I_{ср}$; CF_O; $r_п$)	101,59			0,28	0,6103
14	NPV ($I_{ср}$; $CF_{ср}$; $r_{ср}$)	104,71	108,4	24,76	0,15	0,5596
15	NPV ($I_{ср}$; $CF_п$; r_O)	107,55			0,04	0,516
16	NPV (I_O; $CF_п$; $r_п$)	110,53			-0,08	0,4681
17	NPV ($I_{ср}$; CF_O; $r_{ср}$)	120,59			-0,49	0,3121
18	NPV ($I_{ср}$; $CF_{ср}$; r_O)	124,81			-0,66	0,2546
19	NPV (I_O; $CF_{ср}$; $r_п$)	125,16			-0,68	0,2483
20	NPV (I_O; $CF_п$; $r_{ср}$)	128,22			-0,80	0,2119
21	NPV (I_O; CF_0; $r_п$)	139,79			-1,27	0,102
22	NPV ($I_{ср}$; CF_O; r_O)	142,08			-1,36	0,0869
23	NPV (I_O; $CF_{ср}$; $r_{ср}$)	144,10			-1,44	0,0749
24	NPV (I_O; $CF_п$; r_O)	148,19			-1,61	0,0537
25	NPV (I_O; CF_O; $r_{ср}$)	159,97			-2,08	0,0188
26	NPV (I_O; $CF_{ср}$; r_O)	165,45			-2,30	0,0107
27	NPV (I_O; CF_O; r_O)	182,72			-3,00	0,0013

For the calculated NPV values corresponding to different combinations of cash flow parameters and set probabilities of their occurrence (Table 9), a reliability function is constructed.

On the basis of the interdependence functions, we calculate the values of the parameters RI and IRR, which correspond to NPV at the set level of reliability, that is $NPV_{(N = 0,75)}$ = 91,59 MU and determine if $NPV_{(N)}; IRR_{(N)}; RI_{(N)}$ are within the acceptable range.

We determine the cash flow parameters that provide a set level of reliability (N) and meet acceptable investment performance metrics.

Obviously, using the above logic of calculations, we can solve the inverse problem – to determine the NPV value and the corresponding level of reliability using the given basic performance indicators.

This technique can also be used to evaluate the "sensitivity" of a result to changing influencing parameters, and to determine to which of them one is more or less sensitive.

The proposed approach allows to find out at what values of cash flow parameters (I, CF, r), the NPV value provides the expected return on investment level and to determine the level of other performance indicators that meet the established reliability.

Moreover, the data obtained allow us not only to determine the likelihood of achievement of certain values of performance indicators, but also to conduct a deeper analysis of response sensitivity of the resultant indicator to changes in influencing parameters.

In our case, when the correlation between the total performance indicators is empirically established, in the sensitivity analysis it is possible to determine how much the NPV should change in order to provide a given change in other performance indicators.

14.2. Substantiation of the reliability of investment projects by the method of chain substitutions

Risk and uncertainty factors should be taken into account in calculating the effectiveness of investment projects.

Economic efficiency is estimated by standard, in terms of investment, indicators[6]:

- net present value (NPV);
- internal rate of return (IRR);
- return on investment (PI);

[6] Antypenko E.Iu., Donenko V.Y. (2005). Pryntsyp analyza kapytalnykh vlozhenyi [The principle of analysis of capital investments]. Zaporozhe: FAZAN, 420 p.

– payback period (PP).

As probability values all of them have their distribution parameters, and it is unlikely their reliability will correspond. In this case, the final reliability of the result can be considered as a compromise between the reliability of the parameters that quantify the economic efficiency of the result.

This compromise may be based on prioritizing each parameter in their designated sample. In pieces[7], based on the method of expert analysis, priority was established and a confidence coefficient for each indicator was calculated (Table 10).

Table 10

Summary analysis of the priority of using key project performance indicators

Nomination	NPV	IRR	PI	PP
Total expert numerical assessment (absolute indicator of criterion priority)	117	81	52	32
Relative indicator of criterion priority, %	41,49	28,72	18,44	11,35
Confidence coefficient	0,975	0,675	0,433	0,267

This shows that the most significant indicator when deciding on the effectiveness of investments is the net present value (NPV) indicator. Therefore, we will accept it as an evaluation criterion.

Now, to determine the influence of individual factors on the effectiveness of the planned event (NPV), we use the chain substitution method. A condition for applying this approach is that the dependence should be strictly functional in the form of a sum, a multiplication, or a quotient from dividing some indicators by others.

The essence of this method is the successive replacement of one of the indicators, provided that all the others are unchanged. This is how a sequential change is performed until all factors correspond to the new state. The degree of influence on the function of one or another factor is determined by sequential subtraction the results of a subsequent

[7] Mlodetskiy V.R. (2001). Operativnoe upravlenie investitsionnyim proektom na osnove integralnyih pokazateley effektivnosti [Operational management of an investment project based on integrated performance indicators]. *Visnyk PDABA*, no. 11, pp. 26-31.

calculation from the previous one. In the first calculation, all values correspond to the initial state, in the final one – to the new state[8].

What in this case is understood as influencing factors is, first of all, the parameters that form the cash flow, as the basis of most economic calculations related to investment efficiency.

As it is known, this type of cash flow consists of two parts – investment and positive costs, characterizing the return on investment (I; CF). Also an important influencing parameter is the discount rate (r). If we consider each of these parameters from the perspective of the scenario method, it is logical to introduce the boundary values of each of them (I_0, $I_п$; CF_0, $CF_п$; r_0, $r_п$) into the calculation.

Consider an example of assessing the absolute and relative influence of each of the input parameters of cash flow I, CF, r on the NPV efficiency indicator in the transition from values from the optimistic to the pessimistic scenario (I_0; CF_0; r_0)→($I_п$; $CF_п$; $r_п$).

For our input parameters, appliance of the chain setting method can be described as follows (4):

$$\begin{aligned} NPV_0 &= \{I_0; CF_0; r_0\}; \\ NPVr &= \{I_0; CF_0; r_П\}; \\ NPV_{CF} &= \{I_0; CF_П; r_П\}; \\ NPV_П &= \{I_П; CF_П; r_П\}, \end{aligned} \quad (4)$$

where – I_0; CF_0; r_0 – optimistic values of factors influencing the general indicator of NPV;

$I_п$; $CF_п$; $r_п$ – pessimistic values of factors;

NPVr; NPV_{CF} – intermediate changes in the resulting indicator associated with changes in factors r, CF, respectively.

The total change $\Delta NPV = NPV_П - NPV_0$ is the sum of the changes in the resulting indicator due to changes in each factor for fixed values of the remaining factors (5):

$$\Delta NPV = \sum NPV(I, CF, r) = \Delta NPV_r + \Delta NPV_{CF} + \Delta NPV_П, \quad (5)$$

$$\begin{aligned} \Delta NPV_r &= NPV_r - NPV_0; \\ \Delta NPV_{CF} &= NPV_{CF} - NPV_r; \\ \Delta NPV_П &= NPV_П - NPV_{CF}; \end{aligned} \quad (6)$$

[8] Kovalev V.V. (2011). Kurs finansovoho menedzhmenta: uchebnyk [Financial Management Course: A Textbook]. Moskva: Prospekt, 480 p.

For clarity, we introduce specific conditions for optimistic and pessimistic scenarios for the corresponding cash flow parameters and calculate the efficiency parameters for the given conditions (Tables 11, 12, 13, 14).

Table 11

Calculation of efficiency parameters with an optimistic variant of cash flow parameters (I_0; CF_0; r_0)

Input parameters	Forecasting period, year				
	1	2	3	4	5
Investment (Io)	-100	-100			
NOI (o)			200	200	200
Cash Flow (CFo)	-100	-100	200	200	200
Discount rate (ro)	15				
Discount coefficient	0,870	0,756	0,658	0,572	0,497
DCF	-87,0	-75,6	131,5	114,4	99,4
PV I(o)	-162,6				
PV NOI (o)	345,3				
NPV(o)	182,7				
RI(o)	2,12				
r(o)	15				

Table 12

Calculation of performance parameters with a combined variant of cash flow parameters (I_0; CF_0; $r_п$)

Input parameters	Forecasting period, year				
	1	2	3	4	5
Investment (Io)	-100	-100			
NOI (o)			200	200	200
Cash Flow (CFo)	-100	-100	200	200	200
Discount rate (ro)	20				
Discount coefficient	0,833	0,694	0,579	0,482	0,402
DCF	-83,3	-69,4	115,7	96,5	80,4
IRR	57,5				
PV I(o)	-152,8				
PV NOI (o)	292,6				
NPV	139,8				
RI	1,9				
r(п)	20				

Table 13

Calculation of performance parameters with a combined variant of cash flow parameters (I_0; $CF_п$; $r_п$)

Input parameters	Forecasting period, year				
	1	2	3	4	5
Investment (Io)	-100	-100			
NOI (o)			180	180	180
Cash Flow (CFo)	-100	-100	180	180	180
Discount rate (ro)	20				
Discount coefficient	0,833	0,694	0,579	0,482	0,402
DCF	-83,3	-69,4	104,2	86,8	72,3
IRR	50,5				
PV I(o)	-152,8				
PV NOI (п)	263,3				
NPV	110,5				
RI	1,7				
r(п)	20				

Table 14

Calculation of performance parameters with a pessimistic variant of cash flow parameters ($I_п$; $CF_п$; $r_п$)

Input parameters	Forecasting period, year				
	1	2	3	4	5
Investment (Io)	-150	-150			
NOI (o)			180	180	180
Cash Flow (CFo)	-150	-150	180	180	180
Discount rate (ro)	20				
Discount coefficient	0,833	0,694	0,579	0,482	0,402
DCF	-125,0	-104,2	104,2	86,8	72,3
PV I(п)	-229,2				
PV NOI (п)	263,3				
NPV(п)	34,1				
RI(п)	1,15				
r(п)	20				

The calculation based on the method of chain substitutions is tabulated (Table 15)[9].

[9] Popova V.V. (2012). Ekonomicheskaya nadezhnost parametricheskih protsessov [Economic reliability of parametric processes]. *Ekonomichnyi prostir*, no. 58, pp. 126-134.

Table 15

Analysis of the effect of individual cash flow parameters on the NPV value during the transition (I_0; CF_0; r_0)→($I_п$; $CF_п$; $r_п$)

Cash Flow Parameters	NPV Value	Variable parameter	The effect on the final result	
			magnitude	relative magnitude
I_0; CF_0; r_0	182,7			
I_0; CF_0; $r_п$	139,8	r_0→$r_п$	-42,9	-0,29
I_0; $CF_п$; $r_п$	110,5	CF_0→$CF_п$	-29,3	-0,2
$I_п$; $CF_п$; $r_п$	34,1	I_0→$I_п$	-76,4	-0,51
Column Summary	34,1-182,7= -148,6		-148,6	-1

Based on the analysis of the data in the table above, it is possible to establish the degree of influence of each of the parameters forming the cash flow on the final result during the transition from optimistic to pessimistic expectation. Obviously, the reverse transition will be characterized by the same values characterizing the influence of parameters on the final result, but with their positive value.

For the analyzed parameters of cash flow formation, we can conclude that the main influence on the NPV value is exerted by the change in the present investments value – the share of influence is 51%.

During the implementation of construction projects, it is possible to manage the present investment costs value with a constant amount of their sectors mastered at the construction stages.

As part of the developed calendar plans for the facilities' construction, the types and volumes of work that are provided with needed resources, calculated for each stage in the form of an appropriate resource consumption rate, are linked in time and space (by work zones, by nodes). Thus, the volumes of work are linked with the schedules of their production.

The calculation of the present value of investment costs is based on discounting techniques. Based on the features of this process, the same amount of money, ceteris paribus, have a different present value – the cash amounts of later periods are smaller than the previous ones. Based on this aspect of the discounting process, it is possible to reduce the value of their present value by increasing the planned volume of work in the later stages of construction (while keeping the total cost of construction unchanged).

Obviously, the implementation of this technique is possible if this is ensured by appropriate changes in the work schedules as like any decision regarding changes to the schedule, it should be systematically interconnected with all the components of the schedule (work intensity, resource equipment, sufficient work front to increase the intensity of work, etc.).

Correction of construction plans presented in the form of linear graphs, cyclograms or network diagrams, according to the criterion of ensuring their financial feasibility, has a long history of research[10].

To forecast cash flows, it estimates usage of all income and expenses over time, based on the planned movement of funds and accounts. In construction, the integrated disbursement schedule is S-shaped.

To assess the potential for financial feasibility, charts are built for the late and early periods, and the distance between the curves reflects the flexibility of the financial characteristics of the project. In this case, it is concluded that it is advisable to defer costs until such a delay causes an undesirable increase in the duration of the project. However, on the other hand, over time, it is very likely that costs will increase due to higher prices for materials and others. Therefore, in such a situation it is impossible to focus on solving a particular problem – for example, to reduce the presented cost input, move them as late as possible. It is necessary to make a comprehensive assessment of the situation, taking into account the likelihood of labour expense rising in the future, which can neutralize or worsen the expected positive result of the work in the late stages performance.

CONCLUSION

The proposed methodological approach, which in the case of option modeling of cash flow parameters possible combinations (discrete states) allows to perform the economic justification of investment reliability on the basis of established functional interdependencies of the main performance indicators. This allows to generate cash flow parameters that provide acceptable performance at a given level of reliability of their origination.

On the basis of the chain substitutions method, it was estimated the absolute and relative influence of each of the output parameters of the cash flow (I; CF; r) on the efficiency index in the transition from

[10] Porter M. (2016). Mezhdunarodnaya konkurentsiya. Konkurentnyie preimuschestva stran [International competition. Competitive advantages of countries]. Moskva: Alpina Pablisher, 947 p.

optimistic to pessimistic values (I_0; CF_0; r_0) → (I_p; CF_p; r_p) . This measure made it possible to determine that the change in the value of the investment cost has a major impact on the effectiveness of the planned event. Thus, it allows you to determine the quantitative value of adjustments, that is management of the investment costs present value with a constant sum of their parts mastered by stages of construction.

SUMMARY

The article is devoted to the development of methodological and practical tools for the economic justification of the reliability of investing in a construction company in the conditions of uncertain environment. A methodical approach was developed based on the method of discrete states. It enables any participant in the investment process to conclude that it is advisable to invest their money in a particular project. The method of chain substitutions was developed. On this basis, it was estimated the absolute and relative influence of each of the output parameters of the cash flow on the performance indicator, in the transition from their optimistic to pessimistic values. This allows to set the level of reliability when investments become inappropriate.

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