



## ASSESSMENT OF CONSTRUCTION OBJECT FINANCING SOLUTIONS

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**Abstract.** Theoretical and practical issues related to the applicability of the evaluations of construction project financing having regard to the complexity, timeframe and the limited nature of the resources available have been lately increasingly attracting researchers' attention. The assessment of decisions as to the timing and volume of funding of a project is extremely important and relevant for any organisation; therefore, it has been considered necessary to explore different models for possible financing by applying empiric and financial models, as well as theoretical mathematical methods.

The objective of the present research exercise was to develop an optimal model for the appropriation of financing of defined scope according to different financing scenarios. For that purpose the researchers used a hypothetical reference heuristic financing appropriation plan for four periods of identical duration in three construction objects. By reference to the linear programming theory an optimal plan was identified by assigning, in individual periods and to each object, different priorities rated in points. The financing appropriation plans are assessed in terms of their impact upon the enterprise value that is computed applying the cash flow discounting method and the tax shield effect theory. Since the selection of the financing source is an important factor for the enterprise value the calculations were performed assessing three possible scenarios of the enterprise financing taking into account the enterprise's liquidity: *a* – an enterprise has accumulated sufficient own funds to finance the project, *b* – an enterprise has accumulated funds sufficient only to pay the interest for borrowed capital, *c* – an enterprise does not possess any disposable monetary resources to finance the project during its implementation, therefore it capitalizes the interest payable to the bank. It was concluded that under scenario *a* the selection of a financing plan does not affect the enterprise value, as the enterprise finances the investment from own resources. In the case of scenario *b* the loan obtained from the purpose of the investment creates additional value, the choice of the plan, however, does not affect the enterprise value. When capitalising the interest payable to the bank under scenario *c*, the highest value of an enterprise is created in the case of selection of an optimal plan that is developed by setting an overall limit of the amount to be funded, i.e., by prioritizing mathematical logics without referring to the up-front appropriation of financial resources by objects.

The present article deals with the theory of the evaluation of investment project solutions. The results of the evaluation of the solutions for construction project financing appropriation are presented by criteria for optimal solutions and possible financing scenarios.

**Keywords:** optimal modeling, evaluations of construction project, enterprise value, investment solutions, funding alternatives.

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## 1. Foreword

Implementation of construction projects is a complex process frequently causing controversy for a number of reasons: 1) an enterprise may simultaneously be implementing several projects; 2) the timing for project implementation may be different; 3) labour, material or financial resources required for the implementation of projects frequently are limited. Considering that the procurement and utilisation of labour and material resources are directly related to the financing of projects, the present paper focuses on optimisation of the allocation of financial resources according to construction objects and project implementation periods. The proper allocation of funding resources acquires a special significance in view of a shrinking economy (Rabin, Thaler 2001; Friedman 2010; Ferguson 2009), then it becoming vitally essential to assess the possible funding volumes taking into account the time value of money (Damodaran 2007), and be particularly cautious and efficient in managing borrowed funds (Kale 2008; Brealey *et al.* 2008b). Issues related to long-term accumulation and use of funds should be addressed by employing quantitative or qualitative methods. In this respect research sources show clear preference to quantitative methods (Leibowitz, Langetieg 1989; Bier *et al.* 2008; Peters 2005), since in most cases research data are processed and the findings obtained are assessed by means of different computer-assisted programmes (Stutzer 2004).

In practice the funds required for funding of construction objects are most often accumulated and allocated employing heuristic methods. In research literature the assessment of this funding process has been an object of ardent controversy where special account needs to be taken of peculiarities of timing, cash flow formation, funding sources and other factors that affect the appropriation of financial resources available. The funding process and the relevant outcomes are being assessed following different methodologies (Garvin, Cheah 2004). Nevertheless, each specific case requires not only the relevant knowledge and appropriate competences, but also an ability to exercise a creative insight into the trends of cash flow movements and value fluctuations (Kentouris 2004; Rannou 2008; Shevchenko *et al.* 2008).

The present article provides an overview of the theory for the assessment of investment project solutions applicable to alternative choices of hypothetical corporate activities according to different financing plans. The research covered by the present paper is limited to three optional financing allocation plans according to four periods: the heuristic plan is a hypothetical reference plan, while two other optimal plans were computed with reference to the linear programming theory.

Having established, by means of mathematical methods, the appropriation of financial resources (applying the linear mathematical method) the financial resources allocation plans obtained are assessed from the financial viewpoint: additionally, by reference to cash flow discounting method and the present value of the tax shield effect, the value theory produced serves to assess the effect of the choice of each of the three financial resource appropriation plans upon the value of an enterprise. A simulated situation is used to assess three scenarios

of the funding of a company depending on its liquidity: a) an enterprise has accumulated sufficient amount of own funds to fund the project, b) an enterprise only has accumulated own funds sufficient to pay the interest for borrowed funds only, and c) an enterprise borrows funds and capitalizes the interest payable to the bank.

## 2. Methods of the assessment of investment solutions

Any assessment of the economic viability of a project should specifically focus on all factors and variables that potentially affect the project value. When assessing the projects experts most often use traditional assessment methods not infrequently failing to dedicate sufficient attention to the analysis of preconditions, assumptions or limitations, their identification and formulation. The choice of an appropriate assessment model to a large extent depends upon the peculiarity of the project, also related variables and the inherent market risk (Garvin, Cheah 2004; Ginevičius, Zubrecovas 2009).

Specific relevance the project assessment has acquired in view of the need to further the development of infrastructure, upgrading and modernisation, and specifically under the conditions of economic downturn (Platt *et al.* 2010; Agénor 2010; Pit 2010; Torrisi 2009). Any assessment of long-term projects shall necessarily take into account the ever changing situation in the capital markets (sudden increase or decrease of interest rates, the lending policy pursued by the banks). Although the research literature describes a number of different project assessment methods (Karazijienė, Sabonienė 2008; Parsons 2006; Pratt, Hammond 1979), the authors of the present paper has missed any more profound analysis of reconciliation of economic and mathematical methods, or that of alternatives for project funding in the context of an assessment of an enterprise performance.

Research literature has been focusing on the cash flow discounting methods where the discount rate is defined as the key variable (Ross *et al.* 2002; Galinienė 2005; Fuenzalida, Mongrut 2010; Brown, Reilly 2009). In the opinion of most authors (Loewenstein *et al.* 2002; Grout 2003; Grimsey, Lewis 2005; Florio 2006) the discount rate is the principal and most influential factor in calculating the value of a project, assessing its economic feasibility and taking reasonable decisions as to its implementation.

Discounted cash flow method may be described as one of the most popular methods in evaluating infrastructure projects (Brealey *et al.* 2008b). Under this method the economic viability of an investment is most dependent upon the discount rate. However, quite a number of authors have underestimated the significance of discount rate and chosen to use the alternative cost rate or the arithmetic weighted average cost of capital (WACC) instead (Garvin, Cheah 2004; Kahraman, Kaya 2010; Brown, Reilly 2009; Berk, DeMarzo 2011):

$$WACC = R_e \cdot (E / A) + R_d (D / A) \cdot (1 - t), \quad (1)$$

where  $R_e$  – required return on equity,  $R_d$  – cost of debt,  $t$  – tax rate,  $D$  – value of debt,  $E$  – value of equity, the sum of which represents the total assets  $A$  of an enterprise.

$R_e$  is computed using the long-term capital pricing model (CAPM):

$$R_e = R_f + \beta_e (R_m - R_f), \quad (2)$$

where  $R_f$  – risk free return,  $R_m$  – market return,  $\beta_e$  – equity systemic risk (Sharpe 1964).

For infrastructure projects that, as a rule, do not have a liquid secondary market the principal challenge was to correctly calculate  $\beta_e$ .

Brealey and Myers (2000) propose to compute the return on assets  $R_a$  using the sensitivity of the assets to market fluctuations that is in its own turn calculated by reference to the assets' cyclicity and weight (4).

$$R_a = R_f + \beta_a(R_m - R_f), \quad (3)$$

$$\beta_a = \beta_{revenue} \left[ 1 + \frac{PV_{fixed\ cost}}{PV_{asset}} \right], \quad (4)$$

where  $\beta_{revenue}$  – dependence of proceeds from the assets on the economic cycle,  $R_f$  – risk free return,  $R_m$  – market return,  $\beta_a$  – an approximation of the asset's sensitivity to market movements,  $PV_{fixed\_cost}$  – current value of fixed liabilities,  $PV_{asset}$  – current value of the assets.

With the dependence of revenues on the economic cycle,  $\beta_{revenue}$  approximates 1. The ratio  $[PV_{(fixed\_cost)} / PV_{(assets)}]$  may be calculated by using the fixed costs / EBIT ratio of the same project (in case the costs still have not been established – by analogy of a similar project in the past), where EBIT is the earnings before interest and taxes (Garvin, Cheah 2004).

The discounted cash flow method may be used for project evaluation by making an assumption that the risk throughout the duration of the project is relatively constant (Luehrman 1997) and the company uses its assets passively, i.e., without considering possibilities to expand, postpone or terminate the project (Brealey 2008). This possibility is neither taken into account when conducting a sensitivity analysis or under the Monte Carlo simulation method (Müller *et al.* 2004). The following features are distinguished as characteristic of infrastructure projects: a) most often implemented in stages; b) may be implemented as several sub-projects, c) require feasibility and environmental impact assessment studies. These peculiarities of infrastructure projects may possibly have an impact on the course of the preparation and implementation of an initial project. In view of a lengthy period of a project implementation the project risk in its individual stages tends to change (Trigeorgis 1999; Brach 2003). The discounted cash flow method does not provide a capability to assess all positive development that may potentially create an added value for the project in the future (e.g., decrease in project cost prices due to the emergence of more efficient technologies, or an increase of sale prices due to a sudden increase in demand).

Quite a number of infrastructure projects implemented in individual stages may be postponed for a later period therefore such projects should be attributed certain features characteristic of options (Ford *et al.* 2002; Cox *et al.* 1979; Dagilienė 2008), therefore conventional discounting methods may turn not entirely adequate for the assessment of such projects. Research papers most often present the conventional infrastructure project evaluation methods highlighting the factors directly affecting the project value (Rutkauskas, Stankevičius 2006).

The option pricing model opens a possibility to define the value that shall be created by taking advantage of the possibilities available in the future (Damodaran 2002; Ross *et al.* 2002; Brach 2003; Gatev, Ross 2009). The value of the option may be calculated as a function of the current asset value, asset price fluctuation, exercise price, period and risk-free return. Part of these variables may be also computed applying the discounted cash flow method, therefore the latter should be employed in connection with the real option method this adding some flexibility to the projects, i.e., making it possible to modify the projects having regard to an

actual situation. The real option method's innovativeness lies in the ability it provides to determine a project value higher than the current value of future cash flows where the value of such flows is affected by future events. However, these conditions are met only where the value of the underlying assets is higher (in the case of a call option), or lower (in the case of a put option) than the price of the underlying assets determined in advance. In evaluating a project funded from own and borrowed funds the project owners' equity may be assessed as a call option value, the repayable amount of borrowed capital (nominal debt value) as the price of execution, and the debt term may be treated as the option term (Damodaran 2005; Brealey *et al.* 2008a). According to the evaluation techniques real options may be the *discrete time models* and *continuous-time models*. Conceptually the two models are not different; however, the two models refer to different assumptions, therefore accordingly they employ different mathematical calculation methods, and the application of the same in construction and infrastructure projects (Brealey, Myers 2003; Petravicius 2009).

### 3. Options for the allocation of construction project funding

Since normally the implementation term of construction projects is quite lengthy and funding of a project requires sizable financial resources, modern funding arrangements next to conventional financing sources (own and borrowed capital) employs various complex schemes combining capital of private and public origin (leasing, concessions, temporary transfer of the benefit to the private sector) (Devapriya, Pretorius 2002; Tseng *et al.* 2005; Kutut *et al.* 2008; Kazlauskienė, Christauskas 2008; James, Miller 2004). This leads to a further increase in the project risk, and the cost of funding. Where a project is implemented in stages, or where several projects are implemented simultaneously, the need to appropriate funding resources in a most efficient way by stages of tasks and objects acquires a special significance (Kramarenko, Shevtshenko 2009; Luehrman 1997; Mačerinskienė, Vasiliauskaitė 2007; Mackevičius *et al.* 2007; Tamošiūnienė *et al.* 2006).

The task of an efficient allocation of limited financial resources becomes even more challenging due the money time value factor (Li, Wu 2009). Furthermore, account needs to be taken of: i) funding objectives; ii) prioritization of objects financed and periods, iii) methods for the assessment of alternative solutions (Bier *et al.* 2008; Kazlauskienė, Christauskas 2007).

For the purpose of examining available options for construction project funding the authors of the present paper have selected one of the heuristic plans for financing construction objects (Table 1).

**Table 1.** Allocation of construction project financing: heuristic approach

Object	Item title	Q1	Q2	Q3	Q4	Total per year
A	Amounts by quarters	100	150	50	200	500
B	Amounts by quarters	50	80	20	50	200
C	Amounts by quarters	75	75	75	75	300
Total per quarter		225	305	145	325	1 000 000

Hypothesis put forward: the application of linear programming methods could enhance the optimization of the appropriation of financial resources available. This hypothesis can be confirmed by comparing at least one optimal solution obtained with the existing (heuristic) plan.

The application of linear programming method requires some additional information: i) conditions for limitations, ii) coefficients in the objective function, iii) interpretation of the objective function extremum (Müller *et al.* 2004). The conditions for the restrictions shall be established having regard to the limits of the absorption of funding (Table 2). For example, an object C in Period III is to be allocated the funding of not less than LTL 35,000 and not more than LTL 75,000. Also, the overall funding amounts limits shall be indicated ( $\leq$ ,  $\geq$  or  $=$ ).

**Table 2.** Limitations of object funding

Objects	Limits	Period I	Period II	Period III	Period IV	Total funding amount
Object A	Upper	0	0	0	0	$\leq 500\ 000$
	Lower	50	30	20	40	
Object B	Upper	0	80	0	0	$\leq 200\ 000$
	Lower	40	10	20	15	
Object C	Upper	0	0	75	0	$\leq 300\ 000$
	Lower	25	30	35	40	
Total funding amount		$\leq 250\ 000$	$\leq 400\ 000$	145	$\leq 325\ 000$	Amount to be allocated 1 000 000

The coefficients in the objective functions must reflect the attitude of a decision-maker towards the conceptual expression of the objective function. For example, where profit maximization is sought, the coefficients show the yield of each solution component (variable values to be found). In a construction organization the evaluation of object funding in terms of individual periods poses difficulties due to the multi-stage nature of such projects, and a significantly lengthy time span between the project investment and its return.

The allocation of funding of construction projects is affected by numerous factors part whereof can be assessed in terms of quantitative (Ahern, Anadarajah 2008), and part in terms of qualitative indicators (Turskis 2008; Gerchak, Kilgour 1999; Ginevičius, Podvezko 2008; Ginevičius, Petraškevičius 2008). The authors of the present article have chosen an expert evaluation of an object funding by periods. Having thoroughly explored and examined all the peculiarities of the works carried out in the objects the significance of funding of the projects by periods was rated under a scale of 10 points (Table 3).

**Table 3.** Expert evaluation ( $c_{ij}$ )

Objects	Period I	Period II	Period III	Period IV
A	6	5	10	8
B	10	8	7	7
C	6	5	4	6

Since the significance of each period of an object is assessed in points, the exercise seeks to ensure the best possible results of the overall funding allocation, i.e., the objective function value must be maximised. The interpretation of the significance of the objective function cannot be explained by economic terms – the product of the funding amount and the evaluation of the significance of such funding in points does not have any logically explainable measurement unit. Thus the objective function value is described as a criterion of the optimal solution (the larger the value, the more efficient the solution).

According to such concept of the objective function there should be more than one solution. The authors of the present paper have selected two options for the problem solution: a) the limitations specify the funding amounts by objects (Option 1), b) only the overall funding amount is indicated (Option 2).

The data of Tables 1, 2 and 3 constitute a basis for the generation of Option 1 linear programming problem (1):

$$\left\{ \begin{array}{l} \sum_{i=1}^3 x_{ij}c_{ij} \rightarrow \max, j = \overline{1,4} \\ \sum_{i=1}^3 x_{i1} \geq 250000, \sum_{i=1}^3 x_{i2} \leq 400000, \sum_{i=1}^3 x_{i3} = 145000, \sum_{i=1}^3 x_{i4} \geq 325000, \\ \sum_{j=1}^4 x_{1j} \leq 500000, \sum_{j=1}^4 x_{2j} \leq 200000, \sum_{j=1}^4 x_{3j} \leq 300000, \\ x_{11} \geq 50000, x_{12} \geq 30000, x_{13} \geq 20000, x_{14} \geq 40000, x_{21} \geq 40000, 10000 \leq x_{22} \leq 80000, \\ x_{23} \geq 20000, x_{24} \geq 15000, x_{31} \geq 25000, x_{32} \geq 30000, 35000 \leq x_{33} \leq 75000, x_{34} \geq 40000. \end{array} \right. \quad (5)$$

In Option 2 the financing limitations by objects have been replaced by the general limitations imposed upon funding of all objects (2):

$$\left\{ \begin{array}{l} \sum_{i=1}^3 x_{ij}c_{ij} \rightarrow \max, j = \overline{1,4} \\ \sum_{i=1}^3 x_{i1} \geq 250000, \sum_{i=1}^3 x_{i2} \leq 400000, \sum_{i=1}^3 x_{i3} = 145000, \sum_{i=1}^3 x_{i4} \geq 325000, \\ \sum_{i=1}^3 x_{ij} \leq 1000000, j = \overline{1,4} \\ x_{11} \geq 50000, x_{12} \geq 30000, x_{13} \geq 20000, x_{14} \geq 40000, x_{21} \geq 40000, 10000 \leq x_{22} \leq 80000, \\ x_{23} \geq 20000, x_{24} \geq 15000, x_{31} \geq 25000, x_{32} \geq 30000, 35000 \leq x_{33} \leq 75000, x_{34} \geq 40000. \end{array} \right. \quad (6)$$

The results of optimal solutions are compared with the heuristic financing plan (Fig. 1). Under Option 1 optimal solution the value of object function is 7,565,000, under Option 2 – 8,365,000.



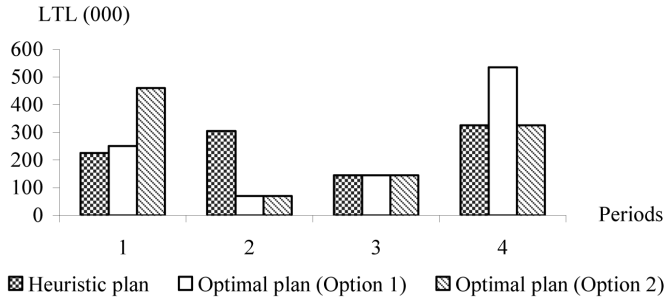


Fig. 1. Funding allocation according to different plans

Mathematically the Option 2 optimal financing plan is better due to a larger value of the object function. This conclusion has been drawn up by reference to the opinion of experts without taking into account the effect of the time factor.

#### 4. Assessment of funding alternatives

Having optimised the allocation of financial resources by applying the linear programming method an expedient further action is to assess the plans for the financial resources allocation in different time periods (quarters) from the financial viewpoint taking into account the profile of the enterprise, objectives and the investment project implementation period. Where the term for an investment project implementation is in excess of one year account shall be taken of the interest rate risk. Where the project implementation, however, lasts for about a year, it may be assumed that the interest rate risk does not produce any material effect upon the funding allocation. Therefore researchers focused upon the evaluation of financing plans from the point of view of cash flows and interest costs.

The assessment of financing allocation plans from a financial view point shall be carried out by means of the analysis of the effect of a selection of one or another plan upon the enterprise value. The impact upon the enterprise value shall be computed by two methods: a) cash flow discounting method, and b) with reference to the theory on the present value of tax shield (Modigliani, Miller 1958).

The enterprise value is a fundamental economic measurement of the entire business market value representing the takeover of the enterprise valuation under free market conditions. This criterion has been selected because: i) the enterprise value is a measurement neutral in respect of the corporate capital structure therefore it may be used for the purpose of comparing enterprises of different capital structure (Modigliani, Miller 1958; Brealey, Myers 2003; Allen *et al.* 2008), and ii) enterprise value much more accurately than the owners' value reflects all interests related to the business, as the enterprise value encompasses the value of borrowed capital (Fig. 2).

For the purpose of determining the enterprise value the claims of all parties concerned shall be added, and then cash is deducted from the amount obtained since cash may be paid in the form of dividends thus reducing the value of the enterprise as a potential purchase; or such cash may be disbursed to creditors. It is specifically in terms of cash amounts that



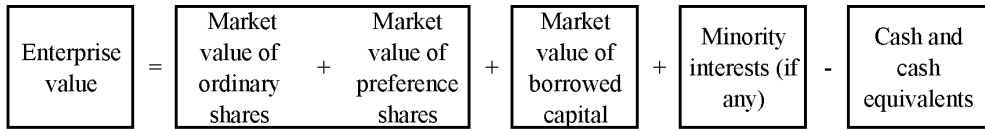


Fig. 2. Components of the enterprise value

the enterprise value may be negative (in the event the amount of cash is in excess of other components constituting the enterprise value).

Since the enterprise value is affected by the choice of financing source the calculations may be performed by assessing three enterprise funding scenarios that are selected depending on the liquidity of the enterprise: scenario *a* – the enterprise has accumulated sufficient own funds to fund the project, *b* – the enterprise has accumulated own funds to pay the interest for the borrowed funds only, *c* – during the project implementation period the enterprise does not have any available monetary resources therefore it capitalizes the interest due to the bank (accrued interest is added to the loan amount so that in each next interest payment period the interest is paid for an increased loan amount).

The assessment of any alternatives for enterprise operations employs a number of assumptions such, as: i) the selection of a financing allocation plan does not affect the amount of investment and cash flows that will be generated upon the completion of the project; ii) investments are effected at the beginning of each quarter; iii) the weighted average cost of capital (WACC) of all three enterprises is the same, since  $WACC = R_A$ , where  $R_A$  is return on assets (Modigliani and Miller 1958); iv) there is no bankruptcy costs (Brealey *et al.* 2008a).

The following conditions have been selected for the purpose of the calculations: WACC – 10%, loan interest rate – 6%, profit before interest and taxes of all enterprises (EBIT) – LTL 500 000, in equal shares by LTL 125 per quarter, and the corporate income tax – 20%.

a) The assessment by cash flow discounting methods seeks to determine the impact of cash flows incurred during the investment period upon the enterprise value depending on the selection of a financing plan. Since the value in the business of interests depends on the future benefit that will be generated to the interests theoretically the correct preferred model would be to project the future benefit and discount it by translating it into the current value (Galiniene, Butvilas 2010; Ross *et al.* 2002; Žaptorius 2006).

According to A. Damodaran (2009), the value of an enterprise is equal to the value of the assets of the enterprise that may be calculated by discounting the cash flows generated by the assets of the enterprise (CFFA), that are composed of operating cash flows (OCF), less net investment (NCS), and the increase in working capital ( $\Delta NWC$ ), where *EBIT* is corporate earnings before interest and taxes (Fig. 3).

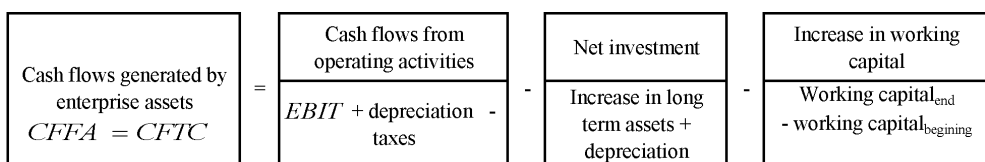


Fig. 3. Cash flows generated by enterprise assets

Depending on the selected funding allocation plan the enterprise value is affected by 2 factors: money time value and loan interest rate (7).

$$PV_{investment} = \sum \frac{(Investment_i)}{(1+WACC)^i} \quad (7)$$

With an investment effected at a later point in time the investment's current value is lower which alleviates the adverse impact upon the enterprise value. According to the Optimal plan 1 the largest share of the investment is allocated in Q4, and, as the only influence is the money time value (discount rate), the value of the investment is the lowest. Therefore in the case of the (financing scenario) enterprise operation *a* the most acceptable is the Optimal plan 1 under which the company does not have to borrow funds, therefore its value is not affected by the factor of the interest rate.

The interest payable for the loan does not effect the cash flows generated by the assets (CFFA), since the interest is paid from the funds earned by the assets of the enterprise. The cash flows generated by an enterprise are allocated to creditors (CFTC), and to owners (CFTS) (Galiniene 2005; Ross *et al.* 2002) (8):

$$CFFA = CFTF = CFTC + CFTS, \quad (8)$$

where  $CFTC = interest - loan\_change$ .

An enterprise that had invested earlier assumes larger interest liabilities which decreases its taxable profit and increases its working capital. An increase of the working capital reduces the cash flow generated by the assets of the enterprise, therefore the enterprise value shall be accordingly reduced (Table 4). This is equally confirmed by the calculations of the impact of the financing scenarios *b* and *c* upon the enterprise value. In the case of *b* and *c* enterprise financing scenarios the Optimal plan 2 is more efficient, as the bulk of the investment is allocated in Q1. In the case of the activity of the enterprise under the scenario *c* the impact upon the enterprise value shall be alleviated, as the enterprise uses larger amounts of borrowed capital.

**Table 4.** Changes in the enterprise value depending on the selection of the funding allocation plan and the funding source

Scenarios for the enterprise funding	Heuristic plan		Optimal plan 1		Optimal plan 2	
	Investment related cash flow change	Effect upon the enterprise value	Investment related cash flow change	Effect upon the enterprise value	Investment related cash flow change	Effect upon the enterprise value
<i>a</i>	-1000	-941	-1000	-932	-1000	-946
<i>b</i>	-883	-832	-902	-841	-872	-827
<i>c</i>	-876	-826	-897	-836	-863	-818

b) The assessment of financing plans on the basis of the theory of the *present value of tax shield* (Modigliani, Miller 1958) analyses the extent to which increases the enterprise value under each financing plan. The theory is based on the enterprise valuation model developed by Miller and Modigliani (M &M) which establishes that the value of an indebted enterprise

is equal to the value of a non-indebted enterprise plus the value generated by the *tax shield effect* (9):

$$V_L = V_U + D \times T_C, \tag{9}$$

where  $V_L$  – levered enterprise value,  $V_U$  – unlevered enterprise value,  $D$  – debt amount,  $T_C$  – tax rate.

The value of unlevered enterprise is calculated by capitalizing the cash flows before interest and taxes (EBIT) of an unlevered enterprise by a capitalization rate  $R_U$ , that is the return required by owners of unlevered enterprise (10) (Modigliani, Miller 1958):

$$V_U = \frac{EBIT(1 - T_C)}{R_U}. \tag{10}$$

Due to the inclusion of the interest into the costs reducing the taxable profit the enterprise’s interest costs will be lower than the interest amount paid. In this particular case the saving are achieved on the account of the taxes. The larger the amount of interest and/or the tax rate, the larger the amount of the savings. The value created for the enterprise by virtue of tax savings is the current value of saved taxes (tax shield effect). For evaluation purposes an assumption is made that the loan is of indefinite duration, therefore the annual value of tax savings ( $PV_{(TaxSch)} = D \cdot R_D \cdot T_C$ ) is capitalized applying the loan interest rate  $R_D$  (according to the assumption used  $R_D = 6\%$ ). The tax saving current value ( $PV_{(TaxSch)}$ ) shall be calculated as follows:

$$PV_{(TaxSch)} = \frac{D \cdot R_D \cdot T_C}{R_D} = D \cdot T_C, \tag{11}$$

where  $T_C$  – corporate income tax rate,  $D$  – loan amount.

Having assessed the impact of selection of the financing plan on the basis of the M&M theory the conclusion was arrived at that the highest value is created where the enterprise selects the activity alternative *c*. In this case the amount of borrowings for funding of the investment project will be the largest.

In the case of selection of the operation alternative *a*, the selection of the financing plan shall have no impact upon the enterprise value since the enterprise will be financing the investment by own funds. Likewise, no effect will be produced upon the enterprise value where the enterprise chooses activity alternative *b*, however, a LTL 1 m loan obtained to fund the investment creates for the enterprise an additional value of LTL 200,000. Where an enterprise chooses operation option *c*, it will be able to generate the largest value in the case of the Optimal plan 2, since the largest amount of the loan shall be accumulated at the end of the year (Fig. 4).

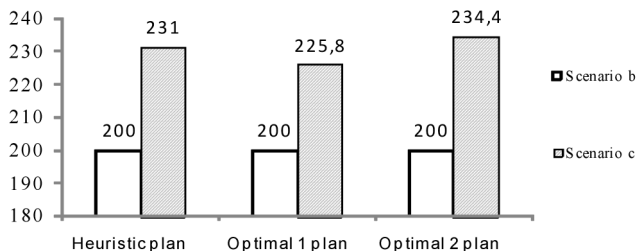


Fig. 4. Impact of the selection of the plan on the enterprise value

It should be noted that financing plans should be assessed in terms of their impact upon the enterprise value. In case of the assessment from the point of view of the owners (Fig. 2), part of the statements would be quite opposite.

The results of the assessment of financing plans allow a conclusion that no optimal plan that could equally suit all alternative options of an enterprise activities exists. Therefore when selecting a financing plan account should be taken not only of the peculiarities of the enterprise's operations, but also of the projected financing sources. Still a combination of different methods for the assessment of the enterprise operations and the optimal resource appropriation allows producing several alternative solutions for project financing.

## 5. Conclusions

1. Challenges related to the implementation of construction project are often linked to limited resources available, and the need for the implementing enterprises to prioritize the allocation of funding in individual periods of project implementation. Hence the need to identify methods to economically substantiated financing plans.
2. The application of mathematical methods such as linear programming for evaluating construction projects turn justifiable only in the case the value of object function is designated as the principal evaluation criterion.
3. Having regard to the impact of the project funding upon its value project executors select the optimal one option the implementation whereof creates the maximum value.
4. The results of the survey related to the present paper demonstrated the difficulties in attempting to drawn up an ideal construction project plan that could equally well suit all alternative modes of an enterprise activities.
5. A need has been identified to develop alternative financial resources allocation plans by means of variety, specifically mathematical, methods. Such plans need to be assessed from different viewpoints with a clear priority assigned to the methods best meeting the expectations of all practitioners.

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## STATYBOS OBJEKTŲ FINANSAVIMO SPRENDIMŲ ĮVERTINIMAS

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**Santrauka.** Statybos projektų finansavimo vertinimo teorinių ir praktinių pritaikymo klausimų nagrinėjimas, atsižvelgiant į šių projektų įgyvendinimo sudėtingumą, laiką bei reikalingų išteklių ribotumą, pastaruoju metu sulaukia vis didesnio dėmesio. Sprendimų, kiek ir kada finansuoti projektą, vertinimas yra labai svarbus kiekvienai organizacijai, todėl turi būti tiriami įvairūs galimo finansavimo modeliai, taikant empirinius ir finansų bei matematikos teorijos metodus. Tyrimo tikslas – parengti optimalių statybos projekto nurodytos finansavimo apimties paskirstymo modelį pagal skirtingus finansavimo scenarijus. Tyrimui naudotas sąlygiškas euristinis finansavimo paskirstymo planas keturiems vienodos trukmės laikotarpiais pagal tris objektus. Taikant tiesinio programavimo teoriją, optimalus planas randamas kiekvienam objektui konkrečiu periodu suteikus skirtingus balais įvertintus prioritetus. Finansavimo paskirstymo planai vertinami pagal jų įtaką įmonės vertei, kuri skaičiuojama taikant pinigų srautų diskontavimo ir skolinto kapitalo dėl mokesčių sutaupymo papildomai sukuriamos vertės teoriją. Kadangi įmonės vertei svarbus finansavimo šaltinio pasirinkimas, skaičiuota vertinant tris įmonės finansavimo scenarijus atsižvelgiant į įmonės likvidumą: *a* – įmonė turi sukaupusi pakankamai nuosavų lėšų projektui finansuoti; *b* – įmonei pakanka nuosavų lėšų tik palūkanoms už skolintas lėšas sumokėti; *c* – įmonė neturi laisvų piniginių išteklių projekto įgyvendinimo laikotarpiu, todėl kapitalizuoja bankui mokėtinas palūkanas. Nustatyta, kad *a* scenarijaus atveju įmonės vertei finansavimo plano pasirinkimas įtakos nedaro, nes ji investicijas finansuoja nuosavomis lėšomis. Pagal *b* scenarijų investicijai paimta paskola sukuria papildomą vertę, tačiau plano pasirinkimas įmonės vertės neveikia. Kapitalizuojant bankui mokėtinas palūkanas pagal *c* scenarijų, didžiausia įmonės vertė sukuriamą pasirinkus optimalų planą, kuris sudaromas nurodžius bendrą finansuojamos sumos apribojimą, t. y. suteikiant prioritetą matematinei logikai atsiskaičius išankstinio finansinių išteklių paskirstymo pagal objektus. Straipsnyje nagrinėjama investicinių projektinių sprendimų vertinimo teorija. Statybos objektų finansavimo paskirstymo vertinimo rezultatai pateikti pagal optimalumo kriterijus ir galimus finansavimo scenarijus.

**Reikšminiai žodžiai:** optimalus modeliavimas, statybos projekto vertinimas, įmonės vertė, investavimo sprendimai, finansavimo alternatyvos.

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