Cash flow optimization in industrial enterprise

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Abstract. Optimization of cash flows of the industrial company provides economic entity necessity and sufficiency of financial resources for sustainable activities. Cash optimization techniques are grouped into two blocks: theoretical - is mainly foreign methods and applied techniques that are mostly used by Russian authors. Models described in the literature are not allowed for the particular industry in the formation of cash. The mathematical models described in the literature do not allow to take into account industry characteristics in the formation of funds. The proposed methodology by authors allows to predict cash amounts based on business company. The balance of cash flows is provided by the budgeting system. The company's the released money can send funds for investment purposes. Effectiveness of confirmed by practical testing methodology on the existing machine-building enterprise.

1 Introduction

The relevance of cash flow optimization for any business entity is acquiring greater significance under conditions of shortage of production resources, including cash funds.

Cash flow can be generated from various types of activity: operating, financing and investing. Along with this, an amount of flow, its vector and dynamics allow us to solve a variety of tasks, among other things in the interests of different participants of business process.

Cash flows from various activities collide with each other, altogether solving the general problem of industrial enterprise - providing ever-increasing economic benefits. For this reason there is a need to create a model of cash flaw optimization for industrial enterprises that is able to meet production, financial and investment goals.

On the one hand, models of cash flow optimization presented in modern scientific literature do not take into account sectoral affiliation of a business entity, which reduces their credibility and practical significance. And on the other hand, they do not help to identify factors that affect total financial result from their use.

It can be assumed that the system of cash funds budgeting can provide an optimal cash flow ratiofor a machine-building enterprise that is sufficient for its effective operating, investing and financing activities.

2 Scientific development of thetopic

Considerable attention to issues of cash flow management has been payed since the second half of 80s. In the beginning of 21st century, the number of scientific and practical researches in this area has grown considerably. The USA leadsin the number of researches (in particular, Ohio State University, New York University, University of California, Los Angeles and other North American universities). A significant part of researches is dedicated to management of the cash flow generated by financial investments. To us, particularfeatures of interest present researches of cash funds management in models of multivariate time seriesthat use past values of indicators as explanatory variables in time series of regression [1].

A number of researchers use the factor model to optimize cash flow. In particular, Martins, P. establishes the relationship between the mainresulting indicator – cash funds and factorsthat form it: workforce and production. Along with this, authors combine them into a single system based on monoproduction (production of one type of goods) without reference to the specifics of an industry, which reduces the usefulness of the presented model [2].

In the paper of Chen, W.-N., Zhang, J., Chung, H.S.-H., Huang, R.-Z., Liu, O the change of cash funds value is taken into account and discounting is introduced. The practical component of the proposed mathematical modeling is a multi-dimensional assessment of analyzed factors. However, even this authors' approach does not take into account the effect on the result of internal factors, such as lack of liquidity, while considering cash flow over time [3].

Works of Russian authors that address the problem of cash flow optimization in enterprises can be classified into two parts. The first one represents works of a theoretical nature. These include works the economic analysisfounders of the Soviet and post-Soviet period (Savitskaya, Kovalev, Sheremet , Lukasiewicz [4-7]), the second one represents works of an applied nature, includingworks that take into account sectorial specificity.They are much rarer. Works of Sanakoev E.V., Novolodsky D.A., Sinkina A.A. are noteworthy [8,9,10]. Along with this, these authors view cash flow without reference to relationship between all activities and industry specifics.

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Table 1. Factors of changesin net cash flow (NCF) for current operations12.

Factors of changes			
Increase of NCF	Decrease of NCF	Factor model	Comment
Growth of net profit	Decrease in net profit	$\Sigma[VMP_i(P_i\text{-}CP_i)]$	VMP_i– volume of manufactured production, goods, services; P_i – price of realization; CP_i– cost price of manufactured good
Decrease in losses	Increase in losses		
Increase in amount of deprecation	Decrease in amount of deprecation	$\Sigma[DA_i^j\cdot RD_i]$	DA_i^j –depreciable asset; RD_i – rate of depreciation of the asset
Decrease in accounts receivable	Increase in accounts receivable	$\Sigma[\dfrac{SP\cdot SCAR}{365}]$	SP – shipped products; $SCAR$– speed of collection of accounts receivable
Decrease in stock	Increase in stock	$\Sigma[Q_i\cdot P_i]$	Q_i –quantity of goods and materials; P_i– price of goods and materials
Increase in short-term financial liabilities	Decrease of short-term financial liabilities	Factor model is compiled on the basis of types of expenses and revenue receipts	
Increase in amount of provisions for future expenses and revenues	Decrease of amount of provisions for future expenses and revenues		

Table 2. Factors of changesin net cash flow for investment operations.

Factors of changes			
Increase of NCF	Decrease of NCF	Factor model	Comment
Increase of revenue from sale of fixed assets	Decrease of revenue from sale of fixed assets	$\Sigma[Q_i\cdot P_i]$	Q_i– quantity of sold fixed assets; S_i – price of realization of fixed assets
Increase of revenue from sale of intangible assets, long-term financial assetsб repurchased shares	Decrease of revenue from sale of intangible assets, long-term financial assetsб repurchased shares	$\Sigma[Q_i\cdot P_i]$	Q_i – quantity of sold assets; P_i – price of realization of fixed assets
Increase of amount of interest and dividends on securities	Decrease of amount of interest and dividends on securities	$\Sigma[TAFI_i\cdot SFI_i\cdot Pr_i]$	TAFI – the total amount of financial investments; SFI_i – structure of financial investments; Pr_i – level of profitability of financial investments
Decrease of investments in purchase of fixed assets	Increase of investments in purchase of fixed assets	$\Sigma[Q_i\cdot P_i]$	Q_i – quantity of purchased fixed assets; P_i – cost of purchased assets

Decrease of investment in capital construction	Increase of investment in capital construction	$\Sigma[Q_i \cdot VPW_i \cdot P_i]$	Q_i – the number of objects under construction; P_i – estimated cost of performed work; VPW_i – volume of performed work on each subject
Decrease of investment in purchase of intangible assets	Increase of investment in purchase of intangible assets	$\Sigma[Q_i \cdot P_i]$	Q_i – quantity of purchased assets; P_i – cost of purchased assets
Decrease of investment in purchase of long-term financial assets	Decrease of investment in purchase of long-term financial assets	Factor model is compiled on the basis of types of expenses and revenue receipts	
Decrease in the number of repurchased shares of enterprise	Increase in the number of repurchased shares of enterprise		
Decrease in amount of other payments	Increase in amount of other payments		
Increase in amount of other revenue receipts	Decrease in amount of other revenue receipts		

3 Dynamics and analysis of cash flow

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Inflows and outflows of cash funds associated with the use of external financingare traditionally reflected in financing activity [4, p. 494].

Results of net cash flow calculations for current, investment and financial operations allow to determine the total net cash flow:

$$NCF = NCF_{CO} + NCF_{IO} + NCF_{FO} \qquad (4)$$

The advantage of this method is the possibility to identify dynamics of all factors that form net cash flow. However, the use of both direct and indirect methodsin combination to obtain accurate data on the composition and amount of cash funds.

The second stage of the complex analysis of funds is the analysis of cash flowbalance. To assess the degree of uniformity of forming of cash flows and inflows and their synchronicity certain indicators are calculated:

- Standard deviation (Formula 5):

$$\sigma = \frac{\sqrt{\sum (x_i - \overline{x})^2}}{n} \qquad (5)$$

where x_i is the value of the i-th indicator;

$\overline{x}$ - the average value of index.

A large standard deviation value indicates a large spread in the values of presentedsetwith an average value ofset; a small value, respectively, shows that the values in a set are grouped around the average value.

- The coefficient of variation, to determine which formula 6 is used:

$$V = \frac{\sigma}{\overline{x}} \cdot 100. \qquad (6)$$

A collection is considered to be homogeneous if the coefficient of variation does not exceed 33% [11, p. 137].

- The correlation coefficient is calculated as follows:

$$r = \frac{\sum x \cdot y - \dfrac{\sum x \cdot \sum y}{n}}{\sqrt{\left(\sum x^2 - \dfrac{(\sum x)^2}{n}\right) \cdot \left(\sum y^2 - \dfrac{(\sum y)^2}{n}\right)}}, \qquad (7)$$

where x is the amount of positive cash flow for the i-th period;

y is the amount of negative cash flow for the i-th period;

The closer the correlation coefficient is to one, the smaller is spread of fluctuations between values of positive and negative cash flow.

The third stage of the cash flow analysis is the ratio analysis or analysis of cash flow intensity and effectiveness.

Table 3. Factors of changesin net cash flow for financial operations.

Factors of changes			
Increase of NCF	Decrease of NCF	Factor model	Comment
Increase in long-term loans and borrowings	Decrease in long-term loans and borrowings	$\Sigma[S_i \cdot T_i \cdot I_i]$	S_i – sum of loans and borrowings; T_i – period (term) of loans and borrowings; I_i –the interest rate of loan
Increase in short-term loans and borrowings	Decrease in short-term loans and borrowings		
Decrease of payments on long-terms loans and borrowings	Increase of payments on long-terms loans and borrowings		
Decrease of payments on short-terms loans and borrowings	Increase of payments on short-terms loans and borrowings		
Increase in amount of received dividends and interest on short-term financial investments	Decrease in amount of received dividends and interest on short-term financial investments	$\Sigma[TAFI \cdot SFI_i \cdot Pr]$	$TAFI$ – the total amount of financial investments; SFI_i– structure of financial investments ; Pr_i – level of profitability of financial investments
Decrease in amount of dividends paid to company shareholders	Increase in amount of dividends paid to company shareholders		
Increase in income from share issue	Decrease in income from share issue	$\Sigma[Q_i \cdot P_i]$	Q_i – quantity of issued assets; P_i – cost of issued assets
Increase in amount of target financing of revenue receipts	Decrease in amount of target financing of revenue receipts	Factor model is compiled on the basis of types of expenses and revenue receipts	
Increase in amount of other revenue receipts	Decrease in amount of other revenue receipts		
Decrease in amount of other payments	Increase in amount of other payments		

The intensity of cash flow is characterized by process of its movement, which includes three stages: procurement, production andsaling. The total duration of these stages gives the total length of the operating cycle:

$$OC = CPGM + CPWP + CPFP + CPAR, \quad (8)$$

where *CPGM* is a circulation period of goods and materials;
CPWP is a circulation period of work in progress;
CPFP is a circulation period of the finished product;
CPAR is a circulation period ofaccounts receivable.

Analysis of time cycle of cash funds circulating allows us to establish on which of the steps there is a delay and to develop activities aimed at the more intensive use of cash funds.

Analysis of cash flow effectiveness is carried out with epyuse of number of factors that are shown in Table IV [12, p. 395; 13, p. 179]

Listed in Table IV coefficients should be analyzed in dynamicswith calculatingof deviations

This technique of cash funds analysis allows to find out, measure and analyze cash flow of an enterprise, as well asoptimize cash funds on the basis of obtained data [14-16].

In the analysis of cash flow of enterprises unbalanced cash flow is identified - an imbalance, prevalence of cash outflow over cash inflow.

Table 4. Indicators of cash flow effectiveness.

Coefficient	Calculation formula	Comment
the efficiency ratio of cash flow	$R_{eff} = \dfrac{NCF}{CF_o}$	NCF – net cash flow

			PLB_i –payments on loans and borrowings; ΔS –increase in stock balance; DP – dividends paid
the adequacy ratio of cash flow	$R_{ad} = \dfrac{NCF}{PLB + \Delta S + DP_i}$		
the efficiency ratio of cash flow	$R_{liq} = \dfrac{CF_i}{CF_o}$	CF_o – cash outflow	
The profitability ratio of cash flow	$R_{pr\,cash\,inflow} = \dfrac{NP}{CF_i}$	CF_i – cash inflow	
	$R_{pr\,cash\,flow} = \dfrac{NF}{\overline{CB}}$	$\overline{CB}$ – average cash balance	
	$R_{pr\,net\,cash\,flow} = \dfrac{NP}{NCF}$	NP – net profit of company	
	$R_{pr\,cash\,outflow} = \dfrac{NP}{CF_o}$	CF_o – cash outflow	

The results cash flow optimization should be reflected in preparation of enterprise cash funds budget for the timely adjustment of cash flow and ensuringsolvency of enterprise.

3 Practical implementation of the computational model of cash flow optimization

Grouping of theoretical and practical developments, as well as the results of original researches on this subject was tested on the materials of production machine building company ZAO(privately held corporation) "UUMK", which produced 22 heavy autograders (models A-98 and DZ-122B) in 2012. In 2016, it is planned to increase production by 30%. The average retail price is going to be 3.6 million rubles with quarterly growth, taking into account projected inflation within 15-17% (according to the Central Bank of the Russian Federation [17]. Sales budget is presented in Table V

Table 5. Sales budget ZAO "UUMK" for 2016.

Production	I quarter	II quarter	III quarter	IV quarter	Total
Sales volume, in units					
Autograder A-98	3	5	4	4	16
Autograder DZ-122B	4	3	3	2	12
The unit price, in thousands of RUR					
Autograder A-98	4 550	4 778	5 016	5 267	-
Autograder DZ-122B	2 680	3 095	3 250	3 413	-
Revenue, in thousands of RUR					
Autograder A-98	13 650	23 888	20 066	21 069	78 672
Autograder DZ-122B	10 720	9 286	9 751	6 825	36 582
Total	24 370	33 174	29 816	27 894	115 254

Thus, it is planned for 2016 to produce and sale 28 autograders with expected value of 115,3 mln. rubles.

After completing sales budget production budget is needed.

The balance of finished goods at the beginning of 2016 is known and is equal to 2 for A-98 model and 1 for DZ-122B model with basic complexion.

Production budget is shown it Table VI.

Table 6. Production budget of ZAO "UUMK", in units.

Production	I quarter	II quarter	III quarter	IV quarter	Total
Sales					
Autograder A-98	3	5	4	4	16
Autograder DZ-122B	4	3	3	2	12
The balance of finished goods at the beginning of year					
Autograder A-98	1	1	1	1	-
Autograder DZ-122B	1	1	1	1	-
The balance of finished goods at the end of year					
Autograder A-98	2	1	1	1	-
Autograder DZ-122B	1	1	1	1	-
Autograder A-98	2	5	4	4	15
Autograder DZ-122B	4	3	3	2	12

The set level of finished goods stock is a prerequisite for trouble-free shipment and rhythm of product supply.

The data on volumes of production allows to start the development of direct material costs. To produce autograders, ZAO "UUMK" buys imported goods and components. Due to depreciation of the national currency rate, the purchase of foreign materials is expensive and, as one of the measures for optimizing company's financial condition is reducing costs, the recommendation will be to purchase goods produced by domestic enterprises.

Material budget is presented in Table VII

In 2015 the total cost of purchasing goods amounted to 64 mln. rubles, which is by 30% higher than value obtained in preparation of material cost budget.

The budget (estimate) of direct material costs is based on the immutability of consumption rates and prices of materials. In the case of changing these settings during budget period values of estimate must be re-calculated [18, p. 348].

The next stage is drawning up the budget of direct labour cost. In this budget, we take into account only labour cost of production workers. Average wage of a production worker amounts to 25 thousands of rubles.

The budget of direct labour costs is presented in Table VIII.

Table 7. Budget of direct material costs of ZAO "UUMK" in 2016.

Autograder A-98	I quarter	II quarter	III quarter	IV quarter	Total
Quantity of production to manufacture, in units	2	5	4	4	15
Direct material costs per unit, in thousands of RUR	2 050	2 153	2 260	2 373	-
Direct material costs, in thousands of RUR	4 100	10 763	9 041	9 493	33 396
Material stock at the end of period, in thousands of RUR	215	181	190	185	-
Material stock at the beginning of period, in thousands of RUR	1 230	215	181	190	-
The amount of cost for purchasing materials, in thousands of RUR	3 085	10 728	9 050	9 487	32 350
Cost of purchasing for producing 1 unit, in thousands of RUR	1 543	2 146	2 262	2 372	-
Quantity of production to manufacture, in units	4	3	3	2	12
Direct material costs per unit, in thousands of RUR	1 450	1 523	1 599	1 679	-
Direct material costs, in thousands of RUR	5 800	4 568	4 796	3 357	18 520
Material stock at the end of period, in thousands of RUR	91	96	67	218	-
Material stock at the beginning of period, in thousands of RUR	1 450	91	96	67	-
The amount of cost for purchasing materials, in thousands of RUR	4 441	4 572	4 767	3 507	17 288
The amount of cost for purchasing materials, in thousands of RUR	1 110	1 524	1 589	1 754	-
Total amount of costs on purchasing materials, thousand of RUR	7 527	15 300	13 817	12 995	49 638

Table 8. Budget of direct labour costs of ZAO "UUMK" in 2016.

Autograder A-98	I quarter	II quarter	III quarter	IV quarter	Total
Quantity of production to manufacture, in units	2	5	4	4	15
Direct labour costs per unit, in thousands of RUR	420	422	424	426	-
Amount of direct labour costs, in thousands of RUR	840	2 111	1 697	1 705	6 353
Quantity of production to manufactu-re, in units	4	3	3	2	12
Direct labour costs per unit, in thousands of RUR	230	231	232	233	-
Amount of direct labour costs, in thousands of RUR	920	693	697	467	2 777
Total amount of labour costs, in thousands of RUR	1760	2 804	2 394	2 172	9 130

Additionally, to optimize cash flow of ZAO "UUMK", it is necessary to make plans for payments to suppliers for materials and payments of buyers for delivered goods. According to cash inflow plan, the

payment for delivered products will be based on advance payment in the amount of 70% with defer of payment (3 months). There also will be repayed receivables of 2015.

Cash inflow plan is shown in Table IX.

Table 9. Cash inflow plan for realized products of ZAO "UUMK" in 2016.

Value	I quarter	II quarter	III quarter	IV quarter	Total
Accounts receivables at the beginning of 2016: 14 635, thousand RUR					
Revenue from sales of products, thousand RUR	24 370	33 174	29 816	27 894	115 254
Payments for products, thousand RUR	18 52 3	32 72 8	33 75 0	31 39 8	116 398
Accounts receivables at the end of 2016, thousand RUR					13 490

According to plan of cash flow, by the end of 2016 accounts receivable can be equal to 13, 5 mln. rubles, which is 9% less than in 2015.

Table 10. Cash inflow plan for realized products of ZAO "UUMK" in 2016.

Value	I quarter	II quarter	III quarter	IV quarter	Total
Accounts payable at the beginning of 2016 , thousand RUR					20 735
Material costs, thousand RUR	7 664	15 437	13 954	13 132	50 186
Payments for products, thousand RUR	5 905	13 128	17 288	19 023	55 344
Accounts payable at the end of 2016 ,.thousand RUR					15 577

Thus, a decrease in accounts payable will amount to 5 mln. rubles, which will significantly affect the liquidity of enterprise.

Cash flow budget is a planning document that includes expected inflow and outflow of cash funds during the planned period. The inflow is formed on the basis of sources of cash funds income and outflow – on the basis of directions of use [19, p. 19].

Cash flow budget of current operations is presented in Table XI.

Table 11. Cash flow budget of ZAO «UUMK», current operations in 2016.

Value	I quarter	II quarter	III quarter	IV quarter	Total
CASH FLOW FROM CURRENT OPERATIONS					
TOTAL INCOME	18 523	32 728	33 750	31 398	116 398
Including sales of products, goods, work and services	18 523	32 728	33 750	31 398	116 398
TOTAL PAYMENTS, including:	14 039	24 219	28 683	30 014	-96 954
payments for goods, work, services	5 905	13 128	17 288	19 023	-55 344
labour payments	2 950	3 998	3 592	3 375	-13 915
payments of interest on loans and borrowings	380	380	380	380	-1 520
payments of taxes and duties	126	2 011	2 698	2 487	-7 322
other payments and transfers	4 678	4 701	4 725	4 749	-18 853
Cash flow balance of current operations	4 483	8 509	5 068	1 384	19 444

The expected net cash flow is positive due to increase in entity's revenue, a decrease of production cost because of use of domestic materials, optimization of customer payments for purchased products, as well as payments to suppliers for materials supplied. Cash flow of financial and investment operations are reflected in cash flow budget as they have a quick turnover, big amounts and short repayment terms [20]. Therefore, the budget will be not on a quarterly, but on a year basis. The cash flow budget for investment and financial operations is shown in Table XII.

Table 12. Cash flow budget of ZAO "UUMK", investment and financial operations in 2016.

Value	Total
CASH FLOW FROM INVESTMENT OPERATIONS	
TOTAL INCOME	4 120
Including interest on financial investment, return of loans	4 120
TOTAL PAYMENTS	3 540
Including payment for purchase of fixed assets(including income bearing investments tangible assets) and intangible assets	-2 300
Payments for financial investments	-1 240
The result of cash flow from investment operations	580

CASH FLOW FROM FINANCIAL OPERATIONS	
TOTAL INCOME	11 200
including loans and borrowings	11 200
TOTAL PAYMENTS	11 028
including repayment of loans and borrowings	-10 822
Payment of dividends	-206
The result of cash flow from financial operations	172

In 2016 ZAO "UUMK" plans to acquire a machine tool that will be able to fo multioperational machining of details with complex configuration. In addition to purchase of this machine, the enterprise plans to carry out a repair of shop premises. For this purpose, it is planned to take an investment loan in the sum of 11 mln. rubles with repayment term of 18 months and an average rate of 15%.

In 2015 the company acquired debt securities that provide income in 2016.

The expected net cash flow from investment and financial operations is positive. Total net cash flow is equal to 20 196 thousand rubles, which will make it possible for organization t carry out further modernization of products at the expense of its own funds without involving expensive external sources of financing.

Conclusion

The monitoring of scientific literature on optimizing cash flow, as well as testing of the hypothesis of research on materials of industrial enterprise allowed to develop a method of cash flow optimization for of ZAO "UUMK" company, which is one of the four largest manufactures of road machines along with ZAO "Bryanskiy arsenal", ZAO "ChSDM", ZAO "Zavod Dormash" and ZAO "PO "Irmash".

Financial analysis showed that the company is financially unstable at the end of 2015 with a high probability of bankruptcy and loss of solvency.

Authors propose a model of cash funds optimization included in budgeting of ZAO "UUMK" that suggests:

• the use of "accelerating-decelerating pay transactions" which provides acceleration of accounts receivable turnover – payment for delivered products will be based on 70% advance payment, defer of payment (3 months) and slowing down payments to suppliers and contractors – 50% will be paid on condition of advance payment with deferred of payment (6 months) in the short term:

• the use of financial instruments for both raising and allocating cash funds, reduction of production cost by reducing costs of enterprise in the long term.

The performed analysis of ZAO "UUMK" targets led to conclusion about the appropriateness of using the optimization model based on obtained data that will provide:

1) positive trend in revenue of 9 mln. rubles due to increase in production of autograders which, as well as increase in machinery prices;

2) decrease of 15 mln. rubles in production cost;

3) the use of "accelerating-decelerating pay transaction system" that will reduce accouts receivable by 1 mln. Rubles, accounts payable – by 5 mln. rubles;

4) Net cash flow and net income suggest that enterprise has its own sources for self-financing of its activities.

Thus, the hypothesis of cash flow optimization through budgeting system was confirmed during the practical experiment in industrial plant.

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