Organizing the cash flow management in the construction industry in the Russian Federation

K V Ketova, I G Rusyak, E V Kasatkina, E A Saburova and D D Vavilova
Kalashnikov Izhevsk State Technical University, Studencheskaya str., 7, Izhevsk, 426069, Russia

E-mail: vavilova_dd@mail.ru

Abstract. This paper presents a mathematical model of organizing the cash flow management in implementing an apartment building construction plan in the context of using an escrow account in the Russian Federation. A mathematical model of organizing the cash flow management implies an increased income of productive activities in the construction industry by means of changing the volume of sales in square meters and sale prices. Furthermore, a mathematical model enables us to determine the sales strategy of a construction organization, which would provide a minimum lending rate for minimizing a percentage rate which is paid by the construction organization. According to the monthly financing schedule of a building project, a mathematical model of organizing the cash flow management enables us to calculate the most suitable escrow account balance, as well as the volume of sales in square meters. Calculating rise in profitability of financial resources in the construction industry is exemplified by an average developer of one of Russia’s regions in which residential construction grows rapidly – the Udmurt Republic.

1. Introduction
Construction is one of the main funding industries of Russia. Business activity in this field has a serious impact on regional wealth, improves demographic performance [1] of the population and, in the long run, facilitates progress and development optimization within an economic system [2]. In this regard, construction industry situation analysis is relevant, as well as studying factors which have bearing on construction organizations’ performance efficiency.

Projects under construction vary based on their purpose: industrial, transportation, civil, military, hydroengineering, etc. [3]. Apartment building participatory construction is a crucial aspect of civil engineering; it had been spreading extensively across Russia throughout 2000s, which brought a vast improvement to housing conditions of millions of families. At present, according to Residential mortgage market indicators (The Central Bank of the Russian Federation), about 80% of households use mortgage lending scheme [4, 5]. Therefore, timely fulfillment of developer organization obligations to equity construction participants becomes a pressing concern.

The framework law which handles relations in the field of civil engineering in Russia is the Federal law №214 «On participating in equity construction of apartment buildings and other pieces of real estate and on amending several legislative acts of the Russian Federation» dated 30.12.2004, which was updated in July of the same year on aiming the successful apartment building equity construction projects implementation. An important change in amendment touches escrow accounts.
Escrow is a liability, according to which the purchaser transfers funds to the third party (an escrow agent), the main function of which is ensuring performance of vendor’s obligations to the purchaser. The purchaser deposits a sum in an escrow account, while the vendor receives these funds only after fulfilling the contract terms. The third party, which acts in the capacity of an escrow agent, is the bank (an independent mediator following up on the contract terms’ implementation). Escrow is a novelty for the Russian legislation, whereas it’s a very popular instrument internationally (USA, Germany, Switzerland, etc.), because it proved itself as risk reducing during settlements between the vendor and the purchaser [6, 7].

Let’s consider the problem of an optimal application of funds in a productive activity of a construction organization in the context of using an escrow account in the Russian Federation. Let’s explore the apartment building financing graph. All construction phase spans a set amount of months. There exists a monthly construction graph-plan and an according monthly development financing graph-plan.

The Developer organization should begin the construction using their own funds no less than a certain share (which is planned to comprise 15%, thought it can be adjustable) of a construction planned volume of a specific building. Simultaneously, item-by-item (apartments, parking lots, offices, shops, etc.) sales are made. Cash assets in payment for equity participation contract are deposited into an escrow account and are paid to the Developer organization after the completion. Subsequently, sells are made without usage of escrow accounts [8].

After depleting internal funds, the Developer organization uses money borrowed from the same bank in which equity construction participants’ escrow accounts are set up due to an equity construction contract payment [9]. Bank cash funds used for the construction work in progress are provided at current finance rate, which is adjusted depending on a relation between an actual debt balance on relevant loan deal and an actual equity construction participants attracted funds balance in an escrow account at that moment.

2. Materials and research methods

Let’s consider the model of optimal sales strategy management. Let’s also use PJSC (Public joint-stock company) “Bank VTB” as a bank which takes part in escrow account operations for illustrative purposes. Its real estate financing terms can be seen at https://www.vtb.ru/krupnyj-biznes/kreditovanie/finansirovanie-proektov-stroitelstva-zhiloj-nedvizhimosti.

As far as escrow accounts imply that purchasers’ money is to be deposited in a specific bank account without the developer being able to access that funds before construction ends (so that purchaser can regain them if the vendor did not fulfill contract obligations), an additional costs of account maintenance can emerge. These expenditures translate in to the loan interest payment. For the purpose of interest rate minimization, the Developer should use sales strategy which provides a minimal lending rate.

Since the Developer is interested in growth of revenue and profitability performance profile, apart from changing productive activity yield factor by means of sales volume, a sale price should be varied optimally.

In the paper, mathematical methods are developed in order to estimate an optimal minimal balance of an escrow account based on construction project financing monthly graph, as well as sales volume in square meters.

An annual interest rate is calculated via the following formula:

$$r_i = \begin{cases} (r_{bi} + r_{ci}) \cdot k_i + r_{nu} \cdot (1 - k_i) - \Delta r_i, & \text{if } r_i > r_{\mu i}, \\ r_{\mu i}, & \text{if } r_i \leq r_{\mu i}, \end{cases}$$

(1)

In the formula (1), the following parameters take place: an $i\text{-th}$ index henceforth means an $i\text{-th}$ construction day, $r_{bi}$ – an interest rate of bank lending to the construction organization in case of comprehensive cover (comprises 3.33%) of escrow accounts by equity construction participants.
(people buying an apartment); \( r_{ci} \) – a base rate of construction organization contributions to Deposit insurance fund (0.60%); \( r_{bi} \) – a base rate of bank lending to the construction organization in case of an incomplete cover of escrow accounts (10.00%); \( r_{ml} \) – minimum bank lending rate to a construction organization in case of escrow accounts’ lending finance debt relief excess (1.75%); \( k_i \) – escrow account current ratio. It’s calculated in accordance with the following formula:

\[
k_i = \begin{cases} 1 - \frac{r_{ml}}{100} & \text{where } B_i > 0, \\ 0, & \text{where } k_i > 1. \end{cases}
\]

In the formula (2), \( r_{ml} \) – rate of contributions for the Mandatory reserve fund (which comprises 4.75% as of 19.03.2020 (https://www.vedomosti.ru/finance/articles/2019/02/12/793925)). Credit \( \Delta r_i \) is determined from the following formula (3):

\[
\Delta r_i = \begin{cases} \frac{D_i(1 - r_{ml}) - B_i}{B_i} & \text{if } D_i(1 - r_{ml}) - B_i > 0, \\ 0, & \text{if } D_i(1 - r_{ml}) - B_i \leq 0. \end{cases}
\]

In the formula (3) \( r_{bi} \) – Russian Central Bank key rate (comprises 6.00% as of 17.03.2020 (https://www.cbr.ru/press/keypr/)).

During the construction of the project, the Developer is interested in the profit maximization \( P \):

\[
P = \left(1 - \frac{\eta}{100}\right) \cdot (D - B - Z) \rightarrow \text{max},
\]

In the formula (4) \( D \) – sales return accumulated sum, \( B \) – accumulated lending outstanding loan, \( Z \) – realized costs of the developer including the loan interest rate, \( \eta \) – income tax (20.00%).

Supposed accumulated return on sales \( D \) (rub.) throughout the construction phase \( T \) is the product of a supposed selling price of a residential square meter \( \bar{p}_i \) (rub./m\(^2\)) and supposed sales volume \( \bar{s}_i \) (m\(^2\)) at a price \( \bar{p}_i \):

\[
D = \sum_{i=1}^{T} D_i = \sum_{i=1}^{T} \bar{p}_i \bar{s}_i = \sum_{i=1}^{T} \left( r_{ci} \bar{p}_i \right) \left( r_{ci} - 1\% \right) B_i .
\]

An optimal sales strategy is one which provides the minimal loan interest rate. Current sales volume is determined via the equation (5). An instrument governing volume sales is a supposed residential square meter price \( \bar{p}_i \):

\[
\bar{p}_i = p_i \cdot \left(1 + \delta_{p_i}\right).
\]

In the formula (6) \( p_i \) – an average market price of a residential square meter (rub./m\(^2\)); \( \delta_{p_i} \) – price relative variation. Notably, \( \delta_{p_{\text{min}}} \leq \delta_{p} \leq \delta_{p_{\text{max}}} \); where \( \delta_{p_{\text{min}}} \) – minimum allowable price reduction considering residential square meter cost price.

Supposed sales volume \( \bar{s}_i \) at a price \( \bar{p}_i \) is determined by the following formula:

\[
\bar{s}_i = s_i \cdot \left(1 + \delta_{p_i}\right)^{-\alpha}.
\]
In the formula (7), an exponential function of price-elasticity dependence is described. Here, $s_i$ – sales volume (m$^2$) at an average market price $p_i$; $\alpha$ – the elasticity coefficient (which shows a change in sales if the price fluctuates by 1%).

3. Research results
Let’s have a look at some particular residential apartment building construction project in one of Russia’s regions. The Udmurt Republic was chosen due to an active housing expansion for illustrative purposes. In a regional Volga Federal District (VFD) ranking dated 2018, the Udmurt Republic was ranked third in terms of residential space built per one thousand residents (375.0 m$^2$). In VFD, the Ulianovskaia oblast kept the leadership (446.1 m$^2$/th. p.). Permsky Krai was ranked the lowest (205.6 m$^2$/th. p.). Currently, 72 developers construct 114 residential building projects in the Udmurt Republic (https://udm-info.ru/rating/24-10-2018/zastroyschiki-udmurtii-kto-skolkо-kogda).

Now, let's observe a residential building project construction process as implemented by an average Udmurt Republic’s developer. The construction phase spans 3 years. The whole project spans 49 months, including a construction preparation stage and a land improvement stage. The data on VTB-bank escrow account funds receipt, as well as the Developer's project implementation costs are given in figure 1.

![Figure 1](image1.png)

**Figure 1.** Escrow account funds receipt dynamics and current construction project costs.

During calculations, an average market sales price is assumed to be equal to 50 th. rub./m$^2$. The sales elasticity coefficient is $\alpha = 1$.

![Figure 2](image2.png)

**Figure 2.** Price change from an average market value (50 th. rub./m$^2$).
Due to the relative variation of the sales price per square meter in the range of the minimum allowable price reduction to the region-wise maximum allowable price rise, a residential housing project sales graph for the best-case scenario (figure 3) implementation in the range [-20%, +20%] (figure 2) was built. Table 1 lists actual and optimal financial indicators of a construction project.

![Figure 3. Volume sold graph.](image)

| Indicators             | Actual  | Optimal  | Variance       | Growth rate, % |
|------------------------|---------|----------|----------------|----------------|
| Proceeds, rub.         | 1 020,251,424 | 1 040,520,526 | +20,269,102 | +2.0 |
| Expenditure, rub.      | 858,702,721   | 857,453,421   | -1,249,300    | -0.1 |
| Borrowing costs, rub.  | 31,550,045    | 30,300,745    | -1,249,300    | -4.0 |
| Profit, rub.           | 161,548,703   | 183,067,105   | +21,518,402   | +13.3 |
| Profitability of sales, % | 12.7       | 14.1       | +1.4          | +11.1 |
| Value for money, %     | 73.1       | 83.5       | +10.3         | +14.1 |

Out of calculations in table 1, it’s apparent that by implementing interest amount minimization strategy and selling price variation, it’s possible for the Developer to rise profits by 21.5 mil.rub., which comprises 13.3%, as well as increase profitability of sales by 11.1% and value for money by 14.1%.

4. Conclusion
The problem of organizing the cash flow management in the production activities in the construction company in the conditions of applying an escrow account in the Russian Federation has been solved. Calculations are presented on optimizing the distribution of financial resources during the construction of an apartment building on the territory of one of the constituent entities of the Russian Federation – the Udmurt Republic.

Since starting July 1, 2019, construction organizations can sell apartments only through escrow accounts, therefore, additional costs for the construction organization to service these accounts arise. Additional expenses are reflected in the payment of interest on loans. To minimize the interest of the construction organization should use sales strategy that provides a minimum loan rate.

The mathematical apparatus presented in the work allows you to determine the optimal balance on the escrow account, based on the monthly schedule for financing the construction project, to determine the optimal physical volume of sales and the optimal value of the price per square meter of housing under construction. Based on these calculations, the construction company has the opportunity to
analyze in a timely manner the factors that increase the profitability of its production activities and optimize financial performance.

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