

Feasibility Analysis of Overhaul and Modernization of Equipment

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Abstract—Overhaul and modernization of equipment directly affect its market value and require significant investments which feasibility needs to be checked. This article analyzes the factors that influence the expediency of equipment overhaul or modernization. The economic effect of repair or modernization is the equipment market value increase and enterprise value change. The equipment market value increase as a result of overhaul and modernization is not the only determining condition of implementation economic feasibility. Firstly, to make an optimal choice between overhaul and modernization of old equipment and the purchase of a new one, it is necessary to compare the economic effect of possible repairs with the amount of costs that will be required in the event of this repair. Secondly, you should consider the possibility of acquiring such equipment, either new or used, but in good condition. The author of the article proposes to compare the cost of replacing objects with the amount of overhaul and modernization cost and to analyze incremental indicators. In general, the economic effect that can be achieved after equipment overhaul and modernization is compared with its cost and considered as an element of business change value. This method can help to analyze whether capital repairs and modernization are beneficial, taking into account the enterprise economic and financial opportunities.

Keywords—Overhaul of Equipment, Modernization of Equipment, Enterprise Value, Market Value, Feasibility Analysis, Incremental Indicators, Enterprise Economic Opportunities.

I. INTRODUCTION

Modern conditions require production enterprises to do regular equipment repair due to high production loads and the need in constant renewal or modernization owing to emergence of more efficient, economical, productive analogues.

Moreover, if overhaul is needed, it is advisable to combine it with modernization, which will improve not only operational, but also economic characteristics of the equipment [1]. However, the high cost of overhaul and modernization, along with financial difficulties, limit the abilities of enterprises to improve equipment. Therefore, it is necessary to allocate funds for these purposes, while justification of such costs requires a thorough analysis.

Such problems of production enterprises are exacerbated especially in the times of crisis. In such periods costs of raw materials are growing, demand and sales in the market are

declining, while time new products appear on the market [2, 3]. In order to keep consumers and maintain competitive positions, production enterprises should optimize costs, processes and allocate time and financial resources to improve equipment, to develop and implement new products [4, 5].

The purpose of this study is to analyze the factors and to find effective ways of choosing options for improving equipment, including overhaul and modernization or acquisition of a new analog.

The following tasks were set to achieve this goal:

- to identify key parameters that influence the decision to choose a specific option for improving equipment;
- to consider the change of the equipment cost as a factor affecting the enterprise value;
- to compare the economic effect of possible repairs with the amount of costs due;
- to develop ways of choosing an effective option for upgrading equipment, taking into account economic capabilities of a particular enterprise.

The theoretical significance of the work is in systematization and clarification of the theoretical assumptions about expediency of overhaul and modernization of manufacturing enterprises' equipment. The practical significance consists in developing ways of choosing an effective option for updating equipment taking into account the economic capabilities of a particular enterprise.

Analysis and synthesis of theoretical information, comparison and observation were chosen as the main methods of investigation. In the process of research, adaptation of theoretical information to the economic possibilities of a particular enterprise was made. The comparison method was chosen as the most important method of the analysis in the study. In this situation, this method makes it possible to evaluate various options for improving equipment, taking into account their effectiveness. The observation method was chosen because observation of real objects - manufacturing enterprises in particular, was required.

The market value of equipment is increased due to overhaul and modernization. However, this is not the only

determining condition for the economic feasibility of their implementation.

Sometimes, when heavily worn-out equipment is analyzed, it turns out that the cost of purchasing of such equipment in good condition is lower than possible repair costs. It is proposed to take into account possible revenues from the old equipment sale. Depending on the situation, it is suggested to consider either market or liquidation value.

This study analyzes various factors that influence expediency of equipment overhaul or modernization, including financial ones. Production enterprises often encounter problems of limited financial resources. These problems especially increase in conditions of a crisis, so this study takes into account various options for financing overhaul, modernization and replacement of equipment.

Overhaul and modernization costs are considered as an element of business value change. The analysis of cost feasibility also takes into account the economic possibilities of a particular enterprise.

II. METHODOLOGY OF USING EQUIPMENT VALUATION RESULTS FOR MAKING MANAGERIAL DECISIONS

The production equipment carries heavy loads. This is the reason why the equipment receives a high degree of deterioration over a relatively short period of time and requires periodic repairs. Overhaul is particularly costly. It is quite often combined with modernization. Modernization can also be carried out on rather new equipment due to appearance of new products on the market and the need to make technological changes for launching updated products. Traditionally, in either case the cost of equipment increases after carrying out of these works.

Let us consider how to use the equipment valuation results when making managerial decisions regarding the expediency of overhaul and modernization of equipment.

When determining the market value of equipment, the cost approach is usually used. The market approach method is applied only in the case of evaluation of standard equipment, which is often sold and bought in the secondary market. The methods of income approach are applicable to the evaluation of equipment extremely rarely, since it is difficult to single out the income generated directly by a specific machine unit [2, 3].

The most accurate results of determining the cost of equipment are achieved when evaluation specialists are involved, which is often difficult due to crisis situations at an enterprise. In such cases it is possible to make a simplified rapid assessment of equipment with the use of, for example Yu. M. Kozyr's methodology, which is based on the popular method of determining equipment depreciation by the ratio of actual and normative terms of use [6]:

$$PV_{eq} = V_b \times (1+i)^k \times f(k/n),$$

where PV_{eq} – indicative present value of the equipment, cu; V_b – value of equipment in the base period, cu; i – rate of structural inflation in the industry; k – time since the base

period, years; n – standard operating life of the equipment being evaluated, years; $f(k/n)$ – function that reflects the degree of equipment depreciation.

If $0 < k/n < 1$, then $f(k/n)$ is calculated as per the formula:

$$f(k/n) = 1 - (1 - V_{rez} / V_b) \times (k/n),$$

where V_{rez} – net book value of equipment, cu.

If $k/n \geq 1$, then $f(k/n) = V_{rez} / V_b$.

Overhaul and modernization directly affect the market value of equipment and require fairly substantial investment, the expediency of which should be checked.

First of all, the economic effect of overhaul and modernization consists in a sharp increase in market value, which is expressed by inequality:

$$V_{b,f.m.} < V_{a,f.m.}$$

where $V_{b,f.m.}$ – value of equipment before overhaul and modernization, cu; $V_{a,f.m.}$ – value of equipment after overhaul and modernization, cu.

Depending on the particular situation, $V_{b,f.m.}$ can be taken as either market value of the equipment calculated as of the date of analysis, or liquidation value, or current value of equipment calculated according to the above mentioned simplified methodology (PV_{eq}).

Usually the equipment which is put out for overhaul has a physical wear of 50-60%. So, if the price of a new machine is 2900 cu, then its residual value before the capital repair is about 1160 cu ($2900 \times (1-0,60) = 1160$ cu).

With a high-quality overhaul, the cost of equipment can increase to an average of 85% of the full replacement cost. In our example, it is up to 2465 cu. Then the economic effect accounts for 1305 cu ($2465 - 1160 = 1305$ cu).

However, the increase in the value of equipment after overhaul and modernization is not the only determining condition for expediency of their implementation. It is necessary to take into account the four other factors:

- the optimal choice between overhaul and modernization of old equipment and purchase of a new one;
- the optimal choice between overhaul and modernization of old equipment and purchase of similar equipment with the required characteristics in good condition;
- analysis of incremental indicators;
- the effect of overhaul and modernization on the enterprise value.

First, for an optimal choice between overhaul (modernization) of old equipment and buying a new one, you need to compare the economic effect of possible repairs with the amount of costs that will be required in the event of this repair. That is, the overhaul and modernization is expedient case of inequality:

$$E_e > C_{f.m.},$$

where E_e – economic effect of overhaul and modernization, $C_{f.m.}$ – overhaul and modernization costs, cu.

Secondly, there should be considered the possibility of purchasing such equipment, either new or used, but in good condition. The cost of replacement objects should not exceed the amount of repair work costs, that is, the following inequality must be obtained:

$$C_{f.m.} < (V_{new} - V_{b.f.m.}),$$

where V_{new} – value of new equipment, cu.

Thirdly, the analysis of incremental indicators is often crucial, since sometimes the incremental cost of purchasing new equipment with respect to major repairs, even if their cost exceeds the costs for modernization, often entails lower operating costs, less downtime for repairs, etc.

Fourth, upgrading equipment will affect the enterprise value. Accordingly, the costs and economic effect of equipment overhaul and modernization should be considered as an element of Value Based Management (VBM).

In the conditions of limited financial resources and the need to replace equipment in the shortest possible time, the calculations should take into account the possible revenues from old equipment sale, and to test the previous inequality as $V_{b.f.m.}$ to take into account not the market, but the liquidation value of the equipment before its repair and modernization. The liquidation value is the expected value of the equipment sold in case of emergency. It will be lower than the market value.

Sometimes, when analyzing heavily damaged equipment, it is not necessary to determine $V_{b.f.m.}$, since the cost of acquiring such equipment in good condition is lower than the possible repair costs.

Let us turn to the most worn out part of the technological equipment fleet of the enterprise we analyze. On the basis of determining the critical values of repairs costs, we will try to define whether the owner of these facilities will benefit from major repairs (Table 1).

TABLE I. CALCULATION OF CRITICAL VALUE OF CAPITAL REPAIR COSTS

№	Indicators	Name of equipment	
		Machine No.1	Machine No.1
1	Depreciation of equipment, %	60	50
2	V_{eq} , RUB.	2 900 000	695 800
3	$V_{b.f.m.}$, RUB.	1 160 000	347 900
4	$V_{a.f.m.}$, RUB.	2 465 000	591 430
5	Critical value of overhaul costs, RUB. (1.4 - 1.3 = 1.5)	1 305 000	243 530
6	Expected overhaul costs, RUB.	157 420	190 560

The data given in the table should become decisive for the owner's choice: machine No.1 which is in emergency condition should be eliminated with the subsequent purchase of similar equipment in an acceptable condition at a market price. As for machine No.2, it is advisable to carry out overhaul repairs.

It should also be borne in mind that manufacturing enterprises often experience problems with limited financial resources, which is especially amplified in times of crisis, so it is necessary to take into account the various options available for financing overhaul or modernization and replacement of equipment [7-9].

In the event of obtaining borrowed financial resources it is necessary to compare the economic and financial possibilities of an enterprise with the potential schedule of debts payment. Thus, it is necessary to consider financing schemes that are acceptable for a particular situation, with different options for deferred payments, including and not including interest capitalization, and the possibility of project financing [5]. Strict requirements of banks for guarantees and collateral also stand in the way of attracting financial resources. A possible way out of this situation, which allows an enterprise to receive the required amount of money and (or) reduce the interest rate by increasing reliability is to attract another legal entity as a security (or a pledger) for the loan [10].

For manufacturing enterprises, the most appropriate loan (мне нравится этот вариант, но на ваше усмотрение) scheme is the one with interest capitalization. A grace period is necessary throughout the time of equipment stoppage, production start-up and subsequent sales of products. Due to the capitalization of unpaid interest during the grace period, the balance of loan debt significantly increases. However, at a seemingly high cost, this financing scheme allows an enterprise not to divert financial resources during the modernization period and begin to repay the loan at the time the cash flow is sufficient to make payments on the loan.

III. OVERHAUL AND MODERNIZATION AS FACTORS OF VALUE BASED MANAGEMENT

The economic effect achieved after repairs and modernization can be considered as an element of changing business value [11-13]. In the case of economically feasible capital expenditures in equipment, the enterprise value will increase. After all, as a consequence of these measures, the value of the enterprise's property increases, costs for current repairs and other operating costs are reduced, the number of equipment downtime due to breakdown or underload is reduced, and the income of the enterprise is growing. However, there are cases when capital costs are excessive from the economic point of view, not justified by the growth of business incomes, and in case of borrowing for this purpose, borrowed resources can lead to liquidity decrease and insolvency of the enterprise.

Let us consider the impact of capital costs and the corresponding change in equipment characteristics on the enterprise value in more detail. The enterprise value is classically determined by three approaches: income, asset and market approaches.

The market approach takes into account multipliers - the relationship between price and any indicators, both financial and natural. However, in order to correctly apply a comparative approach to business valuation, it is difficult to find comparable counterparts and detailed information about them, including the calculation of multipliers associated with equipment. In addition, this approach requires considerable time because of its high complexity and the complexity of information retrieval. When assessing a business, this approach is difficult to apply without involvement of a professional appraiser.

The asset approach takes into account value of property, which, as noted above, increases after overhaul or modernization. However, in the process of assessing the value of an enterprise the company's long-term debt is deducted. Consequently, the use of long-term loans for overhaul or modernization based on the results of applying the asset approach to business valuation may not reflect the real value of capital investments.

The income approach does not directly reflect the property value increase. The advantages of the approach are that it allows taking into account the amount of capital investment, changes in costs and revenues, as well as the prospects for business development, which become more optimistic due to better equipment. Regardless of the method chosen in the income approach, the calculation results will reflect changes in the equipment of the enterprise.

Рассмотрим классическую формулу расчета денежного потока: Let us consider the classical formula of cash flow calculation [14-18]:

$$CF = EBIT \times (1 - ETR) + Depr - CExp - \Delta NWC + \Delta LTD$$

where *EBIT* – Earnings before Interest and Taxes; *ETR* – Effective Tax Rate; *Depr* – Depreciation Expense; *CExp* – Capital Expenditures; ΔNWC – change in Net Working Capital; ΔLTD – change in long-term debt.

Let us consider the possibility of accounting for changes in an enterprise value as a result of the equipment modernization based on the data of the production enterprise. The study also analyzed the project on replacement of extruders with the purpose that the production line could work on cheaper raw materials. The data are presented in Table 2.

TABLE II. CALCULATION OF ENTERPRISE VALUE

№	Indicators	Without the project	With the project
1	Modernization costs, RUB.	0	10 270 000
2	Enterprise value (<i>EV</i>), RUB.	158 617 000	184 674 000
3	<i>EV_{afm}</i> , RUB.	26 057 000	

Calculations showed that the growth of enterprise value exceeds the costs of production line modernization, therefore implementation of the project is economically viable.

Thus, for the purposes of Value Based Management, the most profitable approach is the income approach, in which the changed cash flows due to capital investments in equipment can be taken into account on the basis of the discounted cash flow method. The calculation of cash flows takes into account, among others, changes in the company's income and changes in long-term debt, which may be significant in the event of overhaul and modernization [19, 20].

The non-negativity of the projected cash flows, taking into account capital expenditures, reflects their comparability with the economic capabilities of a particular enterprise.

IV. CONCLUSION

The considered technique comes down to comparing the economic effect that can be achieved after carrying out the repair procedure with the costs of carrying out the repair itself. The presented methodical approach allows to analyze, whether major repairs and (or) modernization will be profitable for an enterprise.

The article proposes to compare the cost of replacing objects to the amount of repair costs, to analyze incremental indicators.

Sometimes, when analyzing heavily worn out equipment, it is revealed that the cost of purchasing such equipment in good condition is lower than the possible repair costs. In the calculations it is proposed to take into account the possible revenues from the sale of old equipment. Depending on the situation, it is suggested to take into account either market or liquidation value.

In general, the proposed analysis of the feasibility of overhaul and modernization is reduced to the optimal choice between overhaul and modernization of old equipment and the purchase of a new one, between overhaul and modernization of old equipment and purchase of similar equipment in good condition with the required characteristics, analysis of incremental indicators and the effect of overhaul or modernization on the enterprise value.

The overhaul and modernization costs are considered as an element of Value Based Management, taking into account the economic opportunities of a particular enterprise.

References

- [1] Zemskov V.M. Economic nature and the feasibility of repair of fixed assets // *Fundamental research*. – 2017. – № 9 (part 2), pp. 428-432.
- [2] M. V. Khairullina, E. S. Gorevaya, "Management of innovations: organizational-economic and marketing aspects" Novosibirsk: Publishing house of the NSTU, 2015, 307 p.
- [3] Sustainable development in conditions of Slovakia and Russia. : monograph / Z. Hajduova, M. Bosak, P. Andrejovsky, R. Lasko, M. Khayrullina, E. Gorevaya . - 1st Edition. - Brussels : EvroScientia vzn, 2016. - 209 p. - 200 copy - ISBN 978-90-822990-4-5.
- [4] A. A. Borisova, M. M. Kiseleva. Commercialization of scientific research results: ways of testing investment attractiveness // *Izvestiya Bajkal'skogo gosudarstvennogo universiteta : nauch. zhurn.* – V. 27, № 2. – pp. 298–302, 2017.
- [5] V. I. Mamonov, V. A. Poluehktov. Assessment problems of reliability of functioning of production // *Rossiiskoe predprinimatel'stvo*. – V. 18, № 11, pp. 1733–1740, 2017.

- [6] Kozyr' YU.V. Valuation and management of company value . – M.: OOO «Rossijskoe obshchestvo ocenishchikov», 2005. – 276 p.
- [7] S.A. Ross, R.W. Westerfield, J.F. Jaffe, Corporate Finance, 10th ed. McGraw-Hill/Irwin, 2013, 1080 pp.
- [8] Brealey, R., Myers, S., Allen, F. Principles of Corporate Finance, 11th ed., McGraw-Hill/Irwin, 2014., 1340 pp.
- [9] E. V. Spiridonova –Fundraising sources for high-tech innovation projects” Russian Entrepreneurship, Vol. 18, No. 11, pp. 1761-1770, 2017.
- [10] Shcherbakova N. A., Gladkaya D. A. Management of cash flows of enterprises taking into account issued guarantees // Lomonosovskie chteniya na Altai: fundamental'nye problemy nauki i obrazovaniya : mezhdunar. konf. (Barnaul, 11–14 noyabrya 2014 g.) / Altajskij gos. un-t. Barnaul : AltGU, 2014. P. 2793–2795. URL: <https://sites.google.com/site/lomchten/arhiv/osborniketrudovkonferencii> (19.04.2018).
- [11] A. Damodaran, Investment Philosophies: Successful Strategies and the Investors. Who Made Them WorkInvestment Philosophies, 2nd ed., Wiley, 2012, 597 pp.
- [12] T. Koller, M., Goedhart, D. Wessels, McKinsey & Company Inc., Valuation Measuring and Managing the Value, 6th ed., JohnWiley & Sons, Inc., Hoboken, New Jersey, 2015, 848 pp.
- [13] Cheremnyh, O. S. Strategic corporate reengineering: process-value approach to business management: Uchebnoe posobie / O. S. Cheremnyh, S. V. Cheremnyh. – M. : Finansy i statistika, 2005. – 734 p.
- [14] Volkov D. L. Value-based management theory: financial and accounting aspects. — 2nd ed. — SPb., 2008. — 320 p.
- [15] Damodaran Aswath. Investment Valuation: Tools and Techniques for Determining the Value of Any Asset. Под ред. Брейли С. , Mc-Graw-Hill, 2002. – 992 p.
- [16] J.B. Abrams, Quantitative Business Valuation: A Mathematical Approach for Today's Professionals, Moscow: Laboratoriya Knigi, 2014, 502 pp.
- [17] Nick Antill, Kenneth Lee M.a Company Valuation Under IFRS: Interpreting and Forecasting Accounts Using International Financial Reporting Standards. 2nd ed. – Hampshire: Harriman House, 2013. — 430 p.
- [18] Dodel K. Private Firm Valuation and M&A: Calculating Value and Estimating Discounts in the New Market Environment. Wiley, 2014. — 206 p. — (Wiley Finance series). — ISBN: 9781119978787
- [19] Shcherbakova N. A. Tailoring research and development practices to the economic capacity of an enterprise / N. A. Shcherbakova // P11 International forum on strategic technology (IFOST 2016) : proc., Novosibirsk, 1–3 June 2016. – Novosibirsk : NSTU, 2016. – [Pt. 3]. - P. 259-262 - ISBN 978-1-5090-0853-7. - EAN 9789082299045
- [20] V.G. Kogdenko, Economic Analysis, Moskow: Yuniti-Dana, 2011, 399 pp.