

## The Efficiency Analysis of Measures to Improve the Labor Productivity

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### Abstract

The present paper substantiated the need to analyze the implementation of measures to increase the labor productivity in companies in accordance with strategic objectives of businesses. It defined possibilities of using instruments of financial mathematics for the creation of analytical information on changes in the net profit, net present value, discounted payback period, and the profitability index of costs. It considered measures to increase labor productivity within the framework of the lean manufacturing concept. Economic calculations were carried out to determine the effectiveness of introduction of the individual lean production elements in one of the largest Russian oil companies: The introduction of small-scale mechanization and the integration of round checks; and the utilization of the fund standardization and visualization. Practical aspects of determining the effectiveness of measures aimed to increase the labor productivity based on principles of the production. It analyzed the impact of measures to increase the labor productivity on key technical and economic indices of the company's activity: Increase in the oil production and growth in sales proceeds due to the reduction in downtime, changes in the number of personnel, and reduction in oil losses. The main approaches to the formation of efficiency criteria were identified: The analysis of using labor resources and the evaluation of efficiency of obtaining general income and profits that allowed developing and making managerial decisions.

**Keywords:** Analysis; labor productivity; Lean production; Efficiency; Profit; Financial mathematics; Technical and economic indices.



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### 1. Introduction

The growth of economy of country or efficiency of production system depends generally on its level of science, technology and strategic management. For the growth of a country, production force that includes production facilities and work force must be developed. To evaluate the right direction of economic development, it is necessary to apply complex economic index like labor productivity (Usubamatov *et al.*, 2008). Sustained long-term economic growth comes from increases in worker productivity, which essentially means how well we do things. Labor productivity is the value that each employed person creates per unit of his or her input. The easiest way to comprehend labor productivity is to imagine a Russian worker who can make 10 loaves of bread in an hour versus a U.S. worker who in the same hour can make only two loaves of bread. In this fictional example, the Russians are more productive. Being more productive essentially means you can do more in the same amount of time. This in turn frees up resources to be used elsewhere.

Recent studies confirm that labor and productivity have historically been mildly positively correlated, but since the mid-80s, have become counter-cyclical (Yepez, 2017). The current modern conditions need companies with new approaches to managing the labor productivity since the efficiency of using labor resources is an important index of competitiveness. The reason for the low labor productivity in companies at the management level is the lack of organizational improvements (Abreu *et al.*, 2018). At the level of the production process, in particular in oil companies, this is a low oil recovery factor caused by inadequate use of methods for the impact on formations (Bakhyt *et al.*, 2018), (Buer *et al.*, 2018) and inefficiency of drilling. In this regard, an increasing number of companies are developing long-term strategies to improve the work efficiency by taking realistic measures to achieve their objectives and overcoming the pressure of external factors. Enterprises abandon obsolete management mechanisms, review their infrastructure and problem areas that hamper development, use the potential of digital technologies to manage production assets allowing them to quickly monitor the situation and make informed decisions (Djakupova, 2012).

All the efforts undertaken have a significant impact on the economic performance of companies. Thus, we ask, how do financial indices such as Net Present Value, Profitability Index, Payback Period, and the Discounted Payback Period analyze the effectiveness of implementing measures to improve the labor productivity according to the case study of a large Russian oil company? This article is closely related to Jermann and Quadrini (2012) who hint toward an important link between financial conditions and productivity. This paper proceeds as follows. Section

2 describes the methods and financial indices formulas. Section 3 indicates results obtain from formulas and discussion about the results. Section 4, 5 and 6, respectively show summary, conclusion and acknowledgement of the research.

## 2. Methods

Tools of financial mathematics allow the amount of money to estimate that the company expects to receive from the introduction of measures to increase the labor productivity, and monitor the profitability of these activities.

The following indices can help analyze the effectiveness of measures with a long period of profit: Net Present Value (NPV); Profitability Index (PI); payback period (PP), and the discounted payback period (DPP).

The net present value can be calculated by the following formula:

$$NPV = \sum_{t=0}^T NCF_T (1+r)^{-1} \quad (1)$$

Where  $NCF_T$ - Net cash flow;

$r$  - Discount rate;

$T$  - Project realization period;

$t$  is the calculation step number.

The profitability index can be determined by the following formula:

$$PI = \frac{NPV}{I_0} = \sum_{t=0}^T \frac{CF_t}{(1+r)^t} \quad (2)$$

NPV - the Net Present Value;

$I_0$  - Initial investment;

$CF_t$  - Cash flow;

$r$  - Discount rate;

$T$  - Project realization period;

$t$  is the calculation step number.

The following formula can be used to determine the payback period reflecting the period of invested return of funds and characterizing the financial risk:

$$PP = T - \frac{\sum_{t=0}^T CF_t}{CF_{T+1}} \quad (3)$$

Where,  $\sum_{t=0}^T CF_t$ - accumulated the balance of cash flows at the step of preceding the payback period;

$CF_{T+1}$ - the cash flow of the settlement period step during which the payback period occurs;

$T$  - The project realization period;

$t$  is the calculation step number.

In calculating the payback period (PP), it should be noted that this index has a number of drawbacks: It does not take into account the discounted value of money; does not determine the amount of cash flows after the payback period; the value of index is distorted for non-permanent cash flows. In order to neutralize these shortcomings, it is possible to determine the discounted payback period by the following formula:

$$DPP = T - \frac{\sum_{t=0}^T DCF_t}{DCF_{T+1}} \quad (4)$$

Where,  $\sum_{t=0}^T DCF_t$ - is the accumulated balance of discounted cash flows at the step preceding the payback period;

$DCF_{T+1}$  - the discounted cash flow of the settlement period step during which the payback period occurs;

$T$  - The project realization period;

$t$  is the calculation step number.

## 3. Results and Discussion

The use of financial mathematics tools is used to analyze the effectiveness of implementing measures to improve the labor productivity according to the case study of a large Russian oil company. The enterprise is an internationally recognized vertically integrated holding in which the production complex of oil and gas production, oil refining and petrochemistry are developing (Filatov and Rudykh, 2014).

Results of studying the best world practices of oil companies indicate that main measures to increase labor productivity should be aimed at the efficiency of each production site. In accordance with this issue, the introduction of lean tools at field facilities is a basic direction in the studied oil company and allows an understanding to formulate that each employee can take a direct part in improving the company's operations. Let's consider the impact from introduction of lean production individual elements during a year on the main performance indices of company:

- Means of small-scale mechanization to reduce the intensity of work and enlargement of ground checks, and consequently, increase the labor productivity in oil production teams;

- Means of standardization and visualization with the aim aimed to reduce the unproductive time. This is an organizational and economic factor affecting the growth of labor productivity.

An approximate calculation of transferring all oil and gas production teams of the oil company's structural subdivision to small-scale mechanization means that the cost savings will be 2,238 thousand rubles/year (excluding the cost of equipment). Similarly, optimizing the number of ground checks releases three operators.

In accordance with the second activity, it is planned to develop eighty-five standard operating charts covering the main operations of oil and gas production operator as well as the formation of stands for monitoring well stock. The use of cards increases the information content of employees, contributes to reduction of number of violations of industrial safety and labor protection by 9.3%, or by 0.12 violations per object. Stands allow the appropriate control

degree to increase, thereby reducing the number of downtime and oil losses. The proposed activities are sufficiently effective since the introduction of the first measure results in an increase in the labor productivity by 2,0706 thousand tons/person, and the second measure by 2,0712 thousand tons/person. In addition, it is necessary to assess how these activities affect the main economic performance of a structural unit of the oil company. To this end, we calculate the economic efficiency from increasing the productivity of labor for each measure based on applied formulas in financial mathematics. Table 1 presents calculations for the first measure.

**Table-1.** Company in the Implementation of Small-scale Mechanization and Enlargement of Round Check Tools

Indices	Normative Duration of Effects, Months								Total
	1	2	3	etc.	9	10	11	12	
Costs before implementation, thousand rub.	-360	-360	-360	...	-360	-360	-360	-360	-4322
Costs after implementation, thousand rub.	-174	-174	-174	...	-174	-174	-174	-174	-2084
Costs economy, thousand rub.	186	186	186	...	186	186	186	186	2238
Income tax, thousand rub.	-37	-37	-37	...	-37	-37	-37	-37	-448
Net profit, thousand rub.	149	149	149	...	149	149	149	149	1790
Discounted factor	1,000	0.992	0,984	...	0.936	0.928	0.920	0.913	
Net total flow, thousand rub.	149	149	149	...	149	149	149	149	1790
Cumulative net total flow, thousand rub.	149	298	448	...	1343	1492	1641	1790	
Discounted balance, thousand rub.	149	149	147	...	140	138	137	136	1712
Net present value (NPV), thousand rub.	149	298	445	...	1300	1439	1576	1712	
Discounted payback period (DPP), months	0.3			...					
Influx of cash, thousand rub.	187	187	187	...	187	187	187	187	2238
Outflow of cash, thousand rub.	-37	-37	-37	...	-37	-37	-37	-37	-448
Profitability index (PI)	5000			...					

We calculated the effectiveness of another measure to improve the productivity of staff - this is the introduction of standardization and visualization tools. Table 2 presents the initial data for calculating the economic efficiency from increasing the labor productivity of personnel in the introduction of standardization and visualization tools.

**Table-2.** Initial Information for the Calculation of Cost Efficiency of the Oil Company

Indicators	Unit	Value
Capital investments	ths. rub	545.393
Expenses for the stands	ths. rub	359.753
Expenses for making standard operations sheets	ths. rub	185,640
Additional oil production	ton per day	14.3
Variable costs on oil extraction	rub. per ton	162.2
Extraction tax rate	rub. per ton	5176.0
Selling value of 1 ton of oil without value added tax	rub. per ton	10149.6
Discount rate	%	10.0
Income tax	%	20
Exploitation coefficient	coef.	0.930
Production decline coefficient	coef.	0.950

Based on data of Table 2, we can calculate the economic efficiency from the increase in the labor productivity of studied company due to the introduction of the second measure to introduce lean manufacturing. Table 3 presents results of calculations.

Table-3. Calculation of Cost Efficiency from Improvement of the Labor Productivity

Indices	Normative Duration of Effects, Months								Total
	1	2	3	etc.	9	10	eleven	12	
Investments on realization of the measure, ths. rub.	-545.4								
Average daily production rate, ton per day	14.31	13.59	12.91	...	9.49	9.02	8.57	8.14	
Oil production, ton	399	379	360	...	265	252	239	227	3670
Total additional oil production, ton	3670								
Proceeds of oil sales without value added tax, ths. rub.	4052	3850	3657	...	2688	2554	2426	2305	37251
Field costs, ths. rub.	-2131	-2025	-1923	...	-1414	-1343	-1276	-1212	-19592
variable costs, ths. rub.	-65	-62	-58	...	-43	-41	-39	-37	-595
- Extraction tax, ths. rub.	-2067	-1963	-1865	...	-1371	-1302	-1237	-1175	-18997
- The implementation of improving oil recovery methods, ths. rub.	-545								
Gross profit, ths. rub.	1921	1825	1734	...	1274	1211	1150	1093	17659
Income tax, ths. rub.	-384	-365	-347	...	-255	-242	-230	-219	-3532
Paid after tax profit, ths. rub.	1537	1460	1387	...	1020	969	920	874	14127
Discounted coefficient	1,0000	0.9917	0.9835	...	0.9358	0.9280	0,9204	0,9128	
Total balance flow, ths. rub.	991	1460	1387	...	1020	969	920	874	13582
Cumulative total balance flow, ths. rub.	991	2451	3838	...	10819	11787	12708	13582	
Discounted balance, ths. rub.	991	1448	1364	...	954	899	847	798	13025
Net present value (NPV), ths. rub.	991	2439	3803	...	10482	11380	12227	13025	
Discounted payback period (DPP), month.	0.3								
Influx of cash, ths. rub.	4052	3850	3657	...	2688	2554	2426	2305	37251
Discounted influx of cash, ths. rub.	4052	3818	3597	...	2516	2370	2233	2104	35783
Total discounted	35783								

influx of cash, ths. rub.									
Outflow of cash, ths. rub.	-3061	-2390	-2270	...	-1669	-1585	-1506	-1431	-23670
Discounted outflow of cash, ths. rub.	-3061	-2370	-2233	...	-1562	-1471	-1386	-1306	-22758
Absolute sum of discounted outflow of cash, ths. rub.	22758								
Profitability index of discounted costs	1,752								
Profitability index (PI)	1,754								

Table 4 presents a summary assessment of the effectiveness of measures to improve the labor productivity in the lean manufacturing.

**Table-4.** Summary Assessment of Indices of Efficiency Measures to Improve the Labor Productivity of Oil Company Structural Division Personnel

Index	Measures to improve the labor productivity within the framework of the lean production	
	Implementation of small-scale mechanization and enlargement of round check tools	Implementation of standardization and visualization means
Costs change on implementation, ths. rub.	-	+545.4
Change of annual saving costs, ths. rub.	+ 2238	-
Change of proceeds of oil sales, ths. rub.	-	+37251
Change of net profit, ths. rub.	+1790	+14127
Change of net present value (NPV), ths. rub.	+1712	+13025
Change of discounted payback period (DPP), months	+0.3	+0.3
Change of profitability index (PI)	+5,000	+1.754

Comparison of performance indices for measures to increase the labor productivity shows that both measures lead to a significant net profit.

The measures to increase the labor productivity have a significant impact on main performance indices of the structural unit of oil companies in order to increase the oil production and reduce downtime of wells. Table 5 compares main technical and economic indices before and after the implementation of measures.

**Table-5.** The Impact of Measures for Improvement of Labor Productivity of Personnel on Technical and Economic Indices of Oil Companies

Index	Unit	Before implementation	Measures to improve the labor productivity within the framework of lean production		Change of indices after implementation of measures
			Implementation of small-scale mechanization and enlargement of round check tools	Implementation of standardization and visualization means	
Change of labor productivity	mln. rub. per person	20,983	+21,024	+ 21,039	+21,080
Change of oil production	ths. ton	3332.61	-	+ 5.219	+ 5.219
Change of number of	person	1612	-3	-	- 3

staff					
Change of sales of oil sales	mln. rub.	33824.66	+2.238	+90.221	+92.459
Selling value of 1 ton of oil	rub.	10149.6			

According to studies, the introduction of new measures to increase the labor productivity should be accompanied by an assessment of indices characterizing the level of profitability of project and an assessment of their impact on key indices of business performance (Hartley and Medlock, 2008). Our research confirms specialists' conclusion indicating the importance of analysis of increasing the efficiency of measures in the decentralization of management (Ike and Lee, 2014), (Liu *et al.*, 2018) as it is associated with the assessment of increased efficiency comparability for the company resources' use, cost reduction, revenue growth, and optimization of staff remuneration (Panwar *et al.*, 2018), (Romanova *et al.*, 2017). In addition, the orientation on the basic principles of evaluating the effectiveness of measures to increase the labor productivity is an essential condition. They cover the consideration of technologies throughout the payback period; prospective modeling of cash flows (Shirai and Amano, 2017) and multi-stage evaluation at various stages of development and implementation of each measure affecting the efficiency of company's operating activities (Shishkina *et al.*, 2015), (Sokolov and Sungatullina, 2015).

#### 4. Summary

Modern business conditions aim to increase the efficiency of company activities. Correctly-chosen measures allow available reserves reveal in companies (Sungatullina and Neizvestnaya, 2017). In this regard, it is important to evaluate measures with the aim to increase the labor productivity, increase profit (Sungatullina and Faizrahmanova, 2017) and meet the regulatory deadlines for reimbursement of spent funds on these measures. For their implementation, it is possible to apply different approaches to the formation of performance criteria on the basis of which management decisions will be developed. They include the comparison of performance at different levels. At the first level, the analysis of application of company's labor resources is carried out in different aspects. At the second level, an assessment of efficiency of obtaining the total income and profits is made and it ensures the financial stability of company (Yepez, 2017), (Villalobos, 2015).

#### 5. Conclusion

Approaches for assessing the increase in the labor productivity allow differentiating the implemented company activities to determine how results of analysis are transformed into real types of activities. This allows giving strategic importance to the success factors that determine the effectiveness of the company operation in order to assess their degrees of influence and emerging trends in their change and significance (Zakharyan *et al.*, 2015).

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