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ANALYTICAL AND PREDICTIVE MODELING OF GROSS PROFIT OF IT COMPANY

АНАЛІТИКО-ПРОГНОСТИЧНЕ МОДЕЛЮВАННЯ ВАЛОВОГО ПРИБУТКУ ІТ-КОМПАНІЇ

The article analytical and prognostic modeling of economic indicators: income, production costs and gross profit of an IT company is provided. Statistical data on the income and cost of production in order to identify the reasons for the decline in profitability of IT-companies is investigated. The relevance of this study is of particular importance with a large number of groups of contractors, when it is necessary to effectively distribute the staff, given the fact that the lion's share of the cost is formed from the hourly pay of programmers. Provided that the use of labor resources is increased, the cost of IT products will decrease and, accordingly, the company's profitability will increase.

For this purpose, based on statistical data, the predictive ARIMA model of income using the Box-Jenkins method is constructed. An analysis of the residuals of the model showed its adequacy. The program of the work result listing for constructing and analyzing the ARIMA model is given. Using a trend analysis of statistical data on production costs, a forecast model is built. An analysis of residues was also performed. Based on the constructed forecast models, the values of income and production cost, as well as gross profit at the end of the year, are determined. The analysis of the company's profitability showed a drop in this indicator. In order to identify the causes of this fact, profitability indicators of all groups of counterparties were analyzed. As a result, two groups of counterparties were identified in which a drop in profitability was noted. A detailed analysis of the aggregate data of these groups showed an increase in the cost of IT products created for them. The graphs of the results of a trend analysis of the growth of gross profit and the increase in the cost of production for the period from January 2017 to September 2018, as well as for the period from November 2018 to September 2019, are presented. It was noted that the reason for a rather sharp increase in cost is the irrational use of personnel. Moreover, because of the reorganization of the teams working with problematic contractors, the situation stabilized and at the end of the year, there was an increase in the profitability of the IT company.

Keywords: autoregressive model, trend analysis, IT company, gross profit, revenue from the sale of services, cost of services provided.

У статті проведено аналітико-прогностичне моделювання економічних показників: доходу, собівартості продукції і валового прибутку ІТ-компанії. Досліджено статистичні дані про дохід і собівартість продукції з метою виявлення причин падіння прибутковості ІТ-компанії. Актуальність даного дослідження набуває особливого значення при великій кількості груп контрагентів, коли необхідно ефективно розподіляти кадровий склад,

враховуючи той факт, що левова частка собівартості формується з погодинної оплати програмістів. За умови збільшення ефективності використання трудових ресурсів зменшиться собівартість IT-продукції і, відповідно, буде збільшуватися прибутковість компанії.

З цією метою на основі статистичних даних методом Бокса-Дженкінса побудована прогнозна ARIMA модель доходу. Проведений аналіз залишків моделі показав її адекватність. Наведено лістинг результату роботи програми побудови та аналізу ARIMA моделі. Використовуючи трендовий аналіз статистичних даних собівартості продукції побудована прогнозна модель. Також проведено аналіз залишків. На основі побудованих прогнозних моделей визначені значення доходу і собівартості продукції, а також і валового прибутку на кінець року. Проведений аналіз прибутковості компанії показав падіння цього показника. З метою виявлення причин цього факту були проаналізовані показники прибутковості всіх груп контрагентів. В результаті ідентифіковані дві групи контрагентів, у яких відбулося падіння прибутковості. Детальний аналіз сукупних даних цих груп показав зростання собівартості створюваної для них IT-продукції. Наведено графіки результатів трендового аналізу приросту валового прибутку і приросту собівартості продукції на період з січня 2017 року по вересень 2018 року, а також на період з листопада 2018 року по вересень 2019 року. Було відзначено, що причиною досить різкого зростання собівартості є нераціональне використання кадрового складу. І в результаті реорганізації працюючих з проблемними контрагентами команд ситуація стабілізувалася і в кінці року спостерігалося зростання прибутковості IT-компанії.

Ключові слова: авторегресійна модель, трендовий аналіз, IT-компанія, валовий прибуток, дохід від реалізації послуг, собівартість наданих послуг.

Introduction. The IT sector in Ukraine is one of the most profitable and fastest growing areas of economic activity, which according to the World Bank, international consulting companies and the domestic IT community, has shown at least 25% annual growth over the last 4-5 years [1]. The persistence of such a trend is predicted at least in the short term and has a significant impact on the state of the domestic economy. With the growth of the market, the scale of IT companies is increasing. In this paper, we will look at one of the largest IT consulting companies in Ukraine that provides services in the field of digital technologies.

With the increase in the volume of the company, it needs quality analysis and forecasting of its performance [2]. The competent organization of accounting and control of finances in the company will allow not only to objectively and timely reflect costs and revenues and to carry out operational control over the implementation of the plan and compliance with the cost estimates, but also to identify the increase in cost of services rendered, to determine such a strategy of the company, which will allow to improve significantly financial results of the enterprise and, accordingly, to increase its competitiveness [3,4].

Setting objectives. The purpose of this work is to analyze statistics for the period from January 2017 to September 2019, to build forecast models of income, cost of services provided and gross profit at the end of 2019.

Methodology: time series analysis, autoregressive models, trend analysis, profitability analysis.

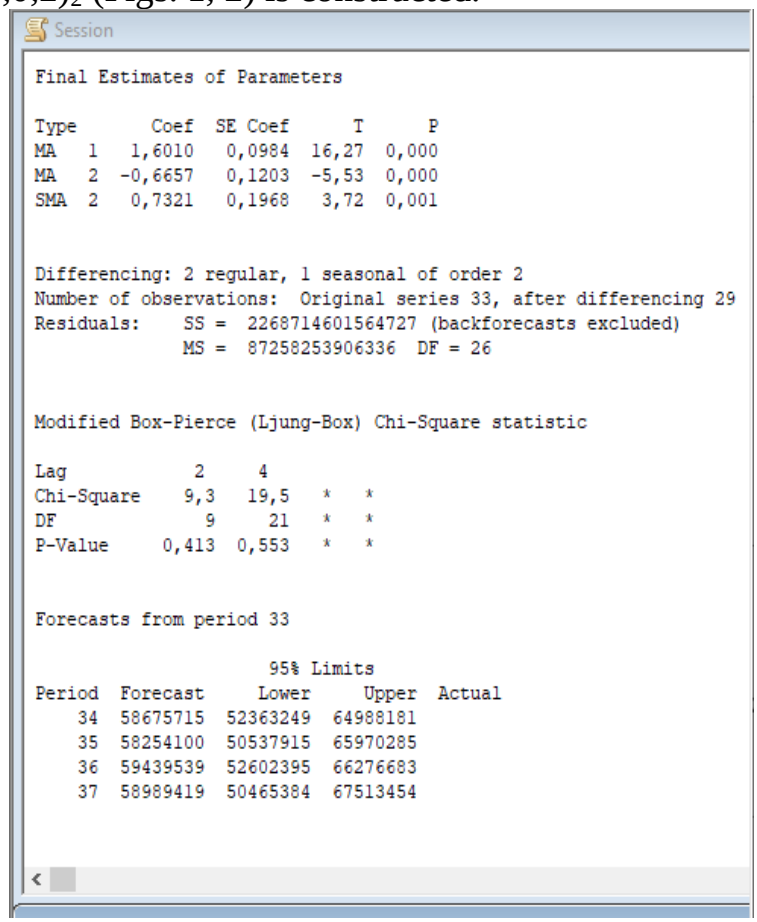
Results of the research. To evaluate the performance of a company for the selected period, it is traditionally made a "Report on financial results", which allows to identify possible problems that will affect the financial position of the company in the future [4, 5]. Based on the financial statements [3] the company calculates gross profit, which is an indicator of business efficiency and by the profit of the company or its losses because of realization of the services produced for a certain period is determined:

$$P = \sum_{t=1}^{T} R_t - \sum_{t=1}^{T} C_t ,$$

where R – revenue from the services provided, C – cost of the services provided.

When monitoring the company's profitability, a discrepancy between the forecast values of gross profit for 2019 and the real value are revealed. To identify the causes therefore, income and cost as components of gross profit are consider separately.

Analysis of data on income from services provided. As a result of the analysis of income data by the Box-Jenkins method [6], a model for forecasting time series data – ARIMA (0,2,2) $(0,0,2)_2$ (Figs. 1, 2) is constructed.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Final Estimates of Parameters

Type		Coef	SE Coef	T	P
MA	1	1,6010	0,0984	16,27	0,000
MA	2	-0,6657	0,1203	-5,53	0,000
SMA	2	0,7321	0,1968	3,72	0,001

Differencing: 2 regular, 1 seasonal of order 2
Number of observations: Original series 33, after differencing 29
Residuals: SS = 2268714601564727 (backforecasts excluded)
MS = 87258253906336 DF = 26

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	2	4		
Chi-Square	9,3	19,5	*	*
DF	9	21	*	*
P-Value	0,413	0,553	*	*

Forecasts from period 33

		95% Limits		
Period	Forecast	Lower	Upper	Actual
34	58675715	52363249	64988181	
35	58254100	50537915	65970285	
36	59439539	52602395	66276683	
37	58989419	50465384	67513454	

Figure 1 – Listing the result of the construction and analysis of the model

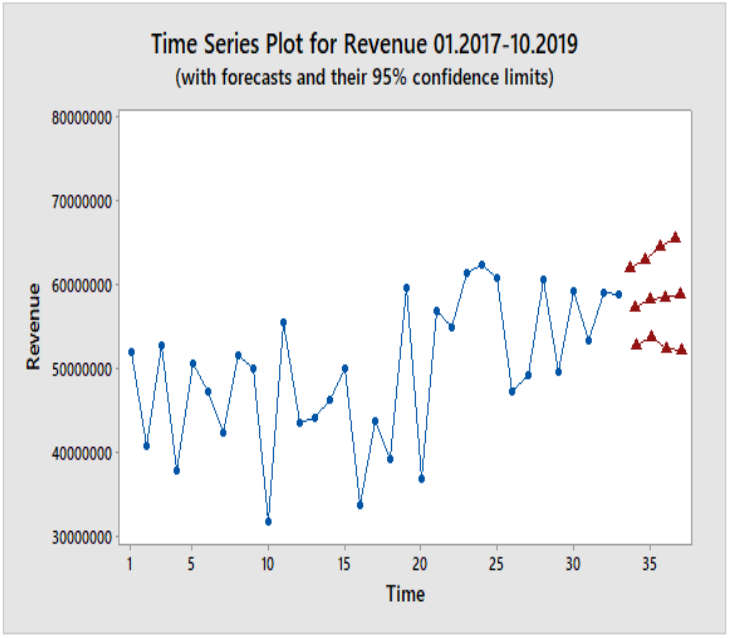

Figure 2 – Graph of the results of the simulation forecast for revenue data

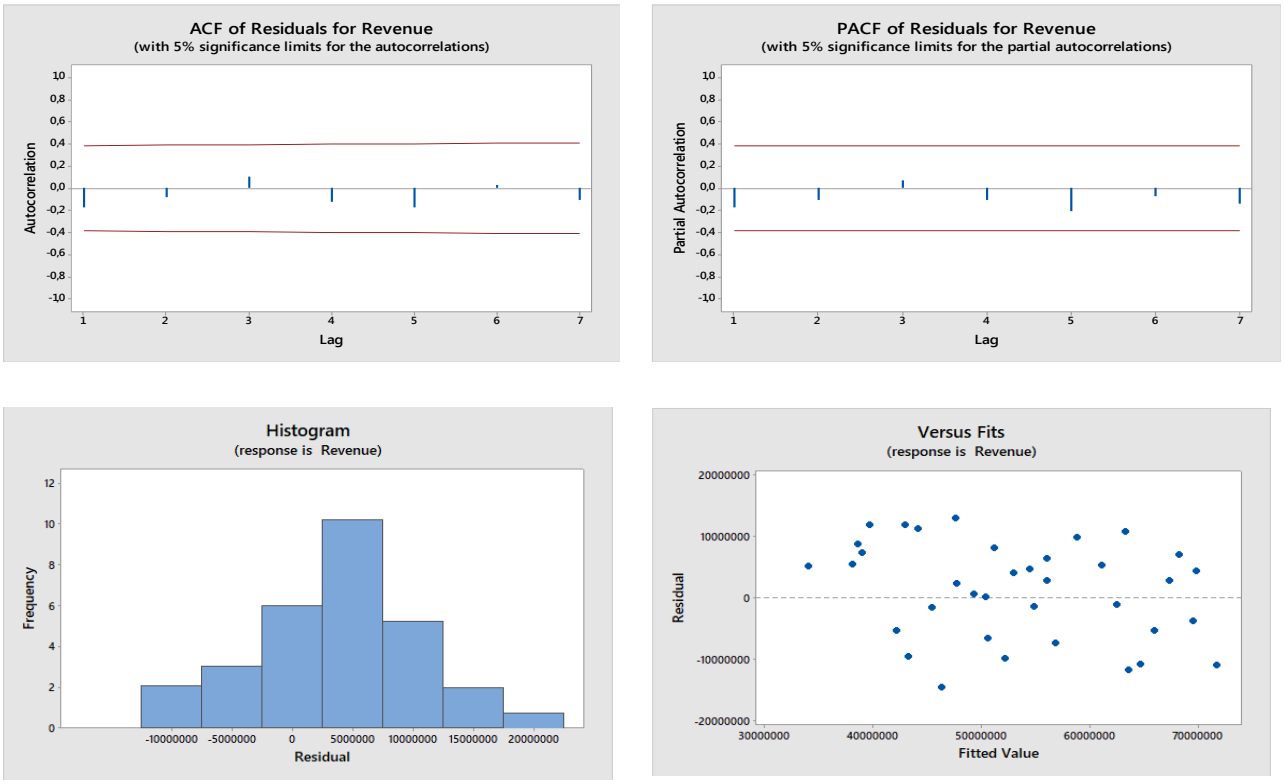

Figure 3 – Investigating the residuals of the ARIMA $(0,2,2)(0,0,2)_2$

The analysis of the residuals of the constructed model gave satisfactory results: the residuals are independent and are located in the range, without large emissions. The histogram of the residuals looks similar to the normal distribution (Fig. 3). These facts testify to the adequacy of the model found.

Cost of services provided. We analyze the input cost of the services provided and build a forecast model. Figure 4 shows the result of trend analysis of cost statistics and the following equation of the forecast model:

$$C(t) = \frac{10^8}{-6{,}62267 + 18{,}726 \cdot 0{,}984111^t}.$$

In addition, relative error of the built model was found:

$$MAPE = \frac{100\%}{n} \sum_{i=1}^{n} \left| \frac{C_i - \hat{C}_i}{C_i} \right| = 2{,}064\%.$$

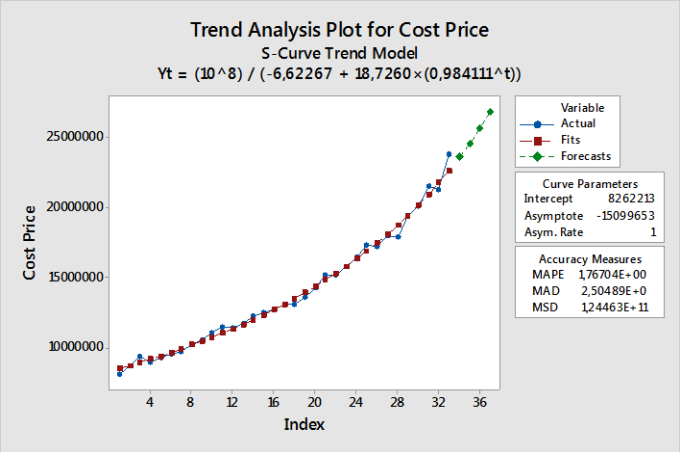

Figure 4 – Graph of the result of the trend analysis and forecast the cost of the services provided

The constructed model is adequate, which confirms the close to normal distribution of residues and finding points in a certain corridor on the plot of the dependence of residues on the predicted values (Fig. 5).

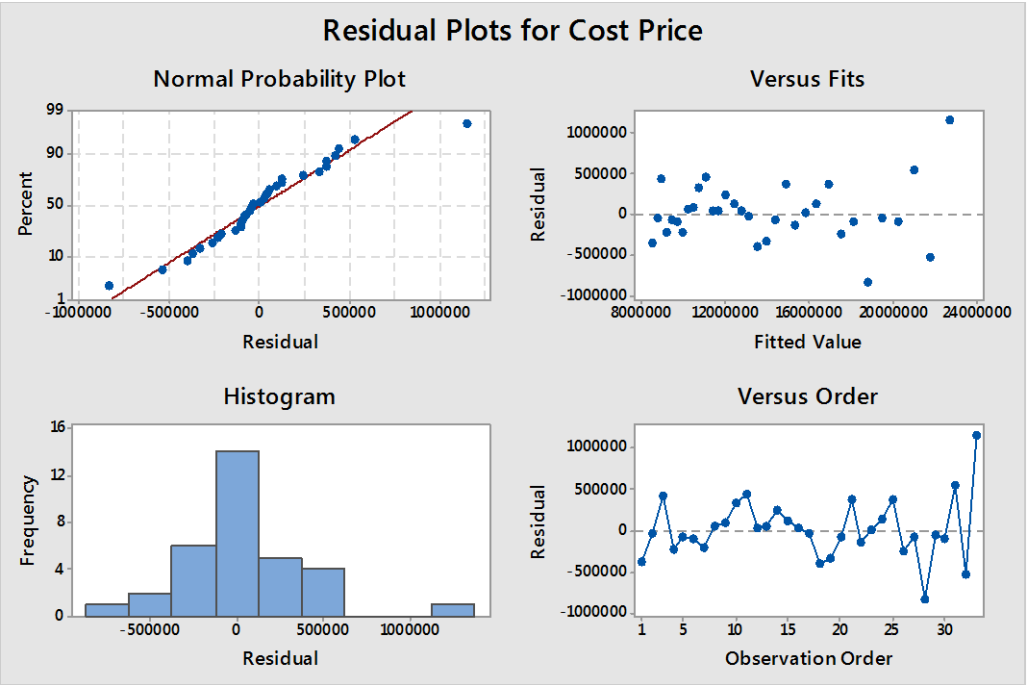

Figure 5 – Analysis of the residuals of the trend model of cost

The calculation of the estimated value of gross profit for 2019 is made by the formula:

$$\hat{P} = \sum_{t=1}^{9} R_t - \sum_{t=1}^{9} C_t + \left(\sum_{t=10}^{12} \hat{R}_t - \sum_{t=10}^{12} \hat{C}_t \right),$$

$\sum_{t=1}^{9} R_t = 295\,919\,005$ – the revenue for the 9 months of 2019,

$\sum_{t=10}^{12} \hat{R}_t = 58\,675\,715 + 58\,254\,100 + 59\,439\,539 = 176\,369\,354$ – predicted revenue for the 10, 11, 12 months of 2019,

$\sum_{t=1}^{9} C_t = 172034889$ – cost of production for 9 months of 2019,

$\sum_{t=10}^{12} \hat{C}_t = 23\,584\,588 + 24\,585\,391 + 25\,656\,830 = 73\,826\,809$ – predicted of production cost for the 10, 11, 12 months of 2019.

So, we have the following predicted value of gross profit:

$$\hat{P} = 295\,919\,005 + 120\,136\,387 - 172\,034\,889 - 66\,411\,937 = 177\,608\,566 .$$

The values of revenue from the sale of services cost of services rendered and gross profit for 2017-2019 are summarized in Table.

Table - Value of revenue, cost and gross profit

Period	Revenue	Cost	Gross profit
2017рік	199883362	108833626	91049736
2018рік	278210254	148362624	129847630
2019рік	416055392	245861698	472288359

Based on the data in Table 1, we calculate the profitability of the company for the 3 considered periods.

Profitability for 2017:

$$profit_{2017} = \frac{R_{2017} - C_{2017}}{R_{2017}} = \frac{199883362 - 108833626}{199883362} = 45{,}6\%. \quad (1)$$

Profitability for 2018:

$$profit_{2018} = \frac{R_{2018} - C_{2018}}{R_{2018}} = \frac{278210254 - 148362624}{278210254} = 46{,}7\%. \quad (2)$$

Profitability for 2019:

$$profit_{2019} = \frac{R_{2019} - C_{2019}}{R_{2019}} = \frac{416055392 - 245861698}{416055392} = 40{,}9\%. \quad (3)$$

From equation (1) – (3) it can be seen that there is a decline in profitability of the company, despite the overall increase in revenue (table 1). As the company creates products for many counterparties, it is necessary to identify which contractors are the cause of the deterioration of the financial condition of the company.

We analyze the profitability by section of counterparty groups (Fig. 6).

As a result, we identified two groups of counterparties that are experiencing declining returns: Software customer 3 counterparties and Software customer Financial Services counterparties.

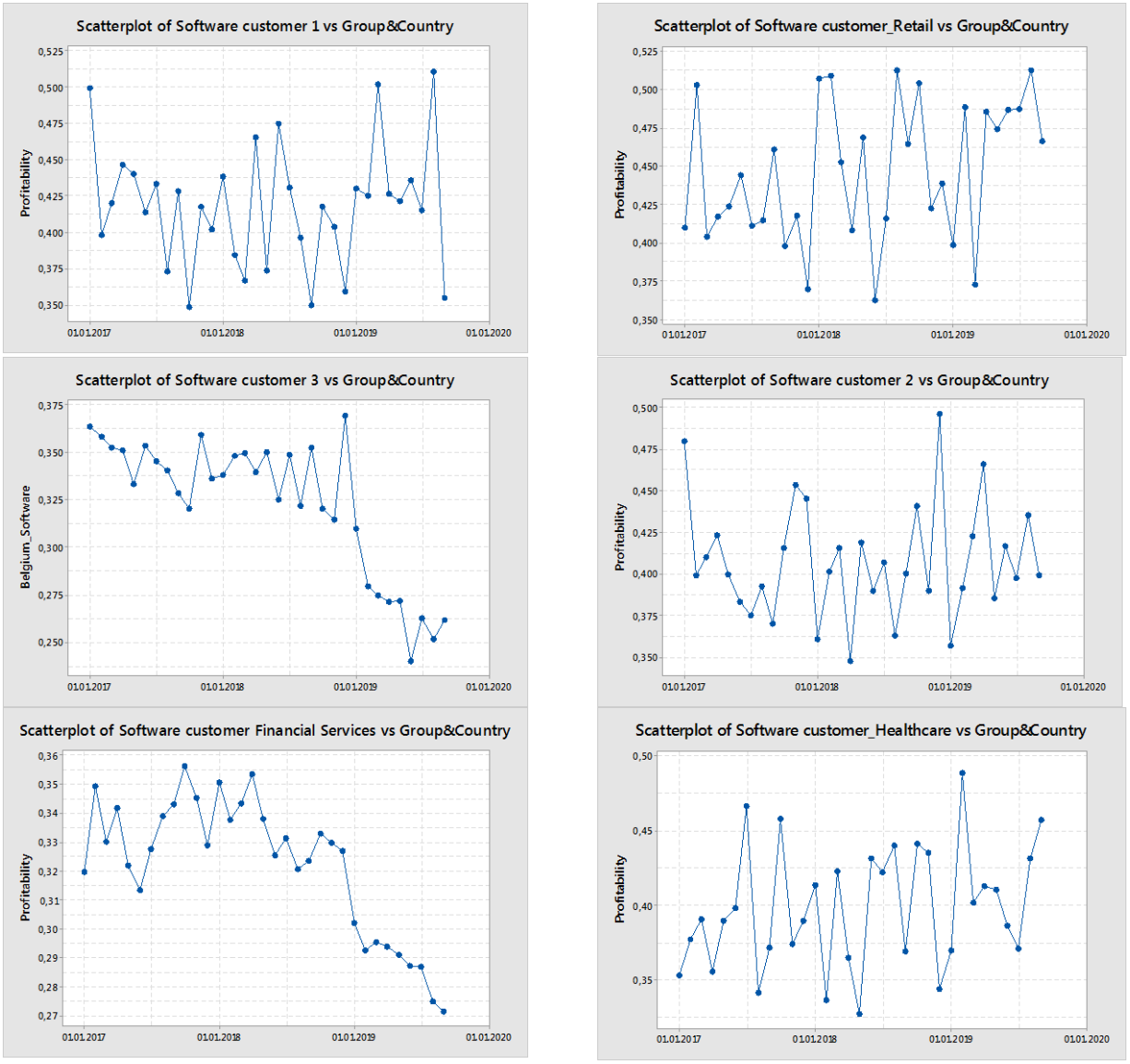

Figure 6 – Analysis of the company's profitability by different groups

A detailed analysis of the aggregate data for the Software customer 3 and Software customer Financial Services groups showed a fall in the gross profit margin and an increase in the cost growth rate (Fig. 7 - Fig. 10). The Figure 7 shows the trend analysis for the period from January 2017 to September 2018. The Figure 8 shows the trend analysis for the period from November 2018 to September 2019. We see a decrease in the growth rate of gross profit growth.

Trend analysis for the period from January 2017 to September 2018 showed a decrease in the cost of production, and in the period from November 2018 to September 2019 an increase in the cost of production (Figs. 9, 10).

The fact of an increase in the cost increase leads to a decrease in the growth rate of gross profit during this period.

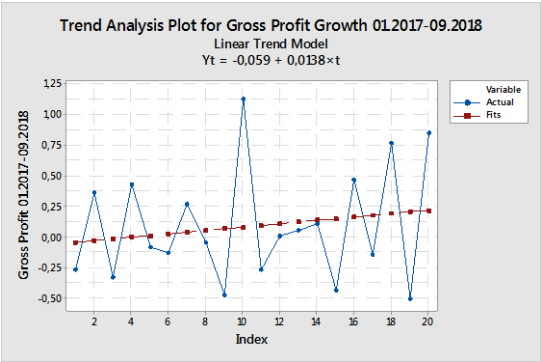

Figure. 7. Trend analysis of gross profit growth for the period from January 2017 to September 2018

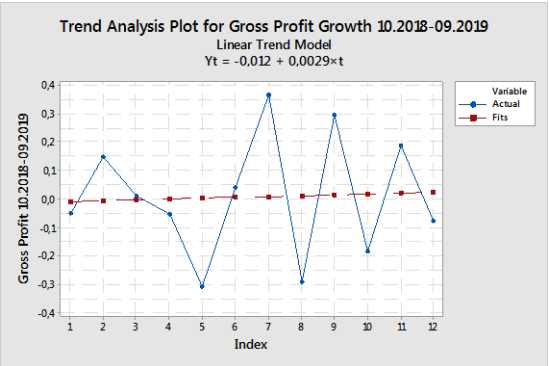

Figure. 8. Trend analysis of growth of gross profit for the period from November 2018 to September 2019

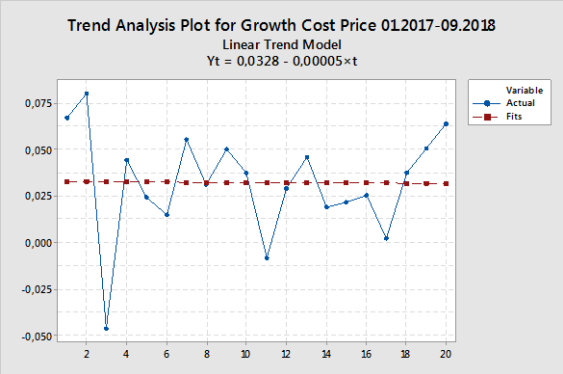

Figure. 9. Trend analysis of the increase in the cost of production for the period from January 2017 to September 2018

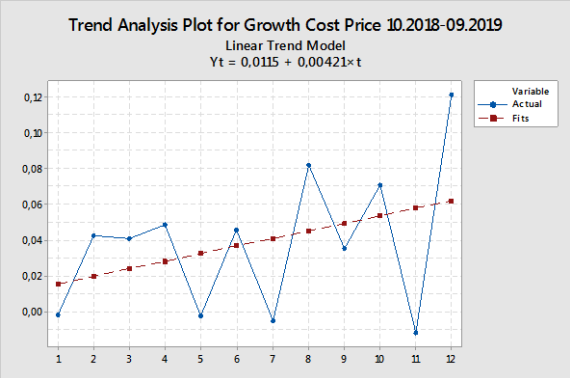

Figure 10. Trend analysis of the increase in the cost of production for the period from November 2018 to September 2019

The cost of the software is mostly due to the hourly payment of the respective specialists. The reason for the rapid increase in the cost of production is the irrational use of staff. After the reorganization of the teams, the situation stabilized and at the end of the year the statistical analysis showed an increase in profitability.

Conclusions. Timely control of the economic performance of the enterprise gives an assessment of the status and prospects of the company, as well as to formulate ways of improvement, or measures to eliminate problems in the enterprise. Therefore, the correct analysis and forecasting of these indicators is extremely important for the effective functioning of the entity.

In this article, the analysis of statistics on the income from the sale of services and the cost of services provided, models for their forecasting at the end of the reporting period. The models obtained were tested for adequacy. Based on the forecast models built, the prospects for the financial position at the end of the year are analyzed and evaluated, and problem groups of customers that have deteriorated the company's profitability are identified.

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