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Methods for Determining and Forecasting the Dynamics of Working Capital in Construction Enterprises

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Abstract

The future activity of enterprises depends significantly on the extent to which they are provided with working capital. The lack of working capital hinders the course of secondary production, creates financial difficulties in the enterprise. An excess of working capital leads to a decrease in its turnover rate, diversion of funds from circulation and a decrease in profitability. Therefore, it is of particular importance to correctly determine the need for working capital in the production process and to ensure that production is adequately provided with these funds.In order to determine the dynamics of working capital in the activities of construction enterprises, the article calculates the absolute growth, growth rate, relative growth of completed works in the Ravan construction company for 2017-2023, and analyzes the average indicators that are important in determining the order of dynamics. The author, using the least squares method, established a relationship equation for the dynamics of accounts payable in the "Ravan" construction company for 2011-2023, and based on the development trend, a forecast of accounts payable for 2024 and 2025 was given. Changing levels over time leads to autocorrelation, and in order to detect autocorrelation using the correlation method, fuel and energy costs in the general classification of the "Ravan" construction company for 2014-2023 were compared based on comparative prices for 2010.

Keywords: working capital, correlation coefficient, autocorrelation coefficient, forecast, construction enterprises

1. Introduction

For uninterrupted construction and installation work, construction enterprises must be constantly provided with building materials, structures, parts, products, fuel reserves, etc. The enterprise periodically sells construction products. In this regard, the funds of enterprises are simultaneously in both the production and circulation spheres. The funds serving the circulation sphere of the enterprise constitute its circulating funds. The circulating funds of construction enterprises consist of cash in the cash register and on the settlement account. There are many

economic similarities between the circulating funds of enterprises and the circulating funds of enterprises. Both of them are related to production. They serve all production and economic activities continuously, are in constant movement and circulation. Such a generalizing indicator is considered to be the circulating funds of construction enterprises. Circulating funds are the main source of financing the current and capital expenses of a construction enterprise and are divided into circulating funds and financial assets. If the firm's current assets are too small compared to its current liabilities, this will affect the development and profitability of the company (Ahmad, M. et al.. 2022). Analysis shows that, according to the sources of formation, working capital is divided into special and equal working capital of the enterprise and debt working capital. A number of indicators are used to forecast working capital in construction companies.

1.1. Absolute and Relative Indicators Used in the Analysis of the Dynamics of Working Capital of Construction Enterprises

The purpose of constructing the dynamics of working capital in the activities of construction enterprises is to determine their development process from various points of view. In this case, a number of indicators are used to characterize the dynamic series. The indicators used in the characteristics of dynamic series include absolute growth, growth rate, relative growth and the absolute value of one percent relative growth. These indicators characterize the intensity of changes at individual levels of the dynamic series (Gryshko, et al., 2020; Ganushchak, 2017; Laamarti, et al., 2024; Thi , Xuan Thuy Huynh, 2025).

Each absolute level, indicating the level of development of socio-economic phenomena, is a generalizing indicator in itself. In order to detect changes in the dynamics of events, it is necessary to compare the levels of the series with each other. As a result of such a comparison, analytical indicators of dynamic series are calculated. Analytical indicators of dynamic series can be calculated both in the main and in the serial order. In previous studies, methods for determining and forecasting the dynamics of working capital in enterprises have been widely used (Kiymaz, et al., 2024; Taghiyeva, 2021; Yadigarov, 2020).

One of the important indicators of the analysis of the dynamics of working capital in construction enterprises is absolute growth.

$$\text{serial} \quad \Delta_i = y_i - y_{i-1}, \qquad (1),$$

$$\text{in the main order} \quad \Delta = y_i - y_1 \qquad (2), \text{ (Shirinov \& Mammadova, 2022).}$$

Let us explain the calculation of absolute growth using the example of the dynamics of the volume of completed works in the Ravan construction company in 2017-2023 (Table 1).

Table 1. Calculation of the absolute growth of completed works in the Ravan construction company in 2017-2023

Years	**Volume of completed works (thousand manats)**	**absolute increase, (thousand manats)**	
		Serial compared to the previous year Δi=Yi-Yi-1	*base compared to 2017 Δ=Yi-Y1*
2017	8 5910	-	-
2018	7 319 0	7 319 0-8 5910 = -12720	7 319 0-8 5910 = -12720
2019	7 660 0	7 660 0-7 319 0 =3410	7 660 0-8 5910 = - 9310
2020	7 762 0	7 762 0-7 660 0 =1020	7 762 0-8 5910 = - 8290
2021	8 4480	8 4480-7 762 0 =6860	8 4480 -8 5910 = -1430
2022	9 439 0	9 439 0-8 4480 =9910	9 439 0-8 5910 =8480
2023	9 5480	9 5480 -9 439 0 =1090	9 5480 -8 5910 =9570

Source: prepared by the author.

As can be seen from Table 1, the volume of completed works will increase more in 2022 and 2023. The growth rate indicator is often used in the analysis of the dynamics of working capital in the activities of construction enterprises. The growth rate is calculated as a coefficient or percentage. Depending on the task of the study, the growth rate can also be calculated in a sequential or basic manner.The growth rate is calculated as a percentage by the following formulas:

$$\text{serial} \quad S_i = \frac{Y_i}{Y_{i-1}} \cdot 100 \quad (3),$$

$$\text{in the main order} \quad S = \frac{Y_i}{Y_1} \cdot 100 \qquad (4), \quad \text{(Yadigarov, 2020)}$$

The calculation of the growth rate can be explained by the example of the dynamics of the volume of completed works in the Ravan construction company in 2017-2023 (presentation.2).

Table 2. Calculation of the growth rate of completed works in the Ravan construction company in 2017-2023

Years	**Volume of completed works (thousand manats)**	**growth rate, (%)**	
		serial compared to the previous year $S_i=Y_i/Y_{i-1}x100$	*base compared to 2017*$S=Y_i/Y_1x100$
2017	8 5910	100	100
2018	7 319 0	7 319 0 x 100: 8 5910 = 85,2	7 319 0 : 8 5910 = 85,2
2019	7 660 0	7 660 0 x 100 : 7 319 0 =104,7	7 660 0 : 8 5910 = 86
2020	7 762 0	7 762 0 x 100: 7 660 0 =101,3	7 762 0 : 8 5910 = 87
2021	8 4480	8 4480 x 100: 7 762 0 =108,8	8 4480 : 8 5910 = 95
2022	9 439 0	9 439 0 x 100: 8 4480 =111,7	9 439 0 : 8 5910 =110
2023	9 5480	9 5480 x 100: 9 439 0 =101,2	9 5480 : 8 5910 =107,2

Source: prepared by the author.

There is a mutual relationship between the growth rate calculated in the sequential and basic way (Yagubov, Mammadov 2010) . Thus, when we multiply the sequential growth rates together, we get the basic growth rate indicator of the corresponding period, and vice versa, when we divide the basic growth rate by each other, we get the sequential growth rate indicator of the corresponding period.

$$S = 0{,}852 \cdot 1.047 \cdot 1.013 \cdot 1.088 \cdot 1.117 \cdot 1{,}012 = 1.072 \quad \text{or} \quad 107{,}2\%$$

In the absence of information about the absolute levels of the dynamics series, it is possible to determine the basic growth rate using the serial growth rate. One of the indicators used in the analysis of the dynamics of the working capital of construction enterprises is relative growth. The ratio of relative growth to the level taken as a basis for comparison is called relative growth.

Another method of calculating relative growth is to subtract 100 from the growth rate (if the growth rate is calculated as a coefficient, then one must be subtracted). If the relative growth is expressed as a percentage, its calculation is carried out using the following formulas:

$$\text{serial -} \quad n_i = \frac{\Delta_i}{y_{i-1}} \cdot 100 \quad \text{or} \quad N_i = S_i - 100\,. \qquad (5),$$

$$\text{in the main order -} \quad n = \frac{\Delta}{y_1} \cdot 100 \quad \text{or} \quad N = S - 100\,. \quad (6),$$

Based on our example in Table 2, $N = S - 100$=107,2% -100%= 7,2%.

The relative increase in completed works in the Ravan construction company for 2017-2023 will be (+7.2%).

1.1.1. Calculation of the Dynamics of Capital of Construction Enterprises Using Average Indicators

Since the production of construction products depends on the climatic conditions of each year, it is necessary to use average indicators. The average level indicator is used to characterize the development patterns of the working capital of construction enterprises. The calculation of the average level is carried out in accordance with the type of dynamic series.To calculate the average level of the series in equally discontinuous dynamic series, it is necessary to sum the levels of the series and divide by the sum of the levels, that is, the calculation is based on the simple formula of the average quantity:

$$\bar{Y} = \frac{\sum y}{n} \qquad (7),$$ (Yadigarov, 2020; Shirinov & Mahas, 2023) is calculated.

Based on our example in Table 1, the average annual cost of completed work at the Ravan construction company for 2017-2023 would be:

$$\bar{Y} = \frac{\sum y}{n} = \frac{85910 + 73190 + 76600 + 77620 + 84480 + 94390 + 95480}{7} = 83952{,}86 th..manats$$

Thus, the volume of work completed in the Ravan construction company for 2017-2023 amounted to an average of 83952.88 thousand manats per year.If the levels of the dynamics series are expressed in the form of incomplete series, that is, non-consecutive periods, the average level of the series should be calculated using the weighted average formula.

$$\bar{y} = \frac{\sum yt}{\sum t} \qquad (8),$$ (Shirinov & Mahas, 2023)

Here, the Y-series levels are indicated by t-periods.

To calculate the average level of the series according to the characteristics of the dynamic series, it is necessary to use the formula called the chronological average:

$$\bar{y} = \frac{\frac{1}{2}y_1 + y_2 + y_3 + \ldots.. + \frac{1}{2}y_n}{n-1} \qquad (9),$$ (Shirinov & Mammadova, 2022)

Here n is the number of levels of the sequence.

If the intervals in the dynamic sequence are uneven, that is, incomplete, the average value is calculated using the following formula:

$$\bar{y} = \frac{(y_1 + y_2)t_1 + (y_2 + y_3)t_2 + \ldots\ldots\ldots + (y_{n-1} + y_n)t_{n-1}}{2(t_1 + t_2 + \ldots\ldots\ldots + t_{n-1})} \qquad (10),$$

Here t1-y1 is the time between registration and y2 registration.

t2-y2 is the time between registration and y3 registration.

Let's explain the calculation of the average quantity with an example when the intervals in the dynamic sequence are uneven, that is, an incomplete series. Suppose the following information is given about the balance of construction materials in 2023 in the Ravan construction company (thousand manats).

I/I	I/IV	I/V	I/XI	31/XII
600	700	500	650	750

The average monthly construction materials balance during the year is:

$$\bar{y} = \frac{(600+700)*3+(700+500)*3+(500+650)*4+(650+750)*2}{2*(3+3+4+2)} = \frac{29800}{24} = 620{,}8 th.manats$$

One of the average indicators that is of great importance in the analysis of the dynamics of the series of working capital in construction enterprises is the average absolute increase. The average absolute increase shows how much the level of the series has increased or decreased on average over a certain period.

The average annual absolute increase is calculated based on the serial absolute increases as follows (in a serial order):

$$\overline{\Delta}_y = \frac{\Delta_1 + \Delta_2 + \cdots\cdots \Delta_n}{n-1} = \frac{\sum \Delta_i}{n-1} \qquad (11),$$

Here - Δ_i is the serial absolute growth, n is the number of rows.

Based on the information in Table 1, the average annual absolute growth of completed works in the Ravan construction company for 2017-2023 will be (in serial order):

$$\overline{\Delta}_y = \frac{\sum \Delta_i}{n-1} = \frac{-12720+3410+1020+6860+9910+1090}{7-1} = \frac{9570}{6} = 1595 th.manats$$ Based on the levels of the dynamics series, the average annual absolute growth is calculated as follows (in the main order):

Based on the information in Table 1, the average annual absolute growth of completed works in the Ravan construction company for 2017-2023 will be (in principle):

$$\overline{\Delta}_y = \frac{y_n - y_1}{n-1} = \frac{95480-85910}{7-1} = \frac{9570}{6} = 1595 .th.manats$$

Thus, the average annual absolute growth of completed works in the Ravan construction company for 2017-2023 was an average of 1,595 thousand manats per year.

As a general indicator of the intensity of the development of socio-economic phenomena, the calculation of the average annual growth rate and average annual relative growth indicators is of great importance in the analysis process.

The average annual growth rate is calculated based on the serial growth rate using the following formula of the geometric mean (serial order):

$$\bar{S} = \sqrt[n]{S_1 \cdot S_2 \cdot \cdots\cdots S_n} \qquad (12), \qquad \text{(Shirinov \& Mammadova, 2022)}$$

Here $\bar{S}$ - is the average annual growth rate,

$S_1, S_2, S_3 \cdots\cdots S_n$ - are the coefficients of the serial growth rate, n-is the number of serial growth rate coefficients.

Based on the information in Table 2, the average annual growth rate of completed works in the Ravan construction company for 2017-2023 will be (in serial order):

$$\bar{S} = \sqrt[6]{0{,}852 * 1{,}047 * 1{,}013 * 1{,}088 * 1{,}117 * 1{,}012} = \sqrt[6]{1{,}072} = 1{,}012 \quad \text{or } 101{,}2\% .$$

Since the growth rate is calculated based on the ratio of the levels of the dynamic series, the average growth rate can be calculated using the following formula (in the main order):

$$\bar{S} = \sqrt[n-1]{\frac{Y_n}{Y_1}} \qquad (13), \qquad (\text{Shirinov \& Mammadova, 2022; Yadigarov, 2020})$$

Here , Yn is the last level of the sequence,Y1 is the first level of the sequence, n is the number of levels of the sequence.

Based on the information in Table 2, the average annual growth rate of completed work at Ravan Construction Company for 2017-2023 will be (in general):

$$\bar{S} = \sqrt[7-1]{\frac{95480}{85910}} = \sqrt[6]{1{,}072} = 1.012 \quad \text{və ya } 101{,}2\% .$$

Therefore, the average annual growth rate of completed works at Ravan Construction Company for 2017-2023 was 101,2 percent. From here, the average annual relative growth rate is:

$$\bar{n} = \bar{S} - 100 = 101{,}2\% - 100\% = 1{,}2\% .$$

The average annual growth rate and the average annual relative growth are important indicators characterizing the intensity of the development of socio-economic phenomena.

2. Analytical Detection and Forecasting of the Main Trend of the Dynamics of Working Capital in Construction Enterprises

One of the most complex and effective methods for freeing the levels of the dynamics series of working capital in construction enterprises from the influence of random fluctuations and determining the development trend over time is the analytical smoothing of the dynamic series.

If socio-economic phenomena develop in the form of more or less equal absolute growth, smoothing should be carried out using a linear equation. If geometric progression is observed in the development of phenomena, smoothing can be carried out using the second and third rules of the parabola.

Often, analytical processing of dynamic series in enterprises is based on the method of least squares. The essence of this method is that the sum of the squares of the deviations between the actual level (y) and the theoretical level (yt) should be minimal. This requirement can be used in the form of a formula as follows:

$$\sum (y - \bar{y}_t)^2 = \min \quad (14), \quad (\text{Shirinov \& Mammadova, 2022; Mammadov et al., 2024}).$$

Here y – are the actual levels, $\bar{y}_t$ – are the theoretical levels, that is, for the corresponding period – are the smoothed values.

Socio-economic phenomena are often smoothed by a linear equation, the simplest form of which is written as follows:

$$\bar{y}_t = a_0 + a_1 t \qquad (15), \qquad (\text{Taghiyeva, 2021; Yadigarov, 2020}).$$

Here $\bar{y}_t - y$ - is the smoothed value of , a_0 və a_1 – are the parameters of the straight line, t – their serial number, or time period.

The solution of the following normal system of equations satisfying the conditions of the least squares method is a_0 və a_1 allows you to define the parameters:

$$\left.\begin{aligned} na_0 + a_1 \sum t = \sum y \\ a_0 \sum t + a_1 \sum t^2 = \sum yt \end{aligned}\right\} \qquad (16), \quad \text{(Yadigarov, 2023)}$$

Here y – are the actual levels of the sequence, t – it is time, n – is the number of levels. a_0 və a_1 It is possible to greatly simplify the calculation of parameters by applying the conditional zero method. For this, the sum of the time indicators of the series $(\sum t)$ it is necessary to ensure that it is equal to zero. $\sum t$ – in order for the sum of - to be equal to zero, the central term of the series is taken equal to zero in single-term dynamic series, and above zero it is expressed as -1, -2, -3 and i.a., and below zero as +1,+2,+3 and i.a..

When the terms of the series are even, in order to ensure that the sum of - is equal to zero, the upper half of the series should be denoted by the numbers -1,-3,-5 and i.a., and the lower half by the numbers +1,+3,+5 and i.a. So, $\sum t = 0$ in this case, the system of normal equations can be written as follows (Shirinov & Mammadova, 2022; Yadigarov, 2023 ;Yagubov, Mammadov 2010) :

$$\left.\begin{aligned} na_0 = \sum y \\ a_1 \sum t^2 = \sum yt \end{aligned}\right\} \quad (17),$$

From here, $a_0 = \dfrac{\sum y}{n}$, $a_1 = \dfrac{\sum yt}{\sum t^2}$, (Shirinov & Mahas, 2023) it will be.

Interpolation and extrapolation of dynamic series give more accurate results when performed on the basis of processing the series by analytical method (Shirinov & Mammadova, 2022). Let's perform the extrapolation of the dynamic series by analytical method based on the dynamics of the accounts payable of the construction company "Ravan" for 2011-2023 based on the information given in Table 3 (Table 3).

Based on the information in Table 3, the parameters of the equation are:

$$a_0 = \frac{\sum y}{n} = \frac{4378{,}85}{12} = 384{,}9 th.manats ,$$

$$a_1 = \frac{\sum yt}{\sum t^2} = \frac{7190{,}15}{572} = 12{,}57$$

$$\bar{y}_t = a_0 + a_1 t = 384{,}9 + 12{,}57 \cdot t$$

Table 3. Dynamics of accounts payable in the construction company "Ravan" for 2011-2023

Years	**Creditor debts are thousand manats**	t	t^2	yt	$\bar{y}_t$
2011	243,95	–11	121	–2683,45	246, 63
2012	258,8	–9	81	–2329,2	271,77
2013	277,8	–7	49	–1944,6	296,91
2014	278,2	–5	25	–1393,5	322,05
2015	306,3	–3	9	–909,0	347,19
2016	328,15	–1	1	–328,15	372,33
2017	389,0	+1	1	+389,0	397,47
2018	422,6	+3	9	1268.8	422,61
2019	443,0	+5	25	2215,0	447,75
2021	459,65	+7	49	3217,55	472,89
2022	476,25	+9	81	4286,25	498,03

Years	**Creditor debts are thousand manats**	t	t^2	yt	$\bar{y}_t$
2023	447,95	+11	121	4927,45	523.17
Total	**4378,85**	**0**	**572**	**7190,15**	**4618,8**

Source: prepared by the author.

This means that between 2011 and 2023, the accounts payable of the "Ravan" construction company will increase by an average of 12.57 thousand manats each year.

$$\bar{y}_1 = a_0 + a_1 t = 384{,}9 + 12{,}57(-11) = 246{,}63 tsmanats\,.$$

The series ends in 2023. In 2024, the value of will be equal to (+13), and in 2025, it will be equal to (+15). That is,

$$\bar{y}_{2024} = a_0 + a_1 t = 384{,}9 + 12{,}57(13) = 548{,}31 tsmanats\,,$$
$$\bar{y}_{2025} = a_0 + a_1 t = 384{,}9 + 12{,}57(15) = 573{,}45 tsmanats\,.$$

That is, the accounts payable of the construction company "Ravan" will be 548.31 thousand manats in 2024 and 573.45 thousand manats in 2025.

Therefore, it is possible to make a forecast for the future based on the development trend of past periods. Extrapolation of dynamic series can also be carried out based on the average annual absolute growth and average annual growth rate. The study of the mutual relations between the events reflected in the dynamic series is possible on the basis of theoretical analysis. A quantitative assessment of the relationship between dynamic series can be obtained using the correlation method.

The application of the correlation method to the analysis of dynamic series has a number of features. If these features are not taken into account, it is impossible to correctly assess the relationship between dynamic series. It is known from the study of the mutual relations of signs that each sign changes as a result of the influence of many reasons. In dynamic series, the change in time in each row is added to these reasons. Therefore, in dynamic series, the time factor, in addition to other factors, also affects the change in the levels of the series (Shirinov & Mahas, 2023; Mammadov et al., 2024).

The change of levels with time leads to autocorrelation. Therefore, the correlation between the levels of the dynamic series preserves the relationship between events, and in each of them it is possible to correctly show the absence of autocorrelation.

Correlation analysis of dynamic series Let us explain the fuel and energy costs of the “Ravan” construction company in the general classification for 2014-2023 based on the comparative prices of 2010 and the information given in Table 4.

Table 4. “Ravan” - physical volume indices of fuel and energy costs in the general classification for the construction company for 2014-2023

Total cost	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fuel (X)	1,48	1,79	1,81	1,92	2,20	2,49	2,61	2,57	2,56	2,97
Energy (Y)	0,87	0,88	0,95	1,02	1,02	1,07	1,13	1,16	1,28	1,27

Source: prepared by the author.

Let us calculate the correlation coefficient between the levels of the two dynamic series in Table 4.

Table 5. Calculation of the correlation coefficient

X	**Y**	**XY**	**X^2**	**Y^2**
1,48	0,87	1,2876	2,1904	0,7569
1,79	0,88	1,5752	3,2041	0,7744
1,81	0,95	1,7195	3,2761	0,9025
1,99	1,02	2,0298	3,9601	1,0404
2,20	1,02	2,2440	4,84	1,0404
2,49	1,07	2,6643	6,2001	1,1449
2,01	1,13	2,9493	6,8121	1,2769
2,57	1,16	2,9812	6,6049	1,3456
2,56	1,23	3,1488	6,5536	1,5129
2,97	1,27	3,7719	8,8209	1,6129
22,47	**10,60**	**24,3716**	**52,4623**	**11,4078**

Source: prepared by the author.

The correlation coefficient between these dynamic series is:

$$r = \frac{x\bar{y} - \bar{x} \cdot \bar{y}}{\sigma_x \sigma_y} \quad (18), \qquad \text{(Yadigarov, 2020)}$$

$$r = \frac{x\bar{y} - \bar{x} \cdot \bar{y}}{\sigma_x \sigma_y} = \frac{2{,}4372 - 2{,}247 \cdot 1{,}06}{0{,}445 \cdot 0{,}13} = 0{,}958$$

Therefore, there is a very close relationship between these two dynamic series, that is, the increase in fuel costs directly depends on the increase in energy costs. However, since the data for which the correlation is calculated develop over time, in order to draw conclusions about the density of the relationship between them, it is necessary to check both dynamic series for autocorrelation. To detect autocorrelation, let's compile the following table for total fuel costs and calculate the autocorrelation coefficient (Table 6.).

Table 6. Autocorrelation table of fuel costs in the general classification for 2014-2023

X_i	1,48	1,79	1,81	1,99	2,20	2,49	2,61	2,57	2,56
X_{i+1}	1,79	1,81	1,99	2,20	2,49	2,61	2,57	2,56	2,97

Source: prepared by the author.

Now, let's compile the following table to calculate the autocorrelation coefficient for these two series in the usual way (Table 7).

Table 7. Calculation of the autocorrelation coefficient for fuel costs

X_i	X_{i+1}	$X_i \cdot X_{i+1}$	X_i^2	X_{i+1}^2
1,48	1,79	2,6492	2,1904	3,2041
1,79	1,81	3,2399	3,2041	3,2761
1,81	1,99	3,6019	3,2761	3,9601
1,99	2,20	4,3780	3,9601	4,8400
2,20	2,49	5,4780	4,8400	6,2001
2,49	2,61	6,4989	6,2001	6,2001
2,61	2,57	6,7077	6,8121	6,6049
2,57	2,56	6,5792	6,6049	6,5536
2,56	2,97	7,6032	6,5536	8,8209
19,50	20,99	46,736	43,6414	50,2719

Source: prepared by the author.

The autocorrelation coefficient for fuel costs is:

$$r_x = \frac{X_i \cdot X_{i+1} - \overline{X}_i \cdot \overline{X}_{i+1}}{\sigma x_i \cdot \sigma x_{i+1}} = \frac{5{,}1529 - 2{,}167 \cdot 2{,}332}{0{,}39 \cdot 0{,}8466} = 0{,}301$$

Now let's calculate the autocorrelation coefficient for energy costs, as in the case of fuel (Table 8).

Table 8. Calculating the autocorrelation coefficient for energy costs

Y_i	Y_{i+1}	$Y_i \cdot Y_{i+1}$	Y_i^2	Y_{i+1}^2
0,87	0,88	0,7656	0,7569	0,7744
0,88	0,95	0,8360	0,7744	0,9025
0,95	1,02	0,9690	0,9025	1,0404
1,02	1,02	1,0404	1,0404	1,0404
1,02	1,07	1,0914	1,0404	1,1449
1,07	1,13	1,2091	1,1449	1,2769
1,13	1,16	1,1308	1,2769	1,3456
1,16	1,23	1,4268	1,3456	1,5129
1,23	1,27	1,5621	1,5129	1,6129
9,33	9,73	10,2112	9,7949	10,6509

Source: prepared by the author.

The autocorrelation coefficient for energy costs is:

$$r_y = \frac{y_i \cdot y_{i+1} - \bar{y}_i \cdot \bar{y}_{i+1}}{\sigma_{yi} \cdot \sigma_{i+1}} = \frac{1.13451 - 1.037 \cdot 1.081}{0.114 \cdot 0.32} = 0.37$$

Therefore, there is autocorrelation in the dynamic series that are interconnected (Mammadov et al., 2024). The application of correlation analysis to study the interaction between dynamic series implies the stability of the ratio between the moving averages over time. In order to maintain such stability, the levels of the dynamic series can be divided into two components using the analytical smoothing method.

Based on the data given in Table-4, let us calculate the linear trends for both series (Table 9).

Table 9. Linear trend of fuel costs

Years	**Total cost million manat** X	***t***	t^2	***Xt***	$\overline{X}_t$
2014	1,48	-9	81	-13,32	1,599
2015	1,79	-7	49	-12,53	1,743
2016	1,81	-5	25	-9,05	1,887
2017	1,99	-3	9	-5,97	2,031
2018	2,20	-1	1	-2,20	2,175
2019	2,49	+1	1	+2,49	2,319
2020	2,61	+3	9	+7,83	2,463
2021	2,57	+5	25	+11,85	2,607
2022	2,56	+7	49	+17,92	2,751
2023	2,97	+9	81	+26,73	2,895
Total	**22,47**	**0**	**330**	**23,81**	**22,470**

Source: prepared by the author.

From the calculation it is clear:

$$a_0 = \frac{\sum x}{n} = \frac{22,47}{10} = 2,247;$$

Linear trend for this series: $a_1 = \frac{\sum Xt}{\sum t^2} = \frac{23,81}{330} = 0,072.$ $\overline{X}_t = a_0 + a_1 t = 2,247 + 0,072t$ will be.

Let's write the result in the last column of the table. Now let's calculate the linear trend in Energy costs (Table 10). Energy costs, million manat.

Table 10. Linear trend in Energy costs.

Years	**Energy costs, million manat,y**	***t***	***t²***	***yt***	$\bar{y}_t$
2014	0,87	-9	81	-7,83	0,856
2015	0,88	-7	49	-6,16	0,901
2016	0,95	-5	25	-4,75	0,947
2017	1,02	-3	9	-3,06	0,992
2018	1,02	-1	1	-1,02	1,037
2019	1,07	+1	1	+1,07	1,083
2020	1,13	+3	9	+3,39	1,128
2021	1,16	+5	25	+5,80	1,173
2022	1,23	+7	49	+8,61	1,219
2023	1,27	+9	81	+11,43	1,264
Total	**10,60**	**0**	**330**	**+7,48**	**10,600**

Source: prepared by the author.

The parameters of the equation are:

$$a_0 = \frac{\sum y}{n} = \frac{10,6}{10} = 1,06 \ ; \ a_1 = \frac{\sum yt}{\sum t^2} = \frac{7,48}{330} = 0,0227$$

The linear trend of energy costs would be:

$$\bar{y}_t = a_0 + a_1 t = 1,06 + 0,0227 \cdot t$$

Let's write the trend values in the last column of the table.

The deviations of the trends from the true levels in both rows are as follows, in the first row $\beta = X - \bar{X}_t$, for the second row $\alpha = y - \bar{y}_t$ let's determine and, after performing the appropriate calculations, calculate the correlation coefficient using the following formula:

$$r = \frac{\sum \alpha \cdot \beta}{\sqrt{\sum \alpha^2 \cdot \sum \beta^2}} \qquad (19), \ \text{(Shirinov \& Mammadova, 2022; Yadigarov, 2020).}$$

For this purpose, let us compile the Table 11.

Table 11. Actual levels of fuel and energy costs, their trends and deviations

Years	X	$\bar{X}_t$	$X - \bar{X}_t = \beta$	β^2	y	$\bar{y}_t$	$\alpha = y - \bar{y}_t$	α^2	$\alpha\beta$
2014	1,43	1,599	-0,119	0,01416	0,87	0,856	+0,014	0,000196	-0,001666
2015	1,79	1,743	+0,047	0,00221	0,88	0,901	-0,021	0,000441	-0,000987
2016	1,81	1,887	-0,077	0,00593	0,95	0,947	+0,003	0,000009	-0,000231
2017	1,99	2,031	-0,041	0,00168	1,02	0,992	+0,028	0,000784	-0,001148
2018	2,20	2,175	+0,025	0,00063	1,02	1,037	-0,017	0,000289	-0,000425
2019	2,49	2,319	+0,171	0,02924	1,07	1,083	-0,013	0,000169	-0,002223
2020	2,61	2,463	+0,147	0,02161	1,13	1,128	+0,002	0,000004	+0,000294
2021	2,57	2,607	+0,037	0,00137	1,16	1,173	-0,013	0,000169	+0,000481
2022	2,56	2,751	+0,191	0,03648	1,23	1,219	+0,011	0,000121	-0,002101
2023	2,97	2,895	+0,075	0,00563	1,27	1,264	+0,006	0,000636	+0,000450
Total	–	–	–	0,11894	–	–	–	0,002218	-0,007556

Source: prepared by the author.

Correlation coefficient will be equal to:

$$r = \frac{\sum \alpha \cdot \beta}{\sqrt{\sum \alpha^2 \cdot \sum \beta^2}} = \frac{-0,007556}{\sqrt{0,002218 \cdot 0,11894}} = 0,463$$

3. Conclusion

Correlation analysis of working capital in the dynamics of construction enterprises is of great importance in forecasting. Parallel comparison of two or more dynamic series allows us to characterize the correspondence between changes in the levels of these series.

The obtained result shows that there is a close and inverse relationship between the residual quantities. As can be seen from the analysis we conducted in our study, there is an unequal ratio between the increase in fuel costs and the increase in energy costs over time. In changing dynamic series, this correspondence may be the result of the parallel development of events or may occur on the basis of the existence of mutual relations between these series.

The first feature of the correlation of dynamic series is the presence of autocorrelation. Therefore, it is advisable to calculate the correlation coefficient not on the basis of the levels of dynamic series, but on the basis of their deviation from the general trend. It is possible to obtain the same result by calculating the correlation coefficient on the basis of the consecutive absolute increase for both series.

When the levels of the dynamic series are replaced by successive absolute increments, the autocorrelation effect is mechanically eliminated in each dynamic series. When the dynamic series has a linear time series, the autocorrelation effect can be eliminated by the first difference rule. When the levels of the dynamic series change over time, the autocorrelation effect can be eliminated by the second difference (difference between the first differences) correlation, according to the second rule of the parabola.

The autoregression model is convenient for calculations. However, it is impossible to calculate the levels of future dynamic series without taking into account the periods between them. According to the autoregression model, the calculation of future levels can only be carried out gradually from year to year. In this case, the parameters of the autoregression model are constantly changing due to the acquisition of new ones. In order to eliminate the distorting effect of autoregression, it is necessary to include a time indicator in the regression equation. As a result, it becomes possible to reveal the true state of relations.

It should be noted that the accuracy of the comparability of dynamic series in construction enterprises and individual sectors of the national economy and the provision of accurate forecasts for future periods directly depend on the accuracy of the annual reports submitted by the enterprises.

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