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Planning expenses in an institution with the use of the forecasting method in terms of economic security

Planowanie wydatków w instytucji z wykorzystaniem metody prognozowania w aspekcie bezpieczeństwa ekonomicznego

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Abstract. The article analyzes and evaluates the time series of expenses incurred in the research subject from January 2016 to December 2023. The research focused on the distribution of the analyzed data. Three regularities were detected: trend, seasonality and random factor. No outliers or extreme values were observed in the data. The distribution of the analyzed data is not normal. That was confirmed by the Shapiro–Wilk test. The expenditure forecast for 2024 is PLN 37 074 834. MAPE was 5,8%.
Keywords: planning, forecasting, costs, expenses, economic security

Abstrakt. W artykule przeanalizowano i oceniono szeregi czasowe wydatków poniesionych w związku z badanym obiektem od stycznia 2016 r. do grudnia 2023 r. Badania koncentrowały się na rozkładzie analizowanych danych. Wykryto trzy prawidłowości: trend, sezonowość i czynnik losowy. W danych nie zaobserwowano wartości odstających ani ekstremalnych. Rozkład analizowanych danych nie jest normalny. Potwierdziła to próba Shapiro–Wilka. Prognoza wydatków na 2024 r. wynosi 37 074 834 zł. MAPE wynosił 5,8%.
Słowa kluczowe: planowanie, prognozowanie, koszty, wydatki, bezpieczeństwo ekonomiczne

Introduction

The article outlines the following research problem: how to plan expenses with retrospective data?

The purpose of the research was outlined for the adopted research problem. It involves the distribution of the time series of the expenses within the research subject and forecasting of the analyzed data for the period from January to December 2024.

For the adopted research problem and research purpose, a research hypothesis was outlined: it is assumed that the MAPE of the obtained forecasts will be lower than 6%. The subject of the research is an institution operating in the Republic of Poland. The research methods used in the study were analysis, inference and synthesis.

Analysis of the literature on the research subject

In the literature, expenses are defined as funds withdrawn from the cash register or bank account regardless of the purpose. Expenditure mainly concerns purchase, withdrawal and payment. Colloquially, the term "expenses" is often used interchangeably with the term "costs". Please remember that not every expense is a cost and not every cost is an expense. An expense concerns the use of cash, i.e., payment for goods or services. The moment of payment does not necessarily mean the moment when the cost arises. The cost may arise first and the expense later.

The term "costs" is defined by Article 3 of the Accounting Act, section 1, point 31, as costs and losses constituting a probable increase in economic benefits of a reliably determined value in the reporting period. That relates directly to a decrease in the value of assets or an increase in the value of liabilities. It literally means a decrease in the volume of assets such as permanent assets, patents, licenses and others, or an increase in the level of debt as an increase in liabilities.

The observation of the difference between expense and cost is easiest to illustrate with an example. One of them is the purchase of goods. The moment of purchase of goods by the enterprise is an expense. However, it becomes a cost (Twaróg, 2003, pp. 15-19; Owsiak, 2015, pp. 74-75) when the product is sold at the applied margin. Another example is the purchase of materials. As with goods, purchasing materials represents an expense. Materials used in the production process will become an expense in the company, so the process of converting an expense into a cost (Leszczyński, Jasiński, 2015, pp. 11-56) is longer. Another example is permanent assets. As with goods and materials, their purchase is an expense. However, the cost (Sadowska, 2017, pp. 53-59; Kiziukiewicz, 2012, pp. 43-49) of permanent assets becomes cyclical due to their gradual wear and tear dynamically. An example of an expense that is not a cost is income tax. However, a cost that is not an expense is depreciation, because in that case there is no payment, the so-called purchase.

To summarize, cost is not always an expense and vice versa. Both cost and expense may appear first or both at the same time. It depends on many factors mentioned above.

Planned (Griffin, 2018, pp. 185-327) state expenditures are included in their budgets. In Poland, expenditures for 2024 are planned at PLN 866,4 billion and revenues at PLN 682,4 billion (Infor, 2024; Sejm RP, 2024).

The article attempts to forecast the expenses of the research subject. The forecasting process (Mitkow, Kozicki, Mizura, 2020; Kozicki, Mitkow, Sowa, 2021) requires the analysis and evaluation of retrospective data. That is related to the detection of the following regularities: trend (Rabiej, 2018, pp. 309-312), seasonality and random factor (Czyżewski, Klóska, 2019, p. 20). Additionally, it should be checked whether there are any outliers and extreme values in the analyzed data. What needs to be examined is the distribution of the data to detect skewness and convexity. Observation of the above trends will allow us to reduce non-stationary series to a stationary form by transforming the data, modeling and, then, forecasting it.

Forecasting (Dittmann, 2016, pp. 11-37; Kot, Jakubowski, Sokołowski, 2016, pp. 391-420) is the process of predicting future events. The output information in the forecasting process is data as forecasts. They are analyzed and evaluated using indices to see if they are good or bad. The most frequently used indices belong to the ex post group. The most popular in the literature are MAPE and APE. Forecasting is extremely important during planning. The obtained forecasts can and should become an input into the development of plans for enterprises and organizations.

The planning process itself (Kozicki, 2022, pp. 97-111; Mizura, Mitkow, Kozicki, 2023, pp. 123-136) is of great significance for an enterprise in terms of ensuring an appropriate level of economic security. Economic security (Zięba, 2018, p. 18; Williams, 2012, pp. 1-14, Nurzyńska, 2016, p. 22; Redo, Wójtowicz, Ciak, 2018, pp. 16-18) consists in ensuring the uninterrupted operation of enterprises, organizations or economies in terms of maintaining balance with the same entities dynamically.

Analysis and forecasting of time series of expenses

Figure 1 presents data on expenses incurred in the research subject from January 2016 to December 2023.

The data presented in Figure 1 indicate the existence of an increasing trend in the amount of expenses incurred in the research subject and the phenomenon of seasonality monthly. The arithmetic mean of the expenses incurred was PLN 14 438 842. The standard deviation from the arithmetic mean is PLN 5 136 789.

Then, in Figure 2, a box plot was created with the median and raw data as monthly expenses incurred in the research subject.

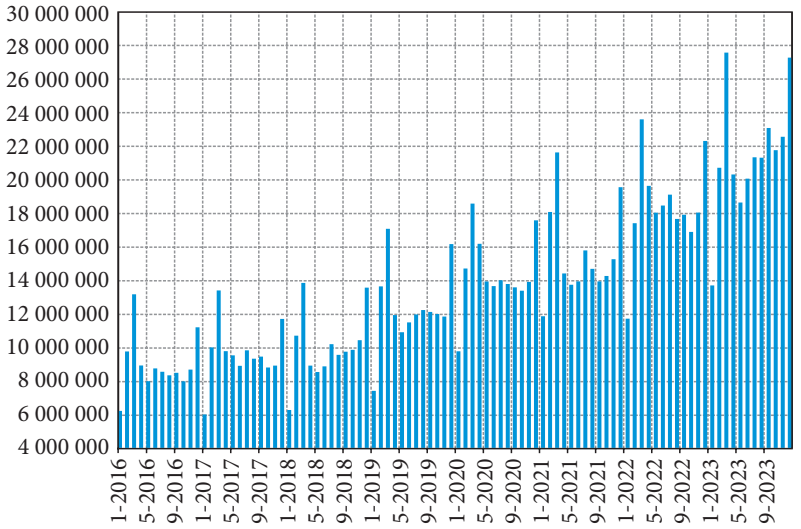

Fig. 1. Chart of expenses incurred in the research subject from January 2016 to December 2023 in PLN

Source: own study based on data obtained from the research subject

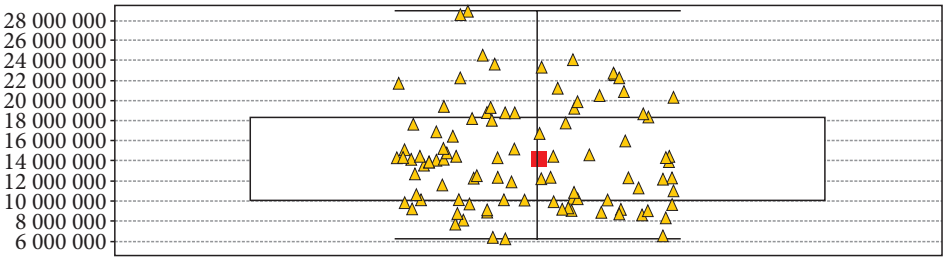

Fig. 2. Box plot with raw data of expenses incurred in the research entity in PLN

Source: own study based on data obtained from the research subject

The data presented in Figure 2 shows that there are no outliers or extreme values. The median of the analyzed data was PLN 14 111 349. The minimum monthly amount of expenses incurred between 2016-2023 is PLN 6 173 650 (January 2017), and the maximum is PLN 28 949 095 (March 2023).

Then, a normality plot with the Shapiro–Wilk test was created in Figure 3.

The distribution of the analyzed data is close to normal. The outlined quantiles do not completely overlap the straight line marked with a dashed red line (the so--called expected normal value), which may indicate the existence of values close to outliers. The Shapiro–Wilk test indicates the lack of a normal distribution, as the p_{value} is lower than the significance level.

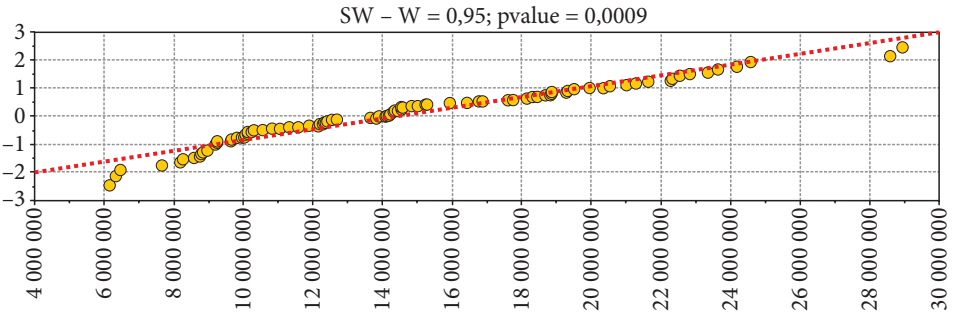

Fig. 3. Normality plot with the Shapiro–Wilk test of expenses incurred in the research subject
Source: own study based on data obtained from the research subject

Then, autocorrelation and partial autocorrelation of the analyzed retrospective data are outlined in Figures 4-5.

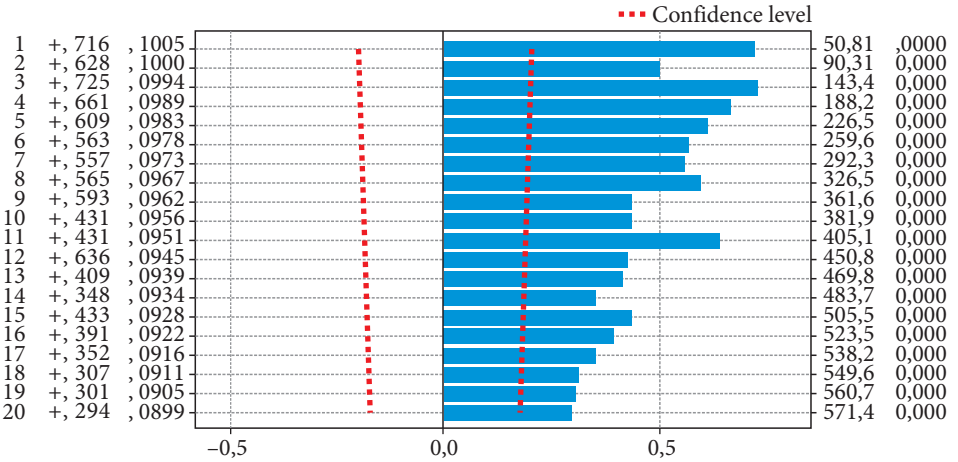

Fig. 4. Autocorrelation of expenses incurred in the research subject
Source: own study based on data obtained from the research subject

The information compiled in the autocorrelogram indicates the existence of trend and seasonality monthly. At the same time, it can be assumed that the analyzed time series is non-stationary.

Partial autocorrelation confirms the existence of trend and seasonality. Then, for research purposes, three regularities were isolated in the considered time series: seasonality, random factor and trend.

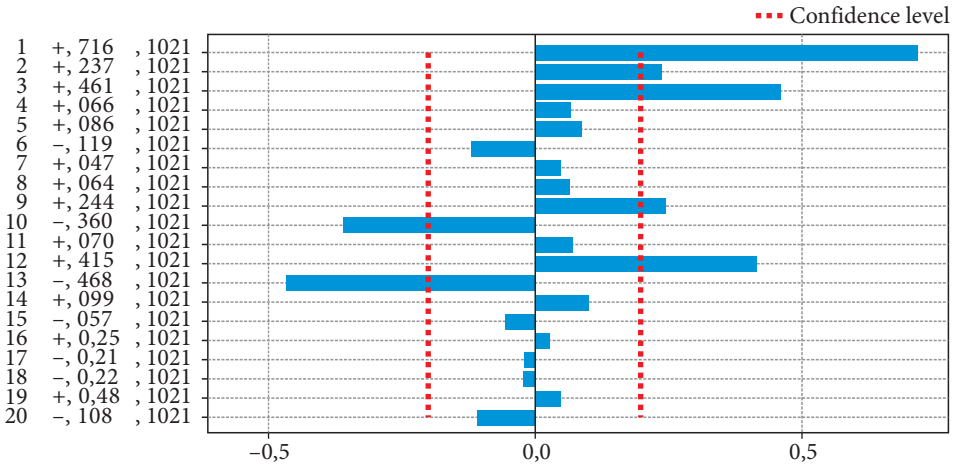

Fig. 5. Partial autocorrelation of expenses incurred in the research subject

Source: own study based on data obtained from the research subject

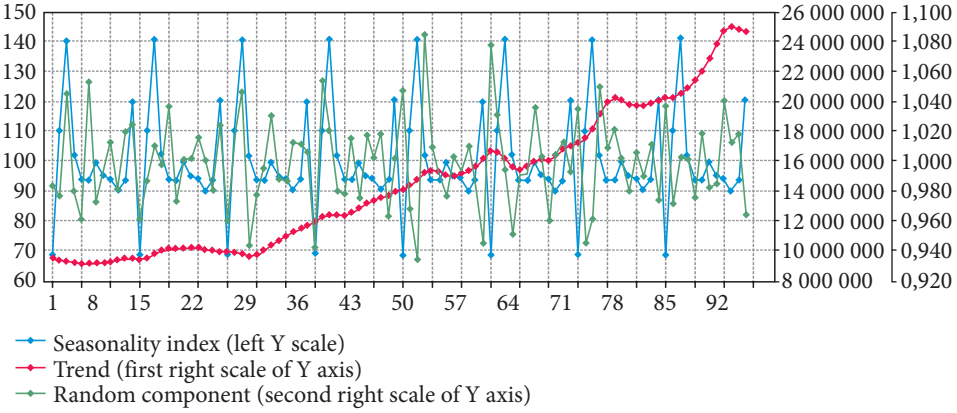

Fig. 6. Distribution of the time series of expenses of the research subject

Source: own study based on data obtained from the research subject

The analyzes allow us to observe three phenomena within retrospective data regarding incurred expenses: trend, seasonality and random phenomena. That became the premise for the forecasting of expenses for twelve future periods (from January to December 2024) with the use of the Holt-Winter's exponential smoothing method.

The obtained forecasts regarding the expenses for the period from January to December 2024 after the application of the Holt-Winter's exponential smoothing method show the preservation of the trends observed in the time series of the analyzed retrospective data. Total planned expenses for 2024 amount to PLN 313 373 609.

Then, for research purposes, an analysis and evaluation of forecasting errors were conducted using the APE and MAPE indices.

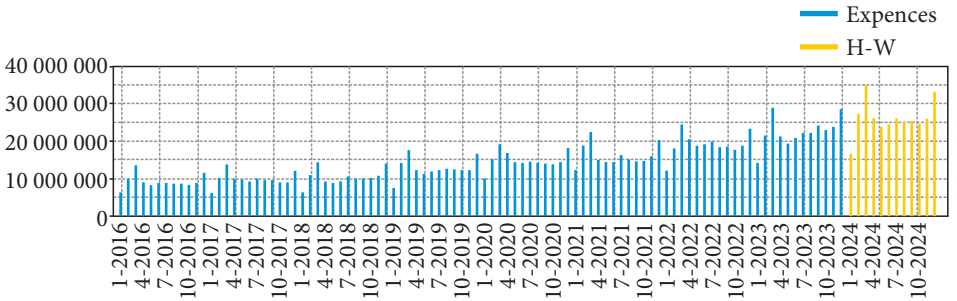

Fig. 7. Bar chart of the conducted forecast with the use of the Holt-Winter's exponential smoothing method of expenses incurred in the research subject for the period from January to December 2024 in PLN with outlined retrospective data

Source: own study based on data obtained from the research subject

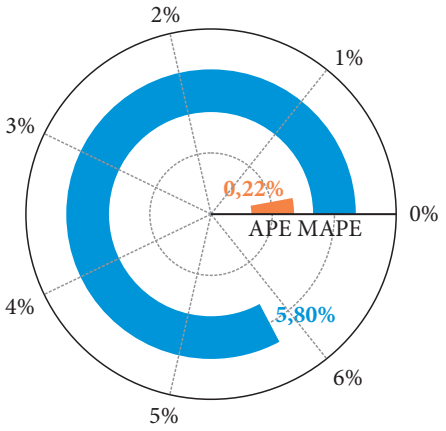

Fig. 8. Pie chart of data on forecast error indices

Source: own study based on data obtained from the research subject

The analysis of the residuals of the forecast shows that it was conducted at a satisfactory level, because MAPE was 5,8% and APE 0,22%. Detailed forecasts of expenses for respective months of 2024 are presented in Figure 9.

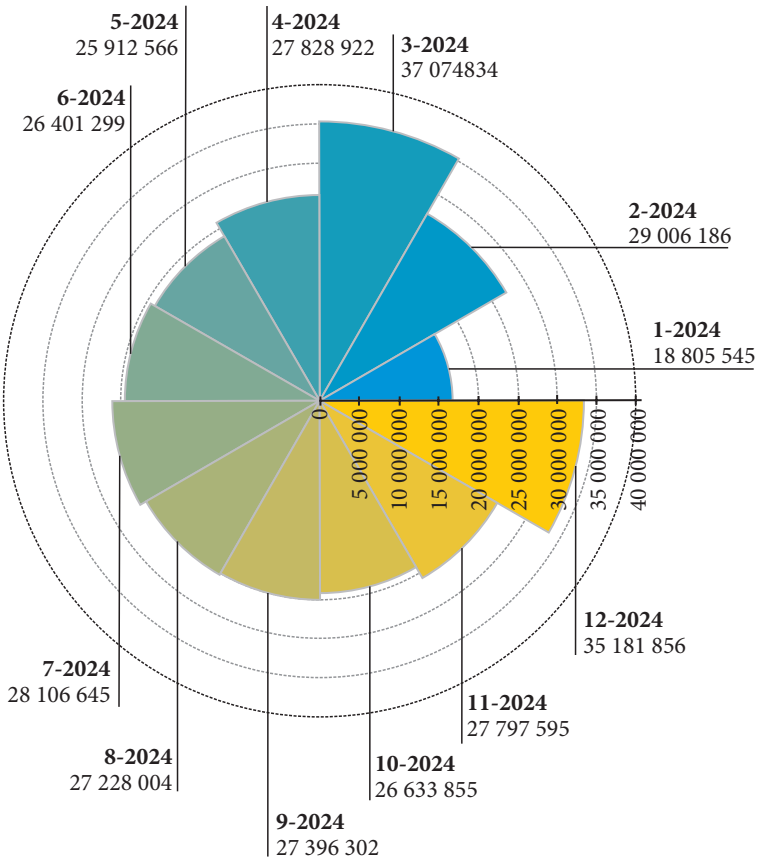

Fig. 9. SiPlot graph of the forecast regarding expenses of the research subject for the period from January to December 2024 in PLN

Source: own study based on data obtained from the research subject

In order to observe the similarities and differences of forecasted expenses monthly for 2024 more precisely, a multidimensional SiPlot graph was applied, in which respective variables were scaled based on their values and distinct colours were given to respective analyzed forecasts. The highest expenses will be incurred in March 2024 in the amount of PLN 37 074 834. Then, in December: PLN 35 181 856. The third place in the ranking of the highest planned expenses in 2024 is February: PLN 29 006 186. The lowest planned expenses will be incurred in January: PLN 18 805 545.

Summary and conclusions

The article analyzes and evaluates data obtained from the research subject regarding one of the types of expenses incurred from January 2016 to December 2023. The median of the analyzed data was PLN 14 111 349. The minimum monthly amount of expenses incurred within the above-mentioned years is PLN 6 173 650 (January 2017), and the maximum is PLN 28 949 095 (March 2023). The analysis allowed for the detection of three regularities as a trend, seasonality and a random factor. The above trends are highlighted in Figure 6 through the application the distribution procedure of the considered time series.

The Holt-Winter's multiplicative exponential smoothing model was used to forecast data for the period from January to December 2024. The total planned expenses for 2024 are PLN 313 373 609. The forecasts obtained were good, as MAPE was 5,8% and APE was 0,22%. Thus, the research hypothesis was verified and the research objective was achieved.

It is worth emphasizing that proper planning of expenses helps identify the potential financial obstacles and allows for early solution of problems. Additionally, correct planning of expenses is a component of achieving higher revenues and implementing strategic investments – significant in terms economic security. The forecasts obtained in the article have become the data included in the planning of future expenses of the research subject and allow for maintaining an appropriate level of economic security.

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