

Economic Security And The Forecasting Of Employee Dismissals As A Building Block For Creating A Personnel Strategy

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Abstract

The article presents the issue of economic security and the forecasting of dismissals for 2018-2019 based on primary information obtained from the research subject. The research began with an analysis and evaluation of the time series related to admissions to work between 2011-2017. Then, the original time series of dismissals was divided into teaching and testing parts. Using the obtained evaluation, the forecasting was conducted on the basis of the training series with the application two forecasting methods which were analyzed and evaluated on the basis of the testing series. The results of the evaluation made it possible to choose the best method for the forecast of the primary series. The forecast of dismissals for 2018 amounted to 3306 employees while in 2019 it decreased to 3032 people.

Keywords: economic security, personnel strategy, forecasting, data analysis.

Introduction

Each organization is focused on the goals it sets. They are achieved by three basic production factors: personnel, resources and work items. Personnel is an extremely important factor of production as a human resource that will determine the functioning and condition of the organization. Therefore, one of the main tasks of building a personnel strategy in an organization is the optimal planning of personnel resources. One aspect that needs to be analyzed is the past data on the dismissals of personnel resources.

The research subject has over 100,000 employees.

The premise for undertaking the research was the observation of the difference between the predicted and actual values released in the subject of the research. This became a premise for the formulation of the research problem.

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The study outlines the research problem: To what extent will the analysis and evaluation of historical data of employee dismissals allow selecting a method for the forecasting of them for the future?

The main aim of the research was to forecast the time series of dismissals for twenty-four future periods.

For such a research problem and the purpose of the work, a research hypothesis was outlined which reads as follows: The application of the analysis and evaluation of primary data and the reminder of the built models should allow choosing a method for their forecasting for the future.

The research period covers the years 2011-2017 while the research area is the area of operation of the research subject. This entity is an institution operating in the area of the European Union while the subject of research is the dismissals from work in the analyzed subject of research.

Forecasting with the use of Holt – Winters exponential smoothing and the ARIMA model was used as a research method. The article consists of an introduction, three substantive points, a summary and conclusions.

Analysis of the literature on the subject of the research

In literature, economic security is considered to be the certainty of survival which involves the access to markets, personnel and financial resources that guarantee the stable development of entities (Nurzyńska, 2016). The COVID-19 pandemic has undoubtedly led to major changes in the economies of respective countries and influenced the broadly understood security of all citizens (Matuka, 2020). It led to deaths of many people around the world in a short time (Kozicki, Mitkow, 2020), as well as contributed to an increase in unemployment in the largest economies of the world such as the United States (up to 14.7%) and long-term drops in oil prices (Kozicki, Bryczek-Wróbel, 2020). The first case of COVID-19 infectious disease was recorded in December 2019 in China (Zhu, Zhang, Wang, et al., 2020). Since 11 March 2020, COVID-19 has become a pandemic (Satomi, et al., 2020). In the case of the research subject, the infectious disease did not significantly change the trends observed in the past related to admissions, dismissals and broadly understood personnel policy in dynamic terms.

The personnel policy of each organization is directly related to the determination of the size and structure of employment and the management of human resources called personnel from the point of view of implemented or future goals. The personnel strategy of human resource management (Król, Ludwiczynski, 2011; Stalewski, 1997) "includes decisions that are of fundamental and far-reaching significance for the employment and development policy in the enterprise, as well as those that affect the mutual relations between management and personnel" (Amstrong, 2007, p. 56). The planning of employment as well as the managing of the existing human resources are particularly important. It should be noted that the quantitative aspect is extremely important in the personnel strategy, related to the article, for example, with the forecast of the number of redundancies from the work of existing staff. Human resource management means a strategic and consistent method of the managing of the most important capital, i.e. people who individually and collectively contribute to the achievement of the company's goals and, thus, strengthen its competitive advantage (Amstrong, 2007, p. 14). To sum up, every organization, to be able to function properly, must have adequate means and resources at a given time.

Therefore, issues related to the forecasting of headcount, including the aspect of dismissals, are becoming extremely important from the point of view of the subject of the work. The analysis of the literature on the terms forecast and forecasting shows that they are interpreted differently by the authors. P. Dittmann states that "a forecast is a judgment about the future of a forecast phenomenon - precise and uncertain" (Dittmann, 2016, p. 9).

Forecasting is considered a process that should be based on the analysis and evaluation of retrospective data. The methodology of time series analysis and evaluation, including multidimensional data analysis, is widely described in the available literature (Kozicki, Bryczek-Wróbel, 2020; Kozicki, Mitkow, 2020; Makridakis et al., 1998; Papież, Śmiech, 2015; Rabiej 2018; Suchwałko, Zagdański, 2016; Żyżyński, 2017). This method allows detecting regularities in the form of trends and seasonality. In the study, by building a multiple regression model (Kot, Jakubowski, Sokołowski, 2011), the existence of a trend and seasonality in the analyzed historical data of employee dismissals in the subject of the study was confirmed. The observed regularities allowed for the selection of two forecasting methods for the forecasting of future dismissals, such as: the Holt-Winters method and the ARIMA model. The ARIMA model turned out to be the best forecasting method as a result of the analysis and evaluation of the reminder of forecasting errors. It was used to forecast the dismissals of employees of the research entity for 2018-2019.

Analysis and evaluation of the time series of employee dismissals

Figure 1 presents the data showing the time series of dismissals in one of the institutions in Poland between 2012-2018 with the use of a line chart.

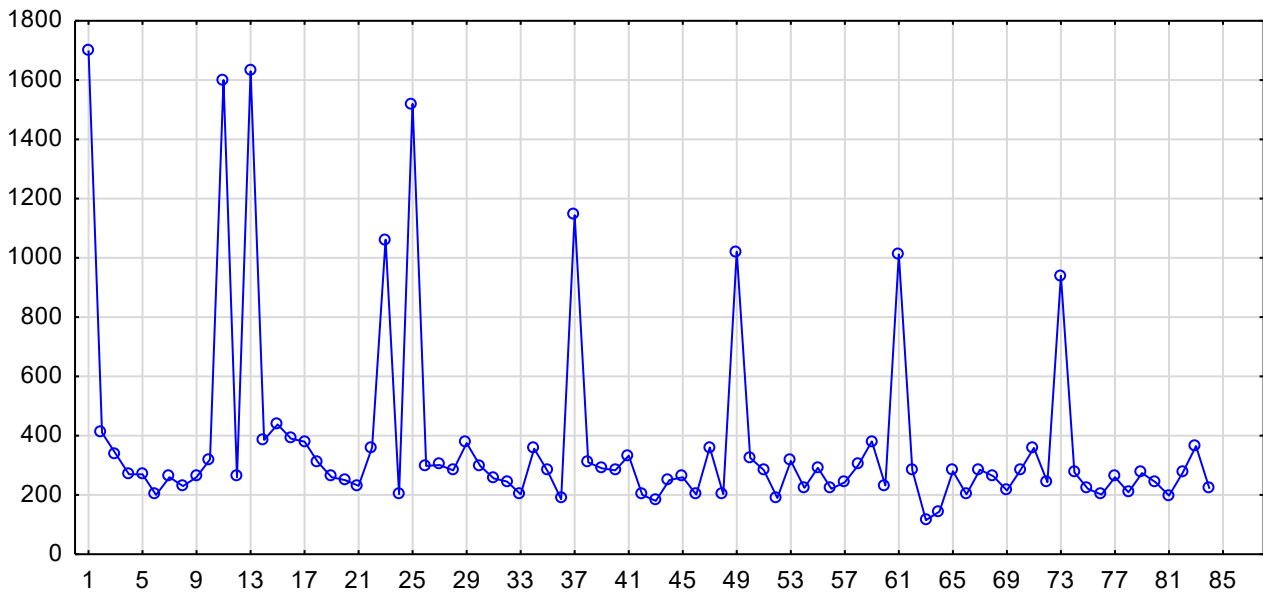


Fig. 1. Summary of data on dismissals on a monthly basis

The data presented in Figure 1 allow us to observe the outliers between 2011-2017 which reoccur regularly (January) and two in November in 2011 and 2012 which are irregular in nature.

The study of the analyzed series began with the confirmation of the existence of outliers and extreme values. For this purpose, a research tool was used in the form of a box plot (Fig. 2).

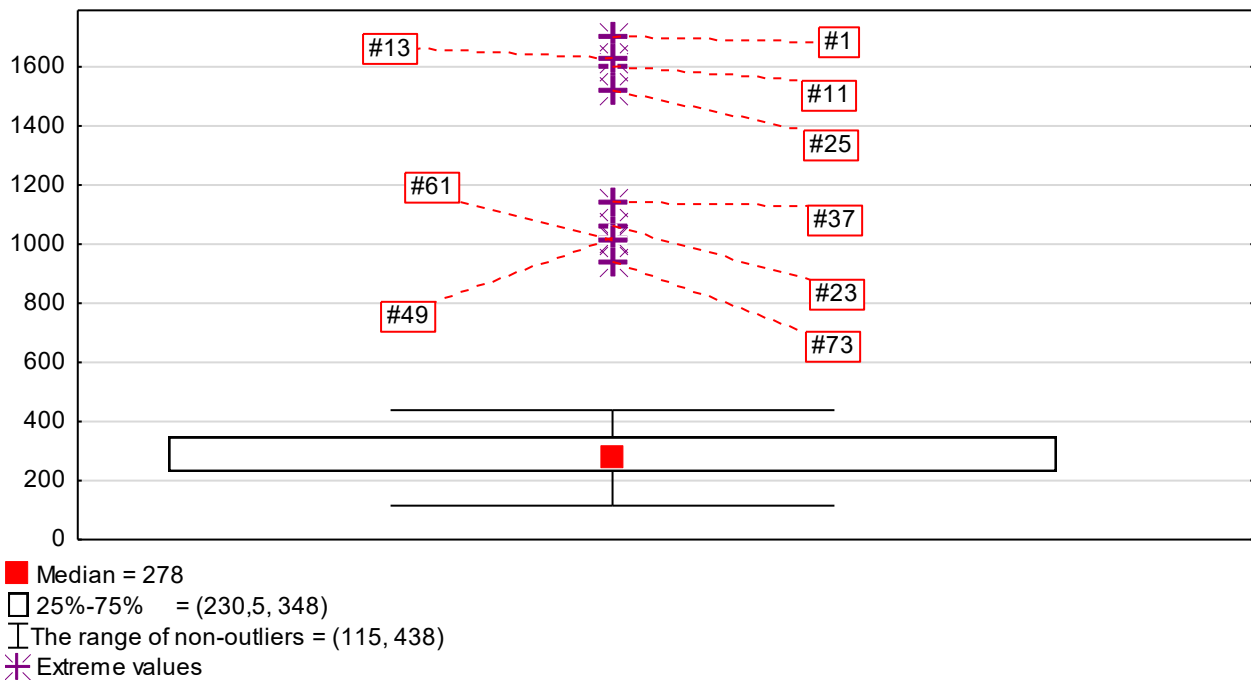


Fig. 2. Searching for outliers and extreme values

The box plot presented in Figure 2 confirms the existence of extreme values for the nine items of retrospective data under consideration.

The analysis and evaluation of the time series of dismissals as well as the own experience allowed for the conclusion that the extreme variables in November in 2011 and 2012 are considered typically random caused by external factors occurring at that time in the analyzed subject of the study. This became a premise for the correction of these variables. For this purpose, arithmetic means for the same time units for the analyzed time series of dismissals were calculated. The data after the correction is presented in Figure 3.

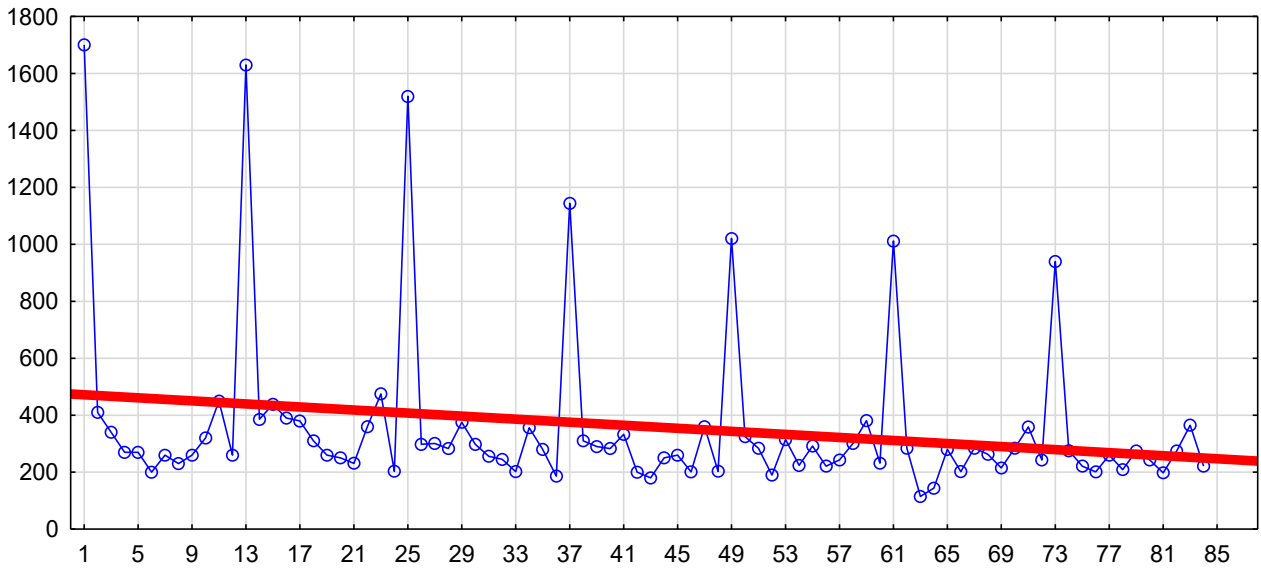


Fig. 3. Correction of the time series of dismissals as a result of the removal of extreme values considered as a random phenomenon

Then, research was initiated to confirm the existence of seasonality and the trend. For this purpose, the following research tools were used in the form of: autocorrelation (Fig. 4), partial autocorrelation (Fig. 5), and histogram (Fig. 6).

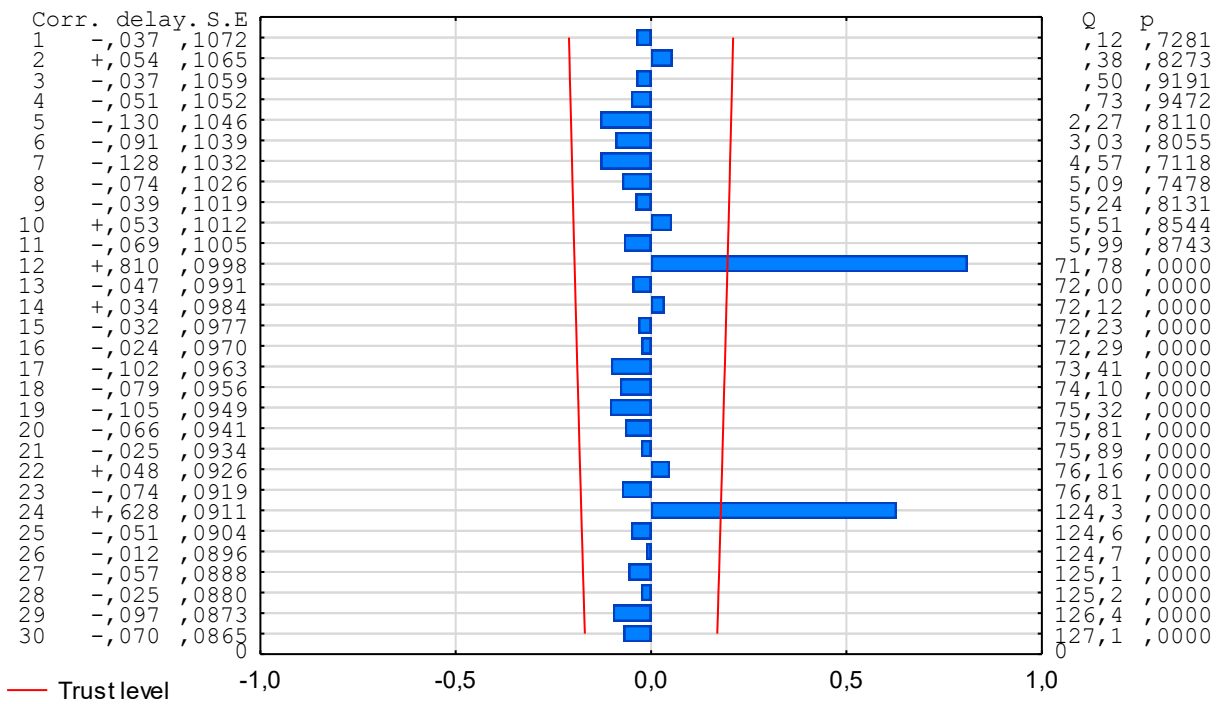


Fig. 4. Autocorrelation of the primary time series

The autocorrelation diagram shown in Figure 4 confirms the existence of seasonality through the significance of the autocorrelation coefficient 12 and 24.

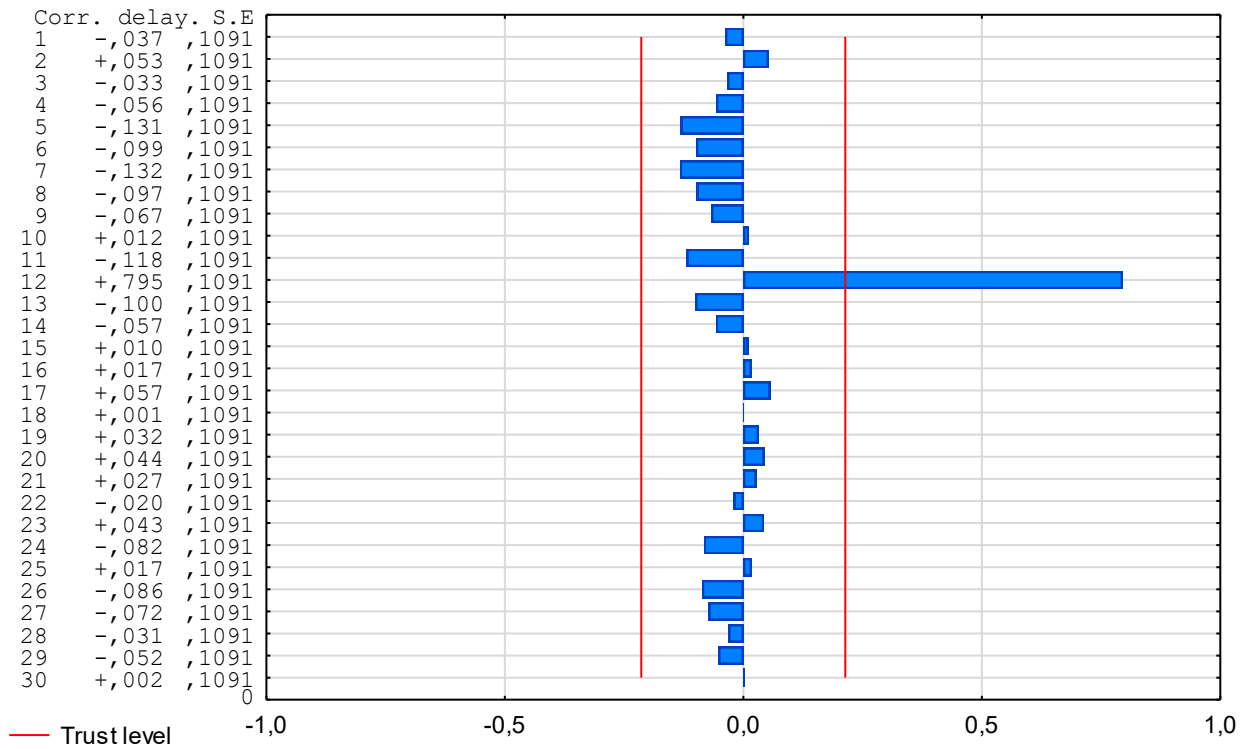


Fig. 5. Partial autocorrelation of the primary time series

Seasonality was also confirmed by the significance of the coefficient 12 of partial autocorrelation (Fig. 5).

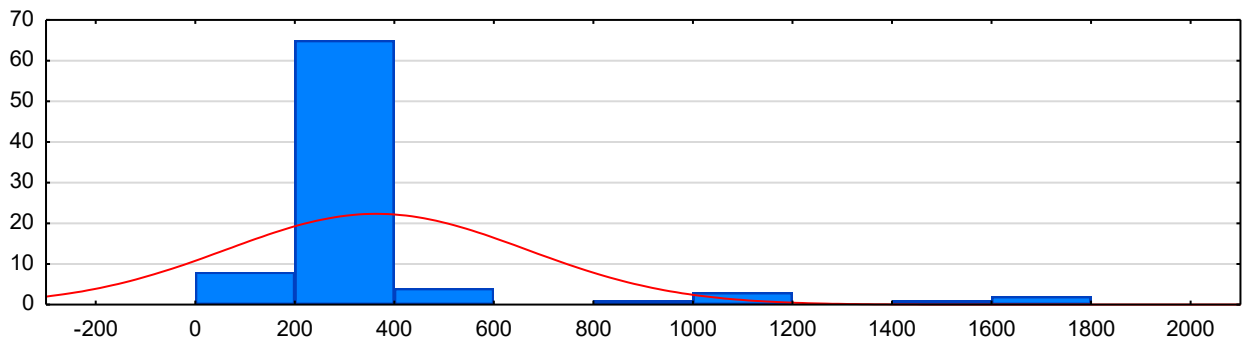


Fig. 6. Histogram of the primary time series

The analyzed time series of dismissals differs from the normal distribution which was clearly confirmed in the histogram (Figure 6).

The next stage of the research was the creation of a zero-one multiple regression model to confirm the existence of the trend and seasonality. For this purpose, a zero-one model consisting of fourteen predictors was built. Only significant predictors are listed in Table 1.

Table 1. Zero-one multiple regression model

N = 84	Summary of the regression of the dependent variable: Number R = 0,95323231 R ² = 0,90865183 Corrected R2 = 0,90522628 Standard error of estimation: 92,387					
	b*	Standard error	b	Standard error	t(80)	p
Absolute term			472,0366	40,32176	11,70675	0,000000
Int	-0,180707	0,034100	-58,9722	11,12832	-5,29929	0,000001
New variable 4	0,918797	0,034165	991,6752	36,87503	26,89287	0,000000
New variable 14	0,116635	0,033986	125,8868	36,68189	3,43185	0,000951

Significant predictors presented in Table 1 confirmed the existence of the trend and seasonality. The model built was very well suited as multiple R² was 0,91. The standard error of the estimation was 92,39.

The analysis of the time series of dismissals shows a weak downward trend and a clear seasonality. This became the premise for the analysis and evaluation of the Holt-Winters method and the ARIMA model in terms of the choice of the best one used to forecast the primary time series for the future.

The forecasting of dismissals of employees in the subject of the research

The analysis and evaluation of the forecasting methods was preceded by the division of the primary time series into two parts (Fig. 7).

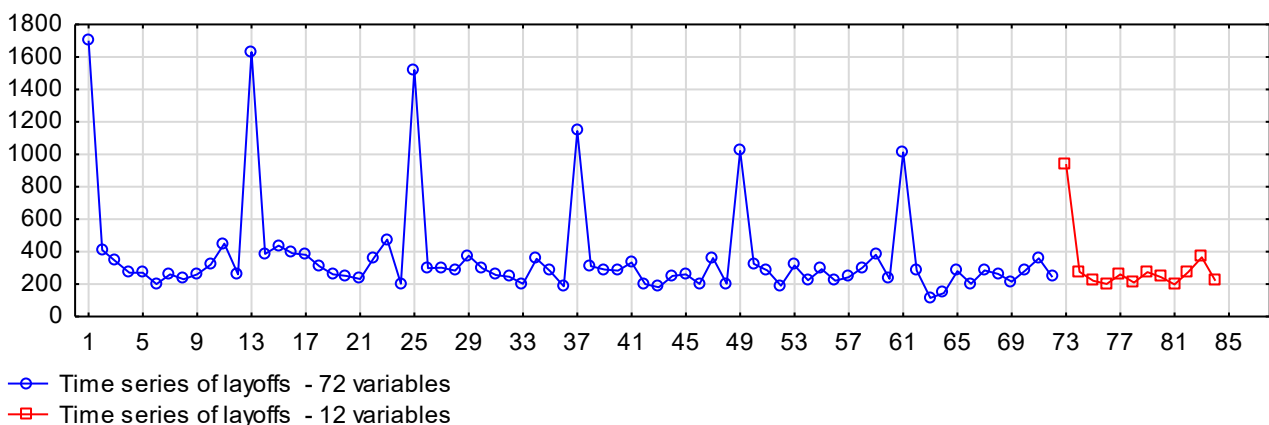


Fig. 7. Division of the dismissal time series into the teaching (blue line) and testing (red line) parts

The division of the primary time series presented in Figure 7 allows for the teaching part - 72 periods (blue) and the testing part - 12 periods (red).

Holt – Winters exponential smoothing method was used as the first method to predict the teaching time series. The forecast results are presented in Figure 8.

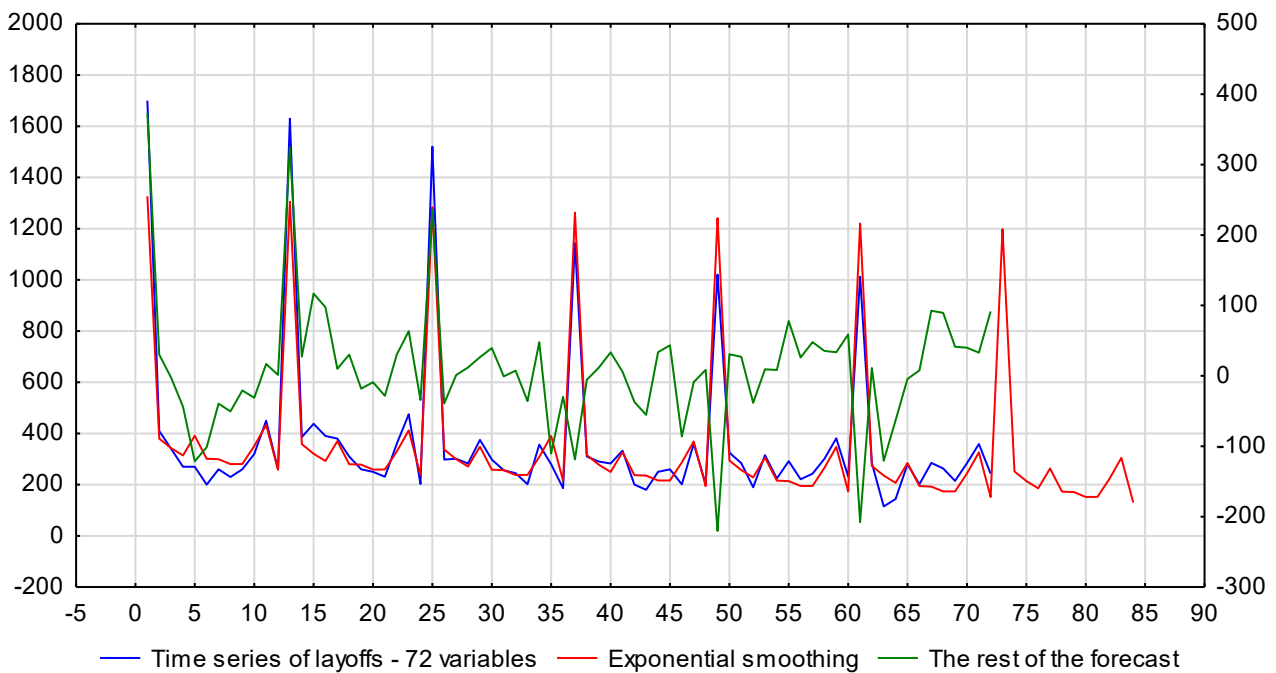


Fig. 8. The Holt-Winters method of the teaching time series

The forecast made with the use of the Holt – Winters method has been drawn with a red line in Figure 8. The rest of the forecast is marked with a green line and the actual value with a blue line. The observation of the data presented in Figure 8 shows that there is a good match between the predicted and observed values.

For research purposes, an ARIMA model was built to forecast the teaching time series. The significance of the parameters used is summarized in Table 2.

Table 2. Structure of the ARIMA model

Parameter	Transformations: $\ln(x), D(1)$ Model: $(1,1,0)(1,0,0)$ Seasonal delay.: 12 Remainder $MS = 0,14864$					
	Parameter	Asymptote	Asymptote	p	Bottom limit	Top limit
p(1)	-0,298130	0,117248	-2,54272	0,013246	-0,532034	-0,064226
Ps(1)	0,865677	0,085976	10,06886	0,000000	0,694160	1,037193

According to the observation of the data presented in Table 2, the p and Ps variables were significant predictors. The constructed model was differentiated D (1) and logarithmic. The constructed ARIMA model will have the form: ARIMA (1,1,0)(1,0,0) with $\ln(x)$, D(1).

The next stage of the research was the forecasting with the ARIMA (1,1,0)(0,0,1) model with $\ln(x)$, D(1). The forecast results are shown in Figure 9.

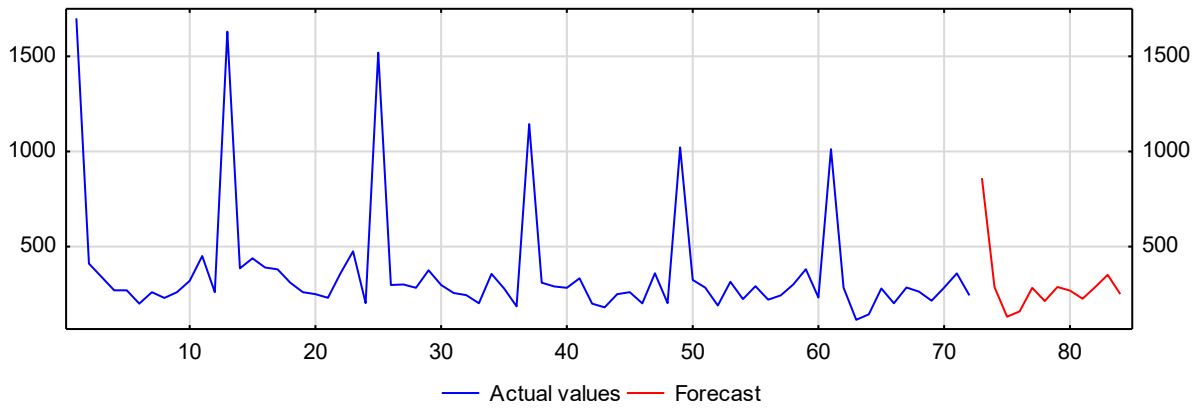


Fig. 9. ARIMA model forecast (1,1,0)(1,0,0) of the teaching time series

The observation of the data presented in Figure 9 allows for the conclusion that in the forecast obtained, made with the constructed ARIMA model, the seasonality of a multiplicative nature was preserved. Then, the constructed forecasting models were evaluated with the application of the mean absolute forecast error analysis (Table 3).

Table 3. Analysis of the mean absolute forecast error of the applied forecast methods

	H-W method	ARIMA model
MAPE	19,996	11,366

The evaluation of the data presented in Table 3 shows that the ARIMA method is the best forecasting method where MAPE was the lowest one and amounted to 11%. It became a premise for making the forecast of the primary time series of dismissals with the ARIMA model.

Then, for research purposes, the ARIMA model was built to forecast primary data for the future. The significance of the parameters used is summarized in Table 4.

Table 4. Structure of the ARIMA model

Parameter	Transformations: $\ln(x)$, $D(1)$ Model: (1,1,0)(1,0,0) Seasonal delay: 12 Reminder MS = 0,13275					
	Parameter	Asymptote	Asymptote	p	Bottom limit	Top limit
p(1)	-0,307200	0,109080	-2,81627	0,006100	-0,524236	-0,090164
Ps(1)	0,839238	0,073888	11,35829	0,000000	0,692225	0,986252

The data presented in Table 4 show that the model will be based on two predictors: p and Ps. The standard error of the constructed model was 0,13. The constructed ARIMA model will have the form: ARIMA (1,1,0)(1,0,0) with $\ln(x)$, $D(1)$.

Then, on the basis of the constructed ARIMA (1,1,0)(1,0,0) model with $\ln(x)$, $D(1)$, the forecasting for twenty-four future periods was conducted for the primary time series of dismissals and the results are summarized in Figure 10.

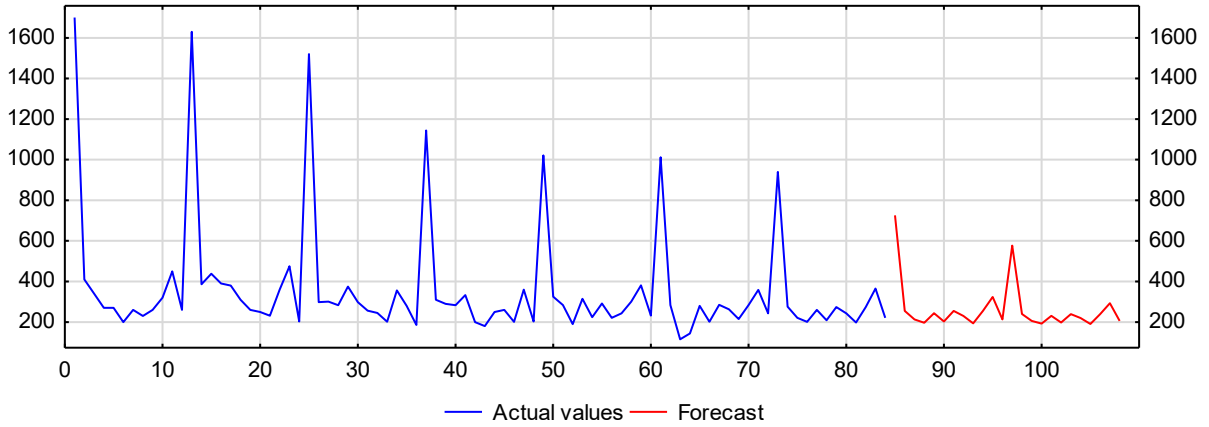


Fig. 10. ARIMA model forecast (1,0,0)(1,0,0), smoothed ln of the primary dismissal time series

The data in Figure 10 indicates that the obtained forecast maintains the seasonality observed retrospective data going downward.

Then, the analysis and evaluation of the remainder of the forecast were conducted using the ARIMA (1,1,0)(1,0,0) ln(x) and D(1) model. The following research tools were used for this purpose: autocorrelation (Fig. 11), partial autocorrelation (Fig. 12), histogram (Fig. 13), normality graph (Fig. 14).

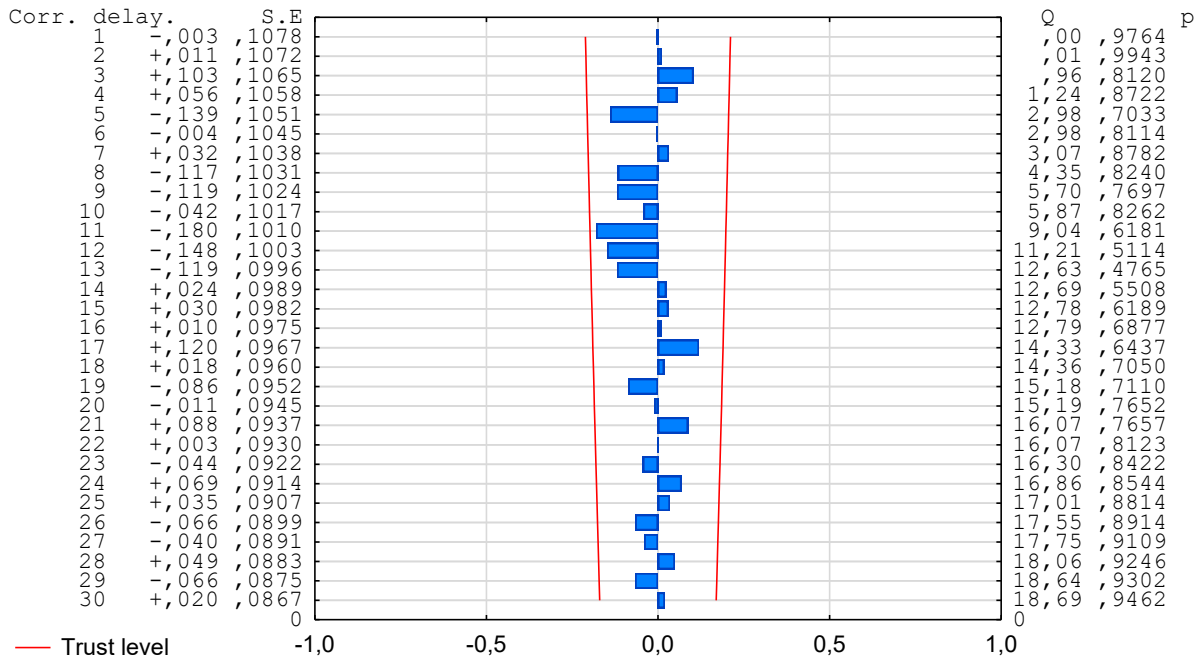


Fig.11. Autocorrelation of the forecast remainder made with the ARIMA model

The evaluation of the research tool used in the form of autocorrelation (Figure 11) is the observation of the white noise phenomenon.

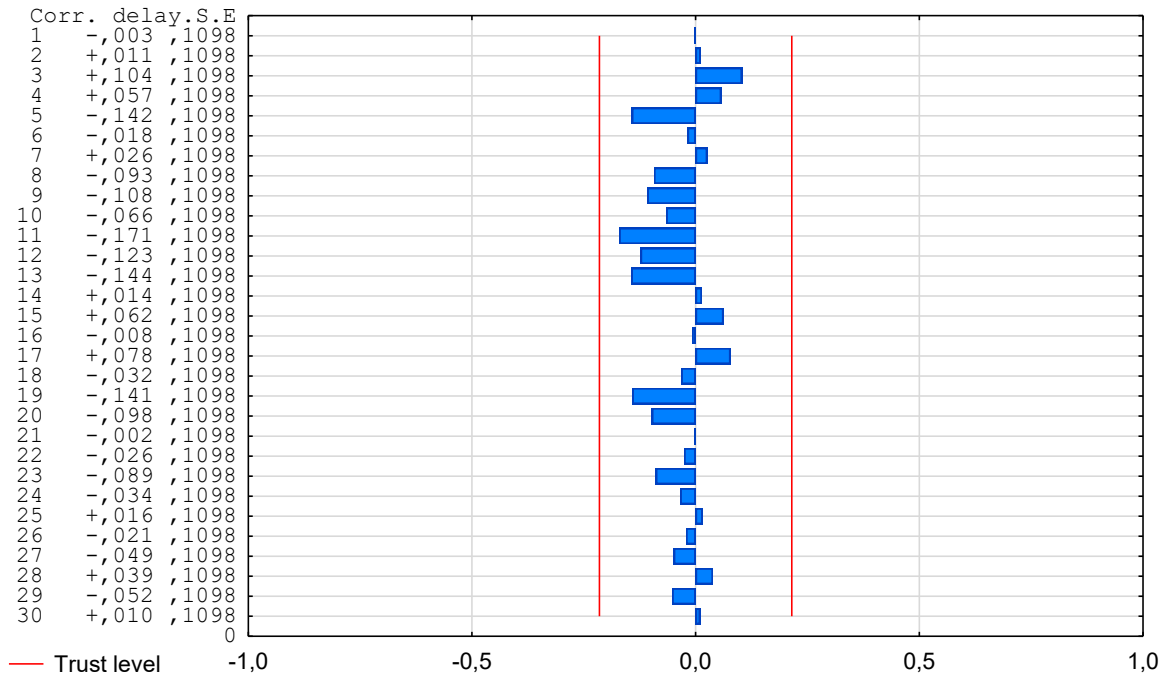


Fig. 12. Partial autocorrelation of the forecast reminder made with the ARIMA model

The white noise phenomenon was also observed after the use of partial autocorrelation (Figure 12).

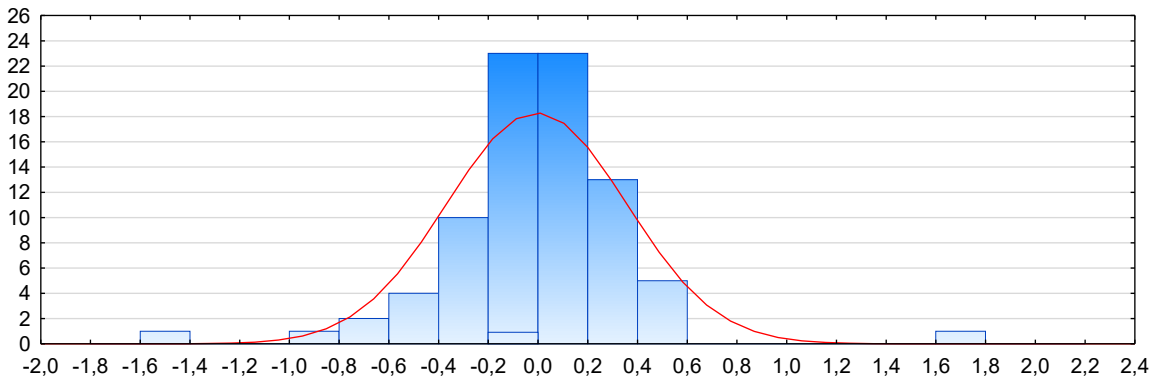


Fig. 13. Histogram of the reminder of the forecast made with the ARIMA model

The use of the histogram indicates that the reminder of the constructed ARIMA model has a distribution close to the normal one.

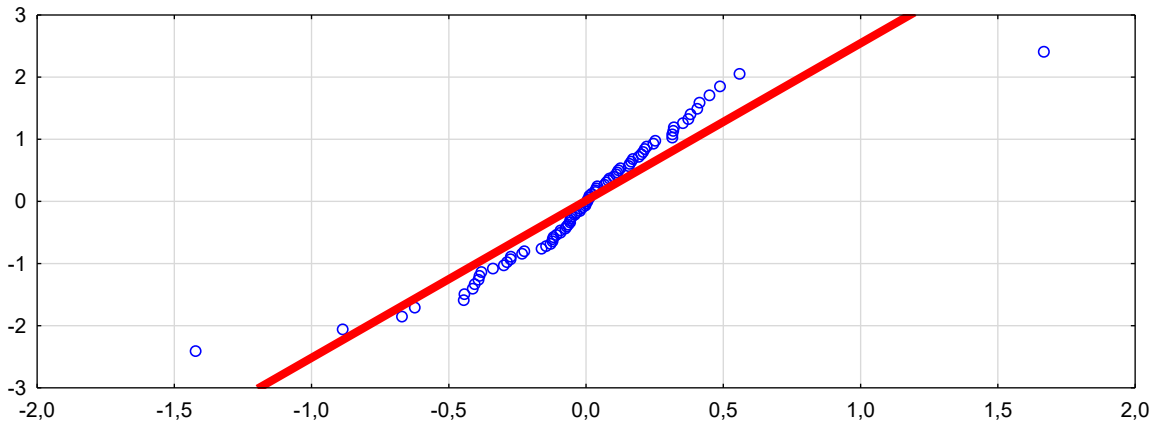


Fig.14. The normality graph of the forecast reminder made with the ARIMA model

The distribution of reminder close to the normal distribution of the obtained forecast with the ARIMA model was confirmed with the use of the research tool in the form of a normality graph (Fig. 14).

Then, for illustrative purposes, Table 5 summarizes the detailed results of the forecast with the use of the ARIMA (1.1.0)(1.0.0) smoothed $\ln(x)$, D(1) time series concerning dismissals between 2011-2017 on a monthly basis, consisting of 84 elements for 24 future periods.

Table 5. The results of the forecast the use of the ARIMA model (1,1,0)(1,0,0) with $\ln(x)$, D(1) data on dismissals for 2018-2019

No.	Month	Forecast of dismissals for 2018-2019
1	January 2018	726
2	February 2018	255
3	March 2018	213
4	April 2018	196
5	May 2018	244
6	June 2018	203
7	July 2018	255
8	August 2018	230
9	September 2018	194
10	October 2018	255
11	November 2018	324
12	December 2018	213
Total 2018		3306
13	January 2019	577
14	February 2019	240
15	March 2019	206
16	April 2019	192
17	May 2019	231
18	June 2019	198
19	July 2019	239
20	August 2019	220
21	September 2019	190
22	October 2019	239
23	November 2019	293
24	December 2019	206
Total 2019		3032

According to Table 5, it is expected that approximately 3306 employees should be dismissed in 2018 while in 2019 the number of those will decrease to 3032 people. The downward trend and the monthly seasonality were maintained in the forecast obtained.

Summary and Conclusions

The conducted analysis and evaluation of the time series of data on dismissals between 2011-2017 on a monthly basis indicate the existence of a clear seasonality and a downward trend. This became a premise for the forecasting of the primary time series of the dismissals in a dynamic perspective for the future.

The main goal of the work has been achieved. Forecasting has been made for the next twenty-four future periods. Due to the lack of a significant correlation in the reminder of the forecast made with the ARIMA model and the distribution of residuals close to normal, the applied model was considered correct.

The forecast of the dismissed for 2018 was 3306 while for 2019 it was lower than 2019 by 274. The largest number of dismissed people is in the same months of January. In January 2018, the forecast of dismisses was 726 while in 2019 it was 577. The month with the lowest number of dismisses is September. The forecast for September for 2018 is 194 dismisses while for September 2019 - 190.

The use of the ARIMA method, with the observed dependencies in the considered time series of dismisses, may improve the creation of a personnel strategy in the analyzed subject of research.

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