

The Forecasting of Total Costs in The Enterprise in The Aspect of Security

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Abstract

The article analyzes and evaluates the total costs of the research subject. As a result, regularities in the form of a trend and slight seasonality were detected. This, in turn, became a premise for the forecasting of the historical data under consideration for the future with the use of two models: Holt – Winters exponential smoothing and the Klein model. Both models were analyzed and evaluated for the remainder of the forecasting. The best method was the Klein model which was used to forecast the total costs of the research subject for 2020. It amounted to PLN 51 233 351.

Keywords: Total Costs, COVID-19, Time Series Analysis, Forecasting, Security.

Introduction

In the twenty-first century, the functioning of enterprises involves the optimal incurring of costs in terms of dynamics. Their forecasting for the future is extremely important as it allows one to secure funds in order to cover them in the future and, thus, to rationally manage one's financial outlays.

The research problem was outlined as a question: To what extent will the detection of regularities in the data of retrospective total costs of the research subject allow selecting a method to forecast them for the future?

Apart from the research problem, the purpose of the work was outlined. It is the forecasting of the total costs of the research subject for 2020.

The subject of the research is a limited liability company located in south-eastern Poland whose main activity is the provision of storage and transport services for food and industrial goods for associated enterprises. The company leases three warehouses with a total area of 45,000 m². The company operates a chain of stores located mainly in the eastern part of Poland.

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The following research methods were used in the article: the Holt – Winters forecasting method and the Klein model.

Analysis of the literature on the subject of the research

Since 2020, companies in Poland and around the world have been affected by the infectious disease COVID-19. The first case of COVID-19 was reported in Wuhan, China in December 2019 (Zhu, et al., 2020). The disease has led to many deaths, it poses a threat to human life or health and causes broadly understood anxiety among citizens of different countries of the world (Kozicki, Mitkow, 2020). On 11 March, 2020 COVID-19 was declared a pandemic (Rabej, 2018). Since then, individual countries of the world have introduced various restrictions, e.g. the obligation to wear face masks, keep safe distance, use exceptional personal hygiene products and others.

In 2020, the research subject under consideration was also affected by the COVID-19 pandemic but the costs incurred and the revenues earned followed the trends observed in the past.

The term cost comes from Latin (*costare*) and means: to spend, to cost (Twaróg, 2003). Our own experience allows us to define a cost as a deliberate financial effort incurred in order to achieve an income. The expenditures in the literature are interpreted in various ways (Table 1).

Table 1. Summary of the definition of the term ‘outlay’

Author	Definitions
D. Begg, S. Fischer, R. Dornbusch	An outlay (or a factor of production) is a good or service used in the production process. The term covers everything from managers' salaries to expenditure on bandages in an on-site infirmary (Begg et al., 1993).
E. Burzymowa	The outlay is the achievement of a useful effect; it does not become a cost as long as this goal is not achieved. It includes any deliberate use of funds (Burzymowa, 1971).
K. Czubakowska	The outlays concern the entire enterprise but only some of them intentionally incurred for a specific economic activity may be a cost (Czubakowska, 2008).
W. Grzywacz, J. Burnewicz	Outlays are expenses incurred for increasing the resource of production factors and for other purposes. Outlays are not costs yet, they become costs, in whole or in part, along with the performance of a certain amount of finished production (Grzywacz, Burnewicz, 1989).

The most accurate definition of outlays relating to the term cost is the interpretation of K. Czubakowska which states that only outlays intentionally incurred on economic activity become costs.

The sum of all costs incurred by an enterprise or organization is defined as total costs. The study covers the total costs of the research subject. The analysis was performed in order to detect regularities in the form of trend and seasonality which is thoroughly described in many literature items (Kozicki, Górniewicz, 2020; Luszniwicz, 2003; Kozicki, et al. 2018; Kozicki 2020; Rabej, 2018; Makridakis et al. 1998) .

The detected regularities allowed for the selection of methods for forecasting the historical data under consideration for the future in the form of the Klein model (Czyżewski, Klóska, 2019) and the Holt – Winters exponential smoothing method (Kot, Jakubowski, Sokołowski, 2011). In the study, the analysis and evaluation of forecasting errors of the two considered methods were performed. The best method was the created Klein model which was used to forecast the total costs of the research subject for 2020.

In the literature, economic security is considered to be a kind of national security, a process that includes various activities, the main goal of which is to ensure the economic conditions necessary for the survival, prosperity and sustainable development of the society, as well as the efficient operation of the state and its institutions (Kitler, 2011, p. 49).

In the literature, forecasting is defined as the rational, scientific prediction of future events (Dittmann, 2016).

The research began with the analysis and evaluation of the total costs of the research subject.

Analysis and evaluation of the total costs of the enterprise

The first stage of the research was to summarize the total costs of the research subject on a monthly basis between 2015-2019 on a bar chart.

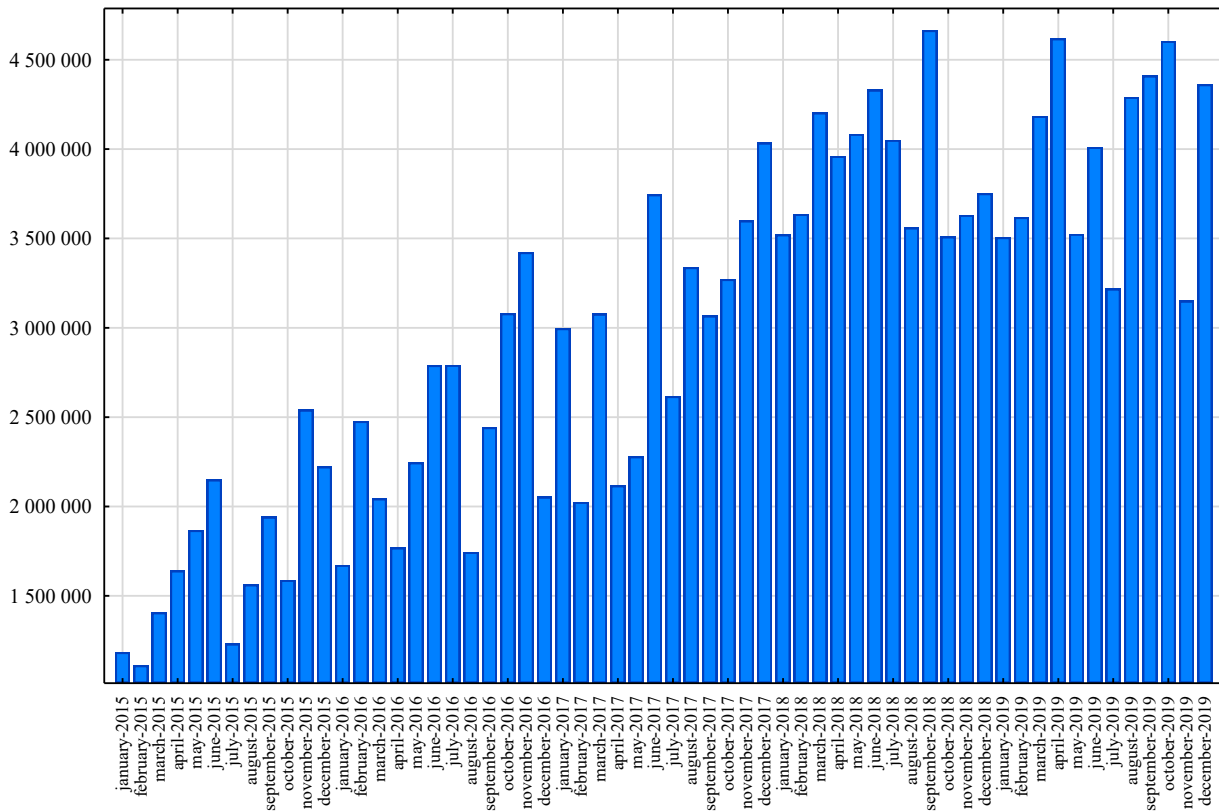


Fig. 1. Total costs of the research subject on a monthly basis between 2015-2019

Figure 1 shows that the retrospective data under consideration shows a growing trend in the total costs of the research subject from January 2015 to December 2019.

Then, the research was conducted to look for outliers and extreme values in the total costs of the research subject from January 2015 to December 2019. The results are outlined in Figure 2.

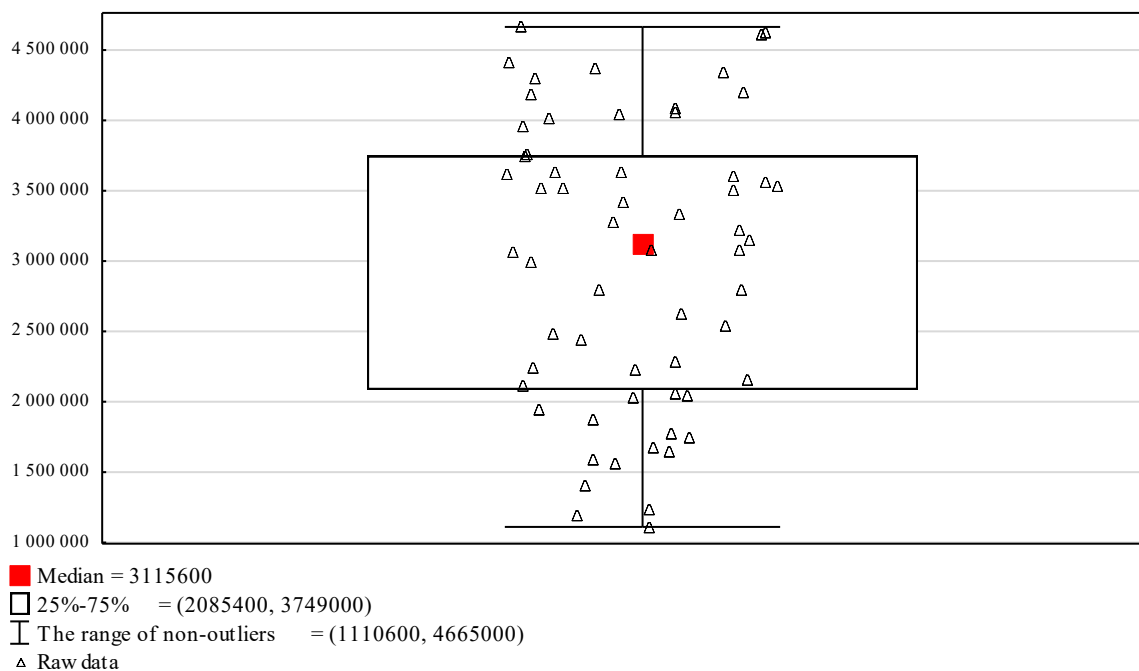


Fig. 2: Searching for outliers and extreme values in the total costs of the research subject from January 2015 to December 2019

The analyzed primary data lacked outliers and extreme values. The median of the primary data under consideration was PLN 3 115 600.

Figure 3, then, presents the sum of the total costs of the research subject between 2015-2019.

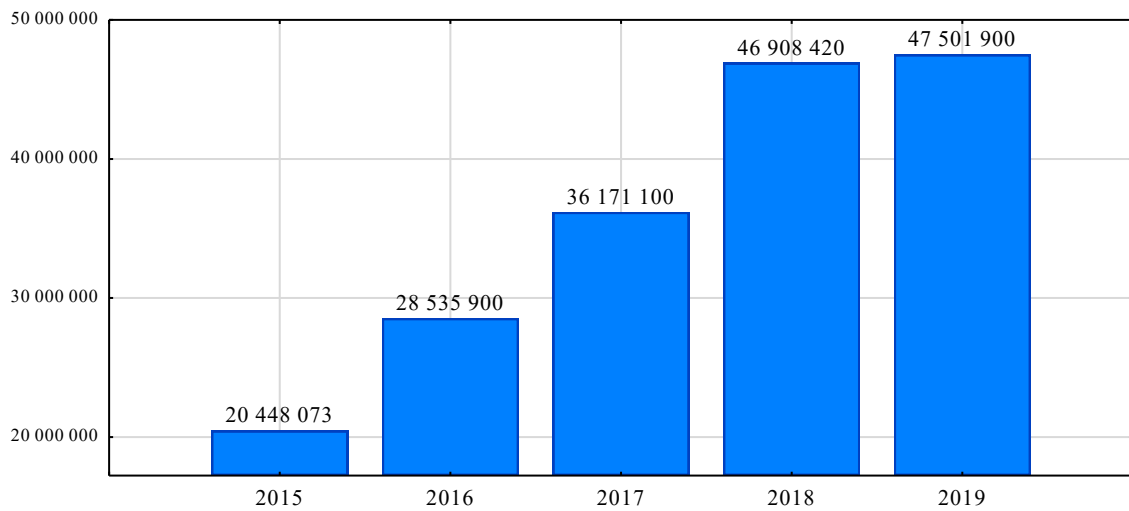


Fig. 3. Total costs of the research subject between 2015-2019

The total sum of costs from 2015 to 2019 increased 2.32 times. The increase was caused by the development of the company. External services had the largest share in the total costs of the enterprise. Their value increased almost fivefold from January 2015 to December 2019.

The next step was to group the primary data under consideration into the same months and to summarize the results in the form of calculated indices as arithmetic means and standard errors in the box plot.

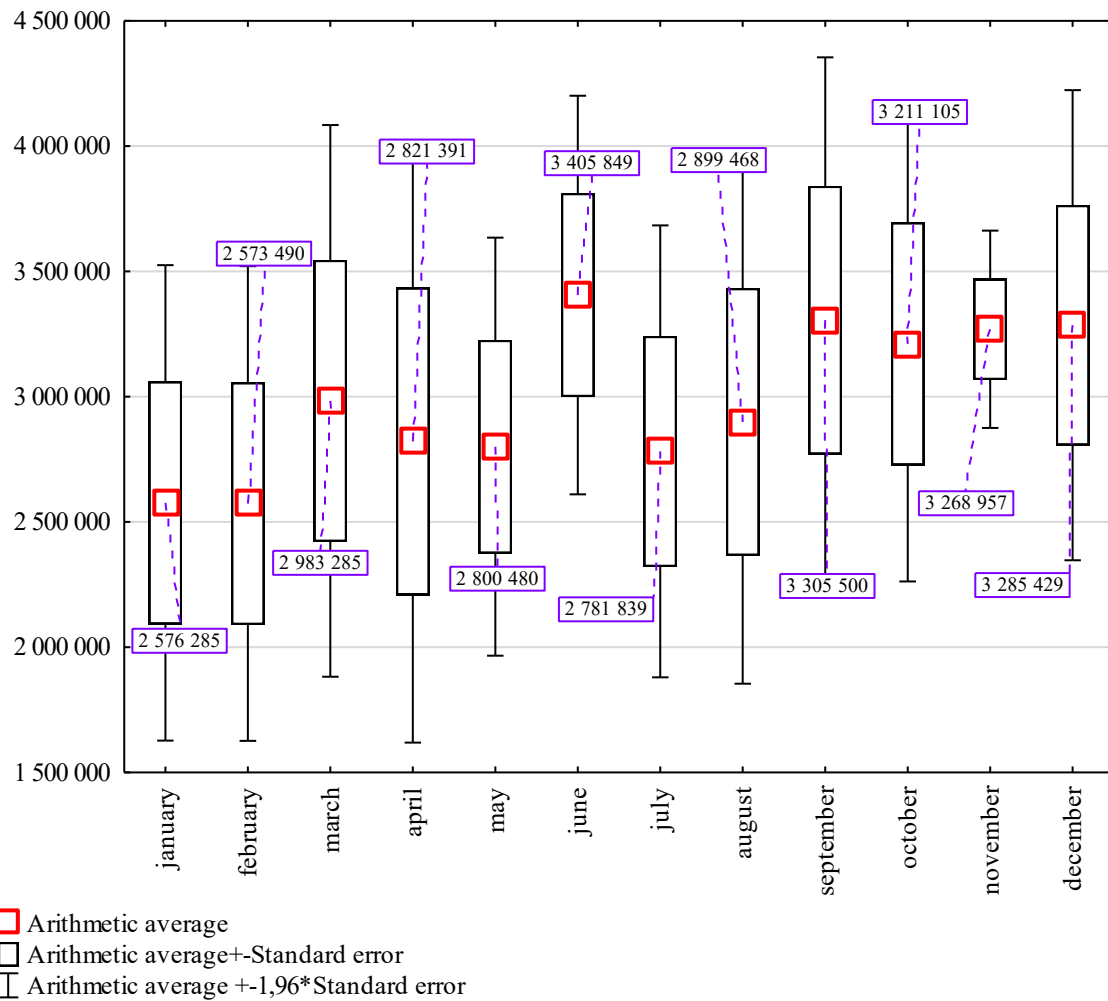


Fig. 4. Box plot of total costs on a monthly basis between 2015-2019

Figure 4 confirms the existence of a slight seasonality on a monthly basis. The lowest arithmetic mean was visible in the same months (January) and amounted to 2 576 285 and the highest one in the same months - June: 3 405 849.

It was decided to investigate the observed regularities in the form of an increasing trend and slight seasonality by building a zero-one model of multiple regression. 14 predictors were used for this. By applying the principle of backward regression, irrelevant predictors were eliminated and the results of the studies are summarized in Table 2.

Table 2. Zero-one model of multiple regression

N = 60	R = 0,90 R ² = 0,81 Correctness R ₂ = 0,80 Standard error of estimation: 458 800					
	b*	Standard error	b	Standard error	t(56)	p
Absolute term			1055424	184554,2	5,71877	0,000000
t	1,454907	0,239603	84414	13901,8	6,07215	0,000000
June	0,129663	0,058952	471391	214320,5	2,19947	0,031990
t2	-0,596571	0,239611	-550	220,9	-2,48975	0,015779

The data summarized in Table 2 shows the existence of three significant predictors in the form of variables: t, t2 and June. This, in turn, confirms the trend and slight seasonality.

The obtained evaluation is a premise for the forecasting of the primary data under consideration with the use of two methods: Holt-Winters exponential smoothing and the Klein model.

The forecasting of the total costs of the research subject

The Holt-Winters exponential smoothing model and the Klein model were used to forecast the data in the company on its total costs. The forecasting results are summarized in Figure 5.

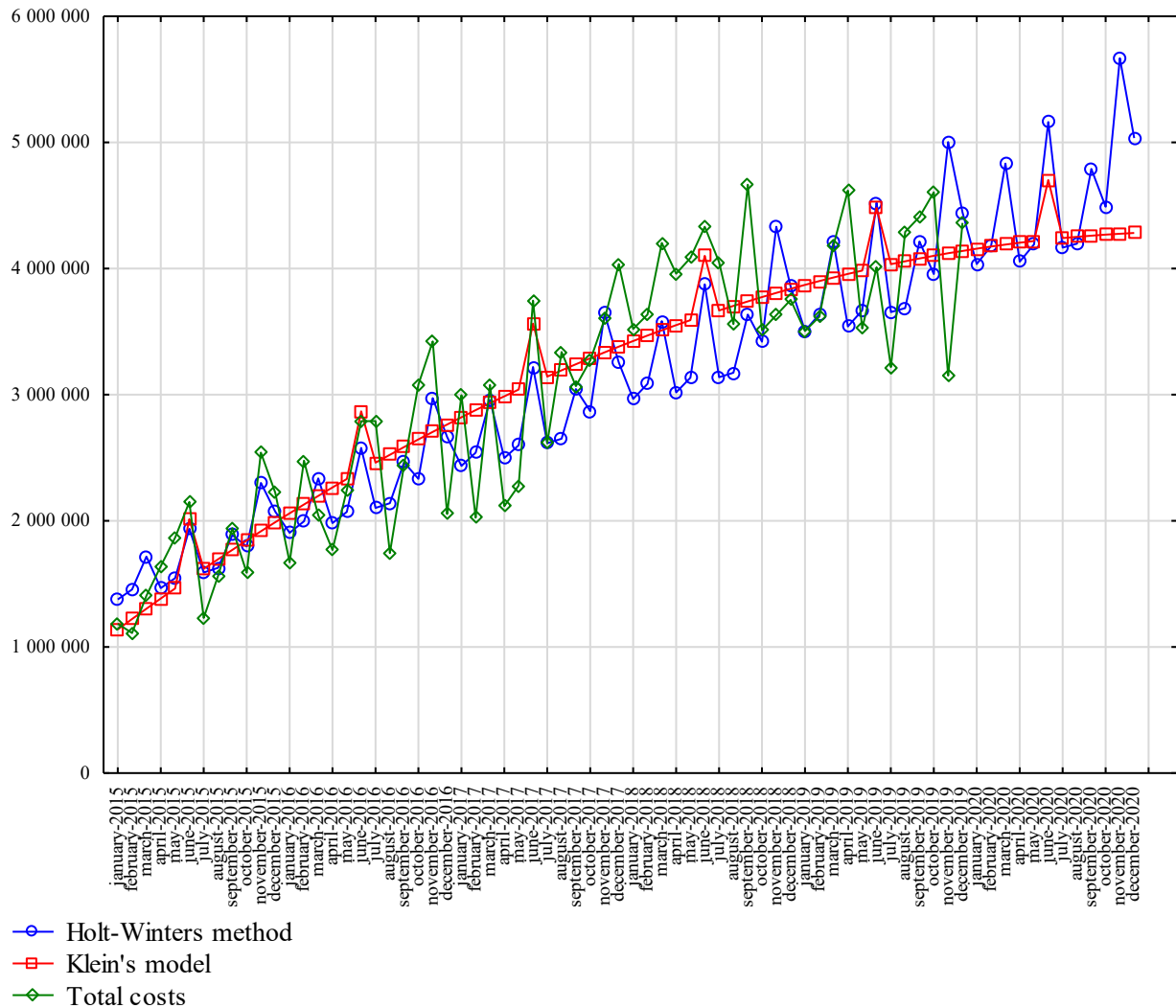


Figure 5. Total cost forecast made with the use of the Holt-Winters method and the Klein model

Figure 5 does not clearly show which forecasting model has a better match between the predicted and observed values. In order to detect the best method of the forecasting of the primary data under consideration, the analysis of forecasting errors was conducted in Table 3.

Table 3. Analysis of forecasting errors

Forecasting errors	Result (%)
Mean absolute percentage error – H-W method	14,05
Mean absolute percentage error – Klein model	11,26

The conducted research indicates that the mean absolute percentage error of the Holt – Winters method reached the level of 14.05% and in the case of the Klein model, 11.02%. Thus, it was assumed that the Klein model is the best forecasting method.

The quantitative forecast of the total costs of the research subject for 2020 with the Klein model is presented in Table 4.

Table 4. Primary data forecast for 2020 with the use of the Klein model

Months	Forecast
January 2020	4 158 128
February 2020	4 174 892
March 2020	4 190 556
April 2020	4 205 120
May 2020	4 218 584
June 2020	4 702 339
July 2020	4 242 212
August 2020	4 252 376
September 2020	4 261 440
October 2020	4 269 404
November 2020	4 276 268
December 2020	4 282 032

The forecast of total costs for 2020 was PLN 51 233 351. The standard deviation from the arithmetic mean of the obtained forecast was PLN 1 423 745,63. On the other hand, the arithmetic mean was PLN 4 269 446 and the median was PLN 4 247 294.

Summary and conclusion

The conducted analysis and evaluation of data on total costs on a monthly basis allowed detecting regularities in the form of an increasing trend and slight seasonality. It became a premise for the forecasting of the retrospective data with the use of two methods: Holt – Winters exponential smoothing and the Klein model. The analysis of forecasting errors shows that the Klein model is the best method with the smallest forecasting error. It was used to forecast historical data for 2020.

The forecast of total costs for 2020 was PLN 51 233 351. The standard deviation from the arithmetic mean of the obtained forecast reached the level of PLN 142 3745,63. The arithmetic mean was PLN 4 269 446 and the median was PLN 4 247 294.

The study provides an answer to the main research question which is: what error rate, after the application of the analysis and evaluation of primary data in terms of the selection of the method for its forecasting, will the obtained forecasts of the total costs of the research subject in 2020 reach? The mean absolute percentage error reached the level of 11.02%. Thus, it can be assumed that the obtained forecast is good.

The participant observation shows that the methodology of the forecasting of total costs used in the study may be one of the variants of the planning of total costs for the future in the subject of the research. The obtained forecasts constitute a solid foundation in the making of financial decisions which involve the planning of expenditures necessary to achieve the adopted goals included in the plans of the research subject.

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