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Application of forecasting methods in harmonising strategic planning for sustainable development of the state

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Abstract. Successful implementation of the global concept of sustainable development requires harmonising the strategic planning of sustainable development of the state to ensure effective monitoring of the progress of states in achieving the Sustainable Development Goals. The purpose of the research is to actualise the problem of applying forecasting methods in the process of harmonising the strategic planning of the sustainable development of the state and to develop methodological tools for its solution. In the course of the study, based on the application of such methods as: literature review, hypothetical-deductive method, comparison method, empirical method and logical analysis, the expediency is substantiated, methodological tools are developed and the method of triple exponential Holt-Winters smoothing based on a long time series is tested using the Forecast Sheet in Microsoft Excel 2016. Within the framework of a harmonised approach to strategic planning for sustainable development, to assess the country's progress in sustainable development, the indicators of decoupling of environmental pressure from economic growth are used, as they are simple, measurable and flexible. Based on the Tapio's methodology, a norm of non-renewable resource decoupling and environmental impact decoupling indicators is determined as a benchmark for the development and analysis of the effectiveness of the national sustainable development strategy, and a forecast of the dynamics of these indicators in the EU as a whole until 2026 is made, as a leader in the greening of the economy. The findings allowed us to identify the main trends in the EU's sustainable development, basing on the classification of the decoupling status. The results obtained contribute to the harmonisation of national strategies to ensure the successful implementation of the global concept of sustainable development, can be used at such a stage of strategic planning as the formation of a goal tree, which makes it possible to set both attainable and relevant goals, as well as in assessing the effectiveness of strategies in achieving the Sustainable Development Goals

Keywords: Sustainable Development Goals; exponential smoothing; decoupling; harmonised approach; national strategy; unification

Introduction

The escalation of global problems has led to the emergence of the sustainable development concept, aiming to ensure a harmonious relationship between humans and nature with sustainable economic growth. Its global nature requires unified approaches and standardised methods for developing national sustainable development strategies. Since 2015, achieving the Sustainable Development Goals (SDGs) has been on the agenda of all 189 countries participating in the 70th session of the UN General Assembly, where the document "Transforming Our World: The 2030 Agenda for Sustainable Development" was adopted (ENAT, 2020). This declared the ambitious global goal of achieving sustainable development in economic, social, and environmental dimensions by 2030, becoming a strategic goal for all national economies.

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The SDGs are global and universal but respect national characteristics, economic differences, capabilities, policies, and interests. Each government chooses how to incorporate the SDGs into national strategic planning, determine links between sustainable development and current economic, social, and environmental processes, and develop progress measures. Each state, within its national strategy, forms its own goals, tools, and indicators, without a standardised approach to interpreting the results.

According to the 2019 Sustainable Development Solutions Network survey, there is no single approach to monitoring the achievement of the SDGs among countries around the world. For example, the EU assesses its success in ensuring sustainable development using 100 indicators, Canada – 244, Belgium – 34 (Sachs *et al.*, 2019). Such a variety of indicators intensifies research activities but creates difficulties and delays in interpreting the results of national sustainable development strategies. This hinders prompt intervention to improve the strategy and the development of useful proposals for forming a successor strategy based on past experience. In addition, there is the problem of international comparison of the levels of countries' progress in ensuring sustainable development in the absence of generally accepted standards for assessing the effectiveness of the implementation of national sustainable development strategies.

Thus, M. Olievska (2019) in research highlights the problem of comparability of indicators due to the use of different methodologies for assessing sustainable development, which is why countries should unify reporting metadata, adapt the SDGs and indicators for their achievement. P. Gennaria & M. D'Oraziob (2020) rightly point out that even leading international organisations do not agree on methods for assessing sustainable development, which can lead to discrepancies in results and, consequently, confusion among decision-makers who will have to base their policy decisions on unreliable and inconsistent assessments. The potential methodological difficulties in auditing national strategies for the effectiveness of achieving the SDGs within the framework of the International Organization of Supreme Audit Institutions (INTOSAI) are emphasised by V. Hanushchak (2023), which the author assumes to exist due to the relative novelty and subjectivity of the methods that can be used. In turn, T.I. Iefymenko (2019) raises the problem of the threat of information asymmetry in the field of sustainable development, to offset which it is necessary to develop common methodological approaches to the formation of a system of indicators at the global and national levels, which will allow to adequately assess the degree of achievement of the SDGs. As noted by J.W. McArthur & K. Rassmusen (2019), differences in concepts, programs, and implemented sustainable development strategies between different institutions only intensify the parallel development of alternative and parallel indicators, while it is a harmonised methodology that can translate the SDGs into an empirical framework that meets the challenges of each country.

Globalisation necessitates studying methods to harmonise strategic planning for sustainable development. This aims to unify approaches for assessing national strategies' effectiveness in achieving the SDGs. These methods should be relevant to strategic management, promote planning harmonisation, and be accessible. Початок формиКінець форми In this case, forecasting methods deserve attention, as according to D. Spokojny (2022), forecasts play an important role in the broader decision-making process, namely strategic planning. Forecasting is considered the basis of strategic planning, as it makes it possible, taking into account the overall dynamics of the system and global trends, to predict its desired future state and form an effective set of tools to achieve it.

The expediency of using forecasting methods in harmonising the strategic planning of the state's sustainable development is due to the fact that they allow to assess future developments based on past and present data (Petropoulos *et al.*, 2022) and to make sure that the decision is correct, or to receive a signal about the ineffectiveness of the strategy in achieving the goals and take appropriate measures. The long-term nature of national strategies requires that a certain level of progress in achieving sustainable development by the state be foreseen in the future. Also, M. Balan (2019) believes that the use of a forecasting system in strategic planning involves the introduction of a system of adequate indicators, the unification of which will allow an objective assessment of the effectiveness of the implementation of national strategies in the context of achieving the SDGs.

The purpose of the research is to actualise the problem of application of forecasting methods in harmonising strategic planning for sustainable development of the state; to suggest methodical tools for solving the problem. Achieving this goal involves the following tasks: to study the forecasting methods used in the strategic planning of sustainable development of the state; to select indicators for forecasting sustainable development in harmonising strategic planning and substantiate their norms; to choose an effective forecasting method in the process of harmonisation of strategic planning of sustainable development of the state and make a forecast.

Scientific novelty of the paper: for the first time the problem of applying forecasting methods within the framework of a harmonised approach to strategic planning of sustainable development of the state is raised; the study of forecasting methods in strategic planning of sustainable development has been further developed, methodical tools for harmonising strategic planning of sustainable development of the state are proposed.

Literature Review

In the framework of the study, it is important to investigate the Sustainable Development at the state level, which will give a basis for choosing such methods to

harmonise strategic planning for sustainable development of the state. Thus, Z.M. Buryk (2017) focuses on the study of theoretical and practical foundations for assessing the effectiveness of state regulation and forecasting indicators of sustainable development of Ukraine and uses the extrapolation method to predict the dynamics of integrated indicators of economic, environmental, social and institutional development of the country. As a result, the author forecasts the achievability of sustainable development indicators of Ukraine in accordance with the Sustainable Development Strategy "Ukraine-2020". A. Bidarbakht-Nia (2017) proposed to select an individual extrapolation method to forecast changes in the values of each of the selected 77 indicators of the SDGs, which, of course, complicates the forecasting procedure, but provides a more reliable result. J. Friedman *et al.* (2020) also used the method of extrapolation in the study of progress in achieving the SDGs, namely a cohort extrapolation model to predict progress in achieving the education-related SDGs.

In turn, I.O. Pyshnograiev & I.O. Tkachenko (2022) built an approximation model using MS Excel and RStudio applications to predict the level of sustainable development in the European context, based on 10 indicators from three dimensions of human life (economic, social and environmental) that had the highest correlation coefficient with the sustainable development index.

The authors A.L. Pomaza-Ponomarenko *et al.* (2021) argue, that forecasting the consequences of state policy to ensure sustainable development can be based on the use of a simulation model of the development of socio-ecological and economic systems with the obligatory correction of the defining parameters of sustainable development.

Scientists D. Firoiu *et al.* (2022) used the ARIMA modeling methodology based on SPSS software to study the country's potential to achieve the SDGs by 2030. The indicators for such a study were selected from 120 indicators for 17 Sustainable Development Goals defined within the EU SDG Indicator set 2021.

L. Hrytsenko *et al.* (2024), exploring the concept of sustainable smart urban development as a fundamental component of the national sustainable development strategy, built additive forecasting models obtained by the simple exponential smoothing method using the Google Trends tool, being convinced that in developing any strategies it is important to find out the level of public interest in this issue, to determine the level of awareness and readiness of citizens to perceive new information.

W. Qu *et al.* (2020) used the method of building scenarios based on the Threshold 21 Integrated Model to develop a national sustainable development strategy, which made it possible to analyse a number of strategic alternatives for the sustainable development of the state by indicators characterising the economic, social and environmental spheres of the state.

The literature review shows a keen interest of scientists in the issue of forecasting the sustainable development of the state, with a variety of forecasting methods and assessment indicators. However, in terms of harmonising strategic planning for sustainable development at the national level, it is important to ensure a unified approach to the selection of indicators and forecasting methods. According to the Ministry of Economy of Ukraine (2017), sustainable development indicators should be objective and suitable for international comparisons and in accordance with the capabilities of national statistical systems. In turn, forecasting methods should be chosen to ensure not only the validity and objectivity of the forecasted data, but also the possibility of comparing the level of achievement of the selected indicators with the norm.

Materials and Methods

This research was carried out in stages in accordance with the tasks set. A literature review was conducted to examine forecasting methods that are already used in strategic planning for sustainable development of the state and have proven their practical significance in this area, which was helpful in choosing such a method for harmonising strategic planning. As forecasting involves predicting the future state of the research object based on an assessment of its current state, it is necessary to select objective indicators for this purpose. The application of the hypothetical-deductive method made it possible to define such an indicator as decoupling of environmental pressure from economic growth, which is defined as a state of the economic system in which its economic growth prevails over its environmental damage on the ecosystem through two groups of factors: resource and environmental impact factors with the prospect of increasing such a gap in the future (Korolchuk, 2021).

The application of the method of comparing the decoupling of environmental pressure from economic growth with the system of sustainable development indicators proposed by the United Nations Commission on Sustainable Development (CSD) and the Organization for Economic Cooperation and Development (OECD), which includes a large number of indicators for which, according to K.Y. Redko & V.R. Miroshnychenko (2022), national statistical reports may lack the necessary information to assess the level of achievement of the SDGs, and some of them cover several areas at once, which greatly complicates the process of harmonising strategic planning, as well as with the sustainable development indices, which are complex indicators and involve multilateral complicated calculations, made it possible to identify the following arguments for using the decoupling indicator as part of a harmonised approach to developing a national sustainable development strategy:

- decoupling is a simple indicator, as it expresses the ratio of two groups of factors;

- decoupling measures the environmental impact of economic growth, that is, how great is the sacrifice of nature in favour of economic development and raising human living standards, how much anthropogenic factor is harmful to the environment, whether harmony is ensured between the existence of nature, society and economy. Thus, it reflects the three-dimensionality of sustainable development, and thus the objectivity of the assessment;
- the indicators for calculating the decoupling index are available within the international, pan-European and national statistical systems, which simplifies the study and increases the validity of its results, as it ensures the consistency and continuity of dynamic series;
- decoupling is a flexible indicator suitable for sustainable development studies at all levels: regional, national, (pan-European) international. It simplifies comparisons and international benchmarking, and helps to define an indicative norm for the level of achievement of selected indicators;
- decoupling itself is defined as one of the main goals of the OECD Environmental Strategy.

In order to analyse decoupling of environmental pressure from economic growth and assess the efficiency of implementing the sustainable development concept, the decoupling index is used. The main approaches to determining the decoupling index are the methodology proposed by OCED (2002) and the P. Tapio (2005) methodology. The P. Tapio's one is the most common practice used in scientific studies by Ukrainian and foreign scientists, as it objectively allows for a more accurate analysis of decoupling, increasing the information content and validity of research results.

Therefore, the decoupling index is calculated using the following formula:

$$DI = (\Delta EP / EPo) / (\Delta DF / DFo); \quad (1)$$

$$\Delta EP = EPt - EPo; \quad (2)$$

$$\Delta DF = DFt - DFo, \quad (3)$$

where EP – environmental pressure, DF – driving force, t – target year, o – base year. The driving force reflects economic growth in the country and is usually described at the national level by the GDP indicator (at the regional and local levels, as well as at the level of the economy sector, appropriate indicators are selected). The use of GDP rather than GNP increases the objectivity of the indicator, as it eliminates the factor of relocation of industrial production to third countries within the TNCs, in which case there will be economic growth in the country of origin, and environmental damage will not be reflected.

At the next stage of the study, the norm of the selected indicator for forecasting was determined, which should be used to guide the development and analysis of the effectiveness of the national strategy, which is a critical element of strategic planning for sustainable development, as it provides basic benchmarks, increases forecasting accuracy, supports alignment with global goals, promotes effective resource and risk management, and thus helps to create sustainable and successful strategies. In the context of harmonising strategic planning, the indicator was chosen based on the best practices of implementing the sustainable development concept in the world, as well as on the norms and standards of developed countries. The EU was chosen as the best example of a sustainable development economy due to the comparative analysis, based on the decoupling index, which was used to determine the norm of this indicator.

To interpret the results, P. Tapio's (2005) classification of the decoupling status was used, which, according to M. Yaremova & A. Mytrofanova (2022), introduces decoupling flexibility into the traditional decoupling model, which can further decompose the coupling state. This classification is presented in Table 1.

Table 1. *Classification of the decoupling status*

ΔEP/EPo	ΔDF/DFo	Decoupling index	Decoupling status	
> 0	< 0	DI < 0	**Negative decoupling**	Strong Negative Decoupling (SND)
< 0	< 0	0 ≤ DI < 0.8		Weak Negative Decoupling (WND)
> 0	> 0	DI > 1.2		Expansive Negative Decoupling (END)
< 0	> 0	DI < 0	**Decoupling**	Strong Decoupling (SD)
> 0	> 0	0 ≤ DI < 0.8		Weak Decoupling (WD)
< 0	< 0	DI > 1.2		Recessive Decoupling (RD)
> 0	> 0	0.8 ≤ DI ≤ 1.2	**Coupling**	Expansive Coupling (EC)
< 0	< 0	0.8 ≤ DI ≤ 1.2		Recessive Coupling (RC)

Source: *developed by the author on the basis of P. Tapio (2005), Q. Wang et al. (2022)*

The decoupling index was calculated for the EU-28 and the EU-27 from 2020 for the period from 2015 (since the declaration of the Sustainable Development Goals at the UN General Assembly and, therefore, since their integration into national socio-economic development strategies) to 2023 (the latest year for which Eurostat statistical reporting was available at the time of the study). The study used data from the websites of the

Eurostat (Official website of Eurostat, 2019, 2024a), GMK's analytical and consulting centre (Yermolenko, 2023) and the global data and business intelligence platform Official website of Statista (2024).

At the next stage, using logical analysis, the most appropriate forecasting methods were selected in the process of harmonising the strategic planning of the state's sustainable development. Quantitative methods are preferred over qualitative ones, since statistical support for decoupling of environmental pressure from economic growth makes it possible to obtain sufficiently long, continuous dynamic data series, which, according to J.G. De Gooijer & R.J. Hyndman (2006), in cases where sufficient numerical data are available, quantitative methods are preferred, while in the absence of such data, judgmental approaches are preferred. It is proposed to apply the extrapolation method, which is designed to study the stable trends of socio-economic development formed in the past and present and transfer them to the future (International Labor Organization, 2023; GeeksforGeeks, 2024).

The forecast was made in Microsoft Excel 2016 with the use of such a tool as the Forecast Sheet, using the exponential smoothing method, which is characterised by simplicity, computational efficiency, ease of adjusting the response to changes in the forecasting process, and sufficient accuracy (Khomyak *et al.*, 2019; Lande, 2021).

In Microsoft Excel 2016, the Forecast Sheet employs the Holt-Winters Triple Exponential Smoothing (ETS) method with automatic determination of smoothing parameters for level, trend, and seasonality based on the data (Hyndman & Athanasopoulos, 2024). The general equation for forecasting using this method depends on the nature of the seasonality: additive or multiplicative, which Excel selects automatically based on data analysis.

In the additive model of the Holt-Winters method, the forecast for h periods ahead is determined as follows:

$$\hat{Y}t + h/t = \ell t + hbt + St + h - m(k + 1), \quad (4)$$

where $\hat{Y}t+h/t$ – is the forecasted value for the t+h period; ℓt – is the current level; bt – is the current trend; St+h-m(k+1) – is the seasonality at t+h, which corresponds to the seasonality at time t+h-m(k+1).

The forecast equation in the multiplicative model for h periods ahead is as follows:

$$\hat{Y}t + h/t = (\ell t + hbt)St + h - m(k + 1). \quad (5)$$

This approach made it possible to obtain a reliable forecast based on time series with both stable and abrupt changes, adapting to newer data, which, compared to the data at the beginning of the time series, have a greater impact on the forecast results (Vocaire, 2022; Simplilearn, 2023). The priority of the method that gives more weight to the latest data in forecasting was given in the context of the subject of the study. Since all dimensions of sustainable development are dynamic systems, effective strategies in this case require taking into account the latest trends:

- in the economic dimension, the introduction of new technologies, policy changes, or global crises (financial crises, pandemics) rapidly change conditions, so taking into account the latest data in forecasting helps to more effectively adapt national sustainable development strategies to such changes;
- in the social dimension, public attitudes and behavior in the country, as well as demographic indicators, are not stable. Taking the latter into account helps to predict changes in the social sphere and plan appropriate actions to support sustainable development;
- unpredictable metamorphoses occur in the environmental dimension as a short- or long-term consequence of anthropogenic factors. Climate change, changing levels of pollution, destruction of ecosystems as a result of armed conflicts, speak in favour of using forecasting methods in strategic planning for sustainable development that take more account of the latest data and help set relevant goals.

The forecast was made for 3 years in accordance with the length of the original dynamic series, since the length of a reliable medium-term forecast should be no more than 30% of the length of such a series according to O.V. Kozyrieva (2021). In addition, I.Y. Kondrat (2000) and E. Ostertagova & O. Ostertag (2012) believe that the exponential smoothing method is effective for forecasting the near future.

Results and Disscusion

Environmental pressure can be measured by two factors: resource and environmental impact, hence the two different types of decoupling – non-renewable resource decoupling and environmental impact decoupling. Since non-renewable resource decoupling implies a disconnect between economic growth and the use of non-renewable resources in social and production processes, the pressure on the environment can be measured by indicators of natural resource consumption, such as FEC (final energy consumption), which is appropriate at the national level. In turn, the environmental burden, which reflects the gap between economic growth and ecosystem pollution by harmful emissions, is measured by the volume of emissions of economic waste into the atmosphere, among which the GHG (Greenhouse Gases) indicator is widely used for a valid assessment. The choice of indicators depends on the object and subject of the study.

Based on the results of Decoupling Index (DI) resource calculations in the EU, based on the methodology of P. Tapio (2005), which are presented in Table 2, the following conclusion is made: the dominant status of DI resource in the EU is weak decoupling, which indicates a slight increase in the consumption of non-renewable natural resources with insignificant economic growth,

that is, DI ≥ 0, but DI < 0.8 (Table 2). This means that the EU is introducing energy-saving technologies, developing alternative energy, promoting economical use of energy by households, but not to the extent required.

Table 2. *DI resource in the EU as a whole for the period 2015-2023*

Periods	ΔEP/EPo	ΔDF/DFo	DI	SND	WND	END	SD	WD	RD	EC	RC
2014-2015	0.021	0.037	0.58					+			
2015-2016	0.020	0.027	0.73					+			
2016-2017	0.012	0.042	0.29					+			
2017-2018	0.003	0.035	0.09					+			
2018-2019	-0.006	0.036	-0.17				+				
2019-2020	-0.082	-0.039	2.09						+		
2020-2021	0.067	0.087	0.78					+			
2021-2022	-0.014	0.086	-0.17				+				
2022-2023	-0.008*	0.007	-1.14				+				

Note: ** calculated on the basis of the forecast indicator for 2023*
Source: *developed by the author on the basis of Official website of Eurostat (2024a; 2024b), H. Yermolenko (2023)*

The results shown in Table 2 may indicate, on the one hand, the ability of the EU economy to maintain a stable level of production and income without significantly increasing the use of limited resources, and, on the other hand, a possible dependence on imports of limited resources. In order to offset potential negative trends, such as increased foreign economic dependence and environmental problems due to the inability to significantly reduce resource use, and to strengthen the already existing positive achievements in achieving the SDGs, it is necessary to implement innovative sustainable development strategies focused on integrating the latest technologies into all spheres of social and economic life to green them and increase the weight of renewable resources.

According to the results of DI impact calculations in the EU, based on the methodology of Tapio (2005), which are presented in Table 3, the following conclusion is made: the dominant status of DI impact in the EU is strong decoupling, which means reducing ecosystem pollution by harmful emissions while ensuring economic growth, that is, DI < 0 (Table 3). It is the achievement of strong decoupling, or absolute decoupling, that is the fundamental goal of the sustainable development concept, as it is ensured by adherence to the principles of the circular economy: energy and resource efficiency, eco-innovation, zero waste, economic stability, reasonable consumption, etc. Strong environmental impact decoupling means that the EU has been very successful in introducing environmentally friendly production technologies.

Table 3. *DI impact in the EU as a whole for the period 2015-2023*

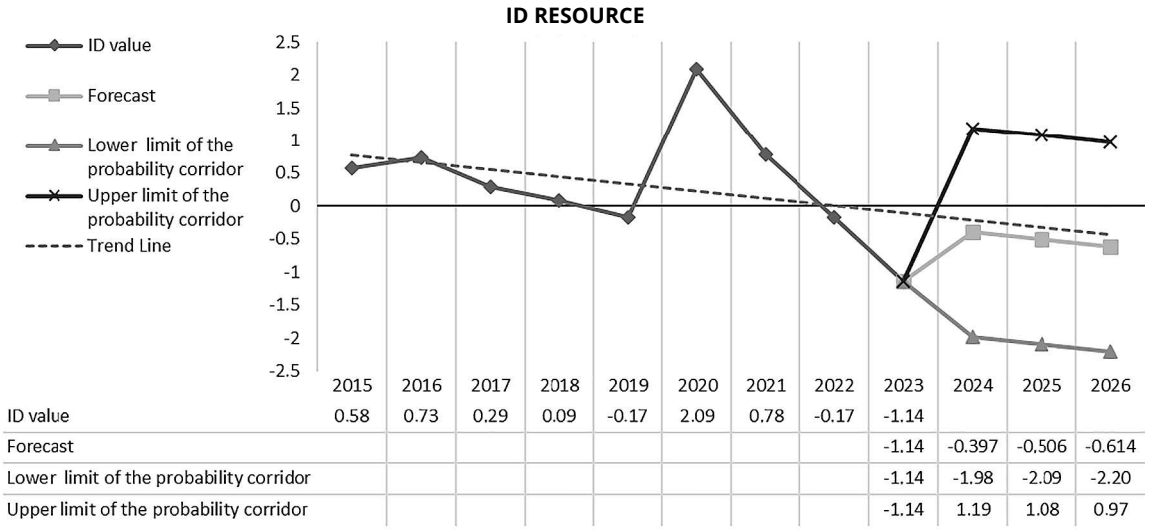
Periods	ΔEP/EPo	ΔDF/DFo	DI	SND	WND	END	SD	WD	RD	EC	RC
2014-2015	0.009	0.037	0.23					+			
2015-2016	0.029	0.027	1.08							+	
2016-2017	-0.019	0.042	-0.46				+				
2017-2018	-0.016	0.035	-0.45				+				
2018-2019	-0.054	0.036	-1.51				+				
2019-2020	-0.052	-0.039	1.34						+		
2020-2021	0.038	0.087	0.44					+			
2021-2022	-0.040	0.086	-0.46				+				
2022-2023	-0.071	0.007	-10.12*				+				

Note: ** calculated based on data for the third quarter of 2022 and 2023*
Source: *developed by the author on the basis of Official website of Eurostat (2024a; 2024b)*

The results presented in Table 3 show that the EU economy is capable of cutting greenhouse gas emissions and thus preserving clean air, water, and soil while ensuring a decent standard of living for its citizens. In such circumstances, strategies to stimulate the development of green infrastructure, sustainable education, and investment in clean technologies will be effective in bridging the gap between economic growth and negative environmental impact.

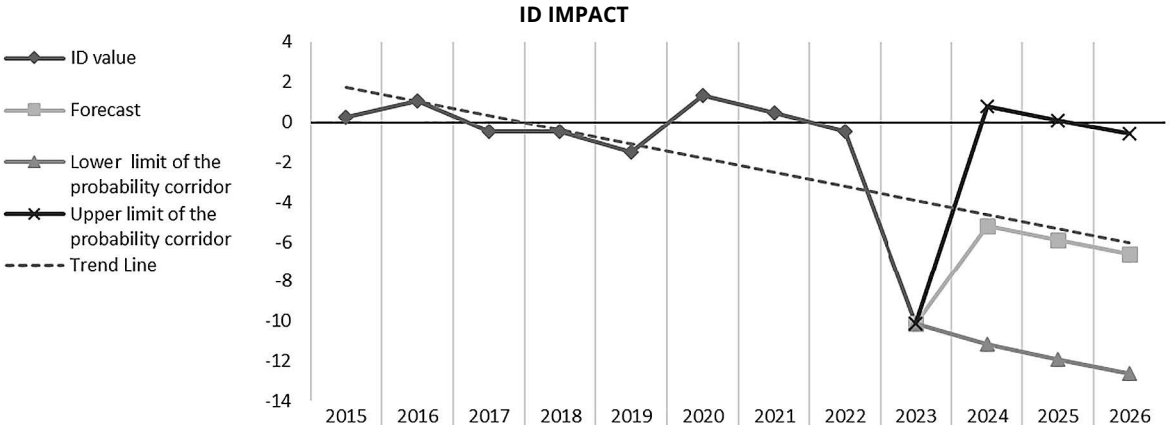
Thus, the norm of non-renewable resource decoupling is weak decoupling status, and the norm of environmental impact decoupling is strong decoupling status. Forecasting the dynamics of DI resource and DI impact in the EU, the results of which are shown in Figures 1 and 2, reveals a positive trend in the indicators. The general trend is visually demonstrated by a tool in Microsoft Excel 2016 called the Trend Line, which clearly predicts a change in the values of indicators in the

direction below zero. In addition, it can be seen that the norm of non-renewable resource decoupling has a tendency to change from weak decoupling status to strong decoupling one by 2026 (Fig. 1). In contrast, the DI impact will remain within the strong decoupling status within the forecast period (Fig. 2).



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ID value	0.58	0.73	0.29	0.09	-0.17	2.09	0.78	-0.17	-1.14			
Forecast									-1.14	-0.397	-0.506	-0.614
Lower limit of the probability corridor									-1.14	-1.98	-2.09	-2.20
Upper limit of the probability corridor									-1.14	1.19	1.08	0.97

Figure 1. *Forecasting the dynamics of DI resource in the EU as a whole until 2026 with the use of Microsoft Excel 2016*
Source: *developed by the author on the basis of R.J. Hyndman & G. Athanasopoulos (2024) and the data of Table 2*



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
ID value	0.23	1.08	-0.46	-0.45	-1.51	1.34	0.44	-0.46	-10.12			
Forecast									-10.12	-5.207	-5.905	-6.604
Lower limit of the probability corridor									-10.12	-11.18	-11.91	-12.64
Upper limit of the probability corridor									-10.12	0.77	0.10	-0.56

Figure 2. *Forecasting the dynamics of DI impact in the EU as a whole until 2026 with the use of Microsoft Excel 2016*
Source: *developed by the author on the basis of R.J. Hyndman & G. Athanasopoulos (2024) and the data of Table 3*

The graphs also show prediction interval in the values of the indicators, which helps to plan the best and worst possible limits when developing the strategy, allowing to maintain flexibility in responding to unforeseen changes in the internal and external environment of the socio-economic system, and to adapt to such challenges without significantly revising the strategy. As shown in Figure 1, the probability corridor of the forecast data allows taking into account such possible variations in the future values of DI resource as Strong Decoupling and Coupling, which can be taken into account in risk management when making strategic decisions.

By analysing the range of fluctuations in the forecasted values of DI impact in Figure 2, the Forecast Sheet also provides additional information about the future dynamics of the indicator, such as its lowest and highest values, which range from Strong Decoupling to Weak Decoupling with a trend towards Strong one.

The practical value of this forecast is the possibility of raising awareness of the competent public authorities,

public organisations, researcher about the norm of decoupling of environmental pressure from economic growth and the prospects for sustainable development of the EU. The norm of the indicator should be used to harmonise national sustainable development strategies in terms of analysing the effectiveness of their implementation as of 2023 through international comparisons, and the data of the future dynamics of DI resource and DI impact in the EU should be used at such a stage of strategic planning as setting short- and medium-term goals when forming a goal tree as part of the development of new sustainable development strategies or adjusting existing ones, as forecasts, according to Z.E. Shershneva (2004), are the tools for setting goals which, by J.S. Armstrong (2000), are used as inputs to the planning process.

The expediency of applying the triple exponential smoothing method for forecasting sustainable development is supported by the existing experience in the research of scientists in this area. For example, D. Firoiu *et al*. (2019) and A. Boto-Álvarez & R. García-Fernández (2020), studying the progress in achieving the SDGs by European countries such as Spain and Romania, used the Forecast Sheet in Microsoft Excel 2016 based on time series of 10 time periods and 11 time periods, respectively. The indicators were used the EU Sustainable Development Goals indicator set (OECD, 2002) and a special statistical database of Eurostat. As a result, forecasts were made to determine to what extent the studied countries could achieve the SDGs by 2030.

Instead, in this article, a forecast of the sustainable development progress of the EU as a whole is made also using the Forecast Sheet, but on the basis of an indicator that is available for processing in the statistical systems of all countries, not only Eurostat, since in the context of the study subject, harmonisation of strategic planning requires unification of indicators for assessing the state's progress in sustainable development, that is, that all civilised countries use the same indicator, which, accordingly, should be reliably provided by national statistical databases, not only by Eurostat. In turn, the use of a large number of indicators (100 indicators) in the assessment process complicates international comparisons of results in terms of their comprehensive interpretation.

In addition, research results differ in the length of the forecast: the authors made a long-term forecast until 2030, which is 130% and 118% of the length of the time series (Firoiu *et al.*, 2019; Boto-Álvarez & García-Fernández, 2020), while the forecast in this article – 30%, according to the recommendations on O.V. Kozyrieva (2021). This may indicate the suitability of the used method also for long-term forecasts.

By comparing the results of the study obtained by applying the triple exponential smoothing method in Microsoft Excel 2016, it was found that all of them, as well as in this article, can be used in strategic planning for the sustainable development of the state. Thus, D. Firoiu *et al.* (2019) hope that the data obtained in the course of the study will become a "starting point" for the relevant Romanian authorities to formulate an effective policy for the successful achievement of sustainable development goals, as well as to draw up effective plans. For their part, A. Boto-Álvarez & R. García-Fernández (2020) suggest that the conclusions reached in the research paper will help public authorities to realise the real state of affairs in the field of sustainable development in Spain and adopt relevant laws, develop policies that will allow for timely reorientation. This indicates the correct choice of the forecasting method in the context of the subject of the current study.

In turn, K. Chenary *et al.* (2024) made a forecast of the progress in achieving the SDGs for global regions by 2030 using smoothing by Holt-Winters' multiplicative technique to improve the accuracy of the moving average autoregressive model ARIMAX, which is an extended version of ARIMA, which, unlike its predecessor, takes into account external factors that affect the selected time period. The database was provided by The Sustainable Development Report, published by Dublin University Press, which uses official SDG indicators (232) endorsed by the UN Statistical Commission. The object of the study was geographic regions defined under the Area Codes for Statistical Use by the UN Statistics Division. To improve the model's performance, the predictors that are most likely to be influenced by artificial intelligence in the future were integrated into the forecast model by selecting filters. As a result of the study, a forecast of progress in achieving the SDGs for geographical regions of the world by 2030 was made. It uses exponential smoothing for long time series (2000-2022), resulting in a long-term forecast to 2030 which is 36% of the length of the time series, closely matching the forecast made in this paper.

The results of the study were obtained using Python programming in Google Colab, rather than Microsoft Excel 2016, which, in turn, is more accessible in use, as it supports traditional analytical tools, which is a key aspect in the harmonisation process. In addition, the authors' attention is focused on regions rather than countries, as they took into account the lack of data within the proposed methodology for individual countries (Chenary *et al.*, 2024). Thus, the database is well-stocked, but not applicable in the context of this study, as strategic planning for sustainable development implies the presence of subjectivity, which geographical regions do not possess. Moreover, among the shortcomings of the selected indicators, it is noted by the authors themselves that the SDGs are interconnected, a wide range of which, although leveled by the use of predictors, the latter, focusing only on the artificial intelligence factor, contribute to a decrease in the objectivity of the results. This confirms the expediency of choosing only one indicator to predict the sustainable development of the state.

The results of the study by K. Chenary *et al.* (2024), according to the authors, are intended to help governments and international organisations effectively allocate resources and prioritise their policies, to strengthen the consolidation of international economic actors around the achievement of the SDGs, and to effectively implement sustainable development strategies. This proves the practical feasibility of using the applied method in the field of strategic planning for sustainable development.

In turn, no examples of using the decoupling index as an indicator for forecasting the sustainable development of the state have been found. However, a number of scholars use it to develop regional development forecasts (Dong & Li, 2022; Yan *et al*., 2023; Liu *et al*., 2023). The method of building scenarios using analytical models is applied. As in the article, the P. Tapio (2005) methodology is employed to calculate the DI impact based on different groups of factors. The object of the study is both regions and industries, which makes the results significant for improving strategic planning for sustainable regional development and coordinating sectoral policies implemented in the regions. Such research experience can also be used in strategic planning for the sustainable development of the state to ensure balanced development and effective management of resources and potential of each region. This testifies in favour of the universality of the decoupling index as an indicator for assessing progress in achieving the SDGs, which is a significant characteristic in the context of unification of indicators for assessing the progress of sustainable development of the world's states as the most effective way to promote harmonisation of strategic planning for sustainable development of the state.

Conclusions

As a result of the study of the problem of application of forecasting methods in the process of harmonisation of strategic planning for sustainable development of the state, the most appropriate forecasting method has been identified and tested. The results are of particular importance at such a stage of strategic planning as goal setting. On the one hand, the proposed indicators and method can be used by countries planning sustainable development at the national level to study the current state of sustainable development and identify future trends, which will allow setting realistic achievable goals; and on the other hand, the possibility of studying foreign experience and international comparison of indicators will allow setting relevant goals, which will contribute to the harmonisation process.

A harmonised approach to strategic planning of the state's sustainable development is crucial in terms of ensuring the coherence of national sustainable development policies. The use of forecasting methods in the harmonisation process allows for the development of strategies that take into account both current needs and future challenges based on international standards and unified methodological tools; it provides for the creation of effective monitoring and evaluation systems to track progress towards the SDGs, and thus makes it possible to identify problems in a timely manner and adjust strategies to improve their effectiveness.

Problem is a promising area of scientific research to ensure the effective implementation of the global concept of sustainable development. The obtained results provide the basis for further research on the problem of applying forecasting methods in the context of harmonising the strategic planning of sustainable development of the state. The fast development of the latest technologies provokes ongoing research to find optimal methods for forecasting sustainable development in the context of rapidly changing technological generations.

The results of the study contribute to the further discussion on the feasibility of finding universal indicators of progress in achieving the SDGs, which would be ensured by the statistical bases of all countries, as well as on ways to improve approaches to evaluating and monitoring the effectiveness of national sustainable development strategies.

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Conflict of Interest

None.

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Застосування методів прогнозування в гармонізації стратегічного планування сталого розвитку держави

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Анотація. Успішна реалізація глобальної концепції сталого розвитку вимагає гармонізації стратегічного планування сталого розвитку держави для забезпечення ефективного моніторингу прогресу держав у досягненні Цілей сталого розвитку. Метою дослідження є актуалізація проблеми застосування методів прогнозування в процесі гармонізації стратегічного планування сталого розвитку держави та розробка методичного інструментарію для її вирішення. У ході дослідження на основі застосування таких методів, як: огляд літератури, гіпотетико-дедуктивний метод, метод порівняння, емпіричний метод та логічний аналіз, обґрунтовано доцільність, розроблено методичний інструментарій та апробовано метод потрійного експоненціального згладжування Холта-Вінтерса на основі довготривалого часового ряду з використанням «Листа прогнозу» в Microsoft Excel 2016. В рамках гармонізованого підходу до стратегічного планування сталого розвитку для оцінки прогресу країни у сфері сталого розвитку використовувалися індикатори відокремлення екологічного тиску від економічного зростання, оскільки вони є простими, вимірюваними та гнучкими. На основі методології Тапіо визначено норматив показників декаплінгу невідновлюваних ресурсів та декаплінгу впливу на довкілля як орієнтир для розробки та аналізу ефективності національної стратегії сталого розвитку, а також зроблено прогноз динаміки цих показників в цілому по ЄС до 2026 року, як лідера в озелененні економіки. Отримані результати дозволили виявити основні тенденції сталого розвитку ЄС на основі класифікації статусу декаплінгу. Отримані результати сприяють гармонізації національних стратегій для забезпечення успішної реалізації глобальної концепції сталого розвитку, можуть бути використані на такому етапі стратегічного планування, як формування дерева цілей, що дає можливість ставити як досяжні, так і релевантні цілі, а також при оцінці ефективності стратегій у досягненні Цілей сталого розвитку

Ключові слова: цілі сталого розвитку; експоненціальне згладжування; декаплінг; гармонізований підхід; національна стратегія; уніфікація