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ECONOMIC TRENDS FORECASTING IN THE DEVELOPMENT OF HOTEL BUSINESS ENTERPRISES

ABSTRACT

The article substantiates and proves the expediency of using economic-mathematical modeling for the formation of a forecast of economic trends and identification of probable ways of development of socio-economic phenomena and processes. These circumstances determine the relevance of in-depth research into the process of forecasting using mathematical methods and evaluation of the adopted decision.

The purpose of the work is the use of modern tools of analytical and simulation economic-mathematical modeling for forecasting the development trends of economic entities in conditions of uncertainty.

An analysis of methods and models for forecasting time series and determination of the most effective combinations of them for forecasting economic phenomena and processes was carried out, and the possibility of using them in practice for the analysis and planning of the activities of economic entities was investigated.

The option of solving the problem of forecasting economic development trends was carried out on the basis of statistical data, using the example of hotel business enterprises. Methods and models of time series research and forecasting were used in the work: correlation analysis, autoregression and moving average methods, artificial neural network (ANN) models, and autoregressive moving average (ARIMA) model. The results showed that both the ARIMA model and the ANN model can be effectively used for forecasting tasks. It is proven that the ANN model has a higher prediction accuracy at time intervals that are close to the original data. At the same time, the ARIMA model is more appropriate for long-term forecasting. The obtained results allow us to put forward ideas about the simultaneous use of both models, which can compensate for the shortcomings of each of them. Also, the models can be used separately for more accurate forecasting of values for the required time period. More effective is the method by which artificial neural networks can be applied to solve the problem of clustering. This will allow you to single out ranges for forecasting. And then apply ARIMA forecasting to the obtained data sets. The proposed algorithm can be used to determine trends in the development of the hotel industry, as its application reduces the risk of forecasting errors.

The results of the work consist of practical recommendations regarding the features of the application of economic and mathematical modeling methods for the construction of forecast indicators and prospects for the development of economic entities. The built model uses the properties of basic forecasting models, which allows for an increase in the degree of reliability and validity of scientific research.

Keywords: forecast, mathematical methods, management, economic trends, model, time series forecasting methods

JEL Classification: M10, O12, Z00

INTRODUCTION

At the present time, one of the most difficult problems of the management system is to predict the future and find effective solutions in conditions of uncertainty. There is a need to use modern tools of analytical and simulation economic-mathematical modeling,

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which would allow taking into account uncertainty of various kinds. Forecasting serves as a tool for minimizing uncertainty. The latter involves a system of scientific conclusions, the use of methods and techniques with varying degrees of formalization, and the consistency of individual conclusions and assessments regarding the future development of the process. The essence of forecasting is to obtain information about the future development of certain parameters limited in the time and space of the study. At the same time, certain existing and future conditions, as well as the probability of occurrence of the expected events, are the basis of the forecast (as a weekend). That is why it is necessary to create forecasts based on the principles of reliability and credibility, even for the near future, which in such transitional periods, as the experience of economic forecasting shows, is extremely difficult.

In evolutionary terms, the ability to predict the future is practically the only adaptation mechanism that allows economic entities to develop a set of preventive measures, compensating for the negative consequences of the occurrence of these events. Therefore, the solution to these issues requires the development of appropriate models, methods, and instrumental means of decision-making support, considering the available results in this field of scientific research.

LITERATURE REVIEW

To study the issue of forming a forecast of economic trends and identifying probable ways and results of the development of socio-economic phenomena, a review of the literature was conducted to analyze the available theoretical and empirical works related to the application of forecasting methods. Obtaining the appropriate accuracy of the forecast is important for the economic activity of business entities. The results of the preliminary review are presented in another study [1], where the methods and means of economic and mathematical modeling to ensure management decision-making were systematized, and the structure and methodology of building models in the conditions of presentation and processing of both clear and fuzzy data were described. Statistical methods of time series analysis are considered in [2]. The main stages of the algorithm for building trend and trend-seasonal models are given, which include: the selection of the main structural-forming components of the time series (trend, seasonal fluctuations, cyclical and residual components), methods of choosing a model for describing the series, as well as methods of checking the selected model on the adequacy and verification of the possibility of forecasting based on the selected model.

Proposed by the authors Aliyev R. et al, [3] the system model based on fuzzy rules for forecasting hotel occupancy was developed by analyzing time series data for 40 months and applying the clustering algorithm of fuzzy c-means. Scientists Zhang, Binru, Yulian Pu, Yuanyuan Wang, and Jueyou Li. [4] emphasize that accurate forecasting of demand for accommodation in hotels is extremely important for the sustainable development of industries related to tourism. Due to the constantly growing amount of tourism data, this article creates a deep learning structure to solve the problem of forecasting hotel accommodation needs.

The approach presented in work [5] changes the traditional approach to clusters and provokes reflection on new clustering criteria and solutions in the field of tourism, especially when considering future cooperation, competitiveness, and sustainable development. There are many studies [6,7,8,9] dedicated to the development of effective hybrid forecasting methods, which are based on several other methods. This approach makes it possible to reduce the deviation of the forecast values from the exact ones.

When forecasting socio-economic processes, preference is given to statistical methods, the predictive result of which is the expected future values of process characteristics [10,11]. Depending on the specific goals of the analysis, various technical and economic indicators or their combination are used, which provide a quantitative and qualitative assessment of the activities of business entities.

In works [12,13,14, 17-23] it is stated that the application of mathematical methods and models for building forecasts should be based on the use of modern information systems, application programs packages for data processing and visualization of modeling results. In this regard, descriptive modeling capabilities were used using the Statgraphics XVII Centurion software package [15].

The conducted analytical review of the works showed that most authors did not pay enough attention to the practical application of mathematical methods for forecasting, in addition, a clear methodology for its application was not formed.

AIMS AND OBJECTIVES

The study's aim is to forecast the development trends of economic entities (hotel business enterprises) in conditions of uncertainty.

In order to realize the research goal, the following tasks were set:

- to generalize data on the example of hotel business enterprises observed over a long period of time and build a mathematical and statistical model;
- on the basis of statistical regularities, determine the value of the forecasted feature, choose the optimal development trend and evaluate the decision from the standpoint of its consequences in the forecasted period.
- to perform diagnostics of the created model;
- to implement the model, and obtain forecast values.

METHODS

In the global practice of applied forecasting, various methods are used: statistical (forecast extrapolation), functional-hierarchical (forecast scenarios), methods of structural analogy, simulation modeling, methods of fuzzy logic, and expert evaluations. Each method has its own characteristics, advantages, disadvantages, its limits of use.

As a result of the research, it was decided to use the methods of system analysis and logical generalizations, statistical and comparative analysis, theoretical generalization, grouping, and comparison; for the clarity of the display of research results, a tabular method was used, and the method of forecasting time series was applied.

The main methods of time series research were used:

- correlation analysis, which makes it possible to identify significant dependencies and their lags - delays within a certain process;
- spectral analysis makes it possible to determine the periodic and quasi-periodic components of the time series;
- smoothing and filtering methods are used to transform dynamic series to remove high-frequency and seasonal fluctuations from them;
- methods of autoregression and moving averages;
- forecasting methods - methods of neural networks (ANN), ARIMA model, which makes it possible to estimate its most probable values in the future based on the created general model of the time series.

RESULTS

The validity of the choice of the forecasting method is determined by the form of the forecast, the forecasting period, the availability, relevance, and suitability of the data, the accuracy of the forecast, and the features of the forecasting object. None of the individual forecasting methods can be universal. It is necessary to establish the degree of their accuracy and expediency, which is why recommendations for calculating accuracy, evaluating the effectiveness of methods, and choosing a forecasting method that would meet the task at the appropriate level of costs and accuracy have been developed.

To analyze the state and determine trends in the development of the hotel business, the method of forecasting time series was used.

The main stages of dynamic series research are:

- graphical presentation and preliminary analysis of the behavior of a series of dynamics;
- identifying and identifying the main properties of the series;
- selection and removal of regular components of the series - trend, seasonal or cyclical;
- research of random components of a dynamic series;
- construction of a general time series model;
- research of the developed model and forecasting of the investigated process.

If the purpose of time series research is forecasting, then the number of levels of the series should be as large as possible, at least three times the period of forecast values.

The input data of the time series was the dynamics of the number of hotels and similar means of accommodation for 1995 - 2019. The length of the series is 24 years, it has 25 levels, which allows us to build its general model and make predictions based on the results of the analysis of the behavior of the dynamic series.

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For the preliminary analysis of the time series, the following characteristics of the dynamics of the time series were determined:

Absolute growth $\Delta x_i = x_i - x_{i-k}$. (1)

Growth coefficient $К_{i(Growth)} = \frac{x_i}{x_{i-k}}$ (2)

Increase coefficient $К_{i(Increase)} = \frac{x_i - x_{i-k}}{x_{i-k}}$ (3)

Growth rate $T_{i(Growth)} = \frac{x_i}{x_{i-k}} \cdot 100\% = К_{i(Growth)} \cdot 100\%$ (4)

Increase rate $Т_{i(Increase)} = \frac{x_i - x_{i-k}}{x_{i-k}} \cdot 100\% = К_{i(Increase)} \cdot 100\%$ (5)

where xi – the i-th level of the time series (i = 1, 2, 3, ..., n); k – the index of the initial level, to obtain basic indicators k=i-1

The input data of the investigated time series and the values of the described characteristics of its dynamics are shown in Table 1.

Table 1. Time series data and its main characteristics.

The year	Number of hotels	Absolute growth	Growth coefficient	Increase coefficient	Growth rate, %	Increase rate, %
1995	1396	–	–	–	–	–
1996	1368	-28	0.979943	-0.02006	97.9943	-2.0057
1997	1375	7	1.005117	0.005117	100.5117	0.5117
1998	1328	-47	0.965818	-0.03418	96.5819	-3.4182
1999	1326	-2	0.998494	-0.00151	99.8494	-0.1506
2000	1308	-18	0.986425	-0.01357	98.6425	-1.3575
2001	1258	-50	0.961774	-0.03823	96.1774	-3.8226
2002	1254	-4	0.99682	-0.00318	99.6820	-0.3180
2003	1218	-36	0.971292	-0.02871	97.1292	-2.8708
2004	1192	-26	0.978654	-0.02135	97.8654	-2.1346
2005	1232	40	1.033557	0.033557	103.3557	3.3557
2006	1269	37	1.030032	0.030032	103.0032	3.0032
2007	1420	151	1.118991	0.118991	111.8991	11.8991
2008	1595	175	1.123239	0.123239	112.3239	12.3239
2009	1684	89	1.055799	0.055799	105.5799	5.5799
2010	1731	47	1.02791	0.02791	102.7910	2.7910
2011	2499	768	1.443674	0.443674	144.3674	44.3674
2012	2375	-124	0.95038	-0.04962	95.0380	-4.9620
2013	2788	413	1.173895	0.173895	117.3895	17.3895
2014	2644	-144	0.94835	-0.05165	94.8350	-5.1650
2015	2478	-166	0.937216	-0.06278	93.7216	-6.2784
2016	2534	56	1.022599	0.022599	102.2599	2.2599
2017	2474	-60	0.976322	-0.02368	97.6322	-2.3678
2018	2777	303	1.122474	0.122474	112.2474	12.2474
2019	3105	328	1.118113	0.118113	111.8113	11.8113
The mean value		71.208			103.8620	3.8620

The following mean values are also important for the study of a series of dynamics

The mean value of the level $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$, (6)

where n – the number of levels.

Mean absolute growth over the entire observation period

$$\Delta\bar{x} = \frac{x_n - x_1}{n-1}$$

characterizes the average rate of change of the time series.

The mean growth rate is calculated using the formula of the geometric mean value of growth rates for separate time intervals:

$$\bar{T}_{i(Increase)} = \sqrt[n-1]{T_{1(Increase)} \cdot T_{2(Increase)} \cdot \ldots \cdot T_{n(Increase)}} \quad (7)$$

Table 2 shows the values of the described average values.

Table 2. Average values of the dynamic series.

Average values of the dynamic series	$\bar{x}$	1825.12
Mean absolute growth over the entire observation period	$\Delta\bar{x}$	71.208
The mean growth rate	$\bar{T}_{i(зрост)}$	3.5050

A graphic representation of the dynamics of the time series and a straight trend line are presented in Figure 1, and Figure 2 shows the dynamics of the series and the exponential and polynomial trend lines.

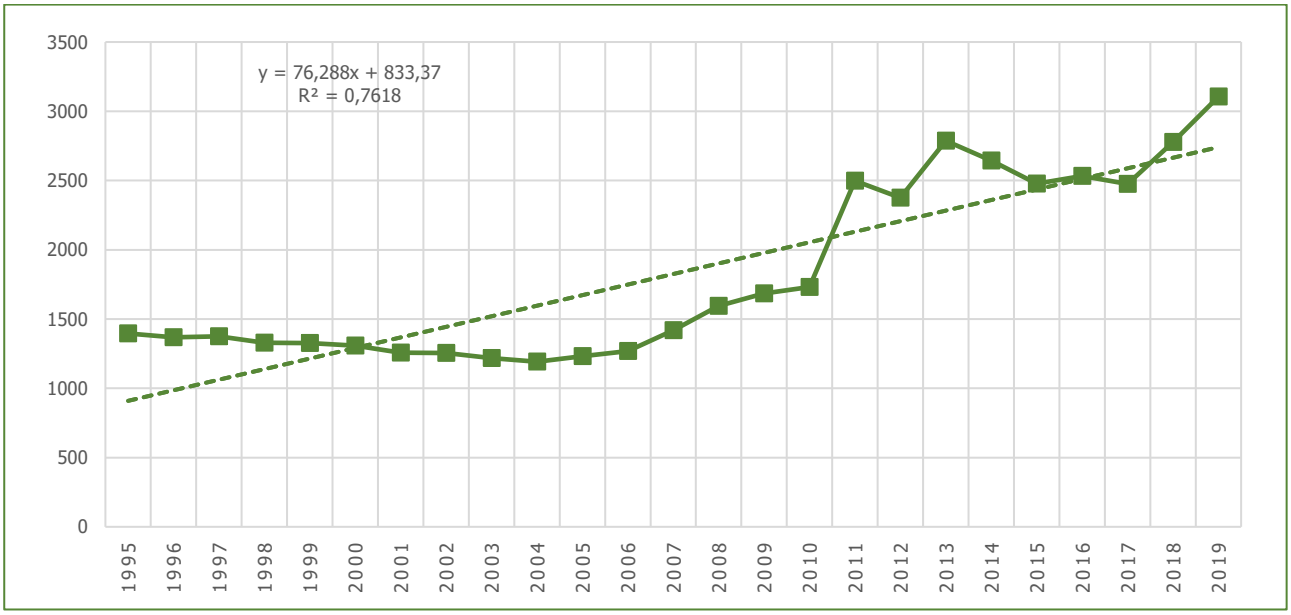

Figure 1. Dynamic series of the number of hotel-type enterprises and a straight trend line.

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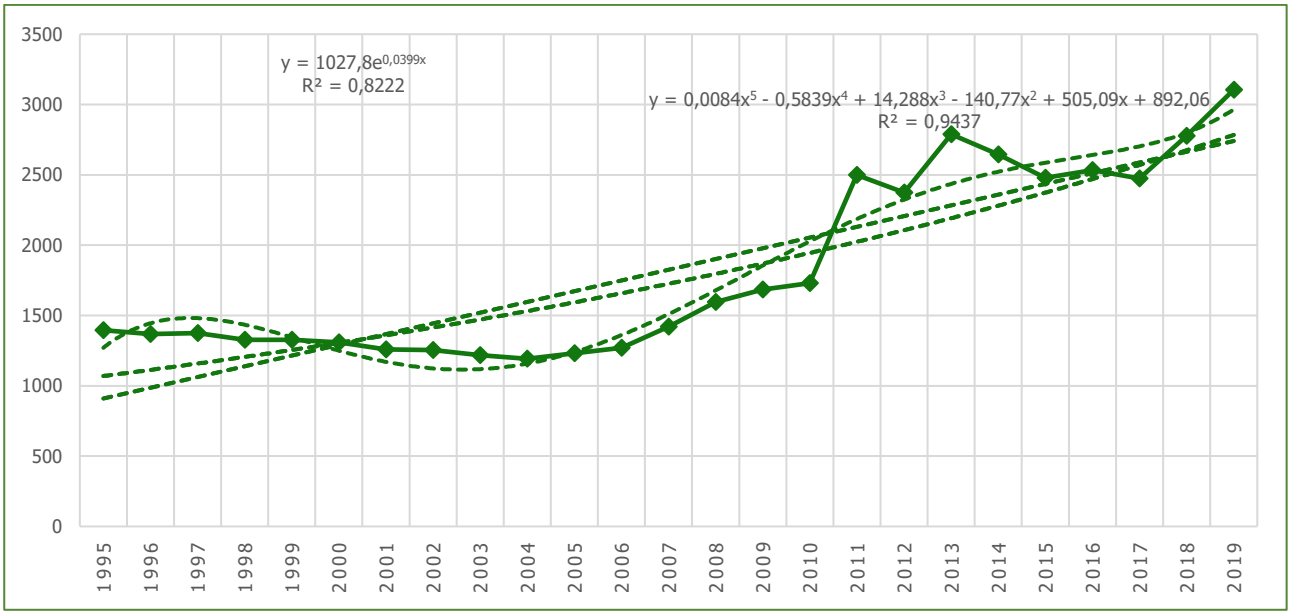

Figure 2. Dynamic series of the number of hotel-type enterprises and exponential and polynomial trend lines.

The reliability of the performed trend analysis is determined by the approximation coefficient, which in all cases is greater than 0.5, which provides the possibility of forecasting (Table 3). The highest approximation coefficient in a polynomial trend (in a polynomial of the fifth degree).

Table 3. Results of trend analysis and forecast indicators.

Approximation equation	Approximation coefficient	Predictive indicators			
		2022	2023	2024	2025
Linear approximation $y = 76{,}28x + 833{,}3$	0. 761	2969	3045	3121	3197
Exponential approximation $y = 1027e^{0{,}039x}$	0.762	3061	3182	3308	3440
Polynomial approximation $y = 0{,}008x^5 - 0{,}583x^4 + 14{,}28x^3 - 140{,}7x^2 + 505x + 892$	0.943	3050	3140	3252	3374

The next step of the research is to determine the statistical characteristics of the time series. The main levels of the time series are not independent and unequally distributed, the law of probability differences between the values of the levels of the time series from the values of standard statistical samples is that the distribution of these values may depend on time.

Among the statistical estimates were calculated:

Dispersion $\sigma_x^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}$ (8)

Root Mean Square Deviation (RMS) $\sigma_x = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}$ (9)

Mean absolute linear deviation (MAD) $MAD = \frac{\sum_{i=1}^{n} |x_i - \bar{x}|}{n}$ (10)

Coefficients of variation:

by scope $VaR = \frac{R}{\bar{x}} = \frac{x_{max} - x_{min}}{\bar{x}}$ (11)

by the average absolute linear deviation $VarMAD = \frac{MAD}{\bar{x}}$; (12)

by Root Mean Square Deviation (RMS) $VarСКВ = \frac{\sigma_x}{\bar{x}}$ (13)

The value of the described statistical characteristics of the studied time series is summarized in Table 4.

Table 4. Statistical characteristics of the time series.

Dispersion	σ_x^2	413820.2
Root Mean Square Deviation (RMS)	σ_x	643.2886
Mean absolute linear deviation (MAD)	MAD	579.8336
Coefficients of variation:		
by scope	VarR	0.778579
by the average absolute linear deviation	VarMAD	0.317696
by Root Mean Square Deviation (RMS)	VarCar	0.3525

To detect anomalous levels of the time series, we will apply the Irwin method. This method is based on the comparison of adjacent values of the series and the calculation of the characteristic \lambda_t, which is calculated according to the formula:

$$\lambda_t = \frac{|x_t - x_{t-1}|}{\sigma_x},\ t = 2,3,\dots,n$$

The obtained sliding values are compared with the critical value λα for the chosen significance level α and if they do not exceed the critical value, then the corresponding levels of xt are considered normal. In the study, for the level of significance α=0.05 with n=24, the critical value λα=1.25. Table 5 shows the sliding values of the characteristic λ_t, from which it can be seen that all values are less than the critical value λα=1.25, so all levels of the time series are normal, that is, the dynamic series does not contain anomalies.

Table 5. Calculation results.

Sliding values λ_t	**Data**	**Sliding values λ_t**	**Data**
λ_1	0.043526	λ_{13}	0.27204
λ_2	0.010882	λ_{14}	0.138352
λ_3	0.073062	λ_{15}	0.073062
λ_4	0.003109	λ_{16}	1.193865
λ_5	0.027981	λ_{17}	0.19276
λ_6	0.077726	λ_{18}	0.642014
λ_7	0.006218	λ_{19}	0.22385
λ_8	0.055962	λ_{20}	0.258049
λ_9	0.040417	λ_{21}	0.087053
λ_{10}	0.06218	λ_{22}	0.093271
λ_{11}	0.057517	λ_{23}	0.471017
λ_{12}	0.234731	λ_{24}	0.50988

Autoregressive models describe a process in which the current value depends on several previous values of this series. The most common among them is the moving average autoregressive model. The basis of this model is a combination of

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the autoregression (AR) function and the moving average (MA). In fact, the moving average acts as a frequency filter through which the process values pass, and the filtered values are subject to autoregression. Such a general model is called ARMA. If, instead of the input data, the values of the levels of the series are not used, but their differences, then the model is called ARIMA. The ARIMA model was used for forecasting - an autoregressive integrated moving average model, namely the Box-Jenkins approach, which is based on an iterative approach. The modeling methodology consists of the following stages:

- Problem formulation, and data analysis;
- Identification of the time series model;
- Evaluation of model parameters;
- Diagnostics of the created model;
- Implementation of the model, the output of forecast values.

This model was implemented in the STATISTICA program.

The most effective method of computational intelligence - artificial neural networks - was used to compare the obtained predictive values. An artificial neural network (ANN) is a mathematical model built on the principle of organization and functioning of biological neural networks — nerve cell networks of a living organism. From the point of view of mathematics, it is a system of connected and interacting computing units called neurons [7]. The success of artificial neural networks in the considered problem is explained by the non-linear nature of the predicted processes and the ability of the neural network to self-learn and generalize, as well as the high level of uncertainty (structural and parametric). Recurrent neural networks (RNNs) were used to create the model and forecast. Recurrent neural networks are a class of artificial neural networks in which connections between nodes form an oriented loop, allowing the network to exhibit dynamic behavior over time. Unlike feedforward neural networks, ANNs can use their internal memory to process arbitrary sequences of inputs. As the architecture of the neural network, we choose the Ellman network, which has recurrent connections of hidden neurons with the context layer. These context elements store the outputs of hidden neurons for one step in time, after which they are transmitted to the output layer. In this way, neurons remember their previous actions. Hidden neurons also transmit information to output neurons that shape the network's response to an external perturbation. Because the nature of feedback is exclusively associated with hidden neurons, they can propagate repeated loops of information across the network over a large number of time steps and provide access to an abstract representation of time. A schematic representation of the Elman network is presented in Figure 3

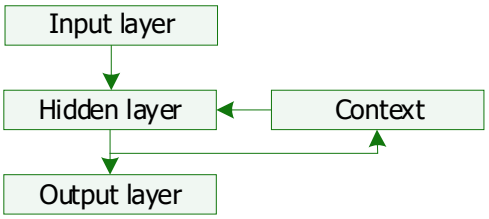

Figure 3. Elman network.

To train the network, the backpropagation algorithm was used, which involves two passes through all layers of the network: forward and reverse.

The neural network is trained according to the following algorithm:

- randomly distribute vectors between training and test samples;
- go through an era of learning;
- record the weighting factors;
- pass through the network all the vectors of the training sample. Calculate the learning error;
- pass through the network all vectors of the test sample. Calculate the generalization error.

The next stage is forecasting. To implement neural network concepts, a program was developed in the object-oriented programming language C#.

The results of forecasting using the ARIMA model and recurrent neural networks (RNNs) are presented in Table 6.

Table 6. Forecast values of the number of hotel-type enterprises.

Forecast level number	The year	ARIMA	PHM
28	2022	3103	3110
29	2023	3125	3120
30	2024	3260	3300
31	2025	3410	3364

The number of the forecast level. It is worth noting that the neural network model has a higher forecast accuracy at time intervals closest to the original data. At the same time, the ARIMA model better determines the direction and value of the forecast in the "far reaches" of the time series and thus is more appropriate for long-term forecasting. The obtained results allow us to put forward ideas about the simultaneous use of both models, which can compensate for the shortcomings of each of them. Also, the models can be used separately for more accurate forecasting of values for the required time period. A more effective technique is that one of the methods, namely, ANN, can be applied to solve the problem of clustering. This will allow better separation of ranges for forecasting. And after that, use ARIMA forecasting for the obtained data sets. The proposed algorithm can be used to determine trends in the development of the hotel industry, as its application reduces the risk of forecasting errors. The combination of several methods of forecasting time series allows the disadvantages of one model to be compensated by the advantages of another.

It is obvious that business entities change over time. In view of this, there is a need to constantly monitor them and, accordingly, adjust the primary information about their condition. At the same time, it should be taken into account that this information arrives for model calculations with a delay, which is a consequence of a long time of observing economic processes and processing empirical data.

In practice, the accuracy of forecast values depends on a number of external factors and unforeseen circumstances. Often these factors cannot be predicted, so they are not included in the forecasting model. But it is necessary to know the importance of these additional factors. The external environment of the organization is not only a source of threats and opportunities for any enterprise, but also a source of new knowledge about the needs of its constituents.

With the help of PEST analysis, political (P - political), economic (E - economic), social (S - social), and technological (T - technological) factors of development are evaluated. Types of PEST-analysis are quite common: SLEPT-analysis (a legal factor is added), PESTLE-analysis (political, economic, social, technological, legal, and environmental factors are added), STEEPLE-analysis (social, demographic, technological, economic factors are added, environment, political, legal, ethical), DESTEP-analysis (Table 7).

Table 7. Comparison and structure of types of analysis of the external environment.

№	PEST-analysis	SLEPT-analysis	PESTLE-analysis	DESTEP- analysis	STEEPLE-analysis
1	Political	Political	Political	Demographic	Socio-demographic
2	Economic	Economic	Economic	Economic	Technological
3	Society	Society	Society	Sociocultural	Economic
4	Technological	Technological	Technological	Technological	Natural
5	–	Law	Law	Ecological	Political
6	–	–	Ecological	Political/Legal	Law
7	–	–	–		Cultural

Enterprises must effectively respond and adapt to changes in the external environment, meet their needs, and ensure the survival of the achievement of the set goals.

DISCUSSION

Since in the conditions of market relations, most forecasts are carried out in conditions of uncertainty, there is an objective need to apply mathematical methods that would provide an opportunity to obtain reliable results for conditions of certainty and uncertainty of external factors of the economic environment. Based on the results of the research, a model was built

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that uses the properties of basic forecasting models, which allows for an increase in the degree of reliability and validity of scientific research.

The obtained results allow us to put forward ideas about the simultaneous use of both models, which can compensate for the shortcomings of each of them. Also, the models can be used separately for more accurate forecasting of values for the required time period. More effective is the method by which artificial neural networks can be applied to solve the problem of clustering. This will allow you to single out ranges for forecasting. And then apply ARIMA forecasting to the obtained data sets. The proposed algorithm can be used to determine trends in the development of the hotel industry, as its application reduces the risk of forecasting errors.

CONCLUSIONS

Thus, the work presents a model example of the application of mathematical methods for forecasting and identifying probable paths and results of the nearest or more distant development of socio-economic phenomena based on real processes. The practical significance of the work lies in the possibility of the owners, managers and specialists of enterprises using methodological recommendations on forecasting development trends using time series research: correlation analysis, spectral analysis, smoothing and filtering methods, autoregression and moving average methods, and forecasting methods: artificial neural network model (ANN), ARIMA model.

At the same time, we note that such an approach to forecasting as the development of many variant forecasts is now widely used. At the same time, the developers of the forecast build not one, but several (most often three) scenarios of the possible development of the situation, which are conventionally called "pessimistic", "optimistic" and "most likely", which is between the first two. Therefore, it is advisable to use the Bayesian network in further research when analyzing possible scenarios. Bayesian probabilities can be used in the scenario approach as a tool to determine the most likely scenario for a given hypothesis.

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ПРОГНОЗУВАННЯ ЕКОНОМІЧНИХ ТЕНДЕНЦІЙ РОЗВИТКУ ПІДПРИЄМСТВ ГОТЕЛЬНОГО БІЗНЕСУ

У статті обґрунтовано та доведено доцільність застосування економіко-математичного моделювання для формування прогнозу економічних тенденцій та виявлення ймовірних шляхів розвитку соціально-економічних явищ і процесів. Ці обставини зумовлюють актуальність поглиблених досліджень процесу прогнозування з використанням математичних методів та оцінювання ухваленого рішення.

Метою роботи є використання сучасного інструментарію аналітичного та імітаційного економіко-математичного моделювання для прогнозування тенденцій розвитку суб'єктів господарювання в умовах невизначеності.

Проведено аналіз методів і моделей прогнозування часових рядів та визначення їх найефективніших комбінацій для прогнозування економічних явищ та процесів, досліджено можливість їх використання на практиці для аналізу й планування діяльності суб'єктів господарювання.

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Варіант виконання завдання прогнозування економічних тенденцій розвитку проведено на основі статистичних даних на прикладі підприємств готельного бізнесу. У роботі використані методи й моделі дослідження та прогнозування часових рядів: кореляційний аналіз, методи авторегресії та ковзних середніх, моделі штучних нейронних мереж (ANN) та авторегресійна модель ковзного середнього (ARIMA). Результати показали, що й модель ARIMA, і модель ANN можуть ефективно використовуватися для завдань прогнозування. Доведено, що модель ANN має більш високу точність прогнозування на проміжках часу, що є близькими до вихідних даних. У той же час модель ARIMA є доречнішою для довгострокового прогнозування. Отримані результати дозволяють висунути ідеї про одночасне використання обох моделей, що може компенсувати недоліки кожної з них. Також моделі можуть бути використані окремо для більш точного прогнозування значень на необхідний часовий проміжок. Більш ефективною є методика, за якою штучні нейронні мережі можна застосувати для вирішення завдання кластеризації. Це дозволить виокремити діапазони для прогнозування, а потім до отриманих наборів даних використати ARIMA-прогнозування. Запропонований алгоритм може бути застосований для визначення тенденцій розвитку готельного господарства, оскільки його застосування знижує ризик виникнення помилок при прогнозуванні.

Результати роботи полягають у практичних рекомендаціях щодо особливостей застосування методів економіко-математичного моделювання для побудови прогнозних показників та перспектив розвитку суб'єктів господарювання. Побудована модель використовує властивості базових моделей прогнозування, що дозволяє підвищити ступінь достовірності та обґрунтованості наукових досліджень.

Ключові слова: прогноз, математичні методи, управління, економічні тенденції, модель, методи прогнозування часових рядів

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