Artificial Neural Networks Enhanced Demand Forecasting in Tourism Industry

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Abstract

Tourism is a dynamic business industry that plays an important role in economic growth, infrastructure development and cultural interaction. Tourism makes a significant contribution on both a global and national scale, generating income, creating jobs, and thus stimulating economic growth. However, the tourism industry can be exposed to various risks, ranging from natural disasters to pandemics, political events to economic uncertainties. Therefore, accurate forecasting of tourism demand is of great importance for both the sustainability of the industry and national economies.

Accordingly, this study aims to accurately forecast the number of tourist arrivals to Türkiye and Kyrgyzstan. In the study, the data of tourists entering Türkiye and Kyrgyzstan between the years 2003-2023 are addressed. The number of tourist arrivals to both countries is obtained from the official websites of the statistical agencies of the respective countries and subjected to a series of analyses. The tourist data are first analyzed with ARIMA, Holt exponential smoothing and Grey forecasting methods, and then these methods are enhanced with Artificial Neural Networks to improve the forecasting results.

The results of the analysis performed with various methods were compared and the most accurate forecasting methods were determined. Thus, the prediction of the number of tourists arriving in Türkiye and Kyrgyzstan in the coming years was made using the most accurate methods determined in the previous step. The findings of the study are expected to help tourism industry managers and policy makers in planning of labor force, financial investments, and other resources.

1 Introduction

The tourism industry plays an important role in infrastructure development and cultural interaction for nations and makes a significant contribution to economic and social growth by generating income and creating jobs. While the contribution of the tourism industry to global GDP was 10% before Covid-19 break, it decreased to 7,7% in 2022 (WTTC, 2024). Nowadays the tourism industry is under recovery and expected to reach 11.6 % of global GDP by 2033 (WTTC, 2024).

The tourism industry can be exposed to various risks, ranging from natural disasters to pandemics, political events to economic uncertainties. Therefore, accurate forecasting of tourism demand is of great importance for both the sustainability of the industry and national economies. Precise predictions assist tourism managers and policy makers in their decisions about forecasting, planning, resource management, marketing, and pricing (Song and Li, 2008; Yao and Cao, 2020).

Despite the importance of the tourism industry, there are limited studies on tourism forecasts for Türkiye. While Önder and Hasgül (2009) and Soysal (2010) implement basic statistical techniques for tourism forecasts, the more recent studies use Artificial Neural Networks (ANNs) to improve the accuracy such as that of Kayral et.al. (2023), Karahan (2015) and Çuhadar (2013).

The literature on Kyrgyzstan tourism is limited to the studies focusing on the contributions of the tourism to the economic growth (Kozhokulov et al., 2021; Kozhokulov et al., 2019); and potentials, trends, and challenges (Yeşiltaş 2019; Jenish, 2018; Akçali, 2014).

In order to fill the gap in the existing literature this study aims to accurately forecast the number of tourist arrivals to Türkiye and Kyrgyzstan.

2 Research Data and Methodology

In this study, the number of tourists entering Türkiye and Kyrgyzstan between the years 2003-2023 are addressed. The data of tourist arrivals to Türkiye was obtained from Turkish Statistical Institute (TUIK, 2024) and tourist arrivals to Kyrgyzstan was obtained from National Statistical Committee of the Kyrgyz Republic (2024). Türkiye and Kyrgyzstan tourist arrival numbers by years are given in the Figure 1 and Figure 2 respectively.

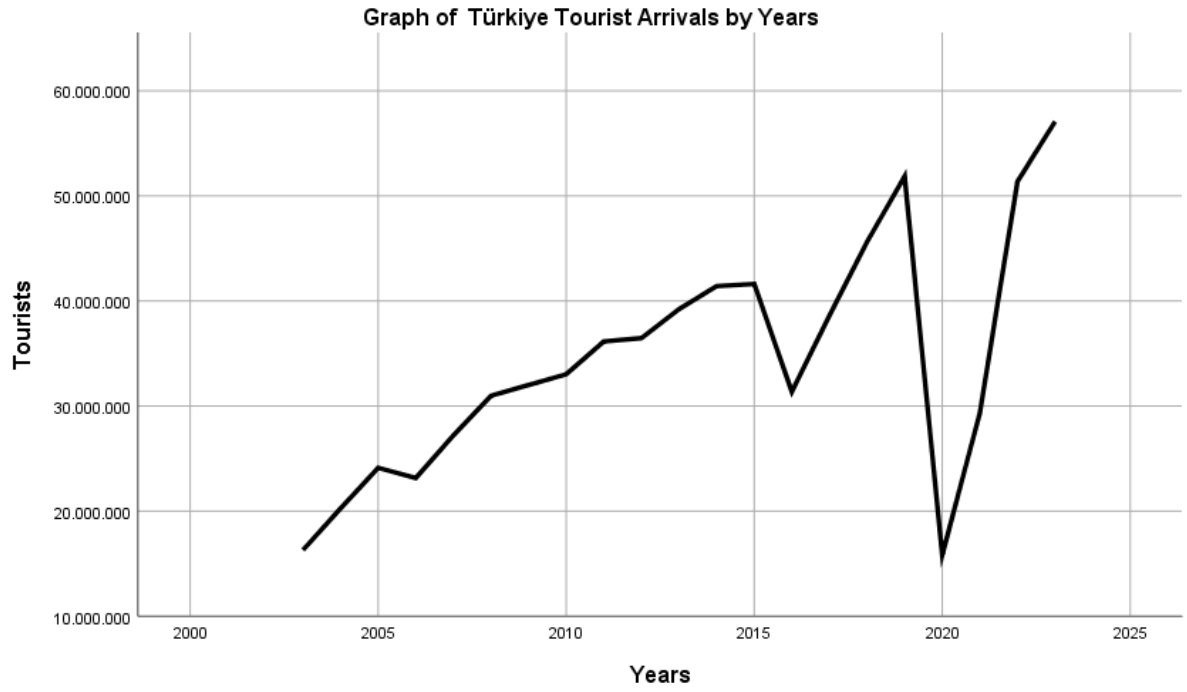

Figure 1. *Türkiye Tourist Arrivals*

Annual Türkiye tourist arrival numbers have been increased from 16,302,053 in 2003 to 57,077,440 in 2023. It can be stated according to the graph in Fig.1 that, tourist numbers have an increasing trend over the last 20 years except for the sharp decreases in the years 2016 and 2020. While the decline in 2016 was due to the Russia warplane crash crisis, the sharpest decline in 2020 was due to the Covid-19 pandemic which has affected tourism industry all over the world.

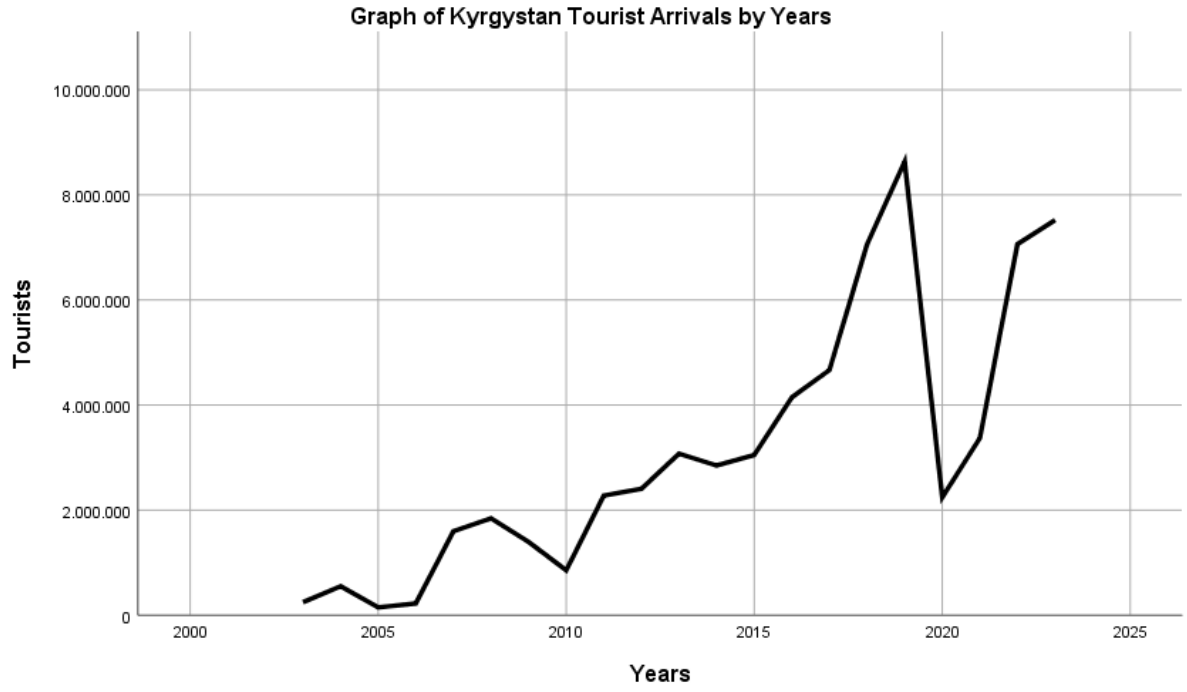

Figure 2. *Kyrgyzstan Tourist Arrivals*

A similar effect caused by Covid-19 can be seen in Kyrgyzstan tourist arrival numbers as well. Although not as much as the Covid-19 effect, it can be observed that the number of tourists coming to Kyrgyzstan fluctuated up and down between 2003 and 2010 due to the political instability. By excluding 2020, we can say that the tourist numbers have an increasing trend from 2,277,000 in 2011 to 7,520,000 in 2023. For this reason, the period for forecasting analyses is limited to years 2011-2023 for Kyrgyzstan.

With the aim of determining the best forecasting method for tourism data of both countries and making accurate tourist estimations for the next years, each dataset is analyzed via a set of forecasting methods. First, the three common statistical methods which include ARIMA, Holt exponential smoothing and Grey forecasting are implemented to the datasets. Then the accuracy of forecasts is improved by Artificial Neural Network (ANN) - Radial Bases Function (RBF). Mean Absolute Percentage Error (MAPE) rates are measured and used for comparison of alternative methods and the best methods are chosen for Türkiye and Kyrgyzstan tourist arrivals. The structure of Grey-ANN model for Türkiye and Holt-ANN model for Kyrgyzstan are given in Fig.3 and Fig.4 respectively.

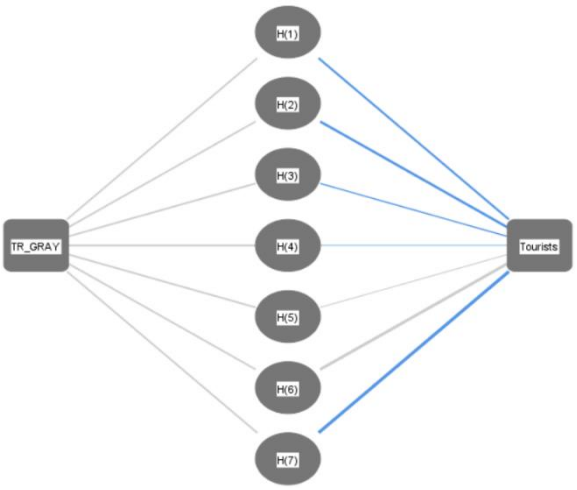

Figure 3. *Türkiye Grey-ANN Model Structure*

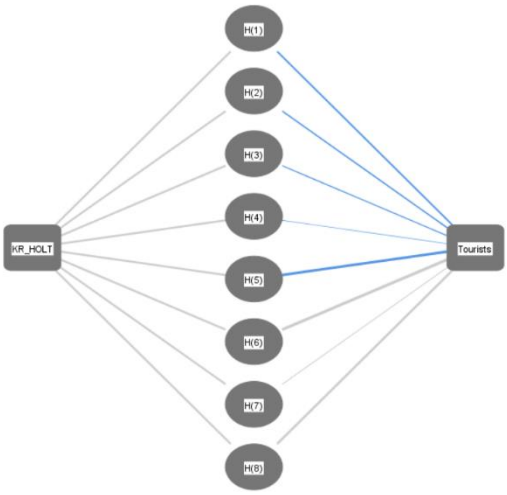

Figure 4. *Kyrgyzstan Holt-ANN Model Structure*

Fig.3 and Fig.4 indicate the structures of ANN (RBF) models for each country. Türkiye Grey-ANN model takes Grey model forecasts as input, and improves these predictions through 7 hidden layers. On the other hand, Kyrgyzstan Holt-ANN Model uses 8 hidden layers to improve the accuracy of the forecasts.

3 Results of Analysis

The analyses are conducted by using SPSS statistics software program, ANN, and forecasting modules. For ANN models, Radial Bases Function with 70 % – 30 % train-test ratio is implemented. The number of units in hidden layers are automatically computed and not restricted. The comparative MAPE values of each model is given in Table 1 for Türkiye and Table 2 for Kyrgyzstan.

Forecasting Model	% MAPE	Forecasting Model	% MAPE
ARIMA	21.77	ARIMA-ANN	16.76
HOLT	22.56	HOLT-ANN	20.86
GREY	21.09	GREY-ANN	08.15

Table 1. *Forecasting Model Accuracies for Türkiye Tourist Arrivals*

Forecasting Model	% MAPE	Forecasting Model	% MAPE
ARIMA	28.98	ARIMA-ANN	10.53
HOLT	33.67	HOLT-ANN	06.03
GREY	30.36	GREY-ANN	08.42

Table 2. *Forecasting Model Accuracies for Kyrgyzstan Tourist Arrivals*

The results of the analyses indicates that, the error rates of forecasts for Türkiye tourist arrivals are changing between 21.09% and 22.56% by using basic statistical methods of ARIMA, Holt and Grey. When the same results are enhanced with ANN-RBF models, we can observe that error rates are decreased. Since ANN-RBF models create new network connections in each iteration, the analyses are repeated 3 times and the resulting mean MAPE values are calculated. According to Table 1, the most accurate model is ANN enhanced Grey model with 8.15% MAPE rate.

The improvements with ANNs are more dramatic for Kyrgyzstan tourist arrival forecasts. Table 2 shows that ANN models decreased MAPE values from 28.98% to 10.53% for ARIMA, 33.67% to 6.03% for Holt and 30.36% to 8.42% for Grey forecasting. According to these results, the most accurate model with minimum MAPE rate is ANN enhanced Holt model.

The forecasts including the next two year's projections are calculated by using the most accurate methods for both countries and presented in the Table 3 and Table 4 respectively.

Years	Tourist Arrivals	Grey-ANN Forecasts
2003	16302053	19168286
2004	20262640	22721331
2005	24124501	22821786
2006	23148669	23998058
2007	27214988	27743034
2008	30979979	30008842
2009	32006149	31280272
2010	33027943	34281125
2011	36151328	35464156
2012	36463921	36850737
2013	39226226	40729460
2014	41415070	41887791
2015	41617530	39760949
2016	31365330	36457291
2017	38620346	40930843
2018	45628673	47635697
2019	51860042	40393327
2020	15826266	20629737
2021	29357463	29572443
2022	51369026	46632997
2023	57077440	58664458
2024		**61763400**
2025		**62105924**

Table 3. *Türkiye Tourist Arrival Forecasts with Grey-ANN Method*

According to Table 1, the expected tourist arrival volumes to Türkiye is 61,763,400 for year 2024, and 62,105,924 for year 2025.

Years	Tourist Arrivals	Holt-ANN Forecasts
2011	2277000	2636627
2012	2406000	2681735
2013	3076000	2720313
2014	2849000	2796277
2015	3050600	3214857
2016	4147400	4009175
2017	4666500	4727054
2018	7057100	7066171
2019	8635700	8071029
2020	2245000	2324997
2021	3371900	3310942
2022	7062800	7050995
2023	7520000	7655766
2024		**7670343**
2025		**7670743**

Table 4. *Kyrgystan Tourist Arrival Forecasts with Holt-ANN Method*

As it can be seen on Table 4, the forecasted tourist arrival volumes to Kyrgyzstan is 7,670,343 for year 2024 and 7,670,743 for year 2025.

4 Conclusion

Tourism industry is one of the dynamic and fast-growing industries in the world. Although Covid-19 pandemic has caused dramatic drops in the number of tourists worldwide, it is expected to reach 11.6 % of global GDP by 2033 (WTTC, 2024). Accurate forecasts help managers and policy makers in their decisions for planning and allocating the resources, therefore it is critical for the future of the tourism industry. Accordingly, the purpose of this study is to accurately forecast the number of tourist arrivals to Türkiye and Kyrgyzstan. For this reason, the number of tourists entering Türkiye between the years 2003 – 2023 and that entering Kyrgyzstan between the years

2011 – 2023 are analyzed first by ARIMA, Holt exponential smoothing and Grey forecasting methods, and then these methods are enhanced with ANNs.

The results of the study reveal that, the ANN models have improved the accuracy of forecasts with traditional statistical methods for the tourist data in both countries. While the best model for predicting the tourist arrivals is Grey-ANN for Türkiye, it is determined as Holt-ANN for Kyrgyzstan. By using these best performing models, the tourist arrival forecasts for Türkiye are 61,763,400 for 2024, and 62,105,924 for 2025; while the forecasts for Kyrgyzstan are 7,670,343 and 7,670,743 respectively.

The findings of the study are expected to help managers and policy makers in planning of labor force, financial investments, and other resources in tourism industry in both countries.

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