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A Machine Learning-Based 10 Years Ahead Prediction of Departing Foreign Visitors by Reasons: A Case on Türkiye

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Abstract: The most important underlying reasons for marketing failures are incomplete understanding of customer wants and needs and the inability to accurately predict their future behaviors. This study develops a machine learning model to estimate the number of departing foreign visitors from Türkiye by reasons for the next 10 years to gain a deeper understanding of their future behaviors. The data between 2003 and 2021 are extensively analyzed, and a multi-dimensional model having a higher-order fractional-order polynomial structure is constructed. The resulting model can predict the 10 reasons of departing foreign visitors for the next 10 years and can update the predictions every year as new data becomes available as it has stable polynomial parameters. In addition, a batch-type genetic algorithm is modified to learn the unknown model parameters by considering the disruptions, such as the coup attempt in 2016 and the COVID-19 pandemic outbreak in 2019, termed as uncertainties. Thus, the model can estimate the overall behavior of the departing foreign visitors in the presence of uncertainties, which is the dominant character of the foreign visitors by their reasons. Furthermore, the developed model is utterly data-driven, meaning it can be trained with the data collected from different cities, regions, and countries. It is predicted that the departing foreign visitors for all reasons will increase at various rates between 2022 and 2031, while the increase in transit visitors is predicted to be higher than the others. The results are discussed, and suggestions are given considering the marketing science. This study can be helpful for global and local firms in tourism, governmental agencies, and civil society organizations.

Keywords: marketing; tourism; Türkiye; machine learning; fractional-order polynomial prediction

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1. Introduction

Tourism, a strong driver of socio-economic progress, plays a pivotal role in international trade, is an important source of income for many developing countries, and is encouraged to become an indispensable tool for development and sustainability [1]. The travel and tourism sectors accounted for a quarter of new jobs worldwide, constituting 10.3% of all jobs, and 10.3% of global GDP (USD 9.6 trillion) before the COVID-19 pandemic, while the international visitors' spending reached USD 1.8 trillion in 2019 [2]. The World Tourism Organization describes 2020 as the worst year in tourism history and claims it may take two and a half to four years for international tourism to return to 2019 levels [3]. World Travel and Tourism Council declared a loss of approximately USD 4.9 trillion (−50.4% decrease) occurred in 2020, while the contribution of travel and tourism to GDP increased by USD 1 trillion (+21.7% increase), and 1 out of 11 jobs is in this field in 2021 based on global data [2].

Türkiye, one of the emerging and Euro-Asian countries, is among the top-performing destinations in Europe in 2021 [4]. According to Hofstede's national cultural model [5], Türkiye is collectivist (score of 37 for individualism) and feminine (score of masculinity

is 45). In the same model, high power distance (66) and uncertainty avoidance (85) are calculated, while a moderate level of long-term orientation (46) and indulgence (49) are also determined for Türkiye. The tourism sector is highly valuable to the Turkish economy. In 2021, the share of the travel and tourism sector in Türkiye's GDP is 7.3%, while this sector constitutes 8.4% of total jobs [6]. Econometric analyses indicate that a 10% increase in the number of tourists increases the GDP by 0.7% [7]. According to data from the World Tourism Organization, Türkiye ranked fourteenth in the world in terms of tourism income in 2019, while it ranked sixth in the world and fourth in Europe according to the number of incoming tourists [8]. The Turkish Statistical Institute announced that Türkiye's annual tourism income decreased by 65.1% in 2020 compared to the previous year and became USD 12,059,320,000, while the country's tourism income increased by 103% in 2021 compared to the previous year and reached USD 24,482,332,000 [9,10]. In 2020, 75.4% of Türkiye's tourism income was provided by foreign visitors [8]. As of 2021, the number of visitors departing from Türkiye increased by 85.5% compared to the previous year (29,357,463 people), while 81.5% of them were foreign visitors (23,940,021 people) [9]. These statistics clearly indicate the significance of foreign visitors in Turkish tourism.

In consumer behavior discipline, reasons are important variables due to their role in the decision-making process [11], the possibility of their ability to drive consumers to engage in behavior [12], and predicting beliefs, tendencies, and global motives such as attitude [13]. Reasons provide individuals with important insights into their decision-making processes to support the acceptability of their decisions [11]. The classical reason approach has assumed that there are strongly accepted reasons that motivate a particular behavior [14].

In behavioral reasoning theory, Westaby defines the concept of reason as "*specific subjective factors people use to explain their anticipated behavior*" and argues that "*reasons serve as important linkages between beliefs, global motives (e.g., attitudes, subjective norms, and perceived control), intentions, and behavior*" [15]. Reasons are examined in two dimensions, "reasons for" and "reasons against" performing a behavior in this theory. The Reasons Theory developed by Westaby and Fishbein engages in self-reported reasons [14]. They have postulated that "*If a person does (or will) perform the behavior, only reasons for performing the behavior represent the person's specific motives*" [14]. Therefore, reasons have an important role in the meaning of individuals' behavior as they are antecedents to individuals' motivation, tendencies, and behaviors.

Individuals generally go on vacation to meet their physical and psychological needs, while making new friendships and gaining prestige are also important reasons for traveling [16]. Foreign tourists mainly visit Türkiye for reasons such as sightseeing, entertainment, sport and cultural activities, visiting relatives and friends, and shopping, according to the information provided by the Turkish Statistical Institute [17]. Although the reasons for traveling to Türkiye are mostly general interest tourism (sea, sun, etc.) oriented, it is predicted that the reasons focused on special interest tourism (such as gastronomy) will have a more important role in the future [18].

In previous studies on foreign visitors, it has been determined that they prefer to come to Türkiye for reasons such as Türkiye's history and natural beauties, the desire to get to know the Turkish people, dishes specific to Turkish cuisine, safe travel to Türkiye, the affordable travel price, the opportunity to shop cheaply [19], shopping, entertainment, prestige [20], quality and affordable health services, the opportunity to have a holiday together with health services and experience the Turkish climate [21], historical/cultural attractions and Turkish cuisine [22], cultural heritage [23], vocation [24], shopping, Turkish cuisine, and the climate of Türkiye [25]. In addition, the profile of Turkish cuisine positively affects the intention to visit Türkiye [18].

Previous research about foreign visitors who visit Türkiye the most and have the most share of the tourism income mostly presents descriptive knowledge and historical statistics. However, there seems to be a gap in the literature regarding the scientific and precise estimation of the reasons for the future arrival of foreign visitors to Türkiye. From a

marketing perspective, a full understanding of the needs and wants of consumers (visitors) is needed to correct the decline in tourism income caused by the COVID-19 pandemic and to improve this income by performing effective marketing strategies. It can also be possible to determine an accurate customer profile to make valuable inferences about their preferences and behaviors by examining the reasons for choosing a particular destination [26]. Thus, accurately predicting these reasons can be an important marketing insight in developing and implementing successful strategies for Turkish and global tourism.

Recently, machine learning approaches have been widely applied to various prediction problems. Energy consumption is estimated by the Catboost, Xgboost and multi-layer neural network machine-learning algorithms to meet electrical energy demands [27]. A long-short-term memory neural network-based machine-learning algorithm is applied to a short-term human motion problem, known as the human trajectory prediction problem, and extensive tourist mobilities are analyzed [28]. A number of machine-learning algorithms, including the random forest model, extreme gradient boosting, and support vector machines, are considered to estimate the protective immunogen, which is a time-consuming and expensive stage of the vaccine development process [29]. A convolutional neural network machine-learning algorithm is considered to instantly estimate the quality of manufactured products using a statistical f1-score of the predictions [30]. In addition, to detect and monitor COVID-19 patients, a number of machine-learning algorithms, including recurrent neural networks, generative adversarial networks, and new ML-based applications, were recently addressed [31]. An advanced machine-learning algorithm called reinforcement learning, which learns the optimal control tasks through a trial and error process, was implemented for the lateral control of a nonlinear vehicle moving in a constrained lane [32].

This study aims to present a machine learning model to be used for the prediction of the number of departing foreign visitors from Türkiye by reasons for the next 10 years to gain a deeper understanding of their future behavior. The behavior of departing foreign visitors is considerably affected by various uncertainties, including the pandemic outbreaks, political turmoil, and global economic crises. Henceforth, the genetic algorithm used in this study is modified to reduce uncertainties and predict future trends by focusing on the dominant character of the data. As a result, the algorithm captures the key pattern of the training data instead of the instant character, so the unseen uncertainties can be avoided. Moreover, a positive definite polynomial basis function is constructed to create a certain, smooth, and higher-order parameter space. This ensures that the model can capture swift and fine changes in the estimates.

To optimize the unknown model parameters with the uncertain and limited training data, a constrained genetic algorithm, a gradient-free meta-heuristic algorithm, is modified. This allows us to build a robust model with proportionally distributed unknown parameter magnitudes. Finally, the algorithm is free of pre-processing approaches, such as normalization and generalization. This causes extra difficulties in the training process of the machine learning algorithms, but it allows us to directly perform the future predictions in the real data magnitude space.

Marketing is defined to be an "applied-synthesis social science" [33], and it is evolving from a descriptive to a predictive science [34]. Thus, the contributions of the study can be briefly summarized:

1. It enhances the knowledge reserve in consumer behavior due to the robust prediction of the reasons for future foreign visitors' behavior with machine learning, as previous studies are mostly based on descriptive knowledge and past statistical data;
2. It develops a multi-dimensional machine-learning model trained effectively with limited uncertain data and can predict the number of departing foreign visitors by their reasons for the next 10 years;
3. The developed model can be trained with the data collected from different cities, regions and countries to predict the future arrival reasons of foreign visitors (consumers).

This study can also be helpful for global and local firms in tourism, governmental agencies, and civil society organizations that engage in reducing the effects of COVID-19 on tourism and pursue sustainable development in tourism. This study can provide useful customer insights for marketers engaging in designing marketing strategies based on customer value (segmentation, targeting, differentiation, and positioning) and marketing mix.

2. Method

The data used in this study were created from the open access data set named "Visitors Leaving by Reason of Arrival" prepared by the Turkish Statistical Institute [17]. The description of the data set is as follows [17]:

- The scope of this data set consists of citizens and foreigners over the age of 14 who arrive to Türkiye for daily and overnight stays and reside abroad;
- The data were obtained through a survey. The questionnaire forms were interviewed face to face four times a year in quarterly periods between 2003 and 2022;
- The reasons for the visitors to come to Türkiye were determined based on the concepts and methods of the World Tourism Organization and Eurostat;
- The model variables are departing foreign visitors by education, health, religion, transit, shopping, business, visiting, accompanying, travel and other reasons;
- Foreign visitors are defined as visitors who do not carry a passport of the Republic of Türkiye and who leave the country through the border gates.

2.1. Input–Output Training Data

The input–output training data must be primarily analyzed to design advanced and accurate machine-learning algorithms. This section provides the departing foreign visitors by reason of arrival to Türkiye and highlights the extraordinary changes in the number of departing foreign visitors that significantly help us to understand future estimates.

2.1.1. Departing Foreign Visitors by Reasons

Türkiye attracts many visitors for various reasons due to its tourism, culture, education, health, and industry infrastructures. Figure 1 shows the number of departing foreign visitors for education, religion, and transit in Türkiye.

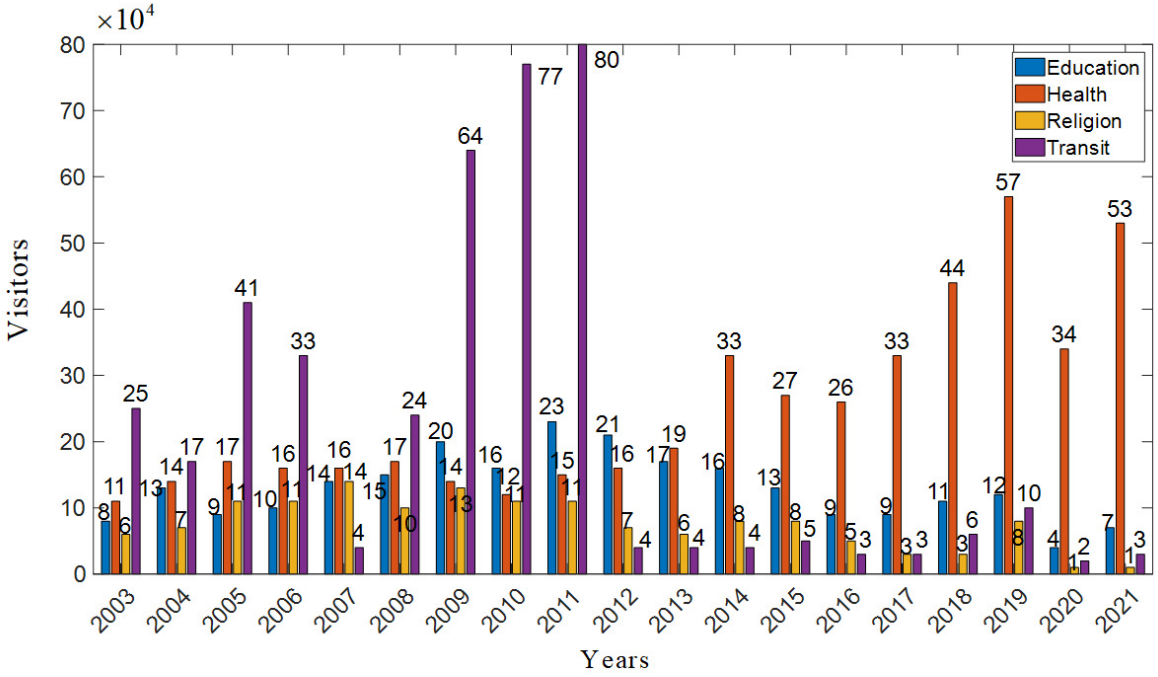

Figure 1. Departing foreign visitors for education, health, religion, and transit reasons.

As can be seen from Figure 1, the number of foreign visitors for the transit reason peaked at 800,000 visitors in 2011, but later it sharply decreased after 2012, and it was only 70,000 in 2021. In this respect, it seems that Türkiye has lost its transit visitors in recent years even though historically, it has noticeable potential for transit visitors. Concerning the number of visitors for the education reason, it steadily fluctuated between 80,000 and 120,000 until 2019, but with the emergence of the COVID-19 pandemic outbreak, it lessened to 40,000 in 2020. Regarding the number of foreign visitors for health reasons, it has grown over the last years, reaching 570,000 in 2019 and slightly reduced to 500,000 in 2021. These numbers indicate that this trend will continue to rise in the coming years. Concerning the departing foreign visitors for religious reasons, it had moderate ups and downs until 2019, and it reached its minimum in 2020 and 2021 due to pandemic outbreaks. Figure 2 illustrates the remaining reasons for the departing foreign visitors in Türkiye.

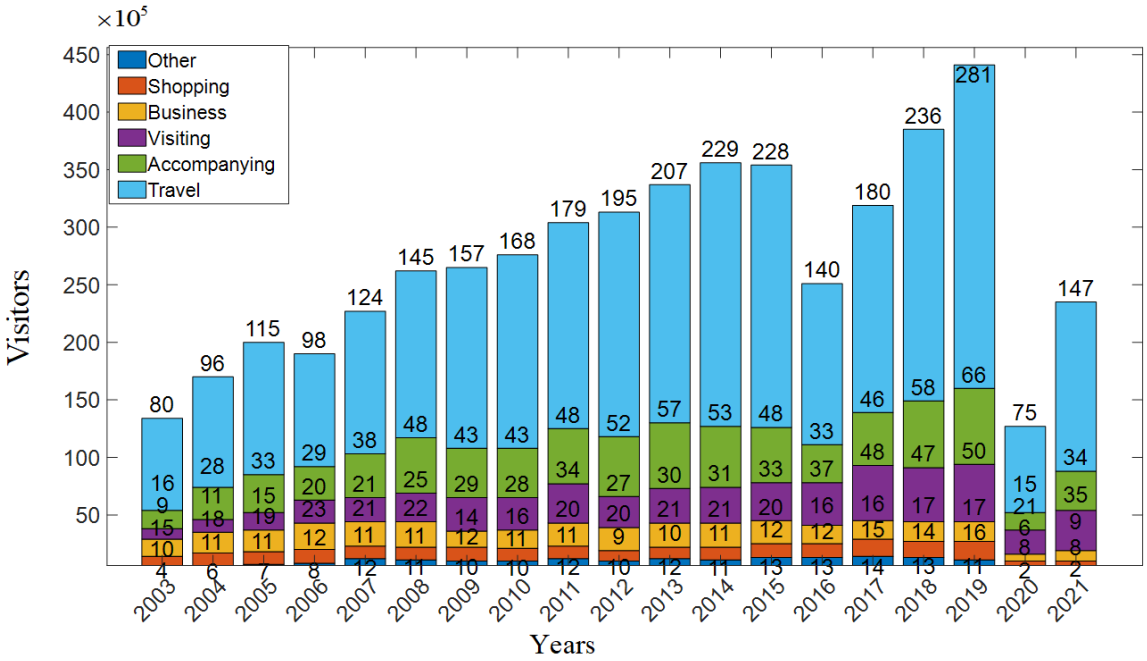

Figure 2. Departing foreign visitors for other, shopping, business, visiting, accommodation, and travel reasons.

As seen from Figure 2, the number of departing foreign visitors for other, shopping, business, visiting, accompanying, and traveling reasons increased and decreased almost proportionally between 2003 and 2021. It is clear that while a small number of departing foreign visitors had other reasons during these years, most of them arrived for traveling reasons. For example, in 2019, only 1,100,000 foreign visitors had other reasons, whereas, in the same year, 28,100,000 departing foreign visitors had arrived in Türkiye for traveling reasons. It was also noticeable from Figure 2 that the overall number of foreign visitors lessened in 2016 due to the coup attempt and the COVID-19 pandemic outbreak in 2020. However, it is important to note that the dominant characteristics of the whole departing foreign visitors, the reasons demonstrated in Figure 2, had incremental trends. This implies that the number of departing foreign visitors will continue to increase unless unexpected disruptions occur. Therefore, the constructed machine-learning algorithm must reflect the dominant characters of the departing foreign visitors rather than the instant characters, which can correspond to the extraordinary years.

Moreover, the machine-learning algorithm must suppress the effects of the uncertainties, including the coup attempt, the pandemic outbreak and the competition from other tourism destinations. Otherwise, future predictions of the model will always heavily reflect the exceptional years. It is important to note that modelling the political crises and outbreaks can be achieved by forming corresponding unknown parameters. Still, we do

not have sufficiently rich data to learn such parameters. In addition, external uncertainties, such as competition by other destination countries, are challenging to quantify and incorporate into a parametric model as proposed in this paper. Thus, the model developed in this paper ignores the explicit learning of external uncertainties. The percentages of the departing foreign visitors by their reasons should be addressed to further process the input–output training data.

2.1.2. Percentages of the Departing Foreign Visitors by Reasons

Figure 3 illustrates the percentages of departing foreign visitors by their reason in Türkiye between 2003 and 2021.

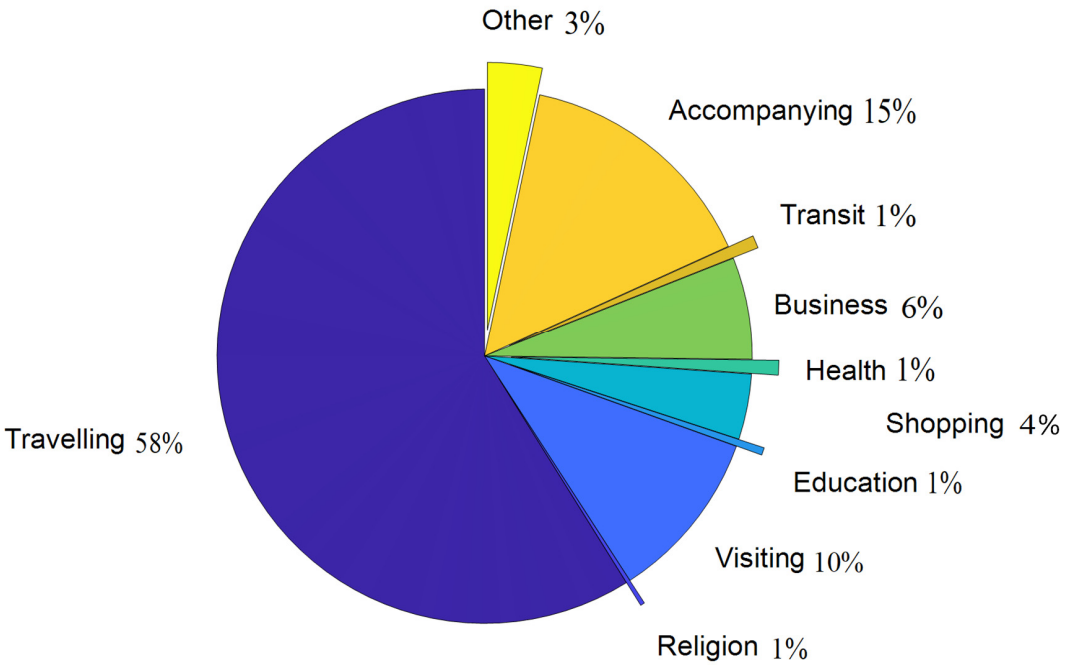

Figure 3. Percentages of the departing foreign visitors by reason.

As shown in Figure 3, the traveling reason constitutes 58%, which is the largest share among all the reasons for the foreign visitors. It is followed by the accompanying 15%, visiting 10%, business 6%, shopping 4%, other 3%, health 1%, transit 1%, education 1%, and religion 1%. The next section constructs a genetic algorithm with fractional-order polynomials to learn the model of the departing foreign visitors by reason of arrival.

2.2. Fractional-Order Polynomial Prediction Model and Genetic Algorithm-Based Optimization

The prediction accuracy of the machine learning algorithms can be improved by building more certain and constrained unknown parameter spaces. Thus, this section initially introduces the fractional-order polynomial prediction model with constrained parameter spaces. In addition, the prediction models must be optimized with an adequately constructed machine-learning algorithm to lessen the impacts of the disruptions. Therefore, this section builds a batch-type genetic algorithm to optimize the prediction model.

2.2.1. Fractional-Order Polynomial Prediction Model

A basis carries the crucial information required for training, testing, validation and future predictions of the model. Henceforth, this basis must be formed to reflect the most informative features of the input data. The fractional-order polynomial basis covering a bias, fractional orders, and linear and quadratic data is constructed to create a smooth

parameter space with a second-order derivative. For example, the batch type basis $\mathbf{b}^{\mathbf{T}_e}$ of the departing foreign visitors for traveling reason $\mathbf{T}_e$ is built as follows:

$$\mathbf{b}^{\mathbf{T}_e} = \begin{bmatrix} 1^{N\times 1} & \mathbf{T}_e^{0.5} \bullet \mathbf{T}_e^{0.5} & \mathbf{T}_e^{0.8} \bullet \mathbf{T}_e^{0.8} & \mathbf{T}_e^{1} \bullet \mathbf{T}_e^{1} & \mathbf{T}_e^{2} \bullet \mathbf{T}_e^{2} \end{bmatrix} \tag{1}$$

where $\mathbf{T}_e \in \mathbb{R}^N$ has dimension of N and $\bullet$ is the vector dot product. The basis in Equation (1) is a batch type that can average the effects of the unstructured uncertainties and biases in the data. If a limited amount of data is biased, then their overall impact on the model will be ignorable. However, if the whole data is biased, the algorithm will learn the mean of the biased data in this case. To ensure that the training data is unbiased, it is collected from the official governmental TÜİK office and also confirmed with open sources. The corresponding unknown parameter vector $\mathbf{w}^{\mathbf{T}_e}$ is:

$$\mathbf{w}^{\mathbf{T}_e} = \begin{bmatrix} w_1^{\mathbf{T}_e} & w_2^{\mathbf{T}_e} & w_3^{\mathbf{T}_e} & w_4^{\mathbf{T}_e} & w_5^{\mathbf{T}_e} \end{bmatrix} \tag{2}$$

The estimated model output $\hat{\mathbf{y}}^{\mathbf{T}_e}$ is:

$$\hat{\mathbf{y}}^{\mathbf{T}_e} = \mathbf{w}^{\mathbf{T}_e} * \mathbf{b}^{\mathbf{T}_e{}^T} \tag{3}$$

The training error $\mathbf{e}^{\mathbf{T}_e}$ is:

$$\mathbf{e}^{\mathbf{T}^e} = \mathbf{y}^{\mathbf{T}^e} - \hat{\mathbf{y}}^{\mathbf{T}^e} \tag{4}$$

The constrained cost function to be minimized for the optimal $\mathbf{w}^{\mathbf{T}_e}$, which is the unknown parameter vector in Equation (2), is:

$$\begin{aligned} J^{\mathbf{T}_e} = \quad & \min \quad \mathbf{e}^{\mathbf{T}_e} * \mathbf{e}^{\mathbf{T}_e{}^T} \\ & \text{subject to} \\ & \mathbf{w}_{\min}^{\mathbf{T}_e} \leq \mathbf{w}^{\mathbf{T}_e} \leq \mathbf{w}_{\max}^{\mathbf{T}_e} \end{aligned} \tag{5}$$

where $\mathbf{w}_{\min}^{\mathbf{T}_e}$ and $\mathbf{w}_{\max}^{\mathbf{T}_e}$ are the minimum and maximum boundaries of the unknown parameter vector $\mathbf{w}^{\mathbf{T}_e}$.

The next section presents the genetic algorithm-based optimization of the fractional-order polynomial prediction model in Equation (3).

2.2.2. Genetic Algorithm-Based Optimization

In this paper, a gradient-free meta-heuristic genetic algorithm is preferred since the corresponding data is highly uncertain due to political crises and pandemic outbreaks. In the case of gradient-based optimization, unknown parameters can become easily unstable or can lose their robustness because of sharp changes. In addition, parameter constraints can be incorporated into the gradient-free optimization problem directly without solving a costate as in the gradient-based constrained optimization problems. Therefore, in this paper, a modified genetic algorithm is considered to search for the best solutions to the constrained optimization problem in Equation (5) by following the biological inspirations of the natural selection of the offspring.

However, similar gradient-free meta-heuristic algorithms can be considered as well. However, since the genetic algorithm is well-known and easy to modify in the presence of multi-dimensional data and constraints, the genetic algorithm is preferred in this paper. Its detailed pseudo-code is presented with Algorithm 1.

Since the optimization algorithm is a batch type, it can implicitly learn the overall character of the uncertainties, including the political crises and pandemic outbreaks. Therefore, the model presupposes that the uncertainty in the input data is averaged and smoothed. In addition, the optimization algorithm is constrained to avoid disproportional unknown model parameters. Henceforth, the model presupposes that the unknown parameters are inside the constrained parameter space. Moreover, since a closed-form solution is not available for such prediction problems, a higher-order polynomial basis is formed and

validated with the training data. Thus, the model presupposes that the polynomial basis can also represent future data.

Algorithm 1: Prediction model optimization with the constrained genetic algorithm.

Input:

The parameter upper and lower limits $\mathbf{w}_{\min}^{\mathbf{T}_e} = -\eta^r / \max\left(\mathbf{b}^{\mathbf{T}_e}\right)$ and $\mathbf{w}_{\max}^{\mathbf{T}_e} = -\mathbf{w}_{\min}^{\mathbf{T}_e}$.

Initialized cost $J^{\mathbf{T}^e}$ in Equation (5) and the best cost $J^{\mathbf{T}_e{}^*}$.

Initialized probability constant β, crossover update rate α, mutation update rate γ, mutation threshold μ.

Initialized *population length* and *search length*.

Output:

Optimized unknown parameters $\mathbf{w}^{\mathbf{T}_e} \in \mathbb{R}^{1\times N}$.

Initialization:

for $i = 1$ to *population length*

1. Generate a random parameter population $\mathbf{w}^{\mathbf{T}_e}$.

$$\mathbf{w}^{\mathbf{T}_e}(i) = unifrnd\left(\mathbf{w}_{\max}^{\mathbf{T}_e}, \mathbf{w}_{\min}^{\mathbf{T}_e}, N\right) \tag{6}$$

2. Construct the basis $\mathbf{b}^{\mathbf{T}_e}(i)$ in Equation (1).
3. Calculate the estimated output $\hat{\mathbf{y}}^{\mathbf{T}_e}(i)$ in Equation (3).
4. Assess the constrained current cost $J^{\mathbf{T}_e}(i)$ in Equation (5).
5. Compare the solution to the best cost $J^{\mathbf{T}_e{}^*}$ as

if the current cost $J^{\mathbf{T}_e}(i)$ is less than *the best cost* $J^{\mathbf{T}_e{}^*}$
Update $\mathbf{w}^{\mathbf{T}_e{}^*} = \mathbf{w}^{\mathbf{T}_e}(i)$, $J^{\mathbf{T}_e{}^*} = J^{\mathbf{T}_e}(i)$.
end if

end for

Main Loop:

for $t = 1$ to *search length*

6. Determine the average cost $J_a^{\mathbf{T}^e} = J^{\mathbf{T}_e}(t) / \sum_{l=1}^{t} J^{\mathbf{T}_e}(l)$.
7. Calculate the probability as $p(t) = e^{-\beta * J^{\mathbf{T}_e}(t)}$.
8. Perform the crossover.

for $k = 1$ to *population length*/2

a. Determine the parent p^1 with the Roulette Wheel selection:

$$r = rand * \sum_{l=1}^{t} p(l) \tag{7}$$

$$c(l) = c(l-1) + p(l) \quad \text{for } l = 2 \text{ to } t \tag{8}$$

$$p^1(k) = find(r \le c) \tag{9}$$

b. Repeat Equations (7)–(9) for the other parent p^2.

c. Perform crossover for the first parent parameter $\mathrm{w}_{c,1}^{\mathbf{T}_e}$

$$\mathrm{w}_{c,1}^{\mathbf{T}_e}(k) = \alpha * p^1(k) + (1-\alpha) p^2(k) \tag{10}$$

d. Repeat the crossover in Equation (10) for the second parent parameter $\mathrm{w}_{c,2}^{\mathbf{T}_e}$.

end for

Algorithm 1: *Cont.*

9. Perform the mutation.

for $l = 1$ to *population length*

a. Mutate the parameters $\mathrm{w}_c^{\mathbf{T}_e}$:

$$f = rand(population\ length) < \mu \tag{11}$$

$$g = randn(population\ length) \tag{12}$$

$$\mathrm{w}_c^{\mathbf{T}_e}(l) = \mathrm{w}_c^{\mathbf{T}_e}(f) + \gamma * g(f) \tag{13}$$

b. Apply the constraints on $\mathrm{w}_c^{\mathbf{T}_e}(l)$:

$$\mathrm{w}_c^{\mathbf{T}_e} = \max\left(\mathrm{w}_c^{\mathbf{T}_e}, \quad \mathrm{w}_{\min}^{\mathbf{T}_e}\right) \tag{14}$$

$$\mathrm{w}_c^{\mathbf{T}_e} = \min\left(\mathrm{w}_c^{\mathbf{T}_e}, \quad \mathrm{w}_{\max}^{\mathbf{T}_e}\right) \tag{15}$$

c. Repeat steps 1, 2, 3 and 4.

end for

It is important to note that the developed model is entirely data-driven; therefore it learns its unknown parameters from the data. This means that the model can be trained with the data collected from different cities, regions and countries. In this case, the resulting model will predict the corresponding departing foreign visitors. The following section provides the results and analyze them extensively.

3. Results

This section initially presents the parameters of the constrained genetic algorithm. Then, this section analyzes the optimization results and provides the predicted departing foreign visitors and their reasonsin Türkiye until 2032.

3.1. Parameters of the Genetic Algorithm

Table 1 specifies the parameters of the genetic algorithm.

Table 1. Parameters of the genetic algorithm.

Parameters	Descriptions
$J^{\mathbf{T}_e} = \inf$	Initialized cost function.
$\beta = 1$	Probability constant.
$\mu = 0.2$	Mutation threshold.
$\gamma = 0.5$	Mutation update rate.
$search\ length = 100$	Search duration.
$population\ length = 100$	Total parameter space.

The next sub-section presents the training results of the constrained genetic algorithm.

3.2. Real and Estimated Results with the Constrained Genetic Algorithm

The genetic algorithm provided in Section 2.2 is modified to learn the dominant characteristics of the departing foreign visitors with reasons in Türkiye. This modification is considered to eliminate the effects of the disruptions, particularly the 2016 coup attempt and the 2019 pandemic outbreaks. Figure 4 shows the real and the estimated results with the constrained genetic algorithm.

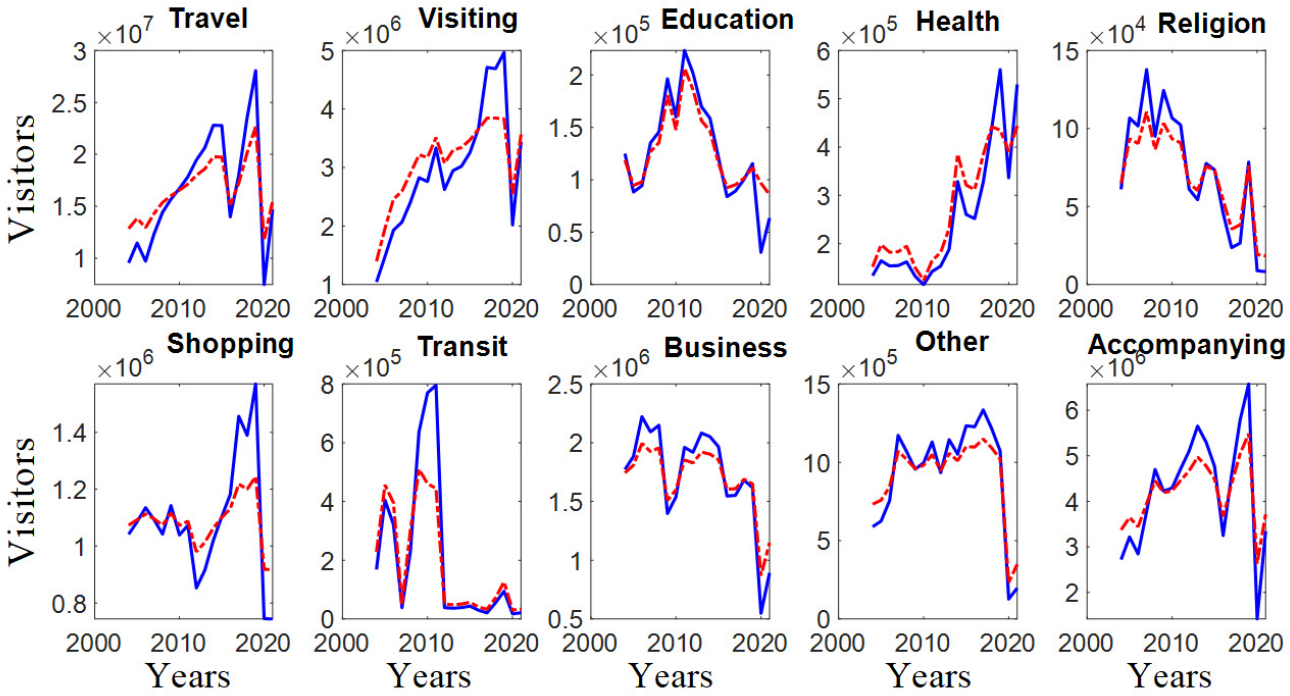

Figure 4. Real and estimated results. The solid blue and dotted red lines represent the real and estimated outputs, respectively.

As can be seen from Figure 4, the real data represented with the solid blue lines have sharp fluctuations where the majority of them have a duration of a year. These are primarily due to unexpected disruptions and do not reflect the major character of the data. Therefore, the modified genetic algorithm reduces the impacts of the uncertainties and performs estimations by focusing on the dominant characteristic of the data. As a result, the constrained genetic algorithm can capture the key pattern of the training data rather than the instant character of the data, which can be exposed to unforeseen uncertainties. The developed prediction model can predict the future departing foreign visitors by reasons, which are provided next.

3.3. Predicted Future Departing Foreign Visitors by Reasons

The prediction model optimized with the constrained genetic algorithm provides stable and characteristic estimates shaped by the dominant character of the departing foreign visitors by reasons as shown in Figure 5.

As can be seen from Figure 5, it is predicted that the departing foreign visitors for all reasons will increase at various rates between 2022 and 2031. While the departing foreign visitors by travel, visiting, education and shopping will rise quickly and then saturate to their maximum values, the departing foreign visitors by religion, business, other, and accompanying reasons are expected to rise slowly after the 2030s. It is important to note the prediction algorithm estimates that the departing foreign visitors by transit reason will initially grow slowly, but later its growth will speed up towards 2030. This indicates that the optimization algorithm captured the dominant character of the training data in Figure 2 and predicts that transit departing has a potential rise in the future even though lately, it has reduced unprecedently.

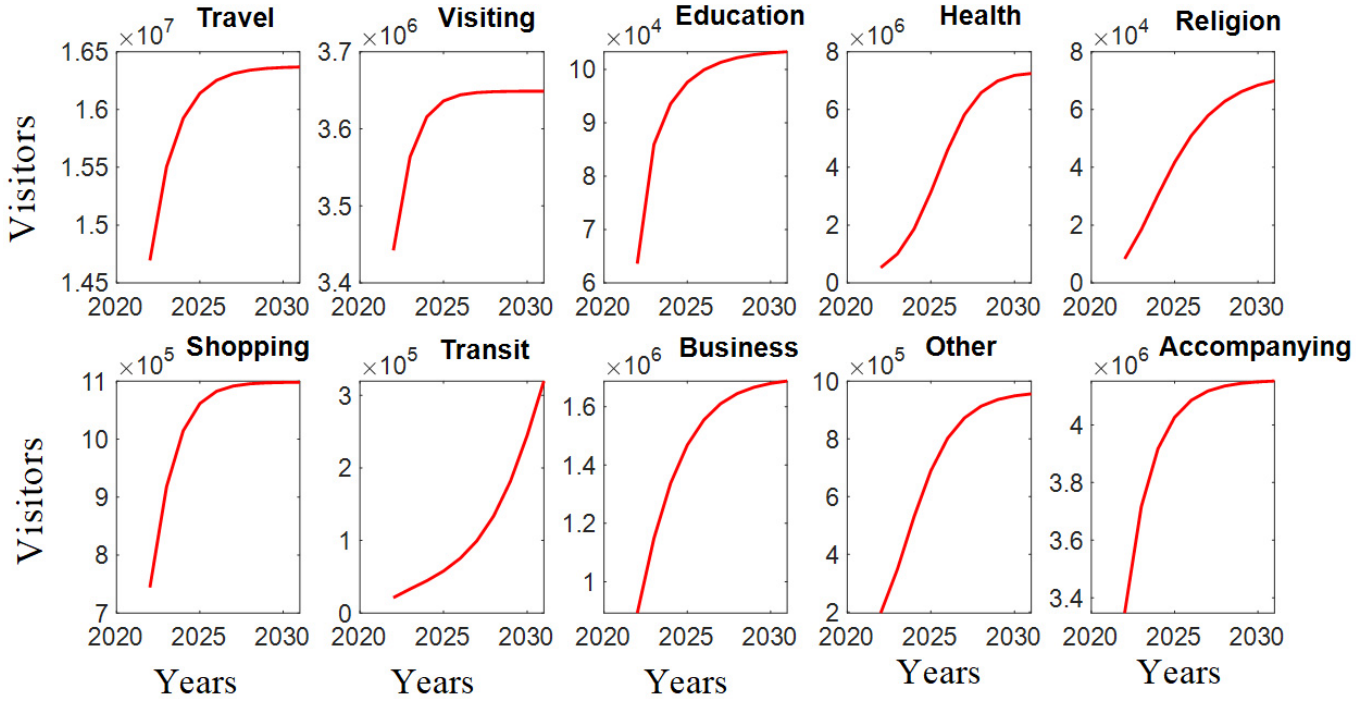

Figure 5. Future predictions of the departing foreign visitors by reasons in Türkiye.

4. Discussion

In this study, the number of foreign visitors departing from Türkiye for the next 10 years (2022–2031) has been estimated through a machine learning model by considering the reasons for their arrival. Thus, it provides a scientific prediction of whether and, if so, how the reasons for the arrival of foreign visitors leaving Türkiye will change over the next 10 years. The findings of the study reveal that arrivals will increase for all the reasons examined. Considering the number of foreign visitors, it is predicted that the number of visitors due to travel will be the highest. However, the rate of increase in this number is not very high compared to those who visit for other reasons. However, the findings show that the increase in arrivals for reasons other than transit will decrease and evolve towards a stationary state. When the increase rates are compared, it is estimated that there is a striking increase in arrivals due to health reasons, but it will stagnate after the 2030s. It is also predicted that the increase in the number of foreign visitors due to transit will continue. The predictions of this study indicate that Türkiye will have a competitive advantage, especially in the fields of health, transportation, and travel in the global tourism environment in the future. This study suggests some strategic insights for the literature and organizations dealing with marketing practices such as global and local firms in tourism, government agencies, and civil society organizations. It gives information about why foreign tourists arrive to Türkiye and for what reasons they may arrive in the future, which can be used for effective strategies.

Meeting customer demands and needs by offering superior values compared to competitors and establishing strong relationships with customers will gain marketing success and provide a competitive advantage in highly dynamic and competitive global marketing environments [35], such as tourism marketing. Precise and accurate estimation of the reasons for the future arrival of foreign visitors can provide important clues about the wants, needs, and expectations of these visitors as consumers and customers. Also, all of the reasons for the arrival of foreign visitors to Türkiye examined within the scope of this research can be helpful in the selection of partners and performance evaluation in establishing strategic partner relationships. These relationships are necessary to offer superior values that create customer satisfaction in these visitors. As the level of participation of tourists in the formation of the services they receive is high [36], they should be supported

in the co-creator role throughout their service encounters. Therefore, physical evidence and processes should be carefully evaluated for marketing efforts and investment decisions, including environmentally friendly and advanced technologies that will provide positive experiences and support their co-creator roles.

Furthermore, there is a high probability of service failures due to high customer-employee interaction/communication and specific features of services (such as heterogeneity) [37]. Service recovery and management of customer complaints are critical for building strong customer relationships and sustainable tourism. In this context, designing and presenting the service marketing mix elements by taking the main reasons for the arrival of foreign visitors into account can provide effectiveness and efficiency in responding to the requests and needs of these visitors.

Reasons can also be used as a variable in marketing strategies to encourage tourism. The findings of this study indicate that health, transit, and travel reasons can be used in occasion segmentation. On the other hand, considering other variables in segmentation (such as lifestyle, nationality, demographic, etc.) along with the reasons examined in this study, which means multiple segmentation, can provide more efficient strategies. Based on the predictions obtained in this study, health, travel, and transit areas have important opportunities in Türkiye's positioning and differentiation efforts in the global tourism environment.

Culture is a driving force that directs individuals' beliefs, perceptions, attitudes, and behaviors; therefore, the marketing mix in tourism must be designed and performed by considering cross-cultural differences [38]. Moreover, in a recent study, it has been determined that the implementation of similar image campaigns prepared for Türkiye in different markets is inefficient, and it is necessary to make adaptations in this regard [39]. In promotional activities for foreign tourists, it should be considered that they are from different countries and cultures, along with the reasons for their preferences. In addition, the importance of experiential marketing efforts in terms of gaining a competitive advantage [36] necessitates the creation of marketing mix elements in a way that will ensure positive experiences for foreign tourists, especially when they arrive for travel, transit, shopping, and religious reasons. To encourage the special interest in tourism, which is predicted to come to the forefront of Turkish tourism in the future [18], the reasons examined in this study should be addressed with its sub-reasons, while elements of the marketing mix should be developed to meet these reasons.

The study's findings indicate that Türkiye will be an important travel destination in the future. Cross-border destinations, especially cross-border neighboring destinations, give tourists easy access and mobility, and they may perceive this travel as more valuable. It is argued that Türkiye will gain social, economic, and political gains thanks to the partnership in this field [40]. The research results also indicate that there will be significant growth in the number of foreign tourists coming for transit and religious purposes. It implies that over the following years, Türkiye is highly likely gain a competitive advantage in transit and religious tourism and increase its performance in these areas. Considering the differentiation and focus strategy as generic strategies proposed by Porter [41,42], effective marketing strategies can be implemented, and high performance can be achieved by applying focus and differentiation strategies to achieve a competitive advantage in transit and religious tourism. To effectively design these strategies, the significant and valuable attributes perceived by foreign tourists regarding the goods and services within the scope of transit and religious tourism should be determined, and the perceived value for them should be increased. The '*value disciplines*' developed by Treacy and Wiersema are also suggested to develop a more customer-oriented competitive marketing strategy [43]. Drawing on customer intimacy as a value discipline, foreign tourists with transit and religious purposes should be segmented into sub-segments/niches. Based on the attractiveness of the segments, targeted segment(s) should be determined, and then tailor and present marketing offers specific to the needs and wants of tourists in the targeted segments. Together with customer intimacy, operational excellence and product leadership strategies as

value disciplines can also be helpful in designing and presenting superior value to foreign tourists with transit and religious purposes. Since operational excellence, which is related to production and delivery, requires superiority in competitive attributes of transit such as convenience, price, speed, quality etc., it can be applied in a wide range that starts before foreign tourists purchase goods and services and continues after their purchase.

Based on the estimation of the increase in health in this study, it can be claimed that the health sector will be a strategic actor in Turkish tourism. Previous studies stated that Turkish health services were preferred in terms of quality and reasonable price [44]. Therefore, for competitive advantage, Porter's generic strategies (cost leadership, differentiation, and focus) [42] and Treacy and Wiersema's value disciplines (customer intimacy, operational excellence and product leadership) [43] can be utilized. In addition, visionary competitive strategies are suggested [44]. Addressing the cause of health with its more specific sub-dimensions (wellness, health care, and medical tourism) can ensure that these strategies are better designed and implemented.

Uncertainties about the future are essential forces to be considered when designing and performing strategies and overcoming them with a proactive approach is necessary to achieve and maintain superior performance and competitive advantage. Innovation is also important in overcoming environmental uncertainties, including market, competition, and technology-based uncertainties. In particular, product innovation is found to mediate the relationship between environmental uncertainty and performance [45]. In other words, using innovations (product, process etc.) to fight against environmental uncertainties increases performance. Therefore, innovations in the fields of health, travel, and transit can contribute significantly to Türkiye's competitive advantage in global tourism. Service innovations, human-technology interaction, alternative distribution channels, quality, and productivity are some critical issues supporting the marketing strategies given above. Furthermore, innovation and repositioning strategies can yield beneficial results in preventing stagnation and maintaining/supporting competitive advantage.

This study has some limitations. The analysis performed was based on secondary data, and the reasons examined were determined in the light of global and local standards. However, examining these reasons (especially health and travel) is recommended by considering sub-reasons to obtain a more specific and in-depth understanding. Moreover, a 20-year data set, including the reasons and numbers of foreign visitors, have been analyzed in this study. Analyzing the reasons for the arrival of foreign tourists and other information together, such as demographic characteristics and lifestyles, can provide more detailed predictions.

The proposed model in this paper should be improved in the future by equipping it with a number of properties. For instance, the model only reflects the overall effects of the uncertainties, including the coup attempt in 2016 and the COVID-19 outbreak in 2019. In the future, the proposed model should be enhanced to reveal the explicit impacts of these uncertainties. In addition, the model should also be enriched with the possible impacts of global recession, economic crises, economic growth, climate change, regional wars, aging populations, and new trends in tourism.

5. Conclusions

This study can contribute to marketing science by presenting a strong estimation of future consumer behavior in tourism through machine-learning-based predictions. In the future, it is predicted that reasons such as health, travel, transportation, religion, shopping, education, and visit will be important for foreign tourists (as consumers) to prefer Türkiye, and their demand for Türkiye will increase. The predictions presented in this study provide strong evidence about Türkiye's future foreign tourist profile and the reasons for consumers' travel abroad behavior. The developed machine-learning model is effectively trained even though the training data is limited and uncertain. The training accuracy of the model confirms that the dominant character of the departing foreign visitors by reasons is

correctly captured. In addition, the learned model is robust and stable since it can provide smooth and bounded for the next ten years of multi-dimensional predictions.

In conclusion, there will be an increase in the number of foreign visitors coming to Türkiye, which means that Türkiye will become a more essential destination center and increase its power in global tourism. In particular, increases in arrivals due to health, transit, and travel offer valuable opportunities for Turkish tourism to gain a competitive advantage in these areas.

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