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THE EVALUATION OF DEVELOPMENT EFFICIENCY FOR THE TOURISM AND RECREATION COMPLEX IN THE REGIONS OF RUSSIA WITH THE DEA METHOD

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Abstract. The article presents the results of assessing the development efficiency of the tourism and recreation complex of Russia's regions for the period from 2017 to 2021. This period includes both years of stability, characterized by predominance of positive trends in tourism development, and crisis and post-crisis years associated with the effects of the COVID-19 pandemic. Taking into account the complexity of the structure of the tourism and recreation system and the need to improve territorial planning and management, an urgent task is to introduce a comprehensive, aggregated efficiency indicator to be used for assessment of regional tourism. The efficiency coefficient (efficiency score) calculated by means of the DEA (Data Envelope Analysis) method is proposed as such an indicator. The study is novel in that it develops a methodology for assessing the efficiency of regional tourism based on DEA. The essence of this method is as follows: basing on the theory of duality, having data of input and output parameters, it is possible to calculate the value of the efficiency indicator for a set of N-objects (in our study – subjects, i.e., constituent entities of the Russian Federation). For the calculations, we used a model focused on the 'input' and taking into account the variable scale effect. In models of this type, each inefficient object is compared with efficient objects that have the structure (ratios) of indicator values closest to the structure of this inefficient object. This allows one to determine how much to change the parameters of the tourism and recreation complex in order to achieve efficiency equal to 1 (which is the maximum score). The model used seven 'input' indicators and six 'output' indicators. The analysis of the results was carried out in the context of the tourist macro-territories designated in the strategic documents for the development of tourism in the Russian Federation. The data obtained indicate a decrease in the efficiency of tourism development in the Russian Federation, with the exception of a number of regions and two tourist macro-territories. The results of the study can be used to adjust regional tourism development programs.

***Keywords*:** tourist macro-territories, tourism efficiency, tourism and recreation complex, DEA (Data Envelope Analysis), tourism in Russian regions

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РЕКРЕАЦИОННАЯ ГЕОГРАФИЯ И ТУРИЗМ
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ОЦЕНКА ЭФФЕКТИВНОСТИ РАЗВИТИЯ ТУРИСТСКО-РЕКРЕАЦИОННОГО КОМПЛЕКСА В РЕГИОНАХ РОССИИ МЕТОДОМ DEA (DATA ENVELOPMENT ANALYSIS)

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Аннотация. В статье представлены результаты оценки эффективности развития туристско-рекреационного комплекса регионов России за период с 2017 по 2021 г. Этот период включает в себя как годы стабильности и преобладания положительных тенденций в развитии туризма, так и кризисные и посткризисные года, обусловленные влиянием пандемии COVID-19. Учитывая сложность структуры туристско-рекреационной системы, в целях совершенствования территориального планирования и управления, актуальной задачей является использование комплексного, агрегированного показателя эффективности при оценке регионального туризма. В качестве такого показателя предлагается коэффициент эффективно-

сти, рассчитанный методом DEA (Data Envelopment Analysis). Разработка методики оценки эффективности развития регионального туризма на основе метода DEA определяет научную новизну исследования. Суть метода DEA состоит в том, что на основе теории двойственности, имея данные входных параметров и выходных параметров, можно рассчитать для множества N-объектов (в нашем исследовании субъекты РФ) значение показателя эффективности. Для расчетов применялась модель, ориентированная на «вход» и учитывающая переменный эффект масштаба. В моделях такого типа каждый неэффективный объект сопоставляется с эффективными объектами, имеющими структуру (соотношения) значений показателей, наиболее близкую к структуре этого неэффективного объекта. Это позволяет определить величину, на которую нужно изменить параметры туристско-рекреационного комплекса, чтобы достичь единичной эффективности. В модели применялось семь «входных» показателей и шесть «выходных». Анализ результатов осуществлялся в разрезе туристских макротерриторий, обозначенных в стратегических документах развития сферы туризма в Российской Федерации. Полученные данные свидетельствуют о снижении эффективности развития туризма в Российской Федерации, за исключением ряда регионов и двух туристских макротерриторий. Результаты исследования могут быть использованы для корректировки региональных программ развития туризма.

Ключевые слова: туристские макротерритории, эффективность туризма, туристско-рекреационный комплекс, метод DEA (Data Envelopment Analysis), туризм в регионах России

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Introduction

The tourism sector in Russia belongs to the priority sectors of economic development. Almost all regions are making efforts to create attractive tourist products, develop the tourism industry and infrastructure, increase the efficiency of using the tourism and recreation potential and boost the tourist flow. Each region has its own unique set of factors and conditions for the development of tourism, which contributes to regional heterogeneity. Therefore, it is extremely difficult to compare regions with each other and to rank them according to the level of tourism development. As a rule, such tasks arise in the process of developing strategic territorial planning documents.

The development of tourist infrastructure is one of the priority goals of the national project 'Tourism and the Hospitality Industry.' At the same time, tourist macro-territories act as the main objects of territorial planning and management as well as of the distribution of state subsidies [24]. Thus, in order to improve state regulation of tourism, it is necessary to regularly assess the efficiency of regional tourism.

Tourism efficiency is defined as 'the ability of tourist destinations to use the capabilities of their hotels, travel agencies and scenic spots (districts) to maximize tourist demand.' The assessment of tourism efficiency can help to correctly direct the intensive use of capital in the tourism industry, depending on the input and output of tourist resources [20]. At the same time, it is desirable to present the value of efficiency in the form of one aggregated indicator. In the light of this, the DEA method can be used to assess the efficiency of the functioning of the tourism and recreation complex. Although the DEA method is mainly used to evaluate the efficiency of individual enterprises, it can also be successfully applied to evaluate tourist regions [5]. The DEA method is based on the construction of the efficiency boundary that reflects the position of the evaluation objects that have the maximum efficiency value among all objects with a given amount of input data in the input-output space. The objects that do not lie on the border of efficiency do not function effectively. In this case, the value of inefficiency is directly proportional to the distance of the point from the efficiency boundary. The efficiency limit is determined with the DEA method, which is based on linear programming.

The method was developed by American scientists A. Charnes, W. Cooper, and E. Rhodes in 1978 [6]. The advantage of this method is that it allows for a comparative analysis of the functioning of objects with similar tourism and recreation potential and the level of the tourist infrastructure development. This approach enables simultaneous processing of multiple input indicators (independent factors) and output indicators (dependent variables), while also taking into account variables external to the system under consideration (for example, environmental factors). Another advantage of the method is that it does not require a priori indication of weight coefficients for the variables

and does not impose any restrictions on the functional form of the dependence between inputs and outputs. Unlike regression analysis, the DEA method is aimed at identifying not averaged trends but best practices. Additionally, if there are databases for a certain time period, it is possible to calculate the change in the aggregated performance indicator for each object over time.

Thus, the purpose of the study is to test the DEA method when used to assess the technological efficiency of the tourism and recreation complex of Russian regions in the period from 2017 to 2021.

Literature review

The DEA method is intended to compare the relative efficiency of objects. Efficiency is understood to mean the ratio of utility functions created based on the values of input and output parameters of objects. The method is successfully used to evaluate the efficiency of the functioning of homogeneous objects, for example, industrial and agricultural enterprises, banks, healthcare and education institutions, government and judicial bodies, etc. [9]. Today it is widely accepted all over the world, covering a huge number of areas. The main areas of research using the DEA method are healthcare, banking, insurance, higher education, social sphere, transport, supply chain management, sustainability, and energy policy.

Although the method was proposed back in 1978, it became most widespread after 2000. At the same time, the method is constantly being developed and modified. In addition to the analysis algorithm itself, the software is also being improved. For example, there have been developed DEAOS (DEA online software), MaxDEA, Open Source DEA, DEAFrontier, DEA software, and PIM-DEA. It also becomes possible to integrate the method with other programs, for example, Microsoft Excel. DEAOS has, among other things, the special features for the application in the field of education, banking, insurance, medicine, transport, agriculture, energy, and tourism.

Over time, more sophisticated DEA-based methods have also emerged, such as a two-stage, cross-efficient, ultra-efficient, virtually-efficient, hybrid model.

In Russian science, the DEA method is known by several names:

- operating environment analysis;
- data shell analysis;
- wrap data analysis;
- shell data analysis.

Morgunov E.P. [18] comes to the conclusion that when choosing the name, it is necessary to rely on such criteria as compliance with the theory of the method, originality, and euphony. In this paper, we will use the original abbreviation DEA, to avoid confusion.

The scope of application of the DEA method at the regional level is very wide. Aleskerov F.T., Belousova V. Yu. [2], consider the efficiency of universities by analyzing 24 studies conducted with the help of the DEA around the world. The authors conclude that the DEA is widely used for evaluating the efficiency of universities, but the input parameters and the results obtained differ, and there is no single universally accepted approach. At the same time, different modifications of the method make it possible to take into account the heterogeneity of the initial sample in different ways. Aleskerov F.T. and Demin S. [1] use two DEA-based methods to assess the vulnerability of regions to natural disasters, comparing the efficiency of 27 regions with a high seismic risk index. The authors note that both methods (the standard DEA approach and the method based on the sequential exclusion of alternatives) provide a reasonable ranking of regions by the efficiency of preventive measures.

Saein A.F. and Saen R.F [22] used an improved DEA model to assess a region's vulnerability to earthquakes. De Almada Garcia Adriano et al. [10] applied DEA to assess the safety level at a nuclear power plant. Using DEA, Zemtsov S. and Kostimer M. [39] assess the efficiency of Russian innovation systems and conclude that the proposed approach allows one to assess the ability of regional innovation systems to create new technologies, but it does not take into account their ability

to implement new products. Kutyshkin A.V. and Shulgin O.V. [15] use the DEA method to assess the efficiency of regional water consumption systems, and, in their other work, to estimate the efficiency of municipal medical institutions in the region. Zemtsov S.P. et al. [28] employ DEA to assess environmental efficiency and sustainable development in the Russian Federation over the past 20 years. Yureskul E.A. [27] relies on the DEA method to assess the efficiency of state power, considering the municipal and federal levels.

Nasrutdinov M.N. [19] uses the DEA methodology to analyze investment efficiency in the regions of the Russian Federation. The author receives a result where, as of 2017, only 17 regions are effective in terms of using their resources. In addition, with the help of the analysis the goals of regional development are outlined.

From the above examples, it becomes clear that the main areas of the method application in Russia coincide with those covered in foreign studies, with the exception of tourism. The latter circumstance seems very strange, given the active use of DEA for assessing the service sector and tourism in foreign research works. For example, according to the DEAOS research [30], from 1996 to 2019, there was an increase in the number of articles on tourism using the DEA method (the largest number was published in 2018). In the articles studied, the most popular keywords were DEA, tourism, efficiency, and hotel. The leaders among the scientific journals publishing articles based on the DEA method were *Tourism Management* and *International Journal of Hospitality Management*.

Examples of the DEA application in tourism studies are presented further. Wijeysinghe B.S. [25] proposed the DEA method for determining the efficiency of tourism management. Baker M. and Riley M. [3] were the first to use the method to evaluate efficiency in the hotel business. Further studies in the field of tourism were conducted by Botti, Briec & Cliquet [4]; Hung, Shang & Wang [13]; Sigala [23]; Yang, C., & Lu, W. M. [26]; Gómez-Vega and Picazo-Tadeo [11] calculate the competitiveness indicator for 136 destinations in the world. Chin-wei Huang [7] presents a comprehensive performance indicator used to measure the overall efficiency of the supply chain in the tourism sector. Radovanov et al. [21] use the DEA two-level assessment method to include sustainability factors in the overall assessment of the efficiency of tourism development. Factors such as the share of GDP from the tourism industry, the number of tourist arrivals, the number of World Heritage sites, etc. were used. 27 EU countries and 5 Balkan countries were analyzed from 2011 to 2017.

Martin J.C. et al. [17] analyze the tourism competitiveness of 17 regions of Spain, applying criteria such as the diversification and structure of the tourist product, human resources and their development, political priorities and tourism management, social and economic indicators, transport accessibility, tourism strategy and competition. The authors conclude that for a more accurate assessment, destination management organizations should also participate in the assessment and make adjustments. In the research work by Ilić I. and Petrevska I. [14], the DEA method is used to assess the efficiency of tourism in 15 European countries. They use tourism costs and the number of beds as input parameters, with income, the number of tourist arrivals, and the number of nights spent used as output parameters. At the city level, Li Wenhua [16] conducts research using the DEA-Malmquist method. The paper provides a dynamic analysis of tourism efficiency for 14 cities of the Guangxi Zhuang Autonomous Region from 2004 to 2018. Tourism investments are used as input parameters, while output parameters include profit and the number of tourists.

Summing up, we can say that the DEA method is widely applied both at the industry level and at the regional level. The method is popular in a variety of studies on the tourism sector. It is also suitable for comparative analysis of efficiency at different spatial levels.

Materials and methods

The DEA method is based on the construction of the so-called efficiency boundary, which reflects the position of the evaluation objects with the maximum efficiency score among all objects in the input-output space. Those objects that do not lie on the border of efficiency function inefficient-

ly. The value of inefficiency is directly proportional to the distance of the point from the efficiency boundary. The advantage of the DEA method is that it allows for a comparative analysis of the functioning of the tourism and recreation complex in regions with a similar set of input characteristics.

Suppose there are K input parameters and M output parameters for each of N objects (the term 'object' can mean regions, industries, enterprises, educational institutions, etc.). For the i-th object, they are represented by column vectors x_i and y_i, respectively. Then the matrix X of dimension K*N represents the matrix of input parameters for all N objects, and the matrix Y of dimension M*N represents the matrix of output parameters for all N objects. There appears a mathematical programming problem, which, using the theory of duality, can be formulated in the following form:

$$-y_i + Y\lambda \geq 0,$$
$$\theta x_i - X\lambda \geq 0,$$
$$\lambda \geq 0, \quad (1)$$

where θ – is a scalar, and λ is a vector of constants of dimension N×1. The value θ obtained when solving the problem will be a measure of the efficiency of the i-th object (region). At the same time, efficiency cannot take on a value of more than 1. For each object (region), a similar problem is solved N times.

Such a model is input-oriented and implies a constant scale effect, i.e., an increase in resource consumption leads to a proportional increase in production. In order to take into account the possibility of variable scale effects, a restriction on the sum of weight coefficients (λ) should be added to this model:

$$\sum \lambda_i = 1$$

As a result, after adding this restriction, a convex combination of reference objects is formed [8]. It is the application of the input-oriented model that makes it possible to assess the technological efficiency of the development of the tourism and recreation complex and determine directions for optimizing the management process.

As a rule, if it is necessary to evaluate the technological efficiency of the development of the tourism and recreation complex, an input-oriented model should be used. In this case, the technological efficiency indicator is the value by which the input parameters need to be changed in order to achieve efficiency equal to 1, which is a maximum score. In other words, the current performance values can be obtained with lower indicators characterizing the tourism and recreation complex (the main recommendations will be associated with a decrease in the values characterizing the tourism and recreation complex). It is also necessary to choose models that take into account the variable scale effect. In models of this type, each inefficient object is compared with efficient objects that have a structure (ratios) of indicator values closest to the structure of this inefficient object.

An essential condition for the selection of evaluation indicators and their division into input and output is their technological connection. It is also necessary to take into account the availability of indicators and their universality for all regions. The possibility of collecting data for a certain period is also of great importance. In this study, data for the period from 2017 to 2021 were used to assess the efficiency of the development of the tourism and recreation complex. Seven indicators were applied as 'input', and six – as 'output' (Table 1).

Table 1

Input and output indicators for the research base (by authors)
Входные и выходные параметры для расчета (разработано авторами)

Input indicators			
1.	The number of people employed in the tourism sector (in thousand people)	https://www.fedstat.ru/indicator/58699	The aggregated indicator was calculated as the sum of those employed in hotels and catering establishments, in travel agencies and other organizations providing services in the field of tourism, in sanatorium-resort organizations, museums, botanical gardens, zoos, state nature reserves, and national parks
2.	The number of rooms in collective accommodation facilities (in units, value of the indicator for the year)	https://www.fedstat.ru/indicator/31586	Ready-made indicator, without additional calculations
3.	The number of seats in public catering facilities (in units, value of the indicator for the year)	https://www.fedstat.ru/indicator/43259	Ready-made indicator, without additional calculations
4.	The number of travel agencies (in units, value of the indicator for the year)	https://www.fedstat.ru/indicator/31615	The number of legal entities, citizens engaged in entrepreneurial activity without the formation of a legal entity (individual entrepreneurs engaged in tourism activities). Total number of travel companies engaged in travel agency and tour operator activities, tour promotion, sightseeing activities, and other tourist activities
5.	The total fund of museums of the Ministry of Culture of the Russian Federation (in thousand units, value of the indicator for the year)	https://www.fedstat.ru/indicator/37794	Ready-made indicator, without additional calculations
6.	The area of protected territories of federal, regional, and local significance (in hectares)	https://rosstat.gov.ru/compendium/document/13295	Ready-made indicator, without additional calculations
7.	Investment in fixed assets (in million rubles, per year)	https://rosstat.gov.ru/folder/210/document/13204	Activities of hotels and catering establishments in the field of culture, sports, leisure, and entertainment (without small businesses)
Output indicators			
1.	Services of travel agencies, tour operators and other booking services and related services (in thousand rubles)	https://www.fedstat.ru/indicator/58467	Ready-made indicator, without additional calculations
2.	Hotel services and similar services providing temporary housing (in thousand rubles)	https://www.fedstat.ru/indicator/58467	Ready-made indicator, without additional calculations
3.	Services of sanatorium-resort organizations (thousand rubles)	https://www.fedstat.ru/indicator/58467	Ready-made indicator, without additional calculations
4.	Services of other specialized CSR (in thousand rubles)	https://www.fedstat.ru/indicator/58467	The indicator was calculated as the difference between the value of ‘Services of specialized collective accommodation facilities’ and ‘Services of sanatorium-resort organizations’
5.	Turnover of public catering (in million rubles)	https://www.fedstat.ru/indicator/31258	Ready-made indicator, without additional calculations
6.	Services of cultural institutions (in thousand rubles)	https://www.fedstat.ru/indicator/58467	Ready-made indicator, without additional calculations

We believe that the selected indicators of ‘entry’ sufficiently characterize the development of the tourism and recreation complex while having a transparent collection methodology, and the indicators of ‘exit’ objectively characterize the economic results of the functioning of the tourism and recreation complex enterprises. In addition, all the data are posted on the website of the Unified Interdepartmental Information and Statistical System and on the website of the Federal State Statistics Service, they are official, reliable, and publicly available. In the course of our research, the indicators were processed and the efficiency was calculated with the use of the DEEP program developed by Professor T. Coeli from Australia (https://economics.uq.edu.au/cepa/software).

Results

The efficiency of the development of the tourism and recreation complex was calculated for 85 subjects (constituent territories) of the Russian Federation for a five-year period, from 2017 to 2021. The change in the efficiency is shown in Fig. 1.

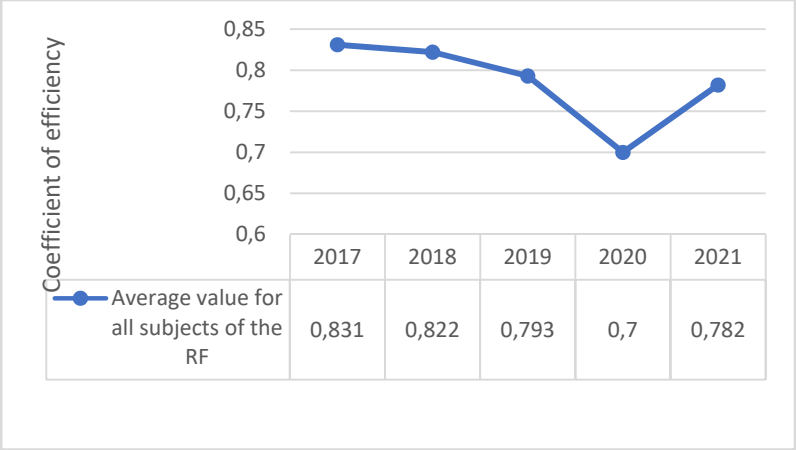
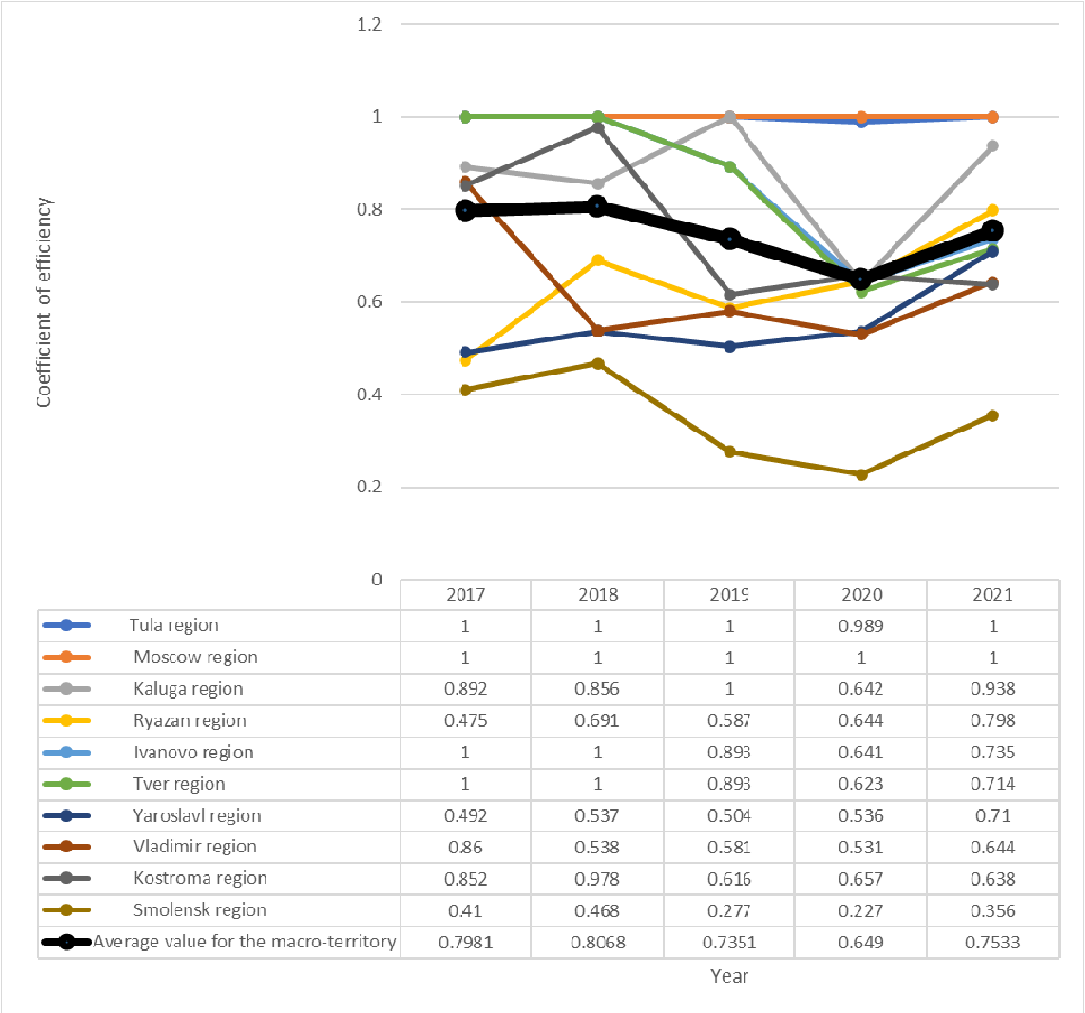


Fig. 1. The average efficiency of the development of the tourism and recreation complex in the subjects of the Russian Federation (compiled by the authors)
Рис.1. Среднее значение эффективности развития туристско-рекреационного комплекса субъектов Российской Федерации (составлено авторами)

The sharp decline in the efficiency that followed a declining but steady trend is explained by the negative impact of the COVID-19 pandemic.

The average efficiency values for the Russian Federation reflect the general trend, but it is more objective to identify spatial differences at the regional level. The objects of spatial analysis of the tourism and recreation complex's development efficiency were tourist macro-territories. On the basis of the State Program of the Russian Federation 'Tourism Development', we compiled a list of 12 tourist macro-territories and their constituent entities, taking into account the potential for tourism development [12]. The macro-territories included subjects of the Russian Federation that met the following criteria: they were attractive to tourists; there were tasks set for them to enhance investment attractiveness, expand the volume of services provided by enterprises of the tourism and recreation complex, develop tourist infrastructure, and increase the growth rate of tourist arrivals.

The subjects of the Russian Federation included in the tourist macro-territory "Bol'shoe Zolotoe Kol'tso" (The Big Golden Ring) are characterized by significant differences in efficiency values (Fig.2). The absolute leader is the Moscow region: it showed the efficiency score equal to 1 throughout all the five-year period. The Tula region is characterized by absolute efficiency values, with the exception of 2020. As a result of restrictions caused by the COVID-19 pandemic, a decrease in performance indicators is noted in 58 out of 85 subjects of the Russian Federation. Among the regions of the macro-territory 'Bol'shoe Zolotoe Kol'tso' (The Big Golden Ring), the efficiency value of the Moscow region did not change, and the Ryazan and Yaroslavl regions showed an increase in comparison with 2017. The Smolensk region has the lowest efficiency values, although there is noted a decrease in the indicator compared to 2017. This may mean that the existing parameters of the region's tourism and recreation complex significantly exceed the required level.



	2017	2018	2019	2020	2021
Tula region	1	1	1	0.989	1
Moscow region	1	1	1	1	1
Kaluga region	0.892	0.856	1	0.642	0.938
Ryazan region	0.475	0.691	0.587	0.644	0.798
Ivanovo region	1	1	0.893	0.641	0.735
Tver region	1	1	0.893	0.623	0.714
Yaroslavl region	0.492	0.537	0.504	0.536	0.71
Vladimir region	0.86	0.538	0.581	0.531	0.644
Kostroma region	0.852	0.978	0.616	0.657	0.638
Smolensk region	0.41	0.468	0.277	0.227	0.356
Average value for the macro-territory	0.7981	0.8068	0.7351	0.649	0.7533

Year

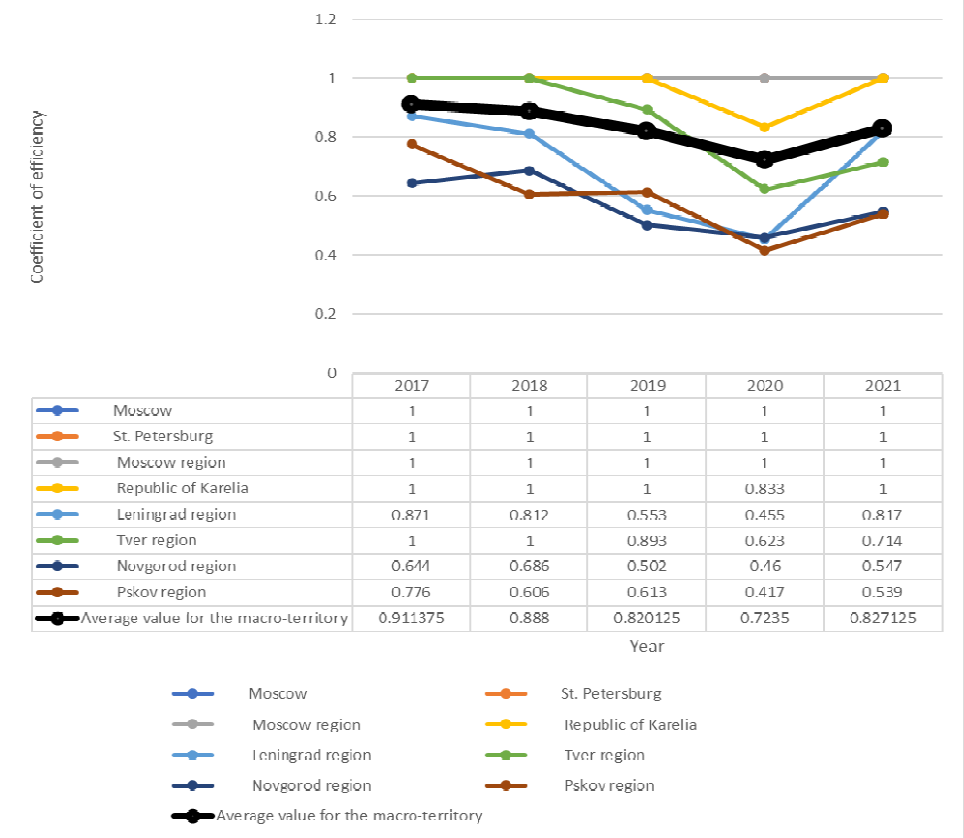
Fig. 2. The efficiency of the development of the tourism and recreation complex in the subjects of the Russian Federation being part of the macro-territory 'Bol'shoe Zolotoe Kol'tso' (The Big Golden Ring) (compiled by the authors)
Рис. 2. Эффективность развития туристско-рекреационного комплекса субъектов Российской Федерации, входящих в "Большое Золотое Кольцо" (составлено авторами)

The tourist macro-territory 'Zapadnyi Yug Rossii' (Western South of Russia) includes only two regions – the Republic of Crimea and the city of Sevastopol. Throughout the five-year period, the efficiency value for both regions is 1.

The tourist macro-territory 'Dal'niy Vostok' (Far East) comprises three subjects of the Russian Federation: Kamchatka and Sakhalin regions, and Primorsky Krai. The latter had the lowest efficiency values among the three regions – 0.711 in 2021, which is less than in 2017. Efficiency also decreased in the Kamchatka region (from 1 in 2017 to 0.854 in 2021). In the Sakhalin region, on the contrary, the efficiency score equal to 1 was observed throughout all the 5 years, which indicates the optimal ratio of the available parameters of the tourism and recreation complex and the economic results of the functioning of the tourism sector.

The regions of the macro-territory 'Vostochnyi Yug Rossii' (Eastern South of Russia) are characterized by a high level of tourism and recreation potential, the development of the tourism industry, and a stable tourist flow. The region where the efficiency score equal to 1 was observed throughout the study period is Krasnodar Territory. The efficiency in the Rostov region and the Republic of Adygea is below 1. Meanwhile, it should be noted that in 2020 the Rostov region showed an efficiency score equal to 1, which means that the ratio of input and output indicators during the pandemic was more optimal.

The tourist macro-territory ‘Iz Moskvy v Sankt-Peterburg’ (From Moscow to Saint Petersburg) is also characterized by a very high potential, a high level of tourist service, and a significant share of foreigners in the tourist flow. Three out of eight regions demonstrated the efficiency score equal to 1 throughout all the five years, from 2017 to 2021 (Fig. 3).



	2017	2018	2019	2020	2021
Moscow	1	1	1	1	1
St. Petersburg	1	1	1	1	1
Moscow region	1	1	1	1	1
Republic of Karelia	1	1	1	0.833	1
Leningrad region	0.871	0.812	0.553	0.455	0.817
Tver region	1	1	0.893	0.623	0.714
Novgorod region	0.641	0.686	0.502	0.46	0.547
Pskov region	0.776	0.606	0.613	0.417	0.539
Average value for the macro-territory	0.911375	0.888	0.820125	0.7235	0.827125

Fig. 3 The efficiency of the development of the tourism and recreation complex in the subjects of the Russian Federation being part of the macro-territory ‘Iz Moskvy v Sankt-Peterburg’ (From Moscow to Saint Petersburg) (compiled by the authors)
Рис.3. Эффективность развития туристско-рекреационного комплекса субъектов Российской Федерации, входящих в макротерриторию "Из Москвы в Санкт-Петербург" (составлено авторами)

These are Moscow, St. Petersburg, and the Moscow region. The Republic of Karelia, after a slight decline in 2020, returned to the efficiency score equal to 1 in 2021. A significant decrease in efficiency is observed in the Tver region. This can be explained by the fact that the pace of development of the tourism and recreation complex exceeds the growth rate of economic results. Consistently low performance indicators are characteristic of the Pskov and Novgorod regions, which are in a transit position between the two capitals.

The tourist macro-territory ‘Bol'shoy Ural’ (The Big Urals) does not have a single entity that would have had the efficiency score equal to 1 throughout all the five years. An overall decline occurred in 2020 and the efficiency score did not recover in 2021 to the values of 2017 (in 2017, all four regions – Perm Krai, the Republic of Bashkortostan, Sverdlovsk, and Chelyabinsk regions showed the efficiency score equal to 1). In general, the most favorable situation in 2021 was in the Perm region (0.933) and Chelyabinsk region (0.928). The Sverdlovsk region had slightly lower efficiency values (0.866), and the Republic of Bashkortostan had the lowest (0.572).

The tourist macro-territory ‘Bol'shaya Volga’ (The Big Volga) is the largest in terms of the number of regions. It consists of 13 subjects of the Russian Federation through the territory of which the Volga River flows (Table 2).

The Republic of Tatarstan and the Nizhny Novgorod region are effective in terms of the ratio of the tourism and recreation complex parameters and the economic results of its development. There is noted an increase in efficiency values in the Republic of Chuvashia and the Astrakhan region, which in 2021 reached a value of 1. A significant reduction in the efficiency indicator was observed in the Ivanovo, Tver, and Saratov regions. Having started in 2019, it intensified in 2020. The efficiency value in the Yaroslavl region increased almost 1.5 times, and, given the growth rate, we should expect the efficiency score equal to 1 in the coming years.

Table 2

The efficiency of the development of the tourism and recreation complex in the subjects of the Russian Federation being part of the tourist macro-territory 'Bol'shaya Volga' (The Big Volga) (compiled by the authors)
Эффективность развития туристско-рекреационного комплекса субъектов Российской Федерации, входящих в туристскую макротерриторию "Большая Волга" (составлено авторами)

Russian Federation regions	*Technological efficiency*				
	2017	*2018*	*2019*	*2020*	*2021*
Nizhny Novgorod region	1	1	1	1	1
Republic of Tatarstan (Tatarstan)	1	1	1	1	1
Chuvash Republic (Chuvashia)	0.908	0.947	1	0.91	1
Astrakhan region	0.762	0.792	0.927	0.828	1
Ivanovo region	1	1	0.893	0.641	0.735
Tver region	1	1	0.893	0.623	0.714
Yaroslavl region	0.492	0.537	0.504	0.536	0.71
Republic of Mari El	0.722	1	1	0.656	0.649
Saratov region	1	0.789	0.789	0.618	0.648
Volgograd region	0.788	0.806	0.841	0.644	0.647
Kostroma region	0.852	0.978	0.616	0.657	0.638
Samara region	0.664	0.835	0.611	0.596	0.634
Ulyanovsk region	0.527	0.516	0.452	0.424	0.626
The average value for the macro-territory	0.824	0.862	0.81	0.703	0.769

The tourist macro-territories 'Russkiy Sever i Arktika' (The Russian North and the Arctic) and 'Bol'shoy Kavkaz' (The Greater Caucasus) differ from the rest in that they are the only to show positive dynamics of changes in the average regional efficiency. On average, the efficiency index of the macro-territory 'Russkiy Sever i Arktika' (The Russian North and the Arctic) increased from 0.795 in 2017 to 0.88 in 2021, and that of 'Bol'shoy Kavkaz' (The Greater Caucasus) – from 0.788 to 0.832. The efficiency indicator increased in three of the four regions of the tourist macro-territory 'Russkiy Sever i Arktika' (The Russian North and the Arctic – the Murmansk region and the Republic of Karelia had an efficiency coefficient of 1 in 2021). The Republic of Ingushetia is the absolute leader in terms of efficiency growth in the 'Bol'shoy Kavkaz' (The Greater Caucasus) tourist macro-territory (0.191 in 2017 and 1 in 2021). In 2021, the efficiency score equal to 1 was also noted in Stavropol Territory, the Chechen Republic, and the Republic of Dagestan.

Among the regions of the tourist macro-territory 'Bol'shoy Altai' (The Big Altai), the leader is the Altai Republic (in all years except 2020, the efficiency coefficient was equal to one). The efficiency of the Kemerovo region was at approximately the same level during the period under review (0.804 in 2021). However, the situation in Altai Territory looks less optimistic: despite the increasing tourist flow and measures to develop tourism taken at the state and regional levels, the efficiency decreased from 0.891 in 2017 to 0.487 in 2021.

The Kaliningrad region, which is part of the 'Russkaya Baltika' (the Russian Baltic) tourist macro-territory, showed the efficiency score equal to 1 throughout the entire period, which indicates a balance between the tourism and recreation complex and the economic results of tourism development.

The situation is somewhat worse for the two regions that are part of the Baikal tourist macro-territory. In the Irkutsk region, the efficiency decreased from one in 2017 to 0.443 in 2021. In the Republic of Buryatia, after a noticeable decrease in efficiency in 2020, in 2021 the value was 0.702.

Of the eighty-five subjects of the Russian Federation, as of 2021, thirty-two are not part of any of the tourist macro-territories. However, among them, there are regions where the performance indicators were at a high level throughout the five studied years (the efficiency coefficient was equal to one). These are the Udmurt Republic and the Penza region. In 2021, the Kursk region (1), the Magadan region (1), the Nenets Autonomous Okrug (1), the Republic of Sakha (Yakutia) (0.963), the Tyumen region (without Khanty-Mansi Autonomous Okrug and Yamalo-Nenets Autonomous Okrug) (0.936), the Chukotka Autonomous Okrug (0.873), and the Kirov region (0.862)

had higher efficiency than the national average. Another group of territories to be noted includes the Novosibirsk region (0.856), the Voronezh region (0.832), the Belgorod region (0.828), the Omsk region (0.821), Khanty-Mansi Autonomous Okrug – Yugra (0.805), the Orenburg region (0.803), the Amur region (0.79), and the Khabarovsk region (0.784) – most of these regions are distinguished not only by the high relative efficiency of the development of the tourism and recreation complex, but can also become part of the existing tourist macro-territories.

Discussion and conclusions

In connection with the national project 'Tourism and the Hospitality Industry' and taking into account the need to improve regional policy in the field of tourism, the task of assessing the efficiency of the development of the tourism and recreation complex appears to be urgent. In our opinion, the efficiency coefficient calculated using the DEA method is a universal, aggregated indicator. As the experience of foreign studies shows, it can be used to create ranking lists related to the field of regional tourism, to compare regions with similar tourism and recreation potential, to assess the efficiency of management, environmental safety, development of various types of tourism, and can also be applied for the purposes of territorial planning and management at various levels of spatial organization.

Tourist macro-territories demonstrate different levels and different dynamics of the development efficiency of the tourism and recreation complex (Table 3).

Table 3

Map of changes in the efficiency indicator of the development of the tourism and recreation complex in tourist macro-territories of Russia for 2017-2021 (compiled by the authors)
Изменение показателя эффективности развития туристско-рекреационного комплекса туристских макротерриторий России с 2017 по 2021 гг. (составлено авторами)

Macro-territories of the Russian Federation	*2017*	*2018*	*2019*	*2020*	*2021*
Bol'shoe Zolotoe Kol'tso (The Big Golden Ring)					
Zapadnyi Yug Rossii (Western South of Russia)					
Dal'niy Vostok (Far East)					
Vostochnyi Yug Rossii (Eastern South of Russia)					
Iz Moskvy v Sankt-Peterburg (From Moscow to Saint Petersburg)					
Bol'shoj Ural (The Big Urals)					
Bol'shaya Volga (The Big Volga)					
Russkiy Sever i Arktika (The Russian North and the Arctic)					
Bol'shoy Altai (The Big Altai)					
Bol'shoy Kavkaz (The Greater Caucasus)					
Russkaya Baltika (Russian Baltic)					
Baikal					
Not included in the tourist macro-territories					

The gray color indicates the territories where the efficiency is lower than the average for the Russian Federation for the relevant year
The dark gray color color indicates the territories where the efficiency is higher than the average for the Russian Federation for the relevant year

The period from 2017 to 2021 included several key events that could affect the efficiency of the development of the tourism and recreation complex. These include the final stage of the 21st FIFA World Cup from June 14 to July 15, 2018, the introduction and operation of restrictions caused by the COVID-19 pandemic in 2020-2021, the launch of the national project 'Tourism and the Hospitality Industry' in 2021.

Unfortunately, it is difficult to unambiguously assess their impact and consequences, given the shortcomings of statistical accounting in the Russian Federation. This is a very time-consuming procedure for each region, requiring the involvement of experts from science, business, and government.

We can definitely say that, despite the general trend of declining efficiency, it is possible to identify several Russian regions that were on the border of efficiency throughout the entire period

under study (the efficiency coefficient was equal to one). In addition to tourist regions recognized as such, this group also comprises those that are not yet included in the tourist macro-territories. In our opinion, regional executive authorities of the Udmurt Republic and the Penza region should make efforts in this direction.

The obtained values of the efficiency coefficient of the tourism and recreation complex's development, showing the position of the regions on or within the efficiency boundary, allow us to develop recommendations for adjusting regional tourism development programs, for measures to be taken to stimulate tourism business, and for revaluation of the economic importance of tourism.

Further prospects for research using the DEA method in tourism are related to the study of the efficiency of transforming the tourism and recreation potential of regions into capital. In addition, it is possible to assess the efficiency of the development of tourism and recreation clusters, compare the efficiency of the functioning of the tourism and recreation complex components (hotels, restaurants, travel companies), and evaluate the budgetary efficiency of regional tourism policy. It should be noted that not only the basic DEA model can be used, but also some of its modifications (BCC-Output, BCC-Input, ADD, VarMult, InvMult, SBM, FDH-model). This would further increase the scope of practical application of the DEA method.

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