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Digital Tourism in the Development of the Arctic Region

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Abstract:

The problems considered in the work are determined by modern requirements in the growth of the tourism industry as an important system of social and economic development. Globalization in the tourism sector determines the need to transform and overcome the traditional forms of tourism. Tourism with the actual rhythm of life has ceased to be a means of rest only, it also acts as an active economic agent and a means of maintaining a remote business in its work. This allows us to say that digital tourism can attract a large audience at relatively low cost. The work defines that digital tourism is not only an external manifestation of the possibility of visiting places without detailed specification of their location, but also have access to technologies that allow designing the functioning of tourism facilities taking into account the data received from the introduction of digital technologies. The work shows that digital tourism completely changes the overall structure of the tourism industry, based on stream modeling, which allows tourists to stay in touch and be online during the entire travel period. The schemes of designing such a tourist route are shown, the ways of its introduction into the Arctic tourism sector are revealed, the mathematical model of the design of the capacity of the tourist flow of the Arctic is developed.

Keywords: tourism; the Arctic; digitalization; technology; designing.

JEL Classification: Z30; Z31; Z32.

Introduction

The Arctic in the Russian Federation acts as an object of economic interest, which is determined by the previously developed parameters on the extraction of minerals in a given natural zone. The arrival of tourists in the area can be noted as a rather fragmentary one. This correlates with the fact that the use of standard routes when traveling in the Arctic creates a strong link to individual settlements without the possibility of changing the location or changing the conditions of travel. It becomes impossible to accurately plan a tourist trip, there are too many factors that are not predictable. For this purpose, when developing tourism activities in the Arctic, it is necessary to provide the tourism space with all the necessary services. In this regard, it is determined that it is advisable to develop digital tourism in those zones that are only planned to be created by tourism.

In general, we can say that digital tourism in the Arctic is extremely developed. This is determined by the fact that the main importance and information resources are consumed in the planning of travel and while in the course of its implementation it is practically impossible to change some of the mechanisms and directions of tourism. In this regard, we see the relevance of the study, related to the definition of the possibility of locating the objects of digital tourism in the design of

tourist activities and tourist infrastructure (Kabanova et al. 2016; Frolova et al. 2016; Frolova et al. 2017; Bolgova et al. 2016; Vinogradova *et al.* 2015).

1. Literature Review

In intensive development of the tourism industry is possible only if there is a modern and efficiently functioning infrastructure (Pace and Dipace 2015). The management of the tourist digital infrastructure is quite a complex process and requires an appropriate scientific justification (Kalbaska et al. 2017). To date, the tourism digital industry needs to develop and implement effective decision support tools for all participants of the tourism market, in particular the tourist digital infrastructure (Evans 1999). In this context, the introduction of the latest information technology is on time and is largely in demand in the tourism industry (Inversini and Rega 2018).

The perspective of the territory from the point of view of the tourist's interest and the implementation of a diverse tourist business is characterized by the integrated indicator "the digital attractiveness of the territory" (Schott, 2015). Therefore, the adoption of effective decisions on the use of digital resources of the territory and the successful operation of a particular individual enterprise, as well as the development of the tourism industry in the region, requires a preliminary analysis of the processing of the corresponding forecast scenarios (Kyriakou 2016; Koroteeva et al. 2016). Currently, the decision to create new objects of tourist digital infrastructure is usually taken in the conditions of uncertainty that arises from the action of such factors as: the mass character of the phenomenon or process; sensitivity to the choice of initial conditions; inaccuracy of measurements; unclear plans; linguistic blurring of the formulation of the conditions of the problem and the purpose of its solution, and the like (Benyon et al. 2014a). Such factors can be taken into account in modern conditions using Soft Computing and the principles of diffusion to model the processes of spatial development, and in many cases, this is the most acceptable way to solve the problem (Benyon et al. 2014b).

So, one of the key factors of successful activity of various types of tourist enterprises is their respective territorial location, the development of methods for assessing the digital attractiveness of the territory and the creation on their basis of appropriate information technology for modeling the spatial development of tourist digital infrastructure facilities and this is an urgent scientific and applied task (Baggio and Del Chiappa 2013a).

The analysis of information technologies for modeling the objects of the tourist digital infrastructure was carried out (Gretzel et al. 2009). Problems are identified that arise when making decisions about investing in a particular tourist business project, choosing the optimal location of an object and estimating the digital resources that the territory has (Schmidt 2018). The notion of "digital attractiveness of the territory" was introduced and modern approaches to assessing the attractiveness of the territory and the digital potential of the territory at different levels were explored (Baggio and Del Chiappa 2013b). The expediency of using hierarchical output systems based on fuzzy logic and spatial modeling algorithms for the development of information technology for modeling the spatial development of tourist digital infrastructure facilities at the regional level is substantiated (Maurer 2015).

2. Methodology

In the work is used the method of modeling the capacity of a tourist territory, which is determined by the fact that the number of digital objects becomes sufficient to cover all the needs of tourists in the sources of access to the network and to provide the possibility of accessing information resources for clarifying information or changing the location for obtaining better information or tourist services. In this case, this forms the basis of the reverse response and the possibility of economic development of tourist facilities in the Arctic through ensuring competition.

Geographical method determines that the development of tourism objects of the digital infrastructure should not be provided only by separate locations. It is proposed to use fully autonomous complexes, which will fully reflect the reality and integrated vision for the development of digital tourist infrastructure facilities. The application of the geographical method is based on the development of maps, routes and perspective locations.

Each of these methods is supplemented by criteria for the advisability of socio-economic calculations for the development of the territory and the linking of data using programs for the development of Russian regions.

International and prognostic methods were used to designate the criteria for the growth of the tourist destination and the prospects for the growth of individual tourist clusters. At the same time, the understanding of digital tourism largely reflects the possibility of designing a sustainable industry than the methods of marketing and promotion in a digital form of the tourist area.

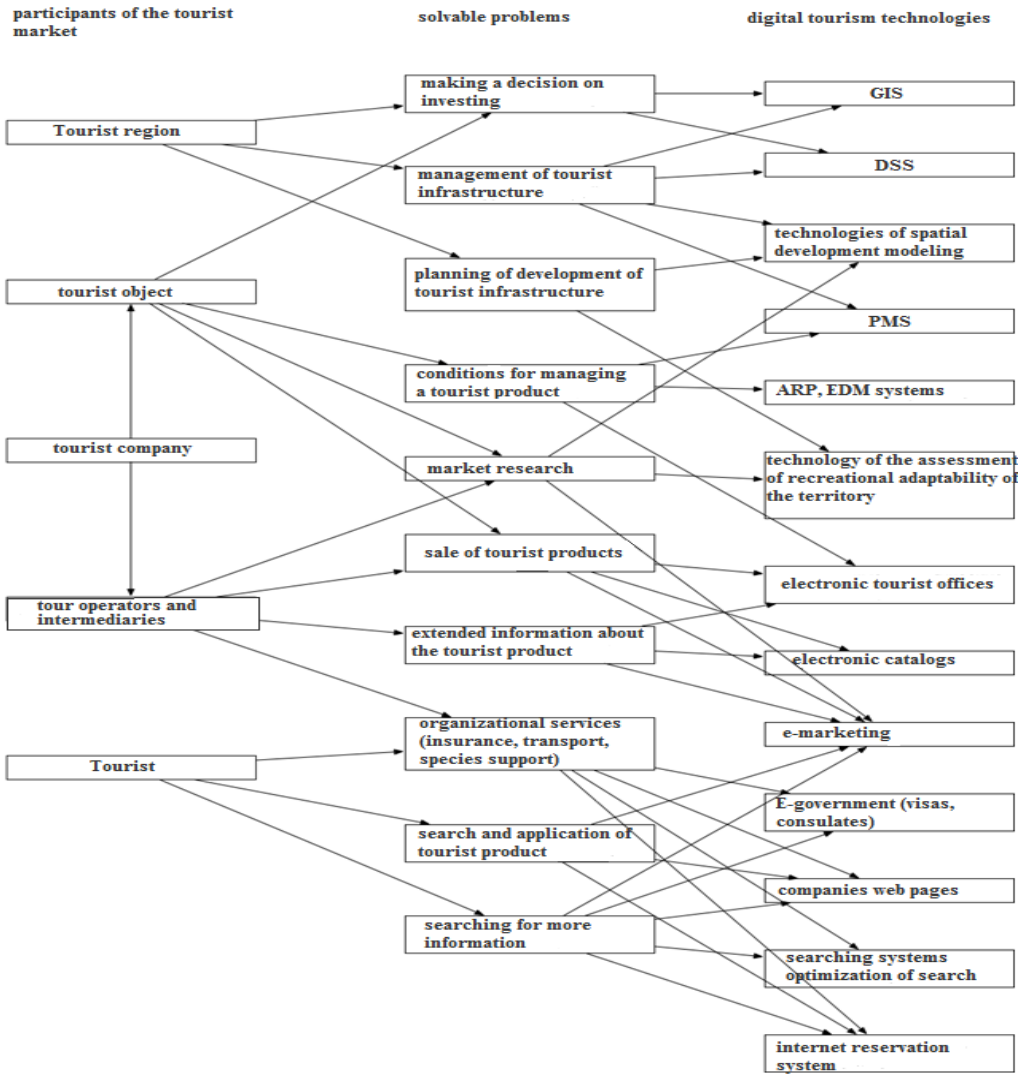
3. Results and Discussion

Digital tourist infrastructure is a combination of artificially created digital institutions and related facilities built for public use through public and private investment (Baggio and Del Chiappa 2014). The development of digital tourist infrastructure is impossible without the concentration of investment, as well as the introduction of technological innovation (Figure 1).

To analyze the prospects for the development of the tourist digital infrastructure in the region, it is necessary to first analyze the availability and quality of digital resources of the territory. The main characteristic of the tourist-digital resource, which influences the development of the tourist digital infrastructure, is its attractiveness. Digital attractiveness of the territory is an indicator of the ability of a certain type of resources to attract tourists to a specific object or complex of objects for a certain period of time with a specific need. The digital potential of the territory is determined by the maximum level of tourist services that can be offered in this territory (Sifiso 2013).

To increase the efficiency of decision – making in the tasks of choosing the optimal place for building and managing the spatial development of the tourist digital infrastructure of the territory at the regional level, it is necessary to create software tools for assessing and analyzing the digital attractiveness of the territory (Jorge 2018).

Figure 1. Application of information technologies by participants in the tourism services market



Based on the analysis of the collected information, it is possible to consider the development of information technologies as the first priority for assessing the index of digital attractiveness of the territory, assessing the digital potential of the territory and predicting the spatial development of tourist digital infrastructure facilities (Keller 2017).

Thus, using the available input data (digital maps, expert assessments, statistical data), it is necessary to create information technology that will allow analyzing the spatial distribution of digital resources in the region, predicting their use and making scientifically sound decisions regarding investing in the tourist digital infrastructure of the region (Zuccalà and Verga 2018).

We formulated the task of assessing the digital attractiveness of the territory and presented a developed method for its solution. The essence of this method is to use hierarchical output systems based on fuzzy logic to estimate the seasonal digital attractiveness of the territory. A model for calculating the index of digital attractiveness of the territory is constructed. The model parameters are defined, justified and mathematically described (Pelet *et al.* 2019).

Comparative analysis of the classical approach to modeling digital attractiveness (the method of analyzing hierarchies) and modeling based on fuzzy logic showed the effectiveness of the last one. The relationship between the seasonal level of the index of digital attractiveness of the territory, and the income from tourism on it is reflected.

The indicator of digital attractiveness of the territory is presented as a linguistic variable P = "digital attractiveness of the territory". The variable P is determined by the types of recreation and recreation that can be organized and implemented in a given territory, which depend on climatic, geographical, historical and cultural conditions and human activities (Liu and Bo 2015).

The indicator scale of digital appeal of the territory has five terms: "very low", "low", "average", "high" and "very high". P = "digital attractiveness of territory" is defined using a hierarchical system of fuzzy inference, which has five input variables and one resultant.

Input variables characterize the indices of attractiveness of certain types of recreation. For the territories of the Arctic, the current types of rest and recreation can be grouped into four groups: p1 = "attractiveness of rest on the specified route"; p2 = "the attractiveness of a route change"; p3 = "attractiveness of rest without using IT"; p4 = "Attractiveness of excursions and examination of historical-cultural monuments".

It is determined that the index of digital attractiveness of the territory P depends on 17 input parameters, which are represented as fuzzy linguistic variables: x1 = "possibility of swimming" x2 = "possibility of changing the route"; x3 = "the possibility of using high-speed Internet"; x4 = "possibility of communication with the technical support of the tour operator"; x5 = "type of rest"; x6 = "quality of access roads and information lines"; x7 = "readiness of the territory for recreation"; x8 = "completeness of information about the object"; x9 = "connection speed"; x10 = "connection exposure"; x11 = "technology change"; x12 = "quality of access roads and information technologies", x13 = "the possibility of conferences and remote work"; x14 = "the possibility of feedback about the facility"; x15 = "the possibility of restoring communication"; x16 = "access coordinates"; x17 = "rating assessments of the significance of the above objects".

It is shown that the overall seasonal level of digital attractiveness of the territorial unit R–Pd_R (t) consists of the attractiveness of all the elementary sites belonging to the territory:

$$PD_r(t) = L_r \times \sum_{i=1}^{n} \sum_{j=1}^{m} \begin{cases} P_{ij}(t) & G_{ij} \in R \\ 0 & G_{ij} \notin R \end{cases} \quad (1)$$

where L_R is the amount of population of the R administrative territorial unit; $P_{ij}(t)$ is the indicator of digital attractiveness of the territory of the elementary area G_{ij}; R – territorial unit; n is the number of elementary areas on which the investigated area is divided, horizontally; m – respectively, the number of elementary sections along the vertical.

Introduced the concept of the specific gravity of the territorial unit R in the total digital attractiveness of the highest by level of hierarchy the administrative-territorial unit in the structure of which includes R- $D_R(t)$ constitutes:

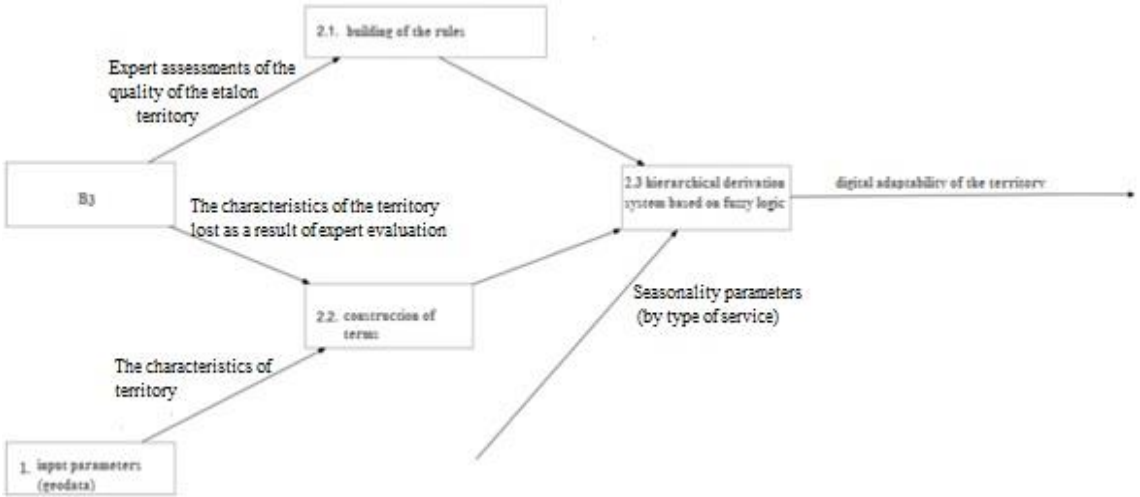
$$D_r(t) = \frac{Pd_r(t)}{\sum_{i=1}^{k} Pd_i(t)} \quad (2)$$

where k is the number of territorial units that are subordinate to one center of the hierarchical structure.

Thus, the main criteria for assessing the digital appeal of the territory of an administrative-territorial unit is the general level of attractiveness of this territory and the specific gravity of the attractiveness of the territorial unit in the digital attractiveness of the highest hierarchy of the administrative-territorial unit (for example, providing Wi-Fi technology in 100% of the hotel complexes of the district in the digital appeal of the area).

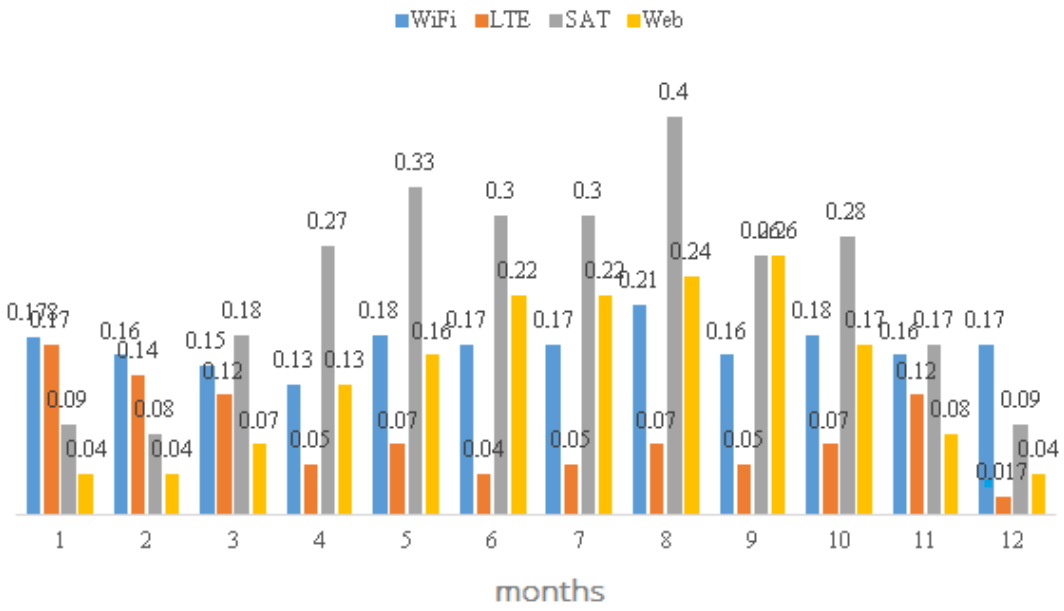
The scheme of data flows that are used in the information technology for modeling the spatial development of tourist infrastructure facilities for assessing the digital attractiveness of the territory is developed, as it is shown in Figure 2.

Figure 2. Scheme of data streams for calculating the digital attractiveness of the territory



Using the developed method and the created information technology, the results of the seasonal distribution of the digital attractiveness of the territory of the tourist objects of the Arctic according to the technologies used (Figure 3) were obtained.

Figure 3. Dynamics of digital attraction of tourist objects in the Arctic using digital technologies (in the context of the year)



Consequently, to assess the digital appeal of the territory for specific tourist-digital objects, territories of any area, populated areas, administrative districts and regions.

We also solved the problem of assessing the digital potential of the territory. A method for estimating the digital potential of the territory is proposed and justified. Automation tools have been developed to implement the proposed approach. The digital potential of the territory is determined by the maximum level of tourist services that can be offered in this territory. The digital potential of the territory is assessed for the existing tourist infrastructure, as well as the types of recreation available on it. It is represented by the linguistic variable A = "Digital potential of the territory", which we define with such a lot of terms "very low", "low", "medium", "high", "very high". A = Digital potential of the territory "= {" very low "," low "," medium "," high "," very high "} = {NB, NS, ZP, PS, PB}. The linguistic variable A is considering as a derivation of the output system based on fuzzy logic for such linguistic variables:

H = "provision of the territory with means of accommodation";

F = "provision of territory with public catering establishments";

E = "providing the territory with sports and entertainment facilities";

T = "level of transport infrastructure";

P = "seasonal digital attraction of the territory".

The linguistic variable H was given by the set of terms NB = "low level", ZP = "middle level", PB = "high level". In turn, the linguistic variable H = "provision of the territory with means of accommodation" depends on the provision of the territory with hotel places and the provision of the territory with places in sanatoria and health institutions. Therefore, the linguistic variable H will be considered as a conclusion of the logical inference system for linguistic variables x18 = "provision of territory with hotel places" and x19 = "provision of territory with the places in sanatoria and health institutions".

The linguistic variable F = "provision of territory by public catering establishments" is represented by a set of three terms NB = "low level", ZP = "medium level", PB = "high level". This variable depends on: x20 = "provision of places in restaurants and other catering establishments with the service of waiters"; x21 = "security in places in catering establishments with self-service".

According to existing regulations, provision of territory in places in restaurants and catering establishments with self-service is high, if there are 120 or more places per 1000 inhabitants. The average is 90 seats per 1000 inhabitants, low – 40 and fewer places.

The provision of the territory with sports and entertainment facilities E is also assessed using a fuzzy inference system that contains two linguistic variables x22 = "provision of territory with sports facilities"; x23 = "providing the territory with entertainment facilities".

The number of sports facilities per 1000 inhabitants is low, if it less than 1, sufficient – from 1 to 2 and high, if it is greater than 2. Entertaining institutions are discos, cinemas, billiard clubs and i.e. The number of entertainment establishments per 1000 inhabitants is also low, if it less than 1, sufficient – from 1 to 2 and high, if it is more than 2.

T = "level of transport infrastructure" depends on the provision of territory with means of communication. To compute T, two linguistic variables are used: x24 = "provision of territory with permanent access to the network" and x25 = "provision of territory with satellite tie".

In Figure 4 shows the scheme of data flows of the developed information technology for modeling the spatial development of tourist digital infrastructure facilities for assessing the digital potential of the territory. In Figure 5 shows the analysis of digital potential of tourist objects in the Arctic.

Figure 4. Scheme of data stream of the task of determining of the digital potential

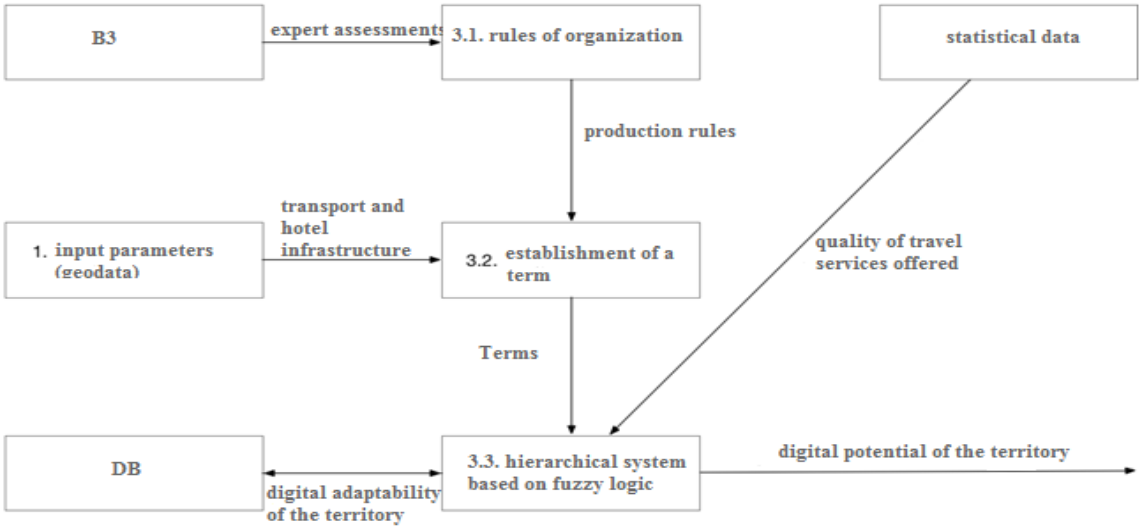
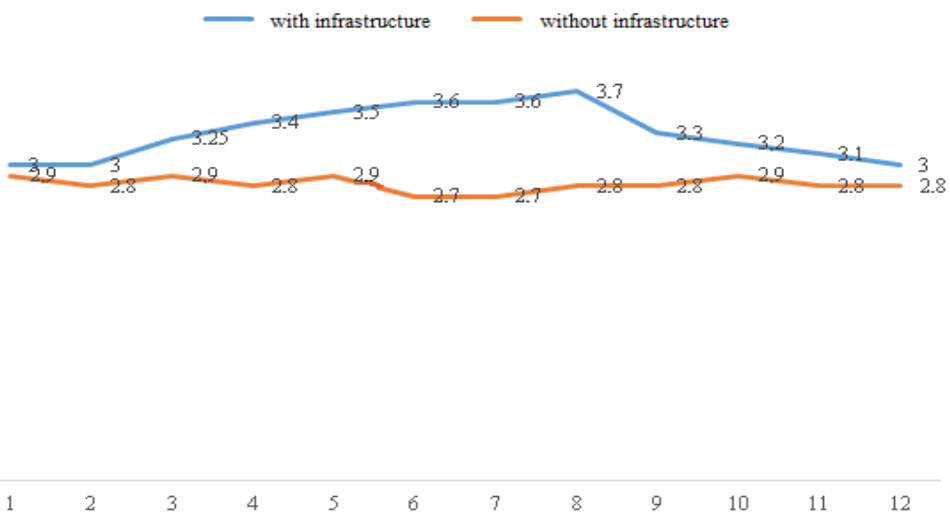


Figure 5. Digital potential of tourist objects in the Arctic

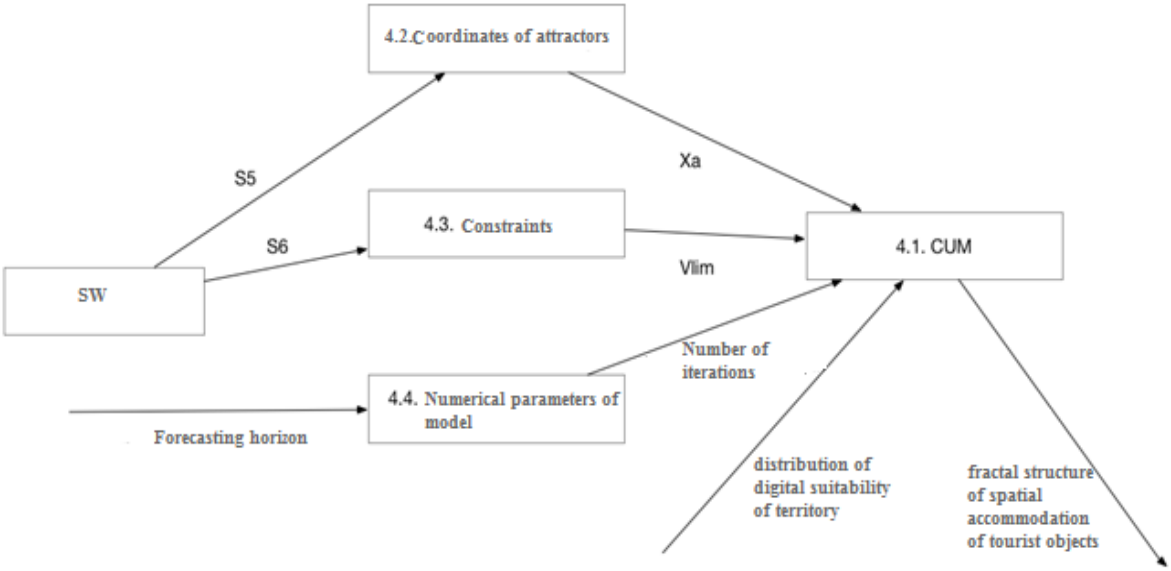


The results of numerical experiments confirm theoretical conclusions and can be used as a scientific basis for the development strategy of the region, its districts and individual settlements.

We have solved the problem of modeling the spatial development of the objects of the tourist digital infrastructure at the regional level.

A method for modeling the spatial distribution of the objects of the tourist digital infrastructure is developed, which takes into account the influence of the potential field of digital attractiveness of the territory, which makes it possible to study the development trends of the tourist digital infrastructure in the region (Figure 6).

Figure 6. Scheme of data flows for modeling the spatial development of tourism infrastructure facilities



To do this, we used the cellular model of urbanization – Cellular Urban Model (CUM), which is based on the theory of cellular automata. CUM implements the process of discrete diffusion using asynchronous cellular automata.

The development of tourist digital infrastructure takes place in areas where a lot of digital resources are concentrated. That is, new infrastructure objects will arise in areas with a high level of digital attractiveness and around them.

The content of the cellular model of urbanization is a multilayer system of matrices of a certain semantic content. The initial state of the system is the existing spatial arrangement of elements of the tourist digital infrastructure and settlements. Each cell of the machine is put in line with an element of the tourist digital infrastructure. The existing digital tourist infrastructure is represented by a matrix of clustering centers. The future tourist digital infrastructure is presented in the form of cells, begin to move in the system from a random remote point.

Particles randomly move to a potential field. As a result of aggregation, they form a cluster. A particle is making an aggregation (accession) or to the point center of clustering or to previously aggregated particles. The rules of interaction between cells can be represented as:

$$F_{diff}^{ur}: (Ter \times V_{lim} \times P) \cup X_a \rightarrow Ty \quad (3)$$

Generation of a flat grid:

$$F_0: Ter \rightarrow 1$$
$$I = \{(i,j)\}$$
$$i = \overline{1, i_{max}}$$
$$j = \overline{1, j_{max}}$$

Calculation of the probability distribution of urbanization:

$$F_1: P \rightarrow P`$$
$$P` = \{p_k\}_{k\in 1}$$

Restrictions on urbanization can be represented in the form of the following mappings:

$$F_2: V_{lim}^{`} \rightarrow V_{lim}^{``}$$
$$V_{lim}^{``} = \{v_k\}_{k\in 1}$$

Modeling of diffusion:

$$F_3^D: C_1 \times C_2 \times P` \times V_{lim}^{``} \rightarrow C_2$$
$$F_4: C_1 \times C_2 \times P` \times V_{lim}^{``} \rightarrow C_1 \quad (4)$$

C_1 – the set of particles of the initial state of the system $C_1 = \{C_k^1\}_{k\in 1}$,

C_2 – a big number of aggregated particles $C_2 = \{C_k^2\}_{k\in 1}$;

Formation of the type of urbanization of Ter sort: $F_5: C_2 \rightarrow Ty$.

The modeling algorithm consists of three steps:

1) a certain i-th cell with coordinates c^i (x, y) is randomly determined on the cellular field;

2) the coordinates of the neighboring with point c^i point c^k are randomly determined;

3) two selected cells interact with each other according to their characteristics j and, by the interaction rules, the cell characteristics c^i_j and $c_k{}^i$ are determined in the next state of the system.

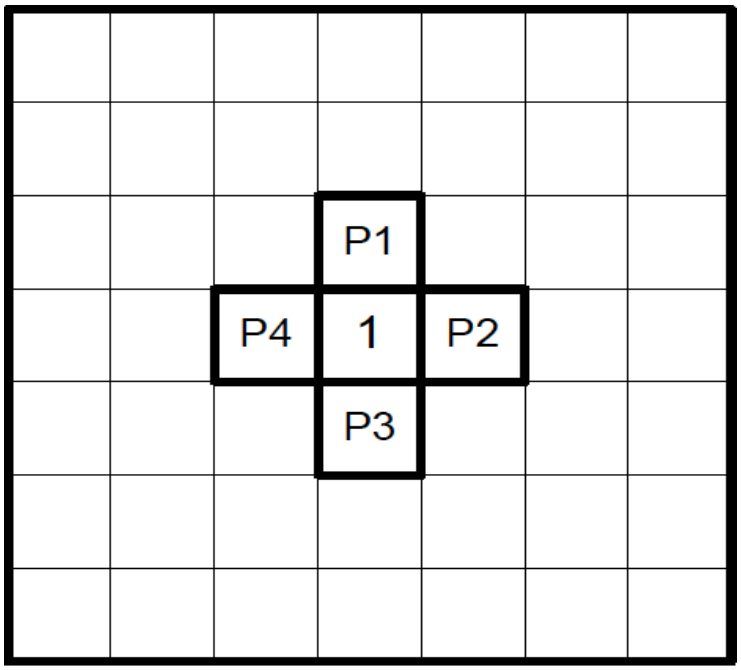
To model the spatial location of the objects of tourist digital infrastructure, we describe the dendritic growth in the form of such a model of discrete diffusion: the matrix c_1 describes the initial state of the system; matrix c_2 – takes into account the possibility of moving particles (0 – motion is forbidden, 1 – motion is allowed).

$$\begin{cases} c_1^i = c_1^i + s(c_1^2 - c_1^1)(1 - c_2^1)(1 - c_2^2) \\ c_2^i = c_2^i + c_2^{i+s}(1 - c_2^i)c_1^i \end{cases} \quad (5)$$

for i =1,2 – indices of two cells that interact, s =+1 for i =1, s = -1 for i =2.

The spatial distribution of the probability of tourist urbanization is taken into account by adding an additional layer of p – distribution of the digital attractiveness of the territory. We denote the probability of the transitions p_i, i = 1,..., 4 (Figure 7).

Figure 7. Probabilities of interaction of cell $c_1{}^i$ with neighboring



To determine the direction of the transition, the p_i values are normalized. After that, integrated probabilities are calculated. Further, ξ is chosen from the homogeneous distribution. Determining the index of the cell, with which the interaction will be performed, k.

$$\overline{p_i} = \frac{p_i}{\sum_1^4 p_i}$$

$$p_{int1} = \overline{p_1}$$
$$p_{int2} = \overline{p_{int1}} + \overline{p_2}$$
$$p_{int3} = \overline{p_{int2}} + \overline{p_3}$$
$$p_{int4} = \overline{p_{int3}} + \overline{p_4}$$

$$k = \begin{cases} 1 & \xi < p_{int1} \\ 2 & p_{int1} \le \xi < p_{int2} \\ 3 & p_{int2} \le \xi < p_{int3} \\ 4 & p_{int3} \le \xi < p_{int4} \end{cases} \quad (6)$$

Figure 8 shows the results of computer modeling of the future spatial location of the objects of the tourist digital infrastructure of the Arctic.

The algorithm was performed with a different number of iterations: the greater the number of acts of cell interaction, the greater the horizon of prediction. To verify the adequacy of the results obtained, let us compare the spatial arrangement of new (aggregated) objects of the tourist digital infrastructure with the spatial location of access points that have arisen in the

Arctic for the period from 2012 to 2018. From Figure 8 it can be seen that the spatial location of the objects projected for 2019 coincides in most cases with the location of tourist digital objects that appeared during the control period.

Figure 8. Prospective locations of the tourist digital infrastructure of the Arctic

Conclusion

The work analyzes the existing information technologies used for decision making in the tourism industry, reveals the lack of tools for modeling the spatial development of tourist digital infrastructure facilities at the regional level, assessing the digital attractiveness of the territory and the digital potential of the territory. The authors developed a method for assessing the digital attractiveness of the territory with the help of output systems based on fuzzy logic, which, unlike geographic methods, allowed to consider the qualitative characteristics of objects, many types of tourism and seasonal features of touristic recreation. The method for estimating the seasonal digital attractiveness of the territory at the local and regional levels and the means for automating the cartographic representation of the spatial distribution of the seasonal digital attractiveness of the territory have been identified, which have made it possible to determine the tourist specialization of the territory that is promising for the development of tourism in the Arctic region and to form a package of tourist services.

We have presented a method for calculating the digital potential of a territory using fuzzy logic output systems and taking into account the qualitative parameters of the territory and the existing tourist digital infrastructure, has been made the analysis of the location of existing and prospective recreation and tourism centers, and have been determined the current trends in recreational in the region. The cellular model of urbanization has been improved to simulate the processes of spatial development of tourist digital infrastructure facilities at the regional level by modifying the algorithm of asynchronous cellular automata, which made it possible to justify and optimize the development of tourist digital objects, and also to supplement them with the corresponding social and transport infrastructure.

The information technology developed by authors, including the developed methods for assessing the digital attractiveness of the territory, the digital potential of the territory and modeling the spatial development of the objects of the

tourist digital infrastructure at the regional level, which made it possible to significantly improve the possibilities for conducting tourist business and using the natural and digital resources of the territory. With the use of the developed information technology, a computer simulation of the spatial development of the objects of the tourist digital infrastructure of the territory of the Arctic region was carried out. The base of seasonal maps of digital attractiveness and digital potential of the Arctic region is formed. The territorial distribution of the digital attractiveness of various types of tourism activities has been obtained.

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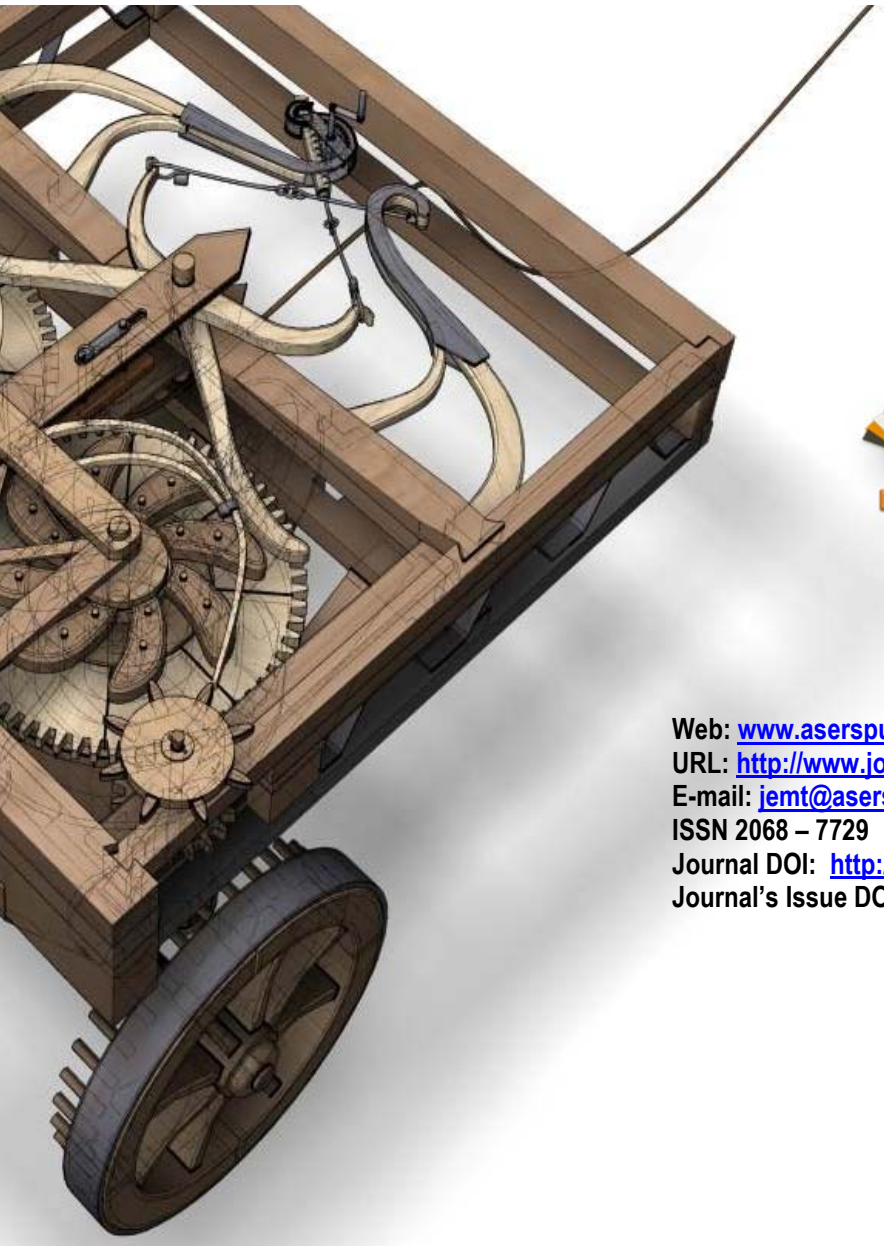

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