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Modeling and Optimization of Socio-Economic Aspects for the Development of Tourism

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Abstract:

The paper deals with the variants of providing digital nomadism with tourist services and service under conditions of global informatization. In order to increase the mobility of this category of tourists, the authors offered a model of information support in accordance with the strategy of global geoinformation supporting of travel infrastructure. The navigation system of information depository is focused on the localization of life support system points with optimal combination of infrastructure objects. For filling the information depository of tourist destination determination and annotation of most significant objects and access points to global tourist system of informatization have been carried out. When choosing the above-mentioned objects, the authors proceeded from the following founding principles: accessibility of objects to Internet system sources; consumer preferences; security. To ensure quality of tourist services and service the analysis of the state of global tourist information system infrastructure is carried out in the paper. Following the findings, proposals for the implementation of information depository model are developed. The markers of system orientation in space providing the link of object location with geoinformation field are included in the depositary information field. In general, the offered model, according to authors, will contribute to comfortable and safe movement of digital nomads on tourist route.

***Keywords*:** travel; informatization; global positioning; depository.

JEL Classification: L83, L86, O18.

Introduction

The tourist branch is saturated with information and modern information technologies, which have a key role along with financial, material, and labor resources, should be used to provide quality level of management. The use of modern information technologies in the tourist branch involves optimization of tourist market's objects' behavior and providing of meeting of their goals. The methods of obtaining and processing data make the analysis more effective, enable to take into account various factors of influence and limitation, to provide management decision

making under conditions of uncertainty (Wallace and Dearden 2005; Kabanova *et al.* 2016; Frolova *et al.* 2017; Frolova *et al.* 2016; Vinogradova *et al.* 2015).

The effective development of tourism depends on the adoption of modern information technologies. This applies to both automatization of work of tourist companies, hotels, staff workplaces and software for strategy planning and support of decision making in the tourist branch. The paper focuses on existing software utilities used in tourism, as well as unsolved tasks and prospects of using information systems of digital tourism (Patokorpi 2006; Akhmetshin *et al.* 2018).

Nowadays there is a contradiction in digital tourism: on the one hand, sufficiently developed mathematical tool of modeling of digital tourism processes, which helps to take decisions reasonable from the scientific point of view; on the other hand, decisions in the tourist branch are taken at quality level (Balyuk and Ermakova, 2013). The solution of this contradiction requires the solution of an important scientific-practical problem, which is to create specialized information system, based on which manager, investor, power institutes could make reasonable decisions by the choice of building place, arrangement of digital tourist infrastructure elements, strategy of touristic-recreational system developments, which conditioned the relevance of the study. At this point we can state the notion of digital nomads – people who use the tourist branch only within the framework of destinations, which are reflected in global information space and have corresponding digital infrastructure (Malek 2006). This infrastructure can be represented not only with traditional version of hotels or any other places for vacation but also is integrated in the social sphere of city. There is no uniform definition of a new form of employment flowing. The "digital nomads" notion unites people, who work in the Internet and lead traveling (or half-sedentary) way of life. There is a lot of methods of making money online (Meyer 2003). Some gain income due to their blogs, online stores or just time-work at large employment platforms like Upwork or Fiverr. Some have full-time job in large international companies, which reject from office in its traditional form and transferred communication between employees to online chats.

1. Methodology

The purpose of the paper is formation of structure of providing digital tourism functioning, determination of unsolved tasks and building the structure of information system for modeling tourist branch infrastructure (Frolova 2012; Frolova 2016). The methods of global geoinformation modeling for the analysis of successful projects of digital nomadism building were used in the paper. The methods of mathematical statistics, modeling and system analysis were used for possible areas of forecasting of existing branch and global structures of digital nomadism. Information technologies used in digital nomadism can be divided into classes, as they are shown in Figure 1.

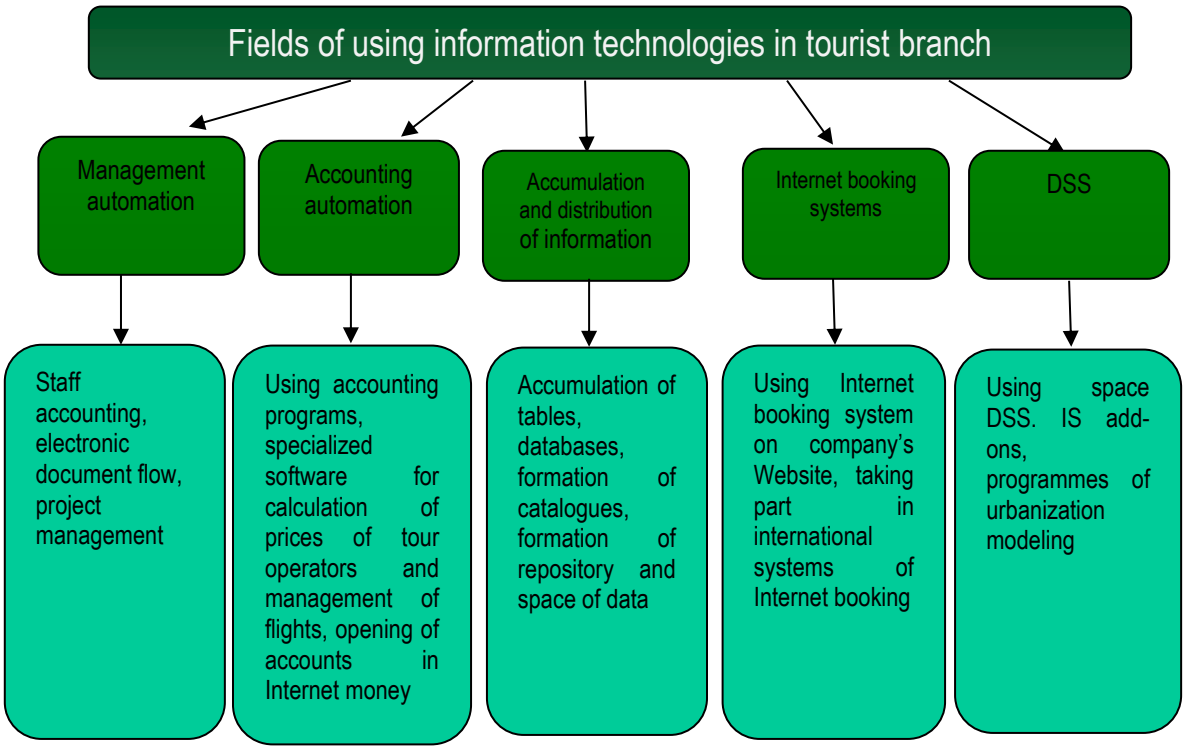

Figure 1 – Fields of using information technologies in digital nomadism

In the field of automation, complex programs of automation are involved, which provide effective functioning of tourist destination, the relation to tour operator – tourist agency, entering the global systems of booking (Wettergreen *et al.* 1998). Such programs allows forming tourist product, preparing special offers with fixed and floating extra charges and discounts, calculating expected gain per tour and amount of commission fee to the agent, controlling information about contracts and its deadlines, executing tourists' documents, printing price lists, tours, tourist lists, vouchers, forms to embassies, financial reports, supervising tours, evaluating financial standing of travel company, creating reference books with description of hotels, transport, policy conditions, visa support, additional services (Rousseaux *et al.* 2014; Bolgova *et al.* 2016).

2. Results and Discussion

Online booking systems – booking.com and others are the most popular systems of automation of management. Such systems involve individual and group booking of rooms, check-in, accommodation and check-out of guests, management of hotel room capacity; they allow interacting with a number of centralized systems of booking, doing business in the Internet, carrying out multidimensional analysis, comparing performance of hotels, revealing tendencies and forecasting business development (Rousseaux *et al.* 2014). The systems of Internet-booking provide airline services, accommodation services, information on location, weather conditions, exchange rates, bus and railway service (de Carvalho 2014).

The systems of management account automate business processes in digital nomadism. Oracle Data Integrator, DB2 Information Integration programs are used for accumulation and distribution of information. It should be noted that these products are used in many areas and are not specialized only for digital nomadism needs. Forecasting and support of decision in tourist branch are carried out using software products of urbanization modeling, geographic information system (GIS) and add-ons and space DSS.

GIS provides analysis, evaluation, forecasting, monitoring of tourist infrastructure, natural resources management, modeling and forecasting of region portrait. One of a few shortages of GIS is in-built tools of data processing, which are significantly inferior to special mathematical packages.

Space decision support system (DSS) are computed systems designed to support users or user groups in achieving the highest effectiveness of the process of decision making at solving partially structured spatial tasks. The systems are consisting of DSS and GIS, are used for rendering of assistance related to spatial planning and management in land-utilization decision making. The review of software showed the absence of specialized spatial DSS for digital nomadism, and existing systems aren't adapted for solving digital nomadism tasks (Naz 2016).

Software used for modeling the processes of urbanization is a complex, multipurpose means and is used in different areas of science (urban studies, geo-informatics, ecology, tourism) (Kiziloz and Kupatadze 2015). From the digital nomadism point of view, software products of such type are used to determine attraction of territory, sites for construction, dynamics of localities' development, which makes it possible to make management and investment decisions reasonable from the scientific point of view at different levels. These programs are focused on the modeling of large cities, as evidenced by a large number of input parameters for determining urbanization probability. Economic factors, transport, data on population, amenities, social field, neighboring types of land use and random factors are weighted interrelated factors, the absence of some of them for small settlements leads to incorrect determination of urbanization probability and ineffective modeling in general. Historical maps of few time periods are also necessary for successful use of programs. Often there are no such data for small tourist towns, many of them are founded relatively not long ago or there are no informative changes in their structure, which is a programs' shortage (Kryukova *et al.* 2016).

The development of tourism in region requires scientifically grounded decision making. Tourist towns develop stochastically, and elements of infrastructure and building are located without proper analysis of attraction and effectiveness of territory use. Management of such processes and forecasting are an important component of successful development of digital nomadism, since they are related to land price, investment, recreational flow, determination of price policy (Winkelhake 2018).

The review of information support showed that existing IS don't allow solving this issue in a complex way, although it is relevant for local government, tourist agency heads, managers, investors.

Cellular automata are one of main approaches, which gain currency in modeling of non-linear complex systems. Besides, the number of using of cellular automata for city system modeling increases. Cellular automata are discrete dynamical systems, which behavior is completely determined by local and generally accepted interaction rules.

The method of Support Vector Machines (SVM) is usually tested as a method determining non-linear rules of navigation for digital nomadism. Variables for modeling are taken from the data of Earth remote sensing, GIS,

government agencies. Data on the development of land from 1988 to 1993 are used for model learning. The offered model was tested with the use of data of development of Shenzhen (China) over the period from 1998 to 2004 and for city status forecasting in 2010. The check of results showed a good correlation between actual and modeled development of the city. The offered method achieves high accuracy as compared to the models of linear logistical regression. Other example of non-linearity accounting is the use of kernelbased learning techniques. The practical modeling of urbanization of Guangzhou (China) showed insignificant increase in modeling accuracy as compared to neuro-net based cellular automata (Teramoto and Jurčys 2014).

The example of fuzzy networks and cellular automata integration with the use of GIS is work in the USA. A three-layer neural network with several output neurons designed for calculation probabilities of transformation for several competitive types of land use was built. The model also includes the iteration cycle of neuro-net to simulate the process of gradual transformation on land use type. GIS was used to get the attribute of location and learning sample of data. This approach was successfully used for modeling regions in the South China, which rapidly develop with the use of real data of satellite images. Modeling accuracy – 83 %, which is quite an acceptable result (Czarniawska 2014).

It is also offered to calculate the distribution of probability using mathematical methods used to process images. Models were approved when modeling the development of a mountain town Ivaki Newtown and showed a high level of adequacy (Vlcek 2017a).

In a number of cases the dynamics of using Buffalo, NY, city lands are modeled, with the use of cellular automata and GIS, the modeling of San Francisco Bay Area urbanization was carried out, the changes of use of Cincinnati city lands by the method of limiting cellular automata were modeled.

Based on different models and methods with a high level of adequacy modeling of territories was carried out, however, the common shortage of these approaches is the absence of automatic information system with the opportunity of selecting territory and parameters of modeling directly by the user.

The detailed spatial models of city growth, which can trace the city development in the past and forecast expansion scenarios in the future are key ones for determining the policy of effective planning. The studies of spatial forms and characteristics of urbanized systems, forecasting of future scenarios of their development were carried out in a number of works (Vlcek 2017b).

A new model of city expansion (UES) is developed by the combination of “ascending” model based on cellular automata and “descending” model based on system dynamics. The implementation of UES model is carried out by the example of Beijing, city growth is modeled from 1991 to 2004 and city development is provided from 2004 to 2020. The results showed problems: city expansion, on the one hand, and limitation of water resources and environmental degradation - on the other hand.

A combined use of the methods of remote sensing, the system of spatial indicators and spatial modeling for analysis and simulation of Santa Barbara city growth (California) has been described. The study is based on 72-year information set based on the interpretation of the historical, aerial photography and satellite images IKONOS. A spatial forecast of the city growth to 2030 has been obtained (Darley *et al.* 2017).

Modeling of Dublin from 1968 to 1998 using cellular automata (CA) has been carried out. Using information set over 1968 was the basis of modeling, the results were compared to information set over 1998. The obtained data are realistic and comparatively accurate, which was confirmed by the effectiveness of CA usage. The disadvantage is the need for using large sets of historical data, which is an obstacle in the case of studying spatial structures of digital nomadism.

When reviewing places of digital nomadism, in which spatial forms of urbanized systems are studied and their future scenarios of developments are forecasted, a sufficiently large variety of approaches of data selection for modeling, building probability distributions, selection of the type of CA has been distinguished. All reviewed models are approved by the example of large cities and territories. However, the use of CA for the needs of tourist industry is a new approach, is poorly studied. Thus, the series of future scenarios of the change of city land use and consequence for building up potential, development of economy and demand for European tourist region are provided. Using MOLAND model, four scenarios of future city growth based on the data for Algarve (Portugal) regions were created. In all scenarios the city growth is a consequence of population increase, in particular, due to tourism and economic changes. However, spatial structures differ with alternative assumptions about city processes of development and goals of expansion. The results of modeling are successfully illustrated in the range of possible scenarios of the change of land use or earth cover for 2020. They contain useful data for the beginning of discussion about “behavior” and the future planning of city infrastructure development in European tourist region.

The separate use of GIS in the area of digital nomadism mainly comes to the tasks of optimal arrangement of infrastructure facilities, search for optimal routes and organization of vacationists’ leisure (Bessant 2014).

The evaluation and comparison of the influence of arrangement of potential ski resorts within two valleys in Italy closely related to tourism are carried out. The used method is based on the calculation of spatial indicators with using GIS for forecasting and quantitative determination of critical impacts, such as ecosystem loss and fragmentation, soil erosion, geomorphic dangers, intervention into the life of local flora and fauna. The multi-criterion analysis is used to create composite indices, as well as to range mountain skiing regions in accordance with their general suitability.

The separate provisions of digital nomadism contain a study based on GIS model, which determine most attractive for ski resort development settlements in the Rocky Mountains, USA. 85 effective resorts of the region have been chosen, each of them was evaluated by four criteria: seasonal snowfall, potential skiing season, proximity to conservation areas and availability of localities, which could render services for skiers and vacationists. The results are used for all localities in the region of the Rocky Mountains and localities potentially suited for rebuilding as ski resorts are determined (Vlcek 2017c).

It's possible to use spatial DSS based on GIS, which are united in a friendly user graphical user interface. The program product is developed to help visitors of national park Great Smoky Mountains in the effective choice and leisure time planning. The disadvantage of the considered DSS is the absence of program web version, which will provide guests with the opportunity to plan travels from their home until they come to the park and allow them to optimize time spent in the park.

The risks of the Taiwan industry of digital nomadism were also evaluated. To build "The estimation model of tourist region" the method of layering and GIS, which integrates the information in relation to emergencies (propagation of landslide, debris flows, precipitations and typhoons, potential inundation maps) was used. The general map of natural danger distribution is built based on this information. The module facilitates the process of decision-making in terms of selection of optimal places for construction of new tourist objects, as well as development of disaster prevention strategy.

Integrated system of analysis based on GIS (IGAS) to support preservation of lakes at the boundary of cities (in potential regions for urbanization) was developed. IGAS consists of the modules of evaluation of land use suitability, demand analysis, evaluation and distribution of land. The example of system implementation is carried out in the region of Hanyang lake within the city Hanyang, central China, which exercises the significant pressure of urbanization. IGAS can help local authorities better understand complex systems of land-use and develop more enhanced strategy of land resource management, which will preserve the balance of city expansion and environment.

The study of trade in tourism and distribution of tourist center of attractiveness is carried out based on GIS ESRI ArcView. The meaning of GIS is shown for decision-makers and developers of tourist destination points (Formica 2013).

A model of optimization of allocation of tourist infrastructure based on genetic algorithms and its usage in European Alps is offered 18 quantitative criteria covering all types of tourist activities and services in the region under study were chosen. These criteria are transferred into GIS layers, created for the procedure of generic optimization, following which the places of optimal allocation were compared to the places of allocation of existing infrastructure and worse scenarios.

The issues of quantitative evaluation of modeling accuracy are considered. All methods can be divided into three groups (O'Carroll 2015):

- visual comparison of maps;
- comparison of maps and fractal structures by relatively abstract values of fractal dimension type;
- quantitative evaluation of the degree of coincidence between two maps (fractal structures) with the use of matrix comparison method.

The first method is intuitive and doesn't shed light on precise quantitative idea of calculation results, that's why it's rarely used in practice. The second method is used to study fractal structures of urbanized systems and test CA models. Other cellular identifiers (square, perimeter) are calculated together with fractal dimension. The base of the third method is a degree of map coincidence with related indices. This approach is convenient to reveal the same cells in both maps taking into account their positions at by-cell comparison. Fractal structure of cities determines the concept of self-similarity. By definition fractal objects are self-similar and are characterized through fractal dimension. That's why the method of structure comparison with comparatively abstract values is most preferable for quantitative evaluation of modeling accuracy (Aurigi 2013).

Today the use of GIS for the purpose of digital nomadism is a sufficiently widespread practice. Numerous studies, the base of which is the use of GIS to solve specific highly specialized problems, touch upon this issue. It's rarer to use GIS in complex tasks and for integration with information systems. Besides, there's an enhancing class

of mathematical models, which can be effectively used in the tasks of the study of characteristics of tourist urbanized systems, forecasting of development processes and effective land use. However, the problem of integration of models and information technologies into a single information system, which can be effectively used by state bodies to manage the industry of digital nomadism, stays relevant and unsolved.

The analysis of existing normative-legislative framework by the issues of recreational-tourist activities demonstrated inadequate attention to informatization of digital nomadism and solution of designing issues, the creation or adoption of automated system of decision support in tourism, a single information system of digital nomadism area. In one of basics of state policy in the area of tourism carrying out research and development, project and search works by the relevant problems of development of recreational-tourist economies, the use of natural and historical-cultural potential of the country, creation of geoinformation system are determined. It should be noted that there's no this system in digital nomadism, although the information could be useful for planning tourist flows and building strategies of territory development by both separate customers of tourist services and state bodies of different levels.

The analysis of software, mathematical means of tourist branch and literary sources allowed distinguishing unsolved issues.

The absence of information system for modeling the processes of digital nomadism infrastructure development. The existing software products are specialized on the modeling of infrastructure of large cities, which are developed according to master plan. In its turn, the branch of digital nomadism develops stochastically, since the determination of territory for infrastructure development depends on the people's or investors' choice. This predetermines the need for development and usage of information system, which will allow studying spatial forms and development of the infrastructure of digital nomadism branch, tourist attractiveness of territories.

The presence of isolated mathematical models of spatial distribution of infrastructure of digital nomadism, which give opportunities to solve the tasks of modeling of tourist infrastructure development. Tourist branch belongs to a class of complex system. To study these systems a multimodel approach is used since each of such models can describe only one system parameter. As a rule, models use similar input data, have advantages and disadvantages and aren't automated. For effective use of these models it's necessary to study peculiarities of their application in the area of digital nomadism, to automate and integrate them into a single information system.

The development of the methods of automation and creation on this basis information, which unites advantages of reviewed software products and designed to forecast digital nomadism infrastructure, stays an unsolved task. It will allow solving the next practical tasks: to provide necessary information to local bodies, which are engaged in planning of development of the infrastructure of tourist settlements, to facilitate the problem of choice of promising tourist sites for investing and doing tourist business. Information system should consist of the following components: input data block, the block of spatial distribution of territory belonging to urbanization, modeling block and decision-making block.

The majority of software, which use for digital nomadism infrastructure modeling and development, get input parameters by GIS, which is a sufficient data source for calculation. The effectiveness of using geoinformation system is confirmed in many papers. GIS-technology, virtually, unites digital processing of images, representative graphics with database technology. This allows the researcher to carry out a wide range of actions, related to selection, processing, storage and analysis of information. Such technologies differ with high flexibility and availability, which makes it possible to assert the high effectiveness of their use as information system components. In the system under development GIS is used to select spatial data, to form training set, to select infrastructure elements and to display modeling results.

Based on GIS a data base is formed, using which the following calculations are carried out: determination of territories for placing new buildings, land price, infrastructure elements, calculation of territory investment attractiveness. In turn, the methods of mathematical statistics are conventionally used. The results obtained in the course of modeling indicate that the use of data base allows obtaining more accurate results, that's why this component will be a part of information system.

Only one automated model is used to forecast city space structure. That's why an automated program module of mathematical model of forecasting digital nomadism is a necessary element of information system. Besides, the use of several mathematical models will allow modeling different aspects of infrastructure, increase the effectiveness of decision-making, since different models have advantages and disadvantages.

The obligatory parameter of many models is a degree of territory fitness to urbanization, which is calculated based on two approaches. The first is based on the theory of probability (calculation of spatial distributions of urbanization probability), the second – based on the use of fuzzy logic device. Calculations based on fuzzy logic showed better results, that's why in this paper the module of building spatial distributions of territory belonging to

urbanized one is used. This will allow automating the process of building distribution, integrating results into a program code of models as an input parameter.
Context of the diagram of data flows of information system is shown in Figure 2 (Data Flow Diagram). By information system there are the following external substances: GIS (1), Matlab (2) and (3). The block scheme of functioning of information system should be as in Figure 3.

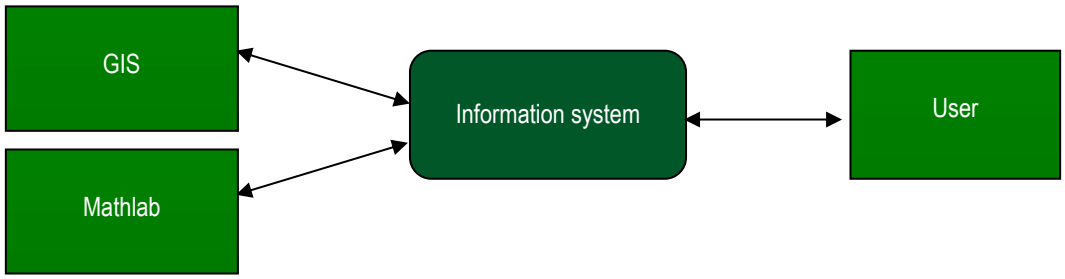

Figure 2 – Context diagram of information system data flows

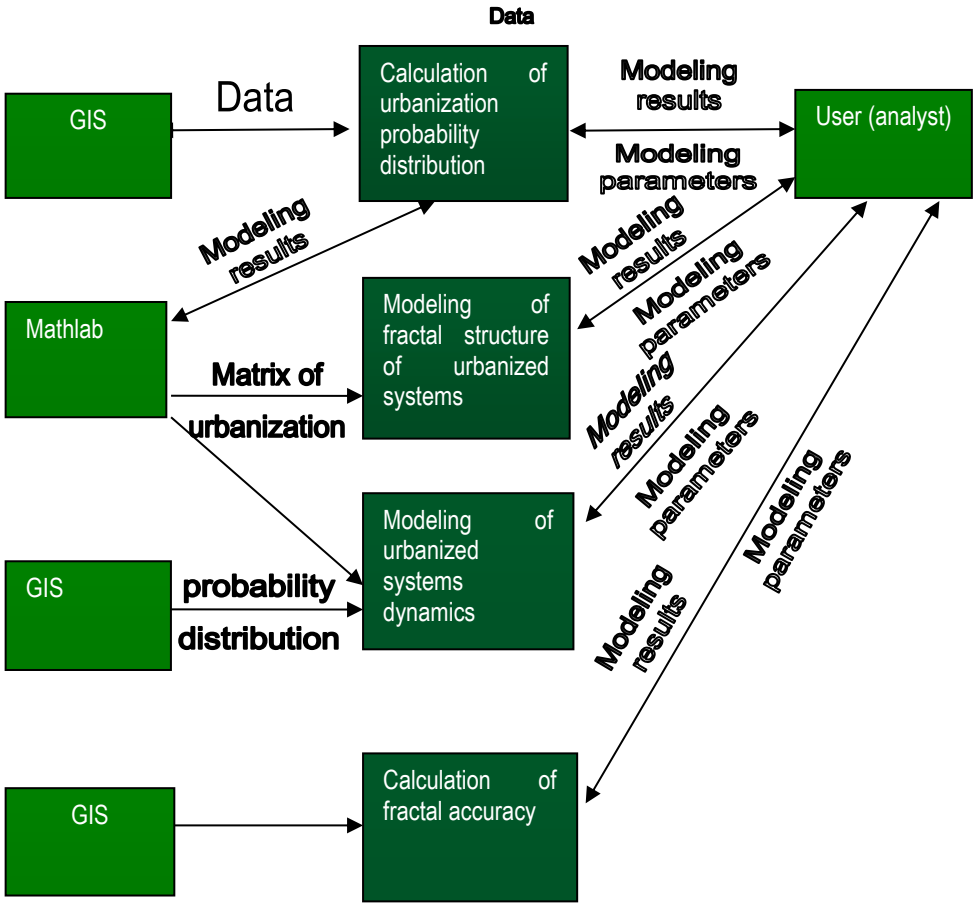

Figure 3 – Diagram of information system data flows

The program graphical interface reflects the upper level of information system, uniting automated models of exchange of geospatial data, building the forms of spatial structures, spatial distribution of probabilities and knowledge base. The user set parameters of modeling, chooses necessary model from the list and the area of modeling with GIS; calculations are carried out based on Matlab, the results of modeling are provided to the user in the form of graphical windows.

Information system has four blocks. The first relates to the calculation of distribution of territory belonging to urbanized one, other three blocks – to modeling of fractal structure, dynamics of development of infrastructure of tourist settlements and accuracy calculation.

The automated relation of information system and GIS gives opportunity to effectively use geospatial data and use opportunities of geoinformation system to solve set tasks. Since information in GIS constantly update – information system automatically acquires capacity to work with modern data. The processing of data in Matlab expands the opportunities of information system, since in-built tools of GIS significantly inferior by the possibilities of mathematical package. The built information system can solve unsolved tasks in the area of digital nomadism and become an instrument for scientifically grounded decision making when planning strategies.

Conclusion

The modern state of program and methodological means, information support of digital nomadism are analyzed in the paper. Software in the area of digital nomadism is generalized and classified. The analysis showed that there is a sufficient number of program products to automate the work of digital nomadism, accounting and booking systems, at the same time there are no specialized software to forecast the development of digital nomadism infrastructure.

From the set of unsolved tasks, it's determined that development of automation methods and creation on this basis information system integrating methods and means of mathematical modeling of digital nomadism infrastructure is the most important one. A structure of information system is offered. It's shown that obligatory components are GIS, data base, automated program module with several mathematical model of digital nomadism infrastructure forecasting, the module of building spatial distribution of territory belonging to urbanized one. The structural scheme of information system flows is built, which gives us the idea of the top level of its functioning.

The development prospects of the branch of digital nomadism taken in conjunction with the results of social-economic modeling should be mentioned. Thus, the use of previously developed principal scheme will mainly allow corresponding to the understanding of general structure and quality filling of migration flows of digital nomads. As a rule, these are people with higher income level, who can implement and multiply the territory potential to the full, balance social and economic development and in such a way determine the structure of government development.

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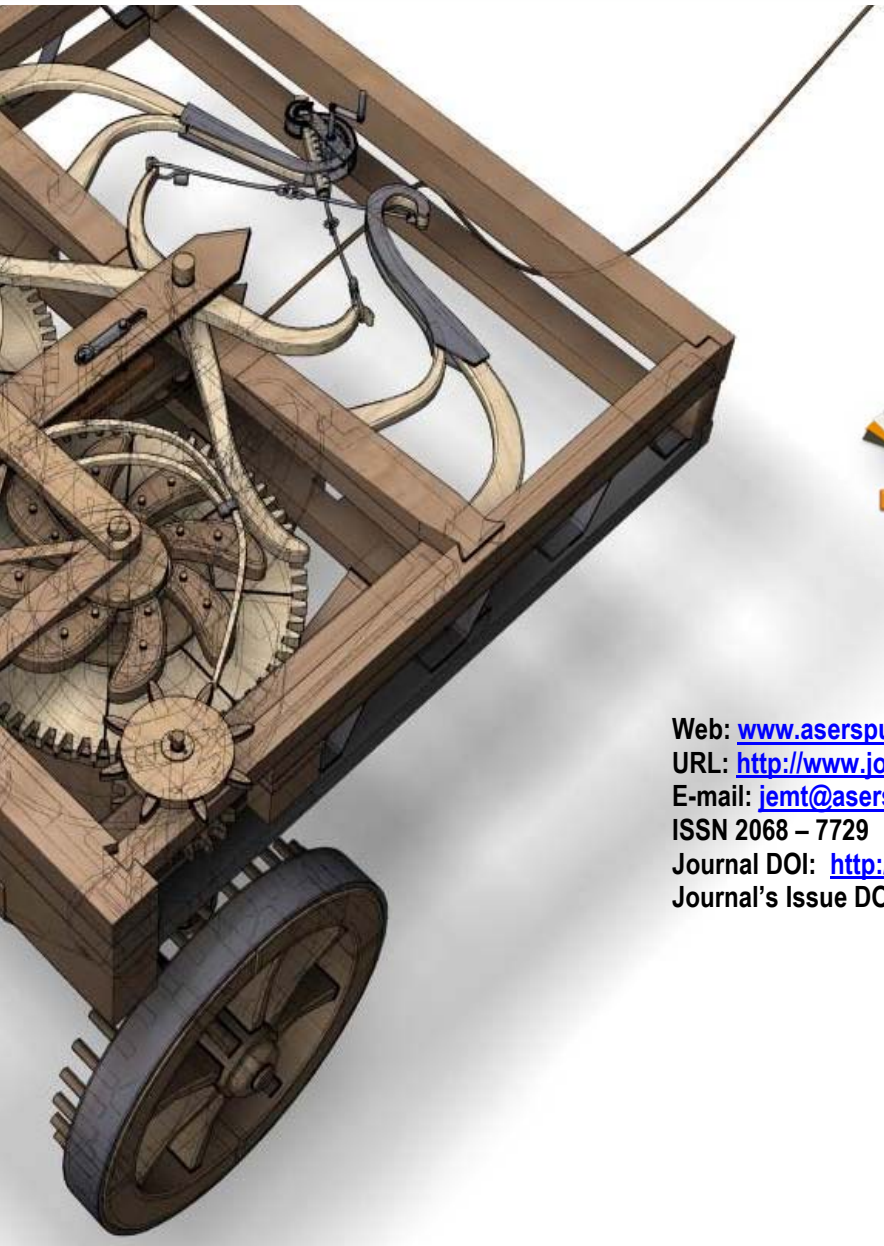

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