Procedures of Expert Evaluation of the Parameters of Smart Sociopolises (on the Example of the Subsector "Medicine")

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Abstract. Prospects and ways of acquiring the status of "smart" by ecosociopolis Truskavets are considered. Achieving the status of "smart" territory will contribute to the development of medical tourism, as the natural resources of the sociopolis have created an excellent recreational area for the development of this area of the economy. For the sociopolis of Truskavets, medicine is one of the most important factors in assessing its sanity. Without the proper state of hospitals, sanatoriums and clinics, without the introduction of telemedicine, the development of the region will slow down.

Keywords: evaluation, criteria, "smart" city, medicine

INTRODUCTION

The development of a certain city to acquire the status of "smart" requires an assessment of its condition and strategic prospects. Evaluation is conducted for each industry separately. To conduct such an analysis, each industry has its own specific criteria. Basically, scientists identify the following areas of evaluation of "smart" cities:

- Smart economy.
- Smart ecology.
- Smart transport infrastructure.
- Smart management.
- Reasonable quality and safety of life.

THE STATE OF RESEARCH OF THE PROBLEM

In this article, taking into account the experience gained by mankind in 2020, during the Covid-19 pandemic, we believe that the industry of "Smart Quality and Safety of Life" is becoming the most relevant. After all, the health of the population and medical care in extreme conditions are one of the key points in this industry. In general, this industry can be divided into several subsectors:

- Education,
- Medicine,
- Security in the city,
- Availability,
- Opportunities for recreation and leisure.

Despite the high development of science, technology and economics, the world was unprepared for the events of 2020. According to the website (https://coronavirus.jhu.edu/map.html) for the whole period since the beginning of the pandemic officially registered 110 million cases, for 2.4 million people they were fatal, in Ukraine for the entire period of the pandemic registered 1.3 million cases . The pandemic affected the economies of all countries. The closure of most countries' borders has caused problems for many industries, including air transport, tourism and small business. The crisis has led to the bankruptcy of many companies. In 2020, the losses of air carriers amounted to about $ 113 billion, although at the end of February 2020 the possible losses were estimated at $ 30 billion [1]. According to world bank forecasts, the fight against the covid-19 pandemic will cost $ 28 trillion. [2].

Mankind has already had to deal with epidemics, in 2009-2010 it was a swine flu pandemic. According to statistics, up to 575,400 people died as a result of this pandemic [3,4]. Gained experience in combating the Ebola epidemic, which was recorded in 2014 in West Africa. In 1918, the Spanish flu claimed the lives of 80 million people. In an interview with Rolling Stone magazine in 2014, Bill Gates predicted the threat of new pandemics of viral diseases. At a 2017 security conference in Munich, Bill Gates warned: "Epidemiologists believe that an airborne pathogen can kill more than 30 million people in a short period of time, less than a calendar year." The appearance of such a pathogen may be associated with a mutation, accident or terrorist act [6]. There are many more examples of the need for humanity to gain experience in preventing

threats to life from man-made and natural disasters, wars, and now infectious diseases.

It is not the first time that humanity has encountered diseases that can spread rapidly and cause the deaths of millions of people. This process is accelerated by the opportunity to travel for leisure, study and business, international trade. However, humanity, as it turned out, was not ready for the manifestations of a global pandemic. There was an urgent need to manufacture a large number of disposable medical clothing, medical masks, medical equipment, the development of artificial intelligence technologies for the analysis of human symptoms, treatment methods, telemedicine.

At the same time, the problems that arise in the field of health care must be addressed not only at the global level, at the level of states, but also in cities where a large part of the world's population lives. The reform of the medical sector of Ukraine envisages the conclusion by patients of a declaration for service by a district doctor. As part of the reform, the family doctor can serve 1,800 patients, the therapist - 2,000, the pediatrician - 900 [7]. During the epidemic, district doctors have a significant daily burden of providing medical care to a large number of patients. As part of the admission procedure, the doctor must communicate with each patient live. That is, to fully examine the patient and listen to him. In this case, despite all the means of protection available to both the patient and the doctor, there is a danger that the patient may infect his doctor, and vice versa, the sick doctor, without knowing it, can transmit infection through contact with the patient [7]. To avoid the risk of infection, telemedicine technologies have been intensively introduced in Ukraine.

EXPERT EVAIUATION OF THE LEVEL OF DEVELOPMENT OF MEDICINE IN THE SOCIOPOLIS OF TRUSKAVETS

This requires the development of a set of information systems and technologies. The solution to the problem will be facilitated by an intelligent information system, which, based on these symptoms, helps to determine the diagnosis and generate recommendations for choosing a treatment protocol, which is carried out under the supervision of a doctor. The functionality of the system reduces the number of misdiagnosis and helps in determining the disease from the input data, such as test results, examinations, the patient's symptoms, etc. This approach eliminates the need for the patient to visit the clinic, and the doctor - trips to the homes of patients without urgency, helps to organize remote procedures for diagnosing the disease and choosing a treatment protocol, reducing the workload of doctors. In addition to such important criteria as the availability of a sufficient number of experienced doctors tand health workers, intelligent information systems and technologies play an important role in the reorganization of the health care sector. An important role in the pandemic situation is played by the condition of the buildings in which hospitals are located,

the organization of a sufficient number of places for potential patients, provided with the necessary equipment, stocks of medicines in case of emergency. An example of unpreparedness for critical situations is the medical system of Italy, which is considered a country with a highly developed economy and medicine. The medical system of this country in the spring of 2020 could not withstand the load due to the significant number of infected patients, which reached 7 thousand new cases per day. If we talk in more detail about the eco-sociopolis Truskavets, the population today is about 160 thousand. At the same time, from the beginning of 2021 (for the period from 01.01.2021-17.02.2021) the total number of registered new patients within the eco-sociopolis Truskavets is 720 people [8]. During this period, the peak days for the number of new diseases are February 12 - 83 people and 60 people - February 5 [8].

According to the website of the National Health Service of Ukraine, there is only one hospital within the Truskavets eco-sociopolis, where patients with Covid-19 can be treated inpatiently - the Stebnytsia City Hospital. The total number of beds for infected patients is 110, beds in the intensive care unit 20, the number of doctors 56, and the number of ventilators 5 [9].

Also, according to this site, the total number of beds for patients infected with Covid-19 in Ukraine is 58.3 thousand. The total percentage of citizens provided with beds in infectious wards of hospitals that receive patients with Covid-19 and inpatient treatment in the eco-sociopolis of Truskavets, Lviv, Kyiv and Ukraine in general (Table 1) [9].

TABLE 1. THE RATIO OF THE NUMBER OF BEDS IN INFECTIOUS DISEASES DEPARTMENTS TO THE POPULATION

Settlement	Number of population	Number of infectious beds	Percentage of providing citizens with a place in a hospital
Ukraine	44 million	58,3thousand	0,1325%
Kyev	3 million	5069	0,16%
Lviv	745 thousand	1910	0,25%
Lviv region	2.5 million	3675	0,147%
Ecosociopolis Truskavets	165 thousand	110	0,06%

According to this table, the ratio of the number of beds in the infectious diseases department of Stebnytsia City Hospital to the population of the Truskavets eco-sociopolis is 2.2 times lower than the general average in Ukraine and 2.45 times lower than the average in Lviv region.

TABLE 2. NUMBER OF DOCTORS AND POPULATION IN THE ECO-SOCIOPOLIS OF TRUSKAVETS

Settlement	Population	Number of doctors	Potential number of patients	Percentage of provision of citizens, number of doctors
Boryslav	33 186	10 family doctor	18000	142,22%
		11 therapists	22000	
		8 pediatricians	7200	
Truskavets	28 701	10 family doctor	18000	86,75%
		3 therapists	6000	
		1 pediatrician	900	
Drogobych	75 396	42 family doctor	75600	115,92%
		5 therapists	10000	
		2 pediatricians	1800	
Stebnyk	20 858	2 family doctor	3600	115,54%
		8 therapists	16000	
		5 pediatricians	4500	
Skhidnytsia	2244	2 family doctor	3600	160,43%

Data on the number of family doctors, therapists and pediatricians were obtained from the web pages of city hospitals. According to the reform of the medical sector of Ukraine, a family doctor can serve 1,800 patients, a therapist - 2,000, a pediatrician - 900 [7], as mentioned above. According to these data and the number of doctors, it can be concluded that the eco-sociopolis of Truskavets is provided with a sufficient number of medical workers, except for the city of Truskavets. The city of Truskavets is provided with 86.75%. But only doctors working in the central hospitals of Boryslav, Truskavets, Stebnyk and Drohobych are taken into account. Excluding medical specialists from private hospitals (such as the Kozyavkin International Rehabilitation Clinic) and sanatoriums, the estimated number of existing sanatoriums in Truskavets is 30, each of which has its own diagnostic and treatment facility. The potential opportunity for patients to make a declaration for medical care with a doctor is 187.2 thousand cases. This potential is enough to make declarations with all residents of the Truskavets eco-sociopolis. The basis for concluding agreements may be the analysis of patient feedback that accumulates on the websites of clinics, hospitals and social networks.

SENTIMENTAL ANALYSIS OF PATIENT REPORTS AS A CRITERION FOR EVALUATING THE QUALITY OF MEDICAL SERVICES

To evaluate the effectiveness of a clinic, an individual doctor should conduct sentiment analysis (sentiment analysis) of messages, which is also called analysis of the tone of the text (opinion mining), because it is a field of research focused on analyzing thoughts, moods, evaluations, emotions, attitudes people to the entities and their attributes expressed in the written text. Conducting sentiment analysis under the entities we understand services, events, problems, topics. In recent years, social networks have been effective platforms for obtaining information on the quality of medical services, as they allow patients to freely share information, express their opinions and views on the quality of medical services. This approach has changed the way it is possible to obtain candid, objective information about the state of work of a medical institution or an individual medical specialist. The basis for making decisions about choosing a medical institution to seek medical care is the information obtained from social media posts that contain opinions about the medical institution. Their analysis is using sentiment analysis methods. Undoubtedly, the impressions about the topics, events and personalities of doctors are discussed on social networks, expressed in posts and become the basis for analysis. According to social media posts, a doctor's sentiment profile can be determined based on the opinions expressed about him by patients in their publications or comments. Such information can be used in various ways, for example to recommend a doctor's services or to analyze the quality of services provided. In addition, social media users not only publish posts, but also interact with each other, discuss, argue and express their attitude to certain objects in this way. Recognition of such information is important for the development of medical institutions. Managers of medical institutions want to know the opinions of patients and the public about the services provided.

Every year, new ideas and approaches to the study of texts on emotional coloring appear, as well as existing methods are improved. This improves the quality of such analysis. Approaches used for sentimental analysis of posts on medical sites and social networks may be different.

Convenient for tonal analysis of posts is the method of machine learning, which is based on the use of lexicons [10, 11].

It is based on knowledge combined into a corpus, there is a study of a particular corpus of texts and vocabulary in it. This method is used to detect tonality and uses different tonal lexicons. This approach can be called one of the simplest, because it comes down to identifying tonal units in the text, which is quite simple in the presence of a lexicon. The preparatory process during which the lexicon is formed is difficult. To obtain the final tone value in the course of our study, we use a simple method: we calculate the arithmetic mean or the sum of the tone values of all words in the document. We

form tonal dictionaries of three types:

1) dictionaries that contain only words;

2) dictionaries that contain words and the polarity of the assessment;

3) dictionaries that contain words, polarity and level of assessment [12].

This method is easy to use, but there are very few corpora for the Ukrainian language.

Another method, based on the rules and templates enshrined in the language, is based on a set of rules that are developed during the study. An example of one of the rules for the sentence "I passed a wonderful examination" can be interpreted as follows, if the adjective "wonderful" belongs to a number of positive adjectives ("wonderful", "beautiful", "good",…) and does not belong to a number of negative adjectives ("terrible", "ugly", "bad",…), the tone should be classified as positive. The described approach can give good results in the presence of a large array of rules. However, creating a large number of rules manually takes a long time. In addition, this approach is not always effective for the analysis of texts from social networks, because they contain a large number of errors, slang expressions, etc.

In our study, a method based on machine learning with a teacher came in handy. In machine learning techniques, training and test samples are used for classification. The set of educational materials contains vectors of input features and corresponding class labels. With the help of a training sample, a classification model is developed, with the help of which the direct classification of input feature vectors according to the corresponding class labels is carried out. To test the model, we used a test sample, providing labels of classes of invisible vectors of objects[13].

The use of machine learning with the teacher provides high accuracy when determining the tone of posts on social networks and websites. The problem of dependence on the subject area is solved by teaching the classifier on the basis of a sample from this area, the classifier itself identifies the features that affect the tone. The disadvantage of this method is that the research can be conducted only on a defined collection of texts, but the posting of posts on social networks is quite a long process.

In the course of research in the sentimental analysis of texts from social networks we used various learning algorithms, ie different classifiers:

- classifiers based on decision trees;

- linear classifiers: on the basis of support vector machines and on the basis of neural networks;

- classifiers based on rules;

- probabilistic classifiers: naive Bayes classifier, classifiers based on the method of maximum entropy (maximum entropy) and many others.

In the study of posts on social networks, an approach based on a combination of lexicon-based methods and machine learning methods was used. We came to the conclusion that for poorly structured texts with a high level of noise, which are posts on social networks, it is better to use models based on the "bag of words" (bag of words).

As with most machine learning programs with a teacher, it is important to identify a number of useful features to classify moods. Such features include individual words (unigrams) and n-grams, which allow calculations of the frequency of their use. They are the most common features used in the classification of thematic text. In some cases, we considered the positions of words. TF IDFs are also used. This is a simple and convenient way to assess the importance of a term for a particular post compared to other posts or comments. We use the following principle: if a word often occurs in one document, and at the same time occurs rarely in all other documents - this word is of great importance for this document [14].

Another class of features used in our study is the partial linguistic affiliation of words. Adjectives in posts on social networks are important indicators of thoughts and feelings, they are determined by special features. Similarly, we use labeling in other parts of speech. An example of a list of tags we use to denote parts of speech is Penn Treebank POS tags [14].

Research of posts on social networks on the basis of emotionally colored words as traditional signs, because they convey positive or negative feelings. For example, good, beautiful, professional and wonderful are positively colored words, and bad, evil, incompetent and terrible are negative. Emotionally colored words are mostly adjectives and adverbs, but nouns (such as nonsense, error, nonsense) and verbs (such as like, hate, and love) are also used to express feelings. In addition to individual words, the study also used emotionally colored phrases and idioms to assess the tone of the text.

Tone composition rules reflect a scenario that conveys positive or negative sentiments. As the analysis shows, it can be a simple emotionally colored word with a certain direction, as well as a compound expression that determines the tone of the message.

The tone of the posts is determined by the words, some of them change the tone, for example, from positive to negative or vice versa. The same words include: little, little, refuse, miss, neglect, far, near, nowhere and many others.

At the same time, when applying the method of machine learning without a teacher, the procedure of data identification is not performed. Instead, hidden structures are detected in the data based on clustering or associative rules construction. However, recognition accuracy is usually not as high as when applying rule-based approaches or machine learning with a teacher.

When analyzing patient feedback, the method of partial machine learning is used, in particular when analyzing a small amount of data to identify other available data. After training the classifier, the recognition

procedure is repeated to improve the quality of recognition. In terms of accuracy, this approach occupies an intermediate position between teaching with a teacher and without. The analysis takes place:

- by the selected unit of analysis:

- classification by object of analysis:

In the first case, the unit of classification is the entire document, fragment of text, word or phrase, etc.

In the second case, a general sentiment analysis is performed, which involves determining the tone of the entire text; or the object is a statement from the message, aimed at determining the relationship to a particular object; or certain aspects of the post.

Of course, there are difficulties in evaluating the texts of posts that contain words in a figurative sense, because it is impossible to determine the individual components of the expression. For example, when in a "sarcastic" text people express the negative, using positively colored words. This greatly complicates the process of recognizing sarcasm by sentiment classifiers.

Complicates the sentimental analysis of negation, which is used as a way to change the polarity of words, phrases and even sentences. Patients use different linguistic rules to express their opinions due to the presence of objections. When studying such posts, it is important to determine the range of words that are affected by negative words. However, there is no fixed number of words that fall under the action of negation.

Thus, the study of posts on social networks helps to determine the quality of medical services provided, helps to choose a doctor to conclude agreements.

COMPARATIVE ANALYSIS OF THE LEVEL OF DEVELOPMENT OF THE MEDICAL INDUSTRY IN THE SETTLEMENTS OF THE SOCIOPOLIS

In total, there are 10 hospitals and clinics within the eco-sociopolis, including 3 in Drohobych, 3 in Truskavets, 2 in Boryslav, 1 in Skhidnytsia and 1 in Stebnyk. This is without taking into account therapeutic departments, children's hospitals and clinics, dental hospitals and offices, sanatoriums, dispensaries, obstetric departments, etc.

In general, the state of hospitals and clinics of the Truskavets eco-sociopolis needs large funds for the reconstruction, repair and construction of additional buildings. For example, in Boryslav, the city hospital has had an unfinished additional 4-storey building for over 20 years. At the beginning of the coronavirus pandemic, 9 chemical protection suits, which have survived since Soviet times, were provided to provide doctors with protective clothing, which led to the dismissal of the director of the Municipal Enterprise "Central City Hospital of Boryslav" Boryslav. According to the ex-director, the same suits were purchased for Drohobych City Hospital and Polyclinic, Truskavets and Stebnytsia Hospitals [15]. Each of the hospitals has its own website, which has the function of making an appointment with a doctor, provides information about the hospital's work schedule, doctor's appointment schedule, telephone numbers for contact with doctors, etc., but telemedicine technologies are not currently implemented in hospitals.

The following table presents the criteria for evaluating the field of medicine for the eco-sociopolis of Truskavets.

TABLE 3. CRITERIA FOR ASSESSING THE REASONABLENESS OF THE CITY IN THE FIELD OF MEDICINE

Domain	Criteria
Medicine	Number of medical institutions per share of the population
	Number of beds in hospitals
	Number of patients per 1 doctor
	Provision of necessary honey. equipment
	Availability of the required amount of medication
	Condition of medical institutions
	Availability of telemedicine
	Provision of medical workers with all necessary means

According to the above-mentioned data, statistics and established criteria, it is possible to evaluate the reasonableness of the Truskavets eco-sociopolis in the field of medicine by presenting the results of the preliminary assessment in the form of radial diagrams below (Fig.1 – Fig.6).

Petal diagram of the smartness evaluation of the settlements that are part of the eco-sociopolis "Truskavets" in the field of medicine according to the 8 criteria listed in Table 3.

Borislav

Stebnik

Fig. 1. Petal diagram of the smartness evaluation of Borislav   Fig. 2. Petal diagram of the smartness evaluation of Stebnik
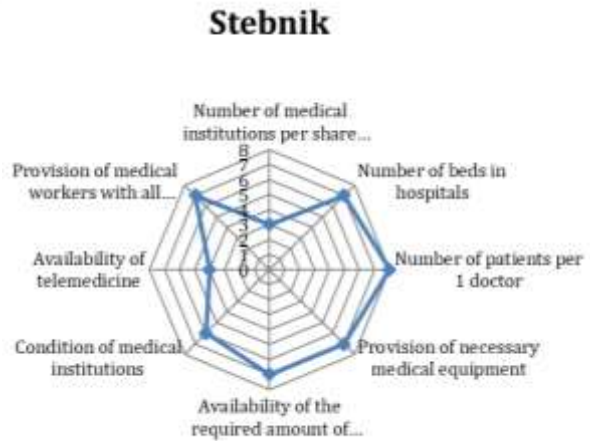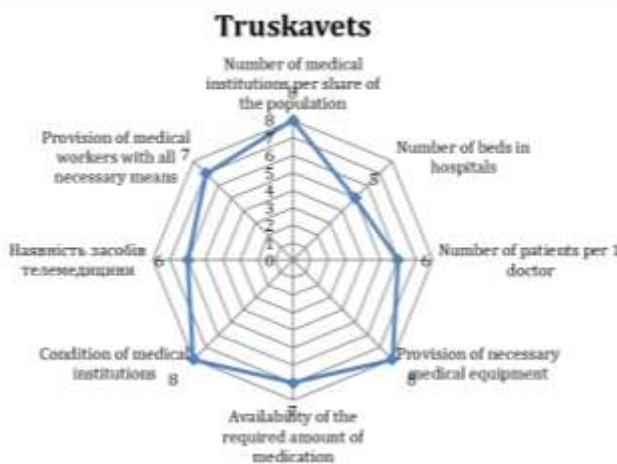
Truskavets

Drogobich

Fig. 3. Petal diagram of the smartness evaluation of Truscavets   Fig. 4. Petal diagram of the smartness evaluation of Drogobich
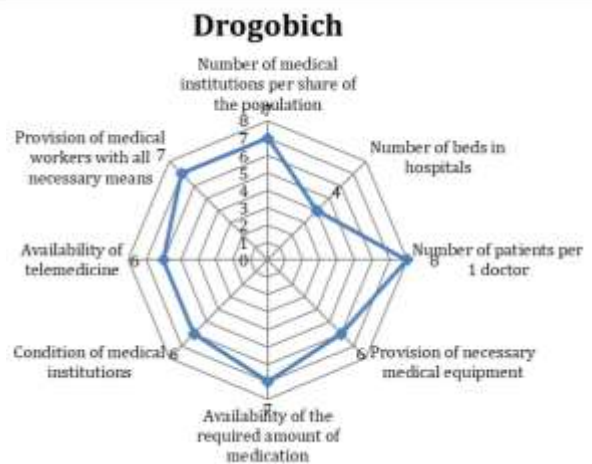
Skhidnytsia

Truskavets eco-sociopolis

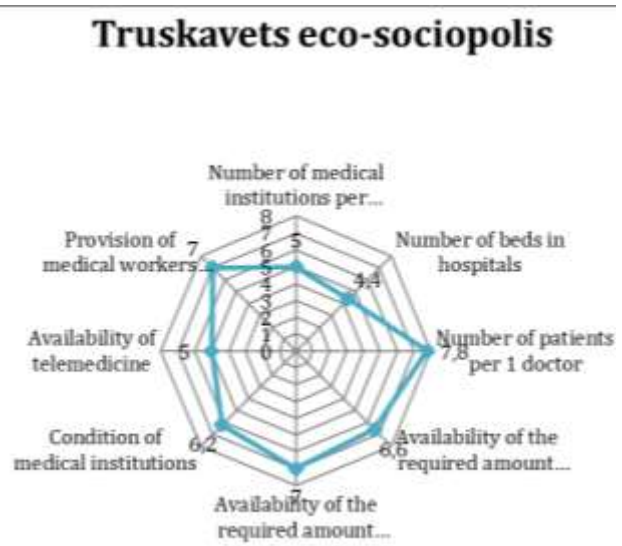Fig. 5. Petal diagram of the smartness evaluation of Skhidnytsia   Fig. 6. Petal diagram of the smartness evaluation of Truscavets eco-sociopolis

And the general petal diagram of the reasonableness of the eco-sociopolis "Truskavets" in the field of medicine (Fig. 6).

CONCLUSIONS

Eco-sociopolis Truskavets has good indicators in the field of medicine, but to get the status of "smart" territory

in the field of medicine, it is necessary to improve the work of medical institutions in many respects.

One of the weakest points is the introduction of telemedicine. At present, patients have the opportunity to see a list of doctors who can provide medical services to residents and vacationers, make an appointment or consult a doctor, but doctors do not have support tools to obtain informational support in making a diagnosis. This problem can be solved as part of health care reform in the state.

Also, in order to improve the results of the evaluation of the efficiency of the medical sector of the sociopolis Truskavets, investments are needed in the overhaul of premises and construction of additional hospital buildings, as the analysis shows an increase in the total number of places in hospitals.

Achieving the status of "smart" territory will contribute to the development of medical tourism, as the natural resources of the sociopolis have created an excellent recreational area for the development of this area of the economy.

For the sociopolis of Truskavets, medicine is one of the most important factors in assessing its sanity. Without the proper state of hospitals, sanatoriums and clinics, without the introduction of telemedicine, the development of the region will slow down.

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