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WEB-BASED INTELLIGENT DECISION SUPPORT SYSTEM FOR REAL ESTATE

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Abstract. By finding, capturing, and sharing explicit and tacit knowledge, real estate companies can significantly improve customer results. One of the main roles of explicit and tacit knowledge management in the real estate sector is sharing best practice. Throughout the world there are many examples of the application of best practice by the major players (appraisal services, brokers, consulting, facility management, insurance, matching/listing services, mortgages, property management, project development, real estate finance, real estate transaction process, relocation services) in the real estate market. In order to demonstrate the application of best practice, explicit and tacit knowledge in the real estate sector, a Web-based Intelligent DSS for Real Estate (IDSS-RE) will be studied as an example.

JEL Classification: R31, C02, D81

Keywords: decision support system, real estate, explicit and tacit knowledge, Multiple Listing Service

Reikšminiai žodžiai: sprendimų paramos sistema, nekilnojamasis turtas, išreikštinės ir neišreikštinės žinios, daugiafunkcė paieškos sistema.

1. Introduction

Explicit knowledge belongs to the group of the traditional resources of a real estate company. Knowledge is the integrated sum of physically intangible resources, the bigger part of which is tacit: skills, competences, experiences, organizational culture, informal organizational communication networks, and intellectual capital of an organization. It is often believed that as employees leave a real estate company at the end of each working day, the utmost knowledge resources existent in their heads leave the company as well. Capturing the tacit knowledge of individuals so that it could be put into practice by real estate companies is perhaps one of the biggest challenges in the real estate sector. For real estate companies that successfully tap into this invaluable information source there is a tremendous payoff in improved customer results.

One of the main roles of explicit and tacit knowledge management in the real estate sector is sharing best practice. Throughout the world there are many examples of the application of best practice by the major players (appraisal services, brokers, consulting, facility management, insurance, matching/listing services, mortgages, property management, project development, real estate finance, real estate transaction process, relocation services) in the real estate market.

The authors of this paper participated in the project Framework 6 “Intelligent Cities” (INTELCITIES). The main objective of INTELCITIES is to create a new and innovative set of interoperable e-government services to meet the needs of both citizens and businesses. One of the INTELCITIES’ goals (on the Lithuanian part) was to develop a Web-based Intelligent DSS for Real Estate (IDSS-RE)

which can use best practice, explicit and tacit knowledge.

The paper is structured as follows: following this introduction, Section 2 deals with explicit and tacit knowledge in the real estate sector; in Section 3 we describe best practice in the real estate sector and Multiple Listing Service Systems; the development of a Web-based Intelligent DSS for Real Estate is introduced in Section 4; finally, some concluding remarks are provided in Section 5.

2. Explicit and Tacit Knowledge in the Real Estate Sector

Knowledge can be explicit and tacit.

Explicit knowledge is comprised of documents (appraisal reports, balance sheets, sale-purchase agreements, insurances, market analyses, contracts, declarations, etc.) and data that are stored within the memory of computers. This information must be easily accessible to a real estate organization, i.e. the obtainment of the necessary knowledge should not be obstructed. Explicit knowledge is information that is widely used in information technologies.

The main real estate organizational knowledge is tacit. The creation and distribution of tacit knowledge requires creativity and competence. Tacit knowledge is a mixture of informal and non-registered procedures, practice, skills, deliberations, subjective insights, intuition, and judgments that employees acquire by virtue of their experience and expertise. This knowledge is vitally important because it defines the abilities and experience of employees. Tacit knowledge represents an important intellectual resource that cannot easily be duplicated by competitors. In order to be recorded, tacit knowledge must be converted into explicit knowledge. However, recorded knowledge is static and can soon become outdated. Therefore, innovative real estate organisations establish an environment where knowledge is continuously created, captured, and disseminated.

The transfer of tacit knowledge is unverifiable and requires face-to-face contact; therefore, spatial nearness is significant. Creating and sharing tacit knowledge are basically social activities. Therefore, the key to effectively capturing tacit knowledge within a real estate organization is the precise choice of the right expert to perform a particular task. Expertise management becomes the central principle of tacit knowledge. Experts can share information about a current issue, problem or topic through meetings, workshops, seminars, video conferencing, e-mail, intranet-based discussion groups, extranets, telephone, working on joint projects, coffee conversations, canteen discussions, brainstorming sessions. For example, via regular meetings know-how can be transmitted among group members, communities of practice can help to drive strategy, solve problems quickly, transfer best practices, and develop new skills.

Experience allows an expert to transform information (economic, technical, infrastructure and qualitative characteristics of a dwelling, market survey, etc.) into a work product (i.e. calculation of the market value of a dwelling) that is delivered to a client. The task is to get this tacit knowledge out of the mind of an expert and capture it in a form that can be used by clients; traditionally, in the form of calculations and written word.

In order to be converted into explicit knowledge, tacit knowledge must be extracted and formatted. Some tacit knowledge systems use the natural learning questions WHAT-HOW-WHY and codify the answers in a specific knowledge structure, which allows stakeholders to analyse their actions and results more effectively. Most advanced real estate organisations have focused on tacit knowledge; they routinely conduct sessions between knowledge management staff and real estate employees to capture tacit knowledge. This knowledge may then be converted into multiple forms of explicit knowledge, such as methodologies, precedent documents or a record of newly acquired skills and expertise. Different knowledge-capture techniques (interview, on-site observation, brainstorming, protocol analysis, consensus decision making, nominal-group technique, Delphi method, concept mapping) can be used to capture tacit knowledge and codify it in a form of appraisal reports, sale-purchase agreements, market analyses, contracts, methodologies. Once knowledge is captured or codified, it is no longer tacit.

Different techniques of harvesting the tacit knowledge of experts and transforming it into explicit forms can be used in practice. LearnerFirst [10] is a company that specializes in harvesting the knowledge of experts and incorporating it into computer-based learning resources. These learning resources encapsulate the tacit knowledge of an expert and transform it into an explicit form. The process is akin to the more familiar Knowledge Engineering practice in the Expert Systems field. As a result of the process, special software is designed in a way that an individual can simultaneously understand, learn, perform, and record the performance. In this sense, such a technique can be classified as an Electronic Performance Support System [10]. According to Mitri [11], “the problem of tacit knowledge capture is a central theme in the field of knowledge management, and assessment management can be thought of as a form of knowledge management”. Therefore, tacit assessment management can be facilitated through technologies commonly used in knowledge management systems such as databases,

Internet architectures, artificial intelligence, and decision-support techniques. Mitri [11] describes tacit performance assessment in the context of knowledge management and presents a prototype decision-support system for managing tacit performance assessment using knowledge management techniques.

Knowledge management systems facilitate the storage, registration, organization, filtration, analysis, collection, and distribution of tacit knowledge.

One of the main roles of knowledge management in real estate sector is sharing best practice.

3. Best Practice in the Real Estate Sector and Multiple Listing Service

Much more attention has to be paid to knowledge creation and its distribution in a form of the databases of best practice; this process has recently begun in the most progressive activities of the real estate sector.

Search, storage, management and improvement of best practice, knowledge, and databases of best practice are among the newest priorities of the real estate sector in most advanced countries.

Comparative analyses of best practice are becoming more popular in the real estate sector. Comparative analyses are based on the analysis of the best examples of services available to clients. The results of comparative analyses allow to make certain recommendations on the possibilities to provide services of higher quality and to better satisfy the needs of the clients. Comparative analyses provide the possibility to quickly and efficiently understand and apply the methods, which could help to achieve the world-class quality of client service.

Best practice in the real estate sector is obtained in different ways, e.g. applied research, wisdom and experience gained through practice and experience of clients and other stakeholders, opinion of experts, etc. Real estate databases and knowledge databases of best practice are knowledge-obtaining tools which allow one to save a lot of time and provide information on the best real estate practice in different forms (appraisal reports, sale-purchase agreements, insurances, market analyses, contracts, declarations, e-mail messages, slide presentations, text, video and audio material).

Stakeholders in the real estate sector usually are trying to achieve different economic, maintenance, facilities management, comfort, technical, technological, social and other aims. Different means could be used to achieve them. Some aims are not so easy to be achieved and may require a lot of expenses. Best practice allows not to limit oneself only to the achievement of economic aims; it creates conditions to reach a higher level and realize the perspective, from which a certain practice is considered the best. The main problem of many best practices is the way they are presented, i.e. they are suggested without taking into account the peculiarities of a certain situation.

Best practice comparative analysis systems facilitate the establishment of the principle lines of activity oriented towards an increase in efficiency. What is more, these systems enable real estate companies to easier estimate their progress: a company is able to compare its performance with the achievements of other organisations. Finally, these systems allow to identify the gaps in activity efficiency and suggest methods to fill these gaps. Modern real estate companies know how to exhaust the possibilities provided by comparative analyses and, consequently, reduce their expenditure and increase their competitive abilities.

In order to demonstrate the application of best practice in the real estate sector a Multiple Listing Service (MLS) system will be studied as an example. Various aspects of MLS systems were investigated by researchers from various countries [2-4, 7, 9, 12-15].

MLS systems have produced outstanding results in different countries and could be adapted for Lithuania and other countries. According to real estate experts, a MLS benefits both, the buyers, who gain access to the maximum numbers of listings, and the sellers, who are enabled to reach the maximum number of potential customers.

The MLS system was introduced at the end of the last century in the US; afterwards it was introduced in the majority of the countries in which the free real estate market exists. Due to the MLS system, complex services were introduced into local real estate markets and the activity of brokers was united [7].

The MLS is created and run by real estate professionals; it accumulates all property listings into a single source, thus, for purchasers it becomes very convenient to review all available properties. The MLS is also designed to regulate commission splitting and deal with other issues regarding the contacts between brokers and agents.

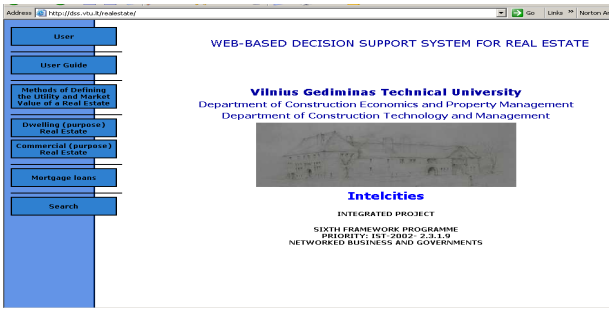
A major part of MLS contains data on various types of real property objects offered for sale and lease. The MLS may be applied for various purposes: to encourage business efficiency, to enable MLS members to occupy a special place on the market, to assist realtors in the search for information about sales of compatible facilities, to accelerate and facilitate the procedures of purchase and sale of property for customers; the MLS may also provide precise statistical data about the market, information on the existing trends, and become a valuable source of income for an association [12].

At present, the developed MLS systems do not allow for the performance of the following functions: multiple criteria analysis of alternatives (priority, utility degree, and market value of the analysed real estate alternatives), negotiations and determination of the most rational real estate purchase variant based on real calculations. In order to demonstrate the abovementioned functions in practice a Web-based Intelligent DSS for Real Estate developed by the authors of the present paper will be studied as an example.

4. Web-based Intelligent DSS for Real Estate

The IDSS-RE is a Web-based Intelligent DSS for Real Estate and is available from: http://dss.vtu.lt/realestate/. Figure 1 shows the screen which appears when the website is loaded:

Fig. 1. The start-up menu screen of the web-based DSS



The IDSS-RE includes an intelligent decision support tool based on methods of alternative generation, multiple criteria analysis, and negotiation [1, 5, 6, 8, 16, 17]. This tool, developed by the authors of this paper, enables the negotiating parties to evaluate their systems of preferences and recognize opportunities for trade-off between differently valued objectives and for joint gains. Negotiators can elaborate on different arguments in support of their position through the e-mail facility. The decisions of the parties are based on a more complete and more thoroughly quantitatively and qualitatively evaluated real estate alternatives.

During the negotiation process, all negotiating parties are automatically networked with one another and can exchange offers and counteroffers via the Internet. Also, private and confidential data is kept safe and secure; this is an obvious advantage when there is a great physical distance between the parties and meetings are difficult to be arranged.

Real estate brokers, wishing to present their knowledge and information on their objects, should ask permission from the IDSS-RE administrator. When the permission is obtained, the broker inserts all necessary information and knowledge about the real estate objects for sale into the IDSS-RE databases and the database of best practice according to the system's requirements (system of explicit and tacit criteria, values and weights of criteria). Access to the brokers' personal IDSS-RE databases and the database of best practice is available only to the broker and to the IDSS-RE administrator.

At the moment the following databases are developed: dwelling real estate (apartments in houses with few flats, apartments in blocks of flats: single-room, 2-room, 3-room, 4-room, 5-room), garden houses, farmsteads, cottages, private houses and commercial real estate (premises, buildings).

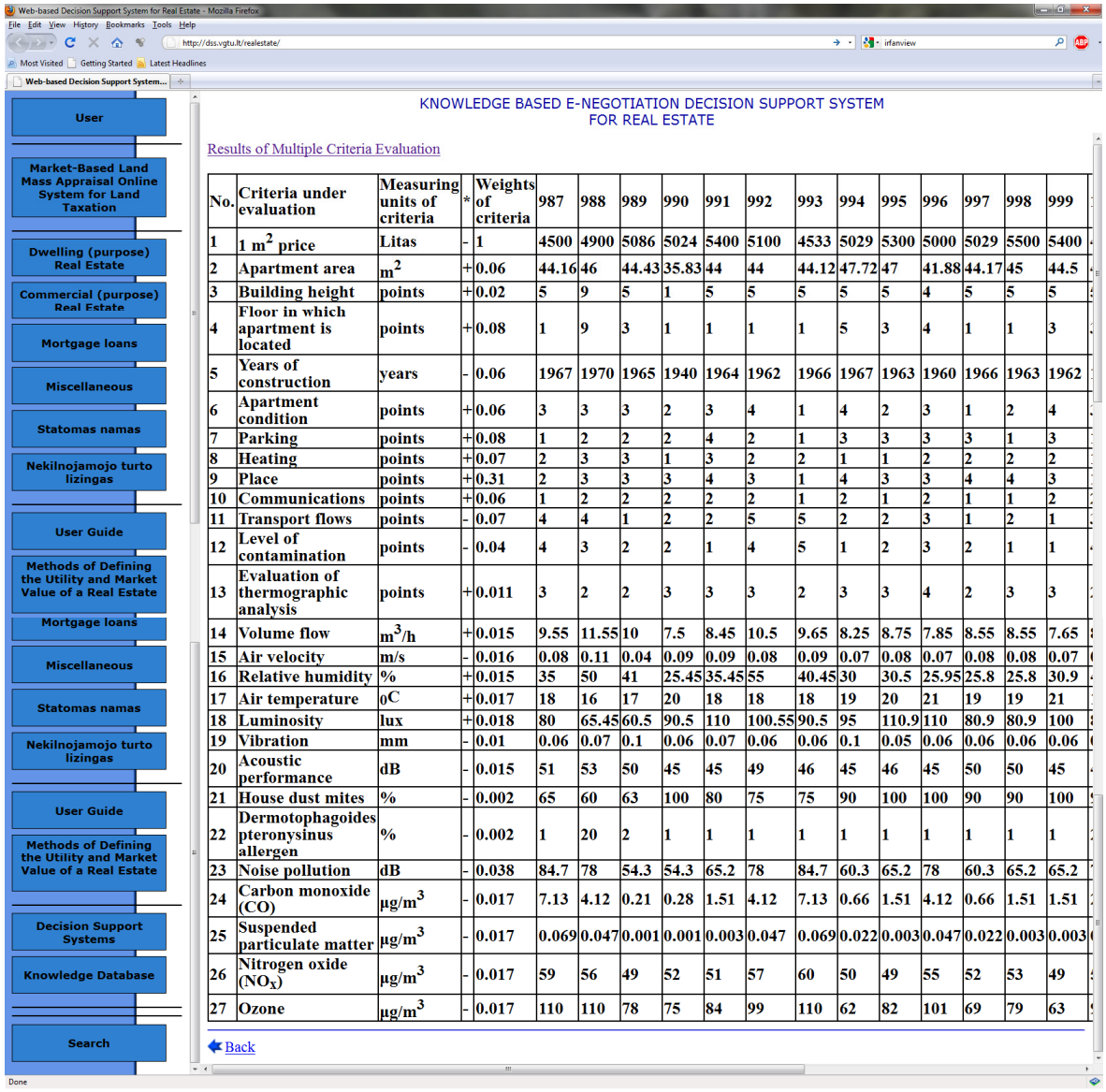
At present, the IDSS-RE allows for the performance of the following five main functions:

1. Search for real estate alternatives. A customer may use databases of different brokers to perform the search for alternatives. This is possible because the forms of data submissions are standardized at a specific level. Such standardization is also advantageous for special intelligent agents that are performing a search for the required real estate in various databases as well as in the database of best practice and gathering information/knowledge.
2. Finding out alternatives and making an initial negotiation table (see Fig. 2). Consumers specify requirements and constraints and the system queries the information regarding a specific real estate item from a number of online brokers. The system performs the tedious, time-consuming, and repetitive tasks of searching various databases and the database of best practice, retrieving and filtering information/knowledge, and delivering it to the user. Results of a search for a specific real estate item are presented in the initial negotiation table, which may include direct links to Web pages of brokers. Due to such a display, the support for the multiple criteria comparisons can become more effective.
3. Multiple criteria analysis of alternatives. During the purchase decision process, a customer should examine a large number of alternatives each of which must be considered with regard to a number of factors (economic, quality (architectural, aesthetic, comfort), infrastructure, technical, legal, technological, etc.). When the information and knowledge are gathered, the multiple criteria analysis is carried out. During this analysis the buyer (broker) determines the initial priority, utility degree, and market value of the analysed real estate alternatives.
4. Negotiations based on real calculations. During negotiations the buyer and the seller may use the IDSS-RE to perform real calculations (the utility degree, market value and purchase priorities) of real estate. These calculations are performed on the basis of characteristics describing real estate alternatives obtained during negotiations (explicit and tacit crite-

ria system, criteria values and weights). According to the results of the calculations, the final comparative table is made.

5. Determination of the most rational real estate purchase variant on the ground of characteristics describing effectiveness of the analysed alternatives (priority, utility degree and market value) (see Fig. 3). When the final comparative table is made, the multiple criteria analysis can be carried out and the best real estate purchase version can be selected using the IDSS-RE.

Fig. 2. A fragment of the process of finding out alternatives and making an initial negotiation table

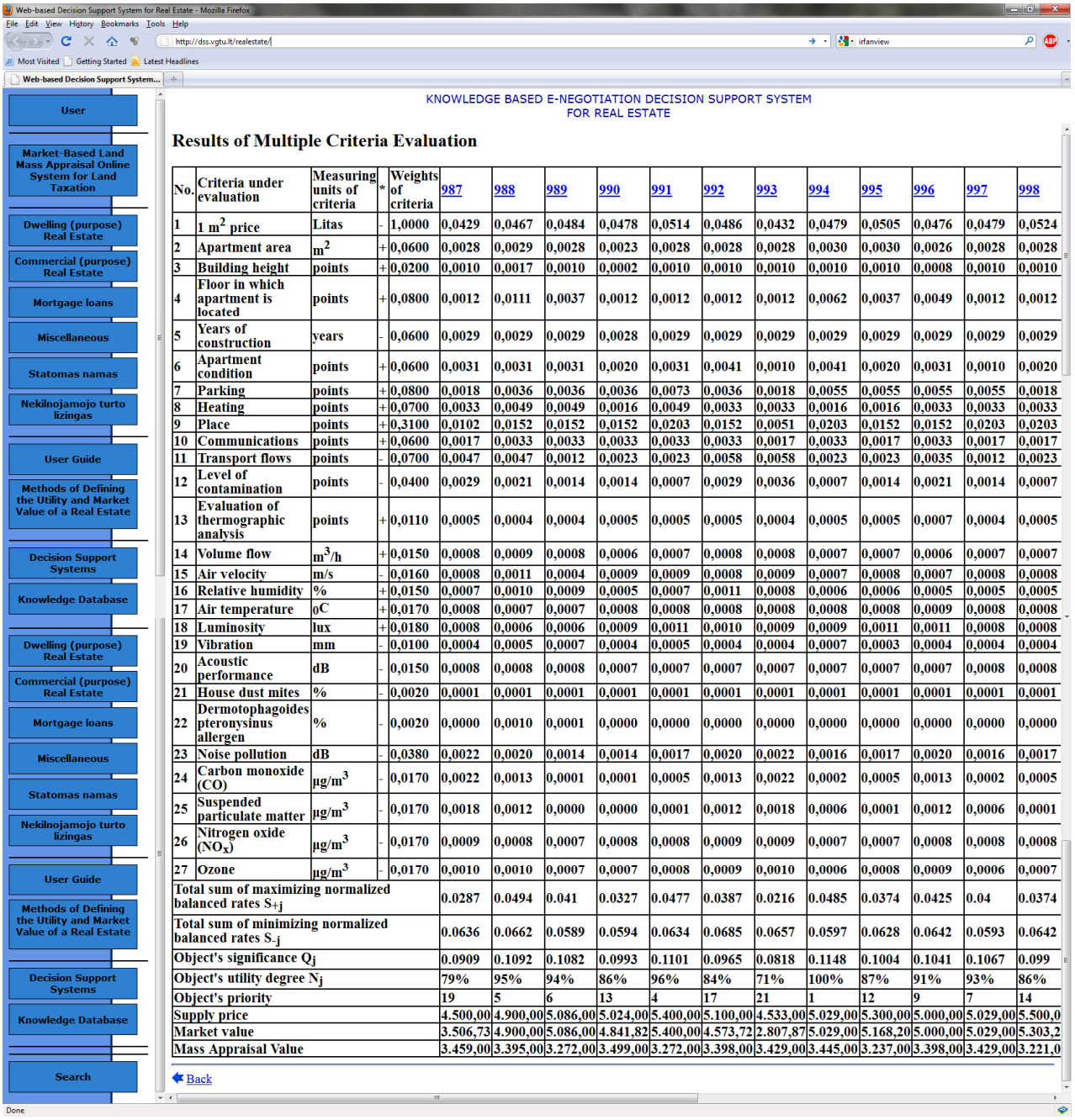


No.	Criteria under evaluation	Measuring units of criteria	*	Weights of criteria	987	988	989	990	991	992	993	994	995	996	997	998	999
1	1 m^2 price	Litas	-	1	4500	4900	5086	5024	5400	5100	4533	5029	5300	5000	5029	5500	5400
2	Apartment area	m^2	+	0.06	44.16	46	44.43	35.83	44	44	44.12	47.72	47	41.88	44.17	45	44.5
3	Building height	points	+	0.02	5	9	5	1	5	5	5	5	5	4	5	5	5
4	Floor in which apartment is located	points	+	0.08	1	9	3	1	1	1	1	5	3	4	1	1	3
5	Years of construction	years	-	0.06	1967	1970	1965	1940	1964	1962	1966	1967	1963	1960	1966	1963	1962
6	Apartment condition	points	+	0.06	3	3	3	2	3	4	1	4	2	3	1	2	4
7	Parking	points	+	0.08	1	2	2	2	4	2	1	3	3	3	3	1	3
8	Heating	points	+	0.07	2	3	3	1	3	2	2	1	1	2	2	2	2
9	Place	points	+	0.31	2	3	3	3	4	3	1	4	3	3	4	4	3
10	Communications	points	+	0.06	1	2	2	2	2	2	1	2	1	2	1	1	2
11	Transport flows	points	-	0.07	4	4	1	2	2	5	5	2	2	3	1	2	1
12	Level of contamination	points	-	0.04	4	3	2	2	1	4	5	1	2	3	2	1	1
13	Evaluation of thermographic analysis	points	+	0.011	3	2	2	3	3	3	2	3	3	4	2	3	3
14	Volume flow	m^3/h	+	0.015	9.55	11.55	10	7.5	8.45	10.5	9.65	8.25	8.75	7.85	8.55	8.55	7.65
15	Air velocity	m/s	-	0.016	0.08	0.11	0.04	0.09	0.09	0.08	0.09	0.07	0.08	0.07	0.08	0.08	0.07
16	Relative humidity	%	+	0.015	35	50	41	25.45	35.45	55	40.45	30	30.5	25.95	25.8	25.8	30.9
17	Air temperature	^0C	+	0.017	18	16	17	20	18	18	18	19	20	21	19	19	21
18	Luminosity	lux	+	0.018	80	65.45	60.5	90.5	110	100.55	90.5	95	110.9	110	80.9	80.9	100
19	Vibration	mm	-	0.01	0.06	0.07	0.1	0.06	0.07	0.06	0.06	0.1	0.05	0.06	0.06	0.06	0.06
20	Acoustic performance	dB	-	0.015	51	53	50	45	45	49	46	45	46	45	50	50	45
21	House dust mites	%	-	0.002	65	60	63	100	80	75	75	90	100	100	90	90	100
22	Dermotophagoides pteronysinus allergen	%	-	0.002	1	20	2	1	1	1	1	1	1	1	1	1	1
23	Noise pollution	dB	-	0.038	84.7	78	54.3	54.3	65.2	78	84.7	60.3	65.2	78	60.3	65.2	65.2
24	Carbon monoxide (CO)	$\mu g/m^3$	-	0.017	7.13	4.12	0.21	0.28	1.51	4.12	7.13	0.66	1.51	4.12	0.66	1.51	1.51
25	Suspended particulate matter	$\mu g/m^3$	-	0.017	0.069	0.047	0.001	0.001	0.003	0.047	0.069	0.022	0.003	0.047	0.022	0.003	0.003
26	Nitrogen oxide (NO_X)	$\mu g/m^3$	-	0.017	59	56	49	52	51	57	60	50	49	55	52	53	49
27	Ozone	$\mu g/m^3$	-	0.017	110	110	78	75	84	99	110	62	82	101	69	79	63

The functions of the IDSS-RE, reasoned negotiations, and determination of the most rational real estate purchase variant are described below.

After a number of alternatives are considered and the most suitable variant is chosen, the process of negotiating starts. As a rule, the buyer usually has a certain strategy for negotiations. For example, at the beginning the buyer offers a 10% lower sum than the price set by the broker or seller and later, during the negotiations, the buyer may increase that initially suggested sum. By that time the seller might have been contacted with the buyer that offered an even higher price. The broker, in his turn, may come up with other reasonable proposals on how to deal with this issue. Besides, an e-moderator may also be of great importance when holding negotiations (for example, an e-moderator can help to assess the market value of a specific real estate item).

Fig. 3. Determination of the initial priority, utility degree and market value of the analysed real estate alternatives



No.	Criteria under evaluation	Measuring units of criteria	*	Weights of criteria	987	988	989	990	991	992	993	994	995	996	997	998
1	1 m^2 price	Litas	-	1,0000	0,0429	0,0467	0,0484	0,0478	0,0514	0,0486	0,0432	0,0479	0,0505	0,0476	0,0479	0,0524
2	Apartment area	m^2	+	0,0600	0,0028	0,0029	0,0028	0,0023	0,0028	0,0028	0,0028	0,0030	0,0030	0,0026	0,0028	0,0028
3	Building height	points	+	0,0200	0,0010	0,0017	0,0010	0,0002	0,0010	0,0010	0,0010	0,0010	0,0010	0,0008	0,0010	0,0010
4	Floor in which apartment is located	points	+	0,0800	0,0012	0,0111	0,0037	0,0012	0,0012	0,0012	0,0012	0,0062	0,0037	0,0049	0,0012	0,0012
5	Years of construction	years	-	0,0600	0,0029	0,0029	0,0029	0,0028	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029	0,0029
6	Apartment condition	points	+	0,0600	0,0031	0,0031	0,0031	0,0020	0,0031	0,0041	0,0010	0,0041	0,0020	0,0031	0,0010	0,0020
7	Parking	points	+	0,0800	0,0018	0,0036	0,0036	0,0036	0,0073	0,0036	0,0018	0,0055	0,0055	0,0055	0,0055	0,0018
8	Heating	points	+	0,0700	0,0033	0,0049	0,0049	0,0016	0,0049	0,0033	0,0033	0,0016	0,0016	0,0033	0,0033	0,0033
9	Place	points	+	0,3100	0,0102	0,0152	0,0152	0,0152	0,0203	0,0152	0,0051	0,0203	0,0152	0,0152	0,0203	0,0203
10	Communications	points	+	0,0600	0,0017	0,0033	0,0033	0,0033	0,0033	0,0033	0,0017	0,0033	0,0017	0,0033	0,0017	0,0017
11	Transport flows	points	-	0,0700	0,0047	0,0047	0,0012	0,0023	0,0023	0,0058	0,0058	0,0023	0,0023	0,0035	0,0012	0,0023
12	Level of contamination	points	-	0,0400	0,0029	0,0021	0,0014	0,0014	0,0007	0,0029	0,0036	0,0007	0,0014	0,0021	0,0014	0,0007
13	Evaluation of thermographic analysis	points	+	0,0110	0,0005	0,0004	0,0004	0,0005	0,0005	0,0005	0,0004	0,0005	0,0005	0,0007	0,0004	0,0005
14	Volume flow	m^3/h	+	0,0150	0,0008	0,0009	0,0008	0,0006	0,0007	0,0008	0,0008	0,0007	0,0007	0,0006	0,0007	0,0007
15	Air velocity	m/s	-	0,0160	0,0008	0,0011	0,0004	0,0009	0,0009	0,0008	0,0009	0,0007	0,0008	0,0007	0,0008	0,0008
16	Relative humidity	%	+	0,0150	0,0007	0,0010	0,0009	0,0005	0,0007	0,0011	0,0008	0,0006	0,0006	0,0005	0,0005	0,0005
17	Air temperature	oC	+	0,0170	0,0008	0,0007	0,0007	0,0008	0,0008	0,0008	0,0008	0,0008	0,0008	0,0009	0,0008	0,0008
18	Luminosity	lux	+	0,0180	0,0008	0,0006	0,0006	0,0009	0,0011	0,0010	0,0009	0,0009	0,0011	0,0011	0,0008	0,0008
19	Vibration	mm	-	0,0100	0,0004	0,0005	0,0007	0,0004	0,0005	0,0004	0,0004	0,0007	0,0003	0,0004	0,0004	0,0004
20	Acoustic performance	dB	-	0,0150	0,0008	0,0008	0,0008	0,0007	0,0007	0,0007	0,0007	0,0007	0,0007	0,0007	0,0008	0,0008
21	House dust mites	%	-	0,0020	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
22	Dermotophagoides pteronysinus allergen	%	-	0,0020	0,0000	0,0010	0,0001	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
23	Noise pollution	dB	-	0,0380	0,0022	0,0020	0,0014	0,0014	0,0017	0,0020	0,0022	0,0016	0,0017	0,0020	0,0016	0,0017
24	Carbon monoxide (CO)	$\mu g/m^3$	-	0,0170	0,0022	0,0013	0,0001	0,0001	0,0005	0,0013	0,0022	0,0002	0,0005	0,0013	0,0002	0,0005
25	Suspended particulate matter	$\mu g/m^3$	-	0,0170	0,0018	0,0012	0,0000	0,0000	0,0001	0,0012	0,0018	0,0006	0,0001	0,0012	0,0006	0,0001
26	Nitrogen oxide (NO_x)	$\mu g/m^3$	-	0,0170	0,0009	0,0008	0,0007	0,0008	0,0008	0,0009	0,0009	0,0007	0,0007	0,0008	0,0008	0,0008
27	Ozone	$\mu g/m^3$	-	0,0170	0,0010	0,0010	0,0007	0,0007	0,0008	0,0009	0,0010	0,0006	0,0008	0,0009	0,0006	0,0007
Total sum of maximizing normalized balanced rates S_{+j}					0.0287	0.0494	0.041	0.0327	0.0477	0.0387	0.0216	0.0485	0.0374	0.0425	0.04	0.0374
Total sum of minimizing normalized balanced rates S_{-j}					0.0636	0.0662	0.0589	0.0594	0.0634	0.0685	0.0657	0.0597	0.0628	0.0642	0.0593	0.0642
Object's significance Q_j					0.0909	0.1092	0.1082	0.0993	0.1101	0.0965	0.0818	0.1148	0.1004	0.1041	0.1067	0.099
Object's utility degree N_j					79%	95%	94%	86%	96%	84%	71%	100%	87%	91%	93%	86%
Object's priority					19	5	6	13	4	17	21	1	12	9	7	14
Supply price					4.500,00	4.900,00	5.086,00	5.024,00	5.400,00	5.100,00	4.533,00	5.029,00	5.300,00	5.000,00	5.029,00	5.500,0
Market value					3.506,73	4.900,00	5.086,00	4.841,82	5.400,00	4.573,72	2.807,87	5.029,00	5.168,20	5.000,00	5.029,00	5.303,2
Mass Appraisal Value					3.459,00	3.395,00	3.272,00	3.499,00	3.272,00	3.398,00	3.429,00	3.445,00	3.237,00	3.398,00	3.429,00	3.221,0

The functions of the IDSS-RE, reasoned negotiations, and determination of the most rational real estate purchase variant are described below.

After a number of alternatives are considered and the most suitable variant is chosen, the process of negotiating starts. As a rule, the buyer usually has a certain strategy for negotiations. For example, at the beginning the buyer offers a 10% lower sum than the price set by the broker or seller and later, during the negotiations, the buyer may increase that initially suggested sum. By that time the seller might have been contacted with the buyer that offered an even higher price. The broker, in his turn, may come up with other reasonable proposals on how to deal with this issue. Besides, an e-moderator may also be of great importance when holding negotiations (for example, an e-moderator can help to assess the market value of a specific real estate item).

It is obvious that the main obstruction to the agreement between the seller and the buyer is price. Both parties have a variety of alternatives. On the other hand, the actions of both are restricted by the set real estate purchase and sale limits. Thus, an optimal decision should be made. This process can be

supported by the reasoned calculations, i.e. the IDSS-RE negotiating subsystem can be applied. Noteworthy is the fact that the real estate buyer and seller can apply this subsystem either individually or together.

In order to decrease the offered prices and find the most rational solution, the buyer can negotiate with many real estate sellers simultaneously and successfully convince them by revealing the discrepancy between the price and the quality. For example, the buyer appeals to the evaluations of alternatives (priority, utility degree and market value of a real estate item) and then, at the third stage, negotiations with the foremost sellers of the most rational real estate variants begin. Buyer sends the address of the IDSS-RE Web site, where the calculations are presented. The seller may repeat the calculations on the Web site by changing the alternatives and their characteristics, e.g. explicit and tacit criteria system, criteria values and weights.

Analogously, the seller, wishing to persuade the potential buyers, may apply the IDSS-RE to demonstrate his/her alternative being the most rational among the existing variants.

The IDSS-RE is based on symmetry and provides an identical set of multiple criteria analysis tools to both parties. The central component of the IDSS-RE is the alternative generation and multiple criteria analysis (AGMCA) model developed by the authors of the present paper; this model provides assistance in individual or joint decision-making as well as the e-moderator decision-making. Alternative generation and the multiple criteria analysis model are aimed at searching for those multiple negotiated solutions that are beneficial for all parties.

The negotiation is modelled as a combination of three processes: individual (real estate broker, seller or buyer) alternative generation and multiple criteria negotiation process; joint problem solving; e-moderator decision-making.

Individual alternative generation and multiple criteria negotiation process is aimed at assisting the parties in structuring their systems of preferences (explicit and tacit criteria system, criteria values and weights) that are related to the rational real estate price determination; therefore, this process can perform the functions of an individual decision support system. Before the actual negotiation, the real estate broker or buyer must consider his or her own criteria system, values and weights of each criterion. The explicit and tacit criteria (criteria system, criteria values and weights) of one party are independent of the criteria of another party. These explicit and tacit criteria are the parties' objectives. Generally, the objectives (or the criteria) can be quantitative and qualitative. Criteria weights, calculated by the party, are individual and confidential. Therefore, the negotiator must define his or her preferences regarding the criteria and consider what trade-off may be required. Each party can individually use the AGMCA model and introduce various real estate price alternatives, criteria values and weights into it. By using the model, each party can calculate market value and its own priority and utility degree for the negotiated alternatives. Priority, utility degree, and market value of the alternatives calculated by the party are confidential. Individual decision support system enables each party to properly analyse and evaluate its negotiation position. The negotiation framework is based on the idea of dynamic evaluation of the objectives which reflect the parties' interests, goals, perceptions, and present position in the real estate market. The IDSS-RE could be used to integrate ongoing negotiations with different brokers/buyers. Each new offer by the opponent could be entered in order to observe the progress that has been made (or the absence of progress) and the possible trade-offs. Each party evaluates (in terms of confidential information) the efficiency (priority, utility degree and market value) of alternative solutions according to his or her own explicit and tacit criteria system, criteria values and weights.

In search of joint gains, the two parties can perform a multiple criteria analysis jointly. An iterative process of negotiations is designed to lead the parties towards solutions that improve their overall satisfaction. The priority and utility degree, as a measure of a party's overall satisfaction, is established on the ground of that party's explicit and tacit criteria system, criteria values and weights. In the new negotiation iteration the parties can change their criteria (objectives) by adding and/or removing criteria, and/or changing their relative weight and values. For both parties the search for rational weights of criteria (objectives) is a problem in the multiple criteria iterative process. An accounting system develops a selection of the best joint negotiation solution for the utility degree of both parties. Once the parties have evaluated their utility degree for a given set of negotiated real estate prices and quality, their individual overall rankings can be presented in a joint utility degree priority.

A new alternative halfway solution may be offered by the e-moderator. E-moderator is a subsystem of the IDSS-RE, creating a possibility to design compromise alternatives in an automated way. An e-moderator can propose and evaluate different alternatives depending on the alternatives previously proposed by the two parties.

The negotiation process is modelled as an alternating sequence of individual, joint, and e-moderator activities which enable the parties to successfully manipulate a set of real estate prices and quality in parallel ongoing negotiations with different bro-

kers/buyers. This system is aimed at improving the negotiation process by creating and proposing new alternatives and removing the ones that are non-efficient. Such enlargement and narrowing of the set of alternatives are repeated in an iterative manner.

There are two main scenarios for finishing negotiations: either the buyer and the seller agree on the price and the purchase is made or they do not agree and the negotiations are stopped. As the broker (buyer) takes part in negotiations at the same time with several potential buyers (sellers), they reach various compromise solutions. The seller sells his or her real estate to the person who offers the best price. During negotiations, the buyer receives a revised decision-making matrix of real estate alternatives. The number of alternatives and their characteristics (explicit and tacit criteria system, criteria values and weights) will already be changed in the revised matrix. By performing an analysis of new results obtained during the negotiation process with the IDSS-RE the priority, the market value, and utility degree of real estate alternatives are calculated. The buyer selects the most ration real estate variant on the basis of the results of the analysis.

The iterative nature of the negotiation process enables the parties to constantly revise their preference structures (explicit and tacit criteria system, values and weight), develop and refer to a dynamic set of the alternative real estate prices and quality. Such a system is supposed to eventually lead to a stable real estate price. Both parties, showing an adequate level of mutual trust and being aware of the present state in the real estate market, set the most rational real estate price by common agreement. However, the negotiators often find themselves in situations when it seems impossible to reach an agreement which would satisfy both parties, consequently, at least one of them breaks off the negotiation process.

5. Conclusions

One of the major difficulties regarding Internet-based information systems is to find what one wants. There are countless alternative products and services that are offered on the Internet. How can customers find the most suitable products and services then? In order to find a desired product or service the customer usually wants to compare alternatives. There are five types of aids to comparison shopping: search on hypertext files by agents, search of alternatives on databases, alternative search and tabular comparison, comparison of alternative products and services from multiple malls, search and multiple criteria decision-making. The authors of the present paper have developed a Web-based Intelligent DSS for Real Estate. The proposed Web-based Intelligent DSS for Real Estate can be applied to: search for real estate alternatives, finding out alternatives and making an initial negotiation table, multiple criteria analysis of alternatives, negotiations based on real calculations, and determination of the most rational real estate purchase variant.

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NEKILNOJAMOJO TURTO INTERNETINĖ INTELEKTINĖ SPRENDIMŲ PARAMOS SISTEMA

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Santrauka. Surasdamos, saugodamos ir pasidalydamos išreikštinėmis ir neišreikštinėmis žiniomis nekilnojamojo turto organizacijos gali gerokai pagerinti užsakovų rezultatus. Vienas iš pagrindinių išreikštinių ir neišreikštinių žinių valdymo nekilnojamojo turto sektoriuje vaidmenų yra dalijimasis geriausia patirtimi. Pasaulyje pateikiama daug geriausios patirties taikymo pavyzdžių, naudojamų daugumos nekilnojamojo turto rinkos dalyvių (vertinimo paslaugos, brokeriai, konsultavimas, pastatų ūkio valdymas, draudimas, hipoteka, turto valdymas, projektų vystimas, nekilnojamojo turto sandorių sudarymas, perkraustymo paslaugos ir t. t.). Norint pademonstruoti geriausios patirties taikymą, išreikštines ir neišreikštines žinias nekilnojamojo turto sektoriuje kaip pavyzdys buvo nagrinėjama Nekilnojamojo turto internetinė intelektinė sprendimų paramos sistema.

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