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Intelligent real estate management

The article analyzes the state and use of intelligent real estate management technologies. It is argued that intelligent real estate management is based on information and digital methods. The key factors in the transition to intellectual real estate management have been pointed out. Breakthrough technologies as a tool for the transition to intelligent management are considered. The analysis of digital assets, digital real estate, digital real estate passports is given. The importance of big data in real estate management is demonstrated. The influence of building information modelling (TIM) technology on the development of the intelligent property management, with the possibility of using artificial neural networks for real estate valuation, is noted. The application of multi-criteria real estate valuation methods, as well as the possibilities of multi-agent systems as a means of intellectual property management, are described. The application of nine modern technologies, called the "Big Nine", as a means of supporting intelligent real estate management is discussed in detail.

Keywords: *management, real estate management, digital methods, intelligent management, breakthrough technologies*

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INTRODUCTION

Digital transformation of society and economy defined an approach to management in general and real estate management issues. Traditional management tools lose their competitiveness used apart from the new technologies. Real estate management (REM) shows current trend of implementing informational, digital and intellectual technologies. The intellectual technologies trend is most obvious. In terms of digital transformation of the society, researches on digital assets implementation and digital real estate are worth noting. There are also "smart cities" and "smart home" [1] methodologies. There is a smart real estate (SRE) new technology as well. The transition to the intelligent real estate management technologies is stipulated increased complexity of the real estate facilities and the situations these facilities face. Environmental and ecological factors, particularly in the cities, lay a great impact on the state of the real estate facility in modern real estate management. The intelligent technologies implementation calls for the revision of the real estate management. For example, there should be a shift from the facility management (FM) to a given spatial situation management. This implies change of the facility management to a situational real estate management (SREM) in some cases. This also means that in other cases the facility management should give place to the corporate real estate management (CREM) [2]. The complexity of the situational real estate management necessitates the implementation of intelligent technologies to reduce the data pressure on the manager.

EVOLUTION OF DISRUPTIVE TECHNOLOGIES FOR REAL ESTATE MANAGEMENT

Innovation and disruptive technologies are integral parts of management and production. Professor Clayton Christensen and his colleagues coined the term "disruptive technologies". It is interpreted as a set of technologies, displacing current technologies and transforming industries, providing new opportunities for innovations and business development. Revolutionary transformations are their positive side. Their challenge is the transformation of the traditionally inertial sectors of national economy such as construction and real estate. Their disruptive nature raises issues in terms of their implementation.

Disruptive technologies in real estate management emerged and evolve with reference to a number of factors: wide use of information and data technologies; digital real estate assets management; emergence of digital real estate models; big data; use of technologies information modelling (TIM).

The importance of information in real estate is determined by two factors. The *first factor* is associated with the widespread usage of information. Currently, information is used in all spheres of life, including the field of public real estate management. The world is becoming more localized and new information technologies are being used. Information serves as a means of globalization and helps to navigate in a localized society. The *second factor* is greater information accessibility. Society requires access to such systems, which a few years ago were available only to officials of federal agencies.

There is a new concept and a digital asset model in the real estate management system. The research considers the definition of a digital asset and examines its features in the real estate management system, in the result of it there is the transaction costs' reduction. The digital asset is aimed at data recording throughout the life cycle of a capital construction facility with a focus on the stage of operation and maintenance.

Recently, there has been an interest in the digital real estate technologies' usage [3]. They have different implementations, for example, innovations that are often called Protect (real estate technology), efficient portfolio management (VTS), new ways of renting housing (Airbnb) or hassle-free service (Fixflo). These technologies have advantages and disadvantages. A critical analysis of the technologies is given in a paper [3].

It is indicated in the study [4] that the lack of a single pool of standardized property information turns out to be the most serious cause of delays in real estate transactions. The most promising technologies to mitigate this problem are digital property passports. They contain all relevant real estate information. However, their implementation faces significant obstacles in its path due to the radical transition from paper technology to a digital one.

Big data has also influenced the real estate market. Big data is not only huge amounts of data, but also the requirements of their processing speed, complexity and diversity of data, which hampers their analysis. On the one hand, they create processing problems, on the other hand, they provide a more comprehensive one. Cloud computing for big data is one of the ways to analyze and process them.

The emergence of Technologies of Information Modeling (TIM) of buildings has influenced the dissemination of information about the building among interested parties. Embedded TIMs in industrial buildings are an important part of the digital transformation of industrial assets. The development of executive TIM has enabled property owners to become not only owners of the assets themselves, but also owners of digital assets. The considered technologies perform the support functions or serve as the basis for intelligent real estate management [5].

Neural network is one of the typical intelligent technologies. It starts being also applied in the real estate sector [6]. The efficiency of the real estate industry using the BP neural network model is studied in this paper. The results prove the efficiency of the network used specifically in the construction industry. This is due to the variety of real estate objects and their operating conditions.

A neural network is just a tool, just like a spreadsheet. It contains the necessary algorithm or method. In particular, it is advisable to use it for complex methods, such as methods of multi-criteria decision analysis in the processes of real estate management and land management [7]. Multi-criteria Decision Analysis (MCDA) methods are listed among the verification and evaluation methods that the European Real Estate Management Community considers useful. Such analyses and methods are performed using methods aimed at achieving the synthesis of various input data forms necessary to identify decision-making issues of similar complexity. Consequently, one or more of the conclusions made enable to take reasonable, well-considered strategic solutions. In the field of land and real estate management, numerous questions often arise regarding such assessments. The study [7] describes the procedure of choosing a multi-criteria method most suitable for specific assessment tasks usually arising when solving problems related to decision-making. In particular, the issues of land and real estate management.

In the context of big data, the management of key resources with use of intelligent approach reveals additional advantages of corporate real estate management.

When appraising real estate in trying circumstances, one often has to deal with a complex system of unstructured data. Heuristic methods could be the only way out then. This problem is solved by multi-agent systems.

These studies [8] introduce the notion of a multi-agent system for providing support in real estate appraisal. The general architecture of the multi-agent real estate appraisal system (MAREA) is described. The estimated data bank is filled with original cadastral databases information. Data-driven evaluation models are created using various algorithms.

The "BIG NINE" AS A SUPPORT FOR REAL ESTATE INTELLIGENT MANAGEMENT

Intelligent real estate is associated with the use of nine smart technologies, called the "Big Nine" [5] ("Big9"). These are: drones (UAVs) , Internet of Things (IoT) , cloud technologies, Software as a Service (SaaS), big data, 3D scanning, mobile technologies, virtual and augmented reality (VR and AR), artificial intelligence (AI) and robotics. All these technologies are used differently depending on the context and objectives of real estate management. The "Big Nine" in terms of its application to real estate helps to provide consumers with high-quality and complete information [9].

In recent years, real estate around the world has attracted huge financial investments. Since 2012, real estate technology companies have raised almost 6.4 billion $ in 817 transactions in the United States alone [10]. Real estate technology is defined as hardware gadgets, online platforms and software tools used by various participants in the real estate industry, including lenders, brokers, property owners, investors and managers, as well as consumers to collect information and distribute data related to real estate[1].

Unlike its industrial counterparts, almost a third of the world's real estate industry worth is 11 trillion $ is managed by spreadsheets, not by special software; innovative tools of information technology (IT) are not in place. Nevertheless, innovative and breakthrough technologies are an integral part of the modern world. Breakthrough technologies are widely used in real estate management.

As a result, breakthrough technologies were considered and evaluated in various industries in accordance with criteria such as computing education and student perspectives, rapid advances in technologies in value-added supply chains, improving students' experience in a massive open online format, specialized courses, risk management using breakthrough technologies, social relations in higher school, clinical trials, and others. The above mentioned studies provide useful information on how breakthrough technologies can be applied, but so far, their application in real estate has not been considered [5]. This study examines the potential application of various breakthrough technologies in the field of real estate to underline their importance, current use, and application, as well as the possibility of their use to meet the needs of stakeholders in the field of real estate.

A specific term used in the field of real estate abroad is "regret". This parameter characterizes customer dissatisfaction after a real estate transaction. The growing concern of the real estate industry caused by an increase in the number of regrets after buying or renting, which are reported by consumers[2]. According to Trulia[2], 44 % of real estate consumers (almost every second) regret their decision to buy or rent real estate facility. The main reasons for these regrets are the information asymmetry caused by the lack of information about the characteristics of real estate and

1 Insights C.B. Real estate tech funding reaches new highs in 2016. URL: https://www.cbinsights.com/research/real-estate-tech-startup-funding/

2 Trulia. Real Estate Regrets: Recovery Edition. URL: https://www.trulia.com/blog/trends/regrets-2017/

the complexity of the purchase process and as a result key information, including fees, remains hidden.

The technologies of the "Big Nine" eliminate the main regrets and information asymmetry of stakeholders in the real estate sector. In the work [5]:

- technological aspects of SRE are considered — its user orientation, sustainability and technological innovations;
- online distribution platforms such as websites, smartphones and social networks are studied;
- stakeholders in the real estate sector and their needs and information interactions are identified;
- technologies of the "Big Nine" are analyzed, the analysis of opportunities, potential losses and levels of operation for each technology is given;
- "Big 9" technologies, distribution platforms and the needs of stakeholders are considered with the help of a holistic technology adaptation model (TAM), which integrates them in online real estate platforms and leads to greater consumer satisfaction, as well as to regrets reduction.

Intelligent real estate management (IREM) uses the concept of key management components. This is the use of "Big9" to solve the problem of the lack of information provided to consumers; distribution of information among them through the conceptual structure TAM; the analysis of the possibilities of potential losses and levels of exploitation (opportunities, potential losses and exploitation levels OPLEL) for each technology.

Despite the fact that the global real estate industry has lagged behind information technology (IT)-based innovations and relies on traditional transaction methods, investment in real estate technologies is growing. This proves the business attractiveness of the industry for investors and potential customers. One and a half billion $ of global investment in 2015 and 1.6 billion $ invested in the first half of 2016 confirms the statement. In this context, the United States is seen as the center of commercial real estate and its technological progress. The report published by Forum [10] compared countries according to seven criteria related to technological progress and implementation opportunities. These include: the network availability, which measures the countries' potential to use the Internet and communication technologies (ICT) to increase competitiveness and well-being; the availability of the latest technologies, such as mobile 4G, 5G and big data availability; individuals using the Internet; the development of technologies at the corporate level; the innovation capacity; the use of the Internet linking businesses and the consumer and the government's success in promoting ICT.

In [5] it is noted that the USA, Great Britain and Australia occupy the first place among 139 countries in accordance with these seven criteria. These three countries were chosen because data was available for each criterion. There is a dominance of the USA in terms of technological progress and readiness for innovation, but the UK also leads when it comes to individual Internet use, namely, the use of the Internet as a link between business and customers and the success of the government in promoting ICT. The ratings show the overall position of the countries among the 139 countries studied. The value is outside of seven and shows the degree to which the criterion is accepted in the country being studied. In general, according to the report, Singapore, Finland and Sweden are among the top three countries in terms of readiness to implement technologies, respectively. All values were obtained using a global questionnaire; the assessment was based on how respondents scored a holistic value. The values show that the USA, Great Britain and Australia are actively implementing the latest technologies. The results also highlight the investment benefit perspectives in these countries, especially in relation to online real estate. These advantages are more likely because the Internet innovations have been successfully implemented and there is a willingness to accept them. The government's positive strategies further stimulate investors clarifying why countries like the US attract huge investments.

SRE technology is closely related to the "smart cities" evolution. The key factor determining the "smart city" is the usage of the cutting-edge breakthrough technologies. A smart city uses various sets of electronic data, as well as technologically advanced sensors to manage effectively its assets and resources. Although technologies change over time, becoming more and more complex, it is the implementation option and their open, innovative nature that make a city or real estate "smart". Due to this, SRE and intelligent management are necessary for the development of smart cities. It is essential to develop SRE evaluation criteria for their best implementation.

In the absence of a generally accepted definition of SRE, there are different aspects of its analysis and description, which are used, as well as key components, according to researchers, are identified.

In particular, they claim [11] that customer **orientation** is a key component, and an experiment based on virtual reality reveals the preferences of customers regarding the purchase or use of a smart home.

Another component is called sustainability and it is necessary if we want real estate to become smarter and attract more global investment. E. Miller[3] focuses on innovation and says that the industry should demonstrate its abilities by using virtual storefronts, crowdfunding, artificial intelligence, smart homes, online markets and smartphone applications.

D. Shulman[4], speaking about the technological needs of Smart Real Estate, cites the Airbnb case, stressing that at the beginning of 2014 it attracted 10 billion $ and, hence, received more market capital than such well-known hotels as Hyatt. Summarizing these findings and research, the study defines SRE as: "Real estate or land in which various electronic sensors are used to collect and provide data to consumers, agents and property managers that can be used for effective asset and resource management. The key features are customer orientation, sustainability and the use of innovative and breakthrough technologies in such a way as to obtain integral benefits that are otherwise unattainable".

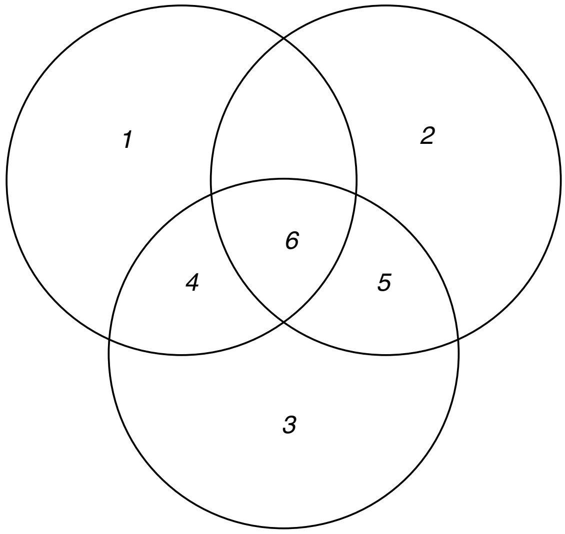
Intelligent real estate management refers to the cumulative management of SRE, which is based on the main principles of the innovative technologies' implementation, sustainability, and customer orientation. This is not limited to infrastructure only but includes asset and resource management.

Real estate agents use online platforms to present their facilities to potential buyers or tenants. The information they provide can prevent customer regret arising from ignorant decisions, and thus reduce disagreements between agents and customers after the purchase. Figure shows the conceptual SRE model.

In Figure the numbers *1–3* indicate the main domains: *1* — marketing and business; *2* — information distribution and

3 Miller E. Trends and Innovations in the Real Estate Industry. URL: http://www.innovationmanagement.se/2017/11/21/trends-and-innovations-in-the-real-estate-industry/

4 Shulman D. Technology vs. commercial real estate: Retail, office and hotel markets face major disruptions. 2014. URL: http://www.anderson.ucla.edu/lib/email/documents/econ_letter_june_2014.pdf



SRE conceptual model

communication; *3* — the main component of SRE. Numbers *4–6* indicate: *4* — sustainability; *5* — customer orientation; *6* — innovation technologies. It should be noted that considering spatial factors determines the usage of geo-marketing in addition to conventional marketing.

In the interests of consumers, smart cities, smart homes and SRE promote key spheres such as privacy, versatility, flexibility, the ability to work from home, teleactivity and time-saving measures. According to the triple principle, sustainability in cities should cover social, environmental and financial aspects.

METHODOLOGICAL AND INFORMATIONAL ASPECTS OF SRE FORMATION

Process-oriented planning is the basis for the SRE formation. Characteristic of SRE is the interaction between real estate objects. Therefore, the principles of corporate governance should be incorporated into the SRE methodology. Intelligent real estate is aimed at meeting the needs of the client. This requires defining the demand for objects of this kind. Information models of objects, processes and situations serve as the basis of the SRE field of activity. Therefore, such models should be used in the formation of intelligent property and the organization of the implementation field. Intelligent real estate, like other intelligent objects, uses not only data and information models, but also knowledge.

Intelligent real estate uses non-deterministic models that have freedom of action and the features of subsidiarity. Therefore, when forming a SRE, it is necessary to take into account risk factors and use risk-oriented technologies. Real estate objects are spatial, so it is necessary to use spatial and geo-knowledge for SRE. To study the algorithms dynamics, it is necessary to use the analysis of structural changes of real estate objects. Currently, the concept of "key indicator" is widely used in the economy. Because of this, intellectual real estate models should be formed based on key indicators. Analysis of the economic feasibility of innovative projects, including the creation of intellectual real estate is in the interests of construction enterprises. Strategy plays an important role in the management of any real estate.

Expert evaluations play an important role in the pilot operation of intelligent real estate. Therefore, expert evaluation should be incorporated in the form of rules in the intelligent real estate management. Intelligent real estate management and corporate real estate management are network-based. An important factor of intelligent real estate is the life cycle modelling. The advantage of intelligent real estate is that its life cycle is changeable.

CONCLUSION

Intelligent real estate management is a modern trend. It requires the use of breakthrough technologies and various intelligent models: smart city, smart home, smart real estate. Intelligent real estate management relies on information and digital methods. Intelligent real estate management is not feasible without proper informatization and digitalization. Intelligent real estate management, like many other smart technologies, requires support. The "big nine" technologies provide such support of intelligent real estate management. In the communication aspect, web sites should be noted as a tool for distributing information about real estate in the Internet. The concept of intelligent real estate management includes ensuring the sustainability of real estate management and customer orientation. As a perspective for the development of intelligent real estate management, we can recommend the usage of real estate information units models.

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Интеллектуальное управление недвижимостью

В статье анализируется состояние и использование интеллектуальных технологий управления недвижимостью. Обосновано, что интеллектуальное управление недвижимостью опирается на информационные и цифровые методы. Отмечены ключевые факторы перехода к управлению недвижимостью. Рассмотрены прорывные технологии как инструмент перехода к интеллектуальному управлению. Дан анализ цифровых активов, цифровой недвижимости, цифровых паспортов недвижимости. Показана важность больших данных в управлении недвижимостью. Отмечено влияние технологий информационного моделирования (ТИМ) зданий на развитие интеллектуального управления недвижимостью с возможностью использования искусственных нейронных сетей для оценки недвижимости. Описано применение многокритериальных методов оценки недвижимости, а также возможности мультиагентных систем как средства управления интеллектуальной собственностью. Подробно рассматривается применение девяти современных технологий, получивших название «Большая девятка», как средства поддержки интеллектуального управления недвижимостью.

Ключевые слова: *менеджмент, управление недвижимостью, цифровые методы, интеллектуальное управление, прорывные технологии*

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