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How Technology Impact the Real Estate Business – Comparative Analysis of European Union Countries

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ABSTRACT

Purpose - The purpose of the article is to evaluate and compare the absorption of new technologies by real estate companies in European Union countries.

Design/methodology/approach - The analysis was conducted based on the dataset from Eurostat database for 2018 and 2019. The scope of data includes variables measuring business digitization and use of e-commerce by real estate companies in 20 countries of the European Union. Data analysis was conducted in two stages: first, using multidimensional analytical tools and second, estimating synthetic measure.

Findings - The main conclusions lead to the statement that the use of modern technology solutions by real estate companies varies across the European Union and is largely derived from the degree of digitalization of society and the economy as a whole.

Research limitations - are due to data gaps and the omissions in reporting of companies with less than 10 employees, which are a significant part of the real estate industry. This limitation raises the need for further research, especially among small real estate businesses.

Keywords:	social media, cloud computing, big data, e-commerce, technology, real estate industry, European Union countries
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INTRODUCTION

"*We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before*." (Schwab, 2015). The Fourth Industrial Revolution – a term formulated by Schwab – describes a new socio-economic reality in which the boundaries between physical, digital and biological space are blurred as a result of unprecedented fusion of technological innovations (Schwab, 2017). The Fourth Industrial Revolution is built on the foundations of the Third, which began in the 1960s and was characterized by the adoption of electronics and IT to automate production. There are many notable inventions and fields of development related to Revolution 4.0, among them Information and Communications Technology (ICT), Artificial Intelligence (AI), Big Data, Smart City, Cyber Physical Systems (CPS) (Jeon and Suh, 2017). With the Internet and universal access to its resources, there exist the Sharing Economy, social networks and the Internet of Things (IoT) (Mączyńska, 2018). These innovations are entering nearly all industries and increasingly influence our everyday life.

Defining the impact of the technological revolution on the real estate industry and forecasting changes in this sector are complex and unobvious matters. The real estate industry is relatively traditional and conservative in its operating. This certainly results from the special nature of real estate and its performance in relation to the legal, technical, economic, spatial and social domains. Also, the real estate market itself seems be less open to the expansion of innovation, due to institutional and legal limitations serving, among others, the protection of real estate transactions. However, current global data proves that technology is also entering this industry and future technological expansion may deeply revolutionize the whole real estate sector, in particular trading. Technology changes the way we operate in the real estate market but, while we can observe innovative solutions and new business models, we must also be aware that we are dealing with a traditional business in which technology enters gradually.

The article focuses on the use of technology by real estate industry. The main purpose is to evaluate and compare the absorption of new technologies by real estate companies in European Union countries.

Based on the data on the digitalization of real estate firms and their involvement in e-commerce, a comparison and evaluation of the level of integration of digital technologies in the real estate industry was made. The research hypothesis is that *the degree of the integration of digital technology*

in the real estate industry is largely related to the level of society's digitalization and the level of technology absorption in the country's own economy. The uniqueness of the real estate industry in particular country is less important. In order to verify this hypothesis, a synthetic measure of integration of digital technology in the real estate industry (IDT-REI Index) has been calculated and correlated with the DESI index measures for examined European Union countries.

BUSINESS DIGITALIZATION AND E-COMMERCE IN REAL ESTATE – AN OVERVIEW

1. Use of social media by real estate companies

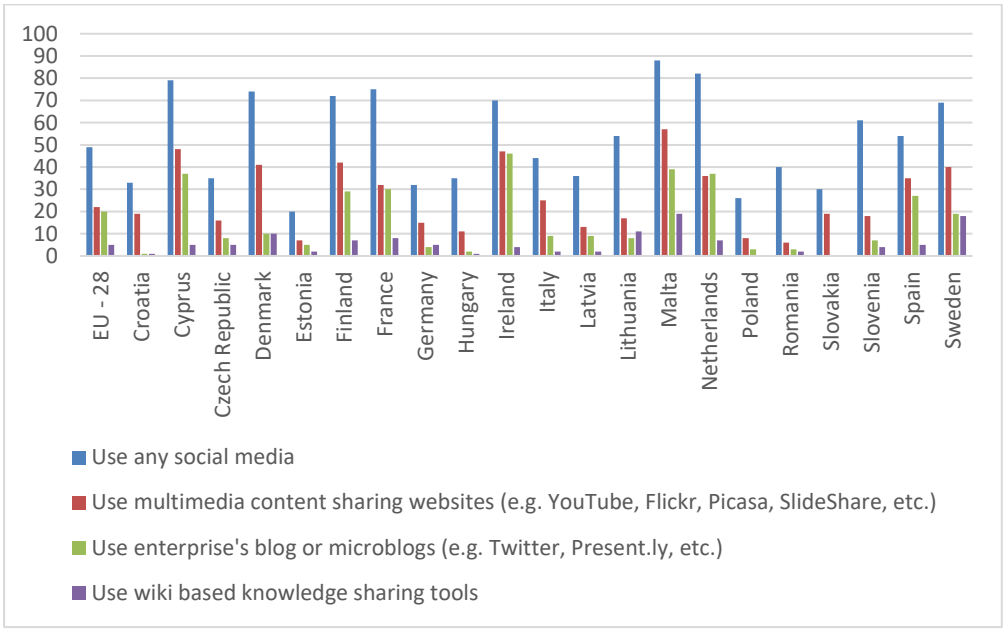
Social media and social networking sites have redefined the way we communicate with each other in every field, in both private and business relationships. Cheng and Shiu (2020, p. 299) define social media "*as applications encompassing easily accessible mobile and web instruments that allow individuals to create, share, and seek content, as well as to communicate and collaborate with one another*". Kaplan and Haenlein (2010, p. 62) identify five general types of social media: collaborative projects, blogs and microblogs, virtual communities, socializing networks, the virtual world of games. The best-known categories of social media are: social networking sites (e.g. *Facebook, LinkedIn*), multimedia content sharing sites (e.g. *YouTube, Instagram, Flickr, SlideShare*), blogs or microblogs (e.g. *Twitter*), and wiki-based knowledge-sharing tools. Through social media, business-to-customer (B2C) communication takes place without any time, space or media restrictions and clients cooperate with the brand and company to create new products, services, business models and values (Aytekin & Keskin Demirli, 2017, p. 19). The virtual environment may also serve to forward the message of the company to its business partners (Özturk & Batum, 2018, p. 117).

Today, social media have become a powerful driver of the real estate market, as real estate professionals and their clients benefit from their use. Most often, companies use social media to build their brand image, for marketing reasons, to gain insight from clients, to communicate within or outside the company, or to recruit.[1] Marketing goals, in particular, are an area where social media generate significant benefits for real estate companies. Research conducted by Olukolajo, Ojo & Akinwamde (2015) among real estate

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Enterprises_using_social_media,_by_selected_purposes_and_economic_activity,_EU-28,_2019_(%25_of_enterprises_using_social_media).png (23.09.2020).

professionals has proven that social media marketing is important and relevant to real estate transactions. It helps marketers improve sales, generates their company's exposure, helps to attract new business partners, reduces marketing expenses, provides insight into the market, and contributes to building a loyal customer base. Also, the client, through Internet and social media, has access to broad range of information in a fast and convenient way, which affects his perception and influences the decision-making process.

Although social media are a global phenomenon, their use for business purposes by real estate companies varies greatly across the European Union. In 2019 49% of EU real estate companies used any type of social media. The highest percentage of companies using social media in real estate business was recorded in Malta (88%), Netherlands (82%), Cyprus (79%), France (75%), Denmark (74%) and Ireland (70%) and the lowest in Estonia (20%) and Poland (26%).



Notes: Data refers to companies employing 10 persons or more. Due to the lack of data, the analysis was limited to selected countries.

Figure 1. Use of social media in the real estate sector in selected EU countries in 2019

Source: Eurostat dataset – ICT usage in enterprises (isoc_e).

The use of different types of social media also varies. Malta, Cyprus and Ireland are leaders in terms of use multimedia content sharing websites (57%, 48% and 47% of companies respectively), while the top user of enterprise

blogs or microblogs is Ireland (with 46% of companies). Wiki-based knowledge sharing tools are the least frequently used by real estate companies.

2. Big data sets analysis by real estate companies

As Diebold (2000) explains "*Big Data refers to the explosion in the quantity (and sometimes, quality) of available and potentially relevant data, largely the result of recent and unprecedented advancements in data recording and storage technology*." It contains both large, interconnected and developed databases, as well as processes that extract useful knowledge from raw and highspeed digital data. Currently, big data is obtained by companies from activities conducted electronically and from communication between machines (e.g. data from production processes). Moorthy et al. (2015) list a number of sources from which large companies and corporations draw data. These are, among others, call center logs, client chats, SMS texts, Instagram pictures, Click Stream on the web, social media, Blogs, CCTV, RFID, Barcode Scanners, Geographic Information Systems (GIS), Youtube, Internet of Things (IoT). The acquisition of large data by companies, often in the course of business operations, requires innovative forms of data management and processing for better understanding and effective use in the decision-making process. The challenges linked to big data were defined by Laney (2001) through the prism of three dimensions that capture the essence of them: Volume, Velocity, Variety (3Vs). Some professionals add more Vs to this list (4Vs by IBM[2]: Volume, Velocity, Variety, Veracity; or 10 Vs by Borne, 2014: Volume, Variety, Velocity, Veracity, Validity, Value, Variability, Venue, Vocabulary, Vagueness). Access to information is a fundamental element of the decision-making process, and due to big data and mining techniques, the decision-making has been changing.

Real estate is an information-intensive and information driven industry (Kumar, 2014). The data on the basis of which analyses, predictions and decisions are made originates from several different sources and are of varied nature. Most of them are location-specific, reflecting the patterns of local real estate markets. New technologies enable the acquisition of a growing range and amount of traditional and non-traditional data, including big data based on human activity, detected via the Internet. Winson-Geideman and Krause (2016) identify three general types of data used in real estate, including traditional and technology-based data sources:

[2] https://www.ibmbigdatahub.com/infographic/four-vs-big-data (23.09.2020).

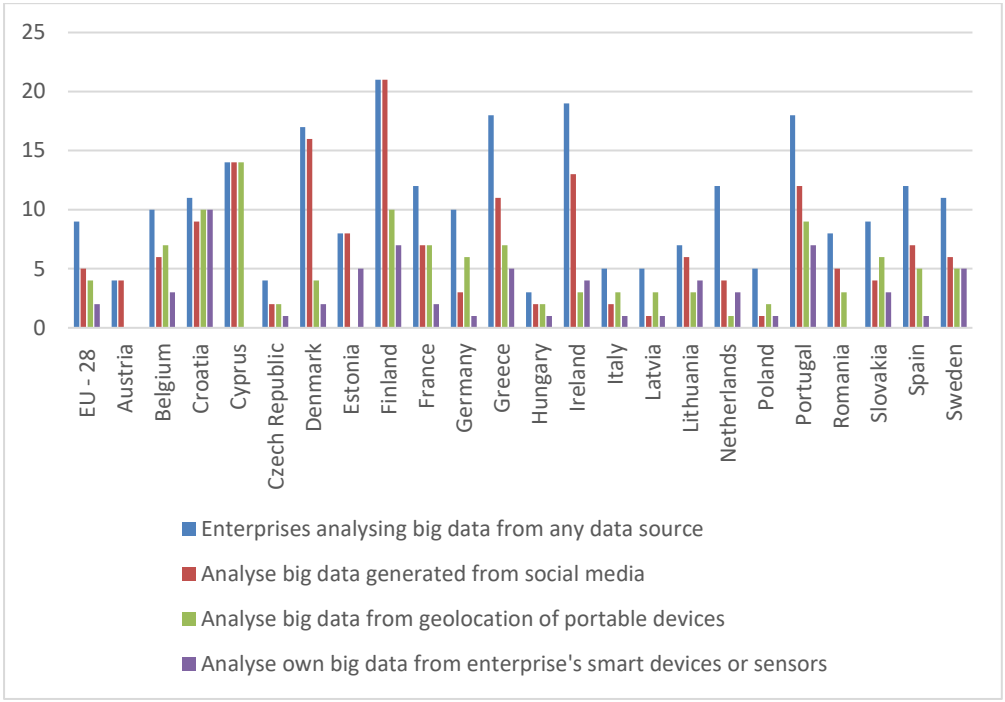
- core information – financial, transactional and physical (*sale transactions, lease transactions, mortgage information, assessment values* and others);
- spatial information – extra-locational information, spatial phenomena outside the boundaries of the property and in its surroundings, available from Geographic Information Systems (GIS) (*census information, road network data, geographic information, spatial economic indicator* and others);
- peripheral data – data focused on people, collected automatically, which allows to include behavioral aspects in real estate analysis (*Internet search, live traffic information, geo-located tweets, pedestrian food counts* and others).

Big data, which are characterized by their dynamics and velocity, are valuable for a short time and therefore must be processed immediately (Wingerath et al., 2016). This poses a challenge and, in a way, a barrier to companies seeking to take advantage of the opportunities offered by big data.

Statistics for selected European Union countries on the use of big data shows its scale (Fig. 2).

In the UE, only 9% of real estate companies with at least 10 employees reported analyzing big data in 2018. However, the statistics for analyzed countries considerably differ. The leader is Finland, with 21% of real estate companies, while the lowest share was recorded in Hungary and the Czech Republic – 3% and 4% respectively. What is worth noting is that in countries with a relatively high share of real estate companies analyzing big data – Finland, Ireland Greece, Portugal and Denmark – the majority of these companies gather and analyze big data from social media.

The opposite trend occurs in countries where large data analysis is not very common – Hungary, the Czech Republic, Italy, Lithuania and Poland – a larger (or similar) number of these companies analyze big data from mobile device geolocation (e.g. portable devices using mobile telephone networks, wireless connections or GPS) as from social media. The lowest share of real estate companies analyze their own big data from enterprise smart devices or sensors.



Notes: Data refers to companies employing 10 persons or more. Due to the lack of data, the analysis was limited to selected countries. Some of the data reported for Greece and Finland are from 2016.

Figure. 2. Use of big data in the real estate sector in selected EU countries in 2018

Source: Eurostat dataset – ICT usage in enterprises (isoc_e).

3. Use of cloud-based tools by real estate companies

According to NIST[3] definition "*cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction*" (Mell and Grance, 2011). Thus, cloud solutions allow to locate the computing infrastructure in the network, which reduces costs associated with the management of hardware and software resources.

Cloud computing (CC) can be distinguished from other computing technologies by five essential features (Mell & Grance, 2011):

- *On-demand self-service* – where the consumer can single-handedly make available computing capabilities such as server time and network

[3] NIST - National Institute of Standards and Technology.

attached storage, automatically and without requiring interaction with any service provider.

- *Broad network access* – where capabilities are available over the network and accessed through standard mechanisms that promote use by client platforms (e.g., mobile phones, tablets, laptops, and workstations).
- *Resource pooling* – the provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources being dynamically allocated and reallocated according to consumer demand.
- *Rapid elasticity* – where capacities can be flexibly provisioned and released, in some cases automatically, for fast scaling inwards and outwards, proportionately to demand.
- *Measured service* – where cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts).

The term "cloud computing" covers both applications delivered as services over the Internet and the hardware and system software in the data centers that provide those services (Armbrust et al., 2010). Vaquero et al. (2008) describe three general cloud service models:

- *Infrastructure as a Service (IaaS)* – where *Infrastructure Providers* manage a large set of computing resources (e.g. storage and processing capacity) and they are able to build ad-hoc systems according to client requirements;
- *Platform as a Service (PaaS)* – where Cloud systems can provide the software platform, on which the systems operate (e.g. Google Apps Engine);
- *Software as a Service (Saas)* – where the Cloud system is a host for services as an alternative to locally run applications (e.g. office applications).

The development of cloud computing brings a number of benefits, for large and small and medium-sized enterprises. Venters and Whitley (2012) conclude that the main benefits of cloud computing for large entities center on gaining better control over data centers and reducing their costs. The benefits for SMEs, in turn, are related to lowering entry barriers to the IT market by allowing access to large data centers that were previously

unavailable due to high capital costs. For some companies it is also important to reduce the need for skilled labor, especially in regions where there appeared skill gaps. For emerging countries, cloud computing offers access to advanced technologies by connecting to cloud service providers operating outside their countries.

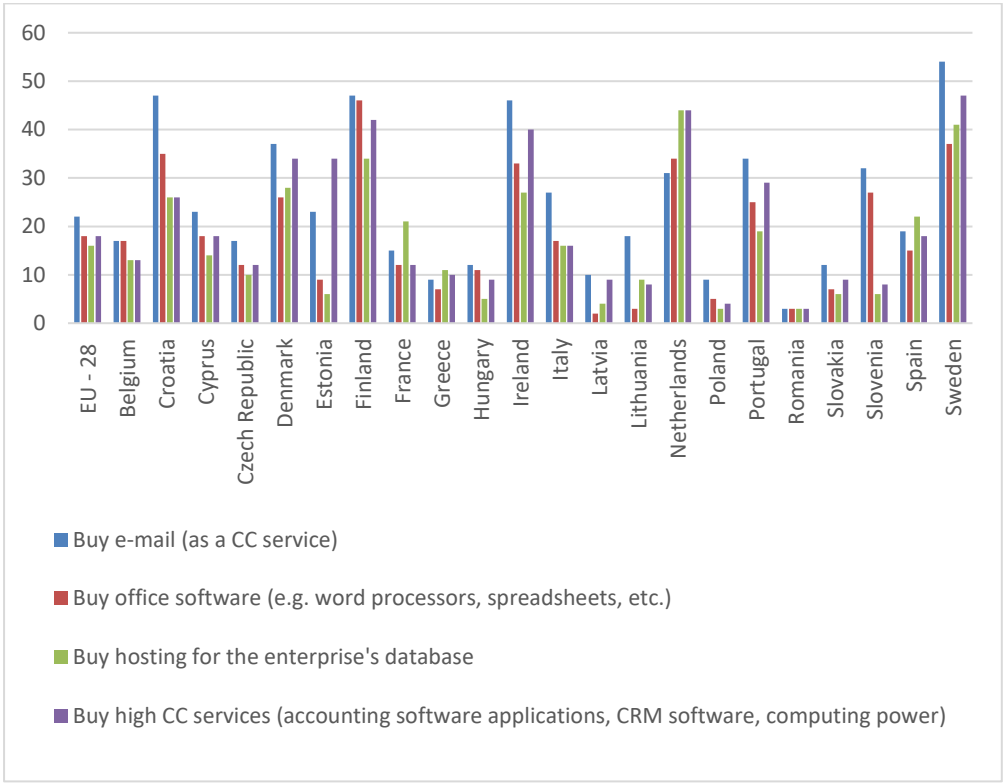
Since relatively recently, cloud-based solutions have also been adopted in the real estate industry. Probably the most common use of cloud computing in real estate is the development of software as a service solutions (SaaS), but the remaining systems: infrastructure as a service (IaaS) and platforms as a service (PaaS) are also employed in property technology (PropTech) innovation development. Cloud computing addresses the problems associated with big data, which are extracted in various formats, including text, audio, visual and spatiotemporal data. It enables the provision of solutions for storing, searching, analyzing and visualizing data in real time (e.g. Hadoop, Spark, GIS Cloud). The PropTech industry uses SaaP to create innovative applications in various fields of real estate services (e.g. Enertiv, Flip) and with SaaS provides software for real estate industry based on license fee (e.g. SAP Cloud for Real Estate, Property Boulevard, Inspection Support Network, Re-Leased, EyeSpy360).

It is also worth mentioning Cloud-BIM technology, which is used, among others, in the construction industry and property management. Building Information Modeling (BIM) is defined by Meng et al. (2020) as "*a shared database that expresses the physical and functional information of a building project in a digital way, and embodies the management process of the life cycle*". Thus, BIM, provides different stakeholders with the opportunity to effectively communicate and collaborate with each other at all stages of the property's life cycle, both in the design and construction phase, as well as in the operation phase involving facility management (Dixit et al., 2019).

In addition to advanced PropTech and ConTech (construction technology) cloud-based innovations, there are a number of universal tools focused on improving the efficiency of business operations. Virtual data rooms have replaced physical documents, teamwork software has become a widely used tool, and digital workflows provide transparency and help maintain time management of standard processes. Professionals can work now from anywhere within the range of a good wireless signal, which is already a standard in many industries, but due to the specifics of real estate (PropTech 2020, 36), it is particularly applicable in the real estate sector.

Statistics for EU countries from Eurostat's database focus both on the use of basic functionalities applied by real estate companies, such as email as

a cloud computing service, but also more advanced, like accounting software applications or CRM software based on the cloud.



Notes: Data refers to companies employing 10 persons or more. Due to the lack of data, the analysis was limited to selected countries. Some of the data reported for Belgium are from 2016 and for Croatia and Portugal from 2017.

Figure 3. Use of cloud-based solutions in the real estate sector in selected EU countries in 2018

Source: Eurostat dataset – ICT usage in enterprises (isoc_e).

As in the case of the previously discussed technological tools, the share of real estate companies using cloud-based solutions varies greatly between EU member states (Fig. 3). In 2018, between 16% and 22% of real estate companies in the European Union used some type of cloud-based solutions. The most common was e-mail as CC service, however, other cloud-based tools were similarly popular. The leading countries are: Sweden (37%-54% of real estate companies used any of CC service), Finland (34%-47%), Croatia (26%-47%), Ireland (27%-46%) and Netherlands (31%-44%). The lowest share of real estate companies using cloud-based tools is in: Romania (3%), Poland (3%-9%) and Latvia (2%-10%).

4. E-commerce in the real estate sector

According to Turban (2010) e-commerce is ‘‘*the process of buying, selling, transferring, or exchanging products, services, and/or information via computer networks, mostly Internet and intranets*”. E-commerce enables not only the exchange of money for products and services, but also for information. Information accompanies market transactions, is the basis of decisions made, and in itself can be a commodity bought and sold (Holsapple & Singh, 2000).

E-commerce is evolving through other technological innovations, such as social media, big data, cloud computing, blockchain, artificial intelligence, machine learning, mobile apps, chatbots and other technologies increase potential and boost e-commerce development. These technologies allow for building varied and new e-commerce solutions for users and developing communication channels with customers.

Currently in practice there are several types of e-commerce business models, with six of them being the most common (Nemat, 2011; Devi, 2018):

- B2B – *business-to-business* – concerns situations where e-commerce is conducted between business partners (instead of individuals), e.g. between a wholesaler and a retailer. This term was originally created to describe electronic communication between businesses, distinguishing it from communication with clients.
- B2C – *business-to-client* – is the most recognizable form of e-commerce, in which products and services are sold to the end consumer. B2C e-commerce are Amazon-type online retailers, but also services such as online banking, travel services, online auctions or health and property information.
- C2B – *consumer-to-business* – is the reversal of the B2C model and within it, it is the consumers (individuals) offering products and services to companies and companies paying for them. An example are blogs or Internet forums, where the author places an advertisement, e.g. with a link to an online business, facilitating the purchase of a product.
- C2C – *consumer-to-consumer* – refers to situations when consumers (individuals) sell products or services to consumers, e.g. through a website created for this purpose, e.g. the global network “olx” of websites carrying localized advertisements.
- B2G – *business-to-government* – is similar to the B2B model, although in this model companies sell their products and services to the

government. B2G networks provide a platform for companies to bid for public projects or products. B2G is also known as "public sector marketing", which involves marketing products and services at different levels of government using integrated marketing communication techniques.

- C2G – *consumer-to-government* – is the model where the consumers offer value to the government.

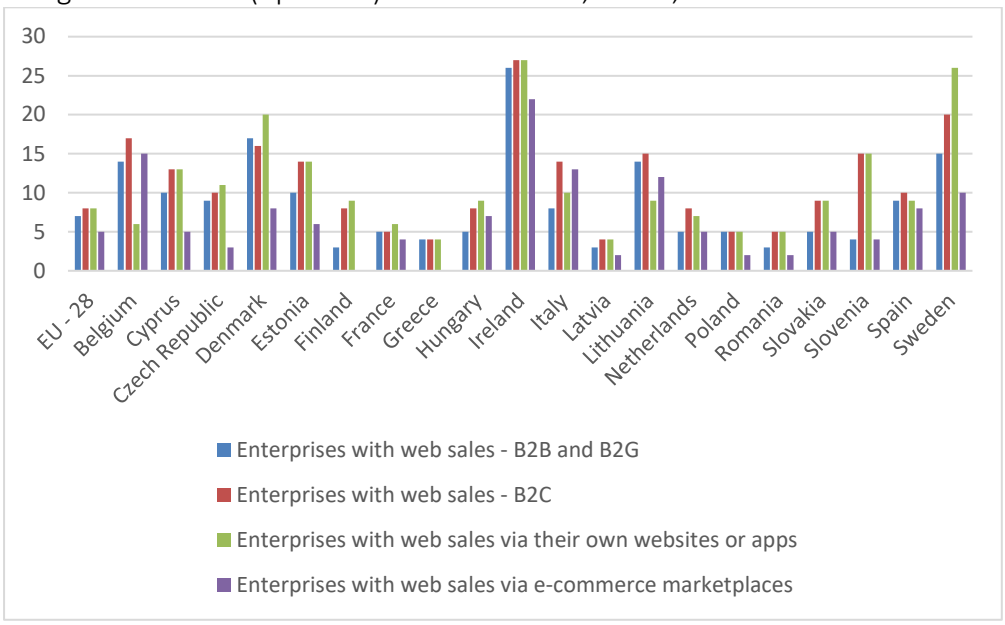
Based on a literature review, Rahayu and Day (2017) have identified a number of benefits that e-commerce may provide to a business. These include: increased revenue, reduced operating costs, purchasing and procurement costs, marketing costs, increased clients loyalty and retention, reduced clients complaints, improved supplier relations, improved competitive position, increased market reach, increased processing speed, improved external and internal communication, improved corporate image.

According to Holsapple and Singh (2000), every company today competes in two worlds: the physical world of resources, and the virtual word of information. The real estate industry is an example of a business, where this statement is clearly confirmed. The real estate industry is a business activity in which information is particularly important. At the same time it is an area where the main product has a specific character (fixed location, differentiation, permanence in time, dependence of value on the environment, high capital intensity) and turnover is determined by legal restrictions and institutional environment. Many stakeholders are involved in transactions in which property rights are transferred. However, it is worth noting that the real estate market itself is also diversified and the trade on this market includes various types of goods. Except property assets, the real estate sector sells many type of services: brokerage, consulting, analysis, valuation, marketing, real estate management, real estate finance, etc. Also e-commerce relations in the real estate market include all the above mentioned business models, with public institutions as a special stakeholder.

The use of e-commerce by real estate companies in the European Union countries, similarly to the previously discussed technology tools, varies (Fig. 4).

The leading countries are Ireland, where 27% of companies declare web sales via their own websites or apps and 22% via e-commerce marketplaces, as well as Sweden, where 27% of companies reported web sales via e-commerce marketplaces. Looking at statistics for individual countries, B2C and B2B with B2G transactions occur at a similar level, with a slight

advantage of the B2C model. The countries with the lowest share of companies using e-commerce (up to 5%) include Greece, Latvia, Romania and Poland.



Notes: Data refers to companies employing 10 persons or more. Due to the lack of data, the analysis was limited to selected countries. Some of the data reported for Belgium are from 2016 and for Croatia and Portugal from 2017.

Figure 4. E-commerce in the real estate sector in selected EU countries in 2019

Source: Eurostat dataset – ICT usage in enterprises (isoc_e).

RESEARCH METHODS AND DATA

The aim of the research is to evaluate the absorption of new technologies by real estate companies in European Union countries. The data used in the analysis came from the Eurostat database[4] for 2018 and 2019. The scope of data includes variables measuring business digitization (use of social media, cloud computing, and big data analysis) and use of e-commerce by real estate companies in 20 countries[5] of the European Union. Descriptive statistics of input variables are included in table 1.

The choice of variables results from two premises: substantive alignment of variables to the studied phenomenon and data availability. Moreover, the selection of variables follows the structure of one of the components of the Digital Economy and Society Index (DESI), namely Integration of Digital Technology sub-index (IDT DESI). The DESI overall index

[4] Eurostat dataset – ICT usage in enterprises (isoc_e).

[5] The gaps in data did not allow to provide the analysis for all EU states.

is calculated as the weighted average of the five main DESI dimensions (sub-indexes): Connectivity (25%), Human Capital (25%), Use of Internet (15%), Integration of Digital Technology (20%) and Digital Public Services (15%). The Integration of Digital Technology sub-index contains data on business digitalization and use of e-commerce by companies from different branches. Although, due to the missing data, it was not possible to fully follow the DESI methodology, in key issues its assumptions were applied, allowing to create the Integration of Digital Technology in the Real Estate Industry Index (IDT-REI Index).

Table 1. Indicators on absorption of new technologies by real estate companies in selected European Union countries - descriptive statistics

Indicators	Year	Mean	Min	Max	DS
Use any social media by real estate companies (% of companies)	2019[1]	50,80	20,00	82,00	20,41
Real estate companies analyzing big data from any data source (% of companies)	2018[1]	10,10	3,00	19,00	4,64
Buy cloud computing services used over the internet (% of companies)	2018[2]	31,55	4,00	73,00	19,62
Real estate companies with e-commerce sales (% of companies)	2019	13,15	4,00	31,00	7,61

Notes: Data refers to real estate companies employing 10 persons or more. Due to missing data, the statistics cover 20 out of 28 EU countries. The data reported for Greece are from [1]2016 and [2]2017.
Source: Eurostat dataset – ICT usage in enterprises (isoc_e).

Data analysis was conducted in two stages.

- In the first stage, the tools of multidimensional analysis – *k-means cluster analysis* and *multidimensional scaling* – were used. They allowed to identify three groups of countries according to their similarity in terms of absorption of new technologies in the real estate business.
- In the second stage, a synthetic measure has been estimated. A simple procedure was used, based on non-projective measure and the DESI methodology. Specifically, the methodology steps were as follows:
  a) Normalization was carried out using the min-max method, according to the equation:

$$f(x) = \frac{x - \min(x)}{\max(x) - \min(x)}; \quad (1)$$

  All variables have a positive direction, so they are stimulants, thus 0 on the normalized scale was anchored to the minimum value on the

original scale of the variable and 1 on the normalized scale was anchored to the maximum value on the scale of the variable.

b) Calculation of sub-index ($U_{s)}$ for business digitalization (based on three variables: using social media, big data and cloud computing by real estate companies), according to the simple non-projective measure, as follows:

$$U_s = \frac{1}{p}\sum x \; ; \tag{2}$$

Where p is the number of indicators.

c) Calculation of the Integration of Digital Technology in the Real Estate Industry Index (IDT-REI Index) using two components – first, the business digitalization sub-index (U_s Sub-Index) with a weight of 60% and second, the standardized e-commerce variable with a weight of 40%. The formula and weights were taken from the DESI methodology:

$$IDT - REI\ Index\ =\ Us\ *\ 0{,}6\ +\ e - commerce\ sale\ *\ 0{,}4 \tag{3}$$

d) Ranking and comparison of countries by IDT-REI Index in reference to countries positions by DESI overall index and DESI component – Integration of Digital Technology Index for all branches.

RESULTS & DISCUSSION

Multidimensional analysis has shown that there are three relatively homogeneous groups of countries in terms of share of real estate companies implementing new technologies (Fig. 5). Descriptive statistics of each cluster can be found in Table 2.

Table 2. Descriptive statistics of clusters

Variable	Cluster 1		Cluster 2		Cluster 3	
	Mean*	SD	Mean	SD	Mean	SD
Use of social media	73,40	5,18	64,60	11,76	32,60	6,98
Use of big data	13,80	3,96	11,60	2,70	7,50	4,35
Use of cloud computing	60,80	8,87	26,60	5,77	19,40	10,48
E-commerce sale	21,60	9,94	13,40	2,70	8,80	3,79

*Notes: Percent of real estate companies employing 10 persons or more.

Source: own elaboration.

The first cluster – *technology leaders* – groups the guiding countries in all four examined areas. A very high percentage of companies in these countries use social media and cloud computing to run their real estate

business. Compared to other clusters, big data analysis and e-commerce sales are also at the highest level.

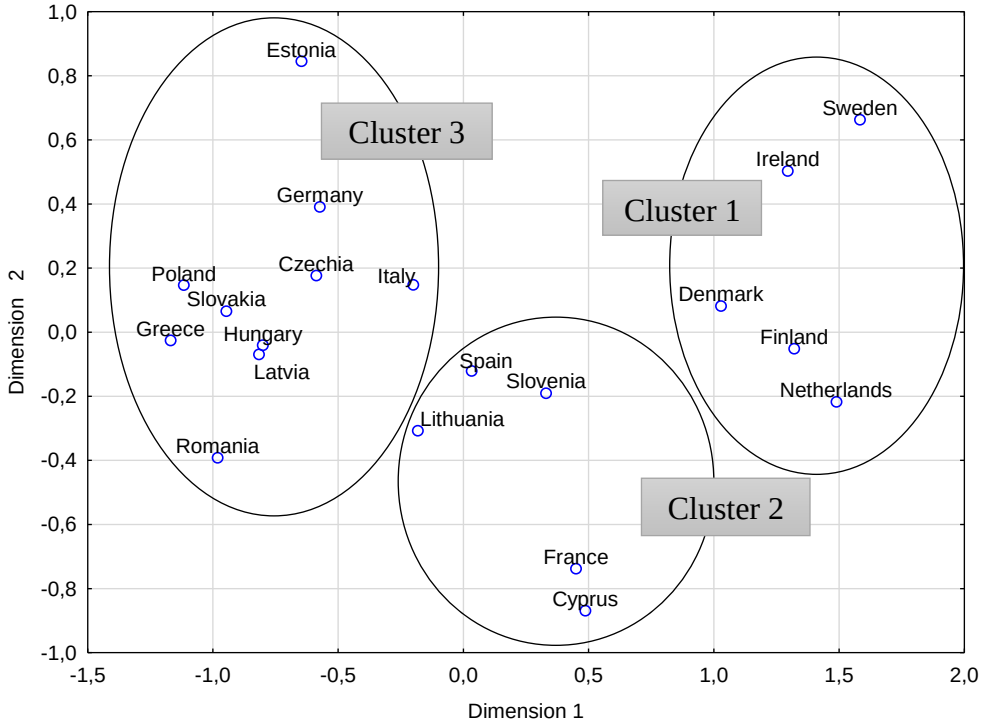


Figure 5. The results of multidimensional analysis

Source: own elaboration

The second cluster – *aspiring to technological advancement* – similarly, is characterized by a high share of companies using social media, but already much lower participation of companies using cloud computing. For all four researched areas, the average percentage of companies is between first and third clusters' results.

The third group – *early explorers of technology* – are the countries with the lowest share of companies in each of the analyzed fields. As in the other groups, social media are the most popular tools, whereas big data analysis is the smallest. This suggests that social media are primarily used to advertise and maintain customer relationships, and to a lesser extent to gain knowledge about clients by collecting big data from this source.

While interpreting the research results, it is possible to indicate a number of factors contributing to diversification in the use of technologies outlined above in the real estate industry:

- The greatest popularity of social media among real estate companies results from several reasons:

a) the huge use of social media around the world has made them into a powerful tool for reaching clients – an estimated 3.6 billion people worldwide were using social media in 2020, with the figure set to rise to nearly 4.41 billion in 2025[6];
b) the prevalence of social media in everyday life makes them intuitive and relatively easy for most people to use – therefore their use in SMEs does not encounter greater barriers in terms of accessibility to technology or lack of specific skills within firms;
c) comparing different segments of the real estate industry, the use of technology has found its greatest place in real estate services – brokerage, rental and real estate marketing (PropTech 2018). The results of research conducted by REALTORS® Research Group (Technology Survey, 2018) indicate that social media are primarily used to promote offers, build and maintain relationships with existing clients, and simply because of companies are expected to be present in social media. Thus, real estate agencies and social media form a successful business duo.
d) social media are a foundation for other technological innovations – they can be a source of big data or serve directly electronic trade.

- Analysis of big data is an area of prospective development in the real estate industry. Today, greater benefits from this type of activities are enjoyed by companies that have easy access to big data and are skilled in using it. Small and medium-sized companies may not see sufficient benefits from big data analysis, taking into account its costs and traditionally focus more on cooperation with long-standing, well-known clients.
- The fairly large and growing popularity of cloud computing is due to the benefits it brings to SMEs, allowing many businesses to access application software over a high-speed Internet connection without having to invest in software and hardware. Moreover, due to the nature of the real estate business, which requires fieldwork and mobility, cloud computing works especially well. Differences between countries may result from higher awareness of the benefits of using technological solutions in highly developed countries, greater availability and universality of cloud computing in business and lower

[6] https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/ (23.09.2020).

cost-efficiency obstacles associated with purchasing access to cloud services.

- E-commerce sales in the real estate industry, while having great potential, also have limitations, which result from specific requirements and conditions of the real estate trade (especially sale of property rights). However, both real estate brokerage services and rental space trading are widely used in e-commerce. The higher level of digitization of society and economy and the developed e-government contribute to the increased popularity of e-commerce in some countries.

A clear hierarchy of identified clusters, reflecting the different levels of technology absorption by real estate companies in each country, makes room for a country-by-country ranking. Table 3 contains a list of countries with the estimated IDT-REI Index, values of the general DESI index and the DESI component – IDT DESI calculated for overall companies from multiple industries. In addition, the table shows the ranks of countries, depending on the value of the index (the highest score is the first place and the lowest is the last).

Table 3. Index values and rankings of European Union states

Countries	Real Estate Industry - Integration of Digital Technology Index	Rank - Real Estate Industry (IDT-REI Index)	DESI component - Integration of Digital Technology Index	Rank - DESI (IDT Index)	DESI overall	Rank - DESI overall
Cyprus	0,52	6	670,16	13	4145,34	17
Czech Rep	0,25	13	854,25	7	4728,20	13
Denmark	0,79	3	1223,75	3	6601,78	3
Estonia	0,31	12	796,79	10	5828,00	5
Finland	0,53	5	1202,95	4	6812,18	1
France	0,43	9	815,12	9	4977,56	11
Germany	0,25	14	783,13	11	5122,44	9
Greece	0,24	15	604,90	15	3507,44	20
Hungary	0,17	17	497,02	17	4226,84	15
Ireland	0,93	1	1382,37	1	5802,10	6
Italy	0,33	11	600,48	16	4159,65	16
Latvia	0,14	19	494,06	18	4993,90	10
Lithuania	0,38	10	951,28	6	5180,27	8
Netherlands	0,58	4	1252,25	2	6359,56	4
Poland	0,10	20	470,14	19	4072,04	18

Romania	0,14	18	426,42	20	3653,33	19
Slovakia	0,21	16	661,24	14	4287,87	14
Slovenia	0,51	7	782,34	12	4869,06	12
Spain	0,44	8	825,67	8	5363,26	7
Sweden	0,84	2	1158,79	5	6745,17	2

Source: own elaboration.

The results of the ranking according to the IDT-REI Index are fully consistent with the results of multidimensional analysis. The first five places are held by countries from the first cluster, the next five are countries from the second cluster and the remaining ten are representatives of the third cluster. The first five countries – Ireland, Sweden, Denmark, Netherlands and Finland – are traditionally considered to be leaders in technology development in EU in general, based both on the figures quoted in the table 3, as well as another research results (Schwab, 2014; Ardielli & Halásková, 2015; Małkowska Urbaniec & Kosała, 2019). Comparison of the IDT-REI index with the two others (Tab. 3), shows that individual countries from the third cluster are moving to higher positions. A good example is Estonia, which is currently considered to be a high-tech country. This status has its origins in the early years of post-communist transformation, when Estonia took the course towards development based on modern technologies. In turn, Poland and Romania have not taken full advantage of the opportunities brought by the last few years and are ranked in last positions.

With a few exceptions (e.g. Cyprus, Greece, Lithuania), the values of indexes and the rankings based on them are correlated (Fig. 6). The correlation coefficient for IDT-REI Index and IDT DESI Index is 0,88, for IDT-REI Index and DESI overall is 0,72 and for IDT DESI Index and DESI overall is 0,86. These results support the hypothesis that *the degree of the integration of digital technology in the real estate industry is largely related to the level of society's digitalization and the level of technology absorption in the country's own economy. The uniqueness of the real estate industry in particular country is less important.*

In addition, the radar chart (Fig. 6) also allows for comparing the consistency of above-mentioned rankings. The points closest to the center of the chart illustrate the highest positions in the ranking, the points located on the outer rim – the weakest positions. Similarly to the correlation coefficients calculated for index values, the country ranks also indicate significant convergence.

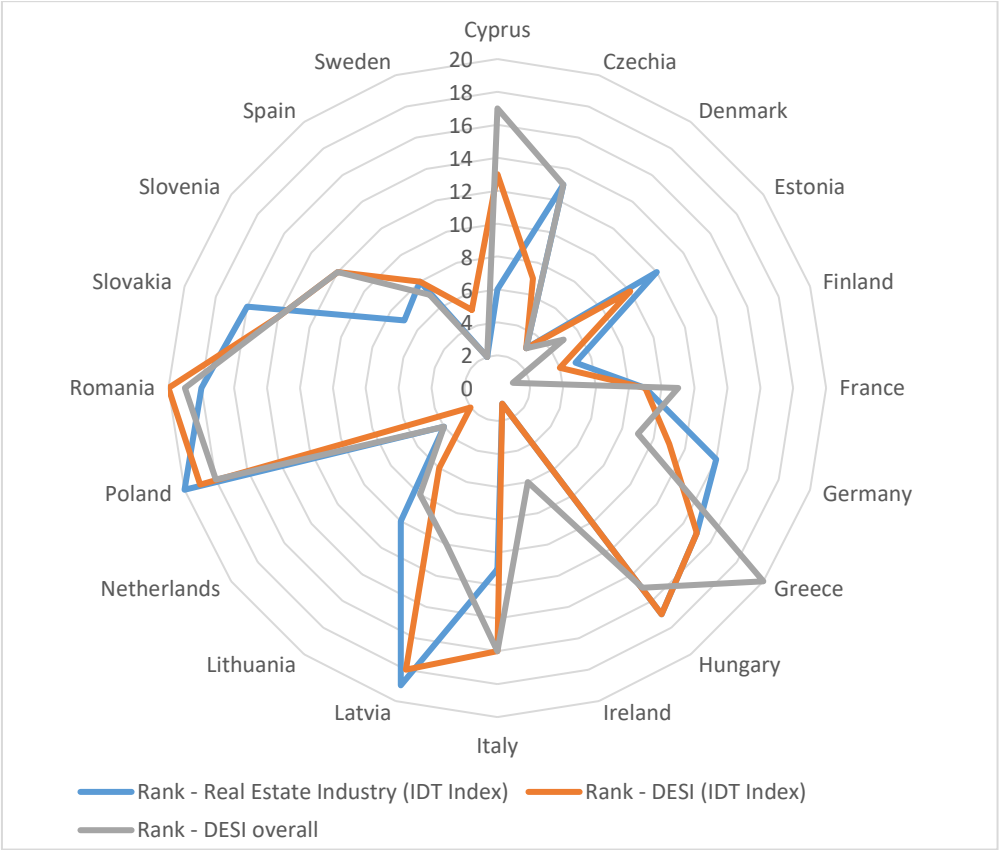


Figure 6. Comparison of the countries' positions in the rankings

Source: own elaboration.

CONCLUSION

The results of this research indicate significant diversity in terms of the adaptation of modern technologies in real estate business in EU countries. The reasons lie both in the factors related to the specificity of the real estate industry, in the limitations associated with the application of specific technological solutions, but primarily have their roots in the overall technological advancement of societies and economies across the EU. The current pandemic crisis provides an opportunity for accelerated technological progress and for bridging the gap that has arisen between technological leaders and countries that are still building-up their technological potential. Especially the digitalization of the public sector could bring great benefits to the real estate industry.

There is also a need for education activities regarding the opportunities offered by new technologies in real estate business and improvement of digital skills. In countries such as Poland, preparation for the real estate professions

basically ignores technological issues. The support of professional associations is also insufficient in this case. In general, there is a lack of courses and training that would allow real estate professionals to improve digital skills and recognize the benefits of using technology.

Although the undertaken analysis allows to realize the aim of the research and positively verify the hypothesis, it has some limitations. It should be noted that the majority of companies providing services to the real estate market are small (Małkowska & Uhruska, 2018), often taking the form of sole proprietorship companies, while data obtained from Eurostat provide statistics for enterprises with 10 employees and more. Thus, the diagnosis of integration of digital technologies in the real estate industry is not complete, as it omits a significant number of entities. It provides space for further research, especially within small companies.

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