

CUSTOMER PREFERENCES OF MODERN TECHNOLOGIES (PROPTECH) ON THE PRIMARY HOUSING MARKET

Anna GÓRSKA^{1*}, Anna MAZURCZAK², Łukasz STRĄCZKOWSKI³

¹ Poznań University of Economics and Business; anna.gorska@ue.poznan.pl, ORCID: 0000-0002-0536-8475

² Poznań University of Economics and Business; anna.mazurczak@ue.poznan.pl, ORCID: 0000-0003-0311-1884

³ Poznań University of Economics and Business; lukasz.straczkowski@ue.poznan.pl,
ORCID: 0000-0002-5555-5324

* Correspondence author

Introduction/background: The residential property market is in a state of constant flux, largely a consequence of the intensive development and increasing availability of modern technologies termed PropTech. Relatively resistant to change, the real estate sector is undoubtedly undergoing a technological revolution. PropTech affects the activities of entities that create both supply and services on the real estate market. In addition, it also affects the customer.

Aim of the paper: The aim of the paper is to identify the attitudes and preferences of primary apartments buyers regarding the use of modern technology (PropTech) by developers in the local residential property market.

Materials and methods: The tool was Internet survey questionnaire. Originally, a face-to-face study was planned, but due to the constraints of the pandemic, it was not possible to reach respondents directly. In some cases, the “snowball” method was also used to increase the sample size.

Results and conclusions: The preference surveys that have been conducted and presented are a contribution to further research work in this area. The results obtained show that the most popular solutions are those that are relatively easy to achieve and do not pose a great challenge to developers, for example. In contrast, those related to digital tools came in last place. Further questions also arise. To what extent, in a situation of relatively expensive housing, are buyers willing to pay for modern solutions. Environmental awareness, such as the use of solar energy or rainwater harvesting, may be at odds with the purchasing capacity of households. To what extent can buyers trust modern technologies without worrying about, for example, lack of energy to use appliances. These and probably other questions require further research in this area.

Keywords: PropTech, customer preference, residential market, housing market, real estate.

1. Introduction

One of the consequences of the fourth technological revolution is the implementation of modern technologies also in the real estate market (Siniak, Kauko, Shavrov, Marina, 2020). The real estate market is more resistant to change than other markets, especially with regard to the use of digital technologies. However, the use of solutions to foster its digitalisation appears to be a necessity driven by economic efficiency. Furthermore, it is a necessary response to the changing needs and preferences of customers in this market. The extensive use of digital technologies in real estate, including the Internet of Things (IoT), cloud computing, decision automation, machine learning and artificial intelligence (Starr, Saginor, Worzala, 2021) is redefining the way people live, work and invest.

The technological revolution in the real estate market is identified with the PropTech phenomenon, which is characterized by the massive implementation of emerging technologies (Siniak, Kauko, Shavrov, Marina, 2020). A narrower approach is taken by Baum and Dearsley (2017), who define PropTech as a small part of the broader digital transformation of the entire real estate industry (real estate market, construction, real estate financing), a move driving the changing mentality and its consumers in technology-driven innovation in data collection, transactions, and building and city design. PropTech definitions in the literature on the subject differ from each other, but all are based on two main elements: “property” - real estate and “technology” - technology, meaning innovative technological products and new business models for the real estate market (Baum, 2017; Siniak, Kauko, Shavrov, Marina, 2020; Shaw, 2018). In recent years, commercial entities, in the form of international consulting companies, have also taken steps to better understand the PropTech phenomenon. In this case, the term means broadly understood technological and digital, hardware and software innovations in the real estate sector, while emphasizing various aspects of the impact of digital technologies and innovations on the real estate market (KPMG, 2018; PWC, 2018; Deloitte, 2018).

PropTech is not a new phenomenon, but still little known in the field of academic research. Preparatory work covering an extensive overview of PropTech as an industry and providing an early definition was written by Baum in 2017. These were expanded in 2020 to include categorization of the main technologies used by PropTech, quantification of market size, and analysis of the scale of investments in various sectors and geographic markets. There are also few studies devoted to the importance of PropTech in the housing market. It is worth mentioning here Landau-Ward and Porter (2019), who examined the impact of digital innovation and PropTech technologies on the residential market in Melbourne. They discover that with the advent of PropTech and their advances in technology, the level of data available has led to increased transparency, higher land prices and greater inaccessibility of housing. The literature on the subject (Siniak et al., 2020; Clayton et al., 2019) shows that technology and innovation play an increasingly important role in the real estate industry and affect every

market participant, especially those who lack innovation. Thus, innovation and the ability to adapt to a changing environment are essential for real estate participants (e.g. investors, brokers, managers) to keep pace with the competition.

Entering into the so-called Economy 4.0 within PropTech there are several industries:

- property market - technology-based platforms that facilitate the operation and management of real estate. Platforms can provide information on the performance of buildings or urban centres, or they can directly facilitate or control construction services. This sector supports real estate management. (Baum, 2017);
- smart cities - internet portals virtualizing cities or city guides, knowledge bases corresponding to local needs, agglomerations with information and communication technologies (ICT), infrastructure attracting relocations of enterprises, general city teleinformation infrastructure providing e-services to citizens, ubiquitous environments, ICT infrastructure for ecological purposes (Anthopoulos, 2015);
- smart building - computer and intelligent technologies to achieve the optimal combination of the overall level of comfort and energy consumption (Wang et al., 2012);
- sharing economy - technology-based platforms that facilitate the use of real estate assets. Assets can be land or buildings, including offices, shops, warehouses, apartments, and other types of real estate. Platforms can simply provide information to potential users and space sellers, or they can more directly facilitate or conduct rent or fee based transactions. This sector supports real estate tenant markets (Baum, 2017);
- construction sector (ConTech) - technological innovations in the design, planning and construction phase of real estate (Unissu, 2019);
- real estate financing (FinTech) - the use of technology and innovative business models in financial services; According to the report by KPMG The Pulse of Fintech (2016), FinTech entities are divided into several key industries (industry sectors), including lending tech, payments / billing tech, personal finance / wealth management, money transfer / remittance, blockchain / bitcoin, institutional / capital markets tech, equity crowdfunding, InsurTech.

According to Baum (2017), three basic phases of the evolution of modern technologies in the real estate sector can be distinguished (Figure 1). The phases highlighted by Baum are arbitrary, and the boundaries of the emergence of PropTech 2.0 and PropTech 3.0 are blurring. The implementation of modern technological solutions on the real estate market depends on the level of market development, and thus on access to capital that could finance these changes.

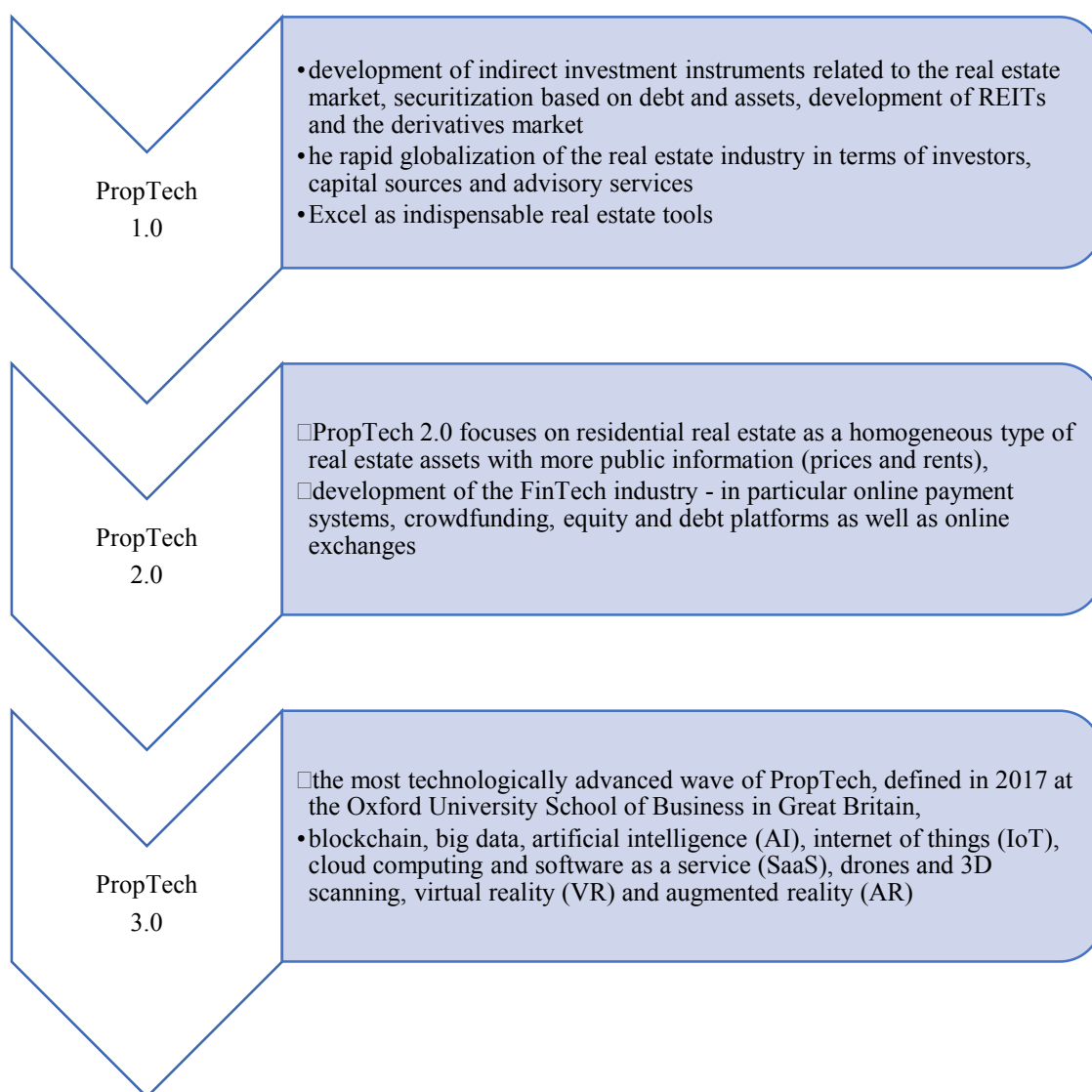


Figure 1. PropTech phases.

Source: own study based on Baum (2017).

PropTech 3.0 is considered to be a phase that is to revolutionize the market, introducing a high level of changes in the entire real estate sector (Baum, 2017). Most market participants, while still in the PropTech 2.0 phase, are rapidly adapting and moving to PropTech 3.0. PropTech 3.0 is related to, among others: blockchain, big data, artificial intelligence (AI), internet of things (IoT), cloud computing and software as a service (SaaS), drones and 3D scanning, virtual reality (VR) and reality extended (AR) (Ullah et al., 2018; Baum, 2017; Shaw, 2018; JLL, 2018).

Already advances in PropTech 2.0 - including cloud and mobile computing, digital platforms, and automated, data-driven decision-making tools - are radically changing the way homeowners and investors buy and sell housing. However, it is only PropTech 3.0 that leads to a digitized global real estate market that is likely to be platform-based and transaction tokenization. Instead of lifetime investment decisions or rental contracts for years, buying, owning or renting real estate can become a seamless process mainly thanks to blockchain-based

tokens. At the same time, smart homes, equipped with countless sensors, will communicate with the owner's smartphone to optimize energy efficiency and user comfort (Braesemann, Baum, 2020).

The real estate market entities that use PropTech technology include, first and foremost, real estate brokers, developers, construction companies, and consulting companies. In shaping the PropTech market, an important role is also played by suppliers of ready-made products and solutions, developers of specialized web and mobile applications, which can generally be called technology companies (startups) (Siniak, Kauko, Shavrov, Marina, 2020) and investors who financially support the development and implementation of innovative concepts. According to a report by SkyConcept and Eurobuild (2018), 83% of real estate executives believe that PropTech technologies are the most important driving force behind the development of the modern real estate market. Entities operating in this market, both on the supply side and entities serving the market, will be forced to adapt to the customer by introducing solutions in the form of artificial intelligence (AI), Internet of Things (IoT), virtual reality (VR) and augmented reality (AR).

The possibilities offered by PropTech 3.0 technologies are enormous and they truly have the power to transform the industry. PropTech players are beginning to use various Artificial Intelligence (AI) and Machine Learning (ML) techniques to improve product visibility, productivity and accuracy. The specific applications of these tools and their potential in the real estate market are already under investigation, especially regarding the impact on how investors and other real estate professionals can incorporate technologies and new strategies into their decision-making and operational processes (Viriato, 2019). Blockchain enables secure and transparent registration of property titles and ensures faster turnaround times for real estate transactions, and improves the liquidity and indivisibility of assets (Veuger, 2017). Big Data contributes to the reduction of the risk associated with the purchase of real estate, and also enables buyers to have a better decision-making process, while eliminating subsequent regrets (Mathew et al., 2015). Cloud computing reduces IT costs in organizations. Drones increase customer attractiveness by offering top-down photos for real estate projects. The Internet of Things (IoT) keeps users more immersed and connected to the built environment. Virtual and augmented reality software and hardware make it possible to visualize real estate without physically visiting it (Casini, 2022). The digital transformation in both the area of rules and market practices to increase efficiency, flexibility and adaptability means a significant advance in the real estate market (Starr, Saginor, Worzala, 2021), both for the customer and the supply side.

2. Materials and methods

PropTech affects the activities of entities that create both supply and services on the real estate market. In addition, it also affects the customer. Nowadays, it would be difficult to find someone who has not felt the influence of PropTech, even unknowingly, in commercial and multi-family spaces or has spent some time looking at real estate online. From the customer's point of view, the most important and tangible area of using PropTech technology were online platforms, which made it possible to quickly search for huge amounts of information about real estate and its surroundings around the world. The COVID-19 pandemic meant that not only searches were performed online, but also finalized real estate purchase transactions.

Taking up the topic as part of PropTech on the local real estate market is aimed at joining the academic discussion in this area and determining the attitudes and preferences of the buyer of apartments on the primary market in Polish conditions. Therefore, the following goals were adopted in the research in the field of modern technologies on the local residential real estate market:

- G1: identifying the sources that are taken into account in the process of acquiring an apartment, by different age groups of people.
- G2: indication of the key elements that should be included on the developer's website among different age groups of people.
- G3: identifying new technologies that people (of all ages) take into account when looking for a target location.

The implementation of the assumed goals was possible by conducting a survey among people potentially interested in buying a flat - the methodological assumptions are presented in Table 1.

Table 1.

Basic information on research in the field of modern technologies on the local housing market

Itemization	Description
Information gathering time	9 months - from May 2021 to January 2022. When collecting the data, it was necessary to take into account the problems that arose in connection with the COVID-19 pandemic (limited access to some respondents, extended time to receive surveys)
Spatial scope of research	The local residential real estate market in Poznań. The housing market has a local character (everyone is different, which is a characteristic feature of the real estate market). This has been proven in many domestic and foreign studies in this field (Schmitz, Brett, 2001, pp. 3-18; Stefaniak, 1997, p. 33; Bryx, 2013, p. 190; Kucharska-Stasiak, 2016, p. 59; Belniak, 2001, p. 42; Strączkowski, 2021, p. 39).
Material scope of the study	research subject: people from different age groups; research subject: sources of information about apartments, information important to potential buyers, what should be on developers' websites, new technologies that can be taken into account when buying apartments. The aim of the paper was to take into account the views of people from different age groups on modern technologies dynamically entering the housing market. More and more people want or require modern solutions, without restrictions or inhibitions, use digital tools.

Cont. table 1.

Time range of the study	It coincides with the time of data collection
Research tool	Internet survey questionnaire Originally, a face-to-face study was planned, but due to the constraints of the pandemic, it was not possible to reach respondents directly. In some cases, the “snowball” method was also used to increase the sample size.
Selection and size of the sample	non-random, random, sample size n = 702 units

Source: own study.

Referring to the information contained in Table 1, it should be added that initially the main group of respondents to whom the questionnaire was addressed were young people, most often defined as those whose maximum age does not exceed 35 years (Kusińska, 2005). However, it was later concluded that a survey addressed to people in subsequent age groups may help to identify possible differences in the perception of modern technologies on the residential real estate market.

The ability to reach respondents was of key importance. Originally, data collection was to take place through two channels, i.e. through: (1) an auditorium survey - mainly, (2) an Internet survey - supplementary. Due to the outbreak of the COVID-19 pandemic and limitations in social contacts, collecting data through an auditorium survey turned out to be impossible, and therefore the first channel was abandoned. Ultimately, 702 respondents were reached. When it comes to the characteristics of the respondents in the study, it can be said that:

- of all the surveyed people, 54.8% were women, and men - 45.2%;
- in the age structure, the largest share was that of people aged 46 to 55 - 28.9%; the second largest group was composed of people who declared the age from 26 to 35 years - 25.7%. The third largest segment is made up of people aged up to 25 - 21.7%, followed by people aged 36 to 45 (16.0%) and over 55 (7.7%). The average age of the respondents was 38.8 years;
- they were mainly made up of farms consisting of 3-4 people (52.8% of respondents) and 1-2 persons (37.6%). 9.6% of the respondents live in larger households of 5 or more;
- these were people who most generally view parenthood favourably, as 20.4% declared having or planning to have one child, 48.6% - two children, 11.7% - three children, 4% - four or more children. Only 15.3% of all respondents did not declare the will to have children.

The respondents are dominated by two groups of people, one of whom indicated a willingness to live in a flat situated in a multi-family building - a block of flats (44.6% of all respondents), and the other in a detached building, popularly known as a house (41.2%). Life in the semi-detached or terraced house was indicated by 14.2% of people.

In the structure of responses regarding space, every fifth respondent (21.7%) indicated interest in premises with an area of up to 35 m², every fourth (25.7%) - in a unit with an area of 36 to 50 m², 16% - from 51 to 65 m², 28.9% - from 66 to 80 m², and 7.7% - the largest apartments with an area exceeding 80 m². The responses indicate that the respondents were interested in quite large premises, as the average area of the declaration reached the level of 81.1 m².

In the case of the number of rooms, the most common desire was to have a three-room flat (44.2% of all respondents), and then a four-room flat (25.1%). On the other hand, 1% and 20.7% of the respondents showed interest in smaller one- and two-room flats, respectively. The rest (9.0%) would like to live in units with at least five rooms.

As a consequence of the information presented above, it is not surprising that the average budget for the purchase of a flat with the respondents was quite high and reached the level of 506.4 thousand. PLN. On the other hand, in the structure of responses, 26.3% of respondents declared a budget of up to PLN 350,000, 24.0% - from PLN 351 thousand to 450 thousand., 20.2% - from PLN 451 to 550 thousand. and 29.6% - over PLN 550 thousand.

Interestingly, some of the people were willing to allocate a certain amount of the budget for the purchase of premises in a building in which modern technologies would be used. On average, it would be 9.8% of the total purchase price of a flat, i.e. nearly PLN 50,000 (PLN 49.6 thousand), with 38.7% of respondents saying that they would spend up to 5% of the price of a flat for this purpose, 37.8% - up to 10% of the price, 8.6% - up to 15% of the price, 11.1% - up to 20% of the price. Only a few would be willing to allocate a higher share, exceeding 20% of the price.

3. Results and discussion

It is worth starting the issue of using modern technologies in the context of clients on the residential real estate market by identifying sources of information, i.e. those places that the respondents would use when looking for their own flat. Of course, there are quite a lot of sources of them - some are places that are available and common to many people (e.g. websites, billboards), and some are informal contacts (an example may be the opinions and helpful opinions of friends and family). Table 2 presents structure of information sources used in searching apartments.

Table 2.

Sources of information that the respondents would use when looking for a flat – in total and by age of the respondents (percentage of responses)

itemization	in total	respondents aged:				
		up to 25 years	from 26 up to 35 years	from 36 up to 45 years	from 46 up to 55 years	over 55 years old
Internet portals with housing offers	91.4%	98.0%	96.7%	90.2%	88.1%	70.4%
family, friends	71.6%	91.4%	71.7%	67.0%	59.9%	68.5%
developer sites	69.1%	82.9%	75.6%	63.4%	61.4%	50.0%
banners, information on investment fences	20.3%	23.7%	20.0%	20.5%	17.8%	20.4%
real estate fairs	19.3%	28.3%	20.0%	13.4%	16.3%	13.0%
local media (daily newspapers)	14.9%	8.6%	7.2%	17.0%	20.3%	31.5%
local TV and radio	5.6%	3.3%	2.8%	3.6%	9.4%	11.1%
billboards	5.1%	2.0%	1.1%	7.1%	9.4%	7.4%
magazines	3.0%	3.3%	0.0%	3.6%	4.5%	5.6%
leaflets (e.g. in mailboxes)	3.0%	1.3%	2.2%	3.6%	3.0%	9.3%

Source: own study.

Among the potential places from which one can gain knowledge about housing, the most important role can be attributed to internet portals with housing offers - this source received 91.4% of responses in total. Great importance can also be attached to family and friends (71.6% of responses), developers' websites (69.1%) as well as banners and real estate fairs (20.3% and 19.3% of responses, respectively). Interestingly, the importance of the sources varies depending on the age of the respondents. It is quite clear, as illustrated in Table 2, that young people - up to 25 years of age, and relatively older people - over 55 - approach some sources differently. For the former, internet portals with housing offers are crucial (98% of responses), for the latter, they are important, but the percentage of responses is much lower and amounted to 70.4%. It is worth noting, however, that for people aged over 55, traditional sources of obtaining information are relatively more important, such as local newspapers, television and radio, billboards or leaflets left in e.g. mailboxes. Looking at the data in Table 2, one can also draw a conclusion that confirms the general assumptions that age may determine the choice of information source and that younger people more often use modern, digital sources, older people - are open to modern methods, but they use traditional sources relatively more often.

As apartment websites and developer websites rank high in the hierarchy of information sources, it is worth looking at the key elements of developer websites - those that are important to respondents. A proper summary of them together with the importance calculated using the arithmetic mean is included in Table 3.

Table 3.

Importance of items on the developer's website in the opinion of respondents – in total and by age of respondents (average values)

itemization	in total	respondents aged:				
		up to 25 years	from 26 to 35 years	from 36 to 45 years old	from 46 to 55 years old	over 55 years old
the ability to check the prices of apartments	4.86	4.89 (1)	4.91 (1)	4.79 (1)	4.82 (1)	4.93 (1)
possibility to see projections of apartments	4.69	4.72 (3)	4.74 (2)	4.66 (2)	4.65 (2)	4.65 (2)
information about the availability of individual apartments	4.65	4.75 (2)	4.71 (3)	4.50 (3)	4.61 (3)	4.63 (3)
information about the investment environment	4.39	4.36 (5)	4.41 (4)	4.27 (5)	4.41 (4)	4.56 (4)
investment visualization	4.29	4.38 (4)	4.27 (5)	4.33 (4)	4.19 (5)	4.39 (5)
visualizations of individual apartments	4.13	4.25	4.08	4.14	4.05	4.32
apartment search engine	3.90	3.93	4.07	3.83	3.84	3.70
the ability to send an email via the contact form	3.62	3.57	3.61	3.61	3.73	3.49
the possibility of taking a virtual walk	3.39	3.64	3.37	3.25	3.35	3.17
virtual arrangement of space	3.39	3.36	3.34	3.34	3.48	3.44
online meeting with apartment sellers	3.35	3.38	3.39	3.29	3.38	3.17
interactive building plans	3.32	3.62	3.37	3.15	3.26	2.87
interactive map of the location	3.31	3.49	3.33	3.11	3.31	3.15
the possibility of filling in a short questionnaire and choosing the apartment to match my answers	3.24	3.36	3.27	3.03	3.30	3.09
photos from the progress of works on the construction site	3.23	3.14	3.16	3.21	3.29	3.49
social media links (Instagram, Facebook, Twitter)	2.95	3.21	3.10	2.71	2.87	2.45
transition from the website to the mobile application	2.71	2.93	2.74	2.88	2.51	2.35
QR code enabling quick access to selected parts of the offer	2.44	2.63	2.40	2.36	2.45	2.20
direct video transmission from the construction site	2.24	2.16	2.17	2.18	2.32	2.48
chat bots	2.23	2.47	2.28	2.08	2.18	1.89

Attention! In the table in individual age groups, next to the average value, their ranking position was entered next to the average value for the five most important elements.

Source: own study.

According to the research, the key role in making a decision to buy a flat is assigned to its price (Strączkowski, 2021). Probably for this reason, the most important element of the developer's website should be the ability to check home prices - the respondents' answers gave an average of 4.86 points - compare table 3. Among the other elements, forming the so-called the top 5 of the most important ones are: the possibility to see projections of apartments (4.69), information about the availability of individual apartments (4.65), information about the investment environment (4.39) and investment visualization (4.29).

It is worth noting that, taking into account the age of the respondents, there are some differences in the perception of the importance of individual elements of developers' websites. While in the case of the possibility of checking prices in all groups, compliance was noted, i.e. it is the most important element, among the youngest respondents, the information about the availability of individual apartments was ranked second, while in the remaining groups - the possibility to see projections of apartments. There were also slight differences in the fourth and fifth items.

Differences in the assessment of individual elements were also noted in the case of the least important details of the website, i.e. links to social media (Instagram, Facebook, Twitter), the possibility of switching from a website to a mobile application (important when using smartphones to obtain knowledge), code QR enabling quick transition to selected parts of the offer, direct video transmission from the construction site or the so-called chat bots. Generally, it can be said that the elements indicated here relatively higher were appreciated by younger respondents and there was a tendency that with age the average score became lower. The exception was the possibility of viewing the construction site via the Internet, which was appreciated by respondents aged 46 to 55 and over 55.

The last part was devoted to checking which technologies currently used in housing construction were the most and least important for the respondents when choosing a flat. The list of indications is presented in table 4. And so, in the case of all respondents, the most important elements were: high thermal insulation of the apartment, alarm and monitoring system, heating control (e.g. building heating depending on the presence of residents), photovoltaic panels and lighting control (e.g. light switch when detects the presence of a person). The following can be considered the least important: weather system (adapting the building to the outside conditions), simulating the presence of household members (e.g. when going on vacation), access control (fingerprint or iris scanning).

Table 4.
Technologies most and least important in choosing a flat in the opinion of the respondents - in total and by age of the respondents (percentage of responses)

itemization	in total	respondents aged:				
		up to 25 years	from 26 to 35 years	from 36 to 45 years old	from 46 to 55 years old	over 55 years old
high thermal insulation of the apartment	73.0%	61.8%	66.1%	77.7%	80.2%	90.7%
alarm and monitoring system	67.7%	64.5%	73.9%	74.1%	61.4%	66.7%
heating control (e.g. building heating depending on the presence of residents)	45.0%	39.5%	44.4%	42.0%	52.0%	42.6%
photovoltaic panels	42.6%	32.9%	41.1%	44.6%	49.5%	44.4%
lighting control (e.g. light sensor when it detects the presence of a person)	37.4%	41.4%	38.9%	32.1%	35.1%	40.7%
air conditioning control	35.9%	54.6%	34.4%	34.8%	29.2%	14.8%
collecting rainwater for watering green areas	34.3%	30.9%	32.2%	33.9%	38.6%	35.2%
use of solar energy to heat water	28.9%	30.3%	26.1%	28.6%	30.7%	27.8%
recuperation	21.1%	14.5%	18.9%	27.7%	23.8%	24.1%
control of electronic equipment	17.6%	32.9%	20.0%	13.4%	8.4%	9.3%
own sewage treatment plant	12.9%	7.2%	12.8%	11.6%	17.8%	13.0%
weather system (adaptation of the building to the outside conditions)	12.1%	16.4%	12.2%	9.8%	9.4%	14.8%
simulation of the presence of household members (e.g. when going on holidays)	10.6%	13.2%	10.0%	7.1%	10.4%	13.0%
access control (fingerprint or iris scanning)	7.4%	11.2%	8.3%	8.0%	4.5%	3.7%

Source: own study.

It is worth noting, however, that there are differences in the declarations of younger and relatively older people. They concern both the order of individual elements and the percentage of indications. For example, for people up to 25 years of age - the most important were (in order): alarm and monitoring system, high thermal insulation of the apartment, air conditioning control, lighting control, heating control, and the least important: simulation of the presence of household members, access control, own sewage treatment plant. In turn, for people from the oldest age group, the most important were: high thermal insulation of the apartment, alarm and monitoring system, photovoltaic panels, heating control, lighting control, and the least important: simulation of the presence of household members, control of electronic equipment, access control.

It should also be noted that in some cases the order of individual elements is similar, but there are differences of a few or a dozen or so percentage points. This can be illustrated by three examples: air conditioning control, electronic equipment and standby control of high thermal insulation of the apartment. According to the indications of people up to 25 years old, air conditioning control was the third most important element that would be taken into account when choosing a flat (54.6%). Meanwhile, in the case of people from the last age group (over 55), it would not play such a big role (15% of responses). It can also be said that there is a tendency - the importance of this element decreases with the age of the respondents. A similar situation can be observed in the case of controlling electronic equipment. Here, too, the highest percentage of indications was recorded for the youngest people, and the lowest for the oldest people.

However, with regard to the high thermal insulation of the apartment - in all age groups, this element is given among the most important ones, but in young people it has 61.8% of indications, and in the oldest people - 90.7% (the difference is therefore almost 30 percentage points). Here, too, one can speak of a tendency that the importance of this element grew with the age of the respondents.

4. Summary

The preference surveys that have been conducted and presented, which relate to modern technologies, are a contribution to further research work in this area. Technological progress will undoubtedly force the increasing use of various solutions that can fit into sustainable construction, environmentally friendly user behavior, the sphere of well-being of residents. However, a number of questions arise about the scope of application of modern technologies in the current situation in the residential real estate market. The results obtained show that the most popular solutions are those that are relatively easy to achieve and do not pose a great challenge to developers, for example. In contrast, those related to digital tools came in last

place. Further questions also arise. To what extent, in a situation of relatively expensive housing, are buyers willing to pay for modern solutions. To what extent, for example, environmental awareness, such as the use of solar energy or rainwater harvesting, may be at odds with the purchasing capacity of households. To what extent can buyers trust modern technologies without worrying about, for example, lack of energy to use appliances. These and probably other questions require further research in this area.

In the research undertaken in the field of modern technologies on the local housing market, it can be assumed that the conducted research allowed for the achievement of the previously mentioned aims.

Undoubtedly, an important aspect of the conducted research is the question of their usefulness for various groups of entities operating on the housing market. It seems worth using them:

- development companies - due to the need to adapt the offer to the client's needs. Adjusting the offer should include not only the basic features of the apartment, such as size, number of rooms, etc., but also equipping the apartment with modern digital technologies that facilitate its use. This type of research may allow developers to increase the awareness of customer expectations, but also be an indication of the growing awareness of customers in the field of modern technologies and home furnishings;
- residential start-ups in the field of innovation in the design, implementation, sale and use of development process products;
- housing cooperatives, housing communities with a housing stock that can and will have to be modernized, meeting technical and environmental standards and the requirements of subsequent generations of apartment buyers and premises users;
- researchers and academics who should contribute to the international discussion on the importance of PropTech in local real estate markets, especially in the context of the competitiveness of developers.

Of course, there are significant research limitations including:

- the local market situation - lack of ordinary housing, developers are selling everything they build in a very short time;
- the COVID-19 pandemic - difficulty in reaching respondents;
- the local market, which may be a limitation since it is an example.

However, despite these limitations, the above study can provide a starting point for examining the sophistication of developers in local real estate markets, taking into account the needs and expectations of potential customers.

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References

1. Anthopoulos, L. (2015). Understanding the Smart City Domain: A Literature Review. In: M. Rodríguez-Bolívar (eds.), *Transforming City Governments for Successful Smart Cities. Public Administration and Information Technology*, vol 8. Cham: Springer. https://doi.org/10.1007/978-3-319-03167-5_2.
2. Baum, A., Dearsley, J. (2017). *What is PropTech*, Unissu Online. Retrieved from <https://www.unissu.com/proptech-resources/what-is-proptech>, 10 April 2022.
3. Baum, A. (2017). *PropTech 3.0: The future of Real Estate*. Saïd Business School, University of Oxford Research.
4. Braesemann, F., Baum, A. (2020). *PropTech: Turning Real Estate Into a Data-Driven Market?* Retrieved from <https://ssrn.com/abstract=3607238>, 10 April 2022.
5. Casini, M. (2022). Extended Reality for Smart Building Operation and Maintenance: A Review. *Energies*, 15, 3785. <https://doi.org/10.3390/en15103785>.
6. Clayton, J., Fabozzi, F., Giliberto, M., Gordon, J., Liang, Y., MacKinnon, G., Mansour, A. (2019). *The Journal of Portfolio Management Special Real Estate*, 45(7), 14-23; DOI: <https://doi.org/10.3905/jpm.2019.45.7.014>.
7. Deloitte (2018). *Blockchain in commercial real estate: The future is here, Perspectives*. Retrieved from <https://www2.deloitte.com/us/en/pages/financial-services/articles/blockchain-in-commercial-real-estate.html>, accessed on 8 May 2022.
8. JLL (2021). *Transform with technology: Shaping the future of real estate*. Retrieved from <https://www.us.jll.com/en/trends-and-insights/research/2021-global-proptech-report#download-form>, 15 August 2021.
9. KPMG (2018). *The road to opportunity: An annual review of the real estate industry's journey into the digital age, Global PropTech Survey*. Retrieved from <https://home.kpmg/content/dam/kpmg/uk/pdf/2018/09/kpmg-global-proptech-survey.pdf>, 8 May 2022.
10. KPMG (2019). *The Pulse of Fintech*. Retrieved form: <https://home.kpmg/xx/en/home/campaigns/2019/07/pulse-of-fintech-h1-2019.html>, 29 June 2022.

11. Landau-Ward, A., Porter, L. (2019). *Digital Innovations, PropTech and Housing – the View from Melbourne*. Planning Theory & Practice, DOI: 10.1080/14649357.2019.1651997.
12. Mathew, P.A., Dunn, L.N., Sohn, M.D., Mercado, A., Custudio, C., Walter, T. (2015). Big-data for building energy performance: Lessons from assembling a very large national database of building energy use. *Appl. Energy*, 140, 85-93.
13. PWC (2018). *Cloud Computing in Real Estate*. Retrieved from <https://www.pwc.de/en/real-estate/digital-real-estate/cloud-computing-in-real-estate.html>, 10 April 2021.
14. Raport PropTech (2018). *Technologie w branży nieruchomości*. Retrieved from <https://skyconcept.pl/PropTech/raport-proptech-2018.pdf>, 29 June 2022.
15. Shaw, J. (2018). Platform Real Estate: theory and practice of new urban real estate markets. *Urban Geography*, 41(8), 1-28.
16. Siniak, N., Kauko, T., Shavrov, S., Marina, N. (2020). The impact of proptech on real estate industry growth. *IOP Conference Series Materials Science and Engineering*, 869, 062041.
17. Starr, C.W., Saginor, J., Worzala, E. (2021). The rise of PropTech: emerging industrial technologies and their impact on real estate. *Journal of Property Investment & Finance*, Vol. 39, No. 2, pp. 157-169. <https://doi.org/10.1108/JPIF-08-2020-0090>.
18. Ullah, F., Sepasgozar, S.M., Wang, C. (2018). A Systematic Review of Smart Real Estate Technology: Drivers of, and Barriers to, the Use of Digital Disruptive Technologies and Online Platforms. *Sustainability*, 10(9), p. 3142.
19. Unissu (2019). *Global PropTech Analysis: Europe*. Retrieved from <https://www.unissu.com/proptech-resources/proptech-europe>, 10 April 2021.
20. Veuger, J. (2017). Attention to Disruption and Blockchain Creates a Viable Real Estate Economy. *Journal of US-China Public Administration*, 14. 10.17265/1548-6591/2017.05.003.
21. Viriato, J. (2019). AI and Machine Learning in Real Estate Investment. *The Journal of Portfolio Management Special Real Estate*, 45(7), 43-54; DOI: <https://doi.org/10.3905/jpm.2019.45.7.043>.
22. Wang, Zhu, Wang, Lingfeng, Dounis, Anastasios, Yang, Rui (2012). Multi-agent control system with information fusion based comfort model for smart buildings. *Applied Energy*. 99, 247-254. 10.1016/j.apenergy.2012.05.020.