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Assessment of the Use and Possibilities of Implementing Modern Technologies by Development Companies on the Local Housing Market

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ABSTRACT

Purpose - The purpose of this study is to assess the level of use and possibilities of implementing modern technologies by developers on the primary local housing market.

Design/methodology/approach– The research was conducted to achieve the purpose. The tool was a form filled in on the basis of an analysis of the content of websites of local developers' investments (non-random sample selection, sample size n=32). Based on the research, it can be concluded that the general level of use of modern technologies by developers is very low and differs from the expectations of potential customers.

Findings – Based on the research, it can be concluded that the general level of use of modern technologies by developers is very low and differs depending on the scope of the entity's activities. Moreover, the scope of applied technologies influences the price of flats and the level of sales.

Research limitations - The presented results relate to the local real estate market in Poznań. The adopted spatial scope results from the specificity of this research area. And although there are no substantive grounds for major generalisations, taking into account the size of the market in Poznań, it can be assumed that in other large Polish cities the degree of use of modern technologies is similar.

Research implications - The results of the research can be used in the activities of developers and entities preparing technologies and tools that can be used on the real estate market in such areas as, for example, sales and development process.

Keywords:	PropTech, developer, residential market, modern technologies
JEL codes:	O14, O18, O33, R31
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INTRODUCTION

The real estate sector is currently changing as a result of the widespread digital transformation. The observed phenomenon consisting in the mass implementation of modern technologies in the form of virtual reality (VR), artificial intelligence (AI), building information modeling (BIM), advanced data analysis tools, Internet of Things (IoT), blockchain, real estate crowdfunding, combined with such trends as smart city, smart home or Sharing Economy they create a new environment known as PropTech. Maududy and Gamal (2019) emphasize that failure to use the available Proptech technologies can lead to lower sales, a decline in competitive position, and eventually exit from the market.

It is a common view that there is no systematic analysis of PropTech on a global scale, but also at the level of local real estate markets. Undoubtedly, this is the result of the short time and narrow scope of the technology's impact on the market. The mail aim of the study is to assess the level of use and possibilities of implementing modern technologies by developers on the primary local housing market. The following research hypotheses were established: (1) the assessment of the level of use of modern technologies in investment projects and (2) the interactivity of websites indicates a relatively low level of their implementation.

The area of development activity on the housing market was selected for the analysis. The research was conducted to achieve the purpose. The tool was a form filled in on the basis of an analysis of the content of websites of local developers' investments (non-random sample selection, sample size n=32).

Taking up the topic within PropTech on the local real estate market was aimed at joining the discussion in this area and determining the possibilities of absorption of new technologies in Polish conditions.

LITERATURE REVIEW

Modern digital technologies are becoming the dominant driving force behind the development of many branches of the economy. Unfortunately, the real estate market is not very susceptible to this type of innovation. Implementation of technologies is delayed and limited to some extent, e.g. only in the case of commercial real estate. However, technological innovations are slowly being used more and more and are becoming an element of competitiveness of entities especially in the field of: online brokerage and

sales, commercialization of space, development process and use of mortgage and equity financing.

The use of modern technologies in the real estate market is a relatively young area, both from the point of view of practice and science. Undoubtedly, the COVID-19 pandemic forced many entities to introduce modern technological solutions related to the organization and service of investments, real estate management or real estate brokerage, which accelerated the dynamics of PropTech. According to the CBRE report (2021), artificial intelligence (AI), Big Data and Internet of Things (IoT) are the main technologies used by PropTech that are changing the real estate sector, which is in the phase of advanced technological transformation. Innovation and digitization serve to search for solutions that will increase efficiency and create new business models. In addition, the COVID-19 pandemic has accelerated other trends such as virtual and augmented reality that have become very important during lockdown moments, allowing remote resource insight, and blockchain or building information modeling (BIM), more advanced and cutting-edge technologies. An important element of the PropTech concept are start-up projects and PropTech Startup Accelerators, the number of which has increased significantly year by year (Siniak et al., 2020). In the last 10 years, the number of startups dealing with real estate technologies has increased by 300% (JLL, 2021), and 80% of startups are less than 5 years old, which confirms the strong growth of the sector (CBRE, 2021). PropTech mainly attracts the residential and office sectors, 70% and 67% respectively provide solutions for this type of asset. In the residential sector, PropTech is clearly more focused on the end customer, 23% of them have a B2C model, compared to the rest of the sectors (for comparison - 13% for retail properties) (CBRE, 2021). The application of modern technology is the subject of latest studies, the vast majority of which deal with commercial real estate. Real Estate 4.0 is defined by Starr, Saginor and Worzala (2021), among others, who present a concept comprised of fintech and proptech and focus on how the COVID-19 pandemic is accelerating proptech, particularly with respect to returning workers to their traditional work environments. Kaur and Solomon (2021) also examined the adoption rate of PropTech technology in the commercial real estate market in India and based on this, proposed a technology-based property management model.

The state of practice and use of specific modern technologies in real estate is comprehensively presented by Ullah, Sepasgozar and Wang (2018). This review further includes research on dissemination mechanisms, including smartphone technologies, social media-based websites and online platforms, and the basic elements of so-called smart real estate (SRE). The authors also

highlight the importance of interactions between different stakeholders and the conctet needs of real estate users that different technologies should address.

In the literature there are various definitions of PropTech. This is illustrated in Table 1. Generally, this concept is a combination of two words "property" - real estate and "technology" - technology. This term is understood as innovative technological products and new business models for the real estate market.

Table 1. PropTech definition overview

Author	Definition of PropTech
Hasenmail & Rieder (2017)	- modern technological achievements used in the real estate industry in the field of introducing or optimising products, processes or the entire business.
CBInsights (2017)	- real estate technology companies, - software tools and platforms used by a variety of real estate actors, including brokers, investors, real estate-focused lenders, property owners and managers.
Maududy & Gamal (2019a)	- FinTech" and "ConTech" refer to technological applications in the financial and construction sectors, but are often difficult to distinguish from PropTech.
Shaw (2018)	- the concept of "Platform Real Estate", which includes the social engineering dynamics driving the digitisation of real estate technology.
KPMG (2018), PWC (2018), Deloitte (2018), EY (2017), Unissu (2019)	- technological and digital, hardware and software innovations for real estate.
JLL (2021)	- combination of data analytics, artificial intelligence, internet of things, virtual reality, blockchain.
Baum (2017)	- sum or blend of software and hardware technologies that have an impact on real estate markets.
RICS (2017)	- all aspects of technology and its impact on developed real estate, including software, hardware, materials or the development process itself.

Source: own study.

As is shown in Table 1, there is no common definition of PropTech, making it difficult to fully identify investments and market segments involved in this new digital wave. It is still unclear what technologies and actors are involved in the digitization of the real estate sector and what their potential for innovation is. Finally, some countries appear more proactive than others in keeping up with the pace of change. (Tagliaro, Bellintani & Ciaramella, 2020)

By subscribing to the so-called Economy 4.0 within PropTech, there are several overlapping areas of using modern technologies (Fig. 1):

- PropTech - real estate technology (startups),
- FinTech - finance technology (startups),
- ConTech - construction technology (startups),
- Smart Real Estate - smart cities and buildings,
- Shared Economy – technologies e.g. rental housing market.

Baum (2017) defines three basic PropTech sectors: smart real estate, shared economy and FinTech. Smart Real Estate are technology-based platforms that facilitate the operation and management of real estate. This sector supports real estate management. The second sector, the Shared Economy, includes technology-based platforms that facilitate the use of real estate assets such as land or buildings, including offices, shops, warehouses, apartments and other types of real estate. This sector supports the real estate tenant markets. The last one, real estate FinTech, are technology-based platforms that facilitate real estate trading within the financing process. This sector supports real estate capital markets.

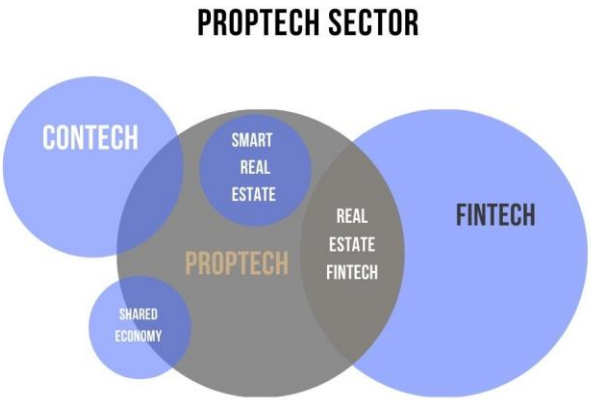

Figure 1. PropTech Sector
Source: (Baum, 2017).

There are three basic phases of the evolution of modern technologies in real estate sector (Baum, 2017). The first wave of PropTech 1.0 in 1980-2000 took place mainly in the United States and Great Britain and included, among others, development of indirect investment instruments related to the real estate market, development of the Real Estate Investment Trust (REIT) and the derivatives market. These changes required a much more quantified and research-focused approach to performance measurement and investment strategy. Excel has become the basic tool supporting processes in the real estate market. PropTech 2.0 continues PropTech 1.0. It focuses on residential real estate as a homogeneous type of real estate asset with more public information (prices and rents). The basis of the PropTech 2.0 revolution is the FinTech industry - in particular, online payment systems, crowdfunding, equity and debt platforms as well as online exchanges. The on-line housing sector (e.g. AirBnB) seems to be the link between PropTech 1.0 and PropTech 2.0. On the other hand, the third phase, which is PropTech 3.0, 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) (Baum, 2017; Shaw, 2018; JLL, 2018).

The dynamic development of the construction industry in Poland offers great opportunities to use innovation. In 2020, according to GUS data, 7% more apartments were commissioned than in 2019. It is the construction industry that is one of the most frequently indicated areas of PropTech use. However, it also includes solutions for managing office space, IoT technologies, solutions for trade or renting real estate, and even financing the purchase of a house or crowdfunding of construction projects.

The main goal of PropTech is to improve the efficiency of the real estate market, which is perceived as relatively technologically backward and very resistant to any changes or amenities. PropTech, similarly to smart city solutions, effectively changes the space in which we exist every day. The problem worth noting is the two speeds of this revolution in Poland. On the one hand, there are large real estate entities, and on the other hand, there are many small companies that are not prepared - both in terms of resources and opportunities to introduce technological innovations or experiments, thus lagging behind.

RESEARCH METHODOLOGY

The use of modern technologies and their importance in the development process is an important field of research. Maududy and Gamal (2019) emphasize the need to introduce innovative technological solutions by developers from the residential real estate sector, interpreting real estate technology as an innovation that changes the real estate development process. A real estate development company focuses on investing in real estate, which increases its value. The developer acts as the coordinator and organizer of the implemented project. In terms of the process, developer activity should be understood as a sequence of actions that make up the process of implementing a development investment project, considered in a broader or narrower aspect (Gostkowska-Drzewiecka, 2007).

The scope of the use of modern technologies by developers was examined, based on the analysis of websites of entities operating on the local housing market in Poznań. The aim of the study was in particular:

- indication of how many developers use modern technologies related to presenting the offer to customers on websites,
- identifying the modern tools used for communicating with the customer,
- determining the degree of implementation of modern technologies on the local primary housing market in terms of both websites and implemented investments.

The study was conducted in August and early September 2021, and the time scope of the study coincided with the time of collecting information, and the spatial scope covered the local primary residential real estate market in Poznań. The subjects of the study were developers, both local and those who carry out investments throughout the country. The object of the study, on the other hand, were websites dedicated to investments carried out in Poznań, with the assumption that there are still flats for sale in a given investment. In order to conduct the study, a research tool was used in the form of a matrix created in Excel, which was then filled in independently by analysing the websites of selected entities. The selection of the sample was deliberate, non-random, and dictated by the availability of data. 32 investments offered by 17 developers were analysed. The current number of investments (as of 10 September 2021) in Poznań, according to the data on the rynekpierwotny.pl website, is 57 construction projects, which means that the website analysis covered over 50% of available investments. Basic methodological information is presented in Table 2.

Table 2. Basic information on research in the field of modern technologies used in the activities of development companies

Specification	Description
Information gathering time	August and September 2021
The spatial scope of the study	The local residential real estate market in Poznań
Material scope of the study	Research subject: local and national developers of the residential real estate market offering investments in Poznań. Object of the study: modern technologies used by developers on websites and in the flats offered
Time range of the study	Coincides with the time the information was collected
Research tool	In Excel, a matrix was created in the program, which was then filled in independently based on the analysis of websites
Selection and size of the sample	The selection of the sample was non-random, purposeful, dictated by the availability of data, sample size n=32 units

Source: own study.

As the analysis showed, the developers being the subject of the study built a total of 8,370 flats within the surveyed investments, of which 1,793 are currently sold. This means that the sales ratio is close to 79%. At the same time, it is worth emphasising that among developers there are those who currently have 1-2 available flats in their offer and those with over 400 available flats. The average time of the developers' operation in the market was 25 years.

RESULTS & DISCUSSION

The analysis of the developers' websites allowed for a general assessment of their interactivity, both in terms of the presentation of individual flats and investment locations, as well as the possibility of contact with a potential customer. On all of the surveyed websites, customers have the opportunity to see projections of flats and information whether a given flat is still available for sale, reserved or already sold (Fig. 2).

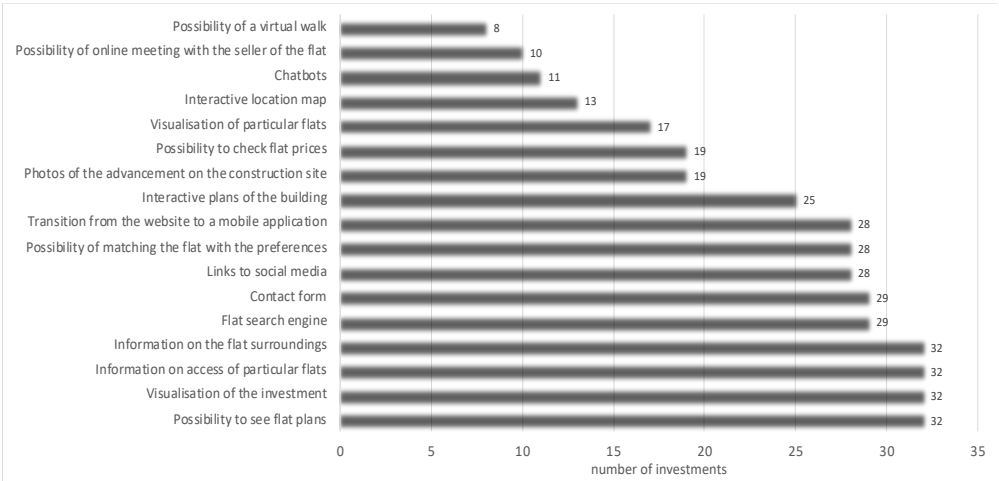

Figure 2. Interactivity of developer websites

Source: own study.

In addition, the entity provides the characteristics of the investment surroundings, including not only the name of the street and district in which it is located, but also the most important elements of the surroundings (parks, shops, public transport, etc.). Unfortunately, this is not the same as an interactive location map that allows a potential buyer to visualise the environment (13 developers). Visualisation of the investment was also present on all analysed websites, but the visualisation of individual flats (not only a projection, but the possibility of viewing the premises in the form of a three-dimensional image, which allows you to present the appearance of the flat in different angles and with different details) appeared only in slightly more than half investment (53%). Modern technologies make it possible to adjust the offer presented on websites to the needs and preferences of customers. Therefore, the search engine, which is important from the customer's point of view, is also present in most of the surveyed entities (over 90%), as well as the related possibility of adjusting the flat to preferences regarding size, floor, number of rooms or price. Unfortunately, one of the most important elements of the comprehensive offer, which is the price, was only on the websites of 19 out of 32 analysed investments. Most often, developers deliberately do not specify the price, trying to mobilise the customer to contact them by phone. This makes it very difficult, for example, to pre-select offers from the point of view of a potential customer and requires additional time. From among the analysed investments, none of them gave customers the opportunity to fill in a short questionnaire regarding their housing needs and then present a specific flat that would meet their expectations.

The least common option is a virtual walk around the investment, and therefore the ability to watch a 3D presentation combining photos, visualisations of the flat, rotating, zooming in and out depending on the customer's needs (1/4 of the investment). Information on the progress of works on the construction site is presented only in the form of a photo report from the construction site updated by the developer on an ongoing basis, which could be found in about 60% of offers (19 out of 32 offers), or as a streaming from the construction site, which was only available on the website of one offer. Most elements of website interactivity (>=11) are owned by domestic developers who can boast relatively extensive websites. The website of only one developer from the entire surveyed group of entities had all the elements that were subject to observation.

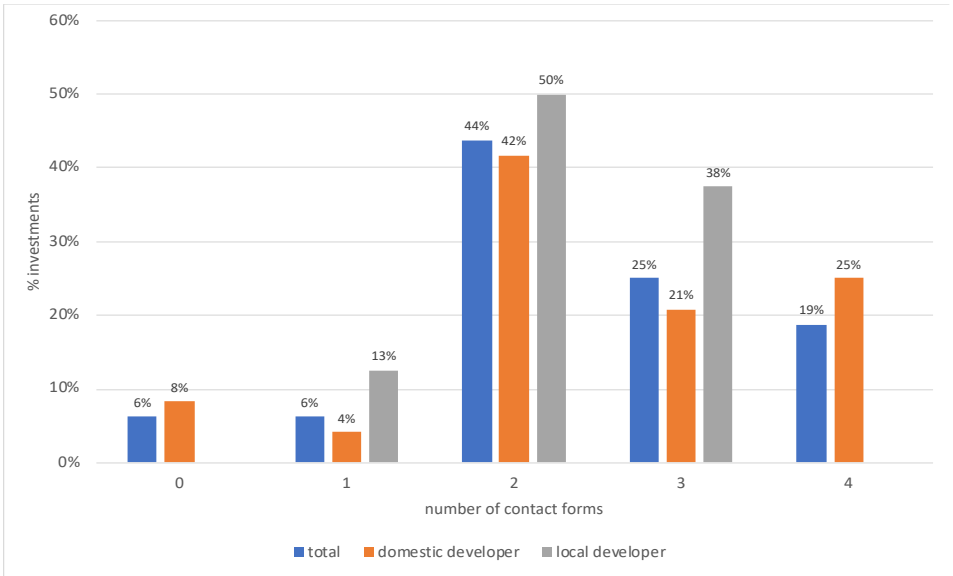

Figure 3. Contact with the customer and the scope of the developer's activity
Source: own study.

Modern technologies are often used to enable, inter alia, customers to make contact faster and easier. Contact forms, online meetings and increasingly popular chatbots are used for this. In the case of the researched development investments, the most frequent option was e-mail contact via a dedicated form - 29 out of 32 investments. Chatbots and online meetings could only be found on just over 30% of the analysed websites. It is quite worrying, especially considering the ongoing COVID-19 pandemic[1] and the

[1] According to WHO COVID-19 (coronavirus disease 2019) - acute infectious disease of the respiratory system caused by infection with the SARS-CoV-2 virus. It was first recognised and

related need to maintain both social distance and often remote work. Figure 3 illustrates the scope of use of available online tools depending on the developer's scope of activity. 17 developers participated in the survey, of which only 5 are local developers (in total, at the time of the analysis, there are 8 investments on sale). In the case of all 8 investments carried out by local entities, it was possible to use the contact form, and 7 had links to social media, such as Facebook, LinkedIn or Twitter (50% of the surveyed entities). Only in 3 investments (2 developers) they offered online meetings to their customers. Chatbots were encountered only in investments carried out by nationwide entities (25% of respondents). Unfortunately, there were also entities that did not have any online contact tools on the website, which shows a high level of maladjustment to the changing market conditions.

The form of contact and openness to communication with a potential customer may also affect the speed of sale of flats on offer. As can be seen in Fig. 4 over 50% of sold flats are characterised by investments that have access to various forms of communication (2 or more forms). However, the analysis did not take into account the time of commencement of sale, and therefore the exposure of the flats on the market, which also significantly affects these values.

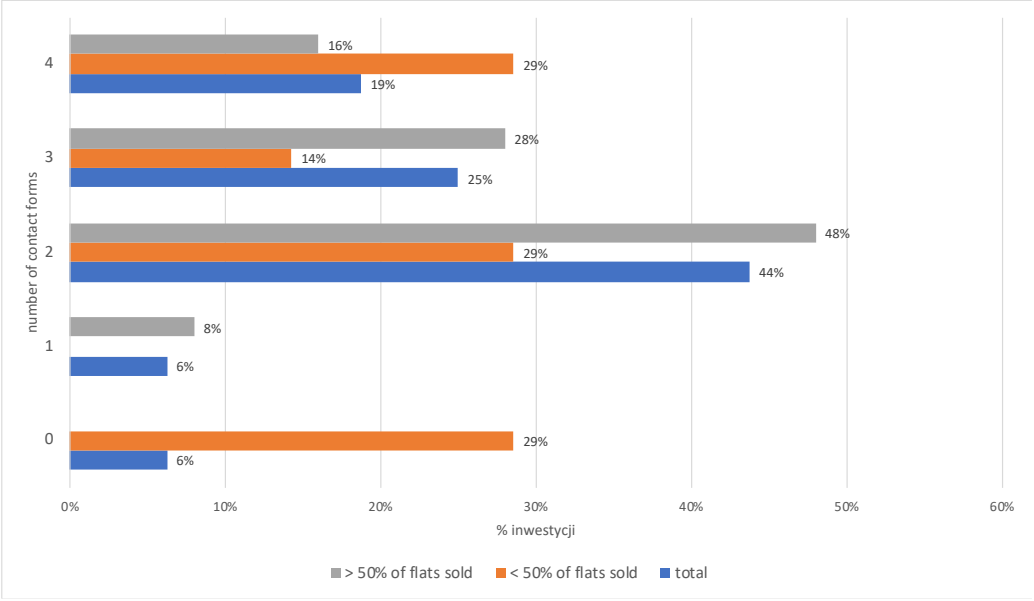

Figure 4. Contact with the customer and the level of flat sales
Source: own study.

described in November 2019, in central China (Wuhan City, Hubei Province), during a series of cases that started the pandemic of this disease.

Due to the development of technology, housing construction ceases to rely solely on the use of modern materials or architectural solutions. Even so resistant to digital technologies, the real estate market is slowly succumbing to PropTech trends, influencing the natural environment by reducing water and energy consumption and, at the same time, reducing maintenance costs, as well as ensuring comfort and safety of use. The developers' housing offer was also analysed precisely in terms of the scope of use of individual solutions in the proposed investments. Unfortunately, as shown in Figure 5, the degree of use of modern technologies by developers is low. In more than half of the investments, there is no information about any solutions that can be classified as modern. Housing construction is still based on traditional technology and is quite resistant to change.

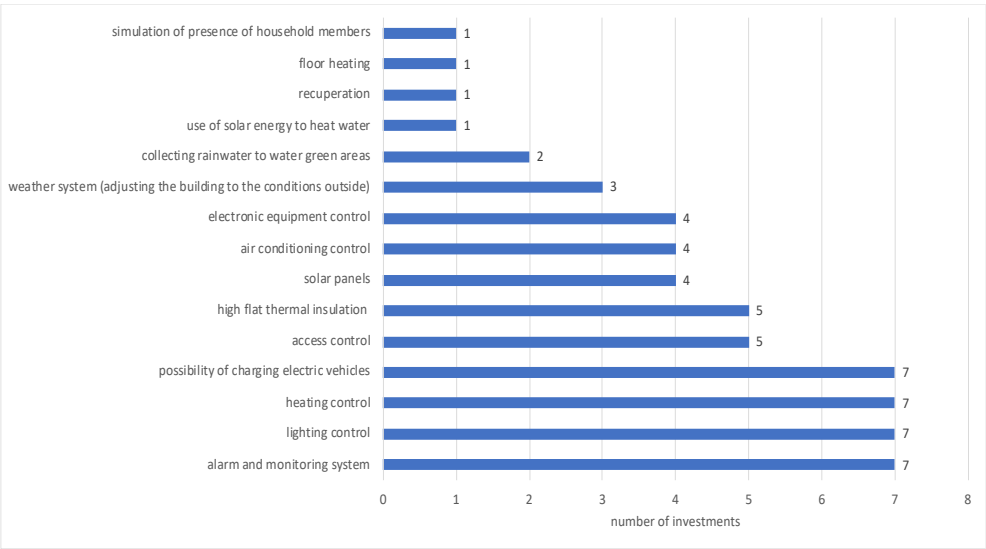

Figure 5. Modern technologies offered by developers
Source: own study.

The most commonly used technologies relate to the so-called smart home (22% of the analysed investments), and therefore include, inter alia, heating, lighting, electronic equipment and air conditioning control. In the case of 4 investments, a complete set of these solutions was offered (13% of investments), and in 3 cases it was only lighting and heating control (9% of investments). Another group of amenities are technologies in the vicinity of the building, including the possibility of charging electric vehicles, a weather system or obtaining rainwater for irrigation of green areas (22% of the analysed investments). Developers most often offered the possibility of charging electric vehicles (7 out of 32 offers), three offers include the convenience of a weather system, and two of the investments collect

rainwater for watering green areas, while none of the developers planned their own sewage treatment plant. The third group of technologies were those related to energy efficiency (they appeared in 30% of offers). The most commonly used solutions concerned high thermal insulation of the flat (5 offers) and allowed the use of solar energy through the use of photovoltaic panels (4 offers). The use of underfloor heating, recuperation or the use of solar energy to heat water are technologies used in only single investments. The last, fourth group of solutions were those defined as home safety (22% of the analysed investments). Both the alarm system and monitoring appeared in 7 offers, and the access control system in 5. The least frequently used technology is the simulation of the presence of household members (used, for example, during a holiday trip) - 1 offer. None of the offers had the entire spectrum of technological possibilities to increase security. Detailed results of the use of technology in each of the four categories are presented in Table 3.

Table 3. Modern technologies offered by developers

Smart home	
air conditioning control	4
lighting control	7
heating control	7
electronic equipment control	4
Energy efficiency of flats	
high thermal insulation of the flat	5
solar panels	4
use of solar energy to heat water	1
recuperation	1
floor heating	1
Modern technologies - housing safety	
alarm and monitoring system	7
access control	5
simulation of the presence of household members	1
Modern technologies in the building's surroundings	
collecting rainwater for watering green areas	2
weather system (adaptation of the building to the outside conditions)	3
possibility of charging electric vehicles	7

Source: own study.

It is also worth pointing to the importance of technologies offered by developers in terms of the average price of flats on offer. In this case, the average price was assumed at the level of PLN 8,000. PLN, based on NBP data for the first quarter of 2021, according to which it amounted to PLN 7,988.

Both the scope of technologies used in the building's surroundings and the smart home technologies undoubtedly affect the price level.

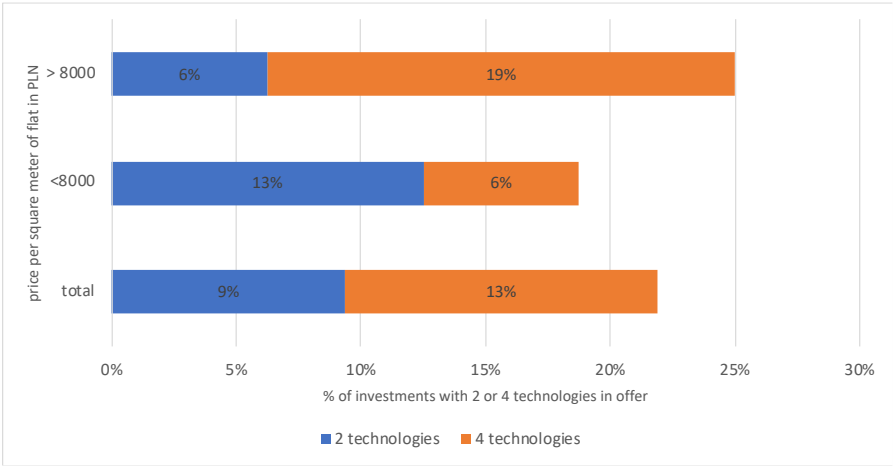

Figure 6. The number of smart home technologies used in the building's surroundings and the price of 1 m^2 of a flat

Source: own study.

The offer of flats with prices exceeding 8,000 PLN per square meter (50% of all surveyed investments), those with smart technologies account for 25%, of which 19% are offered by as many as four of the surveyed technologies. For the most part, cheaper flats only offer two solutions. Therefore, it can be concluded that the greater the range of technological amenities introduced, the higher the price of a flat. This is illustrated in Figure 6.

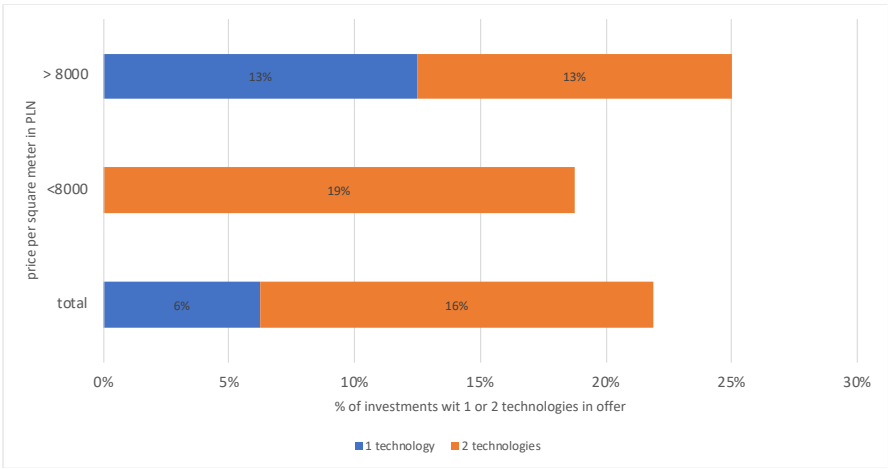

Figure 7. The number of technologies used in the building's surroundings and the price of 1 m^2 of a flat

Source: own study.

Similar conclusions can be drawn on the basis of the analysis of technologies used in the building's surroundings. Again, the price is higher as the number of innovations increases. This is presented in Figure X. The offer of flats with prices exceeding 8,000 PLN per square meter (50% of all surveyed investments), those with technologies related to the surroundings of the building constitute 26%, of which 13% are offered by two and one of the three tested technologies. Cheaper housing offers two solutions - 19%. Therefore, it can be concluded that the greater the range of technological amenities introduced, the higher the price of a flat.

CONCLUSION

The assessment of the level of use of modern technologies in the researched investments and the interactivity of websites indicates a relatively low level of their implementation. Thus, the two hypotheses posed in the introduction were positively verified.

The largest developers operating on the local housing market in Poznań were analysed, yet the level of technological advancement is unsatisfactory. Investors rather offer a traditional product that has little to do with modernity. The level of use of devices that increase the functionality and comfort of use of the flat as well as equipment with technologies related to environmental protection and reducing maintenance costs leaves much to be desired. Of course, there are entities whose technologies on the website as well as those in the buildings or flats themselves stand out from the competition, but this is not the majority of the offer. The analysis of the offers allowed to select a developer who can be classified as using the technologies to the greatest extent - all smart home installations, vehicle charging stations, alarm system and access control system. The website of the offer also uses the most modern technologies. On the other extreme, you can find a developer who does not use even the simplest online communication tools with the customer, there is a lack of interactivity, and the investments underway do not offer any amenities. It can be considered that this is just the beginning of developers' adaptation to technological changes and the digital revolution, which has been observed for several years in industries other than the real estate market.

The results of the above research can make an important contribution to the literature dealing with PropTech in Poland. The national literature on the subject has not really dealt with this topic so far. Therefore, it can be considered that this study fills a research gap in the domestic market. At the same time, it is a voice in the international discussion in the PropTech area that has been going on for several years. Undoubtedly, an important aspect of the

conducted research is the question of its usefulness for various groups of entities active in the housing market: developers, housing market start-ups and researchers or academics as well, as a voice in the international discussion on the importance of PropTech in the local real estate markets, especially in the context of competitiveness of development entities.

There are certain limitations of the presented research results. They certainly require further research steps, which Author assumed and intend to carry out (e.g. face-to-face interviews with representatives of development companies). The research was carried out under the constraints of the COVID-19 pandemic (mobility restrictions, inability to use face-to-face interviews, closure of many places previously open to the public, and reluctance to make direct contacts on the part of many people) which limited its interactive nature.

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