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FINANCIAL SERVICES IN THE PROPTech ECOSYSTEM

The widespread introduction of information technologies into all spheres of human life has transformed the needs of customers in the real estate market. As a result, the PropTech ecosystem has emerged, a component of which are financial services provided on the basis of financial technologies. The aim of the research is to identify the components of the PropTech ecosystem and clarify the place of financial services in it. The research has put forward two hypotheses: the first is that PropTech is transforming into an ecosystem whose participants are interconnected and provide complementary services to clients; the second is that FinTech is a significant participant in the PropTech ecosystem, providing financial support for real estate transactions. To test the hypotheses and achieve the aim, the following methods were used: comparative, systemic and graphical. Programmatic, subject and behavioral approaches to understanding PropTech have been proposed. The technical, economic, social and psychological factors of the PropTech emergence have been identified. The characteristic features of the PropTech evolution stages have been systematized. The global PropTech market has been analyzed. The composition of the PropTech ecosystem is proposed based on the combination of participants with a digital platform and the use of information

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ФІНАНСОВІ ПОСЛУГИ В ЕКОСИСТЕМІ PROPTech

Широке впровадження інформаційних технологій у всі сфери життєдіяльності людини трансформувало потреби клієнтів на ринку нерухомості. Внаслідок цього виникла екосистема PropTech, складовою якої є фінансові послуги, що надаються на основі фінансових технологій. Метою статті є виявлення складових екосистеми PropTech та з'ясування місця у ній фінансових послуг. У ході дослідження висунуто дві гіпотези: перша – PropTech перетворюється в екосистему, учасники якої взаємопов'язані та надають комплементарні послуги клієнтам; друга – вагомим учасником екосистеми PropTech є FinTech, що забезпечує фінансовий супровід операцій з нерухомістю. Для перевірки гіпотез і досягнення мети використано такі методи: компаративний, системний, графічний. Запропоновано програмний, суб'єктивний та поведінковий підходи до розуміння PropTech. Виявлено технічні, економічні та соціально-психологічні чинники виникнення PropTech. Систематизовано характерні риси етапів еволюції PropTech. Здійснено аналіз глобального ринку PropTech. Запропоновано склад екосистеми PropTech на основі поєднання учасників з цифровою платформою та застосуванням інформаційних технологій. Виявлено



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technologies. The advantages and disadvantages of the functioning of financial services within the PropTech ecosystem, threats and opportunities for their development have been identified.

Keywords: real estate, ecosystem, PropTech, GreenTech, FinTech.

переваги та недоліки функціонування фінансових послуг у складі екосистеми PropTech, загрози та можливості їх розвитку.

Ключові слова: нерухомість, екосистема, PropTech, GreenTech, FinTech.

JEL Classification: G1, O3.

Introduction

Innovations affect all stages of social reproduction, including the production of goods and services and their consumption. They change markets, creating new forms of interaction between sellers and buyers. The real estate market is no exception, which has been transformed under the influence of information technologies, which have led to the emergence of the PropTech global phenomenon. The impetus for the PropTech development was the COVID-19 pandemic, in particular, due to the requirements for quarantine restrictions, consumer needs in the real estate market have been transformed towards receiving online services. For clients wishing to purchase or rent commercial or residential real estate, the important criterion is the combination of convenience, environmental friendliness of real estate, accessibility for familiarization with real estate, speed and availability of complementary financial services. The basis for the PropTech functioning was the spread of digital platforms, the increase in the number of Internet and smartphone users, and the possibility of applying information technologies in the real estate market.

PropTech emerged under the influence of the digitalization of the real estate market. Casertano et al. (2020) define the real estate market as a physical or virtual place where real estate values, services or securities that are part of the real estate business are developed and exchanged, and where the market value of the asset is determined as a result of the meeting of supply and demand. An analysis of foreign scientific literature makes it possible to assert that PropTech has been studied in various aspects. Tan and Miller (2023) identified the PropTech impact on sustainable development. Starr et al. (2021) emphasize the growing PropTech impact on the real estate market. Saiz (2020) analyzed the application of information technology in brokerage and commercial real estate financing. Kassner (2024) studied the impact of gross domestic product, unemployment, government bond rates, and foreign direct investment on investments in PropTech. Gilman (2024, May 1) linked the PropTech development with ensuring the human right to housing. In recent years, research by foreign authors has intensified in the context of identifying regional features of PropTech development. In particular, Górska et al. (2021) examine the experience of Poland, Saad and Milala (2024) – the experience of Nigeria, Yunita (2024) – the experience of Indonesia. There are also isolated mentions of the ecosystem in the scientific literature (Nouvel, 2023). Issues of the formation of PropTech ecosystems by industry representatives are considered. Thus, the founder of the startup

Meduoye (2024, July 18) emphasizes that the PropTech ecosystem consists of various stakeholders, including PropTech startups, real estate developers, property managers, investors, government agencies and technology providers, cooperating to promote innovation and digital transformation of the real estate industry. The author initiated an institutional approach to understanding the PropTech ecosystem.

In the national scientific literature, there are only a few references to the digitalization of individual segments of the real estate market. For example, Marchenko and Kolyadenko (2023) focus on the digitalization of the construction industry, Duginets and Aliyev (2020) consider the application of the latest information technologies in the global real estate market.

Based on the results of the scientific literature analysis and analytical reports, it is possible to distinguish software, subject and behavioral approaches to understanding PropTech. The software approach (PriceHubble, 2024, April 3) to PropTech involves the development of (corporate) software for part or the entire life cycle of real estate. Within the framework of this approach, PropTech is also considered as digital solutions for buying, selling or managing real estate Stypułkowski (2020, May 14).

PropTech proponents Braesemann and Baum (2020) consider PropTech to be property technologies in the real estate industry, concentrated in high-income countries, and used by market participants who work directly with digital data.

The behavioral approach assumes that PropTech is part of the digital transformation of the real estate industry, which is driving a change in the mindset of the real estate industry and its consumers towards technological innovations in data collection, transactions, and the design of buildings and cities (Baum et al., 2020, p. 5).

These discussions, as well as insufficient attention to the analysis of PropTech problems in the domestic scientific literature, necessitated our research, since in the context of increasing integration of the real estate market with FinTech, it is important to identify the components of the ecosystem and the place of financial services in it.

The aim of the research is to identify the components of the PropTech ecosystem and clarify the place of financial services in it.

During the research, two hypotheses were put forward: the first is that PropTech is transforming into an ecosystem whose participants are interconnected and provide complementary services to clients; the second is a significant participant of FinTech in the PropTech ecosystem, which provides financial support for real estate transactions. To verify it, an analysis of the essence and evolution of PropTech, factors influencing the development of PropTech, and based on the results, a definition and composition of the PropTech ecosystem were proposed, threats and opportunities for the development of financial services within the PropTech ecosystem were identified. To achieve this aim, a set of methods was applied. The use of a systemic approach made it possible to identify technical, economic, social

and psychological factors of the PropTech emergence. The graphical method helped to clarify the PropTech capabilities in terms of geographical coverage of consumers with its services. The use of comparative analysis formed the basis for revealing the advantages and disadvantages of providing PropTech financial services, threats and opportunities for further development of financial services within the PropTech ecosystem.

The main part of the research consists of three sections: the first is devoted to a description of the factors influencing the PropTech development and a systematization of the characteristics of the PropTech evolution stages; the second is an analysis of the state of PropTech in the world; the third is a definition of the composition of the PropTech ecosystem, the place of financial services in it, and PropTech development trends.

1. The evolution of PropTech: from PropTech 1.0 to PropTech 4.0

Digitalization is gradually covering all spheres of human life. One of the first to actively implement digital technologies was the financial services market. This process was called as FinTech. At the same time, the real estate market, which is the largest type of asset in terms of volume, was one of the last to begin technological transformations. PropTech, like FinTech, TravelTech, GovTech, HealthTech, CivilTech, RetailTech, LegalTech, is a type of EverythingTech (Mazaraki & Volosovich, 2021, p. 7). They all use the same tools and are characterized by interpenetration to a certain extent.

Factors influencing the PropTech development can be divided into economic, technological, social and psychological. Among the economic factors are:

- permanent growth of the real estate market (*Figure 1*);
- growth in global gross product;
- growth in demand for smart homes;
- growth in coworking and flexible spaces;
- growth in demand for real estate rental.

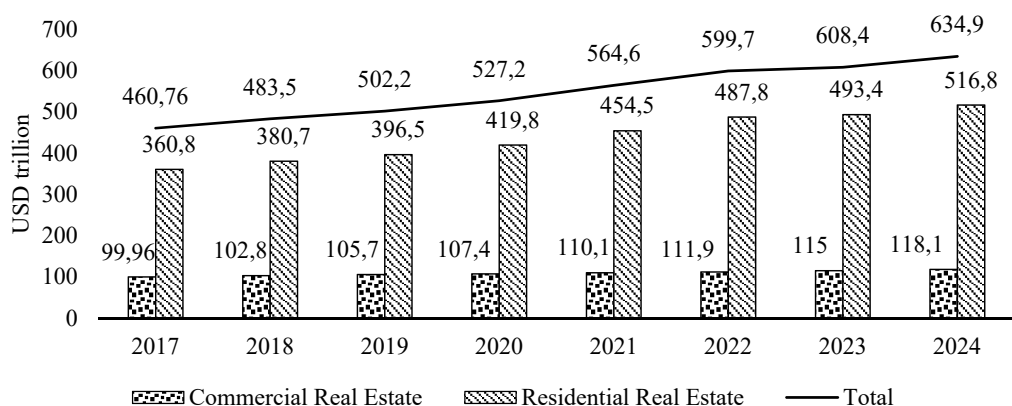


Figure. 1. Total value of the global real estate market, commercial and residential real estate in 2017–2024

Source: compiled by the authors according to (Statista, 2024, July).

Technological factors involve the widespread introduction of such information technologies in the real estate market as: artificial intelligence, the Internet, virtual reality, machine learning, and predictive analytics. The social and psychological factors of PropTech development are based on customer preferences. These include:

- the entry into the real estate market of Z generation and millennials, who rely on the Internet and social networks when making decisions;
- the tendency of real estate market participants to adopt technological innovations;
- increasing customer requirements for the environmental friendliness of real estate and its equipment with modern automation systems.

The PropTech evolution involves the identification of four stages: emergence, maturity (Internet revolution), improvement, development of sustainable and smart property (*Table 1*).

Table 1

PropTech development stages

Stage	Period	Technological basis	Characteristics
PropTech 1.0 Inception	The second half of 1980–2007	Implementation of local software in the activities of real estate market participants	The adoption of property management software, customer relationship management systems and financial analysis tools based on personal computers by real estate market participants to some extent contributed to creating a basis for the digitalization of the real estate market. The next important steps were the introduction of Excel for data organization and analysis and B2C PropTech products or online real estate portals in the real estate market, which helped to expand the capabilities of clients to quickly and efficiently find properties that meet their needs. Subsequently, such solutions became the industry standard. Key PropTech companies: Autodesk (innovation in construction technology), Argus (innovation in investment management), CoStar Group (a leading provider of information and analytics for the commercial real estate industry), Rightmove and Trulia (online real estate portals)
PropTech 2.0 – Maturity (Internet evolution)	2008–2015	Widespread use of local software by real estate market participants, which helps to match supply and demand through social networks and e-commerce	The activation of PropTech is due to the global crisis of 2007–2008, one of the reasons for which was problems in the real estate market. The decline in trust in traditional processes in the real estate market, the formation of a multi-platform environment, the availability of smartphones contributed to the introduction of open application programming interfaces (APIs) and mobile applications, which gave customers instant free access to information on the real estate market. Against this background, there was a PropTech boom: investments are growing, new companies are emerging, and existing companies are being consolidated
PropTech 3.0 – Improvements	2016–2021	Real estate software is becoming a growing service	This stage is characterized by the use of information technology aimed at improving customer service and the functioning of other participants in the real estate market. PropTech 3.0 has become more socially oriented, transforming the use of technology to the needs of the client. This has led to the fact that interfaces have become smarter and more convenient. PropTech 3.0 began with the deepening use of artificial intelligence in the analysis of big data, the introduction of machine learning and blockchain. During this period, there has been a decline in investment in PropTech

End of Table 1

Stage	Period	Technological basis	Characteristics
PropTech 4.0. Development of sustainable and smart property	From 2022 to present	Focus on technological solutions aimed at combating climate change and automating processes in real estate maintenance	<p>The impetus for this phase was provided by the Covid-19 pandemic, which caused challenges for the real estate market due to social distancing and related restrictions. The characteristic features of PropTech 4.0 were:</p> <ul style="list-style-type: none"> • the widespread use of virtual reality, which creates new opportunities for visiting and demonstrating real estate; • the emergence of GreenTech within PropTech; • the activation of the use of the Internet of Things; • the spread of blockchain technology, which ensures transparency of real estate transactions; • the growth of investments in PropTech

Source: compiled by the authors on the basis of (Stypułkowski, 2020, May 14; Snow, 2023, April 29; PropTechBuzz, 2024, April 6; Gambero, 2021, December 3; University of Oxford Research, 2020) and own research.

Thus, in its development, PropTech has moved from the application of certain information technologies in the real estate market to their widespread use. The introduction of information technology was driven by the preferences of customers who, on the one hand, require convenience and speed of service, and, on the other hand, environmental friendliness of housing.

2. State of the global PropTech market

PropTech is now fully integrated into the global and regional real estate markets, despite not so long ago being considered a latecomer to EverythingTech. *Figure 2* shows that 5% of real estate companies worldwide have transitioned to modernized software systems that easily leverage modern digital technologies, while 64% of companies have to some extent upgraded their software systems to enable them to leverage digital technologies.

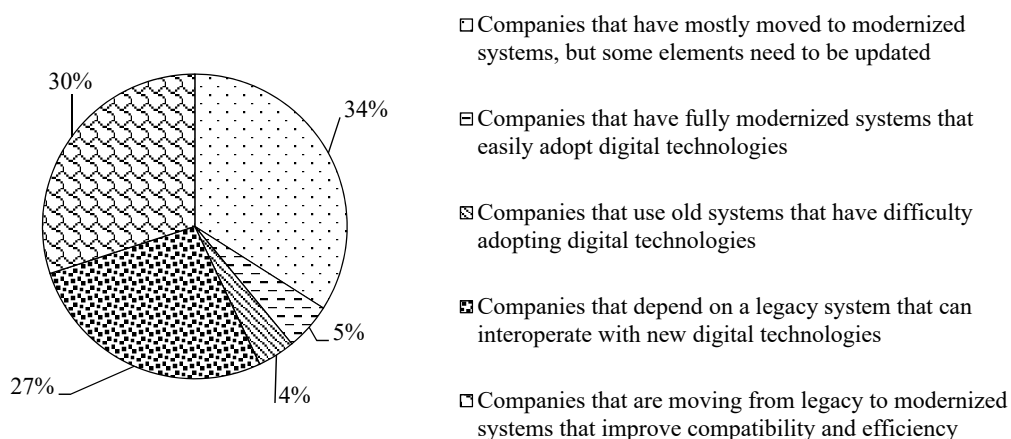


Figure 2. The structure of real estate companies in the world in terms of the use of digital technologies in 2023

Source: compiled by the authors based on (Statista, 2024, July 1).

In 2022, the global PropTech market was worth \$24.9 billion and continues to grow. In 2023, the PropTech market reached \$27.3 billion. According to Fortunebusinessinsights (2024, November 4), the PropTech market is expected to grow by 15% between 2024 and 2032. The PropTech markets of the United States, China, the United Kingdom, Germany, and Switzerland attracted the largest amount of investment during 2012–2023 (*Figure 3*).

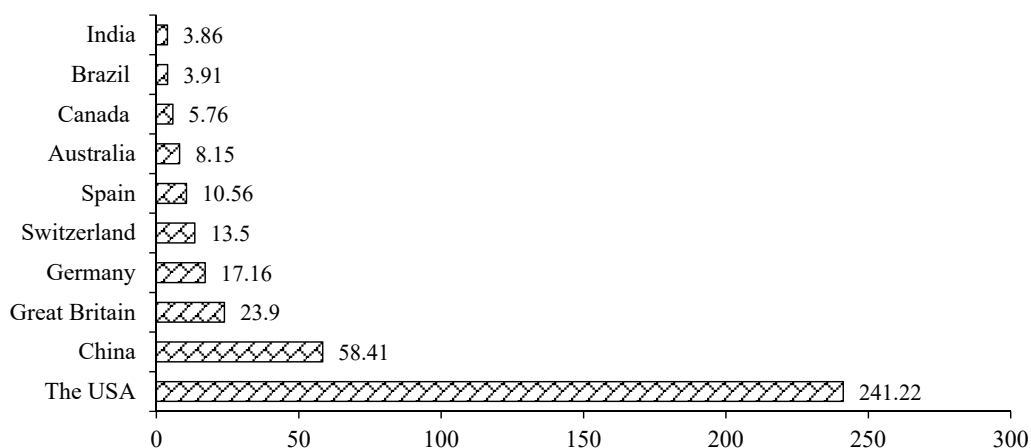


Figure 3. Top 10 countries in terms of investment in PropTech in 2012–2023

Source: compiled by the authors based on (ESCP Business School and the Principality of Monaco, 2023).

Currently, there are over 9,000 PropTech companies in the world (Ascendix, 2024, June 13). *Figure 4* presents their regional structure. The largest share of PropTech companies is located in the USA, followed by Europe. The share of companies in other regions is still insignificant in the global PropTech market.

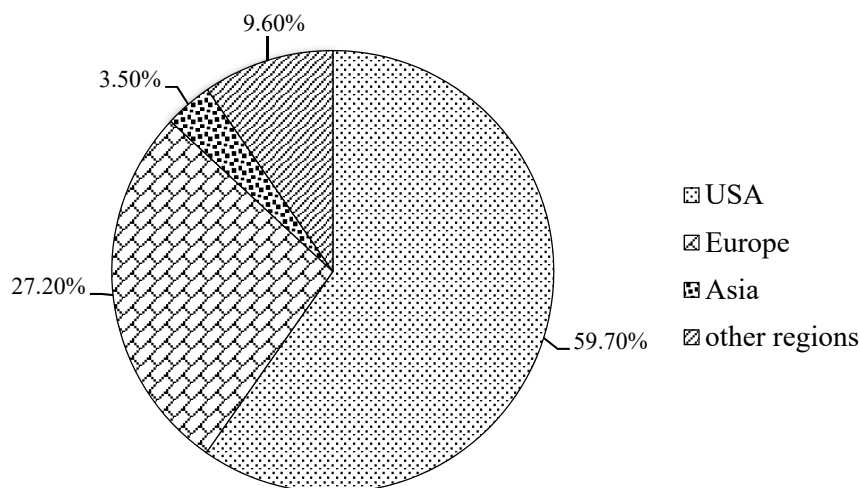


Figure 4. Regional structure of PropTech companies

Source: compiled by the authors based on (Ascendix, 2024, November 14).

In 2023, the PropTech following components were of the greatest interest to investors (CRETI, 2024, April 11):

- commercial real estate – 60% of investors;
- residential real estate – 50% of investors;
- construction technologies (CoTech) – 45% of investors.

Figure 5 shows the sectoral structure of PropTech.

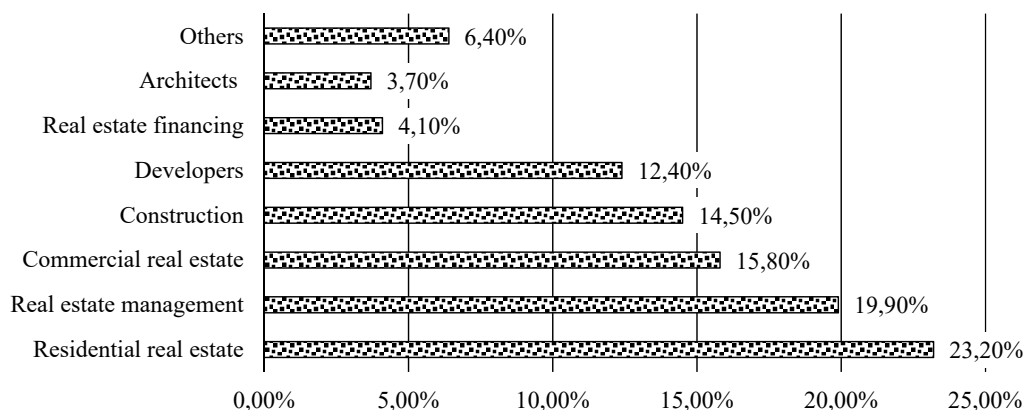


Figure 5. Sectoral PropTech structure

Source: compiled by the authors based on (Brocoders Dev Insights, 2021, June, 12).

The largest shares in PropTech are held by the residential real estate (23.2%) and property management (19.9%). Significant shares are also held by the commercial real estate (15.8%) and construction sectors (14.5%). The real estate financing sector accounts for only 4.1%. However, the role of financial services in PropTech is much greater, since, in addition to investment services, the real estate market provides payment, credit and insurance services, without which transactions in the market are often impossible. The diverse composition of PropTech sectors and the close interaction of their participants necessitate the need to emphasize that they all function within a single ecosystem.

3. PropTech ecosystem: components and development trends

The permanent growth of the number of Internet users determines the increase in PropTech's capabilities to cover significant segments of the real estate market. Under these circumstances, PropTech is transforming into a powerful ecosystem that contributes to the formation of the chain "construction" – "purchase/sale/lease offer" – "client consulting" – "financial and legal services". *Figure 6* presents the components of the PropTech ecosystem. Its core is online platforms that, through the use of information technologies, ensure the interaction of ecosystem participants: investors, tenants, owners, real estate buyers, developers, real estate agencies, startups, FinTech companies and financial institutions, notaries and others. These participants belong to various industries and spheres, in particular, the construction, real estate market, financial services market, IT sphere.

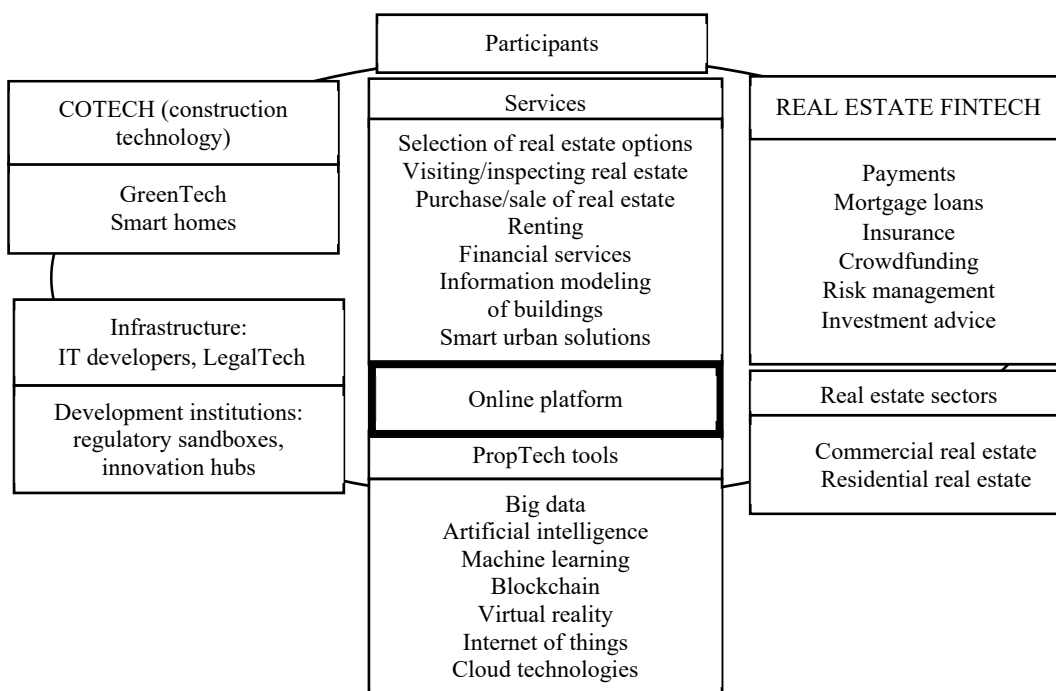


Figure 6. PropTech ecosystem

Source: compiled by the authors based on their own research

The provision of financial services within the PropTech ecosystem has technical, economic and social prerequisites. The basis of the technical prerequisites is the permanent growth of Internet users; the use of the same information technologies in the real estate market and in the FinTech sector; platformization of the financial market and the real estate market.

Economic prerequisites form the complementary nature of financial services in relation to other transactions in the real estate market and low payments or their absence for financial services within the FinTech framework. The social prerequisite for the provision of financial services within the PropTech ecosystem is the increase in the level of acceptance of innovative technologies by consumers.

FinTech Real Estate within the PropTech ecosystem provides:

- provision of payment services when carrying out real estate transactions;
- provision of mortgage loans through lending platforms. At the same time, underwriting is carried out based on artificial intelligence and machine learning when making lending decisions;
- fundraising through platforms based on investment crowdfunding;
- managing risks in the real estate sector by minimizing them when assessing the value of real estate using automatic valuation models in real time;
- optimizing the record-keeping of property rights and other real estate transactions together with monitoring the history of ownership using blockchain technology;

- providing insurance services that accompany mortgage lending services, in particular, insurance of the mortgage subject, life, health and work capacity of the mortgagee, title learning and predictive analytics;
- providing advisory services to clients by robo-advisors through automated investment platforms;
- informing about real estate prices depending on its types in real time based on machine.
- investing in real estate investment trusts through platforms.

The provision of financial services within the PropTech ecosystem has its strengths and weaknesses, carries certain threats and has opportunities for development insurance (*Table 2*).

Table 2

Swot analysis of financial services in the PropTech ecosystem

<i>Strengths</i>	<i>Weaknesses</i>
24/7 access to real estate market information	The use of digital technologies may be too expensive for small real estate market participants.
Provision of financial services that are complementary to real estate transactions	Insufficient level of trust and technical literacy of individual real estate market participants.
Automation of property management and transaction processing	Insufficient compliance with data security and privacy laws.
Reduction of transaction costs for clients	The need to train staff to use digital platforms and information.
Reduction of operating costs for real estate agencies	
No geographical restrictions	
<i>Opportunities</i>	<i>Threats</i>
Rapid adaptation of financial services to the needs of ecosystem participants	Variability in customer preferences.
Ensuring transparency of transactions in the real estate market	Increased innovation spending in certain CoTech segments.
Reducing credit and investment risks in real estate transactions	Lagging behind rapidly evolving digital technologies and customer expectations.
Reducing costs through automation and decision-making based on big data analysis	Limitation of PropTech growth due to data privacy breaches and cyber threats.
Quick access of clients to credit resources	
Increasing the efficiency of communications between real estate market participants	

Source: compiled by the authors on the basis of (Fortunebusinessinsights, 2024, November 04; Saha, 2023) and own research.

In our opinion, the trends in the development of PropTech ecosystems should be:

- increased collaboration between its participants, which will contribute to increasing the efficiency of developments and the adequacy of meeting customer needs;
- increasing the role of GreenTech in the ecosystem, taking into account the growing needs of society in environmental protection and energy efficiency;

- increasing the integration of financial technologies into PropTech, which is based on the need for fast payments, attracting loans, and the security of investments in real estate;

- increasing the globalization of the functioning of ecosystems, which will facilitate user access to the real estate market and facilitate financial transactions related to transactions on it.

So, although PropTech and FinTech are independent sectors of Everything Tech, the globalization and digitalization of the real estate market and the financial services market lead to a deepening collaboration between their participants.

Conclusions

The results of the research confirmed the hypotheses regarding the PropTech transformation into an ecosystem and the collaboration of PropTech with FinTech, which provides financial support for real estate transactions. In the context of digitalization of the real estate market, it is transformed into a PropTech ecosystem, which from an institutional point of view it has been proposed to consider as an interacting set of real estate sectors, CoTech, FinTech, infrastructure and development institutions, which allows providing services to users in the real estate market and complementary services, in particular financial services, in global markets through digital platforms. This expands the understanding of the PropTech ecosystem (Meduoye, 2024). It was found that the emergence of PropTech was facilitated by economic, technological, social and psychological factors, which determined four stages in the development of PropTech: emergence, maturity, improvement, development of sustainable and smart property. The development of information technology and consumer needs has transformed software in the real estate market into a service and ensured the orientation of technological solutions to combat climate change and automate processes in real estate maintenance. PropTech companies mostly have generally updated software, which allows the use of modern information technologies. The provision of financial services within the PropTech ecosystem has technical, economic and social prerequisites. The technical prerequisites are based on the permanent growth of Internet users; the use of the same information technologies in the real estate market and in the FinTech sector; platformization of the financial market and the real estate market. The conducted research made it possible to find out that the provision of financial services within the PropTech ecosystem is due to their complementary nature in relation to other transactions in the real estate market, price attractiveness, increased customer confidence and compatibility of PropTech and FinTech tools. Further interaction of the real estate market and the financial market can change consumer behavior through the integration of financial services into PropTech. At the same time, PropTech ecosystems will become global. Future scientific research should establish measures to strengthen the protection of consumers of financial services within PropTech ecosystems.

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