Trends in the development of the Smart home system and its integration into modern society

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Abstract. The stages of development of smart home systems and integration of these systems into the city infrastructure are considered. The main advantages and disadvantages of these solutions are identified, and problems associated with their installation and use are identified. The research on the volume of markets and target audience is analyzed, and the trends of recent years in the areas of both "smart home" and "smart city in General" are considered. Priority directions of development of the entire field of solutions are indicated. Specific examples of using smart systems in different configurations and with different functions are considered. Conclusions are drawn about the current situation on the market, as well as about the future prospects for implementing smart home systems in the lives of users.

1. Introduction
The term "smart home" appeared in the early 2000s and is inextricably linked with the concept of "smart city", the implementation of which becomes a target for the development of energy companies and involves the use of its infrastructure to improve the efficiency of urban infrastructure use. Since 2015, the degree of distribution of various smart home technologies in Russia, as well as public awareness of modern solutions in this area, has increased significantly [1]. However, the understanding of the concept of "smart home" in Russia and in the rest of the world is slightly different. While in the West, experts have been implementing various solutions and integrating them into the city's infrastructure for quite a long time, becoming partners of governments, in the Russian market, marketers have instilled in the population a not entirely correct idea of "smart" technologies. In the view of most Russians, "smart" is considered to be almost any equipment with a few advanced functionalities, for example, "smart" kettles, water heaters, refrigerators, etc. At the same time, not everyone understands the difference between a refrigerator that can be used to access the Internet, and a "smart" water supply system in the house, which is able to control not only water leaks, but also pipe breaks, as well as quickly call a repair team to fix the problem [2-4].

However, at the current stage of technology development, more and more construction companies are beginning to cooperate with manufacturers of equipment and systems for smart homes, which suggests great prospects for the development of this industry in the Russian market.

2. Materials and methods
Speaking about the "smart home" system, it is worth considering not only the solutions themselves, but also their application in real life, as well as the target audience that may be interested in these technologies. Initially, the smart home system was positioned as a way to reduce energy and water use, but now it is actively used in many areas of life, such as security, convenience, and comfort.
consumption, which reduces operating costs. Experts say that using such solutions can reduce energy consumption by 30-40%, water consumption by 20-30%, and operating costs by 10-30%. In addition, there are three stages of integration of "smart" systems in the urban environment. The first stage is considered to be the development of an efficient infrastructure, then we are talking about primary digitalization and, finally, the last stage is the digital ecosystem (Smart Sustainable City). It should be emphasized that the degree of distribution of each stage in the Russian market differs significantly for Moscow, millionaire cities and the rest of Russia [3-4].

The second advantage of "smart home" is security, which is understood not only to protect against illegal entry into the house, but also to prevent accidents in the presence of various failures and breakdowns. At the moment, there are already solutions on the market that allow you to install special sensors in the house/apartment that monitor the situation in the room around the clock, which allows you to inform the user about failures and problems in a timely manner. For example, some smart systems send a notification to the owner in the event of a water leak or gas leak and then call special services to fix the leaks themselves. Some systems are able to eliminate leaks themselves by shutting off the water or gas supply. There are also sensors that monitor Windows and doors. In case of illegal entry, the user immediately receives a notification from the security system, which can be configured so that the camera distinguishes a cat from a person and reacts depending on the situation. Fully automated security systems are certainly capital-intensive, which indicates that they are not available to the average user, and is considered as the main drawback that prevents their widespread use. For example, to supply a standard two-room apartment with "smart" equipment, you will need about 5 thousand dollars (if you do not take into account the most expensive and modern options) [2]. Thus, investments in the "smart home" will pay off in at least 30 years, which, of course, few people are satisfied with. Average users prefer cheap solutions that do not create a common ecosystem of "smart home", but only help to optimize some processes in the home.

Real and full-fledged smart home systems are found mainly in the capital. For example, when creating a project for the reconstruction of the Narkomfin house in Moscow, which is a monument of avant-garde and constructivism, architects and developers decided to implement "smart" systems in the house. The apartments have special touch panels that allow you to control the climate, lighting and curtains. These control interfaces are connected to a common centralized KNX apartment system, which allows you to program thermostats, panels, and sockets. The programmable smart home system allows you to record scenarios, turn on heating and sockets according to a schedule, and turn off all electrical appliances as necessary.

Most often, the integration of the "smart home" system into the city's infrastructure is associated with the creation of a centralized management system for modern residential complexes (smart intercoms are installed in entrances, electric car chargers are installed in Parking lots, and video surveillance is conducted around the perimeter of the complex, which is integrated into the video surveillance system of the entire city). At the same time, the investment associated with the creation of such systems also varies significantly. If the most common "smart" sockets are currently not so expensive, then to fully integrate the "smart" system into each individual apartment, you need, among other things, a design project, which is likely to include special design solutions. Despite the fact that the cost of "smart" systems has significantly decreased in recent years, however, it is still quite high. For example, the cheapest options for a "smart" system that includes lighting, temperature, curtains and blinds, as well as energy management, will cost the user 35-100 thousand rubles. Such systems have a number of advantages: various scenarios, notifications, remote control, and schedules. Scripts allow the user to program the system for a specific set of actions. For example, when coming home in the evening, the user can turn on the "Evening" scenario using voice control, which involves closing curtains and blinds, setting the light to warm tones, dimming the light, turning on pleasant music, turning on the kettle. Remote monitoring allows the user to monitor the status of various indicators in the house in real time – from electrical appliances to video surveillance cameras. It should be noted that online monitoring of video surveillance cameras is already quite widely used by ordinary users as an effective security measure; however, integrated video surveillance systems are still expensive.
Notifications are also an important part of the smart home system, as they allow you to quickly get information about certain incidents. For example, if there is a power outage in an apartment, the system can automatically switch to the UPS (uninterruptible power supply) and at the same time send a notification to the user about the power outage. Now, there are already relatively inexpensive solutions for security systems that can notify the user in the event of illegal entry into a residential premise, as well as call out-of-house security. If we talk about centralized control systems, we can give an example of the KNX system, which just allows you to program equipment for various scenarios and connect all smart systems of a house or apartment to a single application in a smartphone [5-6]. However, it should be noted that due to lack of investment, lack of all necessary technologies and poor public awareness, such systems are still very poorly distributed in Russia.

3. Results
Speaking about the trends in the development of the smart home market, it is worth considering both the whole world and Russia in particular. Over the past few years, the global market for smart home solutions has been growing rapidly (figure 1), while experts predict that, the trend will continue.

![Figure 1. Global smart home solutions market volume, $ billion [1].](image1)

It should be emphasized that the Russian market lags behind the Western one in terms of development by about 5 years, although the situation has significantly improved over the past two years, and by 2023, it is expected to grow by more than three times the previously achieved level (figure 2).

![Figure 2. The volume of the market of solutions for smart houses in Russia, $ billion.](image2)

At the moment, the market leader is the United States. Their share is approximately 44.4 per cent. The second position is occupied by China with a market share of 13.5%. Germany closes the top three with a share of 5.8% [7-8].
Without a doubt, the volume of the market largely depends on the activity of end users. After analyzing Yandex's research on the audience profile of smart homes, we can draw several conclusions. First, users are poorly aware of the market for these technologies – 60% of users are looking for only one brand – Xiaomi. Second, potential users of smart home systems are mostly men aged 25 to 44 (68% of the audience is in this age group), 65% of the audience has an above-average income, and 64% of search queries about "smart home" are in millionaire cities. In particular, for Moscow and the Moscow region -36%, Saint Petersburg and the Leningrad region -10%, millionaire cities (except Moscow and Leningrad) – 18%, the rest of Russia – 35%). It should also be emphasized that the main audience of smart homes is young, affluent, modern urban people [9-10]. Third, interest in smart homes increased by 31% from 2017 to 2018. At the same time, users are more interested in this topic with the onset of autumn, by the summer interest decreases, which is due to a large number of vacations. In addition, it is obvious that climatic conditions in some regions of Russia are pushing users to find ways to optimize energy consumption and improve the convenience of various home control systems.

World practice shows that most smart home technologies do not immediately enter the free B2C market. In most cases, solutions are first purchased by companies, and then come to the consumer market. We can't say that now most offices and technological premises are equipped with smart systems, but every year more and more companies use different solutions. For example, many processes in the fuel and energy sector have long been automated – the indicators of devices are monitored by special sensors that are programmed for both normal monitoring and a set of actions in emergency situations. Without a doubt, the introduction of such technologies has significantly reduced the percentage of accidents at work, since it is possible to exclude the "human factor". Elements of a smart office system can include motion sensors that monitor power consumption, humidity and temperature sensors, for example, in conference rooms, climate control in different parts of the building, and so on.

After the introduction of such technologies in business and their successful verification, solutions for the consumer sector often begin to be developed. In most cases, solutions are moving from the business to the premium construction segment. For example, a lighting system that allows you to run various scenarios will cost the user 7000-20000 rubles. Temperature and floor heating control systems will require from 7,000 to 25,000 rubles. Depending on the configuration. Solutions for curtains or blinds are offered at a price of 7000-15000 rubles, and security systems with leak sensors and cameras cost about 7000-30000 rubles. Naturally, for this amount, the user will not get a full home equipment, so each additional element, whether it is a sensor or a camera, will cost even more. Systems for energy management are priced on the market from 7000 to 20000 rubles, and solutions for voice control cost up to 15000 rubles [10].

It should be noted that the above offers include a minimum number of elements, so when calculating the cost of equipping a house/apartment, the entire system will cost much more. It should also be emphasized that for proper configuration of all mass-implemented equipment, specialists in "smart homes" are needed, which are currently not so many. Thus, high prices for installation, configuration and maintenance are due to the fact that smart home systems are still rarely used by the population and very few companies have the necessary qualifications to work with them.

4. Discussion
According to the road map of Moscow until 2030, "smart home" is one of the directions of development and implementation of the "smart city" concept. Already, the Moscow government is actively developing infrastructure that allows not only to reduce the number of personnel who provide certain functions, but also to increase the security of the city as a whole. Currently, Moscow has one of the most effective video surveillance systems in the world, which allows you to reduce the number of accidents and other offenses, as well as monitor the overall situation in the city online. In addition, many urban infrastructure management processes are translated into an online format due to the integration of various information developments into the city's ecosystem, which is ensured by the
work of companies that produce solutions for "smart" apartments, houses and courtyards, 49% of which are based in Moscow [7].

The growing interest of investors in the problem contributes to more active development of new solutions, and secondly, to reduce their overall cost. According to experts, in the next 5 years, the price of "smart" gadgets and "smart home" systems in general will decrease by 1.5–5 times. To date, the high price for solutions is set due to the lack of necessary experience in this field. First-time firms need to create such systems according to established standards, localize them for each country separately, and develop strategies to inform the public, create the necessary base of experience in the field of maintenance and reduce production costs. In addition, at the moment there are no systems that allow you to completely manage the entire house from a single device, so new solutions are constantly being developed. In 2014, Apple introduced Apple Homekit, an application that combines more than 50 different devices, but this ecosystem also has its drawbacks. When the technologies are sufficiently developed, it will be possible to talk about reducing their cost in the market [7].

Every year, the number of venture capital investments in smart home technologies is growing, which indicates the investment attractiveness of the market. Manufacturers of household appliances are increasingly implementing smart technologies in their products, so in the near future the number of users of "smart homes" will steadily grow, which will lead to the development of the overall urban infrastructure [8].

5. Conclusion
Summing up, it should be noted that the field of "smart homes" has huge prospects. Investors are already investing heavily in the development of "smart" technologies, which makes it possible to reduce the cost of relevant solutions from year to year. At the same time, it should be emphasized that at the moment there are no full -fledged smart home systems that combine the management of all components and suitable for the price category of average residents, however, the latest developments will soon make the Russian market of smart home technologies more accessible due to the development of healthy competition between manufacturers of modern IT solutions.

Thus, for the end user, the development of the market has only positive aspects: greater awareness of the population, lower price and improved functionality that allows not only to meet certain user requirements, but also to save water and electricity consumption. With the advent of cheap and centralized management systems, the smart technology industry will move from the "unreliable" category to the "ubiquitous" category.

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