Using information technology to design comfortable furniture based on research of seniors' needs

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Abstract—**The paper presents the results of the development of high-tech furniture for the elderly using virtual reality technology (VR). The furniture development was preceded by a study of 120 older people (60+) from all 8 federal districts of Russia and 30 heads of different organizations providing public spaces used by seniors. The study was carried out by the method of online questionnaires using a database of verified respondents from large, medium and small cities. According to the results of the survey, the preferences of the elderly were revealed regarding the organization of inside and outside public spaces. Based on the detected preferences and the barriers that seniors faced with, a virtual reality table was developed, which allows older people to comfortably accommodate, avoid the negative effects of losing touch with reality, as well as making it possible to remotely participate in various public and private events.**

Keywords—**seniors, information technologies, furniture design,**

I. INTRODUCTION

According to the World Health Organization (WHO), the population of 65+ years old is predicted to globally grow to 1.5 billion by 2050 [1]. A sharp increase in the percentage of elderly people is expected in urban areas [2]. It is expected that by the middle of the XXI century every three out of five representatives of the "third age" will live in cities, which corresponds to the general trend of urban population growth to 80% [3]. The living conditions and changes in the environment cause different effects in city planning [4]. This emphasizes the importance of developing urban spaces comfortable and accessible for the elderly and adapting the aging population to the changing conditions of modern society.

Nowadays the concept of active aging is becoming more and more popular especially in connection with new IT

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opportunities [5]. Urbanization and IT-spread are both resulted into the public spaces creations using progressive tools and age-friendly environment [6]. At the same time, some studies identify barriers to technology use including low technology literacy, including lack of familiarity with terminology, and physical challenges, which can make adoption difficult [7]. Summarizing the above, we can talk about the existence of the special needs of older people, as well as some restrictions that must be taken into account when creating comfortable spaces for the elderly, and especially the signs of furniture.

This paper describes a case of special tool for elderly development based on the prominent information technologies and the needs and expectations of the older generation.

II. RESEARCH METHODOLOGY

The survey was performed within realization of international project aiming to provide new knowledge supporting creation of senior-friendly public spaces. The study used an institutional approach and a study of a comfortable environment for the elderly from the perspective of stakeholders. For the purpose, two surveys were carried out:

- a survey of 30 heads of institutions of various orientations visited by the elderly.
- a survey of 120 respondents aged 60 and older in 8 federal districts of the Russian Federation about the assessment of public spaces and the needs of older people.

The first study involved representatives from 14 government agencies, 4 museums, 4 institutions managing public areas, 3 libraries, 2 sports institutions, 2 cafes, 1 educational institution. The survey was focused on identification the demand and use of public places, as well as the plans of institutions for renovation in them.

The second survey involved 120 respondents: 64%-female, 36% male. The study was aimed at identifying assessments by older people of the current equipment of public places, as well as the needs for comfortable furniture and its functionality.

Both surveys were conducted using a web-service Anketolog for the questionnaire creation and collection the answers as well. The heads of organizations received invitations to participate in the research via e-mail. For collection the answers from seniors the respondents' data base was used. Anketolog provides an opportunity for

regular users to register in their data base (with a strict proof of the passport data and other identification tools). This base was use to find the respondent of the required age group.

The data analysis was carried out with statistical package. The research results were discussed with the project development group and reflected into the modern furniture development.

III. RESEARCH RESULTS

A. Services for the elderly in organizations

According to the data, among older people with disabilities who visit the surveyed organizations, 56% are hearing impaired, 46% are visually impaired, 73% have mobility problems. More than half (60%) of older visitors come to organizations alone, 53% in the company of a partner, and a third in the company of children and grandchildren.

Only a third of the respondents said that the public space is well adapted to the needs of the elderly. Only 10% of the surveyed organizations carried out special surveys of older people about the quality of the organized space, furniture, etc.

In the nearest future 43% of respondents told about the plans for the renovation of premises, replacement of furniture, and 57% on the implementation of intelligent solutions. Almost 40% are going to renovate the outside space of the organization, and 23% would concentrate efforts on the inside space.

The heads of the organizations reported that new IT tools, lifts and comfortable furniture are among the most demanded changes for the citizens' needs (fig.1).
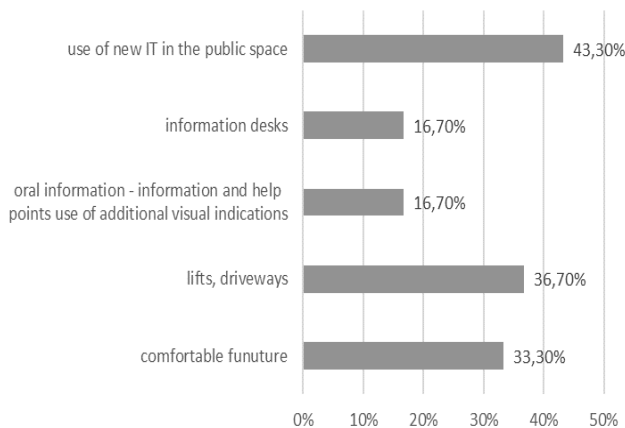
properties of the surface are taken into account. (73%), design (66%), ergonomics (56%), environmental aspects (40%), adaptation to the needs of the elderly (33%).

B. Seniors' needs in new tools for comfortable environment

According to the estimates of the majority of older respondents (64%), they are trying to adapt to the needs of the elderly in public spaces. The surveyed retirees are more likely to use public places outdoors (80%).

More than half of the respondents use some kind of furniture located in the public space every time. Among the most frequently used furniture in public places, the most popular are seats in public transport (71%), benches in parks (68%), seats in waiting rooms (47%), benches in the courtyards of residential buildings (38%), furniture in waiting rooms (27%).

In most cases, they use it alone (43%) and in the company of a husband / wife (49%). Every second respondent said that the environmental friendliness of the furniture used in public spaces is important for him. About 60% noticed that furniture in public places should be made with the use of recyclable materials.

In the study, respondents identified the following shortcomings that hinder the use of furniture in public places: it can be dirty or broken (66%), very few elements of adapted elements outdoors (28%), the elderly have difficulties in sitting or getting out of furniture (11%), they have nowhere to put a cane when using furniture and it falls (10%), they are afraid to sit alone (9%), they are afraid of falling off the furniture (4%).
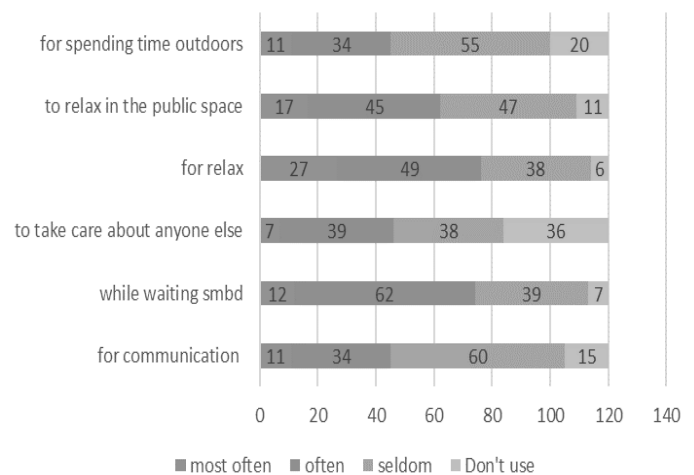

Fig. 1. What facilities do you think could be created for older people in your institution?

Fig. 2. How often do you use the public space and its furniture for the following purposes

According to the survey results, the main obstacles for the elderly-friendly transformation are the lack of finance (60%), restrictions related to tenders (57%), as well as lack of knowledge about the needs of older people (40%). According to the study, when making decisions on the purchase of one or another furniture, criteria such as price (97%), fire safety certificates (98%), duration of the warranty period (90%), ease of cleaning (80%), antibacterial

According to the survey, older people would like to do the following using furniture at home or in public places: relax through design elements (42%), listen to music, radio (46%), watch videos (43%), use a tablet or other IT devices (33%), doing light physical exercises while sitting (17%).

IV. VR Table for Seniors Development

In our time, virtual reality technologies are being increasingly integrated into diverse realms of human activity. One of the most important directions in VR use is therapeutic; wearing a virtual reality helmet, the user can immerse him or herself in a specially created virtual environment. For many senior citizens, VR devices can provide not only the opportunity to relax, but also the ability to be virtually present at such places and events where they cannot be physically. This may include virtual travel to other countries, online learning through a virtual presence, and appearing virtually at important events, family celebrations, and so on. However, a serious impediment to the use of virtual reality technologies by older people is the disorientation that results in motion sickness. Donning a virtual reality device, the user completely loses touch with reality and—depending on the content he or she is watching—may try to move without knowing it: to walk, to wave his or her arms, to dodge nonexistent objects, and more. In the event that the user is standing in the VR helmet instead of sitting, he or she could fall or collide with real objects and people on the premises.

According to the survey results and in order to prevent these effects a special furniture was developed allowing for a closed tactile environment that ensures the user's safety while using VR devices. A comfortable chair that rotates 360° allows the user to comfortably immerse him or herself in any VR environment, and a closed-loop furniture system prevents involuntary movement and offers a surface for hand support throughout the experience—thus minimizing motion sickness (fig. 3). The proposed solution allows seniors to safely and comfortably use virtual reality devices for their medical, education, and communication needs, enhancing their quality of life each day.
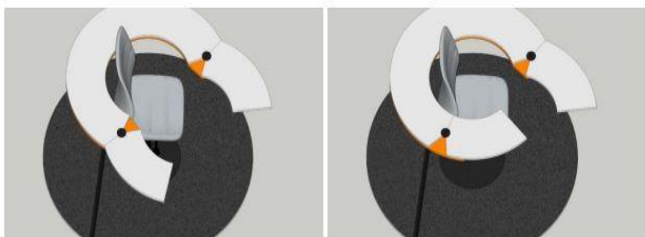

Fig. 3. VR furniture in open and semi-open state

In creating the VR furniture, the team of developers focused on the following principles:

- The design should guarantee comfortable immersion in the virtual environment using a wide variety of VR headsets available on the market, including free 360° rotation controlled by the user.
- The basic aim of the furniture system is the removal, or significant reduction, of the unwanted effects of motion sickness while using VR devices.
- The structure should be adaptable and convenient for older people to use; it should be easy to sit down and get back up, to manage the rotation of the chair, and to limit excess movement of the arms, head, and neck, for the purpose of reducing load on the joints.

- Ease of assembly and transport: The VR furniture should be collapsible and portable, assembled to fit in the trunk of a car. Permit frequent assembly and disassembly using standard tools like Allen wrenches/hex keys and screwdrivers, included optionally in the kit. Assembly and disassembly should be simple, should not require specialized skills or tools, and should take little time.
- The use of standard, mass-produced pieces of furniture with the goal of reducing costs and increasing reliability, along with simplifying the maintenance process.
- The exclusive use of environmentally clear materials in compliance with the EU's environmental standards. Allow for social/physical distancing in the context of the COVID-19 pandemic within the design. In the process of designing a prototype for the VR furniture, each task was analyzed step by step, and essential design requirements and limitations were identified.
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Some units were further refined at the next stage, during production. This included reinforcing the main frame, making it easy to open the access doors, standardizing the foot groves for specific chair models, and more.

V. Conclusions and Discussion

The proposed VR table for seniors and its further usage could open a discussion on the transformative impact of digital technologies on the way of seniors' social inclusion.

During the survey, the respondents noted that due to the aging process, they feel tired much faster than when they were younger. This fatigue makes them sit and rest more often; thus, they pay attention when there is not enough furniture that they can use in a public place, or if such furniture is too far away. A good solution in these cases is the availability of different types of folding tables and chairs in public indoor spaces. These chairs do not take up much space, but are available at any time.

Consequently, a prototype of the VR furniture system was designed, modified in production, and manufactured to fully comply with the requirements. The next proposed step is to test this prototype on the target population—currently this task was postponed due to the establishment of the special social distancing regime.

The development is based on the idea of positive transformations in the life of the elderly through new technologies and furniture that make them comfortable to use. The creation and transformation of public spaces for the elderly is a major architectural, social and design challenge. The analysis of the needs of older people, together with a deep understanding of the attitudes and requirements of older people, will allow restructuring internal public spaces so that older people can fully participate in the life of their communities and maintain an active social life.

The limitations of research and development are related to the insufficient scale of its approbation. At the same time, within the framework of an international project, comparable studies were carried out in Denmark, Finland, Latvia, Poland, Russia and Sweden. The development itself does not guarantee full distribution. However, at the current stage of

the project implementation, presentations are planned with the real use of the VR table in various organizations, where older people often come.

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