APPLYING INTELLIGENT BUILDING CONCEPT PRINCIPLES IN THE CREATION OF COMMUNITY SOCIAL SERVICE FACILITIES

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ABSTRACT: Architectural studies for the Recovery and Resilience Plan - Component 13: Affordable and Quality Long-Term Social and Health Care were prepared at the Faculty of Architecture and Design of STU in Bratislava. In the next few years, over 100 community-type social service facilities, so-called family-type housing, are expected to be built in Slovakia. The Ministry of Labour, Social Affairs and Family in cooperation with the Faculty of Architecture and Design of STU has prepared a catalogue of facilities meeting the criteria of community housing in smaller groups, universal design principles as well as environmental requirements. The paper analyses a case study of a community-type residential social services facility in the form of an atrium family house. It presents specific architectural-constructional and technological determinants of the smart building concept design on a selected community housing case study.

KEYWORDS: social service facilities; intelligent buildings; architecture; community housing

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INTRODUCTION

Smart technologies are slowly becoming a part of our lives, forming an integral element of the intelligent building technology concept. On the other hand, they are becoming a part of domestic appliances and ordinary households due to the concept of the "Internet of Things". As Intelligent Buildings expert G.J. Moreno pointed out As is pointed out by intelligent building expert G. J. Moreno from the Autónoma de Querétaro University in Mexico: "One of the main challenges of intelligent residential buildings is to provide comfort to the occupants, along with increasing their performance at low energy costs."[1] In order to spread smart technologies globally into our lives, they must be universally accessible to meet the needs of a wide range of users and take into account less tech-familiar users as well. Many of the benefits of intelligent homes relate to the provision of better healthcare and convenience for users with specific needs. Communication and monitoring equipment allows users to be interactively connected with the health centre, hospital, general practitioner, and relatives. Smart building technologies are useful for users in situations where they need immediate assistance, monitoring physiological data, checking the condition of the home.

They can be a very effective aid in the provision of social services. They can increase the level of independence of clients in social care services, improve working conditions for service providers or reduce the costs of running buildings. Smart technologies in an intelligent building should improve not only its environmental sustainability, but also its economic sustainability in terms of improving the efficiency and effectiveness of the building and its users, as well as its social sustainability in terms of improving the safety and user quality of the environment.

COMMUNITY HOUSING

The architectural study of the presented atrium house will be used as a platform for the development of further stages of design documentation in order to build community social service facilities financed by the Rehabilitation and Resilience Fund. The goal of the architectural study is to present a model building layout and spatial design that meets the criteria of deinstitutionalization, universal design requirements, as well as environmental requirements, based on the intelligent building concept. The criteria for the deinstitutionalisation of social service facilities applied in the study include the creation of small groups (up to 6 clients) in housing, creating a sense of home for the clients. The layout and operational design of the house respects the above-mentioned requirement. The achieved goal

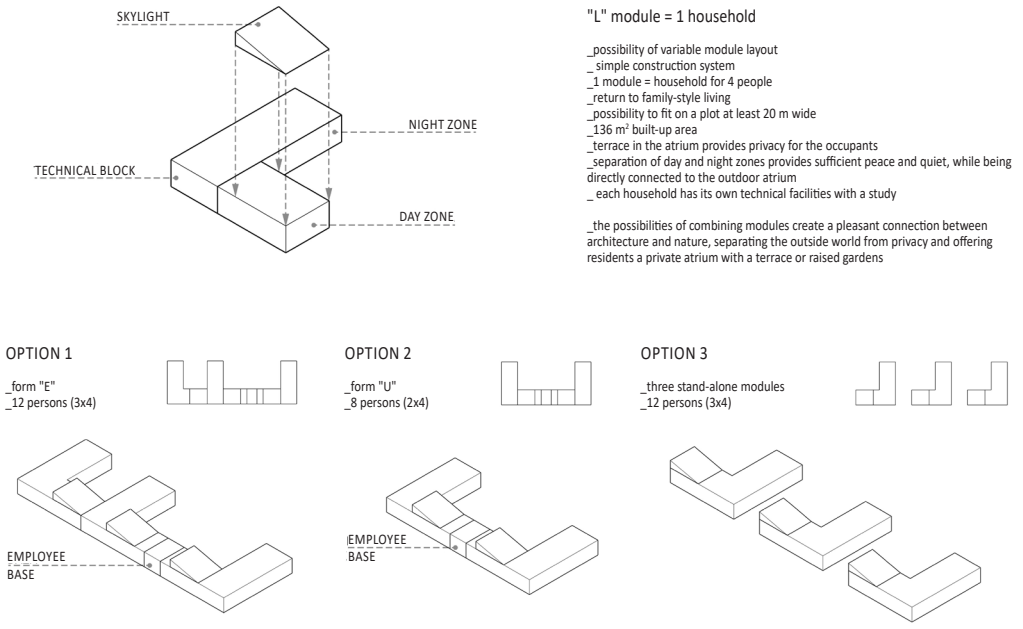

Fig. 1.: Variation of the proposed L-shaped atrium house for community housing of the social services facility. (Source: Puškár,B., Hencze, J. Architectural study.)

[1] BRAD,B.S., MURAR M.M. Smart buildings using IoT technologies, 2014, p. 17.

of the universal design approach of the house is the creation of an accessible and comprehensible environment that can be used by the largest possible segment of population, regardless of age, abilities and limitations.

The L-shaped house floor plan allows a high degree of variability in the arrangement of the E, U, 3L structures. The built-up area of the building in the basic layout shape - E (3x4 clients) is 422 m^2, the usable area is 363 m^2. The built-up area of the building in the shape - U (2x4 clients) is 286 m^2, the usable area is 249 m^2. The optimal orientation of the living rooms is south, southeast and southwest. Orientation of the plot entrance: north, east. The creation of a community space in the atrium area is an important aspect. There are designed spaces for relaxation and activation of the clients in the garden area, with benches for sitting, and raised flower beds. A wide paved walkway connects the street with the entrances to the individual apartments. The outdoor living environment is designed in the atriums as wooden outdoor terraces, partially screened by light steel pergolas.

Fig. 2.: Entrance zone of the atrium house for community housing in the social services facility. (Source: Puškár, B., Hencze, J. Architectural study)

HOUSE VARIABILITY

Variant 1 - for 12 (3x4) occupants - in E-form has a built-up area of 422 m^2, the usable area of the house is 363 m^2. The main entrances to the building are oriented at the long side of the plot, accessible by a pavement on the main street. Each of the three separate households (in an L-shaped floor plan) is divided into an entrance, day and night zone. Entrance is through a lee area providing protection from rain and snow and a vestibule providing a temperature filter. There is a kitchen, dining room and living room integrated into one space in the day zone, allowing free connection to the terrace located in the atrium. The night zone consists of three bedrooms with accessories. One bedroom is shared by two clients (19m^2), two separate bedrooms (2x10m^2) allow variable connection or division of rooms. The night zone includes two wheelchair accessible bathrooms, laundry room, and a maid's room connected to the HVAC space. There is an employee base located between two mirrored households with a separate entrance from the vestibule. The base contains a staff day room with bathroom and locker room with a storage.

Fig. 3.: The community zone of the atrium house in the social services facility. (Source: Puškár, B., Hencze, J. Architectural study)

Variant 2 - for 8 (2x4) recipients - U-shaped floor plan has a built-up area of 286 m2, the usable area of the house is 249 m^2. The main entrances to the building are oriented at the long side of the plot, accessible by a walkway from the public road. Each of the two separate households (L-shaped) is divided into an entrance, day and night zone. The entrance to the building is through a lee area providing protection from rain and snow and a vestibule creating a temperature filter. In the day zone, the kitchen, dining room and living room are integrated in one space, allowing a free connection to the terrace located in the atrium. The night zone consists of three bedrooms with accessories. One bedroom is shared by two clients (19m^2), two separate bedrooms (2x 10m^2) allow variable connection. The accessories of the night zone consist of two wheelchair accessible bathrooms, a laundry room, a maid's room connected to the HVAC room. Between the two mirror-oriented households is a staff base with a separate entrance from the vestibule containing a staff day room with hygiene and locker room along with a storage room.

ARCHITECTURAL DESIGN

The architectural design of the building uses simple shape elements, which are subordinated to the housing function. A key aspect of the design is keeping the principles of universal design. The basic compositional element of the various urban alternatives is the atrium house of the shape - L. The atrium is often found in the world as a layout criterion for intelligent buildings. It represents a design criterion of intelligent buildings according to the Japanese definition of intelligent buildings. In the development of intelligent residential buildings, for example, family houses, the atrium could also become part of the intelligent building concept in our conditions.

A strong expressive element of the house's architecture are the rooflights in the counter slabs above the day zone. All designed rooms have sufficient lighting and natural ventilation provided by windows. Most of the living rooms have direct contact with the exterior through large windows without sills. The façade of the building uses white plaster with an accent - large format coloured cladding at the main entrance, visually differentiating each residential unit. The flat roof of the building and the flat roof of the rooflights is designed as an extensive vegetation, allowing for the efficient placement of photovoltaic panels.

Fig. 4.: Community living room of the atrium house in the social services facility. (Source: Puškár,B., Hencze, J. Architectural study)

The three separate entrances to the building are oriented to the access sidewalk. The ground floor solution of the building contributes to easy accessibility from ground level. The design takes into account the principles of universal design, all spaces for clients and staff are suitable for use by all potential target groups, they are designed for wheelchair users / partly for the movement of people in beds (Most of the living rooms have double doors with the possibility of enlarging to a clear width of 1200 mm). The open plan layout of the day zone allows spatial adaptability in the same way as single rooms with the possibility of interconnecting.

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Fig. 5.: Layout of the E-shaped community house. (Source: Puškár,B., Hencze, J. Architectural study)

INTELLIGENT TECHNOLOGIES

Technical equipment is designed with regard to ecological and energy sustainability of buildings - heat pump, recuperation, water heating through solar collectors, photovoltaic panels for lighting, rainwater collection into a collection tank, use of rainwater for flushing toilets. During the creation of the project, it is necessary to take into account the installation of electrical installations, power and low-current wiring compatible with smart solutions and assistance systems, internet connection is essential. The installation of electric window roller shutters, automatic door opening systems or automatic sliding partition walls is recommended. All installations must be implemented without compromising the adaptability of the spaces. According to B. S. Brad: "The requirements for creating intelligent buildings are derived from performance and operational criteria with respect to comfort, adaptability, life cycle, cost and better control over available resources". The domestic environment in a family house represents a significantly wider range of users (seniors, children or disabled users) than in an office or industrial building. Dealing with these diverse and often demanding needs is a significant challenge for the intelligent building concept. The application of the intelligent building concept to residential buildings for users with specific needs allows the user comfort to be increased. The comfort feeling for the users is largely dependent on the architectural concept of the building - according to the quality of the layout, the area of the rooms, the use of scale and proportion, and the screening and over-lighting of the living rooms. In this context, the architectural concept forms the basic, supporting condition, the starting point for further creation.

The comfort increase is connected with the possibility of easily controlling a multitude devices directly from the mobile phone, smartwatches, smart wall switches. "Internet of Things" (IoT) - a concept that enables the interconnection of devices with built-in internet connectivity. It brings interaction between systems, but also the ability to control, monitor and provide advanced services to devices. The control of peripherals via the Internet allows automatic and manual control of a large number of devices: lighting, external blinds, household appliances, temperature, audio-video equipment, etc. It forms part of the technological concept of intelligent buildings, on the other hand, it is becoming part of ordinary homes and buildings through current domestic appliances.

Along with the development of information technologies, their operation is also becoming easier. Ease of use, its user-friendly design is an important moment for the spread of the concept among users with specific needs. The general operating platform of intelligent buildings has become the smartphone because of its good accessibility and familiarity. A well-known device is given to intelligent building users with specific needs, through which they control a large number of peripherals (communication, lighting, heating, ventilation, fire and intrusion security) via free applications. The alternative possibilities for controlling intelligent buildings, developed, for example, for people with reduced mobility, are interesting. They can be transformed, for example, into geometric shapes (cube), which, by turning on the bed of a reclining user, allows intuitive control of individual peripheries (artificial lighting, shading, info and entertainment, etc.).

The integration of haptic braille labeling is also important in the creation of user control elements. Intelligent building environments make it possible to integrate security systems that monitor users with specific needs, their behaviour, habits, stereotypes and biorhythms, analysing the information intelligently. They use the collected data to improve the safety of users. This enables them to create a sense of security in smart building environments, which is essential for the users' peaceful lives. The security system reacts to the movement of unauthorised persons and ensures the transmission of information to the organisation that provides security for the building. Alarm system devices are a set of technical means - control panels, sensors, signalling and supplementary means forming a system that serves to signal the location of an intrusion into the protected system. The security system includes digital video monitoring, intelligent video and audio analysis. For the safety of users with health limitations, in addition to securing buildings against burglary, it is also important to have a superior fire safety solution to prevent the start and spread of fire, locating and eliminating fire (electronic fire alarms, automatic fire extinguishing systems). Demiris has defined the categories of seniors' needs for which a intelligent home can assist with living: "'Intelligent building' technologies are useful for seniors in situations where an elderly person needs immediate assistance, help with hearing or vision impairment, fall detection, indoor and outdoor temperature monitoring, automatic lighting control, monitoring physiological data (blood pressure, glucose levels) checking closed or open windows, monitoring water flow, security systems, activating fire alarms, reminding of appointments or planned events, timely and accurate contraindication of medications."[2]

The electronic security of entrances is important, for example via fingerprint and face ID, which allows getting rid of standard keys and electronically unlocking entrances in the event of a fire. A higher level of fire safety is the fire suppression function, which activates the automatic fire extinguishing system, initiating sprinklers in and around the site of the fire. By extinguishing before the arrival of emergency services, it seeks to isolate the fire, reducing loss of life and material loss in the building. The evacuation system uses motion sensors and a security system to locate the location of building occupants to be evacuated by the integrated control system. By activating the fire alarm and by means of an audio-visual system, it alerts the

[2] DEMIRIS, G., RANTZ, M., AUD, M., MAREK, K., TYRER, H., SKUBIC, M., HUSSAM, A. Older adults' attitudes towards and perceptions of smart home technologies, 2004, p. 90.

direction of escape and the location of fire escape routes. It is also possible to integrate subsystems for fire ventilation, fire lighting, and a system for emergency shut-off of connections.

Assistance technologies are useful in situations where the client needs immediate assistance, help with hearing or vision impairment, fall detection, monitoring of physiological data (blood pressure, glucose levels). Video analytic devices scan the area, monitor clients and evaluate the recording. The recording is automatically evaluated by intelligent tools that are able to instantly recognize, according to the analysis of the video and audio recording, a threat to the client's health (e.g., epileptic seizure, falling, accident). In case of a positive evaluation, it triggers an alarm and summons help. According to Victoria Haines and Val Mitchell of Loughborough University, UK, "Many of the benefits of intelligent households are related to the better healthcare service and convenience for older people and people with disabilities."[3] Smart Band technology - a device in the form of a smart bracelet, can effectively monitor pulse, temperature, pressure, glycemia directly from the client's wrist. Smart Band senses the client's location within the building, it can detect what position the client is in by rotation, position and time data from the wristband. The recording is automatically evaluated by intelligent tools that are able to instantly recognize a client's health risk based on the data from the wristband. In case of a positive evaluation, it triggers an alarm and summons help. The advantages are the simple installation, the device's collision-free compliance with GDPR regulations (no video and audio recording of clients' privacy) and the low investment costs. According to Sabine Koch: " To design optimal technology devices for the elderly, there is a lack of accurate findings on the needs of seniors. A particularly missing aspect is interdisciplinary research on applications for different age groups of users."[4]

Monitoring devices for physiological functions of users with specific needs represents an initial higher investment cost for investors and operators. However, in the future they are also economically beneficial for facilities providing care for users. They significantly reduce staff costs, especially in decentralised types of facilities - with housing dislocated from the administrative and economic part. A complex issue is the collision of these systems with user privacy and GDPR. With advanced technology, it is possible to resolve this collision as well and monitor physiological functions and location of users even by means without the need for video and audio recording. It is important to consider the fact that the clients of a social services facility have different requirements for buildings compared to ordinary users in order to select intelligent and smart technologies. The fact that the mix of clients in the facility is variable over time is also important, as are their requirements. Therefore, it is important to select smart technologies that are adaptable and adjustable to changing criteria.

CONCLUSION

The accommodation for disabled residents occupying intelligent buildings has undergone progressive development in the last decade. In the early stages of intelligent buildings design, the environment was limiting for these users, especially in terms of controlling and managing advanced technologies. Nowadays, the development of technology design and applications is also oriented towards users with specific needs. Intelligent buildings enable users with specific needs to improve the quality of life and prolong living in their own homes.

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