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Design of Residential Spaces with Consideration for People with Special Needs

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Abstract. This article analyzes the key principles of organizing the residential physical environment for individuals who use wheelchairs. Contemporary architecture is increasingly oriented toward creating comfortable and inclusive spaces; however, for millions of wheelchair users, the lack of adequate comfort and safety within residential settings remains a pressing issue. People with special needs are still often perceived and treated as individuals with «limited abilities» due to environmental barriers. Designing buildings that can be used by individuals of all ages and health conditions should become one of the primary directions in architectural practice. The urgency of creating an inclusive environment stems from the growing recognition of the need to humanize the built environment for those facing temporary or permanent physical limitations. Adapting residential spaces to meet the needs of such individuals requires particular attention, as it directly impacts their quality of life. Many residential buildings, including those in Kazakhstan, fail to meet contemporary accessibility standards. This is evident in features such as narrow doorways and thresholds, the absence of ramps and specialized handrails, and other architectural shortcomings that restrict mobility and hinder the social integration of people with disabilities. Despite legislative efforts to address these challenges, the situation remains problematic in both older and newly constructed buildings. This study explores the principal challenges and proposes potential solutions aimed at creating an accessible and inclusive environment for individuals with musculoskeletal impairments.

Keywords: *barrier-free environment, adaptation for wheelchair users, inclusive design, social isolation and autonomy, accessibility.*

1. Introduction

The creation of a barrier-free environment for wheelchair users is a critical step toward building an inclusive society in which every individual, regardless of physical limitations, can lead a fulfilling and autonomous life. One of the primary challenges faced by people with limited mobility is the lack of accessibility in public facilities and residential spaces, which prevents them from maintaining a full and active lifestyle. This, in turn, often leads to psychological issues caused by social isolation.

A partial solution to these challenges lies in the implementation of universal design principles, adaptive furniture, and smart home technologies, all of which can significantly enhance the quality of life for wheelchair users [4]. The analysis of successful architectural and design practices from various countries provides a basis for developing concrete recommendations for the design of inclusive residential environments. These solutions aim to improve the daily living conditions of individuals with disabilities, facilitate their social integration, and increase their level of independence.

2. Materials and methods

For this study, it is proposed to conduct an analysis of case-based design projects, as well as a survey of individuals with severe musculoskeletal disorders and their family members, followed by a synthesis of the results.

When analyzing the layout of a typical residential building that is not adapted to the needs of people with limited mobility (Figure 1), several aspects can be identified that require modification:

- Narrow doorways, which are unsuitable for wheelchair passage;
- Lack of ramps, elevators, or specialized lifting devices, which significantly hinders movement to and within the building, particularly between different levels;
- Restricted spaces, which do not allow for wheelchair turning and are further complicated by barriers such as thresholds and inconveniently opening doors;
- Furniture and equipment arrangement that fails to consider the needs of individuals confined to a wheelchair, creating additional obstacles to movement and rendering many elements unusable without external assistance.

Possible Solutions for Eliminating Identified Deficiencies

The first critical area of improvement is the building entrance, where it is essential to install gently sloped ramps with an incline not exceeding 5 degrees, along with the use of lifting platforms or elevators in multi-level buildings. Additionally, sufficiently wide doorways with automatic or sliding mechanisms should be implemented to ensure unimpeded access.

As for interior spaces, key solutions include widening corridors and doorways, eliminating thresholds, and using level, seamless flooring throughout. An open-plan layout—minimizing interior partitions and maximizing fluid, inter-

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connected spaces—is particularly aligned with the principles of a barrier-free environment.

Figure 1. Floor plan of a residential building

For bathrooms and toilets, accessible design can include walk-in, curb-free showers with floor drainage systems, non-slip floor coverings, the installation of grab bars, and height-adjustable sinks and toilets [5].

In terms of technical equipment, priority should be given to the automation of basic daily functions. For example, automated curtain systems, lighting controls, extendable wardrobe shelves, and voice-activated commands can significantly ease daily tasks. The so-called smart home system has the potential to address many challenges faced by individuals with limited mobility; however, its high cost makes it inaccessible for many.

A more budget-friendly alternative for adapting residential spaces to the needs of people with limited mobility may include the use of voice assistants, smart plugs, and Wi-Fi-enabled lighting systems, all of which can be controlled remotely.

From a psychological perspective, living in a space that is not accessible for free movement in a wheelchair often leads to emotional discomfort, increased stress, and a sense of helplessness in individuals with special needs. The constant necessity to rely on others for assistance significantly undermines self-confidence and fosters a feeling of dependency [6].

Moreover, the inability to leave one's home independently due to the absence of a barrier-free environment contributes to the social isolation of people with physical disabilities, further exacerbating their psychological and emotional challenges.

These significant issues require targeted solutions, of which at least three key approaches can be identified:

- Fostering autonomy through the design of residential spaces that enable individuals to independently perform essential daily tasks such as cooking, laundry, and remote work;
- Applying an inclusive and personalized approach to the selection and arrangement of equipment, particularly in households where one family member has special needs;
- Incorporating the social dimension into residential design by allocating areas for social interaction, hosting guests, and working from home.

A classic example of successful home adaptation is the Laurent House, designed by Frank Lloyd Wright for Ken Laurent, a World War II veteran who was paralyzed from the waist down. Wright was truly ahead of his time, designing a residence that met all the specific needs of a wheelchair user—based on direct input from Laurent himself, who described in detail what was required for comfortable living.

Among the client's requests were lowered placement of door handles and light switches, widened doorways, and level flooring throughout the home. In addition, the spatial organization of the interior was designed to allow unobstructed wheelchair movement without the need to shift furniture or ask guests to move out of the way—an essential feature for maintaining both functionality and dignity [7].

Accessibility considerations were evident even in the landscape design of the property. The house featured a spacious driveway that ensured easy access (Figure 2). True to Wright's architectural philosophy, which emphasized harmony between the built environment and the natural world, the Laurent House was no exception. It was seamlessly integrated into the surrounding landscape, appearing to blend effortlessly into the lush greenery.

Figure 2. Kenneth Laurent House

In the spatial organization of the Kenneth Laurent House, Wright experimented for the first time with an elliptical form, which—combined with extensive glazing—provided panoramic views of the surrounding nature and ample natural light throughout the interior (Figure 3). This design approach enhanced not only the microclimate within the home but also contributed significantly to the psychological well-being of its occupant.

The wide corridors, open floor plan, and abundance of unobstructed space ensured comfortable and unimpeded movement for a wheelchair user, demonstrating a thoughtful integration of form, function, and accessibility.

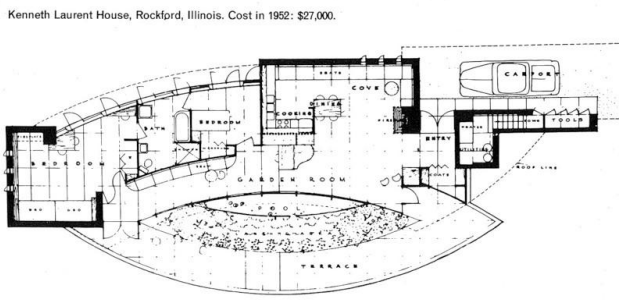


Figure 3. Kenneth Laurent House

Throughout the entire house, there are no thresholds or other physical barriers separating its various areas. The meticulously considered design illustrates how architecture can genuinely empower a person with a disability by providing a sense of freedom and independence—something that conventional design solutions often fail to achieve (Figure 4).

For the comfortable living of the family, the house includes three bedrooms and two bathrooms. Particular attention was given to ergonomics. For instance, in Ken's room, shelves are installed at a height accessible from a seated position, and the

countertop is designed without a lower support, allowing a wheelchair to roll underneath without obstruction.

The corner panorama of the master bedroom provides a strong visual connection with the natural surroundings, creating a unique sense of openness and integration with the environment (Figures 5 and 6).

Figure 4. The patio of Laurent's house

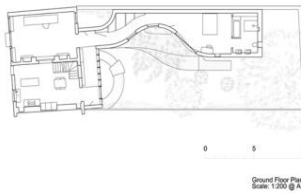
Figure 5. Kenneth Laurent's wheelchair in his Frank Lloyd Wright-designed house

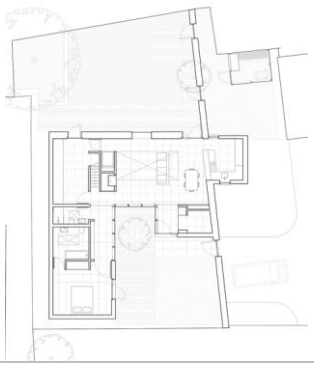
Figure 6. The bedroom of Laurent's house

It is also important to note that this work by Frank Lloyd Wright marked a true breakthrough in the design of environments accessible to individuals with physical limitations. It laid the foundation for accessible design principles long before any official standards were introduced—indeed, such standards were not formally adopted in the United States until forty years later.

By creating a home that was both aesthetically unique and functionally adapted to the needs of a person with limited mobility, Wright not only met the specific requirements of his client but also inspired architects and designers around the world to reimagine how inclusive environments could be created.

Table 1. Inclusive design solutions

object	object photo	planning organization	ways to adapt
«Tree house», London The authors: 6a architects	 [8]		Ramps, Wide Doorways, and Flowing Spaces
Inclusive House, Hampshire Authors: Ayre Chamberlain Gaunt.	 [9]		Height-Adjustable Kitchen Surfaces, Automatic Doors, and Designated Parking Spaces
Residential house «Maison Bordeaux», Japan Author: Rem Koolhaas	 [10]		Smart Home System, Spacious Interiors, Three-Level Design with Lift Platform, Sliding Roof, and Transparent Second Floor Connecting with Nature

Orchard House, Wiltshire, England The authors: Studio Octopi	 [11]		Threshold-Free Layout, Elevator for Vertical Circulation, and Barrier-Free Access to the Garden

3. Results and discussion

The analysis of these case studies formed the foundation for the reconstruction and adaptation project of a residential home designed to accommodate the needs of a person with disabilities and their family (Figures 7, 8).

The project proposes the removal of interior partitions to widen doorways and expand shared spaces. A key modification includes the relocation of the opening between the kitchen-living area and the hall, facilitating easier wheelchair access to the terrace. This revised layout not only improves mobility but also enables clear functional zoning between the kitchen and living areas within the open-plan space.

In addition to shared living areas, the first floor includes a dedicated home office designed specifically for the resident who uses a wheelchair. The hallway expansion makes it possible to install a vertical platform lift connecting the first and second floors (Figures 9, 10).

Bathrooms have been enlarged and equipped in accordance with the needs of a person with limited mobility, incorporating accessibility features such as grab bars, roll-in showers, and height-adjustable fixtures to ensure safety and independence.

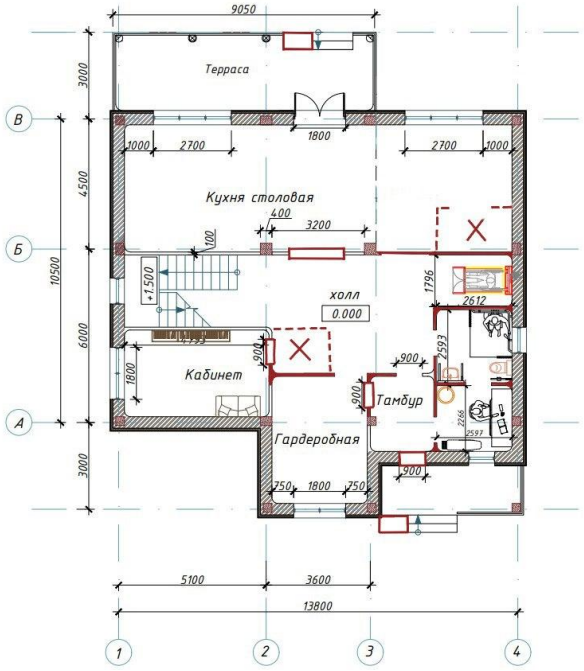


Figure 8. First floor plan after adaptation

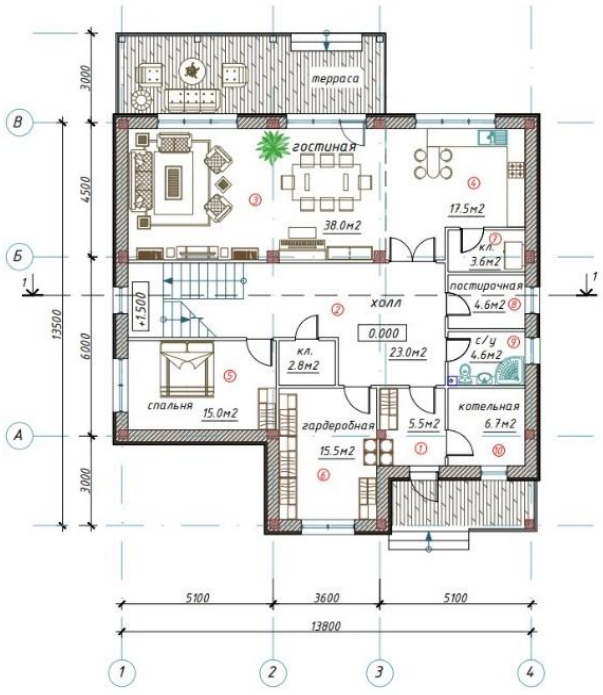


Figure 7. First floor plan before adaptation

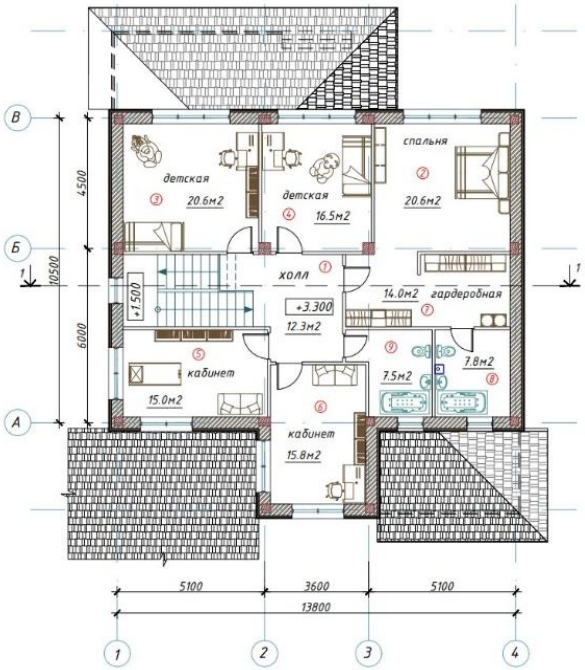


Figure 9. Second floor plan before adaptation

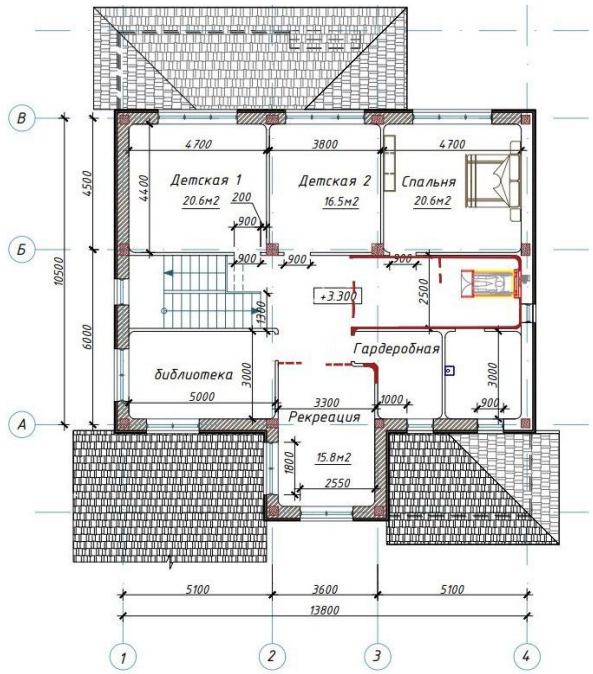


Figure 10. Second floor plan after adaptation

The project includes a reconfiguration of the bedroom area, involving the removal of the walk-in closet to improve maneuverability for a wheelchair user and to accommodate the installation of a lifting platform.

Wall corners have been rounded, and doorways widened to reduce obstacles and ensure safe, fluid circulation. By partially demolishing interior partitions, the design creates a more open and accessible space, enhancing freedom of movement throughout the room.

Additionally, for both shared areas and private rooms used by the wheelchair-using resident, custom furniture is being developed. This furniture is specifically designed for comfortable and functional use from a seated position, ensuring ease of access to storage, work surfaces, and daily household tasks.

4. Conclusions

Undoubtedly, the creation of an inclusive environment for people with disabilities is, above all, about establishing the conditions necessary for their independent, comfortable, and fulfilling life. The example of the house designed by Frank Lloyd Wright for Kenneth Laurent demonstrates how a carefully considered architectural approach can profoundly improve the quality of life for individuals with limited mobility, ensuring not only their physical comfort but also their emotional and social well-being.

The essence of inclusive design lies not merely in dividing spaces into adapted and non-adapted zones, but in creating a unified, accessible, and harmonious environment for all users [6]. Drawing on international best practices, several key principles of universal design can be identified, including:

- Intuitive usability,
- Appropriate dimensions and proportions,
- Flexibility and simplicity in use,
- Minimization of physical effort, and
- Organization of space that facilitates ease of movement.

However, the most important aspect remains the accommodation of the individual needs of all residents. In each case, design solutions must be highly personalized.

For instance, while many of Frank Lloyd Wright's innovations for the Laurent House are exemplary, not all are universally applicable. One such feature—the lowered ceiling, intended to align with the visual perception of a seated person—may, in practice, cause discomfort for other family members due to the resulting sense of spatial compression. This highlights the need for balanced, context-specific solutions that promote inclusivity without compromising the comfort of other users.

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Ерекше қажеттіліктері бар адамдардың тұруын ескере отырып, тұрғын үй кеңістігін ұйымдастыру

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Аңдатпа. Мақалада мүгедектер арбасында жүретін адамдар үшін пәндік-кеңістіктік өмір сүру ортасын ұйымдастырудың негізгі принциптері талданады. Қазіргі заманғы сәулет жайлы орта құруға бағытталған, алайда миллиондаған мүгедектер арбасына таңылған адамдар үшін тұрғын үй кеңістігінде қажетті жайлылық пен қауіпсіздіктің болмауы өзекті мәселе болып қала береді, ал ерекше қажеттіліктері бар адамдар «мүмкіндігі шектеулі адамдар» болып қала береді. Кез келген жастағы және денсаулық жағдайындағы адамдар пайдалана алатын ғимараттарды жобалау сәулет тәжірибесіндегі маңызды бағыттардың бірі болуы керек. Инклюзивті ортаны құру мәселесі денсаулықтың уақытша немесе тұрақты шектеулеріне тап болғандар үшін оны ізгілендіру қажеттілігі туралы хабардарлықтың артуына байланысты. Мұндай адамдар үшін тұрғын үйді бейімдеу мәселесі ерекше назар аударуды қажет етеді, өйткені бұл олардың өмір сүру сапасына тікелей әсер етеді. Көптеген тұрғын үйлер, соның ішінде Қазақстанда, қол жетімділіктің заманауи стандарттарына сәйкес келмейді, бұл тар есіктер мен табалдырықтарда, пандустар мен арнайы тұтқалардың болмауында, сондай-ақ мұқтаж адамдардың қозғалысы мен әлеуметтік бейімделуін шектейтін басқа да сәулеттік кемшіліктерде көрінеді. Осы мәселелерді шешу үшін заң шығарушылардың күш-жігеріне қарамастан, ескі және жаңадан салынған ғимараттарда жағдай күрделі болып қала береді. Бұл жұмыста тірек-қимыл аппараты проблемалары бар адамдар үшін қол жетімді орта құруға бағытталған негізгі проблемалар мен оларды шешудің мүмкін нұсқалары қарастырылған.

Негізгі сөздер: *кедергісіз орта, мүгедектер арбасына бейімделу, инклюзивті дизайн, әлеуметтік оқшаулау және автономия, қол жетімділік.*

Организация жилого пространства с учётом проживания людей с особыми потребностями

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Аннотация. В статье анализируются ключевые принципы организации предметно-пространственной жилой среды для людей, передвигающихся на инвалидных колясках. Современная архитектура ориентирована на создание комфортной среды, однако для миллионов инвалидов-колясочников, отсутствие необходимого комфорта и безопасности в жилом пространстве остаётся актуальной проблемой, а люди с особыми потребностями, остаются «людьми с ограниченными возможностями». Проектирование зданий, которые могут быть использованы людьми любого возраста и состояния здоровья, должно стать одним из важнейших направлений в архитектурной практике. Проблема создания инклюзивной среды обусловлена растущим осознанием необходимости гуманизации ее для тех, кто сталкивается с временными или постоянными ограничениями по здоровью. Проблема адаптации жилья для таких людей требует особого внимания, ведь она напрямую влияет на качество их жизни. Многие жилые дома, в том числе в Казахстане, не соответствуют современным стандартам доступности, что проявляется в узких дверных проемах и порогах, отсутствии пандусов и специальных поручней, а также, других архитектурных недочетах, ограничивающих передвижение и социальную адаптацию тех, кто в этом нуждается. Несмотря на усилия законодателей, предпринимаемые для решения этих проблем, ситуация остаётся сложной как в старых, так и во вновь возводимых зданиях. В данной работе рассмотрены основные проблемы и возможные варианты их решения, направленные на создание доступной среды для людей, имеющих проблемы с опорно-двигательным аппаратом.

Ключевые слова: *безбарьерная среда, адаптация для инвалидов-колясочников, инклюзивное проектирование, социальная изоляция и автономия, доступность.*

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