European Research Studies Journal
Volume XXVIII, Issue 4, 2025

pp. 1277-1297

Analysis of the Accessibility of Public Facilities Using the AuditOmate Application

Submitted 19/09/25, 1st revision 04/10/25, 2nd revision 26/10/25, accepted 30/11/25

Adam Zwoliński[1], Katarzyna Krasowska[2], Agnieszka Olejnik-Krugły[3], Bartłomiej Małachowski[4]

Abstract:

Purpose: *The aim of the research presented in this article was to conduct an individual and comparative analysis of the accessibility of six public institutions in Poland - local city and commune buildings. The scope of the analysis included assessing compliance with architectural, information-communication, and digital accessibility requirements in each of the examined facilities, as well as comparing the overall level of accessibility provided in offices serving residents of different municipalities and towns. An additional objective was to carry out a pilot study using the proprietary AuditOmate tool, developed for the purposes of conducting accessibility audits.*

Approach/Methodology/Design: *The presented research and the developed tool align in their assumptions with the principles of universal design and accessibility. Methodologically, the study is based on an individual and comparative analysis of the examined public buildings, using a custom-developed digital tool - the AuditOmate application. The structure and methodology of the application's operation process are presented in detail in the article.*

Findings: *The pilot studies on the accessibility of public utility buildings conducted in 2022–2023 using the AuditOmate application confirmed the relevance of employing digital tools to support the auditing process. The analysis of six facilities indicated an overall moderate level of accessibility, with significant discrepancies across the three assessment modules. Architectural accessibility was moderately ensured (49%), information and communication accessibility proved to be the weakest area (27%), while the highest level of compliance was recorded in the field of digital accessibility (73%). The results highlight the need for further development of auditing tools and for more in-depth actions aimed at improving accessibility.*

Practical Implications: *The presented research has two aspects of practical application. The digital tool AuditOmate was tested within the pilot studies and can subsequently be used by various public institutions and other entities to conduct accessibility audits of their facilities. The data from the accessibility reports generated by the application may serve as a basis for developing general policies or specific actions aimed at ensuring accessibility for persons with*

[1]*Dsc., PhD., Arch., West Pomeranian University of Technology in Szczecin, Poland*
Faculty of Architecture, Accessibility Knowledge Centre IDM,
e-mail: adam.zwolinski@zut.edu.pl;
[2]*Prof., WPUT, PhD., Arch., the same as in 1, e-mail: katarzyna.krasowska@zut.edu.pl;*
[3]*PhD., West Pomeranian University of Technology in Szczecin, Poland,*
Faculty of Computer Science and Information Technology
e-mail: agnieszka.olejnik.krugly@zut.edu.pl;
[4]*PhD., the same as in 3, e-mail : bartlomiej.malachowski@zut.edu.pl;*

disabilities.
Originality/Value: *The pilot study presented in the article was conducted using the dedicated mobile application AuditOmate, developed by a team of researchers from the West Pomeranian University of Technology in Szczecin, Poland. The application is an innovative digital tool that supports the measurement and analysis of accessibility. The conducted research provides significant value for the development of accessibility-related topics, as it enables comparative analyses of the accessibility of various institutions at both the general level and in detailed, issue-specific areas.*

Keywords: *Accessibility, architecture, AuditOmate, mobile applications, public institutions, disabilities.*

JEL codes: *C83, C88, O31, O35, O36, Q55.*

Paper type: *Research article.*

1. Introduction

According to the World Health Organization report (WHO, 2021), approximately 16% of the global population (equivalent to 1.3 billion people worldwide) experience some form of disability. Every fourth citizen of the European Union is a person with a disability, and more than 48% of them are older adults aged over 65 (European Disability Forum, 2022).

The population of the European Union is steadily aging, and the risk of permanent loss of functional abilities due to non-communicable diseases or injuries continues to increase. As a result, the number of persons with disabilities will systematically rise in the coming decades. It affects economies and social development.

The accessibility of public spaces and public utility buildings is a fundamental right of every person, as guaranteed by both international and national legal acts, including the UN Convention on the Rights of Persons with Disabilities (United Nations, 2006) and the European Accessibility Act (European Commission, 2021).

These regulations ensure equal access to goods and services, including transport, education, and culture, with the European Accessibility Act (European Parliament & Council of the European Union, 2019) serving as the key legal basis in this area.

In the United States, since the 1990s, accessibility has been regulated by the Americans with Disabilities Act (ADA) (United States Congress, 1990), which has become a reference point for many subsequent global accessibility standards. In Poland, the primary legal act governing accessibility is the Act on Ensuring Accessibility for Persons with Special Needs (Polish Journal of Laws, Dz.U. 2019, poz. 1696), which obliges public institutions to ensure architectural, digital, and information-communication accessibility.

These requirements are supplemented by executive acts, including the Regulation of the Minister of Infrastructure on the technical conditions that buildings and their location must meet, as well as the Accessibility Standards for architectural, digital, and information-communication accessibility for public institutions (Polish Ministry of Funds and Regional Policy, 2021) and the Accessibility Standards in Local Government (Polish Ministry of Interior and Administration *et al.,* 2023).

Accessibility concerns not only the surrounding space but also the buildings and equipment. Public utility buildings are a particularly important aspect of accessibility for persons with disabilities, as they bring together numerous and diverse groups of users. Ensuring accessibility in public buildings is one of the foundations of modern social and spatial policy, both in Poland and worldwide.

Accessibility is not solely a matter of technical, pro-accessibility solutions, but above all the implementation of constitutional principles of equality and the right to participate in social life. Ensuring accessibility is therefore not only a technical requirement, but also an expression of the principles of equality, participation, and the right to social inclusion (Imrie, 2012; Lid, 2017).

The importance of accessibility is growing alongside increasing awareness that public utility buildings (schools, universities, offices, libraries, sports facilities, transport hubs, and healthcare institutions) play a key role in social integration. Their design must take into account the needs of people with mobility, sensory (vision, hearing), intellectual, or mental disabilities and provide accessibility solutions such as step-free circulation, accessible restrooms, visual and auditory information systems, Braille signage, and features supporting spatial orientation.

An indispensable element of an effective accessibility implementation policy is the evaluation of existing public utility buildings as well as the design solutions for newly constructed facilities. Evaluation makes it possible to eliminate barriers, adapt spaces to the evolving needs of users, and ensure compliance with legal requirements. The need to streamline, improve, and standardize evaluation procedures highlights the importance of developing and implementing tools for in-situ accessibility assessment, including digital solutions and dedicated applications.

The implementation of universal design (UD) principles requires systematic evaluation of existing buildings and public spaces, as well as the assessment of new investment projects. Evaluation allows for the identification of barriers and the introduction of corrective measures that ensure compliance with current norms and standards (Steinfeld and Maisel, 2012). Increasingly, these processes are supported by digital tools that enable comprehensive and comparable in-situ accessibility audits (Marques *et al.,* 2021).

The article presents a pilot study using a custom-developed tool for the comprehensive assessment of the accessibility of buildings and their surroundings. AuditOmate is a web and mobile application designed to measure accessibility and provide individualized analysis of the results. It was created to support public and non-public institutions in implementing the provisions of the Act on Ensuring Accessibility for Persons with Special Needs (Polish Journal of Laws, Dz.U. 2019, poz. 1696).

The application enables the assessment of a building and its surroundings through three modules aligned with the categories defined in the Act: architectural accessibility, information and communication accessibility, and digital accessibility. The analysis presented in the article is based on accessibility reports generated according to a custom set of access criteria and user needs.

The aim of the research presented in this article was to conduct both individual and comparative analyses of the accessibility of six public utility buildings serving as local municipal and commune offices. Such facilities are expected, in accordance with legal requirements, to provide exemplary accessibility for diverse user groups with special needs.

The objective of the individual analysis was to examine in detail the fulfillment of architectural, information and communication, and digital accessibility parameters in each of the buildings studied, whereas the purpose of the comparative analysis was to assess the overall level of accessibility provided in offices serving residents of different municipalities and towns. An additional aim was to carry out a pilot study using the custom-developed AuditOmate tool designed for this type of analysis.

The research questions stated for this study were:

RQ1: *What is the overall level of the three main types of accessibility in each of the buildings studied?*
RQ2: *Which specific accessibility parameters present the greatest challenges in ensuring accessibility in the six selected public utility buildings?*
RQ3: *Is it possible to use digital tools to measure and analyze accessibility for persons with special needs, and can such tools effectively support the process of increasing accessibility in public utility buildings?*

2. Literature Review

The concept of Universal Design (UD) was developed by a team led by R. Mace at the Center for Universal Design (1997). Its aim is to create environments that are friendly and accessible to the widest possible range of users, regardless of age, ability, or functional limitations (Steinfeld and Maisel, 2012).

The implementation of universal design takes into account diverse local conditions. At both the international and national levels, numerous norms, regulations, and standards exist concerning universal design and design for all, including: the American ADA Act (United States Congress, 1990), the British BS/ISO standards for built environment accessibility (British Standards Institution, 2019), Norwegian universal design guidelines (Norwegian Ministry of Children, Equality and Social Inclusion, 2010), Irish accessibility standards developed by the CEUD/NDA (Centre for Excellence in Universal Design, 2014), and German DIN standards for barrier-free design and accessibility (DIN, 2016).

Today, universal design is understood not only as a set of technical principles but also as a social and ethical process based on the ideas of equality and inclusion (Imrie, 2012; Persson *et al.,* 2015). Lid (2017) emphasizes the need for flexibility in applying UD principles in the context of diverse user needs, while Hamraie (2017) analyses accessible design in the context of "spatial politics" and the agency of persons with disabilities.

Jones and Imrie (2014) as well as Froyen (2012) emphasize the importance of interdisciplinarity and user participation in the design process, which constitutes a key condition for the effective implementation of UD in practice. Marques, McIntosh, and Goonetilleke (2021) highlight the connections between UD and the Smart City concept, in which digital technologies support the development of inclusive urban spaces.

In the context of accessibility assessment methods, tools such as the Multidimensional Assessment System for the Built Environment (Iwarsson and Ståhl, 2003), the Disability Inclusion Evaluation Tool (UNESCAP, 2017), the Disability Inclusion Performance Index (Preiser and Ostroff, 2001), and the Social Criteria of Green Building Assessment Tool (Su and Chang, 2020) are used. Selected aspects of accessibility are also incorporated into sustainable development certification systems, including LEED (USGBC, 2021), BREEAM (BRE Global, 2016), and WELL (IWBI, 2020).

Inclusive design is not limited to public spaces. Its principles are also applied in the design of digital systems and user interfaces. In User Experience (UX) methodology, it is emphasized that tools and technologies can help remove barriers if they are created with the diverse needs of users in mind.

These principles are also important in the context of tools used to assess the accessibility of the physical environment, as the application interface affects how auditors collect and record data in the field. Research has repeatedly shown that the quality of the interface directly impacts task performance: intuitive systems reduce errors, shorten completion time, and increase user engagement (Nielsen, 1994; Hornbæk, 2006).

The UX methodology includes, among other elements, user analysis, interaction design, prototyping, and usability testing, allowing for the systematic improvement of digital tools. The theoretical foundations, derived from cognitive psychology and ergonomics, form the basis of modern interface design. Norman (1988) introduced the concept of "affordances" as cues inherent in the design of interface elements that suggest possible actions to the user. Similarly, Nielsen (1994) developed usability heuristics, which remain one of the most widely used sets of principles for interface evaluation.

Although interface design is not the main focus of this article, the UX literature provides important theoretical frameworks for understanding how tools such as AuditOmate can support the accessibility audit process enabling more accurate and consistent data collection in real-world environments.

In Polish research on universal design and accessibility, the work of I. Benek occupies a particularly important place, developing the issue of design standards from a practical perspective. Benek (2020) analyses the needs of older adults in the context of public space design, emphasizing the necessity of combining universal design principles with the characteristics of the cultural and natural environment.

In subsequent publications, the author (Benek, 2021) highlights the importance of clear and practical guidelines for the accessibility of people with mobility impairments, which form the foundation for implementing pro-accessibility solutions in architecture. Furthermore, Ujma-Wąsowicz and Benek (2021) expand this perspective to the urban level, presenting field studies on barriers in public spaces and methods for assessing accessibility.

A significant contribution to research on the implementation of universal design principles in Polish cities is also made by the work of A. Szewczenko. Szewczenko (2021) analyses the potential applications of universal design in spa town spaces, emphasizing the role of accessibility as a component of urban environmental quality.

In a subsequent publication, the author (Szewczenko, 2022) presents innovative tools for assessing accessibility used in revitalization processes, highlighting the need for systematic methods to diagnose public spaces. Together with Krasowska, Szewczenko and Krasowska (2023) further develop the concept of the Human Smart City, integrating universal design with the idea of intelligent urban development and sustainable mobility.

Parallel to research on the physical environment, studies on digital accessibility and measurement tools are rapidly developing, including those conducted by the Simulatorium of Accessibility WPUT team. In the work of Krasowska and Zwoliński (2022), the authors highlight the potential of digital technologies including mobile applications and geolocation in assessing the accessibility of public spaces and streamlining research processes. Zwoliński (2023) presents the application of accessibility analysis methods using the example of the international event Expo 2020, emphasizing the importance of comprehensive tools for assessing accessibility in modern exhibition spaces.

The latest research by Zwoliński, Krasowska, Juzyszyn, and Freidenberg (2024) focuses on the analysis of tactile guidance systems from the perspective of blind users, proposing an integrated and practical approach that combines design methods, user testing, and measurement technologies.

The work of these authors emphasizes the growing need for tools that enable comprehensive, multidimensional accessibility assessment, encompassing the architectural, digital, and information-communication environments. They also highlight the importance of in-situ research, data-driven diagnostics, and the integration of the design process with the real experiences of users.

3. Methodology

The obligation to ensure architectural, information-communication, and digital accessibility in public finance sector units, as mandated by the Accessibility Act in Poland, places buildings such as municipal and commune offices at the forefront of facilities that should provide exemplary accessibility for persons with special needs.

These offices are the primary point of public contact where city residents handle most matters related to daily functioning in society. For the purposes of a pilot accessibility study using the dedicated mobile application AuditOmate, six municipal office buildings located in small towns in western Poland were selected: Suchań, Barlinek, Gryfino, Stargard, Goleniów, and Przelewice (Figure 1).

Small town commune buildings were chosen due to their limited investment capabilities, which make ensuring accessibility a much greater challenge compared to larger urban centers. The population of the selected towns ranges from 1.400 to 66.000 inhabitants. The audited facilities vary in size and functional-spatial layout, influenced, among other factors, by the number of employees and potential clients, residents.

The buildings represent different construction periods and architectural styles. For example, the office in Stargard (06) is located in a historicist building, whereas the town hall in Gryfino (02) and Goleniów (04) are modern, post-war structures. The surroundings of the buildings are also diverse. Most of the buildings (01, 02, 03, 04, 06) are situated directly on streets with direct access from the street zone, and have minimal exterior grounds associated with the building.

Methodologically, the study is based on individual and comparative analyses of the examined buildings using a custom-developed AuditOmate application. For the studied buildings, the analysis was designed to cover architectural, information-communication, and digital accessibility on an individual basis for each building, using individually defined accessibility parameters, as well as a comparative analysis at both the general and detailed levels.

Figure 1. *Exterior views of the examined public utility buildings (01–06)*

01 Location: Suchań, Poland
Population: 1.395
Building: Municipal Office

02 Location: Przelewice, Poland
Population: 5.115
Building: Commune Office

03 Location: Barlinek, Poland
Population: 12.878
Building: Municipal Office

04 Location: Gryfino, Poland
Population: 19.646
Building: Town and Commune Office

05 Location: Goleniów, Poland
Population: 21.370
Building: Commune and City Office

06 Location: Stargard, Poland
Population: 66.272
Building: Municipal Office

Source: *Authors.*

4. AuditOmate

The presented study was conducted using the dedicated digital tool AuditOmate, designed for carrying out comprehensive accessibility audits of buildings and their surroundings for persons with special needs.

AuditOmate is a free-access application, developed in 2022 by the Simulatorium of Accessibility team at the West Pomeranian University of Technology in Szczecin (ZUT) as part of the Knowledge Center for Accessibility project in Szczecin, carried out in cooperation with the University of Szczecin and funded by the National Centre for Research and Development (NCBR).

The application is available in both web and mobile versions for Android devices. Due to commercial and licensing constraints, on the iOS platform the application must be run in its web version. The AuditOmate tool is available at https://sd-audit.zut.edu.pl. To ensure an optimal user experience, the tool was implemented as a progressive web application (PWA).

This approach made it possible to provide a range of key functionalities, such as offline operation, access to the device's camera, and seamless integration with popular mobile operating systems Android and iOS. Access to the application is protected through a user authentication and registration process. The application was developed in a Polish language version, and a multilingual version is planned for future release.

Figure 2. *Logos of the AuditOmate application and the Simulatorium of Accessibility (ZUT laboratory within which the application was developed).*

Source: *Authors.*

The substantive structure of the tool follows the legally defined types of accessibility, offering three selectable audit modules: Architectural Accessibility, Information and Communication Accessibility, and Digital Accessibility. This division is also reflected in the application's logo. In the process of auditing buildings and their surroundings, a concept of division into four zones was proposed:

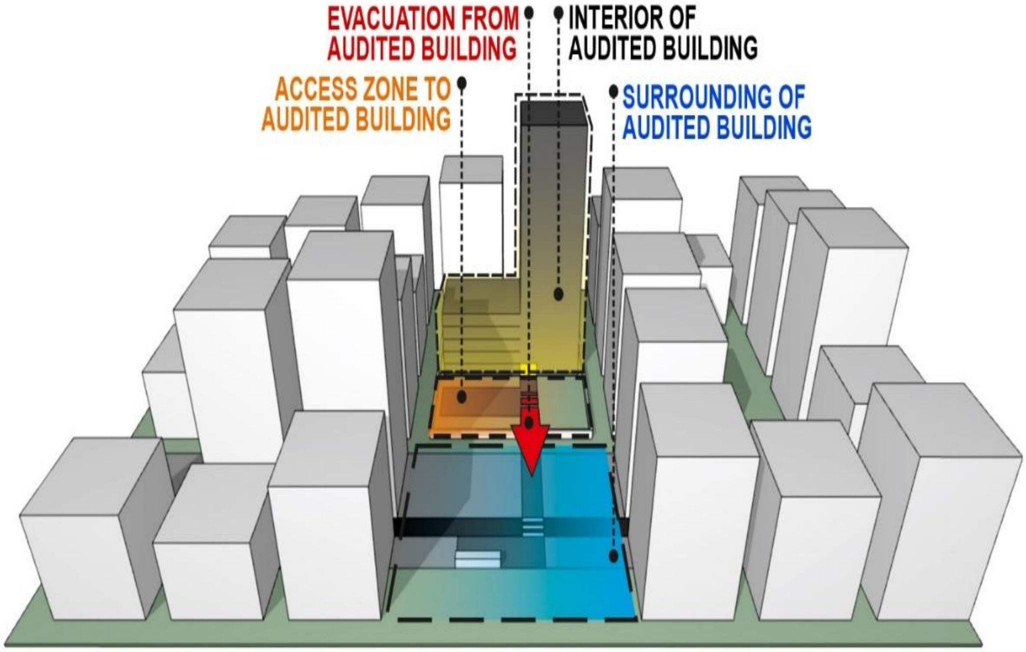
Surroundings of the audited building – accessibility parameters of urban spaces between the audited area and the city's public transportation;

Access zone to the audited building – accessibility parameters of the publicly accessible area around the building, from entry to the institution's grounds to entry into the building;

Interior of the audited building – detailed accessibility parameters of rooms, equipment, signage, horizontal and vertical circulation, and other pro-accessibility solutions;

Evacuation from the audited building – parameters of evacuation solutions from the perspective of accessibility for persons with disabilities.

Figure 3. *Diagram of zones in the auditing process in AuditOmate.*

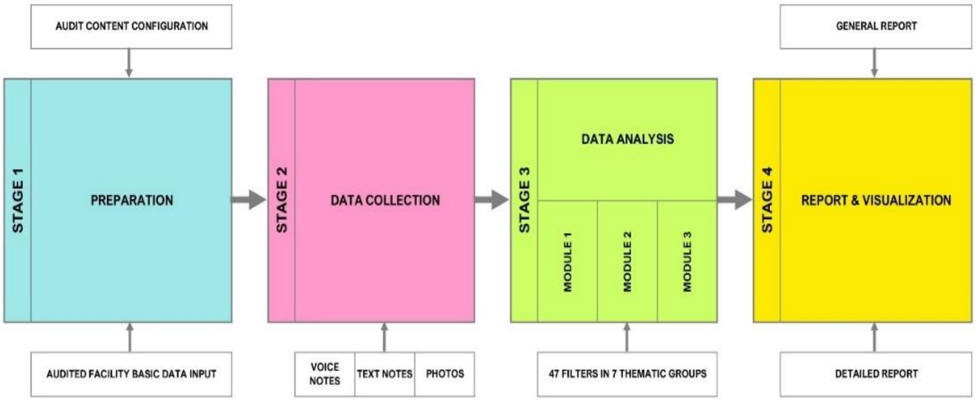


Source: *Authors.*

AuditOmate is based on the concept of four sequential stages in the auditing process: Preparation – Data Recording – Analysis – Reporting. The final outcome of the auditing process is an audit report linked to a dedicated database of supplementary data collected during the in-situ audit. The AuditOmate application offers the following auditing functionalities:

- individual filtering of results and accessibility parameters;
- generation of general and detailed reports based on selected filters;
- recording of voice and text notes;
- adding photos associated with specific audit parameters;
- exporting results in report form;
- compliance of the user interface with WCAG standards, ensuring digital accessibility of the application for persons with disabilities.

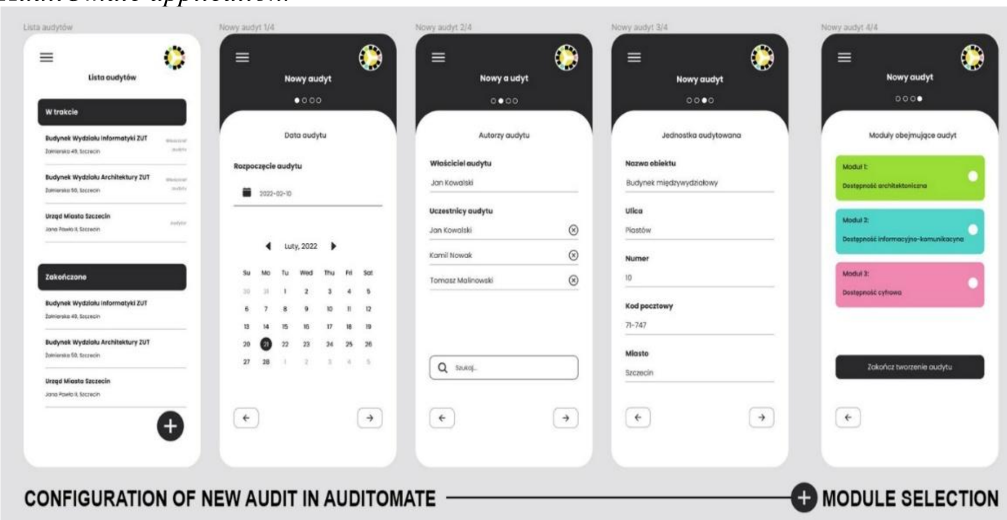
Figure 4. *Diagram of the auditing process in the AuditOmate application.*



Source: *Authors.*

In the preparation stage, basic information about the audited institution and building is entered, and the scope of the audit is defined through the selection of accessibility audit modules. Geolocation data of the audited facility is also entered.

Figure 5. *Defining the scope of the audit (3 modules) – screenshot from the AuditOmate application.*

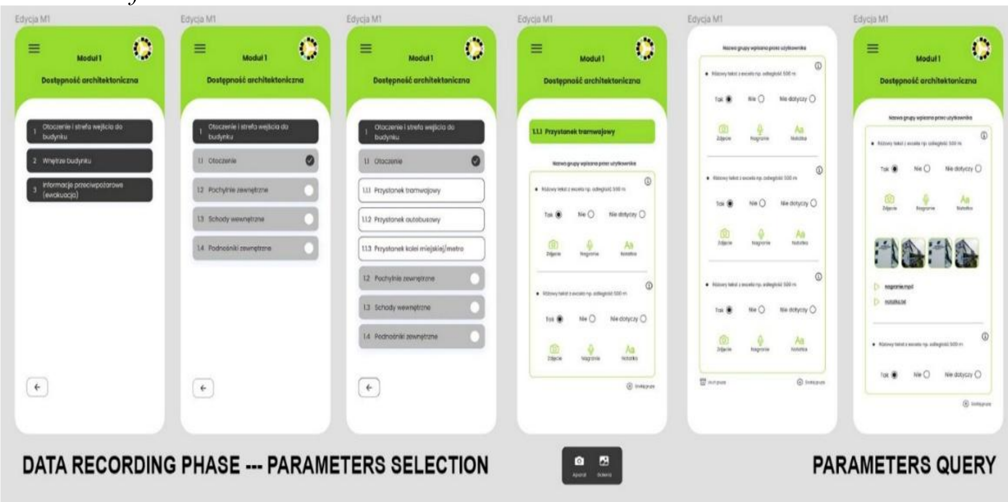


Source: *Authors.*

Data recording is based on a hierarchical set of questions regarding the accessibility parameters of the building and its surroundings, completed in situ by the auditor during the auditing process. The questions cover the assessment of over 600 accessibility parameters. This process is supported by the ability to add text and voice notes, as well as photos related to individual parameters.

The parameter database is editable and easy to update in the event of changes to regulations or accessibility standards.

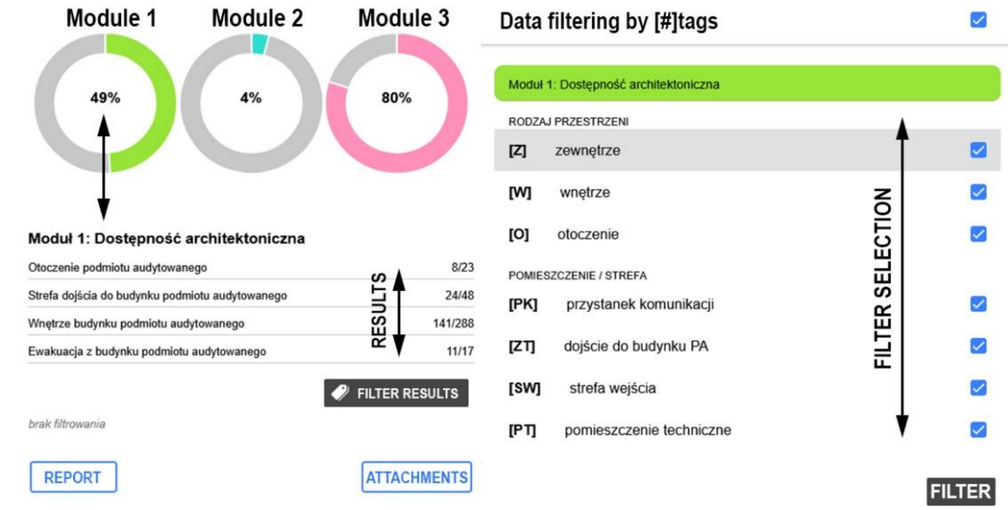
Figure 6. *Data recording phase. Query system for accessibility parameters – screenshot from AuditOmate.*



Source: *Authors.*

In the analysis phase, AuditOmate offers, within the three audit modules, 47 result personalization filters across seven thematic groups (type of accessibility, type of audited space, type of disability, rooms, building equipment elements, and others). The filters can be freely configured by the user.

Figure 7. *Screens for visualization and personalization of results – screenshot from AuditOmate.*



Source: *Authors.*

The final stage of the auditing process is reporting, which involves generating a synthesized accessibility report consisting of general and detailed sections of the audit. The report can be generated in .PDF format or as an editable .XLS file, and an additional database containing notes and photos can be generated in a .ZIP format. Accessibility statistics are visualized in the report as charts showing the percentage of compliance with the required accessibility parameters.

The AuditOmate application was developed in accordance with general user-centered design (UX) principles and WCAG 2.1 accessibility guidelines. The interface provides intuitive navigation, a clear information structure, and compatibility with assistive technologies, facilitating efficient data collection during field audits. Although detailed design solutions are not the main focus of this study, attention to usability and accessibility allowed for the consistent and reliable use of the tool across all analysed buildings.

The basis for defining the technology stack used to build the AuditOmate application was the identification of non-functional requirements. These requirements make it possible to determine the constraints within which the application must operate and shape the overall user experience. Following an analysis of needs, the following set of key requirements was defined:

- the application should operate and provide full functionality on mobile devices such as smartphones and tablets, regardless of their type or mobile operating system;
- the user interface should ensure a high level of usability, taking into account the characteristic features and limitations of mobile devices (limited screen size, touch interface, etc.);
- data collected and processed within the application must be stored securely and persistently on a server and be immediately accessible to other application users;
- the application should utilize the mobile device's camera to capture photographic technical documentation;
- the application must provide user authentication and authorize access to the data stored within the system;
- the application should function correctly during intermittent loss of internet connectivity (offline mode).

The identified requirements listed above indicated that the appropriate development model for the application is a two-tier client–server architecture, in which the client is a browser-based Single Page Application (SPA) and the server is a REST web service providing access to data and ensuring its persistent storage in a database. This model meets the core expectations for the application, particularly with respect to accessibility regardless of the type of mobile device or the parameters and size of its screen (i.e., responsive user interface design).

Access to the application does not require installation and is limited to conveniently opening the application's website. At the same time, implementing Progressive Web App (PWA) features enables the application to be permanently installed within the operating system and used in a manner similar to native mobile applications.

A key consideration was ensuring the security and confidentiality of stored data. Audit records and their photographic documentation are stored on a secure server and protected by a range of security mechanisms commonly applied in web applications, such as cryptographic SSL/TLS certificates (Secure Socket Layer / Transport Layer Security), server-side request authorization using JSON Web Tokens (JWT), and user passwords stored in encrypted form using cryptographic hashing functions. In addition, access to data for application users is regulated by a permissions system that manages visibility and access rights to audit information.

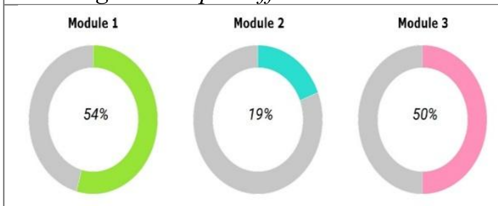
5. Research Results and Discussion

As part of the conducted pilot study, comprehensive accessibility audits of six selected public utility buildings and their surroundings were carried out using the AuditOmate application, covering three accessibility modules: architectural, information and communication, and digital.

Regardless of the detailed results regarding the accessibility of the audited buildings, the study primarily demonstrated the strong justification for implementing and using digital tools to support accessibility audits. The use of the AuditOmate mobile application allowed comprehensive audits of the selected buildings to be conducted in situ within a single several-hour data collection session for each building.

Traditional methods would require at least several days for analysing building documentation and collecting and organizing data, assuming such documentation is available. While additional measurement tools are still required for some detailed parameters, the application's use demonstrated unequivocally that the auditing process can be significantly streamlined.

Figure 8. *Overview of general accessibility levels in the six audited buildings for modules 1, 2, and 3 – visualization of statistics in the AuditOmate application.*

<table>
<tr><td>01 Location: Suchań, Poland
Building: Municipal Office</td><td>02 Location: Przelewice, Poland
Building: Commune Office</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>03 Location: Barlinek, Poland
Building: Municipal Office</td><td>04 Location: Gryfino, Poland
Building: City and Commune Office</td></tr>
</table>

05 Location: Goleniów, Poland
Building: Commune and City Office

06 Location: Stargard, Poland
Building: Municipal Office

Source: *Authors.*

The overall picture of accessibility levels emerging from the conducted pilot study indicates that the audited buildings exhibit an average level of architectural accessibility (Module 1), significant deficiencies in information and communication accessibility (Module 2), and a relatively good level of digital accessibility (Module 3). Translating this into statistics, the average overall level of accessibility in the audited institutions is exactly 50%. Architectural accessibility is at 49%, information and communication accessibility at 27%, and digital accessibility at 73% (Figure 8).

Table 1. *Summary of the detailed accessibility parameter assessment results for the audited buildings, organized by modules and main accessibility areas – analytic data from the AuditOmate application.*

	ACCESSIBILITY AREAS	SUCHAŃ		PRZELEWICE		BARLINEK		GRYFINO		GOLENIÓW		STARGARD		
		01		02		03		04		05		06		AVG
module I	1. Surroundings of the audited facility	14/26	54%	12/55	22%	9/23	39%	8/23	35%	11/24	46%	11/25	44%	**40%**
	2. Access zone to the audited building	24/34	71%	13/25	52%	21/48	44%	24/48	50%	37/51	73%	25/45	56%	**57%**
	3. Interior of the audited building	120/233	52%	169/463	37%	45/196	23%	141/288	49%	124/217	57%	97/173	56%	**46%**
	4. Evacuation from the audited building	10/17	59%	7/21	33%	10/21	48%	11/17	65%	12/18	67%	9/20	45%	**53%**
module II	1. Communication with the client	2/7	29%	2/7	29%	1/7	14%	1/7	14%	1/7	14%	4/7	57%	**26%**
	2. Client Service Point (POI)	0/1	0%	0/5	0%	1/5	20%	0/5	0%	3/5	60%	1/5	20%	**17%**
	3. Information on the Website	2/2	100%	2/2	100%	2/2	100%	0/2	0%	0/2	0%	0/2	0%	**50%**
	4. Procedures & Staff Qualifications	0/11	0%	4/11	36%	0/9	0%	0/7	0%	5/10	50%	1/11	9%	**16%**
module III	1. Perceptibility	4/11	36%	12/13	92%	9/11	82%	11/14	79%	7/15	47%	8/11	73%	**68%**
	2. Functionality	7/14	50%	12/15	80%	8/14	57%	9/12	75%	5/14	36%	13/14	93%	**65%**
	3. Understandability	3/4	75%	5/5	100%	1/5	20%	6/6	100%	5/5	100%	5/6	83%	**80%**
	4. Compatibility	2/3	67%	3/3	100%	2/3	67%	2/3	67%	2/2	100%	2/3	67%	**78%**

Source: *Authors.*

The level of compliance with accessibility parameters in Module 1 is largely due to the fact that the largest number of parameters (over 500) pertains to this module. The wide variation in specific issues across the audited buildings contributes to the "flattening" of results at a level of 50% of architectural accessibility parameters being met. Notable results include values of 23% and 33% in the group of parameters related to the interior of the building, in the Barlinek (03) and Przelewice (02) buildings.

In building 02, the lowest score was also recorded in the group of parameters concerning building evacuation (33%). Architectural accessibility of the surroundings of building 02 also proved highly problematic, with a score of 22% (Table 1). One of the more pronounced accessibility issues in the surroundings of building 02 is the lack of parking adapted to the needs of persons with disabilities.

Accessibility facilitation in the information and communication aspect (Module 2) proved to be a significant challenge for all audited buildings. For various groups of issues related to information and communication accessibility, zero compliance with the parameters was recorded in all buildings. The low level of compliance with accessibility parameters in Module 2 is particularly striking, as the costs (especially financial) are likely lower than, for example, construction works related to architectural adaptations. A contributing factor here may be the low awareness of this type of accessibility.

Notable results in Module 2 include zero scores for three buildings (01, 02, and 04) in the group of parameters related to the existence and organization of an accessible Customer Service Point. Parameters related to communication with clients also proved problematic in buildings 03, 04, and 05, which achieved a score of 1/7 parameters met (14%).

One of the most important issue groups in information and communication accessibility is the level of awareness and training of staff in the audited buildings regarding accessibility. Buildings in Suchań (01), Barlinek (03), and Gryfino (04) scored 0% for these parameters. Even in building 06, located in the largest urban center (Stargard, 66.000 inhabitants), parameters concerning staff procedures and qualifications were met at a level of only 1/11 (7%).

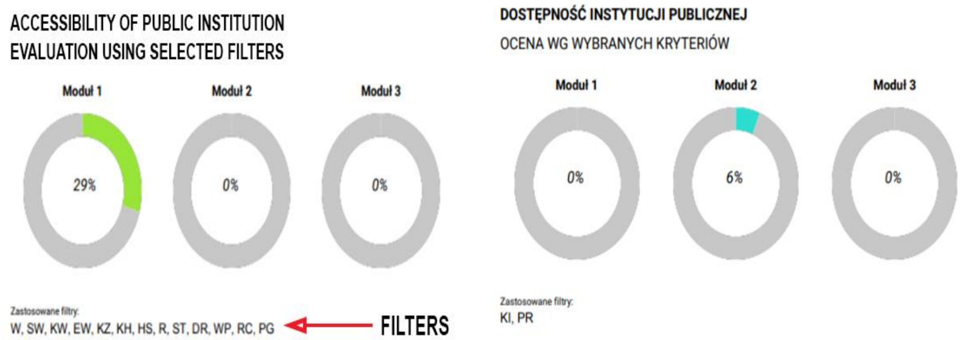
Digital accessibility was a positive surprise in the conducted study, as all audited institutions met over 65% of the defined digital accessibility parameters (Module 3). The results are additionally encouraging given that some of the audited buildings are located in small urban centers, where access to the latest digital technologies may be limited. Buildings 02, 04, and 06 performed particularly well, with Module 3 results exceeding 80% of accessibility parameters met (Table 1).

It is worth noting that these buildings are located in urban centers of different sizes. In the group of parameters related to Understandability, three institutions achieved the maximum score of 100% (02, 04, and 05), and in the Compatibility group, two institutions achieved similarly high results (02 and 05). The positive outcomes in digital accessibility may be influenced by the existence of standardized digital content accessibility guidelines (WCAG, ADA, ISO, etc.) commonly followed by IT professionals. Additionally, in most cases, websites and other digital content are produced by professional entities specializing in internet services.

The AuditOmate application also offers the functionality to customize analyses and statistics related to accessibility. This option includes over 40 filters, which can be individually configured after completing the data recording procedure. For any selected filter sets, accessibility statistics and reports can be generated.

To demonstrate the capabilities of the AuditOmate tool in the study, a series of thematic reports were generated, each linked to different aspects of accessibility. This allows for precise specification of the accessibility area that needs to be analysed at a given moment. Below, two examples of applying different filter sets for building 03 are presented (Figure 9).

Figure 9. *Visualization of accessibility statistics generated for building 03 using two different sets of personalized filters – screenshots from AuditOmate.*



Source: *Authors.*

In the first case (Figure 10, on the left), the focus was broadly on mobility impairments and communication within the audited building. The following detailed filters related to architectural accessibility were applied: W – interior, SW – entrance zone, KW – vertical circulation, EW – evacuation routes, KZ – external circulation, KH – horizontal circulation, HS – sanitary facilities, ST – stairs, R – mobility impairment, WP – equipment, DR – doors, RC – reception, PG – flooring.

The result was generated in Module 1 (the selected parameters belong to this module), and the audit showed 29% of the required parameters met. In the second case, the focus was on a narrow scope of Module 1 concerning staff procedures and qualifications, as well as client communication facilities. Only two filters were selected for this purpose: KI – communication with clients, and PR – procedures and staff. The result of 6% (1/16) reflected the overall trend of a low level of information and communication accessibility, influenced in part by the lack of staff training in accessibility and service for people with disabilities. Below are examples of issues that were covered during the audit (building 03) (Figure 11).

Figure 10. *Examples of inaccessible solutions in building 03 regarding internal communication within the building. Photo: A. Krasowska*

Source: *Authors.*

The following case of building 01 concerned a broader set of accessibility issues, and the analysis applied 16 accessibility parameter filters covering all three AuditOmate modules (Figure 11).

Figure 11. *Example of filtering a wide range of accessibility parameters across different accessibility modules – screenshot from AuditOmate. Examples of an inaccessible reception and vertical circulation in building 06 in Stargard (photo: S. Lewkowicz).*

Source: *Authors.*

6. Conclusions, Proposals, Recommendations and Perspectives

The results of the pilot accessibility audits of public buildings conducted using the AuditOmate application confirmed the high value of developing and using digital tools to support the accessibility auditing process in all its aspects. The findings demonstrated that solutions utilizing web and, in particular, mobile technologies significantly reduce the time required to conduct an audit while simultaneously increasing the accuracy of collected data, and they provide unlimited possibilities for subsequent analysis and customization of accessibility statistics.

AuditOmate also enables real-time in situ analysis, which constitutes a significant added value compared to traditional methods based on design documentation or paper checklists. However, the developed application does not replace the auditor's responsibility for accurate measurements using classical measurement tools (e.g., laser distance meter, contrast meter, etc.).

It does, however, open possibilities for future integration of the application with mobile measurement tools embedded in mobile devices (e.g., LIDAR scanner, laser distance meter, etc.). The flexibility and simplicity of updating the accessibility parameter database used by AuditOmate is another argument for utilizing a tool adapted to current standards and regulations.

The average level of accessibility provision across the six analyzed buildings was 50%, highlighting discrepancies between the three audit modules. The pilot study showed that architectural accessibility (Module 1) was provided at a moderate level (49% of parameters met), information and communication accessibility (Module 2) was the most problematic (27%), while digital accessibility (Module 3) achieved the highest results in the study (73%).

The distribution of results indicates that the largest deficits concern "soft" aspects, such as staff competencies, visual information solutions, building signage, and communication with clients. In this area, the key factor is primarily improving the awareness of public institutions and implementing practical procedures and training in accessibility.

The relatively high level of digital accessibility demonstrates that the internationally defined standards in this domain (e.g., WCAG 2.1, ISO, ARIA, ADA) facilitate the implementation of solutions consistent with universal design principles. Based on this, it can be inferred that developing and implementing similar standards (a current trend in the accessibility field) for other types of accessibility could produce comparable results in the future. However, this remains a challenging task due to cultural and geopolitical differences.

Methodologically, AuditOmate proved to be an effective research tool and a support for the process of measuring accessibility with the aim of improvement. The structure of the application, based on three modules, allows for a comprehensive approach to accessibility auditing, covering spatial, organizational, and digital aspects. Potential directions for further research using AuditOmate include:

- conducting accessibility studies for buildings with different functions (e.g., educational, medical, cultural facilities) and performing comparative analyses across various socio-economic sectors;
- integrating the tool with GIS environments for mapping and visualizing accessibility;
- developing functionalities and automating analyses and recommendations, e.g., through the use of AI;
- adding educational and training components.

The pilot studies confirm that the development of applications such as AuditOmate represents a valid direction for the advancement of tools supporting inclusivity and universal design. The structure of the tool allows for continuous development and adaptation to the needs and expectations of the environment. In the future, the wider implementation of such solutions has the potential to improve accessibility and, consequently, the quality of public spaces.

References:

Benek, I. 2020. Przestrzeń dziedzictwa kulturowego i przyrodniczego 60+. In: Labus, A. (ed.) Dostępność na plus. TRITIA.

Benek, I. 2021. Standardy dostępności w odniesieniu do potrzeb osób z niepełnosprawnością ruchową. Przewodnik Projektanta, 3, 42-46.

BRE Global. 2016. BREEAM New Construction Technical Manual. Watford: BRE.

British Standards Institution. 2019. BS ISO 21542:2011+A1:2019 – Building construction – Accessibility and usability of the built environment. London, BSI.

Centre for Excellence in Universal Design. 2014. Building for Everyone: A Universal Design Approach. National Disability Authority, Dublin.

Centre for Universal Design. 1997. The Principles of Universal Design. NC State University.

DIN. 2016. DIN 18040-1: Construction of accessible buildings – Publicly accessible buildings. Berlin: Deutsches Institut für Normung.

Dz.U. 2019 poz. 1696. 2019. Ustawa z dnia 19 lipca 2019 r. o zapewnianiu dostępności osobom ze szczególnymi potrzebami.

European Commission. 2021. Union of Equality: Strategy for the Rights of Persons with Disabilities 2021-2030. Brussels, European Union.

European Parliament & Council of the European Union. 2019. Directive (EU) 2019/882 on the accessibility requirements for products and services (European Accessibility Act). Official Journal of the European Union, L151, 70-115.

Froyen, H. 2012. Universal Design: Principles and Models. Hasselt University.

Hornbæk, K. 2006. Current practice in measuring usability: Challenges to usability studies and research. International Journal of Human-Computer Studies, 64(2), 79-102.

Imrie, R. 2012. Universalism and equitable access to the built environment. Disability & Rehabilitation, 34(10), 873-882.

Iwarsson, S., Ståhl, A. 2003. MASBE – A Multidimensional Assessment System for the

Built Environment. Technology and Disability, 15(2), 71-87.
IWBI – International WELL Building Institute. 2020. WELL Building Standard v2. NY.
Jones, P., Imrie, R. 2014. Design and the Built Environment: Interdisciplinary Perspectives. Routledge.
Krasowska, K., Zwoliński, A. 2022. Accessible City: Digital tools for accessibility analysis. Space & Form, 52, 33-48.
Lid, I.M. 2017. Universal design and the challenge of diversity. Scandinavian Journal of Disability Research, 19(3), 150-159.
Marques, J., McIntosh, A., Goonetilleke, R. 2021. Universal design and smart urban systems. Cities, 116, 103275.
Ministerstwo Funduszy i Polityki Regionalnej. 2021. Standardy dostępności architektonicznej, cyfrowej i informacyjno-komunikacyjnej dla instytucji publicznych.
MSWiA, FIRR, PFRON & Śląski Związek Gmin i Powiatów. 2023. Standardy dostępności w samorządzie.
Nielsen, J. 1990. 10 Usability Heuristics for User Interface Design. Available at: https://www.nngroup.com/articles/ten-usability-heuristics.
Nielsen, J. 1994. Usability Engineering. Morgan Kaufmann.
Nielsen, J., Molich, R. 1990. Heuristic evaluation of user interfaces. In: Proceedings of ACM CHI Conference, 249-256.
Norman, D.A. 2013. The Design of Everyday Things. Basic Books.
Norwegian Ministry of Children, Equality and Social Inclusion. 2010. Norwegian Universal Design Principles. Oslo.
Persson, H., Åhman, H., Yngling, A.A., Gulliksen, J. 2015. Universal design, inclusive design, accessible design. Universal Access in the Information Society, 14(4), 505-526.
Preiser, W.F.E., Ostroff, E. 2001. Universal Design Handbook. McGraw-Hill.
Su, C.H., Chang, T.Y. 2020. Social Criteria of Green Building Assessment Tool. Sustainability, 12(14), 5632.
Szewczenko, A. 2021. Projektowanie uniwersalne w przestrzeniach uzdrowisk. Politechnika Śląska.
Szewczenko, A. 2022. Innowacyjne narzędzia do oceny dostępności w procesach rewitalizacji. Środowisko Mieszkaniowe, 31, 45-56.
Szewczenko, A., Krasowska, K. 2023. Human Smart City – model integracji UD i inteligentnego miasta. Zeszyty Naukowe Politechniki Śląskiej, 72, 89-102.
UNESCAP. 2017. Disability Inclusion Evaluation Tool. Bangkok.
United Nations. 2006. Convention on the Rights of Persons with Disabilities (CRPD). New York: UN.
United States Congress. 1990. Americans with Disabilities Act of 1990 (ADA). Public Law 101-336. Washington, D.C.
USGBC – U.S. Green Building Council. 2021. LEED v4 for Building Design and Construction.
Web Content Accessibility Guidelines (WCAG) 2.1. 2023. W3C Recommendation 21 September 2023. Available at: https://www.w3.org/TR/WCAG21/.
World Health Organization. 2021. World Report on Disability. Geneva, WHO.
Zwoliński, A. 2023. Dubai Expo 2020 – Accessibility Analysis. Space & Form 56, 25-40.
Zwoliński, A., Krasowska, K., Juzyszyn, W., Freidenberg, M. 2024. Tactile guidance systems from the perspective of blind users. Space & Form, 60, 41-57.