**Original Scientific Paper**

# E-ACCESSIBILITY – DIGITAL PLATFORM
# FOR IMPROVING THE ACCESSIBILITY
# OF URBAN ENVIRONMENTS IN THE REPUBLIC OF SERBIA

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**Abstract**. *In this work author deals with the modeling of the e-platform as a decision-support tool for improving the accessibility of urban areas in the Republic of Serbia. This research systematizes, analyzes and compares existing national and international practices, regulations and norms on the topic of accessibility. Through the research of existing knowledge and good practices and through field research, a theoretical setting of the platform model and an algorithm for calculating the current state of physical accessibility are created, on the example of an adequate statistical theoretical sample taken in the Republic of Serbia (territory of the city municipality of Stari grad of the city of Belgrade). The method for priority decision-making, intervention and application of Universal Design principles in the urban and physical environment in Serbia is presented through interdisciplinary and multi-institutional use of e-platforms. The e-platform model formed in this way will serve as a decision-making aid for all stakeholders, and will enable the current state of accessibility to be displayed in real time, and the approaches and methods in urban and architectural planning and design to be adjusted for more efficient application of Universal Design. This research aims to prove that if we create an e-platform that is accessible to all actors and the public, and data is collected in real time on the spatial components of accessibility, but also on the subjective components of the actors, then conditions are created for the optimization of the management of actions in order to improve accessibility in urban areas.*

**Key words**: *E-platform, universal design, accessibility, inclusion, physical environment*

## 1. INTRODUCTION

The result of modern planning and design must be a space that is accessible to everyone (B.R., C., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Vanderheiden, G., 1997). The design of each physical environment affects the quality of life of the entire population of each settlement. Active and full inclusion of all citizens in social life brings multiple economic and social benefits. In a society of equal citizens, all public facilities and spaces are adapted to persons with certain mobility impairments and persons with disabilities. All facilities and meeting places must have the same standards and must be adapted and designed to allow accessibility, regardless of the planned number of visitors (Belausteguigoitia, J., 2019).

However, in many cities in the world, including cities in our country, complete physical accessibility to public contents is not possible, neither in a physical nor in a functional sense (CA., 2007). From the perspective of sustainable urban development, the key issue is how to establish an adequate social mechanism that would ensure efficient and permanent action in order to overcome physical obstacles and improve physical accessibility for all social categories. One of the conditions for the successful implementation and realization of urban and architectural projects is that as many different users as possible can use the planned spaces and facilities (which leads to a greater number of potential users, economic profit, social equality and happiness) (Galvagno, M., & Dalli, D., 2014). Numerous researchers state that in order to achieve accessibility in urban areas, it is necessary that the planned urban and architectural environment has, from the very beginning until the execution, the integrally applied principles of Universal Design.

The impetus for the research was given by many years of dealing with the subject of accessibility in academic studies, as well as after studies within the framework of several different scientific and professional projects realized in the context of Serbia (Лаловић, К., Кажић, И., Михајлов, В., Дрљача, М., & Петровић, Ф. (2018), Лаловић, К., Чолић, Р., Михајлов, В., Петровић, Ф., Бугарски, Ј., Ђорђевић, А., . . . Кузмановић, М. (2019)) . Also, the life and experience of coexistence with people with different psychophysical limitations in moving through space contributed to the enthusiasm to explore more deeply the possibilities of practical application of the concept and principles of Universal Design, integrally in the entire process from planning to the realization of the space, and not afterwards, very often as forced and a formal solution.

Contribution to a greater inclusiveness of the society through enabling the physical accessibility is recognized as one of the national priorities in the Republic of Serbia. However, the analyzes of the state of accessibility of settlements and cities in Serbia have shown that the practice of managing urban areas should be improved in order to become more effective in implementing policies and strategies for improving physical accessibility.

The state of physical accessibility of the existing built stock is not recorded, and the monitoring of physical accessibility in planned urban areas through the procedures of urban and architectural planning and design has not been established. The lack of control measures and the absence of mechanisms for determining the application of measures to ensure physical accessibility, starting from the highest order planning documents and ending with the use permit for the facility, prevents the future built stock and newly planned urban areas from being used by all users (PC.,2021). Within the framework of numerous national documents and on the basis of conducted preliminary research, it was concluded that interventions on the existing built stock are also necessary, in order to take into account the specific needs of

different groups of users. These restoration interventions would have to be targeted and strategically thought out in order to have an effect for the greatest number of beneficiaries. Our country, like many richer countries (European Commission., 2022) does not have adequate capacities and means to solve all existing problems of physical accessibility at the same time. The lack of information about the actual state of physical accessibility of urban areas in the Republic of Serbia leads to local and often dispersed interventions in the space, which have the effect of improving the lives of a small number of users (Лаловић, К., Кажић, И., Михајлов, В., Дрљача, М., & Петровић, Ф., 2018). The lack of information support for strategic decision-making in the field of improving the physical accessibility of spaces in cities results in the omission of burning points from the perspective of people's daily life needs (United Nations. (2016).

Based on the experience of living with people with impaired and limited mobility, as well as the research process of conducted studies (Лаловић, К., Кажић, И., Михајлов, В., Дрљача, М., & Петровић, Ф. (2018), Лаловић, К., Чолић, Р., Михајлов, В., Петровић, Ф., Бугарски, Ј., Ђорђевић, А., Кузмановић, М., 2019) on the possibility of improving accessibility in Serbian cities, the problem of the impossibility of applying the principles of Universal Design due to the lack of an adequate information and communication platform (Лаловић, К., 2013) that would enable informed decision-making during the entire process was identified from planning to realization of space. That is, the one that would enable the involvement of all actors (competent institutions, investors and users) who are essential for their implementation in real time.

The basic initial theoretical hypotheses are:
▪ By using ICT tools based on GIS technologies, it is possible to create an e-platform that can be used to collect both qualitative and quantitative data on the physical accessibility of space.
▪ The use of such an e-platform enables the focusing of public actions to improve accessibility on priority zones in built-up urban areas, as well as the monitoring of funds at the local level through a reviewed overview, and the participation of all actors in creating solutions for a specific location. This creates decision-making support for the definition and implementation of accessibility corridors.

This work consists of eight chapters: introduction, research context, identification and mapping of stakeholders, e-platform modeling, experimental verification of the model, the e-platform pilot module, presentation of experiment findings and a conclusion that interprets the results of the experiment.

In the introductory chapter, the subject of the work is defined and the research is set in a research and theoretical framework with the scientific hypothesis set.

In the second chapter, briefly methodology steps and expected results are explained and counted.

In the third, fourth and fifth chapter, accessibility criteria and indicators are defined, the way of evaluating and rating accessibility, platform modules, user interface concept and visualization of accessibility characteristics display - personal location map, and sets the implementation process.

In the sixth and seventh chapter, the sample is defined, the selected pilot module of the platform and the results of the conducted experiment are presented.

In the final chapter, called the presentation of the state of accessibility, comparative analyses, syntheses, creation of graphs, statistics and other forms of research of the results are carried out, with the task and intention of analyzing the justification of the scientific

hypothesis and establishing premises and conclusions that can be interpreted and which can be the subject debates, and serve as a starting point for further scientific and research work.

This work will set up the model by induction of findings based on theoretical assumptions, critical analysis of the management mechanism and expressed needs of key actors through a structured interview. Model checking through:
- realization of an experimental pilot model for a selected sample of the territory
- analysis of interviews and surveys of all actors about the developed model - establishing a typology of the needs of all possible users
- Generation of conclusions based on all previous methodological steps and recommendations for further research

According to everything expressed before in this paragraph, this research aims to:
- Create an information communication model on the physical accessibility of built environments
- Experimentally examines the established e-platform, i.e. the pilot module of the platform on a selected sample - an urban environment
- Check the compliance of the conceptual setting of the e-platform model with the needs of all users (survey).
- Propose the process of e-platform development

## 2. RESEARCH CONTEXT

According to the Action Plan for the Implementation of the Strategy for Improving the Position of Persons with Disabilities in the Republic of Serbia for the Period from 2020 to 2024 (RS, 2018), the activities planned for the period from 2021 to 2022 focus on assessing and creating an environment which will effectively and economically ensure the implementation of the concept of universal design in urban areas. By implementing such activities, appropriate conditions will be created for Serbia to be ranked among those countries in Europe that advocate responsible social policy in the domain of accessibility of the physical environment (RS, 2021). The existing regulation, based on the principles of universal design, defines from a legal point of view the conditions for the unimpeded movement of persons with disabilities and persons with persons with certain mobility difficulties in all facilities.

However, physical obstacles in the everyday environment are not only a problem for people with a certain type of disability, but also for all people with reduced mobility, as well as those categories whose current needs require movement without physical obstacles. During the daily movement and use of public facilities and public areas in our country, the aforementioned categories face great challenges. Today, the removal of physical obstacles for the smooth movement of all persons has become imperative. We bear witness to the fact that a certain percentage of public institutions, from public, administrative to commercial facilities, were not designed or constructed in such a way as to meet the basic prescribed standards in terms of physical accessibility. Precisely for this reason, the need for continuous sustainable activities to remove all obstacles and improve general accessibility has been recognized.

Previously conducted studies (Лаловић, К., Кажић, И., Михајлов, В., Дрљача, М., & Петровић, Ф. (2018), Лаловић, К., Чолић, Р., Михајлов, В., Петровић, Ф., Бугарски, J.,

Ђорђевић, А., . . . Кузмановић, М. (2019)) have shown that, except in Belgrade, accessibility to the urban environment and the built stock is at a very low level, even for buildings of vital importance for the daily well-being of citizens. Also, due to the lack of information and visibility of the actual situation on the ground, individual interventions aimed at improving the accessibility of a certain urban area do not reach a large number of users who need it. The process of implementing accessibility solutions is not transparent, the most important stakeholders - people with disabilities - do not participate in it, and also this process is not systematic or comprehensive at the level of the entire country.

Based on further findings from the research, the author concluded that an integral approach to problem solving is an unavoidable starting point. With this approach, the importance of eliminating, not only physical obstacles, but all barriers that we as a society, as well as individuals, are faced with is indicated. The application of modern approaches to the application of the concept of Universal Design implies constant monitoring and detailed analysis of shortcomings and opportunities in the subject urban and architectural framework. Therefore, it is necessary to establish a social mechanism for the continuous collection, use and networking of all data that can positively or negatively affect the accessibility of the urban and architectural environment, in order to create the conditions for more efficient quality decision-making in the process of planning, organizing and controlling the improvement of physical accessibility. The establishment of such a social mechanism implies at the local level of management and the raising of capacities, skills and knowledge for collaborative and strategic planning and design, which in modern conditions implies the use of adequate ICT tools that enable a simple and comprehensible publicly accessible presentation of the database of all key places that are recognized as critical points, which disrupt and prevent safe and unhindered movement and use of all built spaces.

This conclusion is in accordance with the defined activity within the adopted Strategy for improving the position of persons with disabilities in the Republic of Serbia in the period from 2020 to 2024 (RS, 2020). In the period 2021-2022 year, the activity from the subject Strategy under the designation 1.1.1.5 is planned. - Stimulating the use of ICT in public procurement procedures, in order to facilitate access to information, jobs, education and public services and activities on affirmation (RS, 2020). As with the strategy of the National Infrastructure of Geospatial Data (NIGP), the priority is work on the formation and strengthening of the infrastructure, which, along with the fulfillment of the basic requirements and needs of citizens, but also of the public and private sector, by forming certain services, will enable support for quality and sustainable development of the environment, which will be aligned with economic development. The most important element of the success of NIGP implementation is that, through the successful collaboration of all involved entities, users are provided with immediate access to spatial data.

## 3. IDENTIFICATION AND MAPPING OF STAKEHOLDERS

In order for urban environments to be adequately planned and executed in accordance with the principles of Universal Design, it is crucial to identify and map all stakeholders who are important for that process, either from the point of view of decision-making, creation or later use and life in that urban environment.

Stakeholders to address accessibility must be from all sectors (public, civil, private and academia). According to the Rulebook (RS, 2015), accessibility focuses on public

purpose buildings, business buildings, residential and residential-business buildings with ten or more residential units. Associations through which persons with certain types of disabilities or mobility difficulties exercise their rights and express their needs are recognized as a group of primary users.

It is precisely the identification of users that represents the starting point for further elaboration and concretization in the very model of information ICT support for the improvement of physical accessibility. According to that structure, the conceptual formulation of the functionality of the e-platform is carried out.

The primary group of users of this information instrument are all persons who have problems with movement (Table 1) (RS, 2015), namely:

1) a person with a disability is a person with a physical, sensory or intellectual impairment who, due to barriers that exist in the environment, cannot move freely and use public areas, facilities for public use, residential and commercial buildings with ten or more apartments, including public transport and other services intended for the public (RS, 2015);

2) persons with reduced mobility are persons with physical or sensory disabilities, the elderly, pregnant women, and/or other persons whose ability to move freely is temporarily or permanently reduced due to barriers they encounter in the environment (RS, 2015);

According to the data of the Republic Institute of Statistics from 2011, in Serbia 4.7% (approximately 340,000 people) of the total population have some form of permanently reduced movement abilities (Republički zavod za statistiku, 2011). In this sense, first of all, physical accessibility was considered.

The secondary group of users are employees within the public administration, i.e. all institutions that organize and control the implementation of the prescribed standards. This group includes all levels of the vertical and horizontal management structure, i.e. national and local entities (RS, 2015).

The third group of users are all professionals who perform the work of planning and designing space and territorial development. This group includes all institutions, organizations and public companies involved in the planning, organization, implementation and control of territorial development. Also, this group of users includes all academic institutions engaged in scientific and research work in the field of improving the concept of planning and management of territorial development in Serbia (RS, 2015).

The fourth group of users is the general public. This structure of users is only one of the possible ways of grouping, and the detailed structuring should be the result of a communicative process of a wider social discourse between all actors who define the purpose of this instrument, and consequently its functionality. The flexibility of modern technologies allows the complexity of user groups and functionality to increase over time, through the process of its use, which greatly facilitates initialization and implementation through pilot projects that are simpler to understand and organize (Lalović, 2013).

National laws, rules, regulations and documents identify only a part of those stakeholders, thereby reducing the perception of the seriousness of the problem of inaccessibility of urban areas, and also reduce the effect to a very narrow group of people, which is not adequate for everyday life. In order for the identification and mapping of all stakeholders to be comprehensive, national and international documents were reviewed, as well as examples of good practice (Lalović, et al., 2019).

Based on previously conducted research and in order to develop this platform, a detailed typology of users who belong to the primary group of users was created:

**Table 1** Overview of the level of cognitive abilities according to the type of users of the primary group (author)

| No. | Type of user of public space | mobility | independence | reasonableness | visual perception | auditory perception | orientation ability | self control | understanding the environment | emotional dissonance | personal safety | entourage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | PERSONS IN WHEELCHAIRS | 1 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 4 | 3 |
| 02 | PERSONS WITH MOBILE AIDS | 2 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 4 | 3 |
| 03 | PERSONS WITH CHRONIC DISEASES | 3 | 3 | 5 | 4 | 4 | 4 | 5 | 5 | 2 | 4 | 2 |
| 04 | PERSONS WITH NEUROLOGICAL DAMAGE | 3 | 4 | 5 | 5 | 5 | 4 | 3 | 5 | 2 | 4 | 2 |
| 05 | PERSONS WITH SIGHT IMPAIRMENT | 3 | 3 | 5 | 1 | 5 | 1 | 5 | 3 | 1 | 3 | 5 |
| 06 | PEOPLE WITH HEARING IMPAIRMENT | 5 | 5 | 5 | 5 | 1 | 4 | 5 | 4 | 1 | 5 | 1 |
| 07 | PERSONS WITH COGNITIVE IMPAIRMENTS | 4 | 2 | 2 | 5 | 5 | 3 | 2 | 2 | 4 | 2 | 5 |

| 08 | PERSONS WITH MENTAL ILLNESSES | 5 | 4 | 4 | 5 | 5 | 3 | 4 | 5 | 5 | 4 | 1 |
| 09 | PERSONS WITH LEARNING DISABILITIES | 5 | 3 | 4 | 5 | 5 | 3 | 3 | 3 | 4 | 3 | 4 |
| 10 | CHILDREN UNDER 7 YEARS | 5 | 1 | 5 | 5 | 5 | 3 | 4 | 4 | 1 | 2 | 5 |
| 11 | SENIORS OVER 65 YEARS OLD | 3 | 4 | 5 | 4 | 4 | 5 | 5 | 5 | 2 | 4 | 2 |
| 12 | PREGNANT WOMEN | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 4 | 1 |
| 13 | PERSONS WITH SMALL CHILDREN | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1 | 4 | 5 |
| 14 | PERSONS WITH TEMPORARY INJURIES AND | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 3 | 3 |

## 4. E-PLATFORM MODELING

### 4.1. Method of evaluation and assessment of accessibility

For all buildings, a universal scale was developed for displaying accessibility ratings in order to provide a clear graphic representation of the collected data (pictures). This scale is designed as a color scale, with bordeaux representing the lowest grade (completely unavailable) and green representing the highest grade (completely available). Each color has its own explanation:

▪ Bordeaux: the facilities are inaccessible in relation to the urban environment and the bus station, they are not designed according to standards that include the needs of people

with mobility impairments. Also, there is no possibility of entering those buildings (obstacles in the form of a large number of stairs, narrow entrances, etc.).

▪ Red: The facilities can be accessed from the outside and the nearest bus stop is accessible, but these facilities are not designed according to standards that include the needs of people with disabilities, there is also no possibility of entering them (obstacles in the form of a large number of stairs, narrow entrances, etc.).

▪ Orange: The facilities can be accessed from the outside and the nearest bus stop is accessible, but these facilities are not designed according to standards that include the needs of people with disabilities, an access ramp is provided at the entrances if there is a need for it. It also applies to facilities that are designed according to standards, but are poorly connected to the station and require personal transportation.

▪ Yellow: The facilities are accessible in relation to the urban environment and the bus station, the entrance to the facility or access to public facilities is enabled. The basic movement inside the facility has been adapted, but the contents and sanitary facilities have not been adapted.

▪ Green: The facilities are accessible in relation to the urban environment and the bus station, they are designed according to standards that include the needs of people with disabilities, an access ramp is provided at the entrances if there is a need for it. Communications and contents inside the facility are fully accessible.

Recorded items are displayed within the GIS application with standardized icons representing the degree of accessibility according to the defined scale. Also, appropriate symbolic images were selected for each of the sets of important tasks listed in Table 3 to facilitate the overview of geographic information. The goal is to organize the interactive map so that the views can be filtered by layers, giving the user the option to select a region or town, a specific type of central features, or to filter items based on their level of accessibility. In addition, data structured in this way would give other user groups the ability to analyze the distribution of usage and the level of physical availability achieved.

For example, institutions responsible for monitoring the implementation of prescribed standards would have access to information on the overall compliance of the building with the standards and could take appropriate measures. This potential is crucial when it comes to buildings that are privately owned but used by the public and is the only way to ensure compliance with standards through the issuance of a building permit and monitoring of the technical correctness of the building.

### 4.2. The concept of a physical accessibility assessment report of an individual element of an urban or architectural situation

For each individual building, or object of mapping, a standardized comparative display of the characteristics of the buildings according to accessibility criteria, called the "personal map of the location", was conceived (Fig.1). The personal map of the location, uniform A3 format, is divided into 3 parts:

1. Visual display
   ▪ access to the facility
   ▪ entrance to the facility
   ▪ movement in the building
   ▪ sanitary facilities, if any
   ▪ characteristic and contested places

2. Criterion display

According to the established accessibility criteria of the facilities, on the short sketches already defined in the application, all the accessibility criteria are shown with green and red dots in order to easily emphasize: what meets the requirements, what does not meet the requirements and what could not be determined.

3. Textual description of the facility and assessment of the facility in accordance with the established scale

- location, size, type (and all other relevant data)
- comment after mapping - conclusion or supplement with specific information that is not included in the mapping, but is important for the object
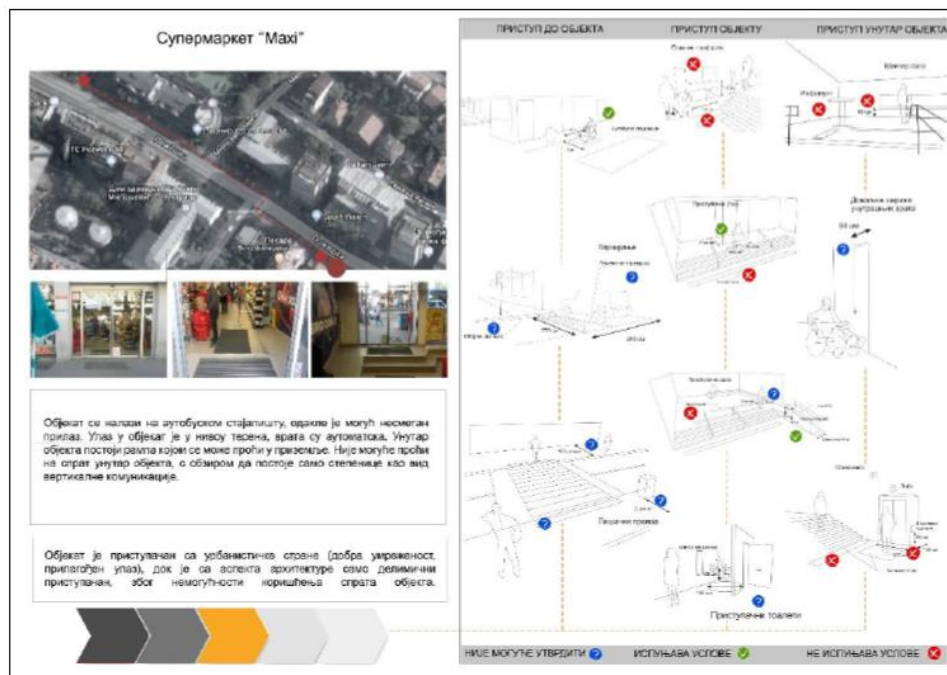- building rating on a scale



**Fig. 1** View of the completed "ID card" for an individual building (Lalović, Kažić, Mihajlov, Drljača, & Petrović, 2018)

### 4.3. Corridor (Zone) Level Physical Accessibility Assessment Report Concept

In order to better and more transparently display units in urban areas, "accessibility corridors" were formed (Fig. 2), that is, displays of entire streets with all mapped objects within them. Based on this, a table showing various contents is formed, statistics of the number of accessible and inaccessible buildings, the most common problem that occurs is singled out, as well as a separate display of access to the building, entrance to the building and accessibility in the building.

This type of data display helps to visualize smaller units of urban areas, facilitates systematic problem solving by stages, as well as enabling the formation of daily routes between different contents for the daily life of citizens and solving accessibility urgently within those routes.

By forming an accessibility corridor within one city, in one city municipality there are 30 streets, it would be possible, through the smallest possible spatial, financial and organizational intervention, to enable all citizens of that municipality, regardless of the degree of mobility difficulties, to use without any obstacles and difficulties daily routes.

Such a holistic approach to addressing accessibility at the level of large urban areas, through minimal interventions, and the maximum possible effect on the daily life of all citizens, is possible only with the application of the e-platform proposed by this research.
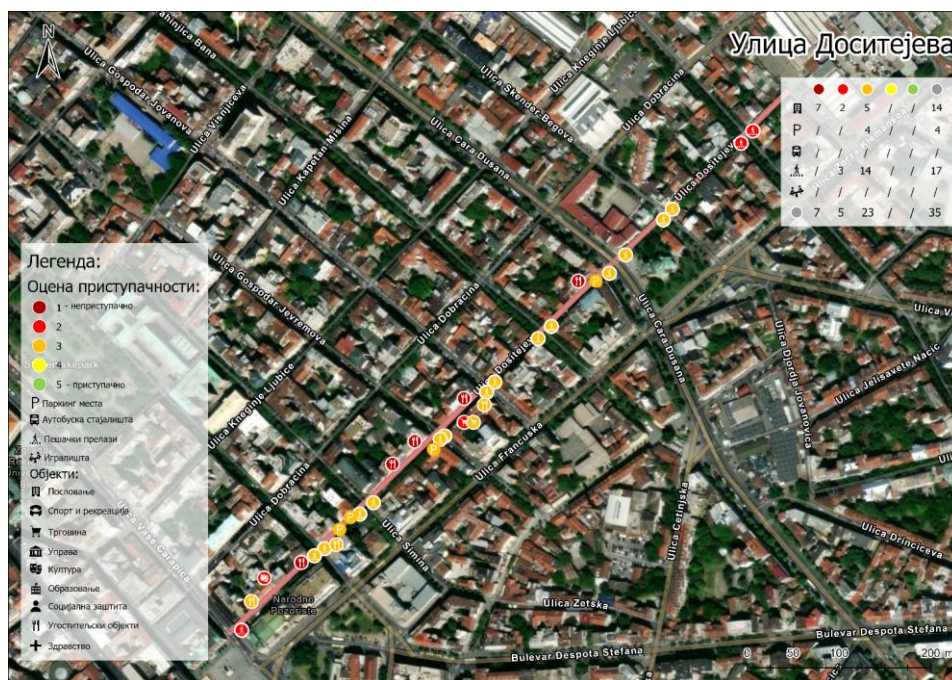


**Fig. 2** Display of all mapped objects at the level of one street – corridor (author)

### 4.4. User interface concept and visualization of accessibility features

The e-platform (Fig.3 left) is conceived as segmental, i.e. made up of parts with different purposes. In order to use the e-platform, the basic prerequisite is that, in addition to having a mobile phone, an application is also installed on the device, which results in the mobile phone maintaining a continuous connection to the Internet and activating the GPS device. After that, you need to register as a new user of the digital platform. Registration when accessing the application and any of its modules is mandatory and crucial so that only relevant data is entered into the application. Although the proposed e-platform is a public service, the relevance of the data is of key importance so that all the effort and work of all users is implemented through implemented solutions in urban areas.

After the approval of the user's request by the organization responsible for maintaining the e-platform database, the institution sends the user an email with electronic instructions for using the application along with a unique username and password that are required to access the database (registration is necessary for monitoring and data validity). After that, the user can use the application and map objects. The program is designed to be easy and simple to use, enabling the mapping of objects with the highest possible precision and the entry of all relevant data (by simultaneously viewing the text and illustrated representations of the mapping objects, possible ambiguities and doubts are avoided).

The primary user group was closely involved in the collaborative process that resulted in the implementation of the user interface idea. The goal was to ensure the most accurate collection of all data necessary for their quality of life, as well as to facilitate geographic analysis and multi-criteria searches, which are key to decision-making for the other categories of users listed above. The collected data must be processed by experts in order to ensure their validity.

The proposed e-platform is conceived as a set of different modules that complement each other, in order to achieve the set goals: continuous collection of data from the field, decision support, involvement of all actors and transparency of all data.

At the base of the proposed e-platform is an attributive work system, which means that most of the input is via dynamic fields. This enables an easy and systematic review of all data, as well as their automatic networking with all other information and systems of the digital system of the Republic of Serbia.

The proposed e-platform consists of 4 modules:
- Module 1 - For collecting data from the field
- Module 2 - For the integration and analysis of data for decision support
- Module 3 - For review and visualization of data of all users
- Module 4 - For communication and collaboration of all actors

The e-platform within all modules requires user registration, clear selection of whether the user is (Fig 3. middle):
- citizen (first name, last name and residential address are entered)
- government sector (with a field to be filled in from which government sector)
- non-governmental sector (with a field to be filled in from which organization)
- organization (with a field to fill in from which organization)
- professional (with a field to fill in which profession)
- interested person (with a field to fill in on what basis)

After registering on the proposed e-platform, a screen opens where the user can choose which module he wants to access (Fig.3 right). Modules 1, 3 and 4 are available to everyone, while Module 2 is available only to holders of public authority, in order to support decision-making through a clear display of data in real time together with data from other E-Systems of the state administration (e-plan, e-health, e - administration, etc.) Access to Module 2 will be enabled by assigning privileges in the system itself to certain registered users. All the modules are interconnected in real time.
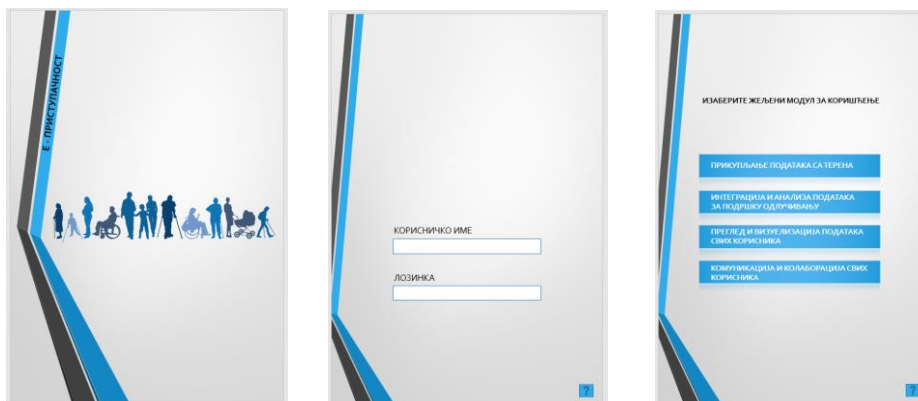
**Fig. 3**. The interface of the e-platform (left is start screen, middle is login screen, right is right screen for selecting the e-platform's desired module) (author)

The e-platform is conceived as a digital application, which would be available on all electronic devices (phone, tablet and computer) and would contain all modules in the same installation, which would make accessibility, updating and maintenance easier.

## 5. EXPERIMENTAL VERIFICATION OF THE MODEL

### 5.1. Defining the sample for the experimental verification of the e-platform model for decision support in improving the accessibility of urban areas in the Republic of Serbia

As part of this research, the entire municipality of Stari grad was mapped. In this regard, it was requested to provide criteria for the selection of items that would be mapped within this research. The need to check the methodological approach to the operationalization of the ICT support model and the need to inspire all actors to support the development of this instrument and start raising awareness about the importance of accessibility in general, led to the need to define criteria for field experiment on the territory of the city of Belgrade. In this sense, it was important to select a territorial sample so that the collected data would be applicable to all mentioned groups of users, and to highlight the key issues that limit the accessibility and smooth daily functioning of persons with disabilities or reduced mobility in the territory of urban areas and cities.

During the interviews, the users' interests were divided into two categories: general centers in small towns and important specialized facilities in cities. Users with reduced mobility avoid using these facilities due to the challenges and complex planning of travel to them and find alternative ways to meet these sporadic or emergency requests. Nevertheless, if the user is highly motivated, he would choose to perform these challenging organizational tasks, such as going downtown. The central core of the city has the appearance of a general center, but since important city services are concentrated here, it is also characterized as an area with "many" specialized centers (culture, catering, etc.).

On the basis of the above, it was decided to record the buildings of public use in the central core of the city of Belgrade for the purposes of this work. Considering the size of the territory of the city of Belgrade, the municipality with the highest population density was chosen both in terms of content and value (cultural-historical), to a large extent based on the fact that it will consequently have a larger share of users with difficulty using space, but also because of the very diverse terrain arrangement, taking into account that terrain morphology has a significant impact on the probability of achieving the highest level of accessible comfort.

## 6. THE E-PLATFORM PILOT MODULE

The pilot module of the e-platform for the purposes of this research is Module 1 - for collecting data from the field.

Module 1 is the basic module and the starting point of the entire e-platform because it collects accurate data about all buildings and locations in real time. Module 2, 3, and 4 are upgrades to Module 1.

Based on the proposed setting of module 1 - For collecting data from the field during research work and scientific research projects (Lalović, Kažić, Mihajlov, Drljača, & Petrović, 2018) (Lalović, et al., 2019), this e-platform module was formed in detail with all views and way of functioning, i.e. defined criteria for each mapping element.

The set criteria extensively define the evaluation of existing accessibility qualities in public facilities, with the aim of enabling accessibility for all users, not only for people with disabilities.

### 6.1. Field work, data collection and their processing

Filming and analysis of facilities' adaptability to access and movement for persons with disabilities (hereinafter referred to as PWD) was carried out in the area of the Stari Grad municipality in Belgrade. The census lasted 45 days, starting from November 1, 2022, to December 15, 2022. Apart from the analysis of the buildings themselves, the analysis and recording of bus stations, parking places, pedestrian crossings and parks and playgrounds was also carried out. The basic categories were: bus stops, pedestrian crossings, parking spaces, approach/entrance to the facility, interior of the facility, and parks and playgrounds. Each of these categories had certain criteria, on the basis of which the degree of adaptability to the access and movement of PWD was determined, which was expressed through a palette of 5 colors (green - fully meets the requirements, yellow - sufficiently meets the requirements, orange - moderately meets the requirements, red - meets the requirements insufficiently, bordeaux - does not meet the requirements at all).

In addition to the suitability rating, each item was accompanied by a comment with an overall impression as well as a photo. For all categories, latitude and longitude were taken, as well as the street in which it is located.

Bus stations - The code for the analyzed stations started with the letter "s" (s1, s2, s3...). The number of stops was taken for each station. There were 7 criteria on the basis of which the grade was formed. The analysis and listing of bus stops as basic criteria had: (public transport stops) width of the pedestrian plateau at least 3m without unevenness, visibly indicated zone of entry into the public transport vehicle with a color with sufficient contrast and tactile surface, (pedestrian paths and sidewalks) adequately connected corridors

movement, surface resistance to sliding and a slope of no more than 5%, the existence of benches up to 45 cm high, the existence of signs and road signs at a height of 160 cm, the existence of text on the board with information written in Braille. In addition to the basic categories, the condition of the stand itself and the presence of rain protection had a great impact on the given rating. A large number of stops met the criterion of the width of the plateau and the existence of a canopy with a bench for sitting, but mostly the zone of entering the vehicle was not marked. The stations located in the less developed part of the site in question often did not meet the conditions. It was noticed that all the information boards are at a higher height than required, and the textual information is not written in Braille.

Pedestrian Crossings - The code for analyzing pedestrian crossings starts with "pp" (pp1, pp2...). There were 7 criteria on the basis of which the grade was formed. The analysis and listing of pedestrian crossings as basic criteria had: (pedestrian crossings and islands) the existence of fallen curbs, equipped with light and sound signaling, (sidewalks and pedestrian paths) adequately connected movement corridors, resistance of surfaces to slipping and a slope of no more than 5%, the existence of benches up to 45 cm high, the existence of signs and road signs at a height of 160 cm, the existence of text on the board with information written in Braille. In addition to these criteria, the assessment was also influenced by the existence of tactile surfaces and surfaces marked with a contrasting color on the pedestrian walkway itself. Depending on the size of the road and the flow of people, the equipment of the pedestrian crossings changes, so in the narrow zone of the center of the location all conditions were met, while on the outskirts, crossings that did not meet the criteria were often encountered.

Parking spaces - The code for analyzing parking spaces started with "pm" (pm1, pm2...). The basic information was the type of parking (public garage, next to the street). There were 8 criteria on the basis of which the grade was formed. The analysis and listing of pedestrian crossings as basic criteria had: (parking spaces for PWD vehicles) existence of parking spaces near the entrance to buildings without exiting onto the roadway, adequate dimensions of the parking space 370x480 cm, adequately marked parking spaces and placed at the same level as the pedestrian along the path, (sidewalks and footpaths) adequately connected movement corridors, slip resistance of surfaces and a slope of no more than 5%, the existence of benches up to 45 cm high, the existence of signs and signposts at a height of 160 cm, the existence of text on the board with information written in Braille . Parking spaces rarely fully met the criteria, first of all regarding the dimensions of the parking space, but also due to the very connection with the movement corridor. Most parking spaces are well marked.

Approach/entrance to the building - The code for analyzing the buildings started with the street code and the letter "o" (1_o1, 1_o2...). The exact address of the object was taken, as well as the purpose group, specific purpose, number of entrances and type of entrance. There were 13 criteria on the basis of which the grade was formed. (4 criteria have sub-criteria, 18 in total). The analysis and listing of pedestrian approaches to the facility as basic criteria had: (parking spaces for vehicles of persons with disabilities) the existence of a parking space at the entrance to the facility separate from the road, adequate dimensions of the parking space 370x480 cm, adequately marked parking spaces and placed in line with footpath, (refers to footpaths and sidewalks) adequately connected directions of movement, surface resistance to slipping and a slope of no more than 5%, the existence of benches up to 45 cm high, the existence of signs and road signs

at a height of 160 cm, the existence of text on the information board written in Braille, (urban planning and architectural criteria - entrance to the building) the existence of ramps - a ramp longer than 6m has a rest area of 1.5m, the width of the ramp is 90cm or 150cm, the height of the handrail is 70 to 90cm, it is slip-resistant and has no slope; existence of stairs - leg width min 120cm, adequately marked first step, steps measuring 15x33cm, handrail, anti-slip treatment and tactile marking; existence of horizontal floor platforms - dimensions 110x140cm, fence height 120cm, equipped with switches and call with safety device; covered entrance to the building - adequate plateau min. 150x150cm, door width 183cm, windshield depth 300cm, slip resistance, automatic door opening, glass partition at the appropriate height with inscription.

Interior of the building - The code for analyzing the buildings started with the street code and the letter "o" (1_o1, 1_o2...). There were 13 criteria on the basis of which the grade was formed (4 criteria have sub-criteria, 19 in total) and 5 special conditions for movement in certain facilities. Analysis and listing of pedestrian approaches to the building as basic criteria had: (movement in the building area) adequate corridor width - 90 or 150 cm, adequate door width min. 80 cm, adequate handle height of 80 cm, unhindered movement without thresholds and obstacles, existence of space for wheelchair access to sanitary facilities; (equipment of sanitary facilities) existence of an alarm device, width of doors in sanitary facilities 90 cm, height of toilet bowl 50 cm, accompanying hand holders, console sink at a height of 80 cm; the existence of ramps - a ramp longer than 6m has a landing of 1.5m, the width of the ramp is 90cm, that is, 150cm, the height of the handrail is 70 to 90cm, flat and resistant to slipping; (overcoming height differences) the existence of stairs - leg width min 120cm, adequately marked first step, size 15x33cm; existence of horizontal floor platforms - dimensions 110x140cm, fence height 120cm, equipped with switches and a call with a safety device; the existence of an elevator - appropriate dimensions for wheelchair access 150x200cm, tactile floor treatment, dimensions of the elevator 110x140cm, cabin door width 80cm, the existence of a folding seat, the existence of handrails on three sides at a height of 90cm, controls with embossed markings, sound and visual signaling; (special conditions in certain facilities) width of the space next to the hospital bed 100x160cm, adequate height of the counter in business facilities, 80cm, places for strollers 90x140cm in sports facilities and recreation facilities, changing cabin 160x210cm in recreational facilities, dropped edges on the pool floor max. 2 cm.

Parks and playgrounds - The code for analyzed parks and playgrounds started with the letter "i" (i1, i2, i3...). There were 5 criteria on the basis of which the grade was formed. The analysis and listing of parks and playgrounds as basic criteria had: (sidewalks and footpaths) adequately connected movement corridors, surface resistance to slipping and a slope of no more than 5%, the existence of benches up to 45 cm high, the existence of signs and road signs at a height of 160 cm, the existence of text on the information board written in Braille. Most of the parks and playgrounds did not meet the criteria for the highest rating due to their condition.

The total number of criteria during mapping was 69.

### 6.2. Method of analysis and listing

The location was divided into 3 parts where the analysis and listing of all public facilities (approach/entrance and interior) was carried out, while bus stops, pedestrian crossings, parking places, parks and playgrounds were listed in the entire location. The photos were taken by phone, and due to the weather conditions, part of the data was taken and recorded in the field, and part was recorded later. The census was taken during the day, in daylight. All buildings were photographed from the outside, while the interior was photographed in cases where the employee allowed it. These data were initially entered into separate Excel tables, which were later merged into one. The latitude and longitude were taken from the Google Map application.

During the assessment, the highest grade - green - was given to facilities, parking lots, pedestrian crossings and stations that fully met the criteria or that can be fully used by PWDs in wheelchairs. The worst grade – bordeaux – is obtained if it completely restricts the movement of PWDs.

In most cases, bus stops met the requirements in terms of space and protection from rain, while boards at an adequate height and tactile surfaces indicating the vehicle entrance zone were often missing. Pedestrian crossings, if they meet all the criteria, received the highest rating, except in cases where the street is not busy, so light and sound signaling is not required. Parking spaces in most cases, except in newer garages, did not meet the required dimensions and connection with the corridor. In the case of buildings, accesses that are barrier-free, with adequate doors for entry, received a green label. Yellow was given to those who had a smaller obstacle that could be overcome independently. The orange color is assigned if the existing obstacle can be overcome but with the help of another person. The red color was given to the building that has a staircase at the entrance as an insurmountable obstacle. The bordeaux color was given to buildings with inadequate stairs and access. As for the interior of the buildings, green color was given to those in which it is possible to move everywhere and have adequate dimensions (and in the case of catering facilities or shops, if the toilets meet the needs). Yellow color was given to buildings if the movement corridors are slightly smaller in size. The orange color was given to those objects that have no obstacles in movement but the toilets are not adequate, or if the object does not have and should not have toilets, if the area has obstacles in the form of stairs. Buildings with stairs inside are colored red, so important parts are not accessible to everyone. The bordeaux color was given to buildings that completely hinder the movement of PWDs, or due to the very small dimensions of the space, access and stay of PWDs is not possible at all. Parks and playgrounds had the highest rating if they completely facilitated and allowed the movement of PWDs and if they were in a preserved state.

### 6.3. Problems encountered during field mapping

One of the first problems that arose during field mapping was related to the period of the year when the analysis and census was carried out. The day is shorter, and the weather was often unfavorable (snow and rain) with low temperature. Low temperatures limited the battery life of the phone used to take photos and record information. Also, the holidays that are celebrated in this period of the year are the reason why a large number of bars and establishments were closed. Bars that work seasonally were also not open during the entire filming period (rafts, cafes and open-air restaurants). Another type of

problem occurred during the analysis of public facilities, where the owners or workers often did not allow the interior to be seen and photographed due to mistrust and the opinion that for some reason they would be punished by the authorities or fear that the analysis would have a bad effect on the status of the premises itself. When it comes to parking spaces, they were almost always filled in the area in question, so those reserved for PWDs could only be recognized if there was a sign with an indication. There is a possibility that there are more parking spaces at the location, i.e. those marked with a contrasting color and symbol on the asphalt itself, which could not be recognized due to parked cars.

When filling out the tables, latitude and longitude were taken from the Google map application, due to accuracy and representation in use by users.

It should be noted that, in a large number of catering facilities (cafes, pubs and restaurants), employees explained that they have customers who have difficulty moving and regardless of the fact that they do not meet the requirements regarding the entrance to the facility, i.e. the interior (most often inadequate toilet).

In a large number of administrative facilities and health facilities, which are specifically intended for people with mobility difficulties, the conditions were not fully or not met at all, which proves the poor condition of the review of the actual state of accessibility of public facilities and urban areas, as well as the lack of systematic and methodologically based decision-making at the micro and macro level in the Republic of Serbia.

## 7. PRESENTATION OF EXPERIMENT FINDINGS

The necessity of public presentation of complex data sets derived from the proposed e-platform model necessitated the use of the publicly available program Quantum Geographic Information System (QGIS). During further urban analysis, more advanced GIS tools will be used, in order to provide more detailed spatial, thematic and financial analyses, as well as multi-criteria assessments of the quality of the territory.

With the help of GIS software, the application of which involves the collection, storage, analysis and visualization of spatial data, mapping of all objects of interest in the area of the Old Town municipality was carried out, including the interior and entrance to the buildings, bus stops, park areas, pedestrian crossings and parking spaces. . With the help of a summary table of objects, which, among other things, contains data on geographic longitude and latitude, which were used to enter objects within the QGIS software and their spatial positioning. In this way, a geospatial database was formed, which contains data on the already mentioned types of objects and spaces that appear. In addition to the spatial display, GIS through its attribute tables also provides an overview of information/attributes about all entered data, which can later be used as a basis for analysis, setting the appearance on the map or performing various spatial queries. With the help of a combination of spatial and tabular display, the entered data was analyzed and visualized in different ways.

As an addition to the original tables, a column was added that serves as a link between the object/point in the spatial display and the photographs that were made during the field research of the municipality of Stari grad. In this way, the spatial display is enriched with the possibility of interactively selecting an object on the map to display additional information about it, which is in the table view, as well as a photo of the selected object. In addition to the attribute that carries data about the connection with the photo, other attributes were used to display and analyze the data. With the help of a combination of accessibility rating attributes and purpose attributes, a basic classification was made that served to select the symbols that would be displayed on the map, according to the principle: Accessibility rating - color spectrum; Purpose – a suitable pictogram, which depicts that purpose. In this way, a legend is created that is used in all views.

Data entry included records of fulfillment of the conditions of accessibility and use of the observed locations according to the established list of criteria (Fig. 4). The plan was to map the entire municipality of Stari Grad for a period of two months. Despite the limited resources for the implementation of field mapping and a short deadline, the entire planned scope of field research was completed by the author within the planned period, which confirms the effectiveness of the established organizational structure of the proposed e-platform model.

**Table 2** Summary of mapped locations and objects of mapping in the territory of the municipality of Stari grad (author)

| Mapping object | Total number of different mappings | Number of criteria | Number of data | Number of comments | Number of images |
|---|---|---|---|---|---|
| Public transport station | 55 | 7 | 385 | 385 | 55 |
| Crosswalk | 539 | 7 | 3773 | 3773 | 539 |
| Parking space for the disabled | 143 | 8 | 1144 | 1144 | 143 |
| Building with driveway | 2085 | 18 | 37530 | 37530 | 2085 |
| Object inside | 2085 | 19 | 29792 | 39615 | 2085 |
| Playground | 16 | 5 | 80 | 80 | 16 |

| | |
|---|---|
| 6 | 🟥 |
| 0 | 🟥 |
| 0 | 🟧 |
| 47 | 🟨 |
| 2 | 🟩 |

Bus stops - the largest number of stops is rated yellow, because they are of sufficient width and length, with a canopy and a bench. These are type stations. Those that, in addition to fulfilling all the condition, also have a designated place of access to the vehicle for persons with disabilities were marked in green. Those that do not fully meet the requirements are marked in bordeaux color: the width and length of the approach is insufficient, there is no canopy or bench.

| | |
|---|---|
| 59 | 🟥 |
| 93 | 🟥 |
| 248 | 🟧 |
| 53 | 🟨 |
| 86 | 🟩 |

Pedestrian crossings - the largest number of pedestrian crossings were rated orange, because they contained fallen curbs, but without any signage. Such pedestrian crossings are the most common in the Dorćol area. The ones that have dropped curbs, light and sound signaling and tactilely marked crossing points are marked in green. Such pedestrian crossings are located near busy streets and in front of important institutions.

| | |
|---|---|
| 2 | 🟥 |
| 3 | 🟥 |
| 81 | 🟧 |
| 50 | 🟨 |
| 7 | 🟩 |

Parking spaces - the largest number of parking spaces is marked in orange. These are places that are smaller than recommended and do not have access to the sidewalk. Those that are smaller but have access to the sidewalk are indicated in yellow. Parking spaces that fully meet the criteria are marked in green. Those that are smaller, not connected to the sidewalk and the terrain is in a big decline are marked in bordeaux and red.

| | |
|---|---|
| 120 | 🟥 |
| 364 | 🟥 |
| 670 | 🟧 |
| 619 | 🟨 |
| 294 | 🟩 |

Approach/entrance to the object - There is almost an equal ratio of objects marked in yellow and orange. However, the conclusion after the tour of the municipality of Stari grad is that the vast majority of buildings are of old construction and that accessibility for persons with disabilities was not taken into account. The green color was most often given to those buildings which, due to equalization of the elevation of the terrain and the entrance, are fully accessible, but which did not fulfill all the necessary letters on purpose.

| | |
|---|---|
| 62 | 🟥 |
| 285 | 🟥 |
| 440 | 🟧 |
| 295 | 🟨 |
| 856 | 🟩 |

Interior of the facility – Most of the interior of the facility is marked in green. The reason is that these are smaller shops that have enough space for wheelchairs to pass, but there are no toilets in them. In such buildings, there are no thresholds and no second floor, which is why they meet the requirements. The general conclusion is that the largest percentage of buildings in question are of old construction, therefore people with disabilities were not taken into account. The fact that the objects are rated green is more a consequence of the fact that the size of the premises does not require that there is a toilet in its composition, and that the basic needs for the movement of people are met, and it is not a matter of purposefully meeting the necessary conditions.

| 0 | <span style="color:darkred">█</span> |
|---|---|
| 3 | <span style="color:red">█</span> |
| 4 | <span style="color:orange">█</span> |
| 9 | <span style="color:yellow">█</span> |
| 0 | <span style="color:green">█</span> |

Parks and playgrounds - Most parks and playgrounds are marked in yellow. They are new, with suitable benches and furniture, but they are not inclusive.

| SUBJECT OF MAPPING | Public parking | IMAGE |
|---|---|---|
| | pm4 | |
| identification number | | |
| latitude | 44,819,174 | |
| longitude | 20,466,359 | |
| type of parking lot | along the street | |
| the name of the street from which it is approached | Cara Dusana | |
| accessibility rating | <span style="background:yellow">　　　　</span> | |
| comment The parking space is smaller than recommended and is not at the level of the sidewalk, but there is a passage and a ramp that connects the parking space with the sidewalk. | | |

**ELIGIBILITY CRITERIA**

| | |
|---|---|
| Adequately connected and marked movement corridors in public transport | yes |
| Slip resistance Surface and slope adequacy up to 5% without unevenness of sufficient width | yes |
| The existence of benches on the walkways placed at a height of 45 cm | no |
| The existence of signs and signposts on the walls at a height of 160 cm | no |
| The existence of text on the information board in Braille | no |
| The existence of a parking space near the entrance to the facilities without exiting to the roadway | yes |
| Adequate dimensions of the parking space 370x480cm | no |
| Adequately marked parking spaces and level with the footpath | no |

**Fig. 4** An example of an individual card of a mapped object according to the criteria and all relevant data (author)

### 7.1. Qualitative evaluation of the pilot model by users

As a result of the fact that this research was initiated by personal experiences and life with people with difficulty using space, and that the entire research is based on the implementation of all user requirements, a semi-structured interview was formed that was completed by people with disabilities, people with difficulty moving in space, professionals, employees in state administration bodies and investors who are engaged in the construction of buildings.

In order for the proposed semi-structured interview to be as relevant as possible, and to show the most accurate picture, it was filled with a sample of people from all stakeholder groups. The interview was completed by a total of 40 persons with disabilities, 50 persons with reduced mobility, 33 professionals, 30 persons employed in the state administration and 20 investors who are engaged in the construction of buildings.

The users in this research, as stated in the previous chapters, are all participants in the creation of urban environments in the Republic of Serbia. This is the only way to show the true state and true evaluation of the pilot model of the proposed e-platform.

The conducted interview consisted of the following questions:
1.  Are you familiar with the term universal design?
2.  Are you satisfied with the accessibility of the facilities and associated external contents in Belgrade?
3.  Do you consider it useful if you knew at any time the accessibility status of each object and shared external content?
4.  Do you support people's networking and joint participation in decision-making through online platforms related to the construction field and urban design?
5.  Do you think that urban environments should be shaped only by professionals, or by everyone together - public, civil and private sectors with professionals?
6.  Do you think that a legal obligation to report on accessibility should be introduced for all interventions in urban areas?
7.  After the presented idea about the "accessibility passport" and the results of the field work in the territory of the municipality of Stari grad, do you consider it useful to implement all of the above into regulations, norms and legal frameworks?

Based on the data obtained from these semi-structured interviews, the following conclusions were reached:

To the first question from the total number of interviewed persons, 25 (14%) answered positively, and 148 (86%) answered negatively. This kind of information shows that most people are not familiar with the term universal design and what it represents, although it is very important both professionally and in everyday life. Promoting the term and concept of universal design, as well as introducing all people to the benefits it brings, is necessary so that the idea of implementing accessibility is present every day.

To the second question from the total number of interviewed persons, 83 (52%) answered negatively, and 91 (48%) positively. This kind of information indicates that people are somewhat aware of the problem, but as a result of the negative responses from people with disabilities in using space, it is clear that people who do not have disabilities in using space do not perceive even inaccessible spaces as such.

To the third question from the total number of interviewed persons, 173 (100%) answered positively. Without thinking, everyone had the same attitude that the display of

the state of accessibility can only use, even though it may not matter to them. Visibility of information and its inclusion is important to all people regardless of interest and need.

To the fourth question from the total number of interviewed persons, 100 (58%) answered positively, while 73 (42%) answered negatively. This ratio of positive and negative responses, i.e. responses from different groups of stakeholders, showed the already observed problem of people's reluctance to do everything together, and that others interfere in the decision-making process. Professionals gave negative answers because of identity, closed nature or vanity. Negative answers were also received from people who make decisions because they believe that others can only contribute opinions sporadically, and not constantly, because that would make the process more difficult and make it "too" transparent. Investors did it from the position of owners, where collaboration and joint decision-making in such a system does not exist in practice. This presentation of the answer to the fourth question shows the necessity of systemic changes in the functioning of planning, creation and realization of urban areas.

To the fifth question from the total number of interviewed persons, 81 (47%) answered positively, while 92 (53%) answered negatively. As expected, all except persons with disabilities in the use of space (even in that group 9 did not give a positive answer) gave a negative answer. It is an established practice that a professional knows best and that he should "impose" a way of life through the creation of urban environments. As with question number four, it is necessary to establish for the first period the necessity of collaboration and the involvement of all stakeholders, until everyone sees in practice how many benefits it brings.

To the sixth question from the total number of interviewed persons, 138 (80%) gave a positive answer, while 35 (20%) gave a negative answer. This result of the answer to this question gives encouragement that the institutionalization of the proposed e-platform would be positively received by the majority of stakeholders. As expected, all the investors' answers were negative, as were the answers of some of the interviewed persons from the state administration.

To the seventh question from the total number of interviewed persons, 143 (83%) gave a positive answer, while 30 (17%) gave a negative answer. Investors gave a negative answer because they do not want additional obligations, costs and controls, while several professionals have experienced it, as well as several people from state administration bodies who also do not want it as an additional obligation.

Based on all the answers to the questions from the semi-structured interview that is part of the research, it is evident that the majority of stakeholders see the benefits and necessity of the proposed e-platform, but it is also evident that the process and the path to full implementation is long and difficult, according to different understandings and the established the way of independent functioning and personal profit as the main goal (long-term goals are perceived as difficult to achieve, without guaranteed financial profit). As the research itself explains, gradually, and in accordance with the already traced path of digital transformation of society, it is necessary to show that even monetary benefits will be evident, just not in an immediate way, which is instant realization in the form of money. The implementation of the proposed e-platform requires an initial increase in costs, controls and obligations, but in the long term it brings comprehensive accessibility to all content, greater attendance of spaces and facilities, improved psychological and physical condition, greater spending of money as well as social inclusion. Instant cash profit which is now a priority, will be a daily profit after the completion of the complete implementation process, only on several different levels.

**7.2. Directions for further research**

Based on the previous research and the information obtained, it is necessary to find the best way to implement this model in the existing Laws and the existing legal and technical regulation. As the research concluded, the biggest problem is the failure to consider all types of users and the different needs of users, along with the optional implementation of the principles of Universal Design when implementing projects. Accordingly, the author, based on the practice of dealing with urban and architectural design, proposes to introduce a new type of project documentation at the level of a building permit with presented interventions in urban areas - Elaboration of accessibility and at the level of a use permit - Passport of accessibility. The new type of project documentation is analogous to the Elaboration of Energy Efficiency and the Energy Passport, as a recently introduced document, which facilitated and enabled the monitoring of the use of energy consumed by each built object and the improvement of its characteristics, and enabled the constant implementation of the same, as it is a mandatory and indispensable part of the documentation for obtaining the Usable permit, without which according to the law, no facility can be used. The regulatory framework as well as legal enforcement would be the same as in the example of energy efficiency, which would make implementation much easier, because the path and process of implementation is well known. The only difference would be that the Accessibility Elaborate and the Accessibility Passport would be applied to every type of intervention in urban areas, not just high-rise buildings. In this way, the principles of Universal Design, which, as stated in this research, are applied in public space, communications, access to buildings and the space inside buildings, would be applied consistently, during every type of intervention in the space - be it a sidewalk with a newly built street, a bus stop or an entire complex of buildings.

An additional argument during further research into the possible improvement of the state of accessibility and the effects of the application of the current legal and technical regulations would be the classification of mapped objects by year of construction or intervention in the area, into those before 2012 and those after 2012, according to the fact that the first change related to accessibility was made that year in the Legislature.

All principles from the established model of the E-accessibility platform from this research are directly applicable to the implementation of two new types of design documentation, that is, one type of design documentation in two different phases and forms. Field research, collaboration with real users of all groups of urban areas and all other stakeholders, provides arguments and indicates the necessity of implementing the proposed solution and introducing the proposed design-technical documentation for all types of interventions in urban areas at the level of the Republic of Serbia.

Based on all of the above, it is necessary to formalize the Accessibility Passport and its implementation in the existing legal framework, primarily within the Construction Planning Act, as well as all accompanying regulations and regulatory documents, in order to enable implementation at all levels simultaneously. The formalization of the Accessibility Passport as a document necessary for obtaining a use permit for any facility or intervention in urban areas would enable constant monitoring and consistent implementation of the principles of Universal Design from paper to the construction site.

## 8. CONCLUSION

In order to shift the social debate from accessibility costs to investments in accessibility as a key part of sustainable development, it is necessary to implement new visions of tools in the form of e-platforms shown in the research in practice. In addition to the almost limitless possibilities of modern ICT tools, a multidisciplinary approach is necessary, first of all in combining the process of viewing space and its adequate visual, numerical and attributive presentation. Coordination and integration of all development participants, integrating people with different functional requirements and impairments, is essential for the effectiveness of this e-platform, which is based on GIS technologies.

The e-platform will serve as a useful information tool for mapping key places that violate the safety of persons of vulnerable groups, but also as a decision support tool in the management of urban development in this area (a clear overview of a specific area that needs to be urgently restored and made accessible), for the simultaneous coordination of all levels of management, for true and up-to-date referral to the public and raising awareness of the problem, for marking the real needs of users through the Android application of the proposed e-platform and for raising the interest of investors and other stakeholders from the private and public sector.

In addition to extremely complicated technological components, the development of an e-platform requires complex socio-economic cooperation in order to ensure its continuous use. The current digitization of all services in the Republic of Serbia is the right time for the establishment of such an e-platform, as well as the creation of a national digital platform E-space, within which the proposed e-platform would be implemented.

In this sense, the creation of an e-platform "step by step" is particularly important in order to more effectively imagine a practical and usable platform through the application cycles. The e-platform is conceived as a multi-stage procedure, with one software and four components, which would present users with all the collected information, make everyday life better and highlight which parts of urban areas and public services they can use without restrictions. Enabling the creation of a navigation map of accessible corridors based on the specific requirements or limitations of each user, as well as the possibility of being involved in each process in a transparent and non-discriminatory manner, are some of the qualities of the e-platform that users have not had until now. Minor modifications of this platform can also define the accessibility of the space for some of the currently current modern forms of individual transport (electric scooter, scooter, Segway (Seagway), Hoverboard (Hoverboard)), which would turn accessibility research through the e-platform into urban research. mobility.

It should be noted that through the presented research, precise results were unequivocally obtained about what is affordable and what is not. The sample for testing the e-platform is a pre-selected urban area in order to generate as diverse data as possible, through a large concentration of public purpose buildings and areas with high frequency of people (the central municipality of the capital of the Republic of Serbia: Stari Grad municipality). In the previous research, other cities in the Republic of Serbia were also mapped, where the results differ significantly, since the degree of inaccessibility of city spaces and urban areas is shown, not accessibility.

As most of the public services that are provided as part of the digitization of the Republic of Serbia are available through the Internet application Google Play (Google Play), the goal is

for this service application to be available to every user by simply downloading and installing it on any type of mobile device, whether it is phone, computer or smart watch.

With further development, it is possible to automate the data processing process itself through the matching of different databases and complete automation of the decision-making process regarding the accessibility of a certain urban environment. The proof of this is the appearance of artificial intelligence that is ahead of us (an example is ChatGPT, an application powered by artificial intelligence technology), which will lead to the automation of the entire process, so that subsequent data processing is trivial for modern ICT systems. Thus, the tool that was used to recognize the suitability of the location will become a co-creator of new urban environments.

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# E PRISTUPAČNOST – DIGITALNA PLATFORMA
## ZA UNAPREĐENJE PRISTUPAČNOSTI
## URBANIH SREDINA U REPUBLICI SRBIJI

*U ovom radu autor se bavi modelovanjem e – platforme kao instrumenta za podršku odlučivanju unapređenja pristupačnosti urbanih sredina u Republici Srbiji. Ovo istraživanje sistematizuje, analizira i upoređuje postojeće nacionalne i internacionalne prakse, regulative i normative na temu pristupačnosti. Kroz istraživanje postojećih saznanja i dobrih praksi i kroz terensko istraživanje, kreira se teorijska postavka modela platforme i algoritam za proračun trenutnog stanja fizičke pristupačnosti, na primeru uzetog adekvatnog statističkog teitorijalnog uzorka u Republici Srbiji (teritorija gradske opštine Stari grad grada Beograda). Prikazuje se način za prioritetno odlučivanje, intervenisanje i primenu principa Univerzalnog dizajna u urbanističkom i fizičkom okruženju u Srbiji kroz interdiscplinarnu i višeinstitucionalnu upotrebu e-platformi. Tako formiran model e-platforme služiće kao pomoć pri odlučivanju svih stejkholdera, i omogućiće da se u realnom vremenu prikazuje trenutno stanje pristupačnosti, i da se pristupi i metodi u urbanističkom i arhitektonskom planiranju i projektovanju prilagođavaju radi efikasnije primene Univerzalnog dizajna. Ovo istraživanje ima za cilj da dokaže da ukoliko napravimo e – platformu koja je dostupna svim akterima i javnosti, i podaci se sakupljaju u realnom vremenu o prostornim komponentama pristupačnosti, ali i subjektivnim komponentama aktera, onda se stvaraju uslovi za optimizaciju upravljanja akcija u cilju unapređenja pristupačnosti u urbanim sredinama.*

Ključne reči: *E-platforma, univerzalni dizajn, pristupačnost, inkluzija, fizičko okruženje*