

# Systemic Approach to Universal Design of Urban Spaces - Case Study of Trbovlje, Slovenia

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**Abstract.** The study consisted of examining universal design principles and applying selected interventions with the goal of solving accessibility issues in the settlement of Trbovlje. As a result of the investigative process and the layered spatial data concerning universal design theory, it was possible to propose the dynamics for the implementation of the design solutions. Deliberate selection of only specific universal design features as a pragmatic decision is what ensures the proposed solution's real-world application value. Subdividing a wholistic design into temporal phases secures a more feasible and pragmatic approach to reach the end goal while still preserving the full functionality of each individual phase immediately and thus its effectiveness. Such a systemic approach is proposed as a way of creating a more focused overview of the settlement, making a better design for the solution of specific issues, assessing these solutions, and implementing them in selected places. This approach and thinking present itself as a good method of granting universal accessibility that could be adopted as a mandatory part of any urban plan.

**Keywords.** universal design, accessibility, inclusivity, spatial plan, phase design

## 1. Introduction

The needs for universal design arise from the necessity of travelling and navigating through urban space on the scale of an entire settlement. Each day anyone of us can face situations when and where we have to navigate to a destination where we encounter either physical or navigational obstacles. These obstacles we might encounter can be overcome with varying levels of effort by different people, when commuting to work or school, visiting shops or post offices. A person can set off on foot, by car or by public transport. Every one of these methods of travel can be problematic for someone with visual impairment, hearing impairment or movement difficulties. With that in mind, the goal of universal design is to establish as accessible and as inclusive public space as possible that encompasses all groups of people in a systemic manner.

The goal of our research was to define priority levels of access paths to central functions of the urban space to enable universal access to create a full spatial assessment with the intent of defining a general spatial strategy on universal design and design features of the settlement of Trbovlje. Inclusive planning focuses on the diversity of people and how they alter spatial planning [3][4]. Our systemic approach to universal design aims to encompass as many different users of the space as is sustainable and viable in practice, not necessarily meeting the needs of the entire population.

## 2. Method

The methodology includes a study of existing universal design principles, including a review of the general standards and practices. This is regarding universal design from the national to the local levels which are followed up by a case study of the settlement of Trbovlje. The objective of this study is to investigate the accessibility of most publicly accessible facilities of the settlement. In our study of different facilities and areas, we try to determine the unique spatial challenges of accessibility and other elements of universal design the residents of Trbovlje people encounter in their daily lives.

The case study was conducted with analysis based on observation of the present state and comparing that to available design standards. The analysis consisted of behavioural spatial mapping, infrastructure spatial mapping, a visual assessment, spatial interpretation, program analysis, and a connection system analysis. These analytical tools served to identify crucial elements of open space and their role within the hierarchy of central functions of the settlement. This overview enabled us to develop and restructure design solutions and guidelines in distinct and clear phases. The authors are aware that the study does not include all the spatial barriers, navigational obstacles and equipment that a public space or a private facility can generate. We have selected only those that we have examined in detail in terms of accessibility specific to the residents of Trbovlje.

## 3. Understanding inclusivity in universal design

Universal design establishes an inclusive planning theory that focuses on the diversity of people and how this affects spatial planning. The British Standards Institute [2] defines inclusion as the design of products and services that are accessible and usable for as many different users as possible, without the need for such a product or service to require any adaptation, a special intervention or retrofit in their use thereafter. The principles of inclusive design in relation to the Commission for Architecture and the Built Environment [5] instrumented in making the public space safe, accessible with ease and dignity, with the flexibility to adapt considering the changing needs of people. This makes the space accessible for all, regardless of their age, gender, mobility, nationality or any other circumstances, removing barriers that could exclude a particular group of people [7]. Persons with functional impairment can involve a variety of age groups, ranging from young children to the elderly, including also pregnant women, people carrying infants with prams, people moving luggage or grocery trollies, etc. The people, who for various reasons have permanently or temporarily reduced their mobility, making it harder or slower to move. These can be again divided in two categories of persons with sensory impairment and people with reduced mobility.

### 3.1. *Persons with sensory impairment*

Although many types of sensory impairment exist, visual impairment is the most difficult to cope with when moving through public spaces. Visual impairments are not conditioned by age, so they can occur at any time in life. Most often low vision or complete blindness can occur in later periods of life. The aging of the population also increases the number of blind and partially sighted. The difference between partial and total visual impairment is important and so the adaptations in the space are different as well. The latter group requires the surfaces on which they move to be as flat as possible

and help themselves with other senses such as hearing and touch [9]. Persons with sensory impairment can be helped with minimal improvements in space, such as making the signs and inscriptions contrasting enough to be able to read them with relative ease. The adaptation for the blind is, therefore, more complex as they need adjustments that rely primarily on hearing such as sound traffic signals, or the sense of touch, making tactile markings and tactile maps necessary. Without any alterations to the space person with these impairments must first learn certain pathways with the help of companions before they can use them on their own [7]. This solution is not a solution at all, because it drastically limits the confidence and freedom of people with sensory impairment.

### *3.2. Persons with motor impairment*

People in wheelchairs are either paraplegics, tetraplegics, dystrophies, or people who live with multiple sclerosis, others include the elderly who face similar illnesses or medical conditions. They might be thought of most often when describing motor impairment, however not all motor disabilities are considered [9]. Many motor disabilities include only temporal injuries and disabilities where people can cope with only crutches or stilts. The adjustments to the space, accessible ramps, for example, are also important for other users of the space, such as parents with prams and people who find traversing stairs difficult for whatever reason. In the case of motor disability, the problem is divided into two sides. The first is when a building or a public program is inaccessible due to obstacles in the open public space. The accessible paths can be built too narrow, are slippery, accompanied by stairs with an unsatisfactory access ramp, or they lack a ramp altogether. The other consideration is the building access on private property, mainly the entrances in parking spaces [7]. These are again made difficult to access due to the constructed obstacles, for example, narrow doors passages or door thresholds being too high, effectively turning them into obstacles.

### *3.3. Design solutions for universal design*

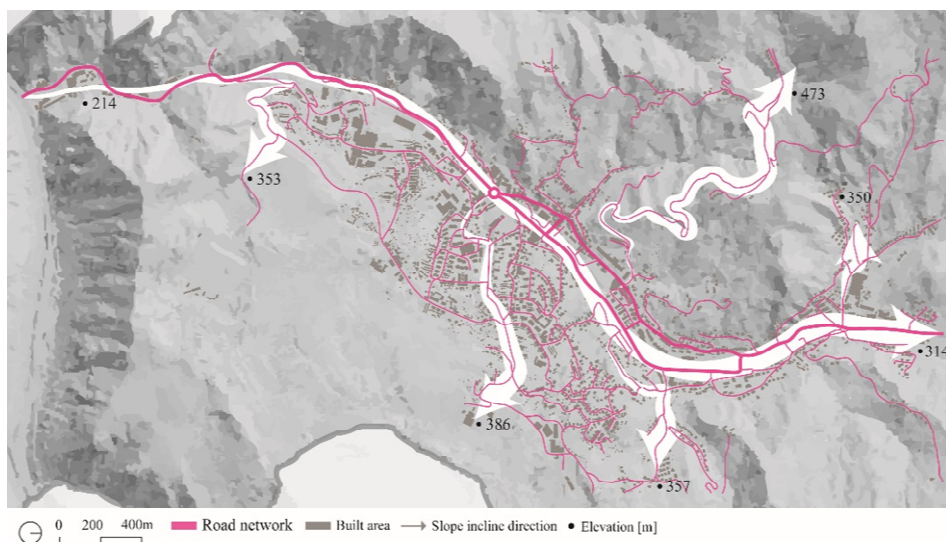
The task of bringing universal design into reality can be tackled on different scales. For example, even land-use policy can make the public space safer and easier to master for those with limited mobility. "To achieve this at the level of planning, one must consider walking distances, levels of incline, and landmark orientation. Short distances are particularly important in residential areas. Long distances to grocery stores, post offices, and public services pose obstacles to the daily life of residents, and these obstacles increase with age." [6]. To adequately plan a commute, a traveller with limited mobility must know whether a path is clear. Whether it is blocked, whether the sidewalk is too steep or rendered unusable due to poor conditions, whether there is a sidewalk at all and if the street can be crossed [1]. During the research process of the case study of Trbovlje and the analytical work, only a specific set of design solutions presented by universal design theory appeared suitable for direct implementation. The reason for this derives from the specific linear character of the settlement which is highly conditional to the topographic features of the landscape. Hence this study rather focuses on traditional solutions to physical obstacles for those with limited mobility that can be applied directly to the settlement. These are listed as follows: building entrance adaptations, parking spaces for the disabled, access ramps, tactile markings, audible traffic lights, and navigational signage. These aforementioned design solutions are further outlined and discussed in the following chapters.

#### 4. Case study of the settlement of Trbovlje

The municipality of Trbovlje is located in the eastern part of Slovenia in the centre of the Zasavje region. The majority of the population of the municipality lives in the settlement of Trbovlje, which stretches over 5 km in a narrow valley along the banks of the Trboveljščica River [9]. Along the entire length of the settlement lies an important traffic axis that branches off for a short distance in part of the settlement and then shortly reconnects back. Roads and streets that branch off from the main traffic axis lead to predominantly residential parts. They are winding and narrow as they have to bridge higher grounds of the steep-inclined valley. The axial character of the settlement means that new interventions to the public transport network can be easy and inexpensive to implement, making it more than suitable for our study. Understanding the population structure revealed the relevance of our research, with a significant share of individuals with impairments, amounting to 6% of the total population [8]. Many were not included in the census, such as the elderly or people with temporary injuries.

##### 4.1. Analysis of accessibility in Trbovlje

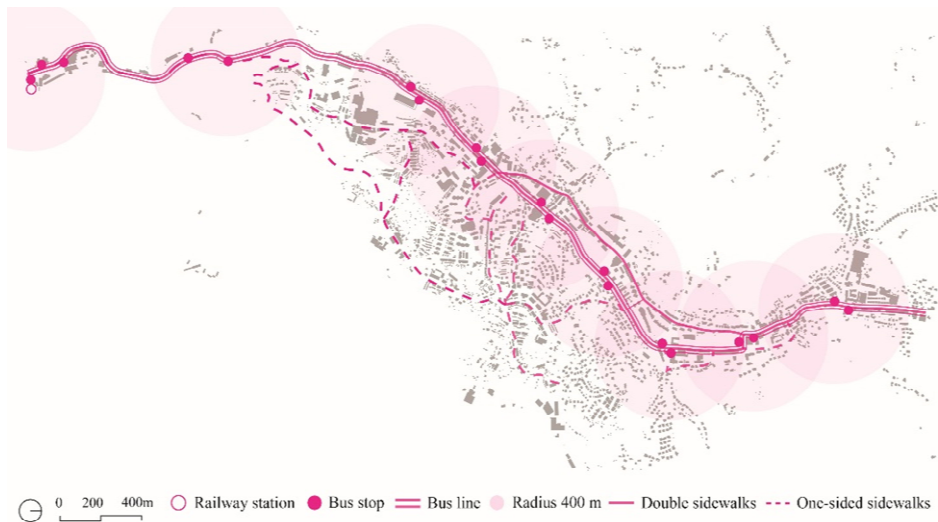
A crucial tool for understanding the complex picture of the accessibility issues within the settlement of Trbovlje was a structured analysis of the various public and private programs that it offers which function in a system of node destinations. This provided us with data segmented in the following topics: the traffic system and public transport connectivity along with public transport stop density, the topography and incline of the valley, the pedestrian sidewalk infrastructure, and the commercial-public program network.



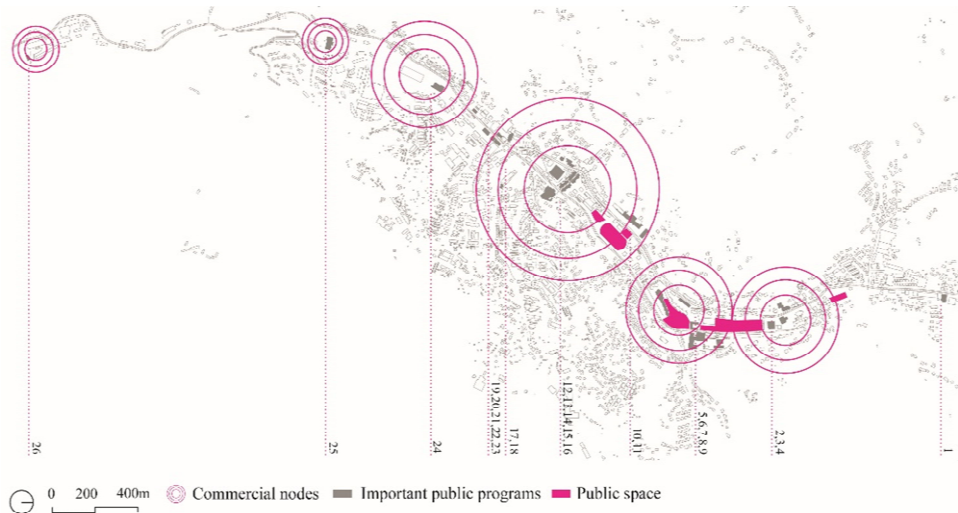
**Figure 2.** Road network, incline direction and elevation data.

The municipality of Trbovlje is well connected via the road network as shown in Figure 2. Alongside the entire length of the settlement leads the main traffic axis that connects to a regional road in the south. The narrow valley requires the roads to have to bridge considerable height differences, which creates a problem for pedestrians. In the

municipality of Trbovlje, a person with reduced mobility can choose between three modes of travel: moving by car, a bus, or taking the sidewalk and possibly using a wheelchair. Most publicly accessible facilities are equipped with a parking space reserved for the disabled, making them well accessible by car. More limited is travel with the public transport or walking. Only one intercity bus line is needed to ensure access to public transportation for the largest part of the population and the area of the settlement is well covered with bus stops, with only a part of the eastern settlement missing coverage. However, this method is not currently suitable for persons with motor and sensory impairment. This is because the bus stops lack the basic safety features, such as tactile markings, or the sidewalk is not accessible (Figure 3).



**Figure 3.** Public transport connectivity in Trbovlje. Each bus station is overlaid with an area of 400 meters in radius.



**Figure 4.** Commercial activities, important buildings of public status and public space in Trbovlje.

The valley topography and steep roads and paths are another problem that is difficult to overcome. Figure 3 is showing that less than half of all road area is equipped with a sidewalk and of those, not all are double-sided. This makes travel more difficult and ideally, any unnecessary crossing of the road to get to a protected sidewalk space should be avoided. The majority of public program in Trbovlje falls under commercial space and is concentrated mainly in the vicinity of the main traffic axis that runs through the entire settlement (Figure 4). They gravitate towards the northern and central part of Trbovlje, surrounding a main square in front of the Delavski dom cultural centre. This allows for an easier implementation of universal design, focused on a single axis. In total, twenty-six buildings with a public status were analysed in regard to their accessibility.

#### 4.2. Synthesis of the spatial evaluation of Trbovlje

We followed the analysis of open public space with an assessment of the 26 individual buildings of public status (Figure 4) and their access. The data was gathered and synthesized in segments (Table 1), giving us a clearer picture of the current state of public programs in Trbovlje. All of them were also assessed on criteria on the basis of (un)equipped space with elements of universal design (as listed in chapter 3.3). Considering the value of any changes to be made in Trbovlje, we proposed that the implementation of universal design is to be accomplished in phases, which could be applied to a municipal strategy.

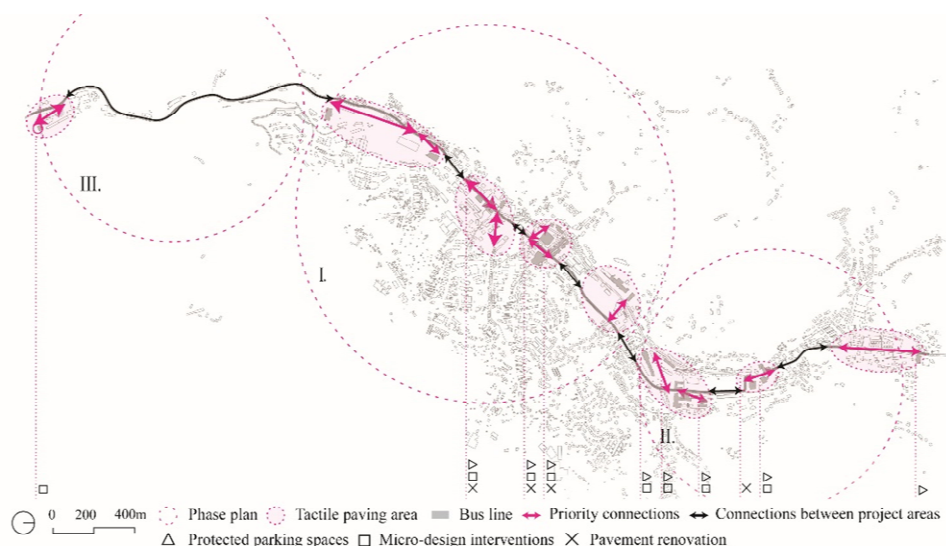
**Table 1.** Combined spatial evaluation of accessibility in public spaces of Trbovlje (areas 1 - 26): satisfactory (+) unsatisfactory (o) absent or problematic (-).

The areas of access of buildings with public status	1 - 9	10 - 25	26
Access with a car	o	+	+
Access without a car	+	+	-
Tactile pavement	o	o	o
Contrast pavement marking	-	-	+
Disabled parking access	o	+	+
Tactile pavement on parking ground	o	o	o
Wheelchair ramp access	-	o	o

Trbovlje as a settlement was divided longitudinally in three distinct segments: a northern, central and a southern segment (I.-III.), based on the criteria of functional connectivity, as shown in (Figure 5). These subdivisions are also reflecting the urban built-up density and the spread of central functions and the public spaces that accompany them. The settlement is divided into these three segments and phases which outline not only the spatial priorities but also temporal implementations of design solutions, to offer a pragmatic and systemic urban renewal. From the planned short-term point of view, each of these individual segments and stages can function disjointed as this can be feasibly included in a strategic municipal plan.

## 5. Universal design for improving mobility in Trbovlje

All elements of proposed spatial solutions are chosen with purpose and specificity, deriving from conclusions made from spatial analysis. The common attribute of all proposed solutions is the possibility of their development in an existing system, tied to existing infrastructure, such as bus stops (Figure 3). As the public transport stops are set up fairly densely the proposed areas of tactile markings that would accompany them and create connections to the outlined public buildings would in turn cover a large area of the settlement as well. The feature of a phasal plan enables the community to implement them whenever opportunities for their realisation occur, given that it can be effortlessly implemented in a municipal strategy and an urban plan. The specificity on the other hand grants a design solution that is intended for the most vulnerable members of the population in mind so that they are treated as a matter of priority through interventions. This is done in such a way as to empower them with equal opportunity to move and use space together with the rest of the population, as envisaged by universal design. The aforementioned design solutions are aggregated in the following four policies: marking territories of tactile marking installation, improving the individual connection between areas of importance, adding new locations of reserved parking spaces, and defining small areas of “micro-interventions” in public space (Figure 5).



**Figure 5.** Universal design plan proposal for improving mobility in Trbovlje.

Paving replacement needed to be included in the plan for certain areas in Trbovlje, as it is currently impossible to be accessed by those with limited mobility. In the plan, the vicinity of outlined programs and buildings of public status, were significant planning these connections. Recognizing the importance of certain programs, even small business and shops, were vital for this plan to be considered universal. In certain parts of the city, especially next to publicly accessible facilities, there is a shortage of parking spaces reserved for disabled people, so the plan reinforced these areas. The biggest deficit was recognized in the residential neighbourhoods, which is where most of them are planned. Access ramps were also envisaged to be added to publicly accessible facilities, with most

problems of accessibility occurring in front of older buildings. The tactile system must be designed in its entirety or completed in segments, as it can otherwise confuse. Hence why it will be established in phase one, in the vicinity of the public transportation stop and around the train station. In the following phases, the longer lines of adapted sidewalks would be connected in between and around commercial hubs.

## 6. Conclusion

What we found out was that a systemic approach should be applied to the design of all networks crucial to connecting the central function of urban space. For example, these solutions should apply to various elements of open urban space, including the crosswalks and crucial elements of roadside proliferation, as well as navigational infrastructure. It is, therefore, necessary to plan the space according to the principle of inclusion so that the urban public space can be adapted and used by everyone. People with disabilities, people with mental disorders, people with visual and hearing impairments, young children, and the elderly should all be considered. This form of spatial planning requires the cooperation of various disciplines. It is especially important to collaborate with people with various impairments because only they can communicate well enough how they will be able to move through the space and what adaptations they would require to be able to access the settlement. This systemic solution provides better made, tested, more effective, and more adaptive solutions. The approach grants immediate and more inclusive space with a better quality of life in the urban space. This design approach to a system solution of urban accessibility should conceivably make for a new all-important or even mandatory layer within an urban plan. Supplementing existing spatial documents and adding another level of missing information.

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