

IGRA USTVARJALNOSTI  
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CREATIVITY GAME  
Theory and Practice of Spatial Planning

A HOLISTIC APPROACH TO THE INTEGRATION OF  
BICYCLE TRAFFIC INTO THE URBAN LANDSCAPE

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Znanstvena revija, št. 3 / leto 2015  
Univerza v Ljubljani  
Fakulteta za arhitekturo in  
Fakulteta za gradbeništvo in geodezijo  
Ljubljana, 2015

Scientific journal, no. 3 / Year 2015  
University of Ljubljana  
Faculty of Architecture and  
Faculty of Civil and Geodetic Engineering  
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Naslov revije: Title of the Journal:

IGRA USTVARJALNOSTI  
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THE CREATIVITY GAME  
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Urednici: Alenka Fikfak, Alma Zavodnik Lamovšek

Editors: Alenka Fikfak, Alma Zavodnik Lamovšek

Uredniki tematskega dela: Cristian Suau,  
Saja Kosanovič, Carmelo Zappulla

Thematic section editors: Cristian Suau,  
Saja Kosanovič, Carmelo Zappulla

Oblikovanje in naslovnica: Gašper Mrak  
Lektoriranje: Mojca Vilfan  
Prevod: Mojca Vilfan

Design and Title page: Gašper Mrak  
Slovene text proofread by: Mojca Vilfan  
Translation: Mojca Vilfan

Klasifikacija: (UDK) Renata Stella Čop, (DOI) Teja Koler Povh

Classification: (UDK) Renata Stella Čop, (DOI) Teja Koler Povh

Založila in izdala: Univerza v Ljubljani,  
Fakulteta za arhitekturo in  
Fakulteta za gradbeništvo in geodezijo

Published by: University of Ljubljana,  
Faculty of Architecture and  
Faculty of Civil and Geodetic Engineering

Spletna stran revije:  
<http://www.iu-cg.org/>

Journal's Web Page:  
<http://www.iu-cg.org/>

Spletna stran številke  
<http://www.iu-cg.org/paper/2015/iu03.html>

Current Issue Link  
<http://www.iu-cg.org/paper/2015/cg03.html>

ISSN 2350-3637

ISSN 2350-3637

Univerza v Ljubljani  
Fakulteta za arhitekturo



Univerza v Ljubljani  
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# Polonca Andrejčič Mušič, Ilka Čerpes: CELOSTNI PRISTOP K INTEGRACIJI KOLESARSKEGA PROMETA V URBANO KRAJINO

## A HOLISTIC APPROACH TO THE INTEGRATION OF BICYCLE TRAFFIC INTO THE URBAN LANDSCAPE

DOI: 10.15292/IU-CG.2015.03.078-089 ■ UDK: 656.183:712.25 ■ 1.01 Izvirni znanstveni članek / Scientific Article ■ SUBMITTED: May 2015 / REVISED: September 2015 / PUBLISHED: October 2015

### IZVLEČEK

Kakovost javnega prostora je mogoče opisati s kvalitativnimi in kvantitativnimi kazalniki. Povezanost prostora s kolesarsko infrastrukturo je kazalnik, ki določa stopnjo privlačnosti javnega prostora za kolesarski promet. Želimo poiskati optimalno razmerje med dobrimi pogoji za kolesarski promet, kot eno izmed vodilnih oblik trajnostne mobilnosti ter obliko in podobo prostora, ki pogojuje zdrav življenjski slog. Novost, ki jo razvijamo, je popolnoma drugačen pogled na izhodišče načrtovanja kolesarske infrastrukture, saj v ospredje načrtovanja, namesto lastnosti fizične infrastrukture, postavimo človeka, kot najpomembnejše merilo kakovosti. Tako problematika reševanja kolesarskega prometa ni več samo prometno-tehnični problem, temveč načrtovanje in urejanje le-tega dobi multidisciplinaren značaj.

Kompleksnost človeka namreč ne more obvladati le ena znanost ali veda. Opredelili bomo celostni multidisciplinarni metodološki pristop k vrednotenju kakovosti kolesarske infrastrukture, ki bo enakovredno vključeval tudi kriterije zaznavanja in dojemanja prostora z vidika različnih uporabnikov kolesarske infrastrukture. Iščemo sistem kriterijev, ki omogoča celostno načrtovanje kolesarske infrastrukture v mestnem prostoru in v zaledju mest. Izboljšati želimo obliko javnega prostora in omogočiti trajnostno mobilnost ter posledično, ob zmanjšanju negativnih posledic prometa na okolje, prispevati k izboljšanju kakovosti življenja. Vsa znanstvena dognanja iz raziskave bomo dokazali na praktičnem primeru sistema za dobro delovanje kolesarskega prometa v štirih slovenskih priobalnih občinah Koper, Izola, Piran in Ankaran.

### KLJUČNE BESEDE

vzdržno urbanistično načrtovanje, vzdržno urbanistično oblikovanje, celostni pristop, integracija kolesarskega prometa, doživljajska vpetost kolesarske infrastrukture

### ABSTRACT

Qualitative and quantitative indicators can be used to assess the quality of public space. The coherence of cycling infrastructure connectivity is an indicator of a public space's attractiveness as a basis for the quality of the bicycle traffic operation. We would like to find an optimal balance between the space's form and its image to provide good conditions for cycling as one of the most important forms of sustainable mobility, and consequently a factor facilitating a healthy lifestyle. The new approach brings a completely different view on planning cycling infrastructure, while rather than physical infrastructure characteristics, humans are placed at the forefront of the cycling infrastructure design as the most important measure of its quality. Since the complexity of human beings cannot be controlled with only one science or profession, solving the problem of bicycle traffic is not just a technical problem, but its design and management also lend a multidisciplinary character. From the perspective of different cycling infrastructure users, the study will define integrated multidisciplinary methodology for evaluating the quality of cycling infrastructure, which will equally include the criteria of sensing and perceiving of space. The new approach seeks a system of criteria, which enables the integrated planning of cycling infrastructure in all spatial, organizational, sectoral, and professional levels. All theoretical findings will be tested and demonstrated on the pilot case of the long-distance cycling connection in the area of four Slovenian coastal municipalities, namely Koper, Izola, Piran, and Ankaran.

### KEY-WORDS

Sustainable Urban Planning, Sustainable Urban Design, The Holistic Approach, Bicycle Traffic Integration, Experiential Integration of Bike Infrastructure into the Environment

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## 1. INTRODUCTION – DEVELOPMENT AND SIGNIFICANCE OF BICYCLE TRAFFIC

The bicycle was once a social status symbol, but during the industrial revolution in the 20th century, it was totally replaced by the car. Urban planning concepts of the time intensively promoted living in the suburbs, and daily commuting to work by car. Many cities turned their streets into broad avenues to improve traffic flows. Pedestrians and cyclists were marginalized from the public space. All attention was given to promoting industrialisation and increasing economic growth. However, the separate treatment of traffic flows completely undermined the traditional role of the street and public space. Public space that was used for socializing was taken away from people and turned into areas for cars and parking lots. Gradually, the cities lost their identity and vibrancy and became completely dominated by the car. The global professional and political legitimacy and breakdown of the compact city had significant consequences on man, society, and nature (Čerpes et al., 2013).

In the final third of the 20th century, urban planning theory saw several shifts that fundamentally changed its structure. Some advanced urban designers of the time already saw the weaknesses of the previous urban planning and design, and as the most important thing of planning the city, brought to the fore the city's image (Lynch, 1960) and humans in relation to their environment in which they live and work (Cullen, 1961). The results of these previous studies were used as the basis for our study.

To date, urban planning approaches have been gradually improved while looking for a middle ground between the compact and dispersed city (Koželj, 2008). However, most cities still have not been able to find the perfect model to discontinue the devastating effects of increasing transport and correct the mistakes made in the past. Sustainably oriented cities intensively promote sustainable mobility to satisfy the needs of all people for mobility while reducing motor traffic. Bicycle traffic is one of the fundamental ways to sustainable mobility and certainly deserves a more important role in our daily lives. So, from economic, environmental, health, personal, and recreational reasons, in developed European countries, cycling is steadily returning to the transport system. With the aim to promote the development of non-motorized traffic and the use of bicycles where possible, better conditions for cyclists can be created only by using a holistic approach to the integration of bicycle traffic in the urban landscape (in entire regional functional areas of cities). This goal has to be achieved through the coordinated efforts of several disciplines while human well-being is taken as the basis of a new approach.

## 2. HUMANS AS THE BASIS FOR CREATING GOOD CONDITIONS FOR BICYCLE TRAFFIC

Being aware that strong cooperation between different professional disciplines, such as traffic engineering, urban planning, and urban design, is of vital importance for developing a well-functioning bicycle network, the Dutch, who are among the leading experts in bicycle traffic, in Design Manual for

Cycle-Friendly Infrastructure (CROW, 2007), estimated the quality of the cycling network by promoting five important elements: safety, directness, coherence, attractiveness, and comfort. The conditions for bicycle traffic must meet the basic criteria of "sustainable safety," such as functionality, homogeneity, legibility, forgivingness, and responsible self-awareness.

To attract as many people as possible who do not cycle yet, the study will also address some other important and deciding factors of human perception, which have been less studied in practice until now. Cycling surfaces must have their own identity, structure, and meaning. The visibility of cycling surfaces must allow for good orientation and simple movement within space. In order to create good conditions for cycling, the cycling infrastructure must deliver, on top of the relevant technical conditions, the appropriate rhythm, enjoyment, stimulation, imageability, and experiential integration with the environment.

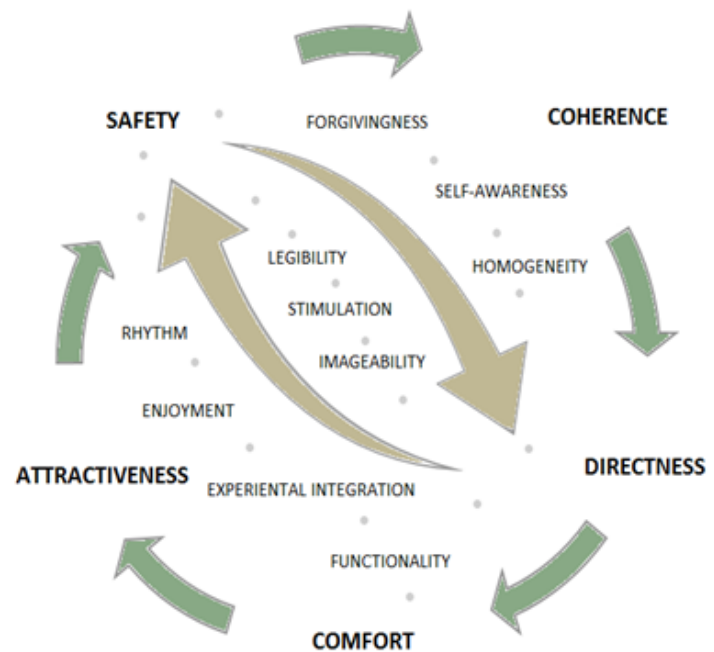


Figure 1: A Basic and Secondary Criteria for Providing Good Conditions for Bicycle Traffic. Source: Polonca Andrejčič Mušič, May 2015.

**Firstly, let us introduce the basic terminology relevant for the study: (Figure 1)**

Sources: Expert complemented by sources (CROW, 2007), (Nasuita Lompair, 2011) and (Dufour, 2010).

**Traffic safety** is the basic requirement that must be given great priority, since cyclists are among the most vulnerable road users. Significant risk is caused by considerable differences in terms of traffic mass and speed of various modes of transport, so we must:

- Reduce the volume and speed (in mixed use the 30 km/h speed limit is recommended).
- Separate cyclists from fast-moving and heavily motorized traffic (reduction of the number of dangerous encounters).
- Implement understandable, clearly legible, and recognisable arrangements that allow all users to adapt their behaviour.

**Directness** of cycling connections enable s cyclists to reach their destination as quickly and as simply as possible (by reducing the number of stops at crossings, adjusting the operation of traffic lights, regulating gradients, etc.). The diversions should be short ( $\leq 20\%$  longer than the shortest route). Over short-distances, the time of cycling travel vs. car travel should be competitive.

**Coherence and connectivity** means that there are no discontinuities between any potential origins and destinations. Discontinuities and obstructions negatively affect the choice of the bicycle as the usual daily means of transport. Home, work, school, and services must be easily accessible by bike, i.e. “from door to door”, and linked with the overall urban network, as well as with other networks, particularly with public transport stops and important hubs. Urban cycling network connections should be linked to long-distance cycling routes in natural landscape.

**Attractiveness** means that the cycling infrastructure is well integrated with the surrounding area. Partially, this perception is individual; however, through appropriate urban planning and urban design we must meet the criteria of good imageability of public space, which encourages us to cycle. The term attractiveness includes also the sense of “personal safety”, which is particularly important in the evening and at night.

**Comfort** is created by a pleasant and relaxing cycling experience without unnecessary stress. The areas that obstruct cycling in conjunction with poor design, implementation, or maintenance can cause unwanted inconveniences, vibrations, and dangers, while more control and concentration during rides is required.

**Functionality** means that we choose an appropriately safe cycling network model which allows movement to function as intended, and destinations to be connected as well as possible. Urban streets, roads, and spaces are always multifunctional.

**Homogeneity** means reducing the relative speed, mass, and directional differences of various road users who share the common transport space (also mixed use), which positively affects the level of the consequences of the road accidents that might happen. Traffic surfaces must be separated (separate infrastructure for cyclists) for various users when the relative speed, mass, and direction are not in a homogeneous relationship.

**Legibility:** The environment that enables us to identify, assess, accept, and control challenges and risks is one of the basic conditions for a healthy emotional, physical, social, mental, and creative development of mankind, therefore, we always have to give cyclists plenty of clearance. Legibility of

cycling facilities allows better orientation within the space and help to the improvement of traffic safety.

**Forgivingness** refers to the possibility of dealing with risks to the limits of their control. Cycling surfaces must be constructed in such a way that a certain tolerance allows for minor errors.

**Rhythm** is something that flows without interruptions, connected to one's movement, without disjunctions. In terms of cycling, rhythm refers to seamless bike rides, in continuously repeated sequences, without interruptions and acyclic stopping. It is a notion referring to distinct but interdependent and continuously recurring movements and events, organised as cyclic occurrences as a function of distance and time.

**Enjoyment** occurs in four phases: perception, feeling, contact, and wish. For example, we cycle along a nice cycle track in a pleasant environment and we are overcome with the feeling of freedom and independence. We try to imagine how the journey continues. If during cycling, we forget about our problems, fears, and dangers, which we otherwise experience in traffic, we feel that cycling is a beautiful and pleasant activity and we continue riding with enjoyment. If the feeling is strong enough, we experience cycling as something joyful, and want to do it again.

**Imageability:** The key images must evoke positive feelings that bring a sense of good orientation, safety, as well as satisfaction with the expectations. Various target groups are susceptible to various kinds of messages, e.g. schoolchildren have different expectations than the elderly, families, or sportspeople, while women's needs are different from those of men. Excessive traffic signalling does not bring across good messages, particularly if poorly designed. Most traffic signs adversely affect the image of space.

**Stimulation** positively affects the further functioning of bicycle traffic, and increases people's activity and desire to cycle in their daily lives as well as for sports and leisure. To a large number of people, particularly during the recession, cycling offers both temporally and financially efficient opportunities; furthermore, a growing number of people take up cycling for health reasons.

**Experiential integration of bicycle connections with the environment:** The cycling environment is a unique and special place offering many great opportunities to a variety of people. It means the harmonization of human beings with their environment, which they also help to develop and adapt to their needs. Experientially integrated cycling surfaces aim to provide the grounds for exploration, discovery, and learning about the surrounding areas.

### 3. INTERDISCIPLINARY SCIENTIFIC AND RESEARCH METHODOLOGY FOR A HOLISTIC APPROACH TO INTEGRATION OF BICYCLE TRAFFIC INTO THE URBAN LANDSCAPE

With the new anthropocentric approach, humans are taken as the starting point of our study. This means that the environment and good cycling conditions are adapted to humans as the central criterion. The new approach requires that all activities must be conducted in a comprehensive and coor-

minated manner, with the ongoing and simultaneous inclusion of the public in the development process. We think that good cycling conditions can be efficiently provided and created by integrated and guided multidisciplinary activities in four main areas (Figure 2):

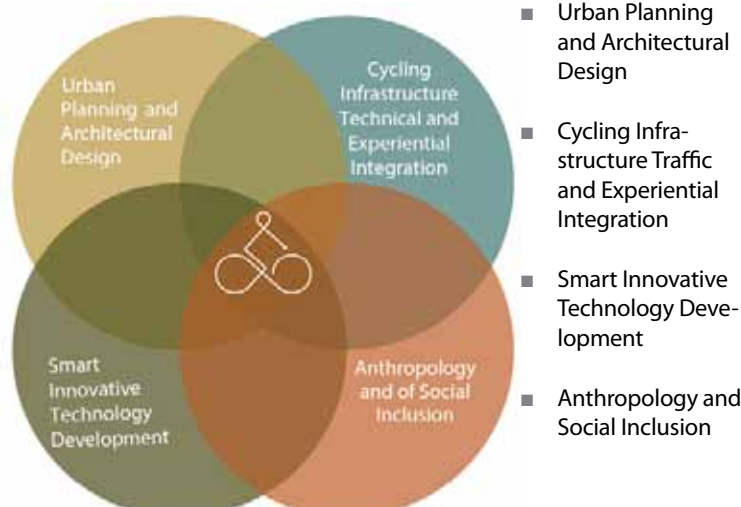


Figure 2: A Holistic Approach to the Good Cycling Traffic Conditions Development in the Urban Landscape. Source: Polonca Andrejčič Mušič, 2014.

High-quality cycling infrastructure positively affects cycling conditions, as well as the image of the city and the landscape, and consequently improves the general living conditions. Thus, managing bicycle traffic is not only the domain of transport experts, but must be addressed in a multidisciplinary manner in the light of various disciplines. Therefore, we use a scientific approach to solve this problem, i.e. by including humans and their relationship with the cycling environment.

Only well-coordinated urban planning and urban design, and efficient technical cycling infrastructure design, while promoting bicycle traffic, i.e. by linking urban and extra-urban areas, can lead to an overall integration of bicycle traffic into the urban landscape. Such an approach can make for improvements in:

- traffic safety, legibility, and coherence of cycling routes,
- functionality, directness, and usefulness of cycling routes,
- homogeneity, stimulation, comfort, and attractiveness of cycling routes.

Balanced provision of these elements allows for experiential integration of cycling surfaces with the environment, while it also provides the cyclists with an appropriate rhythm, image, and enjoyment. This can significantly contribute to growth in the number of cyclists while increase the range of bicycle use and the diversity of users. Innovative technological development while smart technology can greatly improve communication between physical and digital world in terms of providing information on the current cycling traffic conditions towards to achieve greater user satisfaction..

It is important that urban planners and transport experts realize that people's decision to cycle cannot be taken for granted. The key to success is in the creation of an accessible, friendly, and properly maintained urban landscape environment. In this context, the integration of bicycle traffic throughout the urban landscape dimension is the new effective mobility management strategic tool to widen the field of cycling traffic, plus to achieve a rise in diversity of different users, and thus significantly contribute to an increase in the number of cyclists.

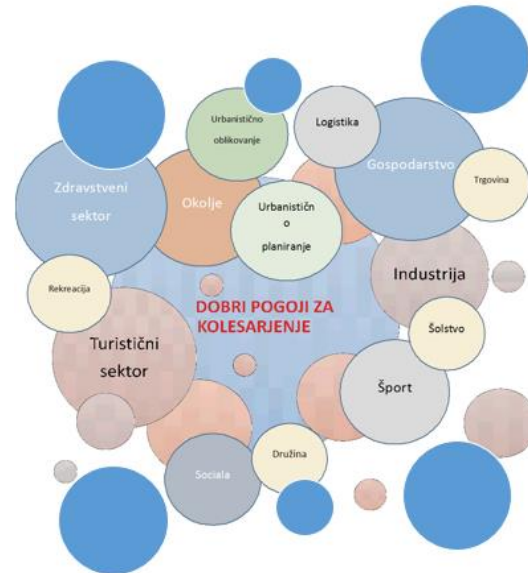


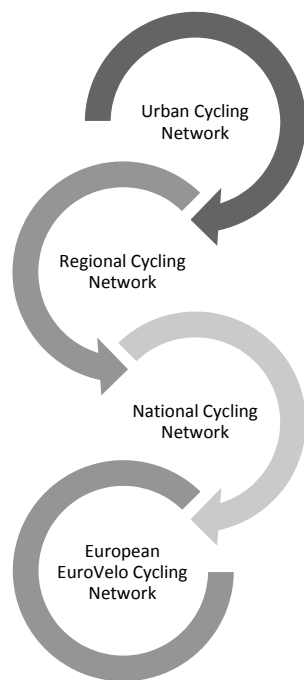
Figure 3: An Integrated Approach within Balanced Coordination of Various Sectors and Policies. Source: Polonca Andrejčič Mušič, 2014.

A cyclist's perception of space is fundamentally different from that of a car driver, so at the same time the bicycle can be an excellent means of transport, the perfect way of recreation and a good tool for understanding the space in which cyclists move and experience the true meaning of urban planning. In the study, the various theoretical and methodological approaches to measuring, collecting, evaluating, assessing, comparing, and integrating data, criteria, and principles, as are relevant to various users, helped us to compare facts and study the processes and the relevant important relationships. These approaches also helped us to discover the similarities and differences of the most important studied notions and phenomena, by using a comparative method and a classification to determine their value and position in the system as a whole. With the objective of improving the environment and people's habits, we analysed all the criteria needed for an efficient integration of bicycle traffic into our lives. Only by comprehensively using the means of urban planning and technical methodological analyses, it is possible to break down the complex phenomena into structural components. By addressing their interdependence and various consequences, we can find the conditions for the optimum functioning of the system as a whole (Figure 3). The important lessons learnt and findings will be shown on a Pilot Case Study.

#### 4. BICYCLE TRAFFIC URBAN PLANNING ANALYSIS IN THE SLOVENE COASTAL AREA: Pilot Case Study in the Territory of Koper, Izola, Piran, and Ankaran Municipalities

Different people experience the city and the landscape in different ways. Furthermore, different factors affect our experience of both the city and the landscape. These can be experienced in various times, weather conditions, and various current roles. Cyclists have their own specific perception, specific needs, and behaviour, which must be considered in designing cycling infrastructure and its spatial integration. The experience of riding a bicycle is strongly connected to experiencing the environment and all its elements, may that be urban or rural. This was tested on a practical case. In the framework of a European project named the PKP Project – “A Creative Way

Figure 4: The Connectivity of Local, Regional, National, and European Systems. Source: Polonca Andrejčič Mušič, March 2015.



to Practical Knowledge”, conducted in 2015 at the University of Ljubljana, Faculty of Architecture, and headed by Prof. Dr. Ilka Čerpes, we tried to find the best possible conditions to integrate bicycle traffic with the urban landscape along the pilot site of the so-called Parenzana long-distance cycling route. It is a new element, which connects the major towns and local cultural, natural, and tourist attractions along the Slovenian coastal urban landscape area. The Parenzana long-distance route is a cycling infrastructure connection of varying lengths and sequences of different technical forms, i.e. separate cycling ways, tracks, lanes, or mixed use; which is also advantageously used by strollers or low volume of motor traffic. It mostly runs along the abandoned Parenzana railway line and cleverly connects the past and the present.

Between 1902 and 1935, the now abandoned Parenzana railway track connected Trieste and Poreč as a narrow gauge railway. It passed through many coastal towns and left an indelible mark on the development of communications in the region. The route of this once important communication, which has long been out of operation due to the changed technology, was largely reconstructed into a national long-distance cycling connection. It has international significance, since it connects Italy, Slovenia, and Croatia and at the same time, in a broader sense, it is a part of the European Cycling Network (Figure 4). Within the EuroVelo Mediterranean Route No. 8 (Internet 1), which stretches from Spain, across France, Monaco, Italy, through Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania, Greece, to Cyprus, it has a cross-border meaning. In Slovenia, to emphasise its local, natural, cultural, and historical sites and the range of tourist services, the cycling route winds its way along many tourist spots and picturesque small towns (Figure 5), with rich cultural, natural, and historical heritage, and offers a pleasant experience during bike riding. In the landscape, the route offers beautiful views of vineyards, olive groves, fields while it runs along forest land (Figure 7), and the sea (Figure 6). The cyclists have easy access to protected natural areas, and to some other areas where beach is to be redeveloped. With the gradual completion of the missing sections, the Parenzana cycling route is becoming more and more appropriate for less experienced cyclists and for family cycling, and is thus accessible to a wide range of users.

The Parenzana long-distance cycling connection has a multifunctional character (Figure 4), while the individual sections give pleasure to many tourists and recreational cyclists, or provide the opportunity to cycle to work or run



Figure 5: Typical appearance of Parenzana corridor in the urban environment. (photos PKP Team, March 28th, 2015).

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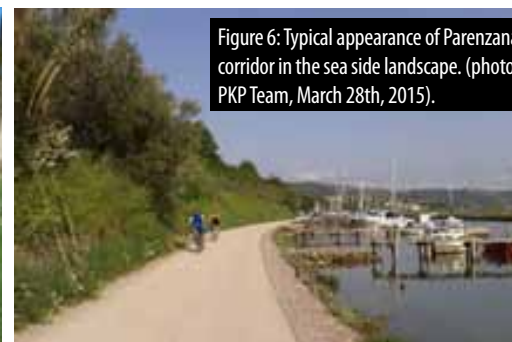


Figure 6: Typical appearance of Parenzana corridor in the sea side landscape. (photos PKP Team, March 28th, 2015).



Figure 7: Typical appearance of Parenzana corridor in the natural landscape. (photos PKP Team, March, 28th, 2015).

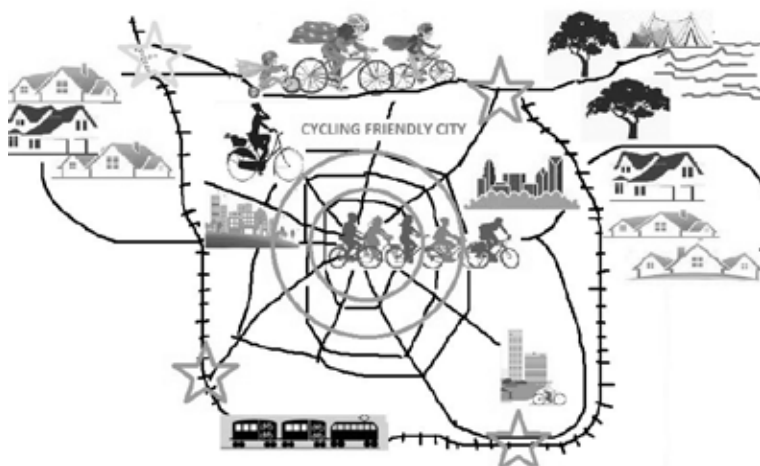


Figure 8: Urban Landscape Cycling Traffic Holistic Integration. Source: Polonca Andrejčič Mušič, March 2015

daily errands in and around urban areas (Figure 5). Intermodal combinations of bicycle traffic with some other sustainable transport modes, i.e. train, bus public transport, maritime transport, even increase these opportunities. The integrated hierarchical system, which intertwiningly links the urban cycling connections to the Parenzana national long-distance cycling route, and its inclusion into the EuroVelo Network is shown in the PKP project (Čerpes, 2015) and in the Workshop (Suau, 2015) where the intended multifunctional

use was specified all along the long-distance cycle path, separately for the individual sections. The urban cycling and extra-urban cycling connections meet at interchange points (Figure 8), which have been upgraded with a new urban meaning in order to increase the attractiveness of cycling in the area.

The entire long-distance cycling route course was divided into ten work sections. For each individual section, the characteristic features, e.g. the average travel time and its intended multifunctional use, were set. To this end, we studied the course of the cycling route across three characteristic areas: compact, more dispersed urban areas, and natural landscape areas (Figures 5-7).

During field visits we found that despite the many years of engineering design experience, along the Parenzana cycling route there is still a lack in terms of adequate selection and appropriate placement of the cycling infrastructure, as well as of networking structure, homogeneity, connectivity, and detailed planning methodology. These drawbacks reduce bicycle traffic efficiency, attractiveness, and safety on the route. In solving extensive spatial problems, such as networking and the comprehensive integration of cycling traffic with the entire urban system, as with all transport systems, it is necessary to consider the coexistence of various spatial contexts adapted to the users, i.e. besides technical requirements considered in the cycling network design, to provide a proper syntax of the environment.

During the journey, the cyclists are critical observers of the space they move in, and the experience of riding a bicycle is strongly connected to experiencing all the sequences that they detect in the movement. A pleasant, organised environment, with many positive visual sequences, where cyclists



Chart 1: The most common purpose for cycling. Source: Polonca Andrejčič Mušič, mentor Ilka Čerpes, the survey on the Parenzana cycling route's experiential integration with the urban landscape, 2015

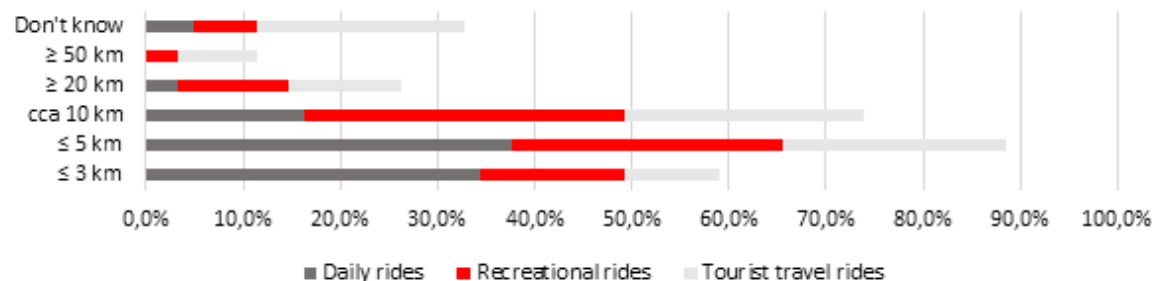
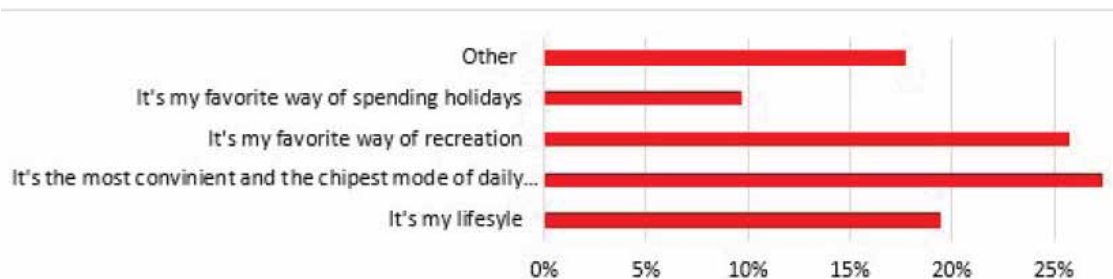


Chart 2: The Typical Distance of Cycling in One Direction according to Different Purposes of Riding a Bike. Source: Polonca Andrejčič Mušič, mentor Ilka Čerpes, the survey on the Parenzana cycling route's experiential integration with the urban landscape, 2015.

can simply orient themselves and easily move around, contributes to the attractiveness of cycling. To provide the Parenzana cycling route with the rhythm, enjoyment, imageability, expressiveness, and stimulation, we studied the elements affecting the cycling routes' experiential integration with the environment on the actual case study.

## 5. PARENZANA CYCLING ROUTE'S EXPERIENTIAL INTEGRATION WITH THE URBAN LANDSCAPE – THE SURVEY

Some very important, but less researched criteria that place the perception of the cycling environment and human experience of cycling to the fore can only be evaluated by surveying the gender, age, occupation, and social group of cyclists.

Location of the Survey	Parenzana Cycling Route: Koper, Žusterna, Izola
Date of the Survey	12th June, 2015
Day of the week and time of day of the Survey	Friday, from 10 a.m. to 6 p.m.
Weather conditions during the Survey	Sunny, 27 °C
Total No. of Respondents	61

The study included 67% men and 33% women, more than half of them were aged between 26 and 50 years. 27.4% of respondents believe that cycling

is the best choice for daily commuting to work, school, shop, etc. 25.8% of respondents believe that cycling is an excellent way of recreation (Chart 1).

More than 50% of respondents cycle only occasionally (seasonally) and do not cycle in cold and bad weather conditions. Most of the riders do not have cycling holidays (Chart 2).

## Summary of the Survey Results

As expected from previous field observations and expert revision assessment, from the analysis follows that most of the respondents rated the urban landscape experiential integration of the Parenzana Bike Route, i.e. pleasure, imageability, personal safety, stimulation, attractiveness and enjoyment, as very good. In the opinion of most respondents, while riding the Parenzana Bike Route, tolerant and responsible behaviour of all road users is recognised. Therefore, the bike route can provide an excellent experience, whatever the purpose of cycling. But some the respondents' opinion is also that there are some drawbacks, i.e. the lack of homogeneity, legibility, and the road safety associated with it. In some sections, there is a lack of path directness and predictability. Therefore below, some directions and practical recommendations are given to increase user satisfaction and improve the cycling conditions in the area.

## Recommendations for improving the bicycle traffic in the Slovene coastal area

The separate approach to solving everyday utilitarian bicycle traffic in urban areas and recreational cycling traffic or long-distance tourist travel cycling in landscape areas is false, flawed, and lacking perspective. A new integrated

approach deal with bicycle traffic issues in coordinated action at all spatial, organizational, sectoral, and professional levels (Figures 2, 3, 4, 8). We find that the individual elements relevant for humans, such as safety, directness, coherence, attractiveness, comfort and functionality, homogeneity, legibility, forgivingness, responsible self-awareness, and rhythm, enjoyment, imageability, expressiveness, and stimulation are strongly interdependent and complementary to each other. Based on field visits (Figure 10) and the comprehensive scientific studying of the suitability of integration of the Parenzana cycling route with the coastal environment, we reached some substantive conclusions, and propose several systematic improvements for long-distance, tourist and recreational cycling route sections, as well as of urban cycling sections, serving daily cycling to work, school, shopping, or to go on errands. In the continuation, as part of drafting the technical project documentation, we propose the following:

- The separation of bicycle and motorized traffic and the provision of a continuous, seamless course of the cycling connection in the form of a separate cycling infrastructure, i.e. a cycling way, track, or lane, is desired. This means the reorganisation of some sections that fail to meet these requirements and are now dangerous, inhomogeneous, uncomfortable, and unattractive to cyclists, and therefore, fail to provide the appropriate rhythm and pleasure.
- The unintelligible traffic signs must be unified and street furniture must be uniformly placed and organised all along the route.
- We propose the installation of additional rest areas, which should provide the view of important landscape landmarks and where drinking water supply is available, including the installation of shelters in case of bad weather, and benches and tables.
- Installation of noise barriers to protect cyclists from exhaust fumes and noise, particularly in some cycling route areas parallel to heavy traffic roads.
- We propose the provision of authentic horticultural arrangements, regular maintenance of avenues, park planting, while defining new substantive arrangements of the parks along the cycling route.
- Removal of obstructive vegetation to prevent traffic safety while enabling the views of authentic area accents.
- To ensure the multimodal travelling choices of bicycle and other sustainable transport modes, i.e. train, bus or maritime traffic, and secure bicycle storage. It is necessary to install new park & ride facilities at interchange areas.
- A bike sharing system, information centres, and fast and simple food and drink supply have to be set up.
- To provide connectivity between the long-distance tourist cycling route and urban cycling infrastructure while provide of hierarchic intersection and clear signposting at interchange sections.
- To ensure a homogenous networking of urban cycling connections, e.g. in Koper, finding the ways to mitigate the disturbing edges, and considering the possibility of installing an elevator, a cable way, a regular bike & bus line, or an electric bike sharing system.
- To provide better bicycle access to the beach, and to reconstruct the

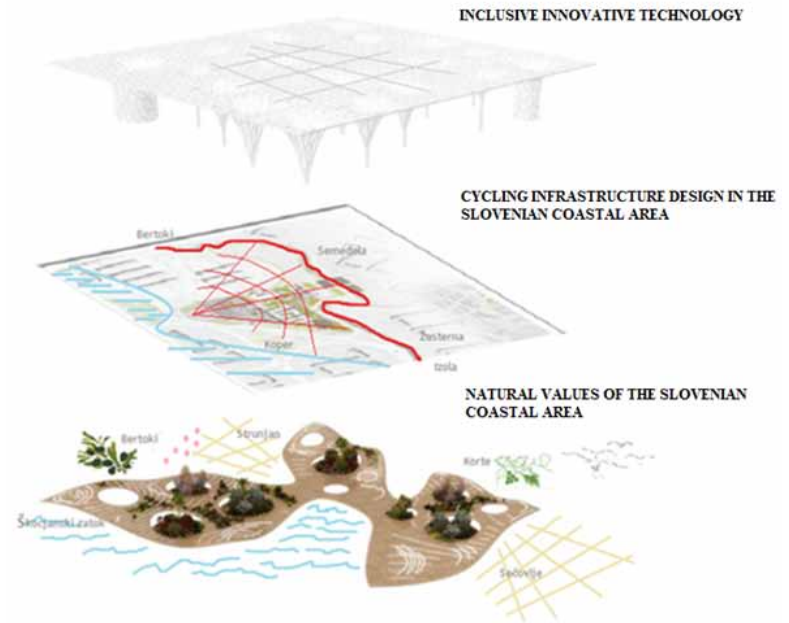


Figure 9: Smart growth of Slovenia's Coastal Area Cycling Network. Source: Polonca Andrejčič Mušič, April 2015.

coastal road and expand it into a multi-purpose lane for both cyclists and pedestrians, e.g. the area between Koper and Izola.

- To preserve protected natural areas and appropriately signpost historical, cultural, tour-ist, and culinary sites.
- Where the cycling route crosses the main, heavily congested thoroughfares for motor vehicles, we propose – for the purpose of improving traffic safety – the installation of smart cyclist counters in combination with Intelligent Transportation Systems (ITS), which detect cyclists and thus via flashing signals warn motor vehicle drivers about cyclists' intention to cross the road.
- The conditions for bicycle traffic can be significantly improved through a network of inclusive innovative digital technology, which was developed within the PKP Project and enables the implementation of "Smart Cycling Connections." (Figure 9).

## 6. THE RELEVANCE OF THE STUDY RESULTS AGAINST THE BACKGROUND OF PREVIOUS SCIENTIFIC RESEARCH AND MODERN URBAN PLANNING REQUIREMENTS

Each place has its own public image, as a combination of its many individual images. A recognizable and clearly legible and noticeable environment invites people to take part in it. Common clear images are needed for the individual to successfully function in his environment while also interact with others (Lynch, 1960). Lynch defined five main types of image elements that



Figure 10: Cycling Traffic Quality Audit as a Tool for its Improved Development. (photo Polonca Andrejčič Mušič; March 28th, 2015).

can form the image of a space: paths, edges, districts, nodes, and landmarks. The same model was considered in our study.

The legibility of individual environmental systems and subsystems is highly important for a good image of space, and the welfare of all people, i.e. residents and visitors. In a detailed manner, the study examines the integration of cycling infrastructure with the environment, which increases bicycle use and creates better living conditions. The organisation of cycling infrastructure by patterns that are predictable and recognisable plays a major role, as this gives them a sense of traffic safety, but also the sense of personal and emotional safety, which is important for attractiveness of a bicycle route, and can only be ensured by proper design of the infrastructure and its surroundings as a whole. Since the system is alive, we can never achieve a perfect level of its design, but rather we strive for such organisation that allows for continuous further development. The regulations cannot provide unified uses of proper technical solutions for each single location, but rather the technical solutions must provide syntaxes and be properly contextualized within its surroundings, while they also allow for low-stress connectivity. Therefore, in addressing spatial problems such as networking and integration of cycling connections with the urban system, it is also necessary to consider the "Pattern Language" (Alexander, 1977), as symbolising the coexistence of various spatial contexts. New urbanism is based on the principle of designing people-friendly public spaces that serve at the pleasure of people, since urban design is a process of creating a better environment for people (Carmona, 2003). We want to offer people better conditions and equal opportunities in the sense of a comprehensive approach to living. Cyclists move in space together with other users. According to Danish Gehl Architects, bicycle-friendly cities can help to create a more socially inclusive and friendly environment, with a higher freedom of mobility and the cooperation of all people (Gehl, 2010). However, for the successful, systematic

organization of high-quality sustainable mobility, in addition to exclusively urban cycling networks, the comprehensive networks of long-distance cycling connections must be designed in a way to provide access to all regional functional urban areas. A valuable role of cycling is that the bicycle allows us to better experience the dimensions of the space that we move in. This means that we can better understand the real meaning of urban landscape planning. In other words, compared to motor drivers, cyclists can more emotionally recognize both the beat of the city and the interaction of urban and rural environments, acting as a whole (Figure 8). Urban planning and urban design are two very important factors of this. Through our research, which puts humans at the heart of planning, we have revealed that we follow pre-vios scientific knowledge (Appleyard, 2003), which by improving the image of the place, allow people a better living environment.

At the same time, the pilot case study demonstrated that we also follow the trends of new contemporary requirements of Europe as a sustainable community. The image of space strongly influences our decisions concerning the choice of the bicycle as a daily means of transport. Environments with a better image reach higher modal shares in bicycle traffic and consequently enable better living conditions. Planning of quality and recognisable city areas, environmental responsibility, social equality, and economic viability is a major challenge for all cities, but the settlement pattern in Europe, with many proximate polycentric cities, creates a broader urban space where city boundaries are no longer clear. An important part of traffic flows passes across the borders of cities, municipalities, regions, and even beyond countries. The new European legislative approaches support the implementation of Polycentric Sustainable Urban Mobility Plans, Poly SUMP (Adell et al., 2014), which include the regional sustainable development of both areas, i.e. urban and extra-urban. In line with the new comprehensive European TEN-T policy (Internet 2), for transport infrastructure development it is important to provi-

de the connectivity of local, regional, national, and European systems. Urban cycling networks must be appropriately linked to regional or national cycling networks, and further to the corridors of transnational cycling connections (Figure 4), i.e. EuroVelo Routes (Internet 1). In the pilot case study of the PKP project and in the Workshop (Suau, 2015) we demonstrated that the Parenzana cycling route is an exemplary case of such guidelines.

## 7. CONCLUSIONS

We do not want to force people regarding their choice of a means of transport, but we want to offer people better conditions and equal opportunities in the sense of a comprehensive approach to living. To achieve global sustainable goals all cities must develop harmoniously, together with their associated functional regions, in both urban and extra-urban areas. If we want cycling infrastructure to provide rhythm, enjoyment, imageability, expressiveness, stimulation and experiential integration with the environment – in addition to traffic safety – we must fully examine all the experiential factors along cycling routes and then, by using various design and technical approaches, improve the routes' traffic safety, directness, and connectivity. Urban planning approaches can improve the conditions of using an area, further provide people with a better environment, and allow for a healthier lifestyle.

The level of commitment to a sustainable approach is a reflection of a population's culture and awareness. Slovenia's advantages lie in its diverse distribution of many tourist centres, small distances, and an abundance of cultural and historical sites, a relatively clean environment, and a favourable geographical position. The country is criss-crossed with fields, forests, and parks, which are without doubt the most appropriate locations for tourist and recreational trails; therefore, proper urban planning can help us create an excellent and attractive cycling environment. By designing an overall strategy, supported by a coherent sustainable mobility development and sustainable development of urban and extra-urban areas, based as it is on human needs, we can find a new framework of integrating the cycling transport with the environment. A new methodology of sensing and perceiving the cycling environment as a whole, which we developed in the pilot case study of the Parenzana long-distance cycling connection is easily transferable to other comparable areas in Slovenia, Europe, and the world at large.

## Acknowledgements

I would sincerely like to thank Prof. Dr. Ilka Čerpes for all her expertise, as she greatly contributed to the study with her extensive experience in urban planning and design. Working with her is a pleasure, and one cannot help but feel the positive energy and dedication to academic research that Professor Ilka Čerpes exudes, while she is always happy to share this wealth with her students. I also thank all the students at the Faculty of Architecture in Ljubljana, who enthusiastically took part in the European project "A Creative Way to Practical Knowledge".

Special thanks goes to EU urban assessor and principal tutor of the seminar workshop Network of Resting Points for Cyclists as an Catalyst of tourist De-

velopment Mr. Cristian Suau from the University of Strathclyde, Department of Architecture, Glasgow, UK for his fruitful consultancy to all participants of the workshop which took place at the University in Ljubljana, Faculty of Architecture in the frame of the European funds financed project Internationalisation of the University in Ljubljana.



The PKP project »Pilot Case Study for Placement and Design of New Cycling Counters«, conducted at the Faculty of Architecture, University of Ljubljana, 2015, was partly financed by the European Union - European Social Fund and carried out under the direct confirmation of the operation-program »After a creative way to practical knowledge« within the Operational Programme Human Resources Development 2007-2013, Priority axis 1: Promoting entrepreneurship and adaptability, and priority policies 1.3 Scholarship schemes.



The Report of Seminar Workshop: Network of resting points for cyclists as a catalyst of tourist development, Suau, C., Čerpes, I., 2015, Ljubljana, Fakulteta za arhitekturo was developed in the frame of the European found financed project Internationalisation of the University in Ljubljana. (»Internacionalizacija Univerze v Ljubljani, Razvoj človeških virov in vseživljenjskega učenja«; prednostne usmeritve 3.3 Kakovost, konkurenčnost in odzivnost visokega šolstva«).

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- Internet 2: <http://www.eurovelo.org> (Accessed on 20 June 2015)