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Soft infrastructure as landscape – a methodology for the assessment and improvement of the user experience of soft mobility

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Abstract

How could Soft Infrastructure qualify the landscape around them? This study aims to provide a methodological framework for the analysis and for the design of cycling paths as a mean to discover the landscape and its qualities. The research project used case studies from the Western United States and in particular the city of Eugene, Oregon to envision a methodology to qualify Cycling Paths in the *Landscape*.

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Keywords: Soft infrastructure; cycling path; soft mobility; landscape; bike; Oregon; West Coast; urban mobility

1. Introduction

In recent years, there has been a dramatic shift in the way politicians, planners and citizens are addressing the need for mobility within our urban areas. Soft mobility, that includes all forms of non-motorized transport that use only "human energy", (Swiss Department of the Environment, Transport, Energy and Communications, 2002), has come to be considered a very viable alternative to the automobile, with important benefits to human health, urban livability and considerable reduction of fossil fuel dependence and air pollution. In this view the concept of "soft

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infrastructure” is strictly referred to a physical infrastructure (e.g. cycling paths) that embraces any forms of “soft mobility”. Therefore “soft infrastructure” are the material support of “soft mobility” and can be considered, indeed, a cornerstone of the sustainable mobility able to optimize urban livability, by keeping the individual right to move (Rosa Anna La Rocca, 2010). Given the importance of soft infrastructure to the sustainability and resilience of our cities, more research is needed to look at both quantitative and qualitative dimensions that may encourage people to switch to this mode. Nowadays planners and designers are called to project or to redevelop parts of the city giving way to new soft infrastructure, not always an easy task. As demonstrated in the study by Adam Martin (University of East Anglia UK, 2014), bicycling commuting, but also bicycling in general ameliorates stress and boosts psychological well-being. In order to achieve a good cycling path project, designers have to combine pragmatic and functional requirements with perceptual forms of urban environments. It is not possible to think of cycling path as a mere connection from point A to point B. Instead, it is necessary to concentrate on its surrounding environment to improve the user’s experience as well. Soft infrastructure design always depends on the city where it has to be integrated, because people’s “choice to bike” is a matter of place and culture. This idea has been deeply investigated by Steven Fleming (2012) who carried out a comparison among the soft infrastructure design and the cycling style of different cities from several countries.

According to what previously stated, this study will provide a methodological framework for the design and the analysis of cycling paths with the aims to improve sustainability and bike-ability of soft infrastructure, associated with user’s comfort and image-ability of urban landscape.

1.1. Research Phases

The research encompasses two phases:

- The first phase presents the main case study used to set the methodological framework for the analysis and the design of a cycling path.
- The second phase tests the methodological framework in other contexts, with case studies from the Western United States in order to verify its validity and its reliability.

2. Case study: Amazon Creek Path

The first part of the research was carried out at the University of Oregon in Eugene (Oregon). It presents the analysis of soft mobility qualities along cycling paths in Eugene and in particular the case study of “Amazon Creek Path”. Amazon Creek Path was chosen for many different reasons; firstly because it runs through many varied types of landscapes and environments. From South-East to North-West going through Amazon Park, the path passes through an urban neighborhood, an industrial area and Fern Ridge Reserve. Another remarkable fact about this path that makes it instrumental for the case study is the range of motor density experienced alongside. Amazon Creek Path runs along separated paths closed to motorized transportation devices, on higher trafficked streets, as well as on shared roadways with lower traffic levels. This diversity along the path provides users with different experiences depending on the landscape they are crossing.

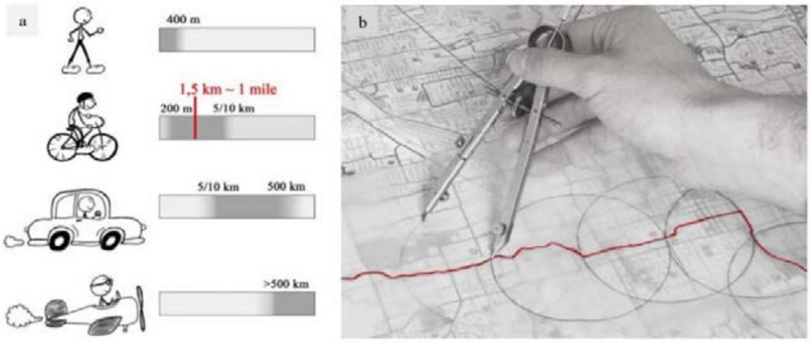

Fig. 1 (a) devices competitiveness as a function of the distance, (b) path's partitioning with 1,5 km intervals.

Analysis of Amazon Creek Path was performed according to a rigorous sampling strategy involving the collection of data at 1,5 km intervals along the biking trail, each representing a 5 to 6 minute bike ride. The specific distance was chosen because of the scientific data presented by Krizek K. and Johnson, (2007) and D.T. Smith Jr. (1976), both of which underline that covering a distance of 1,5 km is more convenient (considering time and costs) by bicycle than any other means of travel.

The diagrams presented in the previous page illustrate how longer distances compete with drivers and with motorized vehicles in general, while shorter distances will appeal to pedestrians. In this way 1,5 km is used as a standard module to carry out this phase of the research and establish a framework.

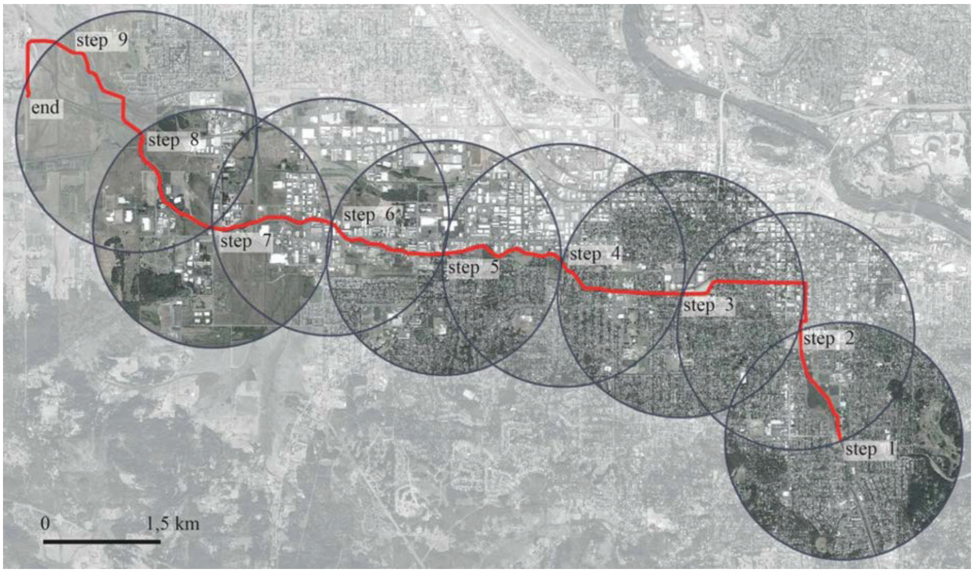

Fig. 2. Amazon Creek Path divided into 1,5 km intervals.

2.1. Data Collection

Daily cycling paths use, both as a researcher and user, has captured parts of the local culture; its customs and Genius Loci. For each step of the bike trail, has been produced a rigorous inventory of physical indicators of landscape, bike trail qualities and design features, which have been identified in the literature as contributing to positive perceptions by users (Jacob Allan B., 1995). In addition, a series of phenomenological qualities have been mapped using a visual strategy involving photography and sketching.

The strength of this strategy lies in the strictness applied in the data collection. Data was divided in two analysis tables. The first examines only quantitative and objective data while the second table explores qualitative and subjective data.

Table One: takes into consideration the area delineated by the first's step circle. Through a progressive sequence of increasing scales, it is possible to investigate sequentially:

- the land use around the cycling path (territorial scale);
- the dimension of the cycling path and its relation with other infrastructures, services and facilities (local scale);
- the relationship between the cycling path and its environment, plants and biodiversity (local and detail scale);
- materials and the urban furniture of the cycling path environment (detail scale).

Maps are better to localize services and points of interest around the cycling path. Landscape sections illustrate the spatial relationship between cycling path and surrounding areas as well as their physical dimension. A 360 degree panorama completes Table One; it is composed by photos taken every 45 degree (North, North/East, East, etc.) that give the real sense of the surrounding space.

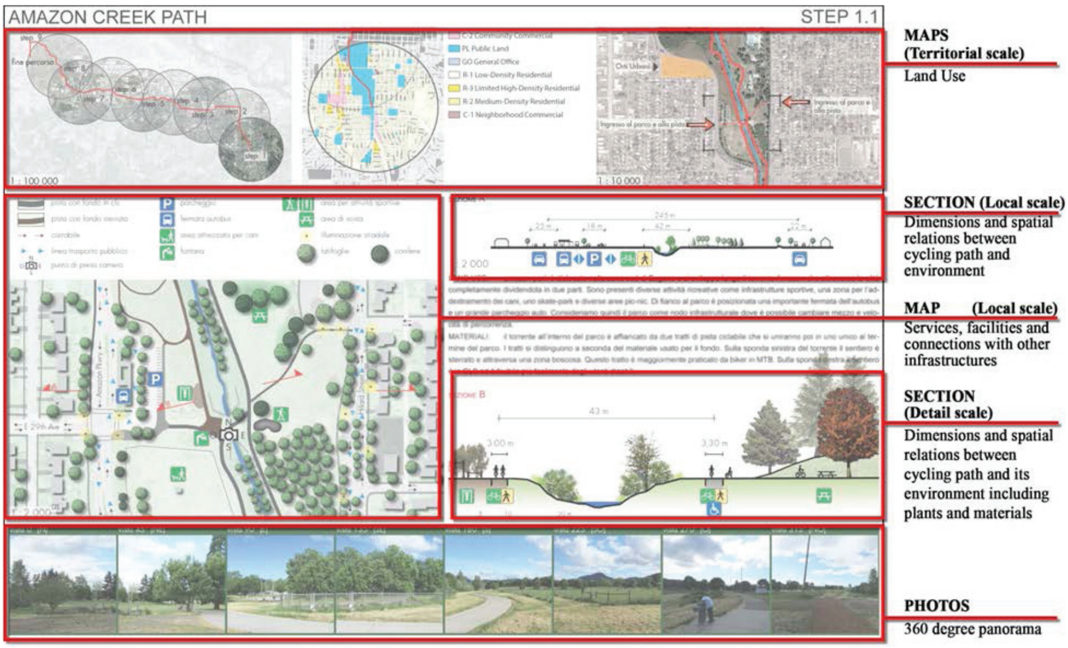

Fig. 3. STEP 1_Table One presenting quantitative and objective data.

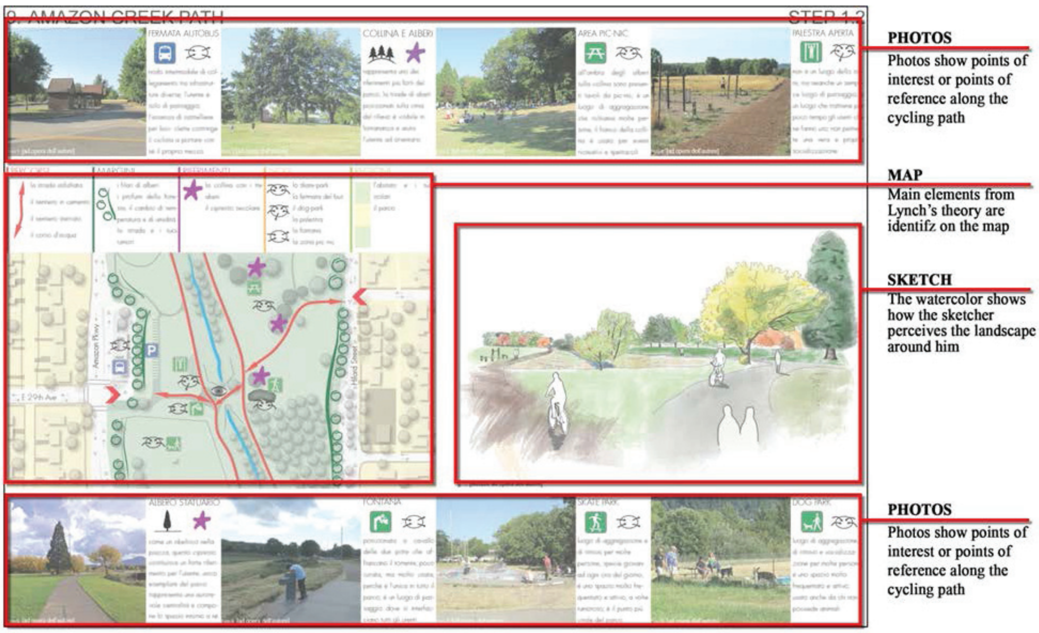

Fig. 4. STEP 1_Table Two presenting qualitative and subjective data.

Table Two presents all qualitative and subjective data. For each step, a series of phenomenological qualities have been mapped as per to Kevin Lynch's study (1960). Lynch states five elements in the following order: path, edges, district, nodes, landmarks which are identified along the cycling path to investigate the "imageability" of a place.

According to Lynch every user looks around the cycling path trying to codify the landscape by shapes, colors, smells or particular points of view. Therefore this analysis is useful to understand the quality of the cycling path from a user's point of view. The photos show points of interests at each step that correspond to Lynch's five elements and the watercolor illustrations demonstrate how the observer perceives the surrounding landscape.

Both tables one and two, use the same template in order to analyze data collected along the entire cycling path; this means that at each step of the path there are two analysis tables (one for quantitative data and one for qualitative data).

2.2. Data Processing

Following the collection data phase of Amazon Creek Path, two data groups were created and data was divided as objective or subjective. For both groups, data was identified by a series of factors recurring at each step of the path, which represent the essential basis for the analysis of the cycling path. Respectively five quantitative factors and five qualitative factors as shown in the table below.

To envision the methodological framework for the analysis and the design of the cycling path it is necessary to evaluate and measure each single factor employing specific indicators. It is easy to establish indicators with quantitative data, but it is not easy to establish indicators with qualitative data (e.g. to quantify the beauty of a cycling path). For this reason the qualitative factors evaluation has been completed with a survey submitted to the users met along the cycling path during the research period. The survey makes reference to the Contingent Valuation Method (a non-market valuation method used to estimate values for all kinds of ecosystem and environmental service) S.V. Ciriacy-Wantrup (1967). The group of users surveyed consisted in different categories (students, employees, retired, homeless, tourists) that were arranged independently from the type of usage (commuting, leisure time, etc.) and frequency of use they were having of the cycling path (habitually, occasionally, rarely, first time). Example of the survey statements supplied to users is reported in the next page (Table 2).

In order to arrange a synthetic evaluation of the entire cycling path and to represent the results of the analysis in a unique Kiviat diagram (radar chart), it is first necessary to establish indicators with the same index (with a value from ten and zero). Despite the difficulty of merging quantitative with qualitative data, this research attempted to generate an innovative cycling path analysis method, employing similar evaluation criteria for both data groups in a combined factors diagram. The following page (Fig.5) demonstrates how objective factors have been measured employing the same index of the subjective factors. For example, the "connection with other cycling paths"- factor, consisted in associating a value to the number of existing connections considered to be sufficient for this cycling path, at least one connection per step (1,5 kilometers). The same procedure was carried out for the "connection with other infrastructure"-factor. On the other hand, "safety" has been evaluated as a sum of several aspects (maintenance, street lighting, type of path, technical aspects, SOS point). As sown in Table 2, survey was set with statements that coincide with the qualitative factors and for each one users selected a grade (from ten to zero). In this way, it has been possible to combine survey results (subjective factors) with measured objective factors.

Table 1. Quantitative and qualitative factor identified along the cycling path.

Objective factors	Subjective factors
Connections with other cycling paths	Legibility
Connections with other infrastructures	Sense of safety
Safety	Maps and informational support
Road signs	Facilities
Weather conditions and topography	Socialization

Table 2. Survey.

Statement	Select a grade										
	Absent	Poor	Below average		Satisfactory		Above average		Excellent		
Legibility of the cycling path	0	1	2	3	4	5	6	7	8	9	10
Sense of safety (traffic, street light lack, skid row, maintenance)	0	1	2	3	4	5	6	7	8	9	10
Maps and informational support	0	1	2	3	4	5	6	7	8	9	10
Facilities (bike sharing, bike renting, info point, public restroom, fountains)	0	1	2	3	4	5	6	7	8	9	10
Socialization (users' courtesy and hospitality)	0	1	2	3	4	5	6	7	8	9	10

0	1	2	3	4	5	6	7	8	9	10
absent	poor		below average		satisfactory		above average		excellent	

Connection with other cycling path
(average number of connection per step):

- < 0,5 → 0 to 2 points
- 1 → 3 to 5 points
- 2 → 6 to 8 points
- > 4 → 9 to 10 points

Safety:

- technical aspect 0 to 2 points
- path (separated or shared bike lane, etc.) 0 to 3 points
- street lighting 0 to 2 points
- maintenence 0 to 2 points
- SOS point 0 to 1 points

Total amount 10 points

Connection with other infrastructure (bus stop, train, ect.)
(average number of connection per step):

- < 0,5 → 0 to 2 points
- 1 → 3 to 5 points
- 2 → 6 to 8 points
- > 4 → 9 to 10 points

Weather conditions and topography:

- precipitation 0 to 2 points
- temperature 0 to 2 points
- humidity 0 to 2 points
- wind 0 to 2 points
- topography 0 to 1 points

Total amount 10 points

Fig. 5. Index (with value from ten to zero) and example of how the objective factors have been measure.

2.3. Results

Results obtained from the data processing were represented in Kiviat diagrams (radar chart). In order to combine objective and subjective factors, two different Kiviat diagrams were produced (one with objective and one with subjective factors) that were then overlapped creating a unique diagram. The yellow polygon represents objective factors while the blue one represents subjective factors.

The following page reveals the Kiviat diagrams (radar chart) that resulted from this case study analysis. The diagrams reveal the overall conditions of the Amazon Creek Path. It is easy to understand the factors' variance and the average factors' index. In particular, regular shape polygons reflect a balanced condition of the path's factors. Conversely, irregular shape polygons illustrate an unbalanced condition of the path's factors.

Nevertheless the colored polygons areas show the proportion and the relationship between objective and subjective factors. For example, when the blue polygon area (subjective factors) is much smaller than the yellow one, it means that the cycling path does not satisfy perceptions and needs of the users.

It is also important to observe the green area generated from the overlapping of the other two areas. This green area represents the uniformity and balance between the two groups of factors. In this case, when the green area is wide, it means that the other two areas are wide and with regular shapes. Vice versa if the green area is small it would mean that the areas are irregular and not proportioned (high variance of the factors).

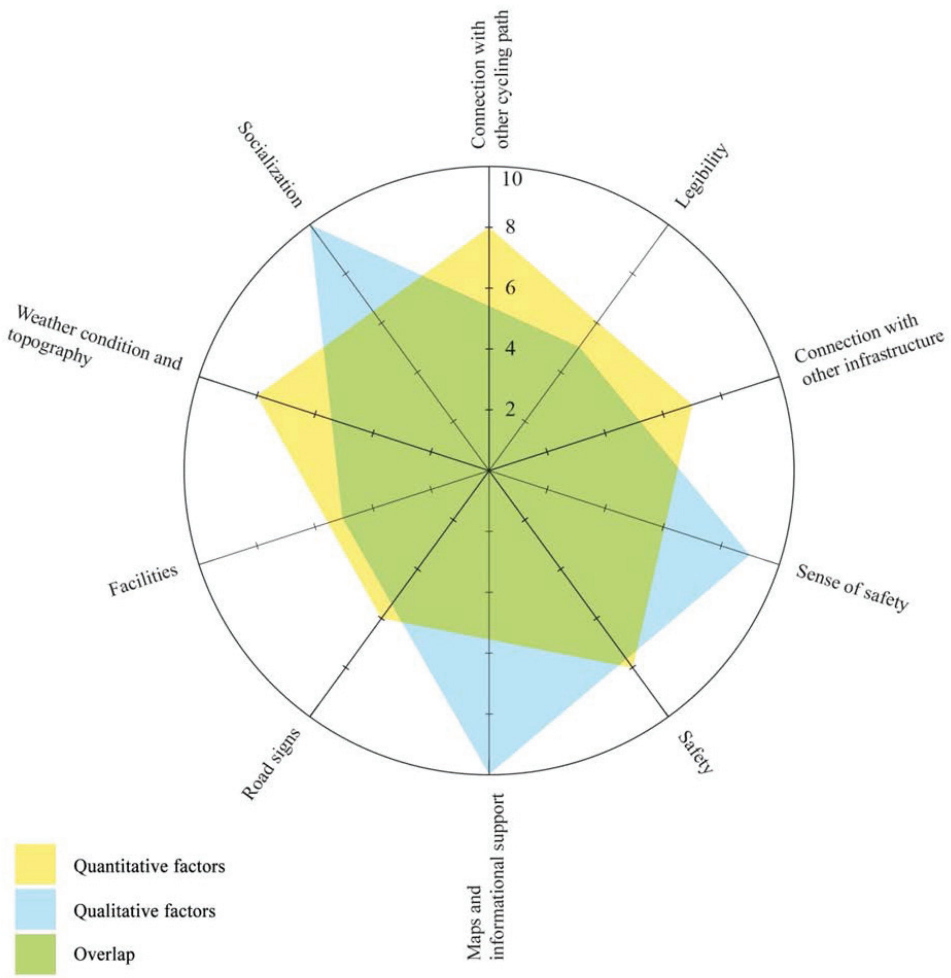

Fig. 6. Kiviat diagram (radar chart) revealing an overall condition of the Amazon Creek Path.

Results obtained from this analysis can be useful for planners and designers when designing or to redeveloping Amazon Creek Path. Employing factors with the Kiviat diagram it is possible to understand which factors and aspects the new project ought to concentrate on. The diagram can easily identify worse and inadequate factors that could be later improved with design actions.

The two groups of identified factors, the application of the evaluation criteria for the factors' evaluation, the survey and the Kiviat diagram represent the bases of the method for the analysis and the design of the cycling path.

This framework created during data collection and analysis proved to be accurate for Amazon Creek Path. However, the intention of the research project was to go beyond this point and to consider how valid this new framework would be within other contexts and settings. The second phase of the project used the new established methodology in other American cities.

3. Testing the methodological framework in other contexts

The first phase of this research presents the main case study that was useful to set up the method for the analysis and the design of the cycling path. The method identifies two groups of cycling paths factors (objective and subjective). Using the survey and the evaluation criteria above illustrated, factors have been measured (with an index value from ten to zero) and represented in a Kiviat diagram (radar chart) revealing an overall condition of the cycling path.

In order to verify the general validity and reliability of the methodology created in phase one, the second phase put the methodological framework to the test in the cities of Seattle (WA), Portland (OR), San Francisco (CA), and Los Angeles (CA).

The selected cycling paths within each city are different from one another; both in type of path and in surrounding landscape. Seattle cycling path stretches along the waterfront connecting Downtown with Magnolia District located northern. Portland Springwater Trial turns around the east part of the city following rivers sides and running along the Highway 205. San Francisco and Santa Monica cycling paths as well as Seattle cycling path are located on the waterfront; the first one passes through the piers connecting the Bay Bridge with the Golden Gate Bridge. While Santa Monica cycling path is actually the connection between Santa Monica and Venice passing on the seaside along the beach.

The analysis carried out using the methodological framework with other case studies did not detect limitations when applying the framework. Therefore, the employed factors were successful to describe the other cycling path conditions demonstrating the reliability and the validity of the method in other contexts.

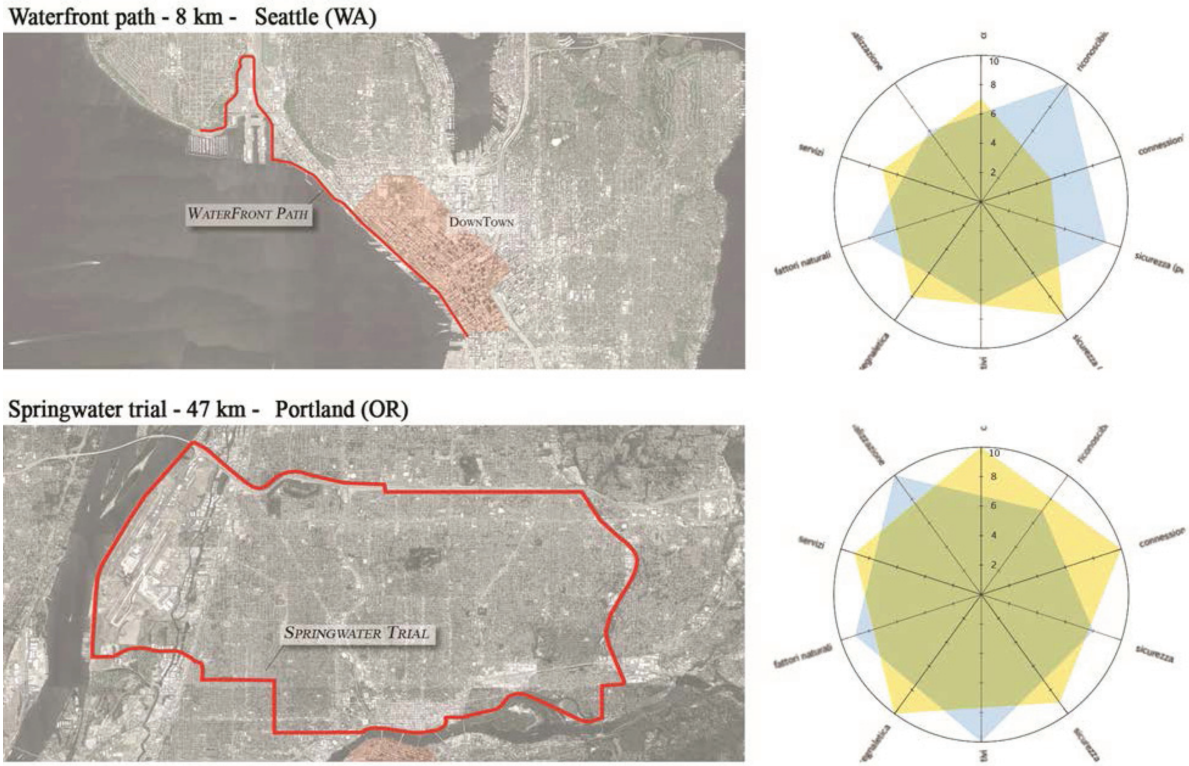

Fig. 7. Case studies from the West Coast with corresponding Kiviat diagram.

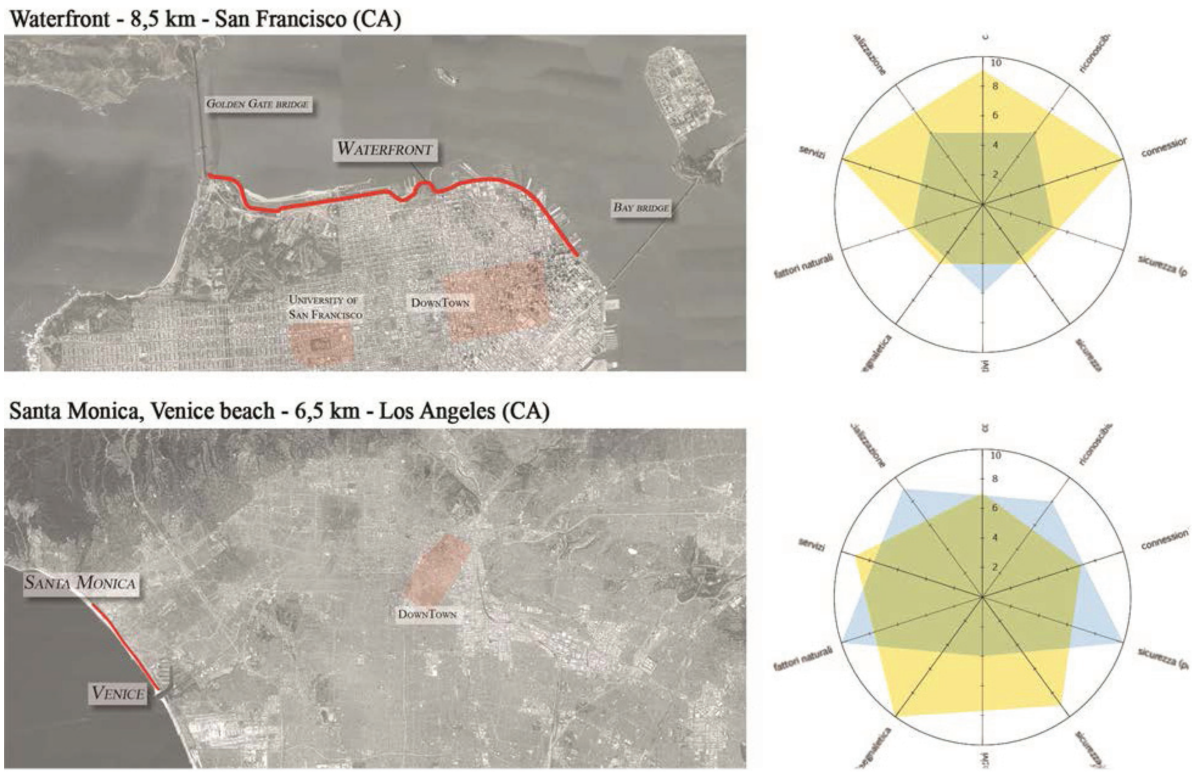

Fig. 8. Case studies from the West Coast with corresponding Kiviat diagram.

The previous images (Figs. 7 and 8) show a city map for each case study along with the cycling path to be tested (marked in red) and the corresponding Kiviat diagram that resulted from the data analysis.

Examining the diagrams of each cycling path, it is easy to infer their strengths and weaknesses. For example the cycling path in Seattle presents disadvantages given from its topography and bad weather conditions. On the other hand, according to the diagram, Portland cycling path results the best example among the others, revealing almost a perfect match between quantitative and qualitative factors.

4. Conclusions

The application of the method showed the potential of the methodology as a possible benchmarking system that could allow a reliable comparative analysis and design method, resulting in a series of design actions to improve the quality of bike-paths.

These results suggest two potentially important applications of this method:

- a methodology for the design of new bike infrastructure or for the improvement of existing trails. In this case, the designer could employ this analysis method along the selected trail, that has to be improved, before the design process. Analysis results and the Kiviat diagram suggest what factor/factors the designer should enhance more than others during the project phases (e.g. Safety). Such a method should operate as a support for the designing phases;
- an ex-post benchmarking system that could be used to assess the quality of existing infrastructure and as a way to identify and later improve certain physical or perceptual dimensions. In this case, external agency or authorities could apply the method on new realized cycling path project in order to verify the users' satisfaction and the effective improvements provided by the project.

Combining quantitative and qualitative (phenomenological) information and merging them into a unique Kiviat diagram generated an easy-to-use tool and a method that is transferable to other localities. For this reason the framework can be considered a “metadesign”.

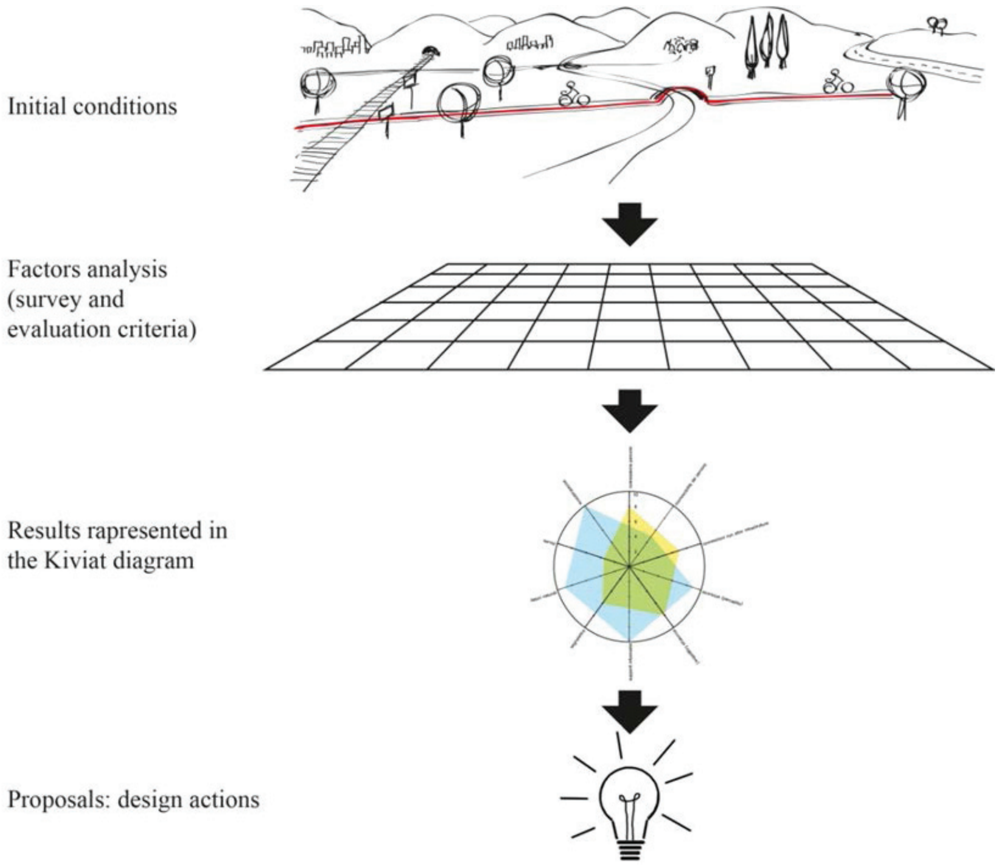

Fig. 9. Essential diagram showing method application.

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