Geografia e tecnologia è un volume delle Memorie Geografiche della Società di Studi Geografici

http://www.societastudigeografici.it

ISBN 978-88-94690125

Numero monografico delle Memorie Geografiche della Società di Studi Geografici
(http://www.societastudigeografici.it)

Certificazione scientifica delle Opere
Le proposte dei contributi pubblicati in questo volume sono state oggetto di un processo di valutazione e di selezione a cura del Comitato scientifico e degli organizzatori delle sessioni della Giornata di studio della Società di Studi Geografici

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M. Lazzeroni, M. Morazzoni, P. Zamperlin (a cura di), Geografia e tecnologia: transizioni, trasformazioni, rappresentazioni
Società di Studi Geografici. Memorie geografiche NS 22, 2023, pp. 449-455. Isbn: 978-88-94690125

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REVEALING RURAL TOURISM PREFERENCES USING STREET VIEW IMAGERY

1. Introduction. – Tourism can be an important development strategy for areas that are losing or reshaping their traditional economic activities based on agriculture, forestry, and livestock breeding, and in this context the study of landscape preferences can guide improvements to the experiences offered to visitors (Carneiro *et al.*, 2015). A possibility for tourism researchers is to embark on visual research projects where photographs are used to analyze the perceptions of an individual with respect to the portrayed context (Matteucci, 2013). However, the analysis of images only can be misleading as the shot has the power to select or exclude certain elements (Bressan and Guaran, 2022). Images from Google Street View can contribute to overcome this shortcoming, by allowing an immersive experience on the portrayed landscape. Luo *et al.* (2022) support this use in research of visual media, as it was found that such images enable viewers to discern the differences in the aesthetic quality of different environments.

In this contribution, advances in technologies are used to develop a platform where 360-degree photographs of points of tourist interest are evaluated in pairs by the research participants. The aim of this exploratory research, which makes use of a tool easily accessible to people of different mother tongues, is to capture the opinions of different domestic and international observers. Previous research found that the same tourist space might have multiple meanings in the eyes of different cultural groups (Stone and Nyaupane, 2019), pointing to the importance of understanding how their viewpoint may be different.

This work is the result of the interaction of two different projects. One setting is an ongoing project on green tourism in the Roman Castles area (Italy), where the current activities consist of characterizing the study area from a socio-economic perspective and identifying local tourist resources. On the other hand, there is the consolidated experience in the development of Decision Support System models, which have recently been applied in the study of citizen's preferences on urban landscapes (selected based on predefined urban design elements) in the Aveiro region (Portugal). In order to detect residents' preferences within this research project, the Portuguese team has built a platform which implements a multicriteria algorithm supported by a pairwise comparison mechanism that uses 360-degree images of different neighborhood settings, implemented on the digital platform Prospect (https://dcspt-getin.ua.pt/prospect). The project described here is intended to extend the experience of collecting urban design preferences in a different geographical context (Italy) and applied to a different scientific domain: to detect preferences regarding views. These features were selected as the orographic nature of the area favors the creation of various panoramic views, which overlook landscapes that in many cases are subject to protection. At the time of writing this article (November 2022), the platform is in the testing phase.

2. Multi-criteria decision-making tools. – Decision processes are essential elements of individuals' daily experience, with most of these procedures guided by personal preferences. Moreover, decision-making can be a collective process, such as when formulating public policies. Thus, decision-making processes can be seen as a set of complex procedures that requires the scientific community's attention to establish a set of frameworks where preferences can be collected in a structured way which ensures decision-making procedure, as described, for example, by Simon (1990).

Decisions involve several difficulties: the balance between costs and benefits is not straightforward or easy to determine; the impacts and consequences associated with each option are not always predictable; decisions affect individuals differently; there may be different views on the decision problem (Dias *et al.*, 2018). In structuring the decision problem, Roy (1996) points out several aspects that must be considered. The starting point of any decision problem is how the decision should be structured and shaped and how alternative actions can be differentiated. A major issue is the ability to define the model of preferences and how to analyze the multiple consequences of decisions. These elements should be translated into a set of interdependent levels representing the global structure of the decision model (*ibidem*; Wang *et al.*, 2009).

Many multicriteria analysis methods have been promoted for solving decision problems. The attempt to structure decision processes is primarily used in organizational/institutional contexts in which it is necessary to make "strategic decisions" (Belton and Stewart, 2002; Dias *et al.*, 2018; Keeney, 2004) or support policy formulation (*ibidem*). Following these contexts, decision theorists have highlighted that the expression of individual preferences in multicriteria methodologies is intrinsically associated with communication capabilities, the perception of those involved, heuristic capabilities, decision rules, and the differentiated levels of access to information (Andrews, 2007), thus, the multicriteria framework should structure and solve decision problems that involve the clear differentiation of alternatives. Moreover, the framework should ensure options should be evaluated according to a procedure of the individuals declaring their preferences.

A typical problem where the multicriteria analysis will be applied should clearly define the decision's objective, the alternatives and the criteria, ensure the correct translation of individuals' preferences, and show the results. A variety of integrated approaches to meet all requirements are available. In this work, the "Analytic Hierarchy Process (AHP)" method (Saaty, 1977) was chosen due to its simplicity, ease of understanding and application. Moreover, these features made it one of the most widely disseminated real-world applications.

The AHP method (and similar techniques) requires that the alternatives must be differentiable, which implies that stated preferences must be translated into a metric which is able to capture the relative importance of one alternative to the other. In the original work by Saaty (1977), comparing pairs of alternatives was conducted by assigning a value on a scale from 1 to 9. This scale allows a high degree of differentiation between alternatives, simultaneously highlighting the respective intensity levels (Franek and Kresta, 2014; Saaty, 1990). However, the scale used in the process of gathering preferences is an element that is subject to vigorous discussion. Cox (1980) presented a short review of the debate on the ideal number of response alternatives allowed, concluding that no perfect number exists to be applied in all circumstances. The author mentions the generic notion that information can be measured and that the amount of information a scale can transmit is ultimately determined by the capacity of the interface or means of communication. Furthermore, he recognizes that there is a vast literature in the field of psychology that contributes to this reflection, namely on the human capacity to process information in different circumstances. Preston and Colman (2000) reinforces these conclusions by positing that various indices of reliability, validity, and discriminating power show that the two-, three-, and four-point scales performed relatively poorly; scores were significantly higher for scales with more response categories, up to about seven, moreover, the authors argue internal consistency did not differ considerably between wider scales, but reliability tended to decrease for scales with more than ten response categories.

In real decision-making procedures, it is impossible to ensure either the total objectivity of the criteria or the objectivity in the assessment by different individuals with diverse preferences, expectations, and values, as more elements are to be compared the complexity increases, requiring a matrix representation of the structure and number of criteria used. An interesting aspect of the AHP method is the possibility of deriving a consistency index, which allows an objective measurement of the preferences and the establishment of a maximum threshold of acceptable inconsistency – that is, a threshold for which it is possible to say with certainty that the answers were not defined randomly. However, Saaty (1977) has already advised that the control values could (and should) be adequate for the size of the matrices – a point highlighted in real-world applications, where authors such as Wolf *et al.* (2021) advocate for a necessary calibration case by case.

The first experiment promoted by the University of Aveiro's research group on territory and innovation adopted a framework based on a two-step procedure: first, a binary pairwise comparison procedure, followed by a pairwise evaluation (continuous scale). This complex procedure was motivated by the specificity of the study (which requires collecting individual valuations for houses). However, as described previously, the equilibrium between the complexity of the decision procedure and the required effort of the structured decision procedure should be ensured and defined for each case study. The platform Prospect, developed by the research group, is now configured to perform pairwise comparisons on a one-step procedure where a seven-point scale is used to evaluate the alternatives.

3. Study area and research design.

3.1 *The geographical context.* – The expression "Roman Castles" is used to define a hilly area – more precisely, what is left of the ancient volcanic complex of the Albani mountains – southeast of Rome. On these heights there are a series of urban centers that since ancient times have been known in this way because each of them was gathered around a castle owned by a Roman feudal family (Gualdi, 1962). Nowadays, this

geographical context is characterized for being part of the system of regional protected areas. In fact, with the Regional Law n. 2 of 13 January 1984, the Roman Castles Regional Park was established, with the aims, as stated in Article 1, "of protecting the integrity of the natural and cultural characteristics of the Lazio volcano in the Albani mountains, of enhancing its resources for the purposes of rational use by citizens and of contributing to the territorial rebalancing and the social and economic development of the populations concerned". At the time of its establishment, there was not only a problem of finding a balance between preservation and utilization of natural and cultural resources, but also to the need to curb local urbanization developments (Cerreti, 1983). In fact, a "new" population had gathered around those centers that were historically based on agriculture. It was a population that made a living by working in the local industrial and service sectors, or that exploited the opportunities of the Roman labor market (Cerreti, 1984). At this point it is in fact important to observe that the group of municipalities intersecting the territory of the park is in a situation of strong continuity with the south-eastern border of the Municipality of Rome (Bozzato, 2011). From the historic center of Rome to the closest municipality (Ciampino), it takes about 40 minutes to cover a journey of less than 20 km. On the other hand, reaching more distant municipalities, such as Velletri, requires covering twice the distance. This proximity allows a significant number of locals residing in the Roman Castles area to commute to Rome to work or study, as documented by the census data (Statistical Office of the Metropolitan area of Rome, 2015). On the other hand, the same favorable infrastructure conditions make it possible for Romans to easily travel by car to a pleasant environment. An example of this possibility of escape from the frenzy and/or the hot weather of the capital is given by the presence in the municipality of Castel Gandolfo, the Pope's summer residence. In light of this, it is no surprise if the Roman Castles area is mentioned in the manuals of tourism geography as an example of holidays in rural areas (Bagnoli, 2022).

The tourist character of the area has also recently been attested by the Italian National Institute of Statistics (Istat). In fact, in response to a law introduced during 2020 to support the tourism sector in the pandemic period, Istat (2022) proceeded to classify Italian municipalities according to a first indicator concerning the "prevailing tourist category" and a second one defined as "tourist density". Looking at the classifications of the municipalities according to the first indicator, it can be observed that fourteen municipalities falling within the park are defined as touristic, while only two municipalities are defined as non-touristic. This result is very positive if compared with the regional one, where 130 out of 378 municipalities are defined as non-touristic. Among the touristic municipalities, half of them have a vocation for lake tourism (the area also features two craters that are now lakes). Two of these municipalities have a dual tourist category, cultural and lake tourism, while one municipality is characterized by offering lake and mountain tourism. Seven municipalities are touristic but do not belong to a specific category. While these indicators are valuable in identifying the localities attracting tourists spending nights in accommodation facilities, it should be remembered that the area is typically a destination for one day excursions, not captured in official statistics. A good network of hiking paths exists, due to the presence of the park. Furthermore, the importance of agriculture means that the territory offers a wide range of typical local products, the objects of food and wine tours.

3.2 *A preliminary description of the platform*. – The main features of the platform will be described below. An important technical feature that we would like to highlight is that the survey was created in three languages (Italian, English and Portuguese) as it is designed to be administered to a mixed audience, referring mainly to the two academic reference communities of the authors.

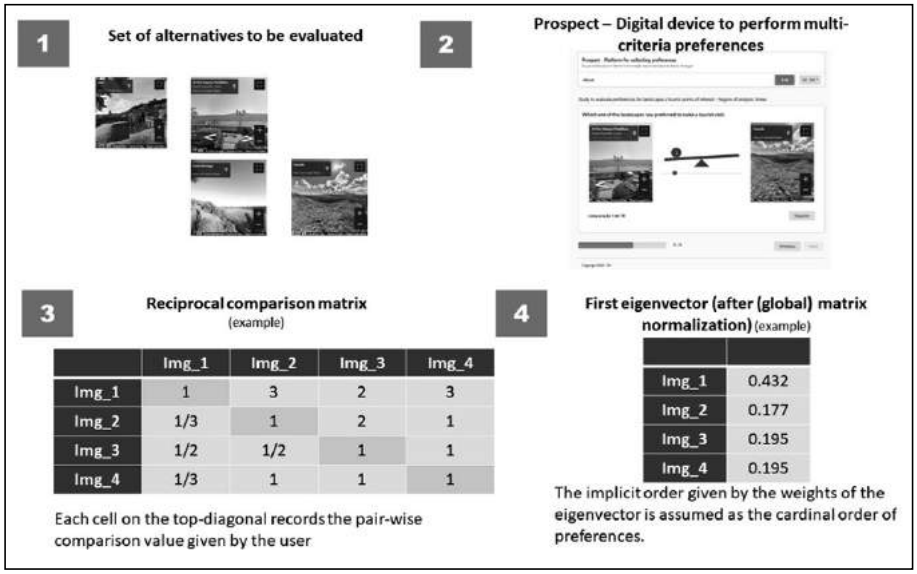
The first part of the platform consists of a series of questions aimed at identifying the main characteristics of the participant (age, sex, educational qualification, residence). We ask whether the respondent belongs to the academic community or not and if so, their role within it. As will be explained later, the core of the platform is a mechanism of pairwise comparison of vistas, which was introduced to surface respondents' tourism preferences. The physical proximity between the participant's residence and the panoramic viewpoint might be insufficient to explain one's sensitivity toward a particular landscape. In light of our willingness to examine the diverse ways in which people might be tied to outdoor places regardless of their residential status (see at this purpose Kaltenborn and Williams, 2002), a multiple-choice question about hobbies is inserted. Finally, a question on whether the respondent has visited the Roman Castle area before or not is available.

The next section will be devoted to a description of the visual part of the survey, consisting of a pairwise comparison of a selection of views. It must be explained beforehand how such points were identified. After an interview with an employee of the park and the analysis of maps of local hiking tracks, a set of possible panoramic points was considered. Such points were georeferenced in the QGIS software. Afterward, the set of

coordinates was reduced by excluding the panoramic points which did not correspond to any image in Google Street View. Other points also had to be removed because, although a 360-degree image existed, the quality was very poor. The selected viewpoints differ in the characteristics they present. For example, some viewpoints are covered in vegetation, implying the need to walk along paths to enjoy such views. Some viewpoints are located in an urban context, making it clear to the observer that they are easy to reach. Other viewpoints are not surrounded completely by built-up areas, but the nearby presence of streets or parking lots hints at the fact that they are accessible by car.

The core of the survey is the pairwise comparison of 360-degree images. The method followed here essentially replicates the AHP approach proposed by Saaty (1977; 2013). The original AHP method was designed to evaluate the relevance of criteria in a hierarchical multicriteria system. Here, the method is used to assess preferences for panoramic views that already incorporate different combinations of criteria to be evaluated – both the criteria used to select the set of panoramic views and the criteria that will be adopted by each user. Thus, an additional step is implemented on our system: a mechanism to analyze the extent of divergences from the criteria adopted to the criteria revealed by the respondents.

Figure 1 summarizes the general procedure of the multi-criteria expression of preference. In each round, two panoramic views were evaluated using an interactive mechanism – a balance or a slider (in mobile view, only a slider) – which gives users the opportunity to state their preferences following four degrees of intensity. The intensity can be translated as: 0, describes equal preference for both panoramic views, slight preference for one of the alternatives will give three additional classes: 1) Slightly prefer one alternative, 2) Prefer that panoramic view and, finally, 3) States an absolute preference for the specified alternative. As described previously, the method to ensure coherence was implemented and, after some preliminary tests, was set as a 0,5-correlation coefficient.



	Img_1	Img_2	Img_3	Img_4
Img_1	1	3	2	3
Img_2	1/3	1	2	1
Img_3	1/2	1/2	1	1
Img_4	1/3	1	1	1

Img_1	0.432
Img_2	0.177
Img_3	0.195
Img_4	0.195

Source: own elaboration.

Fig. 1- Scheme of the process used to identify the cardinal order of preferences

The stated preferences described before are then recorded on a numerical scale and used to build reciprocal comparison matrices, where the bottom diagonal is filled by the inverse of the values on the top diagonal. After a (global) normalization of the matrix values, the first eigenvector is extracted from that (normalized) matrix. As pointed out by Saaty (1977; 2013) the eigenvector can be translated as the cardinal preferences for each of the configuration options. As stated previously, the reliability of this approach is related to the scale used to express the preferences: here, we follow the four-option evaluation scale (similar to a Likert Scale of size 7).

4. Final notes. – The platform developed for this research differs significantly from other available research tools. It is known that most visual research conducted in the tourism sector uses static images (*e.g.* Matteucci, 2013). The 360-degree images embedded in the platform will instead permit respondents to

simulate being in the shoes of a photographer and, in some cases, to move along the transport axes where these panoramic points are located. This feature allows the participants, especially those who have never actually visited the site portrayed in the image, the possibility of almost replicating the experience of being there.

The construction of a platform available on the Internet that allows respondents to carry out experiences that are close to reality is a particularly important fact, as it enables administration to a heterogeneous audience of recipients, especially in terms of residence. In principle, the utilization of the Internet enables collection of a greater number of preference rankings than could be managed in the same period if research participants were interviewed face-to-face. We are still far from achieving a representative sample. In any case, the design of the research, which foresees the administration of the survey to two academic communities of two different European countries, allows for revealing the preferences of a heterogeneous group of participants.

The output of the platform is an ordering of the selected vistas. This information can be useful for those involved in promoting a tourist destination. In fact, it enables the identification of viewpoints that are appreciated but little frequented. They can thus be more effectively advertised, for example by improving communication. Another interesting point is the possibility of analyzing the ordering of panoramic points according to the participant's residence and other personal characteristics (*e.g.* hobbies). The ability to link the sites with the characteristics of the respondents allows tour operators to recommend a destination based on the trait of the profile of the tourist. In addition, the fact that a pair of coordinates is associated with each panoramic point is also very useful, as it makes it possible to analyze the accessibility of these sites. Scarce tourist flows to some sites could in fact come not only from ineffective advertising, but could be explained by the relative remoteness and low accessibility of such place.

This exploratory research can be replicated in other geographical settings where Google Street View images are available. Unfortunately, in the context under examination there is also a limit to data coverage, as in some areas it is not possible to access 360-degree images. This fact has consequences for the research. It means excluding a series of points which can be considered panoramic, but which are technically not available. Furthermore, it should be noted that Google Street View collects photographs that are very heterogeneous in quality and in shooting context. This fact can lead to both disadvantages and advantages. For example, a panoramic point represented in an aesthetically unattractive photograph could still be positively evaluated by a local respondent, as this person could have personal experience of the places and not be conditioned by the photographic rendering. On the other hand, a person without such direct interaction with the local environment could simply discard the photograph without carefully attempting to observe the attractiveness of the features in the landscape portrayed. Not only the quality of the photograph (*e.g.* backlit image) but other factors can influence the attractiveness of the image. For example, the colors of the foliage dictated by the season of the year, or the time of day of the shot, could influence users' perception of the place. It is not possible to control the respondent's emotional reaction, but a multiple-choice question is added to identify the factors influencing the respondent's choice of the favorite and less-preferred image. The heterogeneity of Google Street View's photographs can also be seen as a positive point, as a certain destination is offered to the potential tourist not in its best guise, but with a set of photographs that portray it in a more casual form.

To conclude, this platform highlights the power of new technological tools to offer an immersive experience of a tourism destination. In our case, the development of the platform was finalized to collect preferences on a set of selected landscapes. However, an additional step might exist. Such information could be considered by the actors involved in tourism management and contribute in such a way to remodeling the organization of the tourist space.

Acknowledgement. – The authors want to thank the technical team of the University of Aveiro who intensively collaborated in the construction of the platform. They also want to mention the valuable contribution of an employee of the park for offering his expert knowledge.

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SUMMARY: This work aims to present an innovative method that allows collecting and analyzing users' preferences on a selection of panoramic viewpoints. The proliferation of large-scale imagery platforms and the methodological advances in the field of multicriteria decision analysis make it possible to develop platforms where users can compare pairs of 360-degrees images and discover their most and least preferred landscapes through these comparisons. The platform was purposely made to be applied to the Roman Castles area, a tourist destination bordering the southeastern part of Rome. The peculiar morphology of the area and the different degrees of urbanization favours the creation of diverse viewpoints, making it interesting to assess how a heterogenous public perceives such different landscapes.

RIASSUNTO: *Uso delle immagini di Street View per la rilevazione delle preferenze nell'ambito del turismo rurale.* Questo lavoro vuole presentare un metodo innovativo che consente di raccogliere e analizzare le preferenze degli utenti su una selezione di punti panoramici. La proliferazione di piattaforme di immagini su larga scala e i progressi metodologici nel campo delle analisi decisionali multicriterio permettono lo sviluppo di piattaforme dove è possibile confrontare a coppie immagini a 360 gradi e scoprire dopo tali confronti i panorami più e meno preferiti. La piattaforma è stata appositamente creata per essere applicata ai Castelli Romani, destinazione turistica a sud-est di Roma. La peculiare morfologia dell'area e il diverso grado di urbanizzazione favoriscono la creazione di distinti panorami, rendendo interessante valutare come un pubblico eterogeneo percepisca paesaggi così diversi.

Keywords: multicriteria decision analysis methods, Street View imagery, landscape attributes, tourism, Roman Castles
Parole chiave: metodi di analisi decisionale multicriterio, immagini di Street View, attributi paesaggistici, turismo, Castelli Romani

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