

UTILIZATION OF A CROWDSOURCED LANDSCAPE PERCEPTION MAP TO ASSESS THE URBAN LANDSCAPE IN GIS

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Abstract

A mobile application for participatory urban landscape mapping was introduced in the educational process of the National Technical University of Athens. Using the application students were encouraged to document their perceptions of the landscapes in which they live, while gradually the process was also opened to interested citizens. Participants created a dynamic and evolving landscape map merging spatial and qualitative data and participated in interviews and answered questionnaires to evaluate their participation.

The results investigated the application's impact in three distinct areas. Educationally, evaluating how its modernization of teacher-student interaction enhanced architectural education and helped students embrace architectural and landscape related education. Socially, by evaluating the effect of integrating interactive digital tools that allow democratic social participation in education and whether it managed to engage students in meaningful discussions and critical thinking about urban landscape quality. Scientifically, by yielding valuable data for analyzing urban typologies-landscapes, architecture and public perceptions thereof, supporting further research in the interfaces of the technology of crowdsourcing, Geographic Information Systems (GIS), mobile development, and studies in the area of culture and humanities

By bridging academia and society, the present research improved student's perception regarding architectural education, catalyzed scientific discussion on urban landscape quality, encouraged collective responsibility for improving public spaces and led to the observation of trends regarding the perception of architecture and landscape by the public. The presentation further summarizes the project's achievements, methodology, and implications for architectural education and research on assessing landscapes, in the context of urban landscape sustainability and its determinant natural and socio-cultural factors.

Keywords: *participatory, landscape, architecture, crowdsourcing, GIS, PPGIS, ULQI, education, built environment, architecture, university*

1. Introduction

Technological sectors and types of social interactions have been dramatically transformed by the rapid evolution of information technology. However, in matters of university education

and particularly in specialized academic disciplines such as landscape and architecture, both the educational process and the data collection processes (e.g. those based on the answering of questionnaires) remain relatively untouched by the various profound technological shifts. Similarly, this extends to other societal functions such as the participation of citizens in decision making which could also be facilitated by modern technology.

Literature highlights an ongoing gap in fully leveraging available technologies to enhance educational outcomes, especially at the university level, despite high potential for technological integration (Castro-Guzmán, 2021). Smartphones have become ubiquitous among university students, with over 95% of European youth reporting daily internet use (European Commission. Statistical Office of the European Union., 2022). This extensive accessibility offers opportunities to enhance educational interactions outside traditional classrooms, support real-time communication, facilitate interactive and mobile learning (m-learning), and increase resource availability. This research investigates integrating these technologies into educational practices via a mobile crowdsourcing application designed to enhance interactivity in landscape and architectural education. Participatory crowdsourcing in educational contexts enables students to actively engage with buildings and landscapes studied. This approach has shown success in geosciences and environmental studies, promoting real-world data use and community participation, deepening students' learning and involvement learning (Bartoschek and Keßler, 2013; Sui et al., 2012).

Moreover, in landscape studies and geosciences, public participation significantly contributes to research, data collection, problem-solving, and project design, including geographic information contribution (Corbett, 2013; Smith et al., 2015), landscape perception analysis (Ioannidis and Koutsoyiannis, 2020; West et al., 2010), and co-design (Kosma and Dendrinou, 2017; Moraitis, 2011). The perception of landscapes has gained attention in educational (Betakova et al., 2016; Terkenli et al., 2019) and research contexts (Chesné and Ioannidis, 2024; Romanos Ioannidis et al., 2022a; Scott, 2002; Yamashita, 2002). Recently, landscape perception studies have been closely linked to renewable energy transition debates, addressing public resistance to renewable energy projects, particularly wind and solar infrastructures. Discussions often centre on whether such opposition reflects NIMBY (Not In My Backyard) attitudes or genuine responses to real impacts (Devine-Wright, 2005; van der Horst, 2007; Wolsink, 2000). This debate emphasizes the importance of understanding public perceptions of renewable energy infrastructures (Beer et al., 2023a; Graham et al., 2009; Ioannidis and Koutsoyiannis, 2020).

Furthermore, studies of landscape perception extend beyond renewable energy contexts, exploring societal, ideological, and political influences expressed through architecture and landscape transformations, both historically (Aisopos and Simaioforidis, 2002; Iliopoulou, 2019) and contemporarily (Ioannidis et al., 2019; Moraitis, 2016; Tzortzi et al., 2022; Μωραΐτης, 2017).

This study examines a shift towards a more interactive and synergetic educational approach through the use of mobile crowdsourcing in landscape and architectural education. By leveraging the ubiquitous nature of smartphones among university students, this research explores the implementation of participatory landscape assessment within the academic curriculum, aiming to foster a more engaging and effective learning environment and provide some preliminary feedback on the potential of the utilized participatory crowdsourcing methodology for data collection, in the context of landscape research.

2. Methodology

2.1 Educational methodology and app distribution and participation

Following the development and testing of a mobile application designed for students to submit real-time data during field assessments—including GPS tagging, ratings for architectural and landscape features, and photo uploads—a structured methodological approach was established to enhance student participation and gather their feedback on the educational process (Ioannidis et al., 2024; Mamassis et al., 2024a, 2024c). As illustrated in Figure 1, the methodology consisted of three primary phases: (1) initial student invitation and engagement within landscape and architecture education, (2) continuous educational and technical support while using the mobile crowdsourcing application, and (3) systematic collection of student feedback regarding their participation experience.

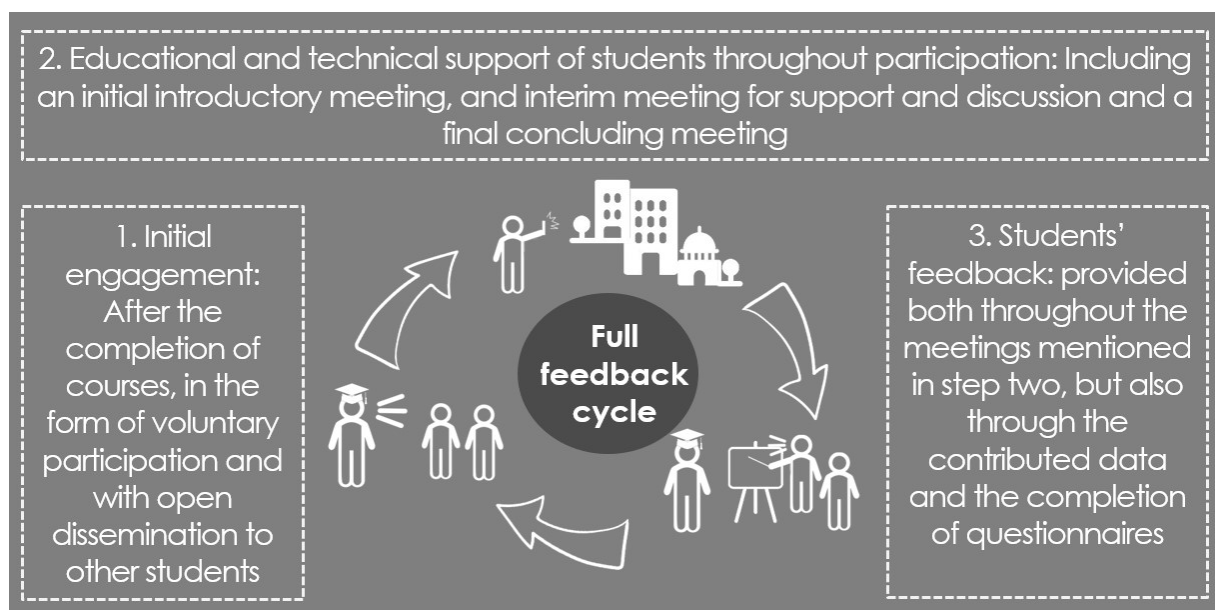


Figure 1 Scheme of steps implemented for student participation (Ioannidis et al., 2024; Mamassis et al., 2024b).

2.1.1 Student engagement

Students from NTUA were engaged in participatory activities as part of their education in landscape and architecture, specifically within the undergraduate course "Laboratory on Humanities – Course Section 2 – Built Environment and Landscape" at the School of Civil Engineering NTUA. This course was significant because it introduced "landscape" into the school's curriculum for the first time since its foundation in 1887, aligning with recommendations by the European Landscape Convention (Council of Europe, 2000) and related academic discussions (Μωραΐτης et al., 2005). Detailed information regarding the courses involved the educational background of students (undergraduate – postgraduate) are provided in the work of Ioannidis et. al (Ioannidis et al., 2024).

A targeted engagement strategy was developed to incorporate voluntary participatory crowdsourcing into the educational process, structured around three core principles: (1) Participation was voluntary to accurately reflect students' genuine willingness. (2) Invitations to participate were distributed after students had completed their course evaluations and were communicated by staff not directly supervising the students to avoid influencing their

participation. (3) Students who were initially invited could further invite peers, reinforcing inclusivity and broader participation.

More than 120 students from NTUA's Schools of Civil Engineering and Architecture, along with summer interns from École des Ingénieurs de la Ville de Paris (EIVP) (see Figure 2), have participated in both initial tests and the formalized engagement approach. Early participation involved detailed recording of students' interactions with the app, their geographic movements, assessments of landscape and architectural features, and evaluation of the application's technical performance.

Initial cycles of participation also involved giving Students the application and recording their interactions with it in detail, tracking their movement and location, recording their landscape and architecture assessments and evaluating the technical performance of the application.



Figure 2 Achieved student engagement to participate to this day, including indicative photos from meetings.

2.1.2 Support of participation and students' feedback

Following student recruitment and initial engagement, participants received a mobile crowdsourcing application on their smartphones, with interaction expected over a period of 3 to 6 months. The participation support framework included three main stages: (1) an introductory meeting providing an educational overview of major architectural movements relevant to Athenian architecture and landscapes, alongside app distribution; (2) an interim meeting allowing students to discuss their participation experiences, technical issues, and topics related to architecture and landscape; and (3) a final meeting focused on gathering detailed student feedback, both through discussions and an anonymous structured questionnaire (Ioannidis et al., 2024).

Participants received a certificate acknowledging their voluntary involvement upon completing the final questionnaire. Technical assistance was continuously available through instant messaging. Feedback collection included informal interviews at interim meetings

covering educational content, app user experience, and peer interactions, as well as structured and anonymous final evaluations regarding demographics, perceptions, educational value, user experience, and suggestions for improvement (Mamassis et al., 2024c).

2.2 Analysis of generated data from a scientific -landscape assessment perspective.

Other than the observation of education, technical and functional challenges (such as software and generated-data related challenges) the study also performed an investigation of the potential scientific-societal utility of the results. This challenge was approached by investigating the correlations and potential synergies of the results of the feedback submitted by the students through the novel crowdsourcing app to other methods of landscape assessment. The participation of students led to the gathering a total of 899 reviews in Athens and its periphery and the expanded participation of citizens led to the collection of an additional 565 reviews within the same area (See Figure 3). Towards the aim of investigating and comparing the crowdsourced data with data generated from other landscape assessments methods the Lycabettus hill and its surrounding neighborhoods were investigated as a case study (see Figure 4).

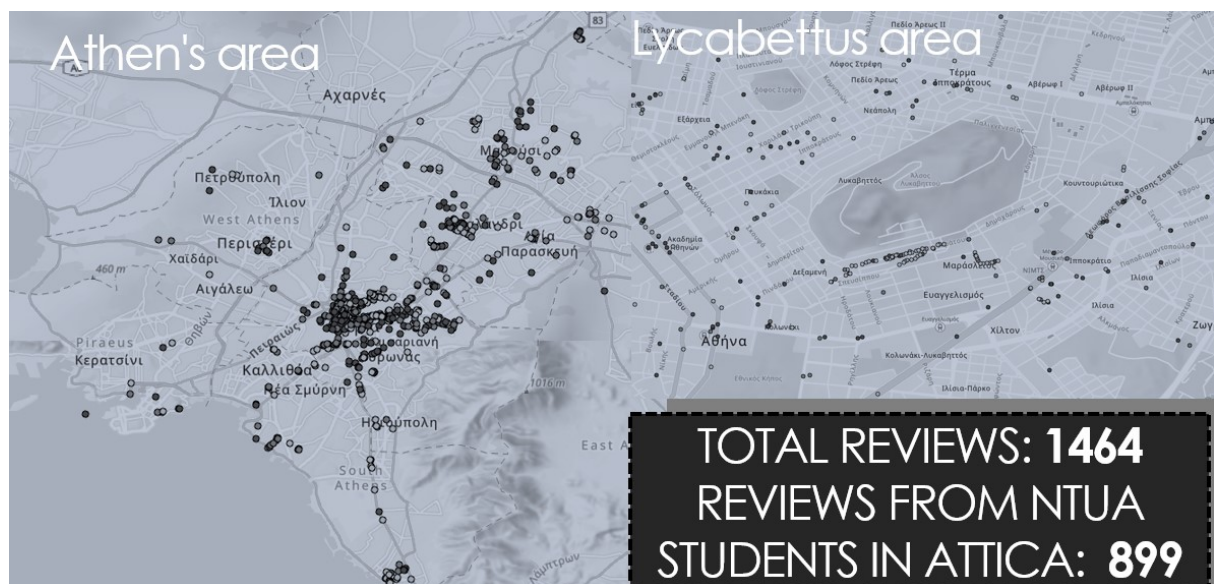


Figure 3 Statistics of uploaded reviews from participants and mapping of reviews in the wider urban areas of Athens and in Lycabettus Area.

In particular, the case study was carried out by implementing two methods of conventional analysis of landscapes: Firstly, the so called ULQI (Urban Landscape Quality Index). It was developed by Athanasios Alexandru Gavriliadis, Cristiana Maria Ciocănea, Mihai Răzvan Niță, Diana Andreea Onose and Irina Iulia Năstase at the university of Bucharest in the Centre of Environmental Research and Impact Studies (Gavriliadis et al., 2016). Secondly, the sensitive approach of urban landscape in combination with Public Participation Geographic Information Systems (PPGS) is a useful method used for the assessment of urban landscapes. In theory, it is considered as a way that can lead to an ideological approach to the development of urban strategies that are in line with the values and the needs of a community (Broc, 2015). This approach concentrates on the perceptions and experiences of citizens, because it understands how important it is for citizens to be satisfied and emotionally connected to their environment are crucial for sustainable urban development. Unlike purely technical assessments, this method integrates social indicators that reflect the aesthetic and functional quality of urban spaces as perceived by residents.

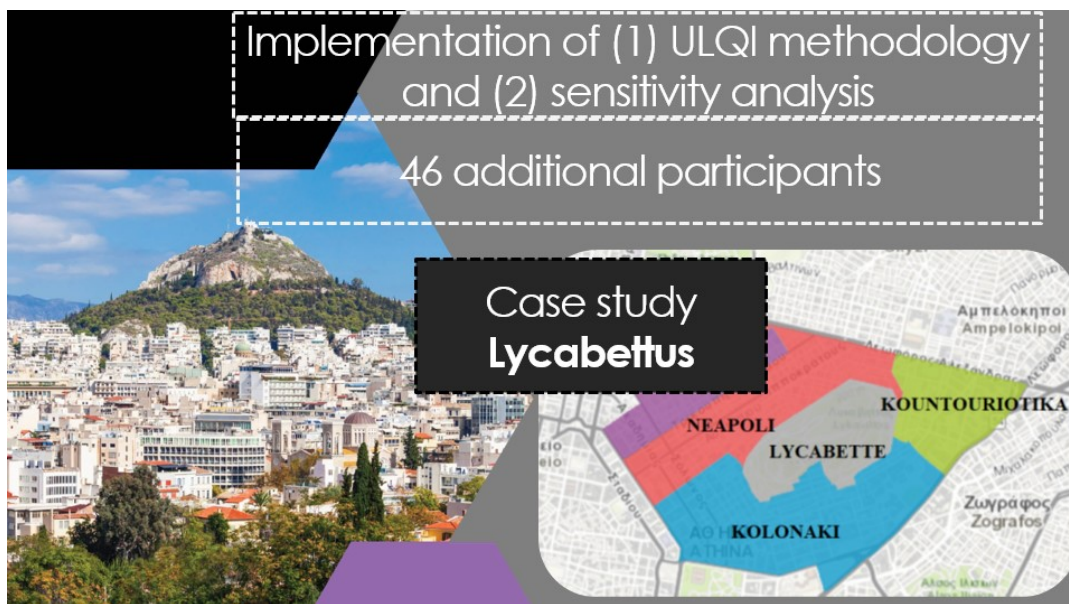


Figure 4 Presentation of the study area and methodological concept

3. Results

3.1 Participation/educational

Out of over 126 students participating in the project, this section's results are based on responses from 66 students who completed their participation and provided feedback via formal questionnaires. Data collection included both quantitative data directly from the mobile application—such as the number of reviews submitted by each student, types of landscapes assessed, and user engagement metrics—and qualitative insights gathered through questionnaires and individual or group discussions. The qualitative data primarily targeted students' subjective experiences, learning reflections, and overall participation feedback. Participation results also illustrated an effectiveness of the voluntary engagement approach, as a significant majority of students recognized their participation as voluntary rather than compulsory (Ioannidis et al., 2024), confirming the success of the voluntary participation strategies.

Further evaluation of the educational process is illustrated in Figures 5 and 6, and through the following questions: Firstly, “Did your participation help you retain knowledge from the course section 'Built Environment and Landscape'?” directly examines educational effectiveness, specifically concerning knowledge retention about architectural movements, landscapes, and urban contexts within Athens and the Attica region. Secondly, “Did your participation make you reflect about the quality of the built environment and architecture?” addresses the broader societal and reflective impact of participation by gauging students' increased awareness of urban landscape quality, architectural heritage, and urban planning considerations, also hinting to the contribution of participation in a societal level.

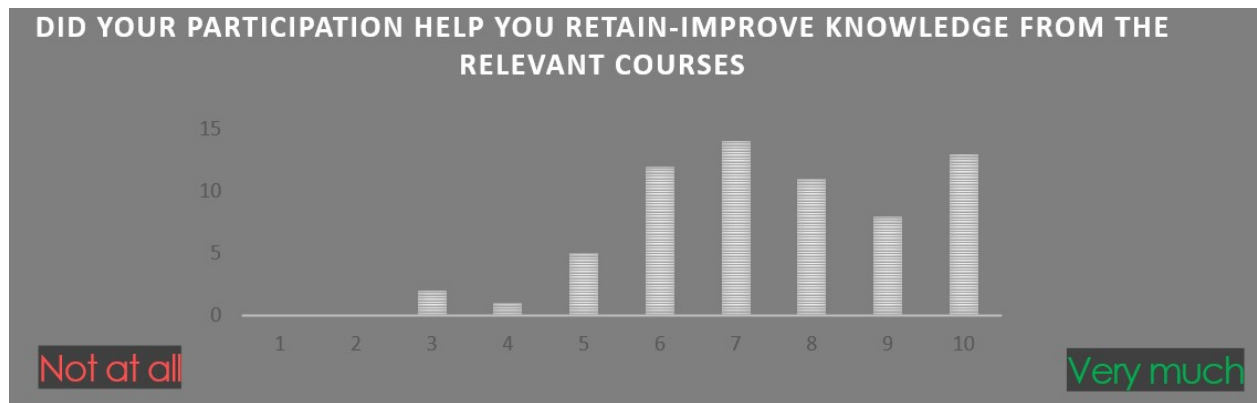


Figure 5 Questionary results on the success of the participation in helping students retaining knowledge from the associated course.

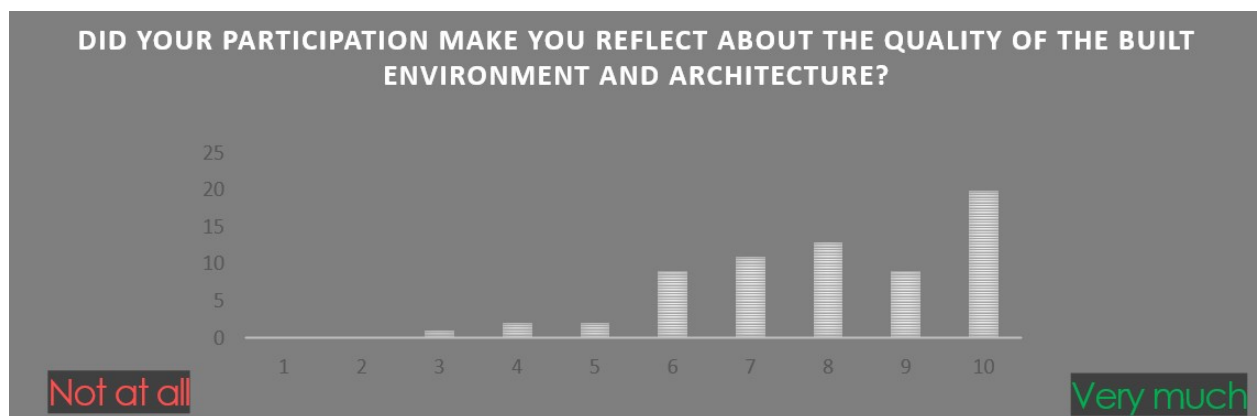


Figure 6 Questionary results regarding the capacity of participations to incite broader reflections and interest in matters of built-environment quality and architecture.

3.2 Scientific/landscape assessment

Figure 7 presents the results from the comparison of urban landscape assessment scores across three neighbourhoods (Kolonaki, Kountouriotika-Mavili, and Neapoli) using the three different methodologies analysed: the Urban Landscape Quality Index (ULQI), the sensitive participatory approach (Public Participation), and the mobile crowdsourcing application.

Kolonaki consistently scores highest across all three methodologies (ULQI: 3.08, Public Participation: 3.09, Crowdsourcing mobile app: 3.04). This alignment suggests a robust positive perception of the neighbourhood’s landscape quality from both technical and community-based perspectives, reflecting Kolonaki's established reputation for high-quality urban spaces.

In contrast, Kountouriotika-Mavili displays significant variation across the three assessment methods. The ULQI method yielded the lowest score (2.07), indicating technical or visual landscape deficiencies, while Public Participation (2.79) and the crowdsourcing mobile app (2.28) suggest higher perceived satisfaction and engagement from residents and participants. This discrepancy highlights the importance of integrating public perception alongside purely technical assessments, as community members may value aspects of their surroundings differently than traditional evaluations indicate (Broc, 2015).

Finally, Neapoli shows moderate consistency across methods, with relatively close scores between ULQI (2.61), Public Participation (2.63), and the crowdsourcing mobile app (2.78). The slightly higher score from the crowdsourcing app may indicate greater responsiveness of the community to interactive and technologically engaging methodologies,

emphasizing the potential benefits of using digital participatory tools in urban landscape studies.

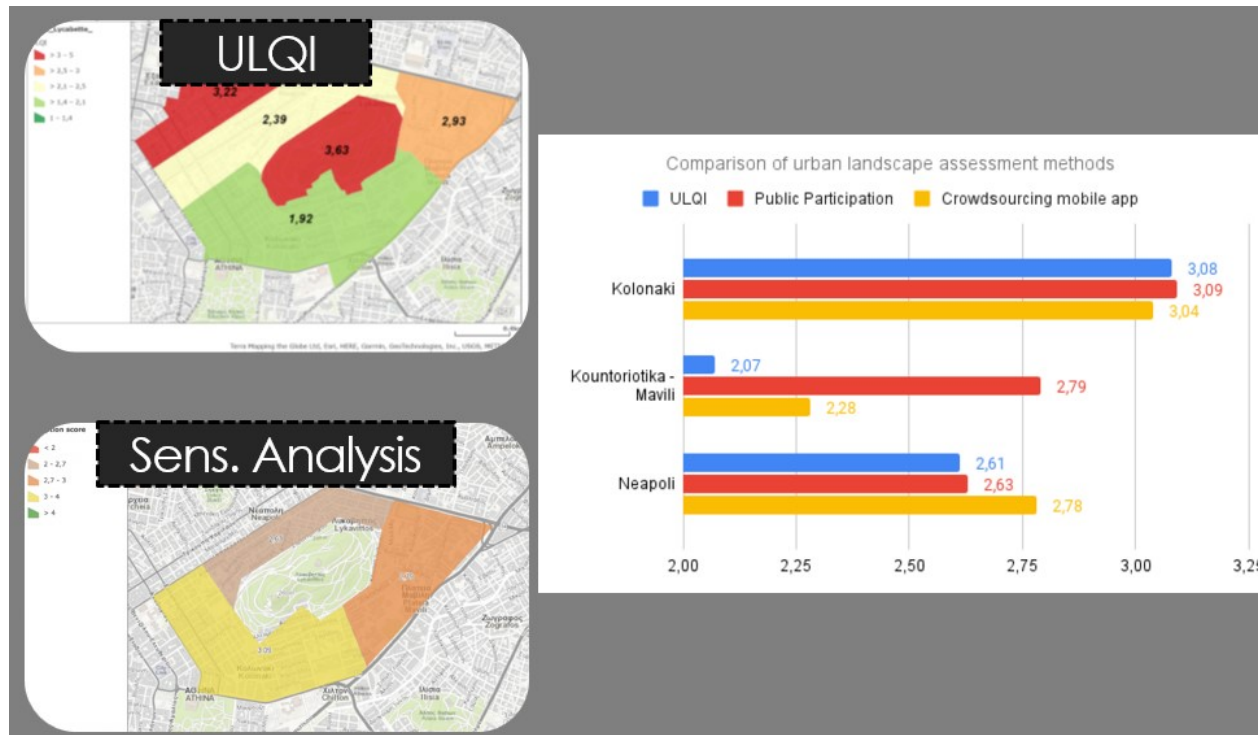


Figure 7 Results from comparisons with conventional methods for landscape assessment

4. Discussion and Conclusions

Overall, these results emphasize the value of integrating technical evaluations (ULQI) with participatory and sensitive methods, such as mobile crowdsourcing, to achieve a comprehensive understanding of urban landscape quality. This combined approach effectively captures both objective conditions and residents' subjective perceptions and experiences, highlighting its importance in landscape research and urban planning. The results obtained from this study confirm that participatory methodologies can significantly enhance the depth and quality of urban landscape assessments. This conclusion is supported by positive feedback from participants, indicating strong satisfaction and engagement when utilizing mobile crowdsourcing tools. Specifically, high ratings provided by participants underscore the application's effectiveness in facilitating meaningful interactions with urban environments and promoting deeper reflection on urban landscape quality.

These findings align with existing literature emphasizing the benefits of participatory mapping and crowdsourcing in both educational contexts and broader societal engagement (Bartoschek and Keßler, 2013; Moraitis, 2017). The approach taken in this research resonates with the concept of "ethical crowdsourcing," as defined by Owens (2016), highlighting participation as a meaningful community activity rather than mere data extraction. In landscape-related contexts, the utility and significance of participatory and crowdsourced data have been well-documented, especially concerning spatial planning and public perception of urban spaces (Ioannidis et al., 2022; Moraitis, 2011; Stober et al., 2021). In matters of landscape assessment the practical importance of participation has been noted multiple times (Dimitrakopoulou et al., 2024; R. Ioannidis et al., 2022; Ioannidis and Mamassis, 2023; Sargentis et al., 2024; Wolsink, 2018) along with the broader philosophical and societal importance of participatory processes (Moraitis, 2011; Sargentis et al., 2021a; Stober et al.,

2021) have been pinpointed both in the context of challenges for contemporary landscape and spatial planning (Romanos Ioannidis et al., 2022b; Sargentis et al., 2021b; Tsani et al., 2024b, 2024a) and for the broader societal and research approach to the perceptions of public spaces (Beer et al., 2023b; Bubalo et al., 2019; Chen et al., 2019, 2018).

The voluntary nature of participant engagement further enhanced the outcomes by fostering autonomy and genuine motivation among participants, resulting in authentic insights into residents' perceptions and preferences. This method of voluntary and open participation proved particularly effective for capturing nuanced qualitative data, which is critical for comprehensive urban assessments.

Given the positive outcomes, future research could explore broader applications of participatory methodologies across diverse demographic groups and varied urban and natural landscape contexts, examining long-term impacts and further refining technological tools and processes. Addressing potential technical challenges, ensuring data consistency, and maintaining participant motivation are essential areas for further exploration to optimize the effectiveness of mobile crowdsourcing in landscape assessments.

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