COPERNICUS MASTER IN DIGITAL EARTH

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ASSESSING WALKABILITY FOR WOMEN IN CITIES: INTEGRATING GIS AND PARTICIPATORY MAPPING

A5: FINAL PAPER

Scientific Methods and Writing Group 1

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Final Paper

Sustainable Development Goal 11 aims to "make cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, 2016) and its targets 11.2 and 11.7 specifically emphasize the need for safe transportation and accessible public spaces for vulnerable groups such as women, children, the elderly and persons with disabilities (United Nations, 2016). In this context, walkability is closely linked to social injustices where marginalized groups have limited opportunities to access areas and walk safely due to their gender, race or socioeconomic background (Quiambao, 2024). However, studies on walkability in cities often take a general perspective without considering the individual needs and perceptions of specific pedestrian groups (Gorrini et al., 2021; Shields et al., 2023). For women in particular, walkability is not only about the physical features of the built environment, but also about a feeling of comfort and personal safety (Golan et al., 2019). This underlines the multidimensional nature of walkability and why multidisciplinary approaches are required to ensure a gender-sensitive analysis (Shields et al., 2023). GIS and participatory mapping can efficiently contribute to a more people-centered approach to walkability assessment by incorporating the specific needs of women, such as a sense of safety and infrastructure that supports caregivers with strollers or young children. This approach captures both objective measures of urban walkability and women's personal perceptions, ultimately contributing to an inclusive, safe and accessible built environment for everyone.

In general, many different definitions of walkability exist, which can be briefly summarized as "a measure of whether the built environment of a neighborhood encourages people to walk" (Wang & Yang, 2019). Accordingly, there are a variety of over 85 variables which can be used to measure walkability at different scales using various methods such as GIS and participatory mapping (Shields et al., 2023). Depending on the definition and the approach, walkability measures can be divided into different categories such as usefulness, safety, comfort and the presence of interesting features (Speck, 2012). Research also suggests that walkability is closely related with street connectivity, land use mix, traffic conditions and residential density (Wang & Yang, 2019). These attributes often describe objective characteristics of the built environment, yet objective measures alone may not be sufficient to capture the perceptions of different user groups such as women, especially in terms of safety and comfort. In particular, studies have shown that women's everyday mobility is limited by fear of sexual assault, which leads them to choose longer routes or avoiding walking at night to increase their perception of safety (Sethi & Velez-Duque, 2021). Therefore, to ensure gender-sensitive walkability assessment, both objective and subjective measures should be considered. These can include sidewalk quality, cleanliness, crime and the presence of parks, businesses or homeless people (Golan et al., 2019).

While Geographic Information Systems (GIS) are widely used in walkability analysis to capture features of the built environment, the existing methods often do not consider gender-specific analysis. In general, a wide range of open data can be used for analysis, although availability and limitations may vary depending on the study area and application (Gorrini et al., 2021; Golan et al., 2019). One commonly used tool to measure walkability is the Walk Score, a walkability index based on the proximity to 13 amenity categories, population density and road metrics (Shields et al., 2023; Wang & Yang, 2019). Although this index is well established and has been validated in various studies, it does not consider certain attributes such as crime rates, topography and neighborhood aesthetics (Golan et al., 2019). However, these attributes are crucial for measuring perceived walkability of certain user groups, such as women. For this reason, studies have found that there is a negative correlation between the commonly used Walk Score and a women-specific walkability index, which is strongly influenced by crime, homelessness and sidewalk cleanliness, features that have been shown to be important for women's perceptions (Golan et al., 2019). This strongly emphasizes the need for gender-sensitive GIS approaches and walkability indices, where women's personal perceptions and experiences are captured through participatory mapping and then integrated into the GIS workflow.

Participatory mapping is an efficient method to grasp the individual views of women on walkability, helping to gain a holistic understanding of how walkability is perceived in terms of safety, comfort and accessibility. In addition to traditional questionnaires such as in the study by Golan et al. (2019), where women were asked a series of questions about their perceptions on walkability, online mapping tools can help to capture the local knowledge and experiences of citizens (Roper et al, 2024). The option to use a map interface to identify the most and least walkable areas in a city and a free-text input option to explain responses can contribute to a deeper understanding of the perceived walkability of vulnerable groups (Roper et al., 2024). This becomes even more promising when combined with GPS trackers and mobile devices to analyze the real-time walking of different user groups (Shields et al., 2023). Ultimately, these participatory mapping approaches provide a bridge between the objective measures and women's subjective experiences of accessibility, safety concerns and comfort, thus providing gender-sensitive improvements in walkability assessment.

The combination of GIS and participatory mapping can be effectively used in urban planning to capture the female perspective on how elements of urban design can negatively impact women's safety and accessibility. In this context, the global online survey *Walk with women* by Sethi and Velez-Duque (2021) with 298 respondents of different ages, gender, culture and demographics identified which urban features restrict women's freedom to walk. More than half of the respondents perceived poorly lit urban spaces as fearful, while active street fronts and streetlights were seen as urban features that

increase the perception of safety (Sethi & Velez-Duque, 2021). These valuable findings can then be put into a spatial context by combining the results of participatory mapping with open data and then formulating a walkability index, as done by Guzman et al. (2022). Similarly, indicator-based frameworks that use reproducible and scalable models such as the one developed by Stutz et al. (2025) can help to assess walkability individually for different pedestrian groups. Here, open spatial data can be used to create indicators that include the presence of pedestrian infrastructure, road categories, noise levels as well as blue and green spaces. The weights of the defined indicators can be adapted to the needs of women to calculate inclusive and user specific walkability indices (Stutz et al., 2025).

In conclusion, the multidimensionality of walkability and the necessity for research at an individual rather than aggregate level is evident. For women as a vulnerable group, their specific needs of personal safety and improved accessibility are explicitly addressed. It is therefore essential to consider not only objective features of the built environment, such as street connectivity or sidewalk quality, but also subjective perceptions, for example in relation to safety issues. This can be achieved through a comprehensive gender-sensitive walkability assessment, which analyzes both spatial characteristics and women's individual views using a multidisciplinary approach of GIS and participatory mapping. However, future research should also be extended to other age groups, races, religions, sexual orientations and disabled people, since these population groups are also often limited in the opportunities that cities can offer. Therefore, implementing diverse approaches to assess walkability at different scales and study areas, with a focus on engaging various pedestrian groups in planning processes through participatory mapping, can significantly contribute to social equity by creating more inclusive, safer cities and thus achieving the Sustainable Development Goals of the United Nations.

Justification

In general, I believe that I was able to improve my essay based on the feedback from my teacher, my peers and also due to the time that passed between the first draft and the final paper, as I was able to recognize some mistakes and weaknesses when rereading the essay myself. I agree with most of the improvements mentioned by my teacher and classmates and implemented them directly. I really appreciated the feedback since I believe it will help me in further writing processes.

While most of the changes made were rather small, by developing more precise sentences, the biggest improvement of my essay is the additional paragraph before the conclusion, which was suggested by both my teacher and classmates. This paragraph now illustrates the bridge between GIS and participatory mapping with concrete examples from relevant sources that can be used to assess the walkability of women.

The only change that I could not integrate, although I thought about it intensively even before writing the first draft, is the inclusion of further user groups such as children or the elderly with their specific needs and perceptions. I felt I had to limit the topic to women only, since the social contexts are already very complex. But I understand the idea behind the criticism, which is why I tried to strengthen my conclusion even more by raising awareness that the individual walkability assessment should not only include women, but a broad range of different population groups. In this regard, I also incorporated my teacher's feedback that social equity in walkability assessment can also be related to race, so future research should also focus in these areas.

Personal Reflection

The writing process for this literature review was incredibly useful for me since it helped me to recognize my strengths, weaknesses and possible improvements. At the same time, the materials provided in this course, especially on efficient sentence and paragraph structure, were extremely helpful during the writing process. I firmly believe that I will use many of the methods and advice learned in this course in my further writing processes.

Dividing the writing process into the different steps of identifying the thesis statement and research questions, drafting the initial essay and conducting a peer review helped me gain a thorough overview of both the topic and my writing style. In addition, the long period of time between the initial draft and the final essay gave me the opportunity to dive even deeper into the topic and find additional sources that advanced my essay further. At the same time, rereading my own essay after so long helped me gain a better perspective and identify weaknesses that I could now address. The peer review was particularly helpful in that we got feedback from another person and were able to see a new perspective on the essay. In this context, I also think that the reverse outline was helpful since I was able to see which paragraphs were correctly understood by the audience and which needed improvement. Moreover, preparing the elevator pitch helped me to identify the most important aspects of my essay, which subsequently helped me to make my final essay more concise.

In terms of the topic I chose, I really enjoyed diving deeper into the general issue, the methods and the links to different pedestrian groups. For this reason, I am very keen to follow up the literature review with a practical implementation of the topic. I think that the literature review has helped me to gain basic knowledge of the methods that I can use for implementation. At the same time, I was able to identify a research gap, especially on the visualization of gender-sensitive walkability analysis. Therefore, as part of a university project, I plan to develop a web map application in which I will adapt the indicator-based assessment model of Stutz et al. (2025). In doing so, I want to integrate and adapt indicators such as the presence of lighting, elevation and sidewalk widths. As part of the user interface,

I plan to create different user profiles, for example women walking at night or caregivers with strollers or young children, since I believe that the needs in these different situations can vary greatly and should therefore be considered separately.

References

Golan, Y., Wilkinson, N., Henderson, J. M., & Weverka, A. (2019). Gendered walkability: Building a daytime walkability index for women. *Journal of Transport and Land Use*, *12*(1). https://doi.org/10.5198/jtlu.2019.1472

Gorrini, A., Presicce, D., Choubassi, R., & Sener, I. N. (2021). Assessing the level of walkability for women using GIS and location-based open data: the case of New York City. *Findings*. https://doi.org/10.32866/001c.30794

Guzman, L. A., Arellana, J., & Castro, W. F. (2022). Desirable streets for pedestrians: Using a street-level index to assess walkability. *Transportation Research Part D: Transport and Environment, 111*, 103462. https://doi.org/10.1016/j.trd.2022.103462

Quiambao, M. (2024). *Walking While…: Walkable communities and the politics of urban neighborhood governance*. *Global Africana Review, 8*, 42–50. https://doi.org/10.17615/k1p8-tt34

Roper, J., Ng, M., Huck, J., & Pettit, C. (2024). A participatory mapping approach to capturing perceived walkability. *Transportation Research Part a Policy and Practice*, *186*, 104133. https://doi.org/10.1016/j.tra.2024.104133

Sethi, S., Velez-Duque, J. (2021). Walk with women: Gendered perceptions of safety in urban spaces. Leading Cities, Boston. https://static-media.fluxio.cloud/leadingcities/CjGjwG7p.pdf

Shields, R., Da Silva, E. J. G., Lima, T. L. E., & Osorio, N. (2021). Walkability: a review of trends. *Journal of Urbanism International Research on Placemaking and Urban Sustainability*, *16*(1), 19–41. https://doi.org/10.1080/17549175.2021.1936601

Speck, J. (2013). Walkable City: How downtown can save America, one step at a time. Farrar, Straus and Giroux.

Stutz, P., Kaziyeva, D., Traun, C., Werner, C., & Loidl, M. (2025). Walkability at street level: An indicator-based assessment model. *Sustainability, 17*, 3634. https://doi.org/10.3390/su17083634

United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. https://sdgs.un.org/2030agenda

Wang, H., & Yang, Y. (2019). Neighbourhood walkability: A review and bibliometric analysis. *Cities*, *93*, 43–61. https://doi.org/10.1016/j.cities.2019.04.015

Note on the Use of AI and Language Tools

For this essay, ChatGPT was used to organize some ideas into a coherent structure and to improve the sentence structure. DeepL was applied to enhance the language quality by correcting grammatical errors.