

Accelerated User Evaluation of a Geovisual Dashboard for Local Government Transportation Planning

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Abstract: This study examined if an accelerated user evaluation process could provide substantial insight into the usability and utility of a geovisual dashboard for local government. To examine the feasibility of a user evaluation carried out in a condensed time frame, a case study was conducted to assess a pedestrian risk dashboard for Allegheny County in Pennsylvania, United States. The user evaluation process was completed within a three-week period, which included recruiting participants from municipal government offices, administering user testing and a survey, and synthesizing results. While researchers have defined gold standard frameworks for user evaluation, many geovisual tools are created without any input from prospective users because of perceived barriers. This study demonstrates that even an abbreviated user evaluation process can yield meaningful feedback for a geovisual interface and that researchers designing interactive cartographic tools should reconsider user evaluations as attainable and consequential.

Keywords: user evaluation, dashboard, geovisualization, local government

1. Introduction

In the past decade, geovisual dashboards have become commonplace in local government planning (Ruda, 2015, McArdle and Kitchin, 2016, Heeres et al., 2018, Pluto-Kossakowska et al., 2022). They bring together otherwise fragmented datasets into interactive maps and data visualizations to guide policies and practices. However, decision-makers on the ground often face dashboards that don't align with their expertise and experience, or are impractical for use in their everyday work. The usability and utility of these dashboards depend on the inclusion of the user perspective.

Despite the plea of researchers like Roth et al. (2017) to include user-centered methods and evaluation in geovisualization design, the majority of studies in the field are carried out without them. User evaluation can bridge the divide between research and applied use domains. In the same way that considering the map reader is foundational for map design, considering the "map user" is also foundational in designing digital map interfaces (Roth et al., 2017). This focus on the user aims to understand the user's experience of interacting with a geovisualization and reflects maps' evolving role as decision-making tools.

There are obstacles to incorporating user evaluation, including timing constraints, practical impediments for comprehensive quantitative user evaluation, and access to domain users (Roth et al., 2017). Geovisual dashboards have the potential to synthesize disparate data sources to provide direction for local government planning, but practical solutions won't be found if academic research on the design of these tools is siloed from their intended applied uses.

Overcoming these barriers demands, in many cases, a user evaluation process stripped of complexity. As such, this study examined if an accelerated user evaluation process could serve to assess the usability and utility of a geovisual dashboard for local government. This question was investigated through a case study of a pedestrian risk geovisualization dashboard that was developed for Allegheny County, Pennsylvania, United States. A user evaluation process conducted with local government personnel was completed in a condensed three-week timeline. Notably, this was not a formal or statistically rigorous user evaluation, yet the feedback from prospective users on the ground was imperative for reviewing the usability and utility of the tool. This approach was grounded in literature on user-centered design of geovisual tools for planning and user evaluation frameworks.

2. Literature Review

2.1 Geovisual Dashboards for Local Government

Over the past two decades, many local governments have made use of geovisual dashboards as a tool for planning, stakeholder collaboration, and decision-making. Previous studies of geovisualization dashboards and their utility in facilitating infrastructure planning for institutions, local government, and the public (Heeres et al., 2018, Pluto-Kossakowska et al., 2022), found that these dashboards added "contextual perspectives to the 'hard' outcomes of conventional tools" (Heeres et al., 2018). In a study of geovisualization for decision-making, author Ruda (2015) suggests that maps for regional development should not provide final rankings for decision-makers but rather present a fuzzy

visualization with clear communication of the constraints within the data and methods. This allows decision-makers to incorporate their own expertise and considerations that may not be captured in the data alone. One example that is documented in academic research is the Dublin Dashboard, which has aided Dublin's process of moving their governmental data from various departments into the public domain and has provided greater opportunities for inter-departmental collaboration and public input (McArdle and Kitchin, 2016). However, McArdle and Kitchin (2016) acknowledged an unmet need for a user evaluation to add credibility to the tool.

2.2 User Evaluation Methods

User-centered design and prototype evaluation is a key element of geovisual analytics. Geovisual interfaces should have usability, that is the ease of use, as well as utility, or practicality for solving real problems (Robison, 2017). The potential of dashboards to support local government planning is limited when they are developed in an academic setting with little input from users. Mendonça and Delazari (2014) cautioned that when cartographers overlook the user experience, they may produce visualizations with little utility. In their research of dashboards for public health, Mendonça and Delazari (2014) found a positive relationship between the preference of the user and their performance in map comprehension. However, understanding the user preference isn't always straightforward. For example, a study on the challenges faced by geovisualization experts identified "human factors," such as the cognitive processes involved in map reading, as one of the main obstacles in designing effective geovisual tools (Çöltekin et al., 2017). Roth et al. (2017) recommend an interdisciplinary approach to overcoming this obstacle, combining evaluation practices from human-computer interaction, cartography, psychology, and other fields.

In a study that was particularly relevant to the present research due to a broad overlap in topic and audience, Nelson and MacEachren (2020) applied an evaluation process grounded in user-centered design to a dashboard for urban planners to assess biking patterns from quantified-self data. Transportation planners were asked to complete open-ended exploration with the tool and complete a set of semi-constrained tasks followed by a quantitative and qualitative survey. Nelson and MacEachren (2020) also incorporated Scenario-based design, a process created by Rosson and Carroll (2012) for centering the user in product development with creative narratives of imagined scenarios to develop a set of claims about the features and functions of the dashboard. Although the Nelson and MacEachren (2020) study spanned a longer timeframe than the present study, elements of its evaluation methods were adapted for use in a condensed research timeframe.

3. Methodology

The case study underlying this research included extensive data analysis and modeling around pedestrian risk, as well as the design of a multi-page web-mapping application. However, this paper focuses on the role of user evaluation in

creating and using visual dashboards for local governments. Specifically, it discusses the methods and findings from the user evaluation process. This work highlights practical strategies for conducting usability assessments, particularly demonstrating the feasibility of an accelerated approach for researchers operating under time constraints. The objective of the methodology was to plan, conduct, and synthesize a user evaluation of the dashboard with local government personnel within a three-week period.

3.1 User-centered design of the dashboard

The dashboard was designed with a focus on communicating the spatial distribution of pedestrian risk in Allegheny County to local government personnel to support data-driven infrastructure planning. In consideration of traffic crash maps found in recent literature, it was evident that interactivity, such as the ability to zoom, pan, search, and filter, would be essential for an effective visualization of pedestrian risk at a sub-block scale over a county-wide map area. By necessity, the design process hinged on consideration of the intended users and use cases. However, the research timeline precluded iterative feedback sessions with stakeholders. This prompted a scenario-based design approach as described by Rosson and Carroll (2012) and applied by Nelson and MacEachren (2020), in which a narrative was written about an imagined user and use case in an Allegheny County municipality (See Appendix A). This exercise helped to establish a set of claims about the required features and functions of the dashboard. For example, claims included "the user can quickly identify areas that pose a higher risk for pedestrians," "the user can explore pedestrian risk at three scales: street, community, and municipality" (Figure 1), and "the user can explore specific reported crashes and filter for selected variables." While this approach was condensed from the original structure described by (Rosson and Carroll, 2012), it helped to inform a systematic and intentional design of the initial prototype of the pedestrian risk dashboard (Figure 2).

3.2 User evaluation

The importance of user evaluation was convincingly demonstrated by Nelson and MacEachren (2020). Time constraints for the present research required the user evaluation to be completed in a three-week period; however, it was an imperative step for building a geovisual tool for practical use on the ground.

First, user participant data was collected and evaluation frameworks were prepared for user evaluation of the dashboard. Contact information for municipal professionals in Allegheny County was retrieved from municipal websites and stored in a spreadsheet. Many municipalities in Allegheny County do not have a planning department, so personnel who were most likely to be involved in transportation planning based on publicly available information, such as job titles and departmental responsibilities, were identified. Of the county's 130 municipalities, thirty municipalities were prioritized for participation based on having higher levels of pedestrian risk and contact information available on the web. A set of semi-constrained test tasks mirroring real-world planning duties was developed, such as "Identify

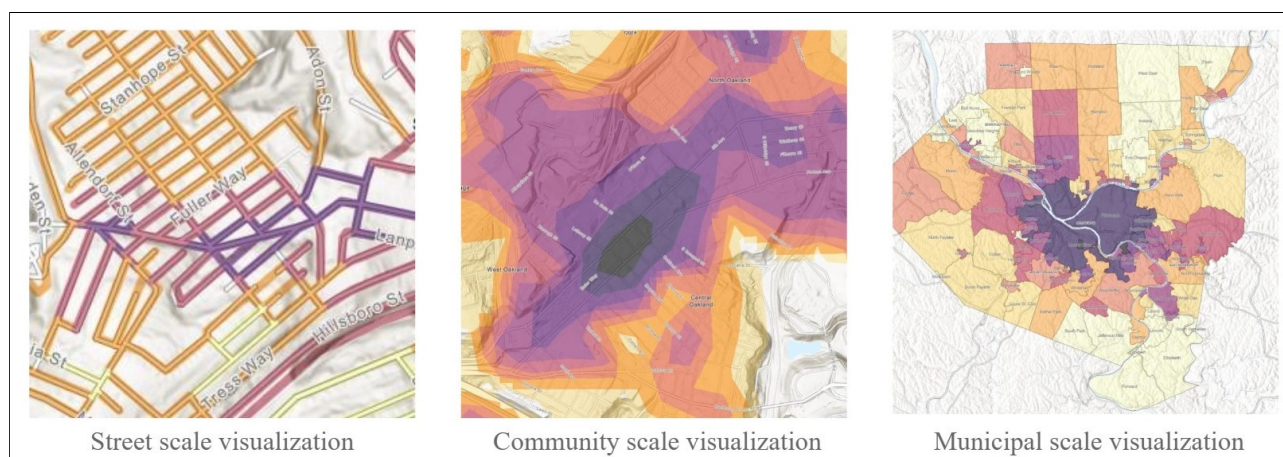


Figure 1. Pedestrian risk visualization at three scales: These three scales of pedestrian risk visualization allow the user to understand how risk varies at a block-by-block scale, at a broader community scale, and at county-wide scale.

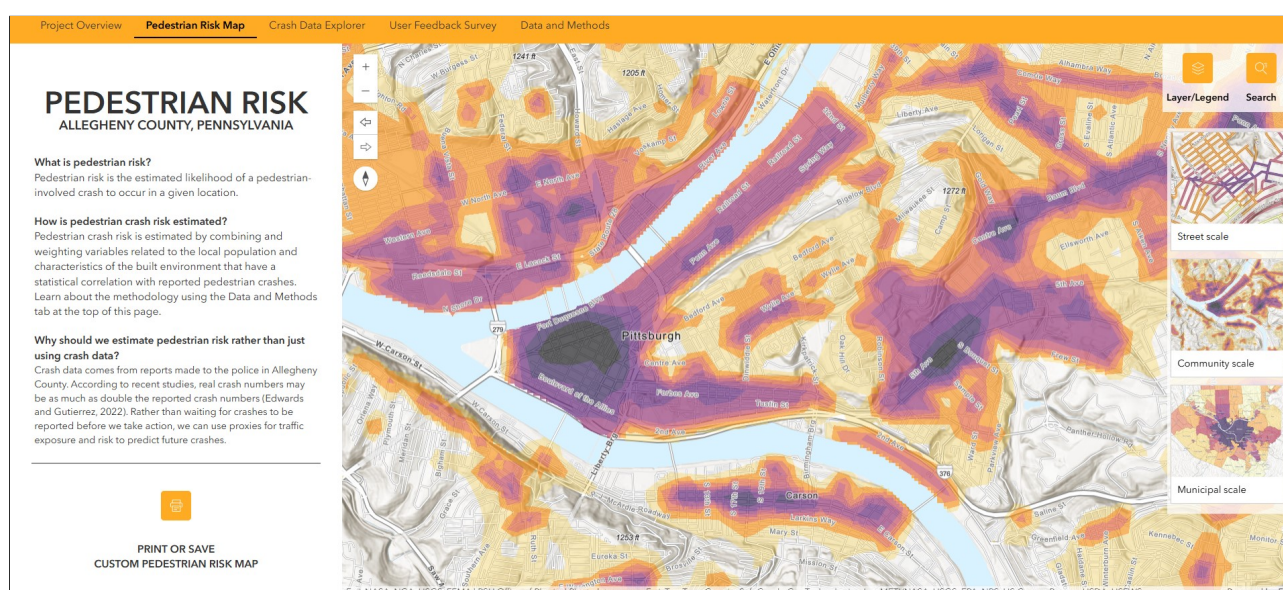


Figure 2. Dashboard, Pedestrian Risk Map: Users can see an overview of hotspots of pedestrian risk to focus on for more detailed data views. Link: <https://experience.arcgis.com/experience/5e2a62fd88d74996b558a441afa9404a>

areas in your municipality with the highest estimated risk for pedestrians.” Then, a survey was formulated including task-based, open-ended, and Likert-scale questions where participants could respond on a 5-point scale from “strongly disagree” to “strongly agree” (Appendix Table 1).

When each framework for the user evaluation was in place, the selected contacts were emailed with requests for participation. Contacts who did not respond within a week received follow-up phone calls or emails. Those who responded affirmatively received a link to the dashboard with instructions for user evaluation. Specifically, participants were instructed to explore the dashboard open-endedly for a few minutes, followed by completing four test tasks. After completing these tasks, the users filled out the survey embedded in the dashboard (Figure 3). Survey responses were recorded and informal interactions with participants that occurred over email or phone were documented as well.

Finally, survey responses were synthesized through a sys-

tematic review of answers to each question, as well as a focused, individual review of each participant’s responses and informal feedback. This helped to determine what patterns were consistent throughout the group, versus specific to an individual. Common themes and unique views were compiled to produce recommendations and next steps.

4. Results

Ten local government employees in Allegheny County completed the user evaluation within a three-week testing period. This included three employees from the City of Pittsburgh, which is the centrally located and most populated municipality in the county; five from inner-ring suburbs, one from an outer-ring suburb, and one from a rural municipality on the edge of the county. Respondent titles varied, though each respondent claimed planning responsibilities in writing or informal conversation. Their titles included planning director, borough administrative assistant, principal planner, planning manager, economic development manager, urban

Project Overview Pedestrian Risk Map Crash Data Explorer **User Feedback Survey** Data and Methods

START HERE

USER FEEDBACK INSTRUCTIONS

- > Step 1: Explore Pedestrian Risk Map and Crash Data Explorer
- > Step 2: Complete four test tasks.

Use the Pedestrian Risk Map page and the Crash Data Explorer page to complete these tasks. Jot down your answers so that you have them ready for the user survey.

 - > Task 1: Identify the areas in your municipality with the highest estimated risk for pedestrians.
 - > Task 2: How does pedestrian risk in your municipality compare to other municipalities in the county?
 - > Task 3: Identify the intersections in Allegheny County that have the most reported pedestrian crashes from 2014 to 2023.
 - > Task 4: How many reported crashes occurred in your municipality just in the year 2023?
- > Step 3: Complete the survey shown on the right. Note that you will not lose your answers if you revisit another page on this dashboard.

Thank you for your help! Your feedback will be used to improve this dashboard.

User Survey

This survey takes about 10 minutes, and includes the following sections:
 Section 1. Task Questions
 Section 2. Open-ended Questions
 Section 3. Usability and Utility Questions
 Section 4. Participant background

While this survey is not anonymous, your honest, direct feedback is strongly encouraged! We are looking forward to using your feedback to improve this dashboard.

Task Questions

Answer the following questions after completing the tasks listed in the instructions.

How much time did you spend on the assigned tasks?*

☐ 1 to 5 minutes

☐ 5 to 10 minutes

☐ 10 or more minutes

What is your municipality?*

Figure 3. Embedded User Survey: A user survey is directly embedded in the page, which allows users to revisit other pages without losing their responses.

planning and sustainability coordinator, municipal traffic engineer, planning assistant, council member and chair of the public safety committee, and chief of police.

4.1 Task Performance Results

After completing a set of four tasks with the Pedestrian Risk Dashboard, users completed a survey. Half of the users spent ten or more minutes exploring the dashboard and completing the four test tasks. Their open-ended responses to task questions were assessed for correctness (Figure 4). The majority of users responded correctly or partially-correctly to the four questions. Users were more successful with tasks that could be completed by viewing the Pedestrian Risk Map. They were less successful with tasks that required using data filtering tools on the dashboard's crash data explorer.

4.2 Likert Question Results

Users also responded to Likert-scale questions about the usability and utility of the Pedestrian Risk Dashboard. The majority of responses to the positively-phrased Likert-scale questions were "agree" or "strongly agree" (Figure 5). All respondents agreed or strongly agreed that the dashboard could help them make informed decisions about infrastructure for pedestrian safety, that they could see themselves using the dashboard in their work, and that they found the dashboard easy to use overall. While the majority of respondents agreed or strongly agreed that they have new insights about where pedestrians face the greatest risk in Allegheny County, three gave "neutral" responses. Half of the respondents agreed or strongly agreed that they trusted the map's representation of pedestrian risk. One respondent strongly disagreed, one disagreed, and three were neutral. One respondent disagreed that it was easy to filter and select crashes on the crash data explorer, and one disagreed that it was easy to zoom and pan to a location on the pedestrian risk map.

4.3 Qualitative Responses

Respondents also answered open-ended questions about their insights, experiences, and questions. While some responses converged on common themes, many viewpoints were unique. Participants generally found the dashboard to be a practical exploratory planning tool that would be useful for gaining insights on pedestrian risk. They also made many suggestions for improvement, such as adding data layers like sidewalks, including functions like a time slider, and providing more granular risk estimations. Most respondents saw potential applications of the dashboard in their municipal operations for education, planning, and grant writing. Perspectives diverged on the utility of specific map views and layers and trust in the accuracy of the risk estimation. Overall, respondents stated that the tool would be useful for their work and noted several opportunities for refinement.

5. Discussion

Despite an accelerated user evaluation timeline for this study, participants were able to provide valuable information about their first-hand experiences in their work and with the dashboard. While all participants provided their feedback through the formal user evaluation survey, several participants also engaged in informal conversations and feedback before or after completing the user evaluation which added ancillary context about their experiences with the dashboard and backgrounds. Their input provided many possible next steps for improving the dashboard's usability and utility, detailed below.

5.1 Formal user evaluation feedback

A clear pattern in survey responses demonstrated the disparity in local government planning resources between Allegheny County's urban center and suburban and rural communities. Participants who were employed by the City of

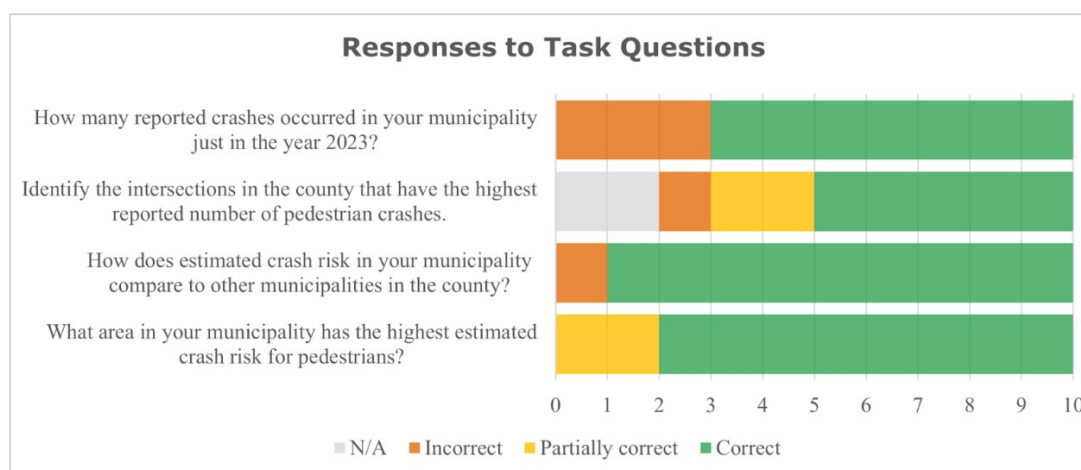


Figure 4. Responses to task questions: Participants were correct or partially correct 83% of the time.

Pittsburgh were familiar with using crash data to prioritize projects under their “vision zero” strategy to eliminate fatal crashes on the city’s roadways. All other participants demonstrated little to no experience using crash data to prioritize projects. They stated that their investments typically followed resident complaints. These differences between urban and suburban/rural practices seemed to impact the participants’ perception of the tool’s utility. Participants from the City of Pittsburgh offered more constructive criticism about the dashboard and had fewer revelations about pedestrian risk in their responses, while participants from smaller municipalities generally showed enthusiastic interest and were able to gain new insights from the dashboard.

Participant feedback proved to be a useful tool for ground truthing the pedestrian risk model. Respondents frequently stated their agreement or disagreement with the hot spots of higher pedestrian risk in their municipalities. This helped identify flaws and strengths in the pedestrian risk model. For example, one participant observed that alleyways, which run parallel to most streets in the county, had misleadingly similar levels of pedestrian risk as adjacent roadways, and noted a need to further dissect the street type variable in the analysis.

5.2 Informal feedback

In addition to formal survey responses, a wealth of information was gained through informal conversation with user participants over email and phone. One participant wrote “The timing of your work is perfect for several projects I am working on” and requested use of the dashboard for a local project to improve pedestrian safety along a 13-mile boulevard that spans several municipalities in the county. In further conversation with this participant, they identified a challenge with the pedestrian risk visualization: the range of pedestrian risk shown within municipalities is relative to the county-wide range of pedestrian risk. This allows the viewer to see a comparative county-wide view, but limits functionality of the dashboard for municipalities with a narrow proportional range of risk.

In another example of informal feedback, a municipal police chief who had received a forwarded email about the

dashboard, had recently been assigned a task of choosing locations to implement crosswalks using state department of transportation funding. However, he had limited insight about where dangerous intersections were because, in his words, “crash incident reports had not been filed at all” prior to the start of his employment with the municipality. Because the pedestrian risk visualization does not solely rely on reported crashes but uses other proxies for crash risk, he thought it could be useful for decision-making in his municipality’s situation. This prompted closer exploration of the crash data which distinctly suggested similar circumstances in other municipalities in the county, and also provided possible directions for future research.

5.3 Refining the dashboard

Information provided by the user evaluation participants, both formally and informally, revealed that very few of the municipalities represented by participants currently use data to prioritize pedestrian risk countermeasures. Considering that pedestrian deaths in Allegheny County were higher in the last recorded year than any year in the past decade (Allegheny County, 2023), evidence-driven planning is an urgent need. Local government officials who participated in user evaluation of the Pedestrian Risk Dashboard clearly are concerned about the inadequacy of local infrastructure for providing safety and accessibility for pedestrians, and they desire a practical tool to guide their decision-making.

The participants identified opportunities for refining the Pedestrian Risk Dashboard so that it could serve that purpose well. Several short-term opportunities for refining the pedestrian risk visualization and dashboard included: exploring options for providing intra-municipal risk visualizations to provide greater contrast in risk values; updating the pedestrian risk model for a more granular risk estimation; clarifying the definition of pedestrian risk presented on the dashboard; including additional filters on the crash data explorer; and incorporating a temporal filter for the pedestrian risk visualization. While not all of these opportunities may be feasible they are worth considering. More broadly, future research directions, largely inspired by questions and observations from user evaluation participants, include:

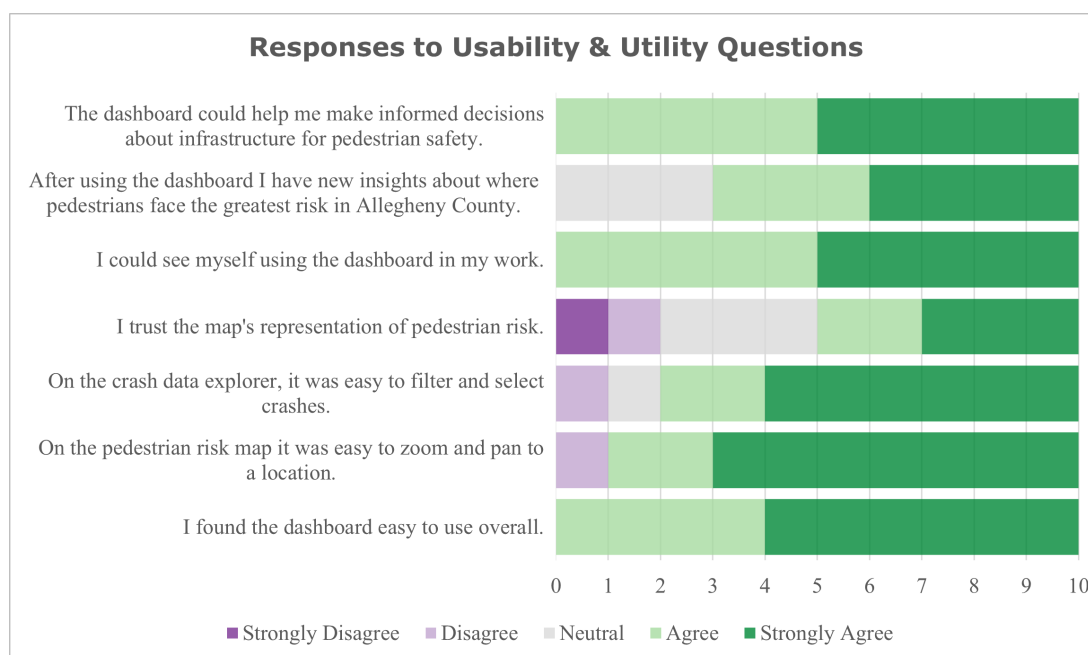


Figure 5. Responses to Usability and Utility Questions: Participants answered positively-worded usability and utility questions with “agree” and “strongly agree” in 84% of responses and with “disagree” and “strongly disagree” in 6% of responses.

1. How does sidewalk condition relate to pedestrian risk? A county-wide sidewalk dataset and audit is needed to address this question.
2. How accurately can the pedestrian risk visualization predict future crashes? A regression analysis could compare the risk visualization with pedestrian crash data from subsequent years when it becomes available.
3. Assess potential data sources for unreported pedestrian crash events, such as hospital records, and determine if this data can be incorporated into the pedestrian risk visualization.
4. The Pedestrian Risk Dashboard helps users understand the issue of pedestrian risk. To take the next step, how can it support users in their search for a solution?

The user evaluation highlighted the potential of the Pedestrian Risk Dashboard to bridge critical gaps in evidence-based planning across Allegheny County’s municipalities. Participant feedback, both formal and informal, guided refinements to the dashboard’s usability and revealed opportunities for future research to enhance its utility. By addressing these insights, the dashboard can evolve into a practical tool for informing data-driven decision-making around pedestrian issues in the county.

6. Conclusions

In a span of three weeks, the user evaluation participants in this study added significant value to the process of designing a pedestrian risk dashboard. They provided rich first-hand knowledge about the experiences of pedestrians in their municipalities, described their local practices around pedestrian safety and crash prevention, and illustrated their experiences with the dashboard.

For geovisual dashboards to be fully integrated into the work of local governments, the researchers who build them can contribute to this goal by asking, ‘Is it usable?’ and ‘Does it have utility?’. The dashboard and map user should have a central role in answering those questions. Too often, researchers assume a user evaluation is beyond the scope of their studies. However, the process demonstrated in this case study was completed in just three weeks with minimal resources, and provided a remarkably valuable assessment of the dashboard that will directly inform future modifications and directions for the tool. There is more to consider in possibilities around accelerated user assessments. Future research could explore minimum requirements for those accelerated evaluations, or tiered requirement frameworks for evaluations, considering levels of limitation.

This study demonstrated that even when rigorous user evaluation methods are not feasible, an accelerated process can yield meaningful feedback for a geovisual interface, and that researchers designing these tools can have confidence that user evaluations are attainable and consequential.

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A. Appendix: Scenario-based Design

The following creative narrative about an imagined user of the pedestrian risk dashboard helped to formulate a set of claims about the features and functions of the dashboard.

A recent string of pedestrian crashes in a small municipality in Allegheny County, Pennsylvania, has spurred interest in pedestrian safety initiatives among residents and local government officials. Frank, a municipal council member and the chairman of the Streets Department, has received calls and emails over the past several months from residents about pedestrian safety and accessibility concerns. Pedestrian safety issues became personal when Frank's neighbor was hit and critically injured while walking to work.

Frank knew that changes needed to be made to protect pedestrians in the town, but he wasn't sure where to start. He was beginning to see how the Street Department's prioritization of traffic flow rate had undermined the safety of pedestrians over the past decades. He began spending time poring over Google Maps satellite imagery of the area and making notes about ideas for infrastructure improvements, especially along the streets where the recent

pedestrian crashes had been reported. The problem was, most streets in the town needed at least some upgrades. The sidewalks that existed were mostly deteriorated or ended abruptly mid-block, and very few intersections had well-marked crosswalks. There just wasn't room in the budget to fix it all. At a state department of transportation conference, Frank learned about a safe streets grant program. He wanted to apply for the program for pedestrian infrastructure improvements, but needed to identify specific intersections or streets for a project. A colleague at the conference had told him about the Pedestrian Crash Risk Dashboard, a website that showed high risk areas for pedestrians in Allegheny County.

Back in the office the next day, Frank pulled up his web browser on his desktop computer and looked up the Pedestrian Crash Risk Dashboard. He read a brief overview of the dashboard and then clicked to see the "pedestrian risk map". A map of Allegheny County filled the screen, and he could see "hot spots" of darker colors here and there which he assumed represented riskier areas for pedestrians. He noticed a legend that confirmed that assumption. Frank saw an address search bar at the top right corner of the map, but rather than typing in his municipality he just dragged his cursor down the screen and used his mouse scroll wheel to zoom in to his location. The hot spots were mostly where he expected. There was one at the notoriously confusing intersection by the high school, as well as around the shopping center intersection. Frank had seen many pedestrians coming from the shopping center hopping over the guardrail and darting across the street like a game of Frogger there.

Frank sat back to look at the other elements on his screen. On the left hand side was a window with information about the map, and a box with options for printing the map. He made a mental note for later so he could save a print for the grant application. He noticed a tab on the top menu labeled "Crash Data Explorer". He opened it, and another map of Allegheny County was in the center of the screen, filled with points that represented crashes. A box next to the map had instructions for how to filter the points based on what he wanted to know. With a little trial and error he was able to add a filter for his municipality. The map automatically zoomed to it. A chart below the map filled with data for pedestrian crashes by year for his municipality. He saw a table to the right with information about the crashes. He scrolled through them and took note of some recurring themes - like many of the crashes happened at night. He continued modifying the filters to see what patterns he could find.

While the Allegheny County Pedestrian Risk Map hadn't explicitly listed what roadways had the highest risk of pedestrian crashes in his municipality, Frank felt confident that he could make a solid argument for prioritizing infrastructure improvements around the shopping center intersection and the high school intersection, especially considering what he knew about the condition of the existing infrastructure there. Frank used the print tool to download a pdf of the pedestrian risk map, centered on his municipality. He saved it to his grant application folder.

Survey questions	Answer format
Section 1: Task questions	Multiple choice
1. How much time did you spend on the tasks?	
2. What is your municipality?	
3. What area in your municipality has the highest estimated crash risk for pedestrians?	
4. How does estimated crash risk in your municipality compare to other municipalities in the county?	
5. Identify the intersections in the county that have the highest reported number of pedestrian crashes.	
6. How many crashes occurred in your municipality just in the year 2023?	Open-ended
Section 2: Open-ended questions	
7. What general insights did you gather from the dashboard?	
8. What questions do you have about the dashboard?	
9. What were some issues that you encountered while trying to use it?	
10. How do you and your coworkers currently make decisions about where to add or improve infrastructure for pedestrians, like crosswalks, sidewalks, or intersection bump-outs?	
11. If this dashboard was available to you and your coworkers, could you imagine using it in your work? If so, how? If not, why not?	
12. Do you have any questions or concerns about the data used in this dashboard?	
13. Do you have any other feedback or suggestions about this tool?	
14. Do you have any other feedback or suggestions?	Open-ended
Section 3: Usability & utility questions	
15. I found the tool to be easy to use overall.	
16. On the pedestrian risk map it was easy to zoom and pan to a location.	
17. On the crash data explorer, it was easy to filter and select crashes.	
18. I trust the map's representation of pedestrian risk.	
19. I could see myself using the dashboard in my work.	
20. After using the dashboard I have new insights about where pedestrians face the greatest risk in Allegheny County.	
21. The dashboard could help me make informed decisions about infrastructure for pedestrian safety.	Likert scale
Section 4: Participant background	
22. Name	
23. Job Title	
24. Municipality/Local Government Entity & Department (if applicable)	
25. Email (optional)	
26. Is there anything else we should know?	Open-ended

Table 1. Survey questions: The user evaluation survey included quantitative and qualitative questions with a mix of pre-determined answer choices and open-ended formats.