Active Transportation, Citizen Engagement and Livability: Coupling Citizens and Smartphones to Make the Change

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Abstract: *Supporting livable cities is a key priority of the Obama Administration, fully embraced by the U.S. Secretary of Transportation, and necessitates increased active transportation (walking and cycling) in communities across the country. Transportation data that support active transportation planning are lacking for most communities. With the increasing pervasiveness of smartphones that are graphically rich, spatially accurate, and simple to use, it is now possible to approach transportation and livability data collection in a new way by engaging citizens directly in the process.*

This paper describes the development and testing of an iPhone-based transportation livability audit tool called the Fix This Tool, a tool specifically designed to engage and empower citizens across the country to easily collect active transportation data to help local communities and transportation agencies meet the needs of the livability era. The tool requires no special training, is spatially specific, and addresses subjective perception of place as well as key objective variables that underlie that perception.

Through initial development and testing, we found the tool to be intuitive for people to use and the data robust, and that the combination of features available on a smartphone-based tool provides a rich set of opportunities for both the citizen and the public agency to be engaged in improving their active transportation system. That said, it is clear that active transportation data can be complex and "messy" and will require new approaches toward use compared to traditional, objective measured regional scale measures used for transportation modeling.

INTRODUCTION

Supporting livable cities is a key priority of the Obama Administration, fully embraced by the U.S. Secretary of Transportation. Because the concept of livability implicitly focuses on land use and community design first, and transportation systems optimized to fit those land-use patterns second, the move toward a livability agenda is a radical shift in how transportation planning is carried out by local and state agencies.

In the context of livability, transportation not only becomes subservient to land-use decision making, but nonautomobile modes receive an increasing share of attention for walking, biking, and transit often are the most efficient means of helping people access destinations. Yet given the slower and more human-scaled pace and experience of these active modes, planning for pedestrian and bicycle transportation requires a detailed and more nuanced set of tools and indicators than does traditional car-based modeling. And while traditional transportation models are beginning to address walking and biking, a different type of data and planning may be needed to properly plan for increased shares of active transportation.

Unlike with the car, the decision to walk or bike and the route to take often is based on a more complex set of inputs, in addition to the importance of directness and speed. Some of those built-environment qualities may include sidewalk presence and condition, buffer between sidewalk and moving cars, type of bike facilities, lighting, street trees, architectural design, and scores of other potential variables (Pikora, Bull et al. 2002; Vernez Moudon and Lee 2003; Clifton, Smith et al. 2007). For all these objective indicators, however, they may never fully explain an individual's quick intuitive assessment of the built environment (McGinn, Evenson et al. 2007). For active transportation planning, it is likely that initial perceptions, especially the perception of safety, are critical in deciding whether individuals will even consider biking or walking as an option in the future (Ogilvie, Egan et al. 2004). This more subjective and perception-based relationship between active transportation users (or potential users) and the built environment presents a new and more complex challenge to transportation planners.

A key question then becomes, how do we create a set of national data, useful for active transportation planning, and based on individual experience of the local walking or biking environment? This paper explores a potential approach to bridging the new data needs of transportation agencies by catalyzing a general citizenry, equipped with their own smartphones, mobilized to act as both data gatherers and system users to assist local public officials in prioritizing and improving local active transportation systems. Specifically, the paper will explain the technical details and broader rationale and use of the Fix This Tool, a customized iPhone application that allows users anywhere in the country to instantly and spatially document subjective and objective conditions of their local active transportation environment.

CONTEXT

Within its recently released strategic plan, the U.S. Department of Transportation presented the visionary new goal of transportation-supported livability. Transportation Secretary Ray LaHood described a livable community as one "where if people don't want an automobile, they don't have to have one. A community where you can walk to work, your doctor's appointment, pharmacy or grocery store. Or you could take light rail, a bus or ride a bike" (Findlay 2009).

While the predominant transportation focus of the past 70 years has been to increase the mobility of automobiles, a livability orientation toward the nation's transportation systems focuses on access. The difference could not be more fundamental; the status quo seeks to move vehicles quickly (mobility) and the new goal seeks to get people to where they want to go more easily (accessibility). Placing transportation planning under the umbrella of livability represents a critical policy statement that suggests that people do not consume transportation for its own sake but rather use transportation to get to where they want. Focusing on destinations rather than on just moving vehicles allows regional planners to be more effective in rebalancing the transportation system so that different modes of travel are appropriately used for the types of trips for which they are best suited.

Of course, translating broad national policy goals for systemic change into local action can be difficult. There are many fundamental barriers, including: (1) generations of transportation planning and engineering staff have little or no experience approaching walking or biking as equally appropriate modes of transportation; (2) almost no data are available at the local level to support active transportation decision making; and (3) communities across the country are diverse in land use and culture.

The U.S. Department of Transportation (2010) recognizes the need for appropriate treatment of place and context while addressing these substantive barriers related to scale, authority, and capacity, suggesting that one of the key federal roles, in addition to direct funding, is to "give communities the tools and technical assistance they need so that they can develop the capacity to assess their transportation systems, plan for needed improvements, and integrate transportation and other community needs" (49). The Fix This Tool, a class of planning support tools that combines detailed built-environment assessments, spatial accuracy, and public involvement, was designed to meet this key gap.

Tools for Addressing the Data Needs of Local Communities

A variety of planning support and data-gathering tools have been developed over the past decade to assist with active transportation planning (although most focus on pedestrian rather than bicycle infrastructure) (Pikora, Bull et al. 2002; Vernez Moudon and Lee 2003; Schlossberg 2006). These tools range from paper and pen checklists to mobile GIS-based systems for gathering appropriate built-environment data directly in the field. Some of these tools are targeted toward community groups interested in auditing their local neighborhoods (Schlossberg and Brehm 2009), while others attempt to collect highly rigorous, comprehensive city-wide data to advance transportation planning and modeling for active transportation (Clifton, Smith et al. 2007).

Transportation decisions are invariably limited by the availability of spatial street data. Data currently used in transportation decisions largely consists of a comprehensive street network, augmented by local lane and speed data. Pedestrian network data (i.e., sidewalks) are inconsistent and rarely complete (even when adjacent to the streets) and often lack pedestrian paths that do not follow roadways. Pedestrian volume data are largely nonexistent. Bicycle infrastructure data also are limited, partly because most cities in the United States lack bicycle infrastructure, and partly because there are few agencies that care or have the capacity to do anything with bicycle-related data. Local governments often are reluctant to rectify these gaps because most transportation planning revolves around the work trip and the share of both bicycling and walking commuters are generally quite low.

What seems clear is that bicycle and pedestrian transportation system planning is in its infancy in the United States, especially relative to the comprehensive and dominant emphasis of the automobile-based transportation planning of the past 70 years. And given that active transportation users are impacted more by small variations in the streetscape than are car drivers, it seems appropriate that the experiences of these cyclists and pedestrians should play a role in the transition toward livability. This process will not only produce data useful for improving local conditions, but the participation in the process itself may lead to social learning (Bull, Petts et al. 2008). Research suggests that the process may be just as important as the data that is collected (Schlossberg and Brehm 2009); as more people reimagine their local environment in terms of biking or walking, the easier it may become to achieve a greater use of such modes.

It also is important to understand that active transportation (walking and biking) are not fringe modes of travel relegated to the elderly, young, or poor—or those who simply cannot own and operate a car. The full potential modal split of walking and biking for all kinds of trips—work and nonwork—is unknown because the transportation infrastructure in most American cities makes choosing these modes undesirable, unsafe, and irrational. There is a disconnect between what current active transportation rates are and what their potential might be, and identifying the barriers from the user perspective is an important component in catalyzing cities to improve their active transportation infrastructure.

There is a lot of potential. Almost half of all daily American trips are under three miles and 28 percent of all trips are under one mile (Bureau of Transportation Statistics 2001), meaning there are a significant number of potential active transportation trips.

Bicycling rates are about the same across income levels, although motivation for use differs across income group (Pucher, Buehler et al. 2011). For children walking to school—an issue of importance to families of every income and racial demographic—there has been a dramatic decline in rates of walking and biking to school (Kindergarten to 8th grade) from 48 percent in 1969 to 13 percent in 2009 (National Center for Safe Routes to School 2011). According to a national poll, "Americans would like to walk more than they are currently, but they are held back by poorly designed communities that encourage speeding and dangerous intersections" and "More than half (55 percent) say they would like to walk rather than drive more throughout the day either for exercise or to get to specific places" (Belden Russonello and Stewart 2003).

There is a desire to walk and bike more, and new federal initiatives are helping to support cities in meeting this desire. Yet, the ability to make decisions at a very local scale—the scale of most importance to active transportation users — is limited because data does not exist at such a fine grain and collecting that data is time consuming, difficult, and seemingly endless. Engaging community residents in that data gathering, however, may be an approach to bridge citizen desire, federal policy, and municipal paralysis. Moreover, engaging a broader public in this data-collection process actually may yield decisions that are smarter, spatially targeted where they will be most effective, and would be more sustainable in that the beneficiaries of improved infrastructure could be the ones most responsible for identifying the priority areas of need.

Citizen Involvement in Spatial Data Collection and Analysis

Using geographic information systems (GIS) for local government decision making is not a new concept (O'Looney 2000) and, perhaps surprisingly to some, neither is connecting ordinary citizens to GIS for local community decision making. Participatory GIS, for example, has been used in a variety of ways to connect fairly sophisticated information technology with lay-citizen engagement (Harris 1998; Obermeyer 1998; Talen 2000; Craig, Harris et al. 2002; English and Feaster 2003). Even in the area of engaging citizens in active transportation, there have been some preliminary efforts of experimentation. The Complete Streets Assessment Tool (CSAT) and the School Environment Assessment Tool (SEAT) connect concerned citizens with mobile GIS data-collection tools so that citizens themselves collect objective built-environment data and subjectively evaluate the same (Schlossberg and Brehm 2009).

A key potential benefit to transportation agencies utilizing a general citizenry in data collection is both the distributed approach to actually gathering the data (no need to hire a new staff) and to connect system users to system improvement (public involvement). Empowering citizens to collect and rate their local active transportation environment can help direct limited agency resources to areas in the community most in need. In a larger context, this "soft" benefit of cultivating an engaged and empowered citizenry can have longer-term benefits such as the establishment of trust and the experience of success often needed to push community change forward (Arnstein 1969).

Yet collecting data in a decentralized, community-managed, and mobile GIS environment is difficult to scale beyond select individual communities. GIS requires a fair amount of technical expertise, even if handled by a technician independent of citizen data gatherers, and collecting field data using GIS (e.g., Arcpad) requires training the user. Facilitator-led training for data collection, as has been the case for most past community-based or researcher-based active transportation assessments, is expensive, time consuming, and severely limited in geographic coverage. These technical and process-based limitations are especially relevant in the context of a national push toward planning for livability, which requires data that are national in coverage but engagement that is locally scaled. Smartphones may provide advantages where previous spatial data collection tools could not.

Capitalizing on the Emergence of Spatially Aware Mobile Technology

Current mobile devices (i.e., smartphones) differ markedly from previous generations of mobile phones in three significant ways: (1) they have active GPS capability; (2) they have near unlimited Internet access; and (3) graphical resolution and interactivity allows users to push data out from the phone rather than just receive calls and simple static information. This two-way information exchange, in conjunction with GPS location capability, creates a spatially aware mobile technology increasingly ubiquitous in the hands of people across the country and even across the globe.

More than 80 percent of all U.S. adults own a cell phone, and, of those, 42 percent use smartphones, meaning that almost one third of all adults currently own and use smartphones (Smith 2011). Smartphone sales are growing at more than ten times the rate of other mobile-device sales (Gartner Research 2010) with the industry-leading Apple iPhone nearly doubling past sales from 2009 to 2010 with the sale of 25 million units within a single year (International Data Corporation (IDC) 2010). Urban and suburban residents are twice as likely to own a smartphone as those in rural areas and minorities are more likely to own them compared to whites (Smith 2011). The least likely to own smartphones are those over age 65 (11 percent) and those earning less than $30,000 (22 percent) (Smith 2011), but with new options for lower cost data plans and the continued increase in smartphone choices, price no longer will be a significant barrier to owning a smartphone. In fact, owning a smartphone actually "provides teens from lower income households without a computer an opportunity to use the Internet, hence helping to bridge the digital divide" (Amanda Lenhart, Ling et al. 2010). The main barrier to smartphone adoption, then, seems to be technological unfamiliarity, explaining a lower adoption rate by older Americans. That said, even 62 percent of those older than 75 live in a household with a cell phone (Kathryn Zickuhr 2011).

Spatial technology also has matured to the extent that online map and GPS use (i.e., satellite navigation systems or online tools such as MapQuest) are widely used, inexpensive (one dollar for a GPS chip), and can quickly combine user location and fairly detailed maps almost anywhere across the country. Not surprisingly, analysts predict greater public demand for, and industry capacity for providing, these location-aware information services (Tarmo 2009).

The spread of smartphones, access to customizable applications, and growing familiarity with mapping and location-based applications presents new opportunities for transportation agencies to interact with their citizenry. There may be real opportunities for citizens to help transportation agencies better target their resources and for agencies to be more responsible to citizen concerns. Not surprisingly, there are already examples of local governments and private developers releasing spatial tools designed around general public input (Sutter 2009) although most act as simple reporting tools such as telling the public works department the location of potholes.

The data relevant to active transportation planning are of a grain much finer than that traditionally collected for automobile travel based around mobility and level of service. These micro characteristics of the streetscape can all act to encourage or exclude individuals walking or biking.

Collecting the Data That Matters

The decision to walk or bike and the choice of route is based, in part, on minimizing personal risk. This individual risk calculation can be thought of in two distinct ways. Risk that is perceived *as feeling* informs a person's instinctual aversion to danger (i.e., hazard). Risk *as analysis* adds the faculties of reason and logic. Local governments normally seek to minimize risk analytically, while individuals tend to seek to minimize risk intuitively. When a person crosses the street, the decision is made in the moment, intuitively, and often with incomplete information. This heuristic form of decision making is based primarily on affective qualities—that is, good or bad—of the environment. The mother who drives her child to school on a daily basis does not know which safety interventions are lacking that make her feel it would be unsafe to let her child walk to school; rather, she just feels concern about her child's safety, so she drives.

Furthermore, research has shown that these two forms of decision making interact. If a person believes something is "good," they also are more likely to perceive a higher benefit in the action and a lower degree of risk, irrespective of any logical conclusion to the contrary. Likewise, a "bad" decision accentuates possible risks and attenuates perceived benefits (Alhakami and Slovic 1994). As a result, the benefits of any safety interventions will likely be moot if the individual continues to perceive his or her environment as hostile or dangerous. Examples are abundant: While many cities now provide dedicated bike lanes on arterial roadways, only the least risk-adverse individuals (i.e., younger male riders) actually use those facilities (Baker 2009).

In planning for active transportation, it is important to include both components while retrofitting cities toward livability. Inventories of physical infrastructure needs that could support increased walking and cycling are clearly needed, as it is impossible to plan for the future within an accounting of what exists today. For active transportation in particular, it may be equally important to understand how individuals perceive their environments. Combining these two sets of data, along with deliberately including citizens in the direct process of evaluating their active transportation environment, is what led to the development of the Fix This Tool.

THE FIX THIS TOOL: DECENTRALIZED, AFFECT-BASED, CITIZEN-LED DATA COLLECTION IN SUPPORT OF ACTIVE TRANSPORTATION

The Fix This Tool is an initial attempt to utilize the latest smartphone technology via Apple's iPhone to create a location-based, quick, and easy way for citizens across the country to rate the bicycle and pedestrian environments within their communities and to apply these data toward local change in livability. The development of the Fix This Tool can easily be adapted to other smartphones, although we were drawn to the iPhone because of its ease of use and superior graphical quality.

Our use of iPhones differs markedly from other public engagement tools because there is no technical limit to the number of devices (thus participants) that can be simultaneously involved in the data-collection process. This is a "decentralized" process for it follows a model of data collection using survey devices not centrally owned or controlled. Instead, survey tools are privately owned and any person is free to become a contributor to the data collection. Devices and software do not require any centralized setup by a trained technician; the application can be downloaded to the device by anyone and anyone can collect data immediately. There is no need for any user training for the interface and controls utilize common standards.

Guiding Principles and Assumptions

When developing the Fix This Tool, we assumed that the following assertions are true:

> *People are influenced by their surroundings and they are more sensitive to their surroundings when walking or biking than when in a car.*

Within a hierarchy of transportation modes, cyclists and pedestrians are the most vulnerable. Not only is safety from cars a constant concern, but cyclists and pedestrians also are influenced by small and unique things, such as leaves left in a bike lane, a house with an aggressive dog in the yard, or a simple lack of path continuity. Do nice walking environments attract more pedestrians or do bad environments repulse them? This is an

This is the introductory “splash” screen that appears when the iPhone application is launched.

The application uses the built-in GPS and “always-on” Internet access to zoom in to the user’s exact location using Google maps as a backdrop. Users then just tap on the screen to begin entering data.

Figure 1. Visual interface of the Fix This Tool

open question, and as a result, the tool was designed for users to record good, bad, objective, and subjective data as they choose.

The Fix This Tool treats all street elements as “observations,” whether it is something built (e.g., streets, signage, etc.) or something felt (e.g., danger, poor lighting, etc.).

A person can identify places where he or she does not feel comfortable and safe, even if he or she may not be able to identify every contributing factor. Each person perceives benefits and risks differently. Yet how people perceive risk depends on many factors, including how beneficial walking or biking is seen in the first place. People choose routes and modes of transportation that minimize risk and maximize speed/directness, yet individual navigation decisions never are based on a complete inventory of one’s surroundings. The Fix This Tool asks individuals to first rate an environment based on their initial subjective feeling, then asks more detailed questions seeking to objectively identify what the issues may be.

Interface

The Fix This Tool is made up of two principle elements: (1) the map interface and (2) the survey interface. These two interface elements allow the user to easily switch between navigating the local built environment and entering information about his or her street-level observations.

Aerial Navigation Map

The map interface allows the user to virtually navigate to a given location, which is aided by the iPhone’s built-in GPS. The map is controlled using simple “gestures,” such as swiping the finger across the screen or using the index and thumb to either “pinch” or “pull” the map to zoom in or out. In comparison to other mobile devices, we have found this system extremely intuitive, often requiring no previous explanation.

An observation is registered by either double tapping at the appropriate location on the map or by having the device automatically place the point at the current GPS location (see Figure 1). As a result, a person can either register a point that he or she noticed earlier or in the case he or she actually is at the location of observation can simply rely on the built-in GPS.

Transportation Observation Survey

The survey interface is composed of a hierarchy of interconnected tables that allow the user to select one or multiple responses depending on the question. The wording and question responses are stored in independent tables, making the tool not only highly flexible but also customizable by other potential developers.

Survey questions are asked in three groupings. The initial survey question asks the user to note the affective quality of the observation. We are interested in this subjective feeling of the environment and it is important to capture that feeling before a

This screenshot shows the general categories of questions to answer, presented in a visually appealing, easy-to-use interface.

Here is a specific data-entry screen that includes a series of typical issues that the user can scroll through to select, or the user can enter a customized description as needed.

Figure 2. Screenshots of data-entry screens

user pays too much attention to the details of his or her environment from an analytical perspective.

After the initial subjective evaluation, the user describes the location using keywords, pictures (using the iPhone's built-in camera or potentially a preloaded set of imagery), or custom text (see Figure 2). A final set of optional questions ask about the related impact of the observation being noted, including the area that it affects (i.e., specific point or corridor), the time of day that the issue is most pronounced, the modes of transportation most affected, and the types of users who the issue might impact (i.e., children, people with disabilities, etc.).

RESULTS

The types of data collected by the Fix This Tool were chosen based on the assumption that people are sensitive to their environment, that transportation decisions are made intuitively based on momentary and incomplete information, and that that information is assembled and used primarily based on its affective qualities. But what does affective street-level data collected in an unstructured and decentralized format look like?

Tool Testers

During our testing of the tool and citizen-based approach, we followed a hybrid centralized/decentralized approach. We purchased ten iPhones with prepaid data plans and cycled the phones through a self-selecting group of volunteers. The Fix This Tool was preloaded on each iPhone and each user was assigned a unique ID for research purposes. The volunteers kept the iPhone for a weeklong period and were instructed to make note of "those things they felt important to share on those routes that they regularly bike and walk within a given week."

Our Fix This Tool testers consisted of 25 self-selected volunteers. The participants were primarily university students (91 percent), male (64 percent), and under the age of 25 (64 percent). Most volunteers used active transportation regularly, reporting on average 12 hours spent weekly either biking or walking. Very few hours were reported spent in a car. Each volunteer was given an explanation of the project, a quick tutorial on the application's use, and then issued an iPhone for a weeklong data-collection period. On returning the iPhones, the volunteers were given a quick post-survey to collect basic demographics and to allow them to comment on their experience using the tool and performing the assessment.

Data-collection Behavior

Over the four-week data-collection period, 307 data points were recorded over an area of approximately five square miles, with the majority of data focused in or near the University of Oregon campus. On average, volunteers noted 18 points of interest during the weeklong period they had their iPhones, although actual numbers varied largely by the individual.

Volunteers noted that for the majority of cases, observations were recorded on location and at the time first noticed (as opposed to returning to the location at a later point or recording it remotely). Observations were noted during all times of day although they were concentrated around typical travel times of students in the morning (33 percent) or at midday (33 percent).

Nonspatial Character of Data

As described previously, the survey captured affective qualities of the built environment before recording more objective built-environment characteristics. The majority (65 percent) of observations noted were considered bad (41 percent bad and 24 percent very bad). Interestingly however, nearly one quarter of the responses noted something that was perceived as good (11 percent good and 11 percent very good). Users saw the remainder of observations (13 percent) as value-neutral.

Description of Issue

Participants were asked to describe the issue in one or more ways, categorizing the issue by keyword, by photograph, or as a custom description written by the user. While users were required to categorize the observation, both photographs and text were optional. For 63 percent of the observations, the user submitted additional text and added a photograph in 25 percent of the observations.

In the majority of observations (Figure 3), users identified the general travel path as the issue, whether it was the road (25 percent), the bike lane (28 percent), or the sidewalk (21 percent). Interestingly, crossings and intersections were noted less often. More subtle aspects of the built environment such as signage or signaling devices were noted even less often. Very few participants noted observations related to the routing, hills, or curves, which is not surprising for most data were collected in a flat, gridded area of the city. Users were able to select one or more of these categories and the average number of issues selected per observation was 1.67. For some observations, however, as many as nine different problems/keywords were selected for a single location.

Description of Impact

The survey did not require users to answer all the questions. That said, all users did enter data about impacted user groups and the time of day that the issue is most relevant. For those questions without a complete response rate, 77 percent of the users recorded data about the frequency of the issue observed as well as noting the spatial extent of the impact (although postsurveys indicated some confusion by users over how to describe the spatial extent of the observation).

When asked to assess which user groups would be most affected by the issue being noted, cyclists and walkers were cited for the majority of the observations. For about a third of all observations, people with disabilities and motorists were indicated. Children and the elderly were the groups least noted to be affected by observed issues, which could be explained by bias on the part of university student volunteers. Participants could select more than one impacted user group and most did, selecting on average 2.56 impacted groups.

The majority of observations addressed permanent characteristics that would always be experienced (53 percent). Slightly less than half (42 percent) of the data points addressed conditions that would be relevant at all hours of the day, compared to conditions that would only be significant during daylight hours (53).

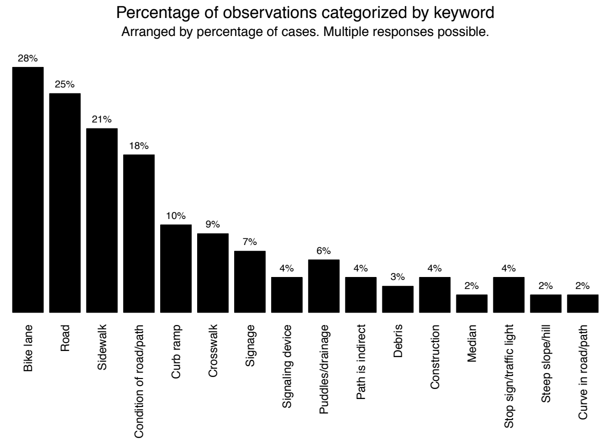

Figure 3. Percentage of observations categorized by keyword

How to Use the Data: A Bicycle Boulevard Example

Because the observation data are associated with geographically specific locations, the data can be isolated or aggregated with GIS as needed within a particular planning exercise. For example, the city of Eugene wishes to make significant improvements to its bicycle infrastructure, beginning with the creation of a signature bicycle boulevard along Alder Street near the University of Oregon campus (which has since received a major bicycling upgrade to a two-way cycle track). Oriented vertically in the center of Figure 4, the Alder Street corridor is color coded by an aggregated average rating of quality: darker colors (e.g., toward the top of the map) represent a poorer evaluation compared to the lighter that represent a favorable evaluation. Aggregating and mapping the data in this way is highly useful for analysis, planning, and urban design.

Because the details also are important in terms of the experiences of users along the corridors, individual comments on the right of the corridor map illustrate some of the good and bad qualities along it. This format is similar to community forums where citizens are asked to place Post-it notes on a map indicating areas of concern. However, the digital format of the Fix This Tool allows individual geographically specific observations to be extracted or aggregated for analysis. Finally, users can take advantage of the iPhone camera that is directly integrated into the tool to visually capture the nature of an observation. Photographs serve as powerful visual evidence and support effective communication with public officials and agency staff.

FINDINGS AND DISCUSSION

The primary purpose of this project was to create an intuitive, decentralized, citizen-based tool to spatially collect transportation-based livability data. Having developed this tool and tested it, and even with a small and biased set of participants, several unexpected and interesting observations can be made.

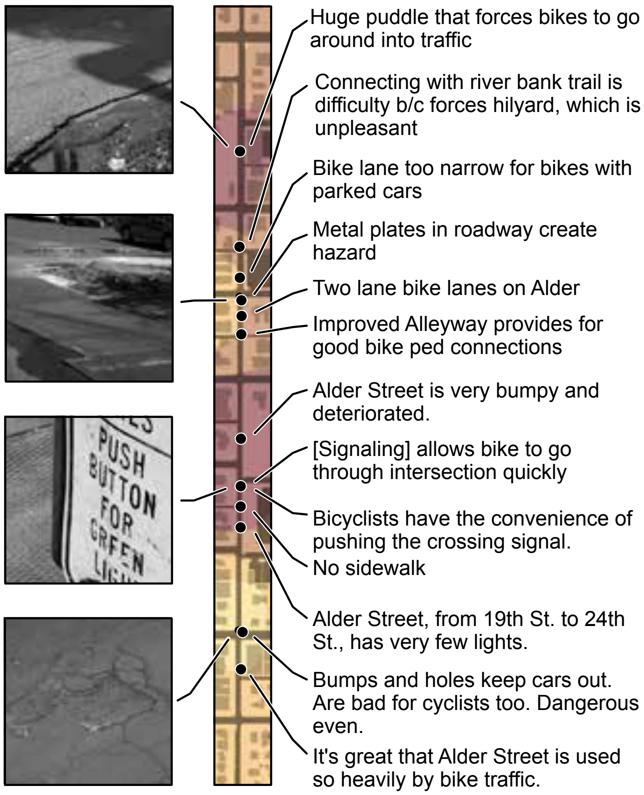

Figure 4. Using integrated data for bicycle boulevard planning

Users Principally Focus on Risks

Users were free to note good or bad aspects of their built environment, yet approximately two-thirds of the observations were described as bad or very bad. This suggests that a participant's likelihood to walk or bike is decreased more by the presence of barriers to walking and biking than by the absence of positive pedestrian and cycling amenities.

Data Is "Messy" at the Microscale

Our initial work seems to indicate that even with a semihomogenous group of participants, there can be a wide variety of ideas about the quality of the active transportation environment. The more users that traveled an area, the greater the range of qualitative assessments that were made. In contrast to system-wide transportation planning at a regional scale, experiences at the microscale—that experienced by pedestrians and cyclists who directly interact with their physical environment in an immediate way—is complex with an almost unlimited number of real or perceived conditions that can influence decision making. Many built-environment research studies have tried (and failed) to isolate a minimal number of factors that actually matter for active transportation users, and we suggest that for the issue of livability, transportation professionals may need to rethink how to embrace the complexity and messiness of microenvironments and find ways to utilize data and experiences to improve conditions without unnecessarily homogenizing or summarizing complex environments.

We understand this may be difficult and require a fairly radical change in thinking. In a traditional data-driven decision paradigm, such inconsistency of evaluation across auditors would be a serious cause of concern for it would point to a lack of rigor in training and data collection. Our take on the variation, however, is that it illustrates the nature of plural knowledge. Aggregating or averaging data to have a singular result may mask the true variation of space and quality. We believe that there is a need for new ways of analysis that can take advantage of such "messy" data, and in fact celebrate the fact that vibrant, livable spaces are often "messy" (after all, that's what often makes them enjoyable), and that different responses to similar environments merely illustrate that there is a need to plan environments that accommodate a range of types of people. Thus, in some ways, developing new ways of using "messy" data also honors the central intent of citizen engagement by retaining an ability to treat citizen input as coming from the very real heterogeneous reality of our society.

A "Complex Public" Is Complex

The fact is that in this approach to citizen empowerment, we are suggesting that a "complex public" be engaged. A complex public is one that is so large, poorly defined, and heterogeneous that engagement becomes extremely difficult (Thomas 1995). Public involvement often is difficult even with small groups, which explains why so much of public engagement is really only token in nature (Arnstein 1969). Suggesting that every citizen is equally capable of engaging in the process of data collection necessarily adds a level of complexity that will be unfamiliar to most transportation engineers and planners. We believe it is of critical importance to pursue such engagement, however, for engaging the public in data collection can be part of the cultural education and transformation that is needed to increase rates of walking and biking. That is, the social learning of engaging in this public process may be an important component toward changing actual behavior (Bull, Petts et al. 2008).

Subjective Data Is Okay

Within transportation planning, data is normally understood at a macrolevel expressed through system connectivity and transportation modeling. Such an approach requires objective and easily quantifiable data. Any behavior not accounted for by such objective measures is thought to be inherently unpredictable and, therefore, the result of error on the part of the user. However, we assert that subjective data is equally important, for the perception of risk is critical to pedestrians and cyclists and some of this risk may be difficult to ascertain simply through objective measures of the built environment.

The Tool Is Easy to Use

An important motivation in tool development via the iPhone platform was to create both a tool and a tool distribution system that did not require much technical knowledge or specialized hardware or software to use. From the user's point of view, the technical requirements are just an iPhone (or iPod Touch) and the ability to download an application from the Apple App Store. For citizen users, there is no real technical barrier to use. Our volunteers seemed remarkably comfortable using their fingers to navigate maps and applications, much more so than previous PDA-based audit tools that required a stylus to enter data via ArcPad.

The Data-collection Paradox

Naturally, users are the most aware of issues along the corridors they frequently travel. In an unstructured data-collection format carried out by a decentralized and unsupervised public, a type of data-collection paradox thus emerges: How does data get collected in areas with low active transportation use if predominantly active transportation users are collecting the data? This is a challenge to take up once a wider scale adoption of a tool like the Fix This Tool begins in earnest.

CONCLUSION

The livability agenda is a very different paradigm toward transportation planning than the nation has seen over the modern transportation era. It implies that transportation should be about helping people access the places they want to go rather than facilitating the movement of vehicles unimpeded. Moreover, the livability context directly calls for a significant increase in the amount of active transportation—walking and biking—than current levels, especially for the 40 percent of trips that are two miles or less.

That said, there are at least two large data hurdles to effectively plan for a national retrofit of communities toward livability. First, there exists very little bicycle or pedestrian data, including physical infrastructure such as sidewalks, counts of users, or any comprehensive set of built-environment variables that promote or impede active travel. Second, pedestrians and cyclists are much more influenced by microscaled aspects of the local environment than streetscape features affect car drivers, so the complexity of data to support active transportation is more difficult to collect and use. Moreover, subjective reactions to the built environment are important for cyclists or pedestrians feel more vulnerable to their physical environment, meaning that objective-only data may not be fully adequate to understand the quality of one space over another.

The Fix This Tool has been designed to meet both of these limitations. Its ease of use and model of distribution easily lends itself to a decentralized approach to engaging citizens across the country to use their existing smartphones (an iPhone in the case of this particular study) to begin to collect microscale data within their own communities that can be easily aggregated to any other geographic scale of interest. The tool requires no special training, is spatially specific, and focuses both on the subjective perception of place as well as some of the objective variables that may be important to note.

Clearly, engaging hundreds of thousands of citizens to collect data in their own way and at their own pace represents a very different approach toward accumulating data for transportation planning. New ways of both aggregating data into meaningful forms as well as honoring the very specific and individual experiences of citizens are needed. The era of livability necessitates new types of data and new ways of gathering that data. With the increasing pervasiveness of smartphones that are graphically rich, spatially accurate, and simple to use, it is now possible to approach transportation and livability data collection in a new way by engaging citizens directly in the process. The Fix This Tool begins to demonstrate this way forward.

Acknowledgments

The authors wish to thank the Oregon Transportation Research and Education Consortium (OTREC) for their support of this project.

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