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Virtual and actual: Relative accuracy of on-site and web-based instruments in auditing the environment for physical activity

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ABSTRACT

Objectives: To assess the relative accuracy and usefulness of web tools in evaluating and measuring street-scale built environment characteristics.
Methods: A well-known audit tool was used to evaluate 84 street segments at the urban edge of metropolitan Boston, Massachusetts, using on-site visits and three web-based tools. The assessments were compared to evaluate their relative accuracy and usefulness.
Results: Web-based audits, based-on Google Maps, Google Street View, and MS Visual Oblique, tend to strongly agree with on-site audits on land-use and transportation characteristics (e.g., types of buildings, commercial destinations, and streets). However, the two approaches to conducting audits (web versus on-site) tend to agree only weakly on fine-grain, temporal, and qualitative environmental elements. Among the web tools used, auditors rated MS Visual Oblique as the most valuable. Yet Street View tends to be rated as the most useful in measuring fine-grain features, such as levelness and condition of sidewalks.
Conclusion: While web-based tools do not offer a perfect substitute for on-site audits, they allow for preliminary audits to be performed accurately from remote locations, potentially saving time and cost and increasing the effectiveness of subsequent on-site visits.

1. Introduction

The relationships between the built environment and physical activities have attracted the interest of researchers and planners from disciplines that include public health, urban design, and transportation planning. An ongoing challenge in this line of research is the development of reliable and valid micro-scale measures of pedestrian and street environments that may influence behaviors such as walking and bicycling for utilitarian or recreation purposes (Ewing et al., 2006; Forsyth et al., 2008; Lovasi et al., 2009). As part of this research effort, researchers have developed and tested several audit tools aimed at assessing the physical qualities of the built environment (especially street scale) by visiting sites in the field (Fänge and Iwarsson, 1999; Hoehner et al., 2005; Pikora et al., 2002; Moudon and Lee, 2003; Brownson et al., 2004a, 2004b).

Planners and researchers now have a set of powerful tools, developed for general use or specifically for planning purposes, to help design, visualize, and study the implications of urban planning approaches (Mitchell, 2003; Zeile et al., 2007; Batty, 2007). In particular, Google Maps™ mapping service and Google Street View™ mapping service, which integrate photos in a geospatial framework, provide a rich experience of visual evidence in a study area (O'Reilly, 2006; Ratti and Berry, 2007; Ben-Joseph, 2011). At present, web-based urban imaging tools have become an important resource available to all. More practitioners, researchers, and students are relying on web tools, such as Google Maps, Google Street View, and Microsoft Oblique Viewer, to perform quantitative and qualitative audits and assessments of sites remotely before visiting them or as a substitute for visiting a site at all. Evidence of the widespread use of these tools is Planetizen, a leading urban information exchange portal, offering courses on the use of Google Maps for urban planning (Planetizen, 2009). Each of the three tools provides views of the street environment.

Google Maps provides two-dimensional aerial photographs with streets and roads labeled by name. It also includes information about

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the direction of traffic (one-way or two-way), public transit, and the presence of destinations, such as retail shops, parks, and hospitals. In addition, its distance measurement tool allows users to take measurements of built environment attributes such as "building setback" and "width of the street and sidewalk".

Google Street View provides street-level images. These images replicate an 'eye level' experience, allowing the user to virtually walk down the street. These images not only provide information about detailed urban features such as "road material", and "relative height of trees" but also convey qualitative information about the site such as "comfort level" and "esthetics".

Microsoft Oblique Viewer (*Bing Maps*) provides a bird's-eye view from a low viewing angle, providing three-dimensional information about a site. These images show the height of buildings and trees, clearly depict building setbacks and reveal the presence of detailed features such as fences, streetlights and benches.

Though the data generated by traditional on-site audit tools generally appears accurate, auditing large numbers of street segments can be time- and cost-intensive. The use of web tools may reduce costs of on-site auditing, while generating valid data. Despite the convenience of these web-based tools, few studies have examined their strengths and limitations in auditing quantitative and qualitative urban features of a given site. In the study of public open space quality in Sydney, Australia, investigators compared a remote-assessment with Google Earth Pro to direct observation (Taylor et al., 2011). Their analysis found that a remote-access method can provide a reliable and time-efficient alternative to direct observation. Clarke et al. (2010) evaluated the reliability of a virtual audit instrument, using Google Street View, and found that Google Street View was a reliable method for measuring recreational facilities and general land use. However, the virtual tool was less reliable auditing fine-grain features. Assessing the level of agreement between on-site and web-based (using Google Street View) audits, Badland et al. (2010) revealed that a web-based audit can save time, while demonstrating acceptable agreement with an on-site audit. Comparing in-person and Google Street View-based audits on neighborhood characteristics, Rundle et al. (2011) found a high level of concordance for measures of pedestrian safety, traffic and parking, and infrastructure for activity. However, "temporal" (likely to move or change within 1 week) or "small" (smaller than a backpack) features had lower levels of concordance. While these studies investigated the accuracy of web-based audit instruments, none of them comprehensively employed multiple web-based tools available online, comparing their usefulness.

To examine the potential of web-based tools for substituting or complementing on-site visits and assessment, this study compared two separate audit approaches – (1) on-site and (2) web-based, simultaneously using Google Maps, Google Street View, and Microsoft Visual Oblique – in order to evaluate the extent to which on-site and web-based audits agree. Then, we compared the three web tools' usefulness, rated by auditors while conducting the web-based audit.

2. Methods

2.1. Audit instruments

Two instruments were developed to conduct the on-site and web-based audits, based on two established audit instruments developed by Brownson et al. (2004a, 2004b). The instruments cover 6 major domains – land-use environment, transportation environment, recreational facilities, physical disorder (esthetics), signage, and social environment. Items pertaining to transportation environment and social environment domains utilize Likert-scale and ordinal response choices, designed to capture variation across street segments. The items are designed to assess the quantitative physical features of the site such as "the approximate width of the sidewalks." Items for land-use environment, recreational facilities, esthetics, and signage domains contain dichotomous response choices (e.g., visible/not visible), since these questions simply ask whether a rater can identify certain physical elements (e.g., single-family homes, supermarket, and library) and qualitative features (e.g., attractive features and physical disorder).

While the on-site and web-based versions of the audit tool contained identical items in the 6 domains, the web-based instrument included additional questions to evaluate the usefulness of the three web tools, Google Maps, Google Street View, and Microsoft Visual Oblique, in answering each item (i.e., not used, not useful, somewhat useful, and very useful). Auditors conducted the web-based audits, using the three web tools simultaneously, and then, compared the usefulness of the web-based tools, in completing individual items. Hence, the evaluation of web-based audits was intended to measure (1) relative accuracy – i.e., treating the on-site audits as the "gold standard" and testing accuracy of the web-based audits – as well as (2) usefulness of the three web tools.

2.2. Selection of study areas

This evaluation of Google Maps, Google Street View, and Microsoft Visual Oblique was part of a larger study designed to examine cross-sectional relationships between objective built environment characteristics and physical activity in suburban communities. To test these tools, street segments were identified for 21 participants in the larger study who resided at locations 10–20 miles north, west, and south of downtown Boston. The nearest street intersection to each respondent's geocoded address was used to map street segments within 1000 m of the intersection. A total of 84 suburban residential street segments were audited.

2.3. Training

A protocol for audit-tool data collection was developed to address both on-site audit issues (e.g., safety) and web-based issues (e.g. use of software interface). Four auditors participated in a one-day training session that covered audit protocols. The training also included on-site and web-based audits of one street segment not included in the study.

2.4. Data collection

During the summer of 2010 each auditor was required to conduct two separate audits (a web-based audit and an on-site audit) on a single street segment within each buffer for one participant-resident. The auditors produced a single web-based audit dataset by utilizing all three web tools (Google Maps, Google Street View, and Microsoft Oblique Viewer) simultaneously. When producing the web-based dataset, the auditors evaluated the usefulness of each web tool. This phase was prerequisite to conducting the on-site audit. Most planning professionals compile some level of information about a site from published maps or the Internet before actually visiting it. For this reason, we decided to follow the same approach and conduct the web-based audits before the actual visit.[1] Auditors were also

[1] Web audits were conducted between July 28, 2010 and July 31, 2010. Site audits were conducted from August 2, 2010 to August 5, 2010, as well as from September 7, 2010 to September 11, 2010. All observations occurred between 10 AM and 3:00 PM.