Walkability as a Performance Indicator for Urban Spaces

Strategies and tools for the social construction of experiences

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Abstract. This paper frames walkability as a performance indicator for urban spaces and critically addresses some of the existing evaluation methods. It introduces alternative strategies and tools for enabling the collective evaluation of walkability and discusses how experiences of the citizens can possibly lead to a social construct of walkability. This discussion is elaborated by a pilot study which includes exploratory research, social-geographic web services and heat maps. Using these tools and methods, it was possible to derive various experiential and environmental spatial qualities, extract problems and identify problematic areas. From these we have learned that walkability may serve as a fruitful conversation framework and a participatory research concept. Furthermore, we were able to develop ideas for solutions to design and planning problems.

Keywords. Walkability; experiential knowledge; collective mapping; social web.

INTRODUCTION

This study is based on two main motivations: the potential of walkability as a performance indicator for urban spaces and the new possibilities offered by the social media and novel information and communication technologies (ICT) for the collective location-based representation of individual experiences.

To begin with, walkability is not a new concept and has been prescribed as an essential urban quality by numerous planners during the last century. In brief, walkability is a measure of how walking friendly an area is.

Various evaluation methods have been introduced from the perspectives of medicine, transportation, environmental design and psycho-sociology, including a significant number of alternative performance dimensions: connectivity of path network, linkage with other transportation modes, land use patterns, safety (traffic/social), the quality of the path context, spatial definitions and overall explorability (Southworth, 2005). Despite the wide range of aspects and dimensions above, humans live in and perceive all of these dimensions as a whole. Therefore, collecting and processing the experiences of the citizens at a large scale can possibly lead to a social construct of walkability.

Furthermore, web 2.0-based social media and geographic services are potential tools for the collective understanding of walkability. By using these tools, dynamic knowledge acquired through lived experience can be used as a vital resource for research and design purposes. Alternative location-
based maps can be created by involving the public to represent urban dynamics that are not accessible to authorities. Multiple perspectives of individuals, social groups and organizations can be dynamically represented and socially discussed. By working with alternative depictions of urban environments, one can simultaneously account for representations of the existing urban environment and imaginations of different realities. Such strategies provide different frameworks for discussion, knowledge-construction as well as participation (Pak and Verbeke, 2012).

In this context, in Section 2, we will start with a brief discussion of walkability and critically address some of the existing evaluation methods. In section 3 we will introduce a suit of open-source tools for collection and rating of walkability. This will be followed by the demonstration of a pilot study and a brief review of the findings.

In conclusion (Section 4), we will reflect on the strengths, short comings and potentials of experiential walkability evaluation and draw future prospects.

WALKABILITY AS A PERFORMANCE INDICATOR
One of the earliest references to pedestrian-oriented development was Perry’s (1929) introduction of the “Five-Minute Walk” as an essential urban design tool. It is possible to trace the origins of these ideas to Howard’s Garden City and Drummond’s Chicago plans (Johnson, 2002).

Perry (1929) prescribed the 5-minute walk (0.4 km radius, the average distance that a pedestrian would desire to walk) as the central design component for structuring a Neighborhood Unit considering the walking distances from residential to non-residential components. It would not be wrong to claim that Perry’s concept made a significant impact on the practices and still applies to contemporary design and planning at a large extent (Patricios, 2002).

In Europe and the USA, walkability became even more important after the Second World War, following the automobile invasion and rapid urbanization accompanied by the gigantism of the brutal international style development which defied the human scale. The suburban development model of development disconnected the residential areas from the business districts, creating auto-dependent commuters and traffic congestion [1]. Dominant modernist planning approaches put a low priority on pedestrianism and weakened the traditional function of city place as a meeting place and social forum for the inhabitants (Gehl, 2010).

Jane Jacobs was one of the first critics to defend the street life and walkability. In her legendary book, “The Death and Life of Great American Cities” she reserved the first two chapters on the uses of sidewalks and described the benefits of safe, diverse and lively streets (Jacobs, 1961).

Around the same time, Lynch (1961) in his seminal book “The Image of the City” drew attention to the importance of the walking experience and offered mental maps of paths, edges, districts, nodes and landmarks for analysis. He developed a theory of “good city form” through which the performance of the city is evaluated in terms of various qualities such as vitality, sense, fit, accessibility and control. He focused on sense among the other qualities, which according to him consists of identity, structure, meaning, transparency, congruence and legibility.

Today, walkability is considered as an essential urban quality and referred to as closely related to experience of a sense of place, social cohesion as well as resilience by the Charter of the New Urbanism [2]. Influential practitioners such as Gehl (2010) have urged planners and architects to shift their focus towards the human dimension and strengthen pedestrianism as an integrated design strategy as well as a comprehensive city policy.

In various studies, walkability is referenced as a predictor of public health (Frank et al., 2009), house values (Cortright, 2009) and pursued as a top prerequisite for environmental sustainability by LEED ND [3] and neighborhood vitality [2].

In the last decade, various walkability assessment methods have been developed. Among these were: estimation using data from Geographical In-
formation Systems (Frank et al., 2005), systematic pedestrian and cycling environmental scan (SPACES) (Pikora et al., 2006), Google-based Walkscore [4] and citizen surveys such as the Neighborhood Environment Walkability Scale (NEWS) (Saelens et al., 2002).

Print surveys such as NEWS aim at individual perceptual evaluation and measure walkability only as an “overall” quality of a certain neighborhood which can be considered as a rough evaluation. SPACES focuses on blocks for auditing, but this method requires separate audit forms for each block making it difficult to manage for the surveyors on the field.

The performance categories in the studies above can be briefly summarized as: the connectivity of path network, linkage with other transportation modes, land use patterns, safety (traffic/social), the quality of the path context, spatial definition and overall explorability (Southworth, 2005). These may seem to be computable using GIS data at a first glance; however, it is difficult to make a good estimation of the complex dimensions, especially the explorability.

When it comes to GIS estimations of walkability, it is clear that the performance indicators are too complicated to be solely estimated by data (Figure 1). As an example, WalkScore [4] measures the number of “errands” within walking distance of a specific location, with scores ranging from 0 (car dependent) to 100 (most walkable). By the WalkScore measure, walkability is a direct function of how many destinations are located within 400 meters to 1.6 km.

In conclusion, in order to properly diagnose urban problems and create novel design solutions, it is necessary to create a finer lens in terms of various dimensions, time, scale and learning from the experiences of local citizens. It has become clear that additional methods and tools for evaluation are needed for the assessment of walkability as a location-based human experience.

SOCIAL CONSTRUCTION OF WALKING EXPERIENCES: STRATEGIES AND TOOLS
Motivated with the problems above, we have created multiple scenarios for enabling the analysis of walkability and then combined and tested a suite of ICT tools (Figure 2). In this suite, open-source social content management platform serves as a backbone with an advanced open-source database (PostgreSQL) which is enhanced by libraries such as JQuery, Openlayers, Heatmaps [5] and various modules which are also distributed in an open-source manner.

In this paper, we will share a single scenario with two alternative methods which aim at the collection of experiential information from the inhabitants of a specific neighborhood. This is followed by serving this information to decision makers and urban designers in a structured, easy to understand format.
Both of the methods M01 and M02 make use of heat maps (e.g. Figure 5) for analysis and evaluation. Heat maps enable the dynamic visualization of three dimensional data, in which two dimensions represent Cartesian coordinates and the third dimension is used for visualizing the intensity of walkability or a dimension of walkability as a datapoint in relative comparison to the absolute maximum of the data set.

Using the datapoints, an alpha map is created using a radial gradient with 0.1 alpha as the maximum value which fades out to alpha=0. Then these values are converted to RGB. This method gives us the flexibility to build a customized color shift from alpha 255 to 0 and control the radius of the data points.

The intensity is shown as a color; red (hot) for the maxima and blue (cold) for minima. This visualization tool reduces the representation complexity and allows the analysis of urban spaces in relation to its surroundings. As a result of the study, the findings are transferred to the urban designers, planners and other public authorities in this easy to understand format.

The first method (M01) follows the research tradition of Lynch (1961), a qualitative research method focusing on exploring how people experience walkability. It makes use of the open-source social content management platform introduced above. In this method, an urban designer arranges several Lynch (1961) style walk-through interviews in the neighborhood with the inhabitants while making notes and collecting visual information, which are entered on the platform both during and after the study. The aim of this method is the exploration of the walkability concept, the extraction of its culturally bound dimensions and using these in a future large-scale experiment (M02, introduced below).

The second method (M02) involves motivating the inhabitants to get involved in the walkability evaluation; reflect their experiences and learn from their neighbors. An open-source social content management platform serves as the backbone, and provides alternative interfaces for web and mobile browsers, enabling the input of ratings as well as output in the forms of maps and dashboards (Figure 3). This interface is currently under development.

Using the provided rating interfaces, the inhab-
Inhabitants rate walkability of specific locations in their surroundings. A significant advantage of this system is the fact that users with mobile devices do not need to manually enter their location information. It is automatically gathered from internal GPS of their device and translated into places and addresses through the geocoder module with their consent. For ease of use, only a limited number of experiential aspects of walkability are entered through interactive sliders (Figure 3).

An important motivational aspect is the location-based delivery of the walkability ratings. When the platform is accessed by a mobile browser, the system asks for a permission to use their location. If inhabitants voluntarily turn on this service, they are continuously provided with the average ratings for their actual location and will be motivated to reflect their own experiences.

According to our scenario, both of the methods M01 and M02 make use of heat maps (Figure 5) for analysis and evaluation. These maps enable the dynamic visualization of three dimensional data, in which two dimensions represent Cartesian coordinates and the third dimension is used for visualizing the intensity of walkability or a dimension of walkability as a datapoint in relative comparison to the absolute maximum of the dataset. The intensity is shown as a color; red (hot) for the maxima and blue (cold) for minima. This visualization tool reduces the representation complexity and allows the analysis of urban spaces in relation to its surroundings. As a result of the study, the findings are transferred to the urban designers, planners and other public authorities in this easy to understand format.

**Pilot Study**

A pilot study (P01) was conducted in Brussels in order to test the walkability analysis scenario introduced in the former section as well as the preliminary examination the effectiveness the open-source social content management platform and the heat map visualization method.

This study utilized the M01 method, which can be considered more suitable for exploratory piloting. The primary intention was to test the overall concept and transfer what is learned from the P01 to a future large-scale experiment (M02). A secondary aim was to extract and verify the various socio-spatial and sensory dimensions of walkability from the viewpoints of the users to be used for testing in future studies *(examples are reviewed in the previous section)* as they can be culturally bound.

With the aims and motivations above, an exploratory research study was initiated with the contribution of six participants who actively use this urban space on a daily basis. A specific triangular path around Liedts Square in Brussels was chosen as a test zone. This area is one of the most controversial and segregated places in the city, which happens to include the North Station and an ethnic shopping street.

Each participant was asked to walk around the neighborhood and continuously express their opinions on the walkability problems of the location. The

![Figure 3](image)

*The conceptual interface design of the mobile dashboard, currently under development and operational testing.*
first author accompanied and interviewed each participant during a two-hour walk-along, while making location-based notes and taking photos (Figure 4).

Following the M01 method, the collected information was uploaded to the platform via:
- A mobile device / geolocated notes and photos, during the walk, on location
- A desktop browser, after the walk, based on the notes

After the participatory study, a joint heatmap was constructed using the walkability ratings of the six contributors (Figure 5). This heat map renders a predefined gradient based on the intensity of a datapoint. The more negative points, the more it shifts towards red.

Combining this map and the location-based notes revealed various problematic areas (due to the limited space in this paper, only significant findings are included).

According to the findings, the walkability of the shopping street (red area on the map) was perceived as very poor due to low pedestrian flow, uncollected trash, sidewalks occupied by the shops and permanently parked trucks used as storage spaces by the stores. In contrast, the number and variety of amenities and attraction points were seen as positive factors which added to the sense of place, identity and explorability.

Various intersection points were reported as extremely unsafe in terms of traffic as well as unpleasantly noisy. Especially in less visible areas, overspill parking by the cars and motorcycles were reported as a common negative factor limiting walkability. At various locations, physical qualities and placement of the urban furniture, policy enforcement devices and signs were reported as extremely poor.

The traffic regulations and signs at the intersection points in Liedts Square (seen as a red spot on top of the triangle in the heat map) were also indicated as negative factors reducing the walkability in this area.

In addition, the connection of the shopping street to the North Station (seen next to the railroad on the map) was perceived as unsafe. The sidewalk in front of various abandoned building sites and wide monofunctional administrative buildings were also indicated as unwalkable due to their aesthetic repulsiveness.

Besides the identification of problematic areas in the pilot study area, by analyzing the location-based notes entered on the content management platform, it was possible to extract various interrelated spatial qualities. These have been reported by the participants as related to the walkability of the neighborhood. Determining these locally situated qualities were important because these can be used as predefined dimensions while testing method M02. We have grouped those under two main categories: experiential and environmental (Table 1).
There is a significant difference between the two categories: it is possible to identify quantifiable measures for the dimensions in the environmental category. On the other hand, the experiential dimensions cannot be purely quantifiable. This observation leads to the conclusion that the environmental aspects can be measured and represented with and without the help of the inhabitants; but human contribution is mostly essential for the experiential evaluation.

Based on Table 1, it would not be wrong to claim that an experiential quality (such as the sense of place) may emerge as a result of the combination of other environmental and experiential qualities (such as the physical layout, aesthetical appeal etc.). For instance, in the pilot study, some of the participants have connected the sense of place, identity and explorability with a number and variety of amenities and attraction points.

A significant benefit of the walkability evaluation was the use of results to develop possible solutions to design and planning problems. For instance, as a result of our pilot study, we were able to come up with a significant number of design ideas:

- Limited pedestrianization of the shopping street and inclusion of trees and seating elements without blocking the pedestrian flow.
- Designing a structure to facilitate temporary use of abandoned sites as a market place.
- Designing urban furniture resistant to public violence.
- Scalable seating places integrated into the facades of the buildings to facilitate the use of the neighborhood as a recreational area.
- Specially designed safe bike parking spaces in front of the station to enable linkage to bike transport.
- Redesign of the pedestrian crossings at four points.
- Adjustment of the traffic flow to prioritize pedestrian use around the Liedts Square and disencouragement of parking on the square.
- Redesign of the bridge at the end of the shopping street to enable a better connection to the city network and creating a more pleasurable passage by designing small retail shops under it.

The ideas above are currently being developed as a concrete architectural project which will be presented during the conference.
CONCLUSIONS AND FUTURE DIRECTIONS

In this study, we have discussed the concept of walkability as a performance indicator and introduced various strategies and tools for the analysis of walkability.

We have provided a pilot study demonstrating how the location-based evaluations of walkability can be dynamically combined and visualized using heat maps which lead to the extraction of the problematic areas.

From the pilot study we were also able to derive various experiential and environmental spatial qualities as dimensions of walkability. These are planned to be used as a resource for our next study, in which we will follow the M02 method and ask the inhabitants to categorize their walkability experience according to the extracted qualities and observe the relations between.

During the pilot study, the participants made various suggestions at different scales, not only on the designerly aspects but also on public management and planning policies. From these we have learned that walkability may serve as a fruitful conversation framework and a participatory research concept. Several controversial topics emerged as a result; among those were: loitering, graffiti and the governmental regulation of the retails. These were seen as positive by some of the participants and disruptive by others.

These findings also motivate the new study with the use of the M02 method: involving a higher number of inhabitants which can be treated as a representative sample size. Using their reports and the heat map, it will be possible to extract the most common problems, visualize and extract the priorities of the locals.

Considering the technological aspects, we found several advantages of the proposed open-source social content management platform. It was possible to generate heat maps from the collected geolocated ratings (Figure 5). We visualized these in various forms and mashed them up with external

Qualities Extracted from the Pilot Study

<table>
<thead>
<tr>
<th>Experiential</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Aesthetical appeal</td>
<td>- Number and variety of amenities and attraction points</td>
</tr>
<tr>
<td>- Sense of place</td>
<td>- Linkage to public/bike transport</td>
</tr>
<tr>
<td>- Sense of identity</td>
<td>- Physical layout <em>(block length, intersection density, street width etc.)</em></td>
</tr>
<tr>
<td>- Special and Somatic Sensory Experiences <em>(odor, noise, wind, vibration, temperature, kinesthetic, balance etc.)</em></td>
<td>- Land use mixity</td>
</tr>
<tr>
<td>- Recreational capacity</td>
<td>- Linkage to other parts of the city</td>
</tr>
<tr>
<td>- Explorability</td>
<td>- The physical qualities of the sidewalks <em>(width, height, surface etc.)</em></td>
</tr>
<tr>
<td>- Perception of safety</td>
<td>- The physical qualities and placement of the urban furniture and policy enforcement tools <em>(benches, parking meters, signs etc.)</em></td>
</tr>
</tbody>
</table>

Table 1
Dimensions of walkability: spatial qualities extracted from the pilot study (other qualities reported in the literature are not included).
data resources. Then they were exported in various GIS formats (KML, GeoRSS).

In contrast, various challenges of the introduced open-source social content management platform were observed during the pilot study:

- There were precision problems due to the mobile location sensing methods.
- Using mobile devices in unwalkable places was difficult and unsafe in certain conditions such as busy sidewalks or dangerous crossings.
- The gradient visualization of the heat maps needed to be calibrated according to the neighborhood size and various zoom levels.

However, despite these fallbacks, it is important to conclude that the introduced tools and method (M01) enabled us to extract and diagnose a significant number of problems. In addition to the findings above, by using the heat maps in combination with the walk-along experiences, we were able to develop ideas for solutions to design and planning problems which may provide measurable benefits to the inhabitants. For instance, we have suggested limited pedestrianization of the shopping street with a high number of negative walkability ratings (red on the heat map on Figure 5). We recommended the redesign of the pedestrian crossings at two points, again highlighted as red on the map and referenced during the interviews by all of the participants.

For similar future studies, we would like to introduce a number of recommendations:

- In order to guarantee the sustainability of this platform, on-site motivational activities and interactive public displays can be useful.
- Utilizing the time data from the content management platform and enabling time-based visualizations using a time slider.
- Providing a public map of walkability may make the neighborhood open to the abuse of the real estate market and therefore promoting gentrification. Therefore, access limitations and additional measures should be introduced.
- Security measures should be taken to block the invasion of privacy of the users and their identities should be protected.

As a final remark, we would like to conclude that walkability is a useful performance indicator of urban spaces because it places the human dimension at the center of urban design. Walkability research focuses on the experiential and environmental qualities of urban spaces but also relates to many other qualities. For instance, in the case of safety it was evident that economic and social contexts play a significant role. In this sense, walkability should not be interpreted as a sole consequence of the urban design and planning decisions. It also includes various economic and social dimensions which can possibly inspire new design solutions from alternative perspectives; and these should definitely be taken into account.

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