Participatory Evaluation of the Walkability of two Neighborhoods in Brussels

Human Sensors versus Space Syntax

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In this paper, we further develop and test a walkability evaluation method developed by the first author to understand two neighborhoods in Brussels. This method introduced alternative strategies and tools for enabling the evaluation of walkability and discussed how a structured collection of human experiences could lead to a social construct of walkability. In this study, following this method, we made a field survey with architecture students to measure the walkability of the two referenced neighborhoods. In addition, considering the close links of walkability with the physical layout and configuration, we made a Space Syntax analysis (visual integration and axial connectivity) and compared this with the walkability ratings made by the students. As a result, we found moderate to high correlations between the experiential evaluation of the students and the Space Syntax results. Besides establishing links between subjective and computational surveys, this study led to the conception of a web-based platform with a mobile app which integrates location-based experiential and computational evaluations of walkability.

Keywords: Walkability, Human sensors, Experiential Knowledge, Field Survey, Space Syntax

INTRODUCTION

This research is the follow-up of a former study (Pak and Verbeke, 2013)(Pak and Verbeke, 2014) which explored the potential of walkability as a performance indicator for urban spaces and revealed a method for crowdsourcing walkability. This method introduced alternative strategies and tools for enabling the collective evaluation of walkability and discussed how a structured collection of human experiences could possibly lead to a social construct of walkability.

For the readers who have not read the referenced paper yet, we want to clarify what we mean by the term Walkability. Walkability is a measure of how walking-friendly a specific place is (Pak and Verbeke 2013). Walking-oriented design idea was first introduced in design and planning theory by Perry (1929) through the “Five-Minute Walk” neighborhood concept, the average distance that a pedestrian would desire to walk. Lynch (1961) revealed the importance to the user-walker experience and offered mental maps of
paths, edges, districts, nodes and landmarks for analysis. Jacobs (1961) stressed the uses of sidewalks and described the benefits of safe, diverse and lively streets.

Walkability is an essential urban quality closely related to the experience of a sense of place, social cohesion as well as resilience (CNU, 2017). Walkability is considered to be a predictor of public health (Frank et al., 2009), house values (Cortright 2009) and pursued as a top prerequisite for environmental sustainability (LEED ND 2015) and neighborhood vitality (CNU 2017). Several studies attempted to link walkability with spatial configuration methods such as Space Syntax. In “New methods in Space Syntax”, Bill Hillier and Chris Stutz (2005) introduced Walkability Index as a complex construct of several factors such as transport nodes, land use, building frontage, infrastructural elements, major attractors or generators, and aesthetic features. Furthermore, Koohsari et al. (2016) found that the concept and methods of space syntax can provide an understanding how urban design influences walking behavior.

In addition to these, the empirical field research of the first author (Pak and Verbeke 2013) observed and revealed a set of qualities which were found to be associated with the perception of walkability. Among those, the experiential qualities were: aesthetic appeal, sense of place, sense of identity, particular and somatic sensory experiences (odor, noise, wind etc.) and perception of safety (Table 1). Furthermore associated quantifiable qualities were: the number and variety of amenities and attraction points, linkage to public/bike transport, physical layout (block length, intersection density, street width etc.), land use mix, linkage to other parts of the city, the physical qualities of the sidewalks (width, height, surface etc.), the physical qualities and placement of the urban furniture and policy enforcement tools (benches, parking meters, signs etc.), level of pollution (collection of trash, air quality etc.), number of pedestrians on the street, density of the car traffic, weather conditions and natural elements.

Based on the studies reviewed above we can identify at least two different approaches to walkability. The first is a positivist approach to walkability, an absolute measure, which can be measured and verified by repeatable surveys, experiments or other possible means.

The second view of walkability is a constructivist one which approaches this concept as a relative measure, a social construct which emerge as a result of human experience. We are not going to make an epistemological inquiry and stress the differences in this study. In contrast, we believe that these two views of the world have merits on their own and they can provide different types of data, information and knowledge to the researchers.

This discussion evokes two research questions which motivated our current research study:

- Can we measure walkability of a neighborhood using the associated experiential qualities by using a group of human sensors?
- Considering the close links with the physical layout, configuration and linkage detected in the former study, is it possible to make an estimation of walkability using Space Syntax methods such as visual integration and axial connectivity?
- What are the possible relations between these two evaluations?

In order to test these research questions and understand the walkability of two historic urban neighborhoods in Brussels, we initiated two observation studies. In the second part of our research, we compared the collected data with space syntax analysis results (visual integration and axial connectivity).

As a result, we found moderate to high correlations between the experiential evaluation of the students and space syntax results. In the following section we will elaborate on these and discuss the significance of our findings. After elaborating on these, in the last part of this section, we will introduce the idea of a novel ICT-enabled location-based method which integrates experiential and computational evaluation of walkability.
### Table 1

Dimensions of walkability: spatial qualities revealed (Pak and Verbeke 2013)

<table>
<thead>
<tr>
<th>Qualities Extracted</th>
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<tbody>
<tr>
<td><strong>Experiential</strong></td>
</tr>
<tr>
<td>- Aesthetical appeal</td>
</tr>
<tr>
<td>- Sense of place</td>
</tr>
<tr>
<td>- Sense of identity</td>
</tr>
<tr>
<td>- Special and Somatic Sensory Experiences <em>(odor, noise, wind, vibration, temperature, kinesthetic, balance etc.)</em></td>
</tr>
<tr>
<td>- Recreational capacity</td>
</tr>
<tr>
<td>- Explorability</td>
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<tr>
<td>- Perception of safety</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
</tr>
<tr>
<td>- Number and variety of amenities and attraction points</td>
</tr>
<tr>
<td>- Linkage to public/bike transport</td>
</tr>
<tr>
<td>- Physical layout <em>(block length, intersection density, street width etc.)</em></td>
</tr>
<tr>
<td>- Land use mixity</td>
</tr>
<tr>
<td>- Linkage to other parts of the city</td>
</tr>
<tr>
<td>- The physical qualities of the sidewalks <em>(width, height, surface etc.)</em></td>
</tr>
<tr>
<td>- The physical qualities and placement of the urban furniture and policy enforcement tools <em>(benches, parking meters, signs etc.)</em></td>
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<tr>
<td>- Level of pollution <em>(collection of trash, air quality etc.)</em></td>
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<td>- Number of pedestrians on the street</td>
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<tr>
<td>- Density of the car traffic</td>
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<tr>
<td>- Weather conditions</td>
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<tr>
<td>- Natural elements</td>
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</tbody>
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**Figure 1**

The walkability survey made with the students from the KU Leuven Faculty of Architecture and Tunghai University Department of Architecture. Workshop leaders: Burak Pak, Chotima Ag-ukrikul and Simon Shu.
HUMAN SENSORS VERSUS SPACE SYNTAX

In the first part of our study, we organized a workshop at the KU Leuven Faculty of Architecture with the contribution of Prof. Dr. Simon Shu and his students at the Tunghai University Department of Architecture.

We employed 40 students as human sensors to rate a selection of the walkability-associated qualities in a structured manner. The students walked in two small neighborhoods and made ratings in all streets in each neighborhood (Figure 1). They rated:

1. A selection of 10 different criteria for Walkability (Table 1) (Pak and Verbeke 2013) (Pak and Verbeke 2014): Aesthetical Appeal, Sense of Place, Sense of Identity, Physical Quality of the Sidewalk, Urban Furniture, Natural elements, Pollution, Smell, Noise, Wind.
2. An overall perception of walkability

The ratings have been made through a location-based Likert scale form, at the predesignated specific locations distributed with 20-meter distance in between and covered all of the streets in the relevant neighborhoods. These ratings have been codified to make collective maps of walkability and associated qualities as a social construct (Figure 2).

In the second part of our study, we have been inspired by the research by Bill Hillier, which revealed that the distribution of spatial integration values in the axial map can predict the actual and the potential number of pedestrians (Campos et al 2003). The space syntax pedestrian analysis project in London (Hillier et al 1992) showed the correlation between spatial integration and pedestrian flow (R-squared 0.75).

Since the link with the number of pedestrians on the street and walkability is quite evident (if a place is walkable, there should be more people walking), we hypothesized that the ratings made in our study should have a relation with Space Syntax analysis. Prof. Dr. Simon Shu and his assistants ran a Space Syntax analysis to test this hypothesis. Then we compared the results of Space Syntax and the student ratings. This correlation analysis revealed interesting findings.

In the neighborhood of Rue de Bouchers:

- There is moderate correlation (0.61) between Rn Global Visual Integration and the walkability evaluation of the students (their conclusive judgment, not average)
- There is moderate correlation (0.59) between R3 Local Visual Integration and the walkability evaluation of the students (their conclusive judgment, not average)
- There is a moderate correlation (0.64) between axial connectivity and the walkability evaluation of the students (their conclusive judgment, not average)
- There are moderate-low (0.4-0.61) correlations between Rn Global Visual Integration and the first 5 walkability factors (individually).
- There is a high correlation (0.73) between axial connectivity and the Average of 5 walkability factors: Aesthetical, physical quality of the sidewalk, urban furniture, natural elements, noise

In the neighborhood of Saint-Catherine:

- There is moderate correlation (0.65) between the Average of 5 walkability factors: Aesthetical, physical quality of the sidewalk, urban furniture, natural elements, noise and R3 Local Visual Integration
- There is moderate correlation (0.63) between the Average of 5 walkability factors: Aesthetical, physical quality of the sidewalk, urban furniture, natural elements, noise and Rn Global Visual Integration
- There are moderate-low (0.38-0.63) correlations between Rn Local Visual Integration and the first 5 walkability factors (individually).
- There are moderate-low (0.32-0.63) correlations between Rn Global Visual Integration and the first 5 walkability factors (individually).
Figure 2
The results of the walkability survey derived from the ratings of the students (averages of the rating of 10 variables of 40 students).
As evident in Table 2, Strong autocorrelations between the Walkability indicators are evident in the correlation chart and an evident expected result.

### CONCLUSIONS

In this study we evaluated the walkability of two neighborhoods focusing on ten different experiential qualities with a group of human sensors, particularly architecture students. In addition to this research, we made a Space Syntax study including visual integration and axial connectivity, compared the results and searched for possible relations between these two evaluations.

We found moderate to high correlations between the experiential evaluation of the students and the Space Syntax results. These findings confirm the research of Hillier (1992), Hillier and Stutz (2005), Campos et al. (2003), Koohsari et al. (2016) and numerous other studies not covered in this paper.

In this sense, this study is a partial proof that two different approaches to walkability coincide and correlate: a positivist one interpreting walkability as an absolute measure and a constructivist one which approaches this concept as a relative measure.

Furthermore, strong autocorrelations between four Walkability indicators were evident in the correlation table 2 (Aesthetical Appeal, Sense of Place, Sense of Identity, Physical Quality of the Sidewalk). This is a confirmation of our former findings (Pak and Verbeke, 2013). In contrast, some of the variables were not capable of predicting walkability, specifically the inter-subjective ones relating to the human senses such as smell, noise and wind. These variables did not relate to Space Syntax analysis too.

We found that average of five variables (aesthetical appeal, physical quality of the sidewalk, urban furniture, natural elements, noise) is strongly correlated to axial connectivity (R= 0.73) as well as with overall walkability (R=0.94). This finding suggests that these specific variables could be used as core indicators for a future experiential analysis.

The study is limited in several aspects. The experiential evaluation was conducted by 40 international architecture students with different backgrounds. This evokes questions on expertise, as well
as on how a smaller group could also provide similar results.

In addition, parallel to our previous study, our comparative research triggered a discussion on possible solutions to the local walkability problems. During the reflection moments, the students were able to come up with a significant number of ideas which revealed the sources of poor walkability and possible design approaches to avoid these.

Besides these aspects we would like to quote an important point brought out by one of the reviewers of this paper: “Limiting the study to the students of architecture introduces a significant bias, most likely because the conceptual frameworks of the students are similar to those who were designing the Space Syntax. In this sense it’s not a coincidence that the correlations are high. There should be a new study with a control group of lay people that would evaluate walkability in an unstructured way.”

After elaborating on our findings, and considering the input of the conference reviewers, the authors conceived the idea of a web platform which integrates location-based experiential and computational evaluations of walkability. This method involves a mobile app that suggests a walkability rating for human observers (lay-people) to reflect on and collect feedback, incorporate this feedback in real-time and create an ongoing evaluation of walkability.

The future aim is to develop and test a tool which can help us understand the change of walkability in time and its relation to social and spatial interventions. A research project proposal concerning this platform and the suggested method is under evaluation, therefore, we are not allowed to share images in this paper (further details will be revealed during the conference presentation).

ACKNOWLEDGEMENTS
We would like to thank Prof. Dr. Simon Shu for supervising the Space Syntax Analysis and his valuable contributions to the workshop. We are also grateful to the students of KU Leuven Faculty of Architecture and Tunghai University Department of Architecture who spent time on ratings and carefully processed the data.

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