PERRON – Enhanced Pedestrian Routing and Navigation as well as Walkability Assessment of Pedestrian Ways

ERA-NET TRANSPORT III Flagship Call 2013
Future Travelling – Information and Services for Users

Start date of project: October 1st, 2014
Duration: 36 months

D.1.2

Report on Requirements for Pedestrian Navigation and Quality Criteria of Pedestrian Ways

Cristina Olaverri Monreal (Austrian Institute of Technology GmbH)

Stephanie Schwarz (Austrian Institute of Technology GmbH)

David Sellitsch (Austrian Institute of Technology GmbH)

Dirk Heinemann (Institut f. Automation und Kommunikation e.V. Magdeburg)

Sebastian Naumann (Institut f. Automation und Kommunikation e.V. Magdeburg)

Version: 005
Date: 03/06/2015
Dissemination level: (PU, PP, RE, CO): CO

Project Co-Funded by the European Commission within the 7th Framework Programme

Document History:

Version	Author(s)	Date	Changes
V001	David Sellitsch	28.04.2015	Added assignment of quality criteria (Dirk Heinemann and Sebastian Naumann)
V002	David Sellitsch	29.04.2015	Content
V003	Cristina Olaverri	8.5.2015	Review, Editing
V004	David Sellitsch	26.05.2015	Revised document
V005	Cristina Olaverri	03.6.2015	Final Review, Editing

Summary

PERRON aims at supporting pedestrians through a tailored information presentation that considers pedestrian needs for an optimal user experience. In order to determine way finding strategies, in this part of the 1st workpackage we conducted two workshops with participants that after a screening process to acquire data from persons who were interested in the topic.
The focus of this deliverable is on identifying way-finding and orientation strategies through the preferences of landmarks and other objects of interest, as well as categorization of parameters that might affect pedestrian route choice.

Table of Contents

1. Introduction

Typical turn-by-turn navigation instructions found in car navigation systems (e.g. “turn right in 300m”) are impractical for pedestrians. For this reason, PERRON focuses on a navigation more closed to the instructions that a person would give a pedestrian based on landmarks. In order to be able to determine the best ways of providing information, we needed to acquire data related to the identification and selection of points of interest in an environment. This data is essential for landmark-based navigation systems.
To this end, we developed two workshops in which we analyzed two extreme situations:

1) a landmark-rich environment, that made challenging to select the most appropriate landmark from the high palette available and
2) an environment with a limited number of landmarks, where in some situations, points of interest were not always visible at the first sight.

We addressed the customization for route choice in PERRON making it possible for the users to select routes that fit their current needs and situational context. In order to minimize “awareness mismatch” or situations in which system behavior does not correspond with the expectation of users [Schmidt, 2014], we made sure that parameters affecting route choice were categorized in a way that made sense for users. For example, if someone wanted to select a safe route, we needed to know what safety meant to him or her (e.g. safe crossings, lighting,..). To this end, we created a user centered mapping between customization options and the actual parameters affecting route choice, by performing open a card sorting experiment with potential users of the PERRON navigation system.

In chapter 2, we review the quality criteria models we developed for the user centered mapping approach. Chapter 3 describes the open card sort methodology used to acquire the quality criteria data. Chapter 4 describes the landmark identification workshop.

2. Related Literature

2.1 Parameters Affecting Pedestrian Route Choices:

Route choices are affected by various quality factors. The most important determinants [Czogalla and Hermann, 2011] are depicted in Table 1 and they affect each of the four quality categories concerning the quality of a pedestrian route (safety, accessibility, attractiveness, comfort) described by [Czogalla and Hermann, 2011] and summarized in the Deliverable 1.1:

- Safety: This category aims at the safety from a traffic point of view, i.e. how probable are collisions with other road users. Assaults or harassments are not considered here.
- Accessibility: This factor is particularly important for special users with restricted mobility that might need wheelchairs or other walking aid and prefer a way that is free of obstacles.
- Attractiveness: The attractiveness includes parameters such as wide spaces, and illuminated ways.
- Comfort: The comfort of ways deals with aspects like noise level and vegetation. Particularly a high noise level caused by traffic is very uncomfortable.

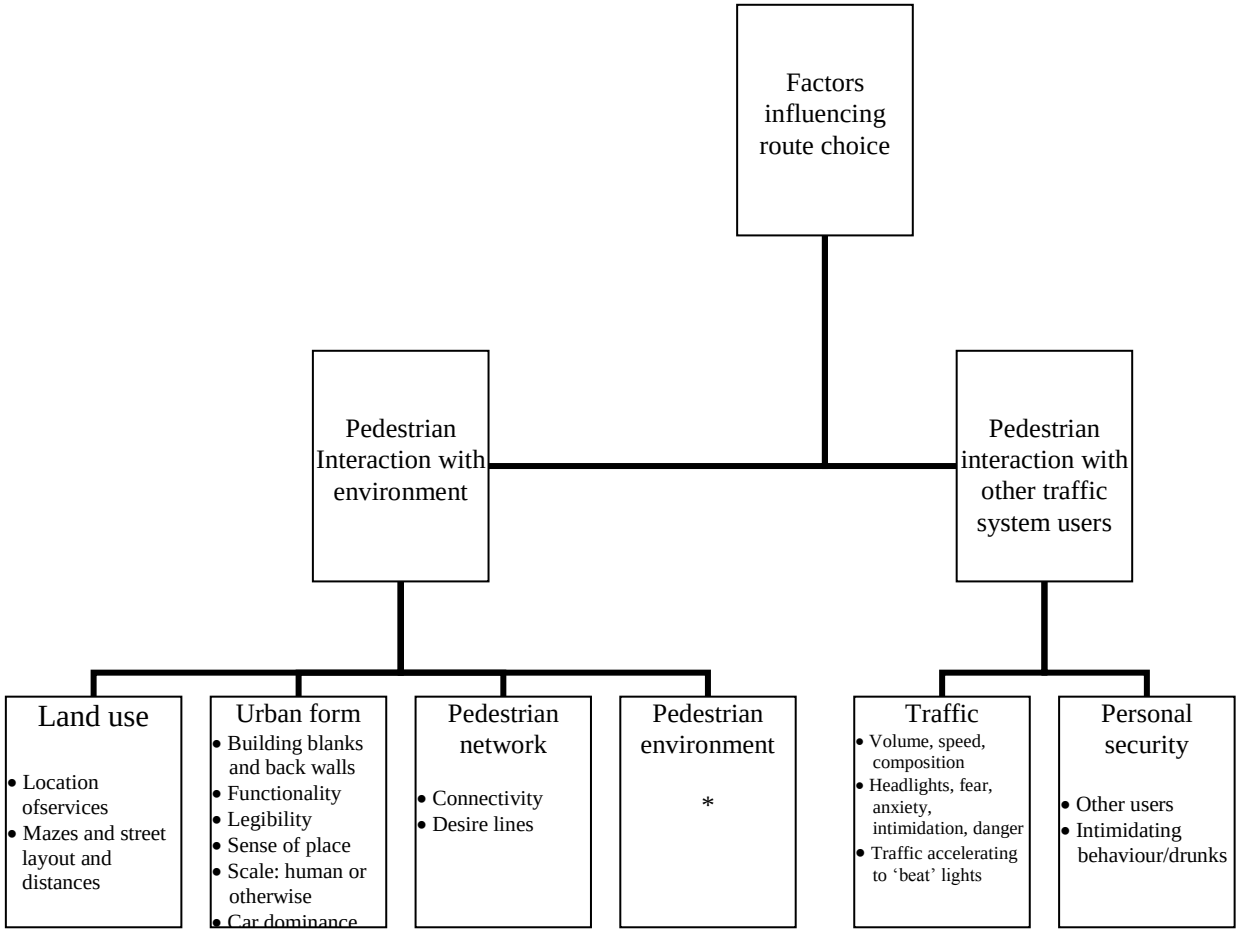
The categories are characterized by different criteria. These criteria resemble the existing features of a street or path.

Quality Category	Quality Factor	Quality Factor
Distance		
Safety	Safe crossing facilities	Motor traffic volume and speeds
Accessibility	Sufficient width of sidewalks	Steepness of slopes
Attractiveness	Maintenance of open space	Lighting
Comfort	Noise level	Vegetation and cast of shadow

Table 1: Parameters Affecting Pedestrian Route Choices

Another classification for factors influencing route choice was performed in [Tight et al., 2004]. See Figure 1.

The authors divided factor categories by interaction type: pedestrian interaction with the environment and pedestrian interaction with other road users. They then grouped the factors into the following categories: pedestrian environment, pedestrian network, urban form, land use, traffic, and personal security.



*Surface evenness, Tactile signals, Footpath width, Gradient, Ramps, Steps, Handrails, Guard rails, Street furniture (Obstructions), Benches, Meeting points, Toilets, Carriageway width and no of lanes, Crossing placement, Crossing distance removed from traffic, Crossing types, Drainage/puddles/car splashing, Cleanliness (Litter, Dog fouling, Graffiti)

Figure 1: Factors influencing route choice [Tight, 2004, p.10]

3. Open Card Sorting experiment to determine the parameters affecting route choice

Method

We asked 14 participants to perform an open card sorting experiment. Unlike closed card sorting, where categories are predefined [Olaverri-Monreal et al., 2014], in open card sorting, participants create their own categories and category names. To this end we designed cards that described situations that might affect pedestrian route choice relying on the factors influencing route choice depicted in Figure 1:

Factors influencing route choice	
Cleanliness (Litter, Dog fouling, Graffiti)	Safe crossing facilities
Drainage/puddles/car splashing	Sufficient width of sidewalks
Benches	Noise level
Ramps	Motor traffic volume and speeds
Toilets	Steepness of slopes
Other users	Lighting
Connectivity	Vegetation and cast of shadow
Intimidating behavior/drunks	Distance

Table 2: Selected parameters for card sorting

In addition to the text, the cards included photos depicting the parameters (see Figure 2).
We asked the experiment participants to group these 16 items into any number of categories. By letting users create their own groups, our goal was to obtain a categorization based on their mental models in order to consequently use the resulting classifications in the design process of customization options related to quality criteria in pedestrian navigation apps.

Figure 2: Participants sorting cards

We then created a similarity matrix from the collected data. We performed a cluster analysis on the similarity matrix to create a dendrogram, or tree diagram which depicts the clusters of user centered quality criteria [Salmoni, 2012].

Results

The mean number of groups created by the 14 participants was 3.86 (std. 0,83). We therefore performed a cluster analysis with four groups. The resulting dendogram in Figure 3 shows the hierarchical coherence of quality criteria, based on the data we collected with the open card sorting method. Nodes on the same branch show stronger association. Groups are represented by red boxes.

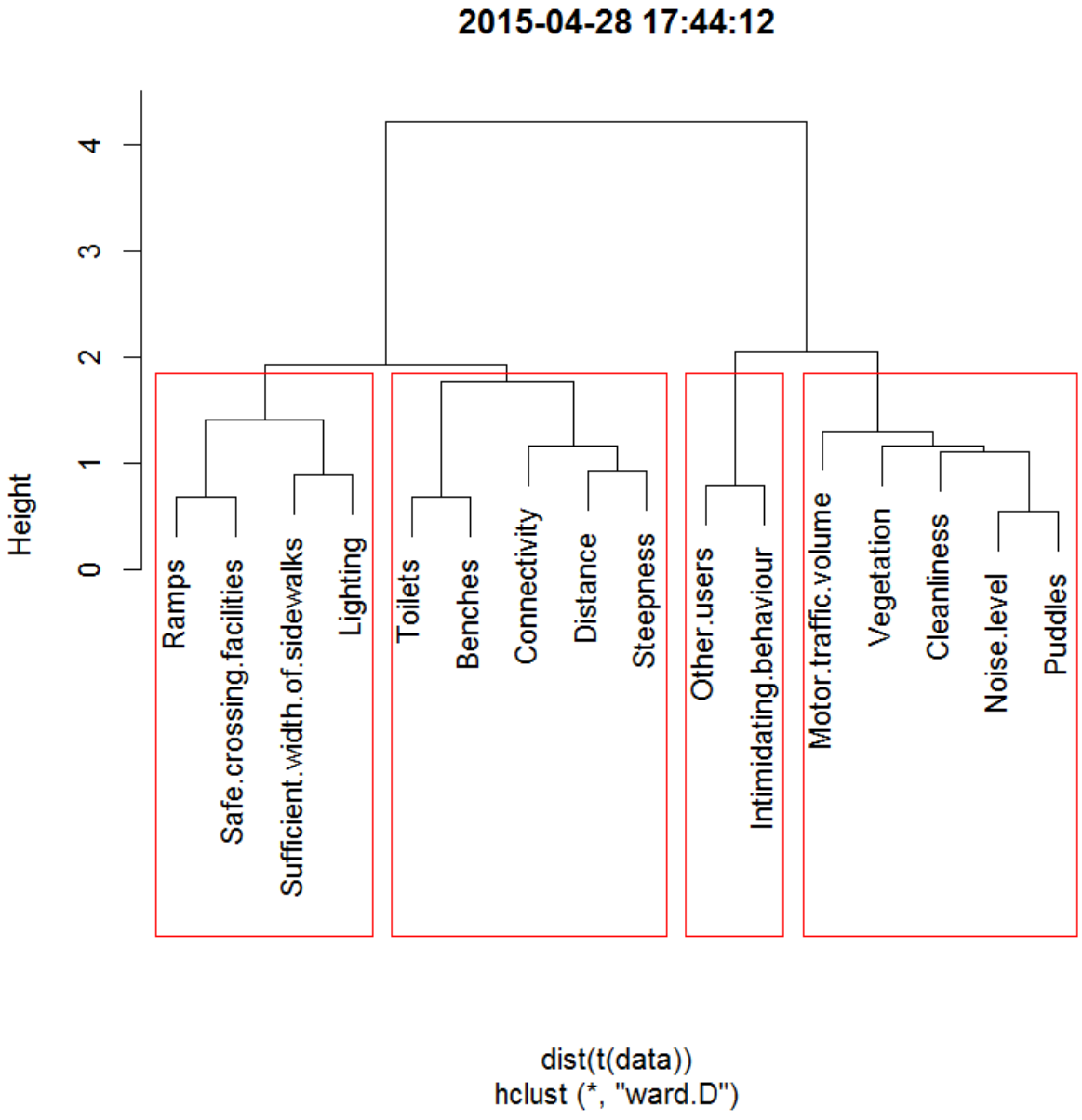


Figure 3: Results of open card sort analysis

Based on the categories presented in chapter 2.1 we were able to propose a new categorization:

- **Safety/Accessibility:** Ramps, Safe crossing facilities, sufficient width of sidewalks, lighting
- **Comfort:** Toilet, Benches, Connectivity, Distance, Steepness of slopes
- **Pedestrian Interaction with other users:** Other users, Intimidating behaviour
- **Attractiveness:** Motor traffic, vegetation, cleanness, noise level, puddles

When comparing this categorization with the ones from literature, we observe that safety and accessibility features according to our participants cannot be easily separated. This can be explained by the fact that some of the criteria include aspects of both categories. Sufficient width of sidewalks for example, can be an accessibility factor for people in a wheelchair, but also safety related. We can confirm the results from [Tight et al., 2004] regarding the identification of a group "pedestrian interaction with other users", and within this group, "personal security" (Figure 1). The classification into "other users" and "intimidating behaviour" could be found within the same group. Compared to the categories in Table 1, participants put "distance" in the comfort category rather than creating their own category. Vegetation was assigned to attractiveness, compared to comfort in Table 1. Also lighting was identified as a safety/accessibility factor rather than an attractiveness factor.
Associations and categories we identified using open card sort analysis will be reflected in the design of the customization interface of the PERRON navigation system prototype.

4. Workshop on landmark identification

Method

To determine landmark identification strategies in the city of Vienna, we created 2 videos of an approximate duration of 5 minutes. We focused on the first district in Vienna to get a first impression and used a wide angle camera on high aperture settings in order to achieve a "neutral" view. Our intention was to show the test persons the videos so that they could give directions in the environment when asked about how to get to a specific place. The first video was recorded in a landmark-rich environment (see Figure 4) and the second one in a landmark-scarce environment (see Figure 5).
The videos were used in 2 workshops with 6 participants each, who were asked describe the way as they would to a friend on the phone on the go, writing down the directions. Goal was to determine the strategies that persons would use to show the way to a person not familiar with the environment. The directions were then presented to the rest of the group within the workshop and then discussed by all the participants . In the discussion participants provided feedback on whether they understood and liked the directions given by others. They also compared descriptions, trying to find similarities and differences within their workshop group.

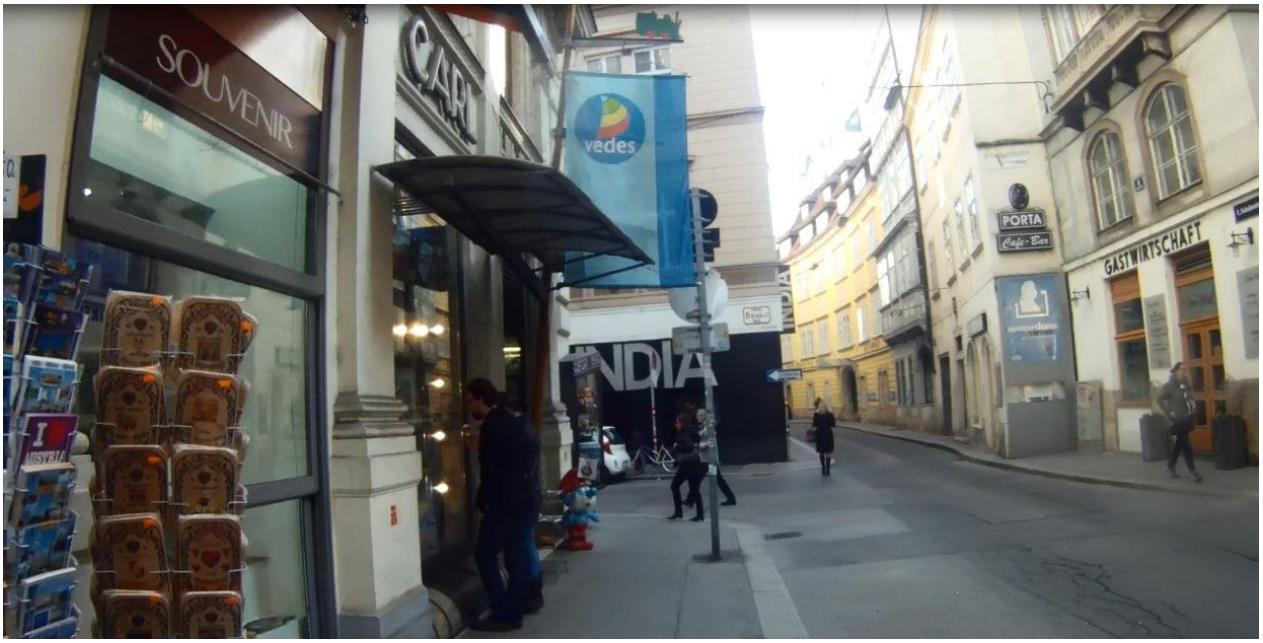
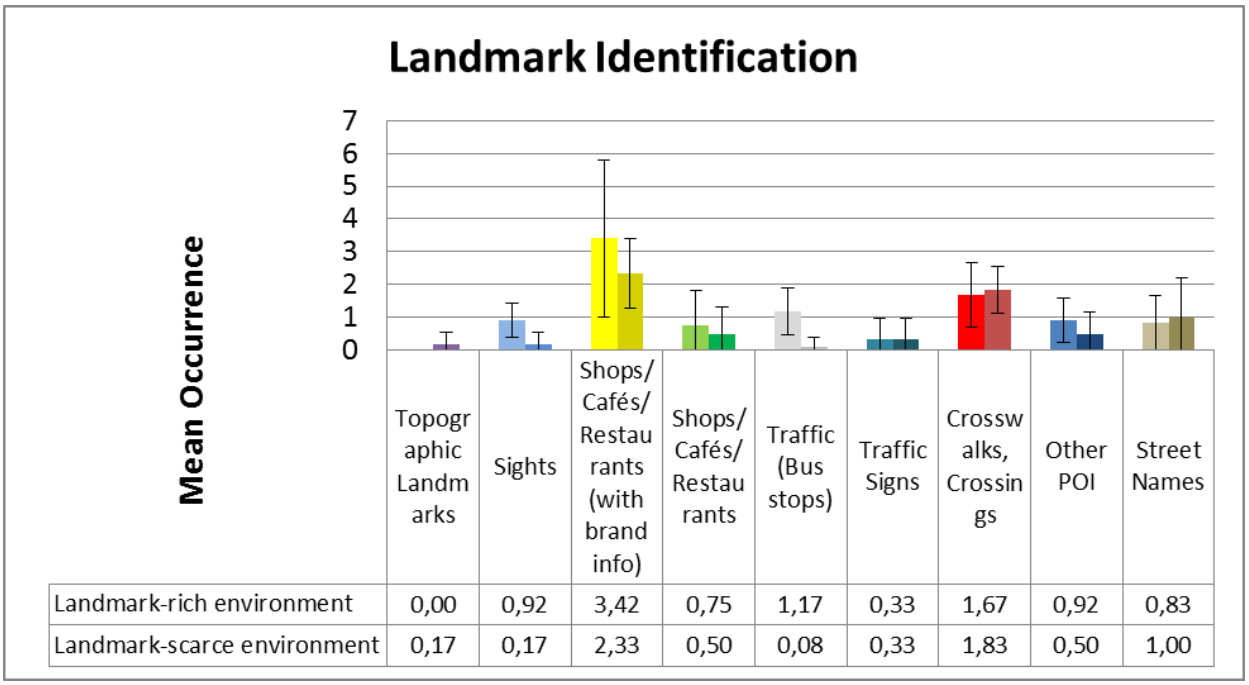


Figure 4: Landmark-rich environment (camera view)

Figure 5: Landmark-scarce environment (camera view)

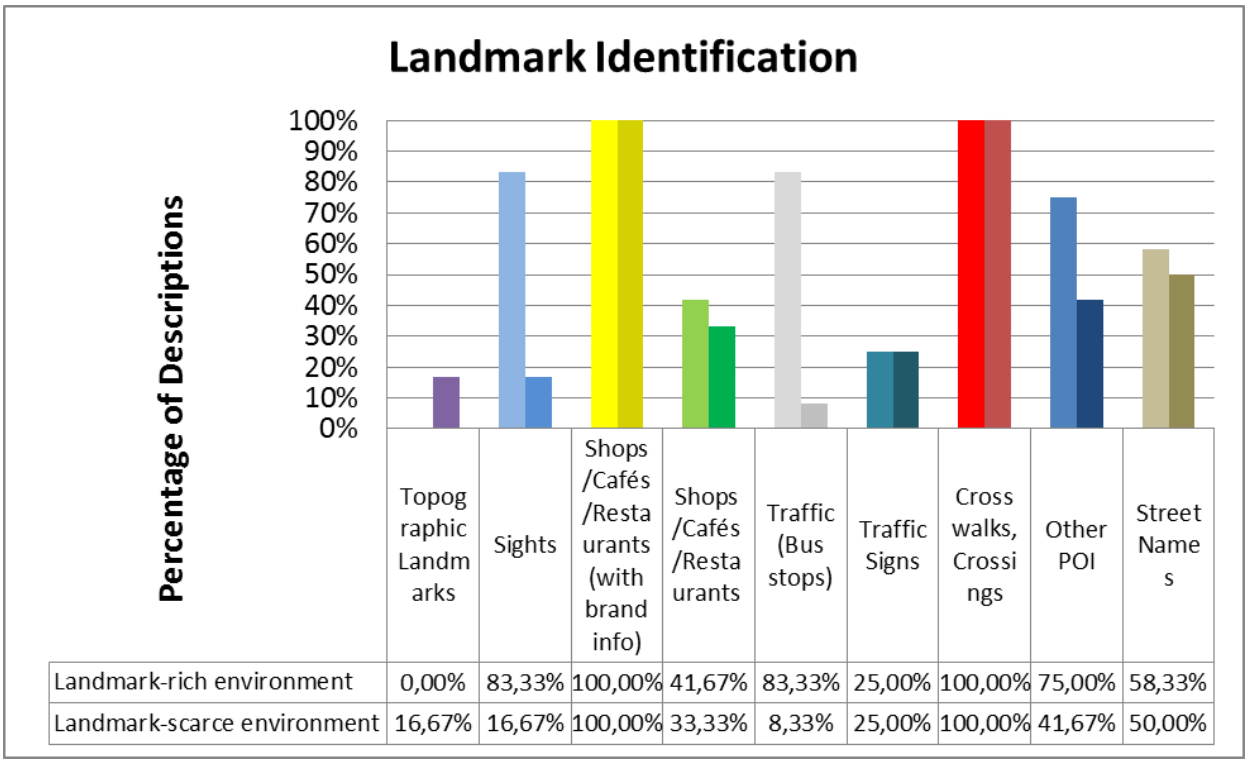
Results

Landmarks selected by participants were sorted in different categories (Table 3). Figure 6 shows the mean occurrence of landmarks by category in both environments. Figure 7 shows in how many descriptions a certain type of landmarks was used.



	Topographic Landmarks	Sights	Shops/ Cafés/ Restaurants (with brand info)	Shops/ Cafés/ Restaurants	Traffic (Bus stops)	Traffic Signs	Crosswalks, Crossings	Other POI	Street Names
Landmark-rich environment	0,00	0,92	3,42	0,75	1,17	0,33	1,67	0,92	0,83
Landmark-scarce environment	0,17	0,17	2,33	0,50	0,08	0,33	1,83	0,50	1,00

Figure 6: Mean occurrence of landmarks by category



	Topographic Landmarks	Sights	Shops /Cafés /Restaurants (with brand info)	Shops /Cafés /Restaurants	Traffic (Bus stops)	Traffic Signs	Cross walks, Crossings	Other POI	Street Names
Landmark-rich environment	0,00%	83,33%	100,00%	41,67%	83,33%	25,00%	100,00%	75,00%	58,33%
Landmark-scarce environment	16,67%	16,67%	100,00%	33,33%	8,33%	25,00%	100,00%	41,67%	50,00%

Figure 7: Percentage of descriptions containing a certain category at least once

Findings:

- Brand logos and shop names are often used as landmarks.
- Walking the same route, participants perceived different shops. With the exception of big franchises like Billa or Subway, which appeared in almost every given direction, participants named a wide range of shops. During the review phase participants discussed these differences. They suggested that personal preferences, (shopping-)habits and gender may have influenced their landmark selection.

- Two participants who were unfamiliar with the area had difficulties identifying sights.
- In a landmark scarce environment one participant used descriptions like “at the yellow house“– which was strongly advised not to do by the other participants, since the characteristics were not unique in the observed area.
- There were mixed opinions about the use of street signs and crosswalks in descriptions. Although they were frequently used (especially in landmark-scarce environments), participants found them to be less useful compared to shops and sights.
- In the direction review phase, some participants suggested to use street names when there is a lack of landmarks since they are precise. The downside is that people need to look for street name signs which cannot be easily identified from a distance.
- When crossing Stephansplatz people used the entrance of the cathedral for orientation.

#	Topographic Landmarks
1	Donaukanal
1	Hügel

#	Sights
10	Stephansdom
2	Urania
1	Wasserturm

#	Shops/Cafés/Restaurants (with brand info)
11	Billa
11	Subway
7	Morawa
5	INDIA
4	Sun Company
4	Bonita
3	Sonnentor
3	Manner-Shop
2	Facultas
2	Libro
2	Seidensticker
1	Aida
1	Frick
1	Pirker
1	Kecksilber
1	Luxardo
1	Vedes Spielverkauf
1	Gemmini
1	Papillon
1	Olsen
1	Fena
1	Uhr Schaumann
1	KAOS
1	Urania Beauty

1	Berndorf
1	Café Diana

#	Shops/Cafés/Restaurants
3	Gastwirtschaft/Wirtshaus
2	Italiener
1	Spielwarengeschäft
1	Uhrengeschäft
1	Büchergeschäft
1	Sonnenstudio
1	Souvenirladen
1	Juwelier
1	Beautysalon
1	Antiquariat
1	Café
1	Apotheke

#	Traffic
9	Fiaker/Kutschen/Pferterln
4	Bushaltestelle
1	Schräg parkende Autos

#	Traffic Signs
4	Einbahn

#	Crosswalks, Crossings
20	Kreuzung
14	Zebrastreifen
3	Ampelkreuzung
2	Platz
2	Sackgasse
1	Ecke
1	Insel
1	Linksabbiegemöglichkeit
1	Nebenfahrbahn

#	Other POI
7	Stiegen/Treppen/Stufen
2	Gelbes Gebäude
2	Mistkübel/Container
1	Vitrinen
1	Auslagen
1	Park
1	Baustelle
1	Gittertor

#	Street Names
5	Biberstraße

4	Rotenturmstraße
3	Wollzeile
3	Schwedenplatz
2	Strobelgasse
2	Franz Josefs Kai
1	Wiesingerstraße

Table 3: Landmarks named, grouped by category

5. References

[Czogalla and Hermann, 2011]
Czogalla, O. and Hermann, A. (2011).
Parameters determining route choice in pedestrian networks.
In Transportation Research Board Annual Meeting. Washington, DC, USA.

[Salmoni, 2012]
Salmoni, A. (2012), Open Card Sort Analysis 101
http://www.uxbooth.com/articles/open-card-sort-analysis-101/ (visited 21.4.2015)

[Schmidt, 2014]
Schmidt, A. (2014): Context-Aware Computing: Context-Awareness, Context-Aware User Interfaces, and Implicit Interaction. In: Soegaard, Mads and Dam, Rikke Friis (eds.). "The Encyclopedia of Human-Computer Interaction, 2nd Ed.". Aarhus, Denmark: The Interaction Design Foundation. Available online at https://www.interaction-design.org/encyclopedia/context-aware_computing.html

[Tight et al., 2004]
Tight, M.R., Kelly, C., Hodgson, F. and Page, M. (2004) Improving Pedestrian Accessibility and Quality of Life. In: 10th World Conference on Transport Research, 4th-8th July 2004., Istanbul, Turkey.

[Olaverri-Monreal et al., 2014]
Olaverri-Monreal, C., Hasan, A., Bulut, J., Körber, M., Bengler, K. (2014) "Impact of In-Vehicle Displays Location Preferences on Drivers' Performance and Gaze.", In IEEE Transactions on Intelligent Transportations Systems (IEEE T-ITS). Special Issue on Human Factors in Intelligent Vehicles. Volume 15 , Issue 4, pp. 1770 - 1780.