Participative Mapping of Elderly Mobility and Distances to Their Favourite Destinations

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ABSTRACT

Abstract. To improve engagement of elderly residents in local community decision making and urban space improvement, two online web mapping applications based on Emotinalmaps.eu were designed. They are intended to collect seniors' emotions and mark mobility targets. The application utilizes Leaflet library, MySQL database and stores spatial data in GeoJSON. The results of the first campaign in two Czech cities show differences in radii of attractive and repulsive places and paths and provide important information on what the reasons for attractivity/repulsivity are for local elderly. Steep slopes, slippery surfaces, and stairs were recognised as the main barriers. Fourteen categories of mobility targets were marked by respondents. Their spatial distribution was compared against a distribution of all available targets. The testing of M-function confirmed the significant clustering of marked targets for small distances (200-380 m). The distance analysis of targets shows that the selection of targets in an urban close neighbourhood is not driven by the shortest distance and that is why the selection of targets in urban accessibility analysis should not use the distance order of targets, such as the closest facility, but rather a distance threshold or gravity weightings.

CCS CONCEPTS

• **Collaborative content creation**; • **Sociology**; • **Empirical studies**;

KEYWORDS

participative mapping, elderly, mobility, emotional maps, destinations

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1 INTRODUCTION

Participative mapping [1] represents an important tool to impel people to participate in municipal decision making. A specific form of participative mapping is emotional mapping suitable for collecting personal opinions and feelings about various aspects of, and events and phenomena in the territory. It is essential to understand such human attitudes to build smart cities. The main advantage of the web mapping is the ability to specify locations where addresses are useless, such as parks, natural places, and usage of supporting mapping tools. It enables e.g., in-detail specification of littered locations as well as use of a large map symbol to hide home addresses to protect privacy.

Elderly inhabitants are often less active in participation in community decision making. Due to their low engagement, urban planning and development may overlook their wishes and concerns. Smart cities need to use all channels to monitor and explore the opinions of all inhabitants. The participative mapping, and emotional maps especially, may help fill the gap and increase active participation of elderly in adapting urban space and services to their requirements. It will increase the well-being of elderly and improve their quality of life. One of the issues which elderly face is physical accessibility of various services. The spatial mobility of elderly is supported or impeded by a range of factors usually connected to distance, time constraints, ambient conditions, terrain characteristics, external physical loads, demands on attention, postural transitions, and traffic levels [2].

Residential accessibility analyses usually evaluate travel conditions to selected targets. The choice of targets depends on the socio-economic status of residents, their age, health and habits, time of year/week/day, and local conditions. Three main criteria are applied to select a subset which will act as destinations for travel modelling – by the distance, by the order of distance (e.g., 5 closest in [3]) and the selection based on weights assigned in gravity models (e.g., [4]). Often, a simple selection of one closest target is applied (e.g., PTWAI indicator [5], the closest employer [6]). Especially for elderly, it is quite often anticipated that due to their physical as well as financial constraints (deepened with age), their activity radius is decreased, and they prefer to select the closest target to minimise their travel.

Two web map applications were developed to map emotions of elderly in their surroundings and to map their mobility targets. So far, a small number of seniors have participated in the survey and they have delineated only 479 locations. The aim of this paper is to present the applied methodology and temporary results, and to focus on one specific problem – distance analysis of targets and impacts to selection of destinations for accessibility modelling.

2 STUDY AREA AND WEB MAP APPLICATION

The study area covers Ostrava (290,000 inhab.; area 214 km2) and Hradec Kralove (91,000 inhab.; 106 km2), two regional capitals in Czechia. The promotion of the survey was done by local clubs, social services and seniors' homes.

The specific web application, Emotional Maps (EmotionalMaps.eu, in Czech), was used to collect data. The application is based on Leaflet library [7]. The application runs with MySQL database in the backend and uses PHP to operate the frontend. Unlike Ushahidi, Umap, or ArcGIS Online, the application does not require any registration or installation which enables the use of any available browser which promotes a wide usage [8]. Data is stored in GeoJSON, an extension of JSON format for encoding spatial data suitably for processing in GIS software [9]. The application was developed into two map survey applications – the emotional map and the mobility map.

Respondents first specify their age and mobility constraints (mainly health limitations). Further, respondents are asked to mark one or more locations on the map: attractive locations (where they like to walk), repulsive locations (where they do not like to walk), barriers of movement, attractive paths (where they like to walk), repulsive paths (where they do not like to walk), and finally to place an approximate location of their home. The location of home is indicated by a large circle to avoid respondents' fear of lost privacy. When a respondent specifies the location, they are asked to describe their feeling about this location or path. We are interested in what the reasons are for attractivity or repulsivity (16 reasons are offered with a multiple-choice option + free text), what the visiting frequency of this location/path is, temporal aspects (i.e., scheduled events, daytime, weekday), weather conditions, and social aspects (i.e., accompanying other people, too many people, alone).

A different style of questions was proposed for the mobility maps. Here, respondents specify locations for their favourite of the following destinations: home, workplace, retail, pharmacy, post office, doctor (general practitioner), supermarket (large shopping, usually hypermarket), ATM, worship, services, park or other place of relaxation, restaurant, visit family or friends, garden or cottage, or another place (free text). When they place a location, they are asked to specify frequency of attendance, and usual transport mode.

3 RESULTS OF MAPPING

We selected only records for elderly age categories (65+). Overall, 333 emotional locations have been placed thus far. Their distribution (fig.1) shows a much larger extent of attractive places than repulsive places. It indicates that the radius of elderly activity may be quite large. As expected, the radius of repulsive locations is small. While attractive places motivate people towards mobility, the contrary can be seen with repulsive places registered only within close proximity of the residence. We believe more distant repulsive locations are not of interest if they do not influence respondents' quality of life. The major important reasons for attractiveness are: pleasant walking (52%), pleasant environmental conditions (warm, cold, sunshine, shade, etc.) (50%), nature observation (48%), pleasant relaxation (26%), good path (surface) (23%). On the other hand, the main impedances are related to clutter and mess (50%), social issues (homeless people) (40%), and ugly or inaesthetic views (40%). As barriers of mobility steep slopes (43%), sliding surface (35%), and stairs (30%) dominate. Attractive paths are selected for nature observation (76%), physical pleasantness (67%), good surface (47%) and moderate physical activity (47%). Bad paths are criticised due to bad resting opportunity and no benches (61%), physically unpleasant environment (56%), danger of traffic (44%), ugliness (33%) and poor surface (33%). It is worth mentioning that a portion of seniors face computer literacy issues, especially with digitizing paths, therefore follow-up manual editing is required to clean data.

In the mobility mapping, 479 locations in the above mentioned categories have thus far been marked. Their spatial distribution in Ostrava (fig. 2 left) is uneven, where the majority are located in the city centre, followed by relatively concentrated occurrences in the western part of the city, and more dispersed locations in the southern sector and surroundings. The output reflects both the spatial layout of the settlement (3 main parts) and uneven distribution of respondents, caused by mainly the southern sector being as yet undersampled.

4 DISTANCE ANALYSIS

Outputs of the internet map survey are exported to GeoJSON and transformed using QGIS and database processing into structures suitable for statistical processing in SPSS and graphical outputs in Excel.

The distribution of destinations is evaluated according to the main available factors: age, target category, and travel mode. One of the goals was to compare distribution of identified real targets with an offer of targets in the given locality.

To evaluate the potential offer of targets, target locations in the cities and their surroundings in the following categories were collected: retail (OpenStreetMap OSM, codes 2307, 2501-5, 2511-23, 2526, 2528, 2543-4, n=2750), pharmacy (national Register of health care facilities RHCF, n=566), post office (OSM, code 2005, n=752), doctor (RHCF, general practitioner, n=1217), hypermarket (OSM audited, n=44), ATM (OSM, code 2602, n=464), park (OSM, code 7202, N=921), and restaurant (OSM, codes 2301-5, 2307, n=3490). The density of targets was calculated using kernel density estimation KDE (quadratic density function, bandwidth 500 m, ArcGIS). The intensity of KDE in Ostrava (fig. 2 left) shows a high concentration of all available targets in the centre and western part of the city, and less dense intensity in the southern part. The comparison with marked targets collected in the survey shows that while in the centre the targets are well matched, the distribution of available targets in the west, south and east sectors does not correspond to the marked targets. The reasons for this can be seen in the variable preferences of elderly to satisfy their needs; they may not prioritise short distances over other reasons such as offered services, prices, spatio-temporal availability and combination with other purposes.

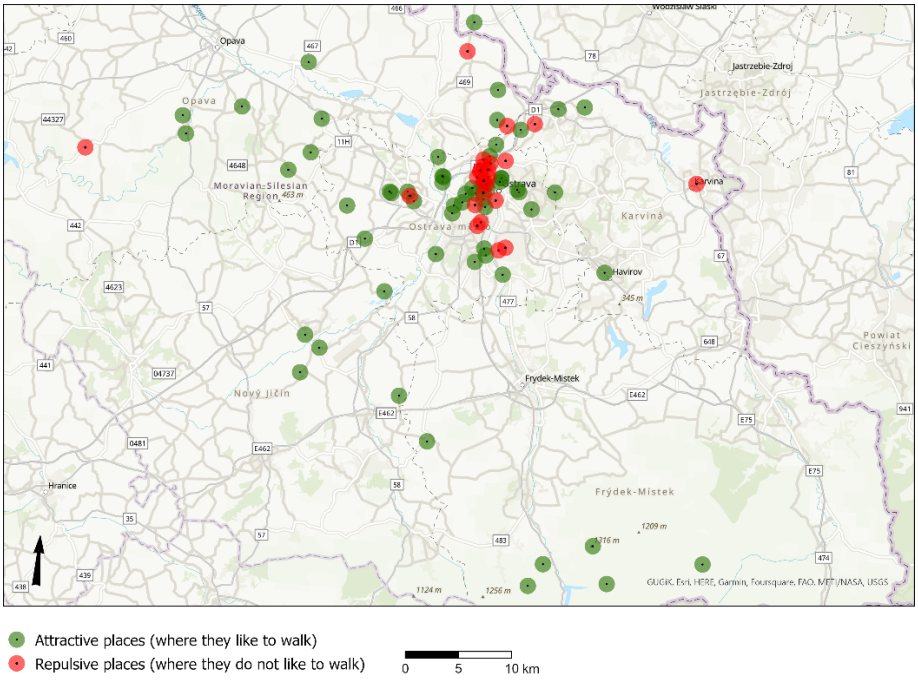

Figure 1: Attractive and repulsive places in the Ostrava region

The difference between these distributions was confirmed by calculation and testing of M-function [10]. The divergence is confirmed for the distance 200-380 m where the distribution of real targets is significantly (p=0.05) more clustered than the distribution of all available targets (fig. 2 right). It indicates a selection of more popular targets rather than a random selection. The hitherto small sample of respondents with uneven distribution of residency presents a limitation.

To confirm the idea of a secondary role of target distances, the Euclidean distances to all targets were calculated for each residence from the questionnaire, including marked targets. Relationships between selected targets' categories confirm the expected behaviour – distances to the marked doctors are usually much higher than to the marked retail (but surprisingly not in all cases) while distances to the marked pharmacy and the marked post office are more equivalent with some local deviations (fig. 3).

For each category, targets were sorted in ascending order according to these Euclidean distances. Further, the order of targets and corresponding distance from the residency are compared.

The distribution of potential targets from the residences shows significant differences between the cities in some categories (fig. 4). E.g., shops, doctors, and parks in Ostrava display a growing function without sudden breaks, while these categories in Hradec Kralove show steep changes of slope near 4 km and again near 15 km. The reason for this is that Ostrava lies in the centre of a metropolitan area with continuous settlement expanding namely to the SE, while Hradec Kralove is surrounded by villages with practically no offer of destinations except for at 15 km where the city of Pardubice (90k inhab.) offers a wide range of shops. A detailed study of the relationship between the order and distance for shops (fig.5) (for selected real targets) shows that the closest retail destination is exploited only in a small share of cases, an important share of real targets are among the first five but we cannot omit more distant targets (up to 20th in order), especially in cities with a good offer of available shops. In both cities, elderly select retail according to an approximate distance within 1500 m. Similar results were also obtained for other target categories.

Our findings (although for a small sample) support the idea that, in the selected cities, the distance is not the crucial factor for retail selection, but other factors such as brand, offers, services, prices and overall spatio-temporal availability prevail. Further findings confirm the role of age (the mobility radius for 75+ is decreased except in the case of doctors, gardens and cottages) and a car availability.

5 CONCLUSION

Participative mapping is an important tool for the collection of georeferenced opinions, suggestions and comments of inhabitants. Emotinalmaps.eu was developed into two map survey's applications - the emotional map and the mobility map, which were applied to map the circumstances of elderly in two Czech cities, namely Ostrava and Hradec Kralove. Spatial data are stored in GeoJSON which enables further GIS and statistical processing. The emotional map distinguishes attractive and repulsive places and paths, as well as barriers within the city, and supports the understanding of reasons for such evaluations including temporal, meteorological and social aspects. The mobility map specifies location of used targets in 14 categories including frequency of visits and transport mode. The main research question was to discover the relationship between the distance of a marked target and its order among all available targets. Although currently we deal with a small sample size, the

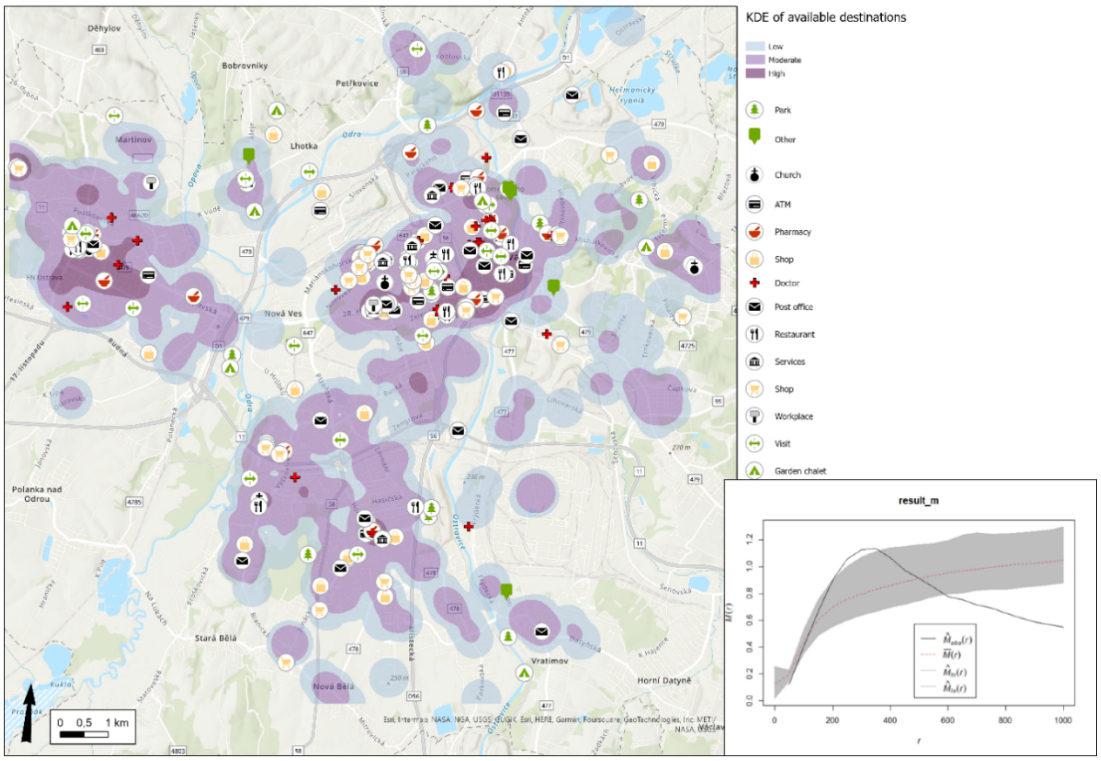

Figure 2: Distribution of marked mobility targets and a kernel density of available targets in Ostrava (left), and the result of M-function testing (right down)

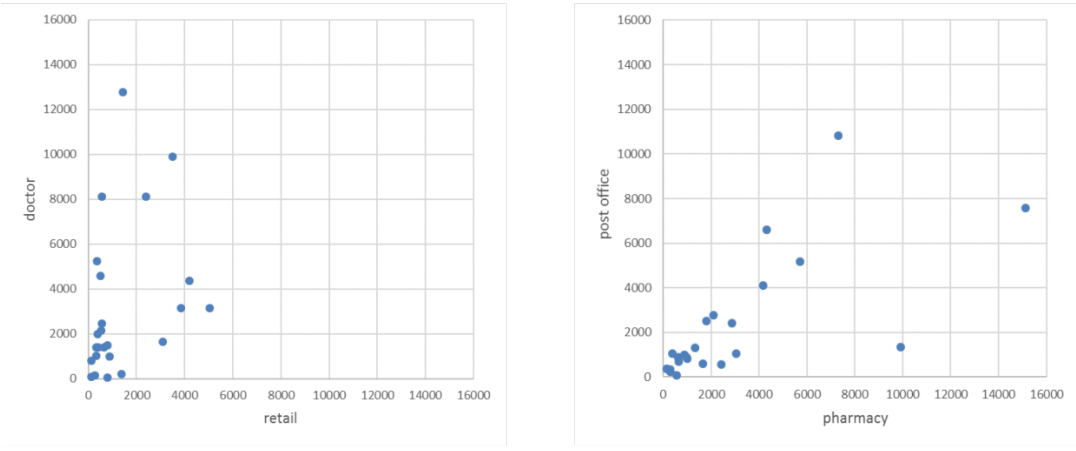

Figure 3: Distances from residence to targets marked by elderly in Ostrava

results support the idea that in a close neighbourhood within a city (e.g., 2 kms) the Euclidean distance in not the main factor influencing selection of destinations for elderly. It indicates that for accessibility evaluation in city conditions selection of targets based on only the closest target or on their distance order (e.g., up to 3) is less suitable than selection of all targets by distance threshold or gravity weightings.

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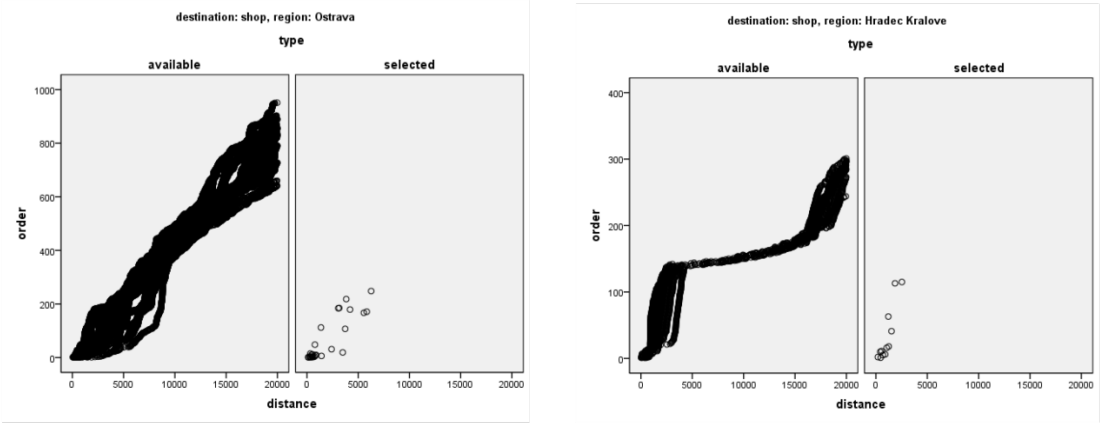

Figure 4: Relationships between the order and distance of shops (all available and marked) (Ostrava left, Hradec Kralove right)

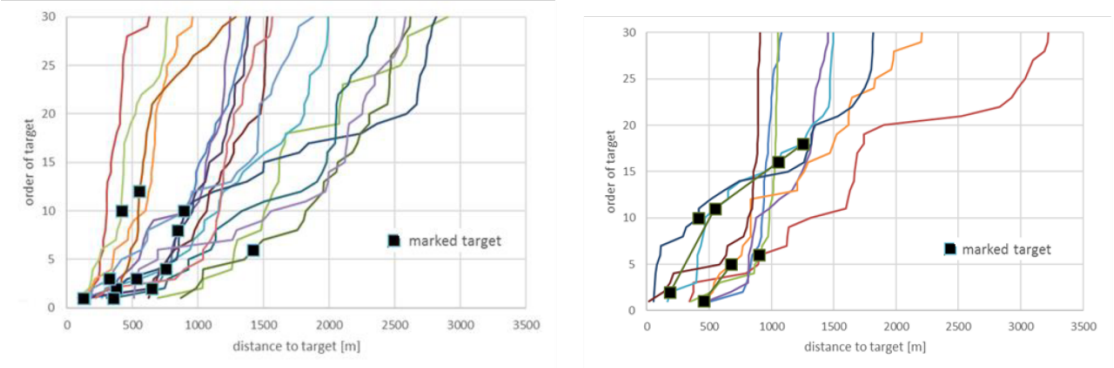

Figure 5: Details of relationships between the order and distance of shops (Ostrava left, Hradec K. right)

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