G.4 Data4City – A Hyperlocal Citizen App

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1 Introduction

Exploring upon the phenomena of smart cities, this paper elaborates the potential of crowdsourced data collection in small scale urban quarters. The development of the Data4City (D4C) hyperlocal app – PinCity – is based on the idea of increasing the density of real-time information in urban areas (urban neighborhoods) in order to optimize or create innovative urban services (such as public transportation, garbage collection) or urban planning, thus improving the quality of life of quarter inhabitants as a long-term goal. The main principle of the app is the small-scale implementation, as opposed to top-down smart city approaches worldwide, preferably in a city quarter, or a community, which can be subsequently scaled and interlaced to other parts of the city.

2 Motivation

Today's smart city approaches often deal with top-down motivated implementations of technical sensors into the built environment, such as the the IoT-platform Kinetic by Cisco[1]. The D4C hyperlocal app, on the other hand, wants to empower the inhabitants to gather georeferenced information that could replace, or at least supplement technical sensors, once a critical mass of users is exceeded. Thus, structural work and sensor infrastructure does not necessarily have to be undertaken and implemented to collect relevant and objective urban data. Urban data can generally be defined by answering the w-questions, such as "who, what, where and when" (Gehl & Svarre, 2013, pp. 11–19). Its objectivity, in this case, is valorized by accumulation and reciprocal valorization of the information and source in real-time. The citizens and users of the app can be considered a voluntary replacement of sensors, which need to be calibrated and aggregated for still high costs and energy consumption. This leads us to a bottom-up crowd-based generation of urban (objectified) data. Additionally, not only quantitative data (such as parking space occupancy, properties of trash bins, etc.), but also qualitative subjective feelings (such as safety, cleanliness) can be determined by the crowd/community. The first test-quarter for the app is in Dresden-Johannstadt, with the planned introduction of the app during the last quarter of 2018.

1 www.cisco.com/c/en/us/solutions/internet-of-things/iot-kinetic.html

3 Methodology

The approach is to first define relevant urban topics necessary for service providers and planners, which can be in turn described with the citizens (front-end app users). We assume that most of the urban data collected in the city is georeferenced (similarly to the approach of other map-based applications, e.g. Google Maps), with the exception of general statements to the overall quality/attributes of the considered area. We consider georeferenced data to be clustered to individual Points of Interest (PoI) (Yuan Q., Cong G., Ma Z., Sun A., and Thalmann N.M., 2013, pp. 363–372), which are always in a relationship with observable elements of the city. In our practice-oriented research, we differentiate between market-driven PoI and citizen-defined PoI. Currently, market-driven PoI are connected to information relevant to urban services and stakeholders interested in quality management and improvement of their products, filtered through the app. These are compensated with and supported by diverse incentives provided by local participating businesses. The citizen-defined Points of Interest are linked with the bottom-up approach to define and visualize problems and chances of the quarter, with a possibility for an in-app discussion (forum). Here, during the latter testing phases of the app, semantic analysis (Strengell N., Sigg S., pp 5–6) tools will be implemented for the back-end data exploitation to define relevant urban clusters, necessary for topic generation and more refined community creation. The mutual relationship between the two different types of PoI and their contributors cares for an initial two-sided platform approach. A group of PoI can be clustered to an Area of Interest, connected to the same elements with comparable attributes. The last group of elements describable by the users are non-georeferenced urban data acquainted through general public surveys (both on site and online), which are necessary to describe the notions of the local inhabitants. The aforementioned function can be considered as a native function of the app (similarly to the citizen.me-app[2]). Currently, most of the datasets used in the first version can be clustered under "urban services, leisure, mobility and neighborhood" and their particular plurality of subcategories, followed by an in-app switch between user-oriented opinions and market-driven questions.

2 www.citizenme.com

Name:	Point of Interest (POI)	Area of Interest (AOI)	General Data of Interest
Data reference (location / no location)	georeferenced point	multiple georeferenced point (POIs) sum up to an area	no georeference
Located Examples:	Public waste disposals	Parking spaces (multiple single parking spots)	District of interest
	Mailboxes	Streets	
	Traffic Lights	Squares	
	Street Lights	Parks (multiple trees & multiple benches)	
	Bus stop		
	Benches		
	Trees		
Themes of Interest:	Filling level (obj. Data)	Occupancies (obj. Data)	Cleanliness (sub. Data)
	Safety (sub. Data)	Frequencies (obj. Data)	Safety (sub. Data)
	Cleanliness (sub. Data)	Noise Level (obj. Data)	Life Quality (sub. Data)
	Reachability (obj. Data)	Speed (obj. Data)	Condition (sub. Data)
	Damage (obj. Data)	Light Level (obj. Data)	
	Healthiness (e.g. of trees)		

Figure 1: Urban Data Structure

The app is seen as a constant work in progress through its crowd-sourced nature. The feedback function empowers the users to locate problematic topics, unclear issues or user-unfriendly interfaces of the app.

The citizens are encouraged by a multi-layer incentive mechanism to collect urban data in their surroundings, rewarded by points, starting from information incentives, providing analyzed and evaluated information back to the user. The aim of the following types of incentivations is to examine the majority of the individual user interests and possible motivations. The mechanism covers the multiple layers of data (from PoI to AoI), where an app-internal dashboard serves (1) neighborhood-based (topic-related) evaluation, e.g. current safety of the sum of all bus stops in the quarter (Dresden - Johannstadt) and (2) PoI-related evaluation, e.g. safety at an individual bus stop ("Bönischplatz") in the quarter. Lastly, topics and location-based evaluation connected to semantic analysis, such as in the following scenario: the inhabitants of Johannstadt rated the area between the bus stop "Bönischplatz" (PoI A), specific bench on Bönischplatz (PoI B) and the local pharmacy at Bönischplatz (PoI C) as particularly bad; here the semantic link is the topic "security" and the specific place "Bönischplatz".

Another approach for incentives are monetary or material incentives, with the involvement of local businesses (aiming at a hyper-local community promoting local services, e.g. coffee at a local bakery). Furthermore, participation can be seen as a social incentive, where people define and solve problems together using social dynamics through comparing and sharing of information and ideas. Our aim is to define local interest groups formed around shared goals (e.g. repair of broken components on a playground). In later stages, more local interest groups could compete to promote individual interventions.

The last incentive approach points into a rather idealistic direction, calling for users willing to give and also observe data to improve the overall livability and quality of life of the neighborhood in long-term . Interested individuals can also be motivated by data insights regarding their own habits compared to the local community.

The app is also using gamification approaches to keep the players interested in both their individual and community goals, comparable to progress of other players (in other communities).

The D4C data analysis approach is based on an interconnection of qualitative (mostly subjective) data, such as impressions about cleanliness or safety and quantitative (mostly objective) data (McCrea R., Shyy T-K., Stimson R., 2006, pp. 80–87), such as filling levels or reachability (compare figure 1) and the classification of data into relevant urban categories (Hick D., Urban A., Noennig J.R., 2017, pp 113–116). The challenge is a valid comparison of both data types. Therefore, we quantify/measure qualitative data with the aim to convert a problem into a data-based (measurable) problem (e.g. “I usually cannot find parking spaces close to my home” into “I need [12,4 min] to find a parking space in [walking distance from my home]”, describing both time and location). Prospectively, we intend to develop a methodology to intersect different data categories in order to produce new data insights.

A second data analysis approach deals with the value determination of data (La Valle S., Lesser E., Shockley R., Hopkins M.S., Kruschwitz N., 2011, pp. 7–9). Users can help rank the relevance of a given data set explicitly by single choice value voting and its up or down ranking or implicitly by analysis tools observing the user interaction with the PoI (citizen defined PoIs). Another option is to define specific data value by the frequency of the usage for diverse use-cases or business models (market-driven PoIs).

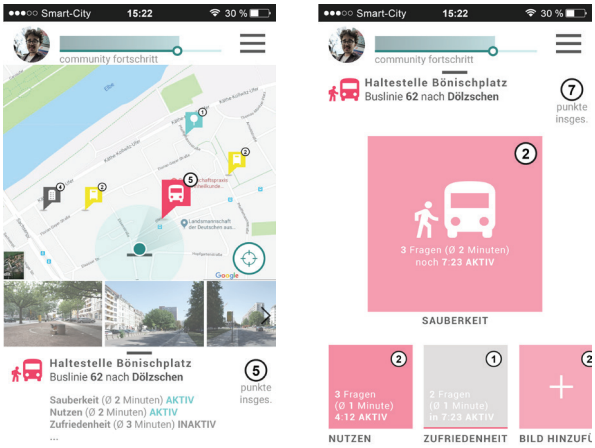

Figure 2: Citizen App Mock Up: Citizen App Mock Up's (german): map based PoI visualization (left), questionnaire list (right)

4 From Data to Use-Case

The purpose of the methodology is to understand/define, evaluate and act upon relevant urban topics originating from both the urban stakeholders and citizens themselves. Currently, we consider two kinds of urban applications/interventions as suitable; 1) optimization or generation of innovative urban services and 2) urban planning with the following examples:

1. **Urban service**: Through an aggregation of real-time subjective data from citizens about the individual levels of trash bins throughout the quarter, collected via Community App, city services may optimize the route of waste collection.

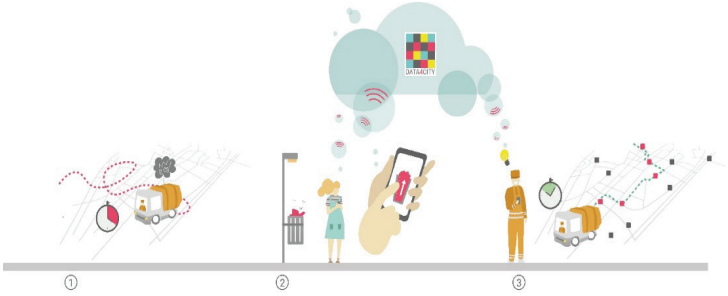

Figure 3: 1) Urban service: optimization of trash collection

2. **Urban planning**: Through a constant identification of relevant urban topics defined by citizens via Community-App a need for more green space at a specific location has been pinpointed. Following, the intervention can either be crowdsourced or defined by the communal planning office. Here, the app is the first step to a "data-based-urban-design-approach".

5 Outlook

The methodology, as defined within the thesis, offers the possibility to redefine urban boundaries into clusters of objectively observed activities, preferences and habits of citizens. The objectification of clustered and accumulated subjective data sets an image of previously only atmospheric perception of different city habitats. The redefinition of the boundaries (Cranshaw J., Schwartz R., J. Hong, and Sadeh. N., 2012, pp 3–4) allows for more targeted improvement of quality of life for specific quarters. Furthermore, the framework of the crowdsourced data collection enables dynamical data collection, where the actual needs of inhabitants can be determined and answered to. This also allows for dynamic data evaluation based upon market-typical behavior (demand and supply of relevant data). Data4City is currently developing a the PinCity-App and a sensor-kit which will prospectively be distributed throughout the community in Dresden-Johannstadt. Both products will be tested in our pilot phase by the end of 2018. Aim of the project is to set up a hyperlocal urban data platform scalable and applicable to every city worldwide.

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