EVALUATING URBAN DESIGN IDEAS FROM CITIZENS FROM CROWDSOURCING AND PARTICIPATORY DESIGN

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Abstract. Participatory planning aims at engaging multiple stakeholders including citizens in various stages of planning projects. Adopting participatory design approach in the early stage of planning project facilitates the ideation process of citizens. We have implemented a participatory design study during the 2017 Beijing Design Week and have conducted an interactive design project called “Design your perfect Dashilar: You Place it!” Participants including local residents and visitors were asked to redesign the Yangmeizhu street, a historical street located in Dashilar area by rearranging the buildings of residential, commercial, administration, and cultural functionalities. Apart from using digital design tools, questionnaires, interviews, and sensor network were applied to collect personal preferences data. Computational approaches were used to extract features from designs and personal preferences. In this paper, we illustrate the implementation of the participatory design and the possible applications by combining with crowdsourcing. Participatory design data and citizens profiles with personal preferences were analysed and their correlations were computed. By using crowdsourcing and participatory design, this study shows that the digitalization of participatory design with data science perspective can indicate the implicit requirements, needs and design ideas of citizens.

Keywords. Participatory design; Crowdsourcing; Human computation; Citizen Design Science; Human Computer Interaction.

1. Introduction

Urban planning needs to consider the judgment of the public in order to decide the choice of society (Davidoff and Reiner 1962). The concept of responsiveness

is rooted from the theory of pluralism applied in urban planning. Urban design and planning will be more responsive by incorporating the requirements, concerns and ideas from citizens (Klein et al. 2017). In recent years, citizen participation in urban planning has attracted an increasing attention from researchers and practitioners. Participatory planning uses various visualizations and methods to engage citizens in different stages of planning projects. Participatory workshops and meetings are considered as the most common ways to involve citizens in urban planning projects. It provides a social platform for people to discuss urban planning related issues. However, most of the methods are too time-consuming and it is still very difficult to increase the level of engagement. Therefore, there is plenty of room for improvement. Digital tools can potentially attract public who are not normally included in the conventional planning process, for example, people who don’t have time to attend planning workshops, children or elderly people. The common ways of applying digital tools include crowdsourcing, public participation geographic information system (PPGIS), mobile applications, games (Cristie and Berger 2017), and social media.

City authorities start to apply digital technology for e-governance. Zueri wie nue platform uses crowdsourcing to collect residents’ complaints about urban infrastructure; Neugasse urban renewal project in Zuerich develops an online website that collects people’s ideas about the redevelopment plan and people can propose their ideas with textual descriptions. The city of Paris launched a project called “Madam Mayor, I have an idea” and have collected citizens’ opinions and ideas of various social, planning problems, for example, how to use data to solve urban issues. The UN-Habitat Block-by-block uses the popular video game Minecraft to engage youngster in the early stage of public space redeveloping project across many developing countries (Heland et al. 2015). The Finish government has conducted a crowdsourced off-road traffic law experiment in 2013 by engaging people in identifying problems, proposing solutions and evaluating generated ideas of current traffic laws (Aitamurto and Landemore 2013). Meanwhile, researchers from multidisciplinary disciplines such as urban science, human computer interaction, and cognitive science have been studying topics ranging from designing the digital system to improve participatory planning process and understanding human perceptions in urban environments.

Adopting the concept of crowdsourcing and participatory design and further bringing to participatory planning, we have developed a strategy to invite citizens in actively expressing their urban design ideas (Mueller et al. 2017). The approach requires the implementations of the easy-to-use urban design environment, where 3D modules indicating buildings and urban elements are set up by experts. Stakeholders including citizens and non-professionals can arrange locations of building blocks on a map. Thus, urban design ideas can be proposed by designing urban layouts or describing ideas in texts. Serious game and gamification methods are proved to be efficient in many participatory planning applications and can be introduced to the design process as well. In this way, the obstacles of participation and time consumption are largely reduced. Similar ideas have been proposed in research projects including urban pinborad (Haeusler et al. 2017), urban API (Khan et al. 2014), and CommunityCrit. We have introduced additionally
the quantitative analysis by evaluating the design ideas from citizens including geometrical urban layouts and textual information. Therefore, the collected and evaluated design ideas from the citizens will provide substantial support for the decision-making of urban planning.

In this paper, we introduce a case study implemented in the design exhibition during the 2017 Beijing design week. The described strategy was carried out in an empirical setting for the first time and a digital tool was developed to fulfil the goal. We seek to answer following questions in this research:

- How to engage citizens in expressing their urban design ideas with digital tools?
- How to quantitatively interpret the urban design ideas from citizens?

The following sections illustrate the implementation of the design activities, methods and results of design ideas evaluations, and further indications and applications.

2. Methods

2.1. CONTEXT AND SETTING

The case study is implemented in an interactive design exhibition for Dashilar renewal project in Beijing. It is an open platform to engage multiple stakeholders including Beijing municipality, urban developers, planners, architects, private companies, and local residents on exploring new ways to transform the old city center Dashilar. The Dashilar project starts from 2011 and it holds annual design exhibitions during Beijing design week. In Beijing design week Dashilar design community, we have conducted a project called “Design your perfect Dashilar: you place it!”. The project aims at exploring computational and interactive methods to engage citizens to express their ideas and opinions of the future urban planning of Dashilar area. Data were collected during the 10-day design exhibition during Beijing Design Week from 25th September to 5th October 2017.

The essential part of the project is the application of the web-based, open-source software Qua-Kit, developed from the Chair of Information Architecture, ETH Zurich. It is a 3D geometrical editor which contains predefined urban design elements like buildings in 3D. The user can visualize their design ideas by moving and placing the elements. A set of 3D models were predefined and created by reconstructing buildings and other urban elements of a typical historical street (Hutong). Different types of 3D buildings were created with functions including residential, commercial, administration, and cultural functions. They were displayed in different colors on a map so that participants can design different scenarios. Figure 1 describes the design canvas with the predefined buildings.
2.2. DATA COLLECTION

As described in the context and setting, the design space is based on the Yangmeizhu street, the main street at the Beijing design week Dashilar area. Participants are either visitors of the exhibition or local residents of the Dashilar area. We have developed four approaches for data collection, including Qua-Kit based design, questionnaires, semi-structured interviews, and the Internet of Things (IoT) sensor network. The aim is to collect design behaviour, descriptive verbal behaviour, personal preference, and environmental measurements. In this paper, we mainly focus on subjective perspectives of participatory design activities, thus, the analysis of the physical environments is not the focus of this paper. To our knowledge, this paper is the first one conducted with the computational aspects of participatory design that combines heterogeneous crowdsourcing and participatory design dataset.

Qua-Kit based design uses the previously described 3D reconstruction of the Yangmeizhu street which contains buildings of various functions and volumes. We asked participants to make their designs in a sequential order, meaning the next participant can view the previous participant’s design and propose his/her design ideas by directly modifying the previous participant’s design. With the digital system, we are able to track and record user behaviors in the design process. We have collected users actions (including rotation and translation), time of design, the distance of movement, and designed geometrical urban layouts.

The questionnaire was designed to collect three aspects of information including user profiles, feedback of crowdsourcing participatory design digital system, and qualitative information of designs. For user profiles, we have asked the participants about their age, gender, occupation, whether they are local residents, whether they are from Beijing, if they are familiar with historical Hutong.
areas, and open questions regarding the preferred city, preferred street in Beijing with reasons, preferred historical street in Beijing with reasons, and disliked street in Beijing with reasons. For feedback on crowdsourcing participatory design system, questions were asked regarding the feedback of current system and wished functionality of such system with multiple choices and open questions.

During the semi-structured interviews, participants were asked about their motivations of participation in such design activities and feedback of current and future digital system. This dataset can compensate the questionnaire dataset since not all the exhibition visitors were willing to fill in the questionnaires which causes incomplete dataset. During the participatory design exhibition, there are in total 1373 people who visited the site, 120 people who finished the questionnaires, 99 people finished the qua-kit design.

2.3. DATA ANALYSIS

In addition to standard statistical analysis, we have developed methods to interpret design results from the participants. It is conducted from the previous work (Muller and Lu 2017) in crowdsourcing participatory design data analysis.

- Planning index computation
  (a). The number of constructed buildings. If combined with information with
height and volume, it can be used to compute floor plot ratio or floor area ratio.

(b). Setback distance: the distance of buildings set back from the center of main street

- Functional analysis

Since each building is attached to a different functionality, we have investigated two taxonomy of functionality. The first category is the land use indicating the purpose of the building usage. According to the local urban planning regulations in China, we have divided the land usage into six types including the commercial with merchandise, commercial with restaurants, commercial with hotels, residential, administration, and cultural functionalities. Another category is the main target users of the building including target users such as local residents, tourists, or shared users.

- Volume analysis

In the 3D model, buildings have different volumes. For example, residential apartments occupies much more space than small traditional courtyard or local restaurants. We have computed the distribution of small, medium and large volumes of buildings.

- Vicinity Analysis

For this type of analysis, we would like to compute the distribution of building in the vicinity of several important areas, for example, corner of the main street, monumental building in the street, and center of the main street.

- Feature extraction from combined dataset

From the questionnaire and interviews, we could extract user profile including local/non-local, from Beijing/not from Beijing, gender, design related occupation/non-design related occupation. Besides, preferences of several urban design features can be also extracted including preference towards the broad street, preference towards the commercial street, preference toward city size and so on. Correlation of the pairwise features will be computed using Pearson Correlations.

3. RESULTS AND DISCUSSION

Among the 99 persons who finished the qua-kit design, 72 people also completed the questionnaires and interviews. Within the 72 people, there are only 24 people whose design preferences are clearly identified from survey and interviews.
In our design scenario in Qua-Kit, there are 125 buildings in totals, of which 73 are located in the Yangmeizhu street available for users to design. Figure 3 indicates the functional distribution by utility & target user group and volume distribution of the design space with regards to the whole design space, street center and street corner. By comparison, participants tend to place the building of smaller volume in the street corner and medium volume buildings in the center.

In general, 2603 user actions are detected including rotation and translation. On average, 23.4 actions are conducted per user, with the maximum of 174 actions and median of 8 actions. On average, user spent 222.9 seconds per design, with the maximum of 1136.0 seconds and median of 105.0 seconds.

From the combined dataset, we have extracted 12 features, of which 7 features indicate the citizen profiles and the 5 features are computed from design layout and participatory data. The seven features of citizens profiles include (a). whether from Beijing (b). gender (c). occupation: whether design related job (d). whether familiar with Hutong (historical area) (e). preference towards broad street (f). preference towards commercial area (g). preference towards large city. The other five design and participation related data include (a). setback distance (b). time spent on design (c). number of design actions (d). number of moved objects (e). distance of objects’ movements.

The distribution of the 12 distinctive features are illustrated in Figure 4 while the correlation of the features are displayed in Figure 5. It indicates the relationship
between user profiles and design features. The number of time user spent on design, the number of design actions, the number of the moved object, and distance of objects’ movement are positively correlated. Setback distance is positively correlated with the preference towards the large city and negatively correlated with the familiarity of Hutong, meaning participants who prefer large city and who are not familiar with Hutong tend to place the buildings further on both sides of the main street.

From interviews and survey, we made following conclusion from our participants of such digital crowdsourcing participatory design system.

- People prefer to combine textual description with design ideas (55.8%)
- People prefer using lego-like modules to make their design (49.4%)
- Most people think the 3D model implemented in Qua-Kit is understandable though a bit abstract (71.3%)
- People prefer to get social impact of the their design ideas (68.9%), spatial features (53.3%), comparison with other participants (17.8%), and rating from the professionals (13.3%)

There are still many limitations in our research, for example, noises from the gathered dataset due to participants’ motivation and data quality. In addition, the results from the analysis only represent the ideas of the participants in our studies instead of all the residence at Dashilar. We are aware that other participatory
or crowdsourcing projects face the similar problem as well. Our case study provides us with the possibility to implement our theoretical approach combining crowdsourcing with participatory design, which has a broad application in various domains. It would be much more time and energy consuming if we use the standard method of participatory planning. The proposed the digitized process can be conducted completely online, therefore larger amount of data can be collected and analyzed.

4. Conclusions
We carried out an empirical study in combining crowdsourcing and participatory design and analyzed the results from the participants with data science perspective. The work also applied data sources and used the developed digital tools for 3D participatory design, survey and questionnaires, and sensor network. Features are extracted from the dataset including users profiles and design attributes. We have computed the correlations of the most distinctive features and plotted their distributions in order to quantitatively analyzed the urban design ideas from the participants. From interviews and surveys, we summarize the requirement and feedback from participants for the digital system of such crowdsourcing and participatory design. Taking into account the feedback, further work can be done to improve the system. The developed strategy can be applied in other
studies for large-scale crowdsourcing in participatory urban planning or other ideas collection.

Acknowledgement
This work is partially supported by Scientific & Technological Cooperation Program Switzerland-Russia (STCPSR), project IZLRZ1_164056. We would like to thank our collaborators from Human Data Lab at TalkingData in Beijing. Moreover, we wish to thank Artem Chirkin and the team at chair of information architecture, ETH Zurich who has developed the Quick Urban Analysis Kit.

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