6. Methodology and application of data augmented design: a case study of urban redevelopment design for the Panyu-Xinhua Area, Shanghai

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1. INTRODUCTION

The tension between science and design has been a long-debated issue in the field of urban planning and design. How should design, a traditionally bottom-up approach of feature-capturing based on fieldwork, site visits and surveys, be integrated with science, a deductive approach to understanding the city through universal laws from above (Townsend 2015)? In response, the introduction of systems science for urban studies raises the issue of science for design/planning, which concentrates on how to make cities and urban forms function and perform better through modelling. As for the perspective of urban planning and design, its focus has become science in design/planning, or how urban planning is done through systemic and scientific processes with goals such as sustainability, resilience and competitiveness (Batty 2013; Yang and Yamagata 2019).

In an age defined by digital technology, the growing abundance of, and easy access to, massive urban data sets allows new urban science to validate theoretical suppositions about cities at an ever-increasing rate and level of detail (Townsend 2015). Yet from science for design/planning to science in design/planning, in the field of urban planning and design, will the concerns and interests of citizens be better understood and satisfied through the guidance of new urban science (Mueller et al. 2018)? Is there any methodology that can appropriately respond to the new data environment?

Over the past few decades, computer-aided design (CAD), decision support systems (DSS), geographical information systems (GIS) and planning support systems (PSS) have been developed to respond to the new era, enabled by new technologies and data (Long et al. 2011). However, PSS are facing challenges and bottlenecks with the boom of big data and open data, such as the difficulties in comprehending the systems, their limited functions and applications, and the lack of motivation by planners (Liu et al. 2014). To meet the rapid development of artificial intelligence, machine learning, then the Internet of things (IoT) and many other digital and information technologies, more powerful theories and methods are needed to better interpret our cities (Batty 2013).

Quantitative urban studies focusing on the measurement of urban form, quality, vitality and evaluation of urban design have been launched to re-examine cities at a much more refined level (Song 2016). For example, Bao et al. (2017) planned bicycle lanes on the basis of bicycle-sharing trajectories, and Andrienko et al. (2017) proposed that existing intelligent transportation systems can be further improved by the science of visual analytics

in the future.[1] However, the majority of existing research studies are only an evaluation of the status quo or problem recognition within the urban system, and the proportion of research that is future-orientated is relatively small.

In response, Long and Shen (2015) propose a new planning and design methodology termed data augmented design (DAD) to highlight the application of data in the planning and decision-making process and improve the science of planning and design. Empowered by quantitative urban studies, the application of empirical data analysis in DAD not only improves the scientific level of urban planning and design, but also sparks the inspiration and creativity of planners and designers. Data augmented design is not software or a platform; it presents a methodology to comprehend the physical and social environment, which can be utilized to indicate the future environment and urban life in our cities.

Moreover, the aim of DAD is to fill the gap between the support systems used to understand the existing physical and social environment and the methods and tools applied for future-orientated programming, planning and design. As a new support system for the whole planning and design process, compared with preceding supporting platforms, the advantages of DAD lie in its simple and direct approach, full use of new data as well as traditional data, emphasis on urban planning/design and its evaluation, ease of use and respect to a site's uniqueness. Consequently, instead of rebelling against orthodox urban planning/design, DAD is dedicated to easing the burden of designers, emphasizing the inspirations that quantitative analysis would bring while enhancing the predictability and evaluability of urban designs (Long and Shen 2015).

Therefore, the application of DAD ranges from field investigation, existing condition analysis and spatial parameter extraction to scheme design and future prediction, and has been gaining recognition in programs of both urban redevelopment design and 'new district' construction (Cao and Long 2017; Long and Shen 2015; Zheng 2016; Zhou and Long 2016). In addition, positive feedback is received continuously from the educational sector, from institutions like Tsinghua University (Long 2017).

Taking the urban redevelopment design theme associated with the Shanghai International Film Festival in the Panyu-Xinhua Area of Shanghai, as an example, this chapter illustrates the feasibility of applying DAD in historical built-up areas, where approaches such as abstract spatial models, data mining and visualization, and the processing of natural languages, are applied. Is large-scale spatial intervention needed and, if so, in which ways can it be achieved? How can communities be created that are suitable for different types of people? How can public space be designed which can promote the integration of different groups of people? As indicated at the beginning of this chapter, all the questions above are design questions and this chapter

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1. Visual analytics approaches have arisen in response to both the complex data and problems which characterize the transportation domain. Generally, great contributions have been made for urban planners and designers to understand data (for example, the space–time cube visualization method), traffic (for example, the microscopic view offered by TripVista and FromDaDy, and overall traffic behaviours over space offered by density maps and three-dimensional presentations) and users of transportation means and services (for example, the classification of georeferenced tweets concerning people's activities and movements) by visual analytics approaches, as well as their application in modelling and planning.

is organized as follows: Section 2 reviews the diverse approaches of DAD in urban redevelopment programmes. Section 3 discusses the application of DAD approaches applied in the Panyu-Xinhua Area of Shanghai in detail. Section 4 demonstrates the evaluation of these approaches and the chapter concludes with a further discussion in section 5.

2. METHODS AND TOOLS OF DATA AUGMENTED DESIGN

Data augmented design provides each phase of an urban design and planning process with support and enhancement, as a new quantitative planning and design methodology (Long and Shen 2015). Developed on Esri's ArcGIS platform, data were collected, cleaned, formatted and analysed to improve the accuracy and creativity of the design process in the new data environment.

There are five steps in a typical DAD process (Long and Shen 2015), shown in Figure 6.1: data analysis of key urban design elements; site evaluation and stimulation of the urban design scheme; output of planning and design results; final results, reports and determinations; and public engagement and city management. These steps overcome two main difficulties in traditional planning and design processes: first, they can integrate data and information from different sources and scales at the same scale for better analysis and application; secondly, the models are used to extract the most appropriate urban design elements and scheme, improving the science in this process by controlling the influence of personal preferences and judgements of planners and decision-makers (Long and Shen 2015). In this chapter, we focus on the first three steps (data analysis, site evaluation and stimulation, and planning and design output) and try to figure out the appropriate methods and tools of DAD and verify their validity.

2.1 DAD Users

The potential users of DAD are urban planners and designers, urban planning and management officers, and citizens. As the direct users of DAD, urban planners and designers might conduct urban studies including land use, transportation, space vitality and so on, as well as working on design proposals based on the results and then present the proposals to officers and citizens in a clear and accurate manner. The officers who are in charge of urban planning and management enjoy the convenience of monitoring and managing urban development and a smoother communication with planners, which

Source: Adapted by the authors from Long and Shen (2015).

Figure 6.1 Steps in a typical DAD application

makes them another user and beneficiary of DAD (Long and Cao 2018; Long and Li 2017). For the citizens caring about their future habitats, DAD provides a platform for them to witness and participate in the urban development process. Thanks to increasingly affordable devices, citizens themselves are also acting as real-time sensors of daily life (Ratti and Townsend 2011), which could widen the data sources for DAD and improve its accuracy.

Data augmented design will also intensify the communication and interaction among key players in city life, such as officers, planners, developers, citizens and tourists. The open-source platform of DAD makes data analysis, data visualization and urban design much more transparent. Developers are able to co-work with planners to estimate the development potential, calculate the development intensity and choose the building styles, during which, officers and citizens can keep an eye on different phases of this process. Also, public participation and community engagement will become more viable and time-saving owing to the new data platform.

2.2 Step 1: Existing Condition Analysis (Data Analysis of Key Urban Design Elements)

Identifying the key factors (KFs) of existing conditions and figuring out their control indicators is of great importance in urban redevelopment projects, which could/should be finished more quickly, more accurately and more conveniently with the help of DAD. Typical control indicators in urban redevelopment design include:

- Urban fabric (F) – this indicator refers to the usage of land, which may be a building or an open space like a road or a park; the value of F could be 1 for buildings and 0 for open spaces.
- Land-use type (T) – this indicates the land-use condition of different buildings, communities or areas; the value of T could be residential (R), commercial (C), education (E), and so on.
- Building height (H) – this indicator measures the height of existing buildings; the value of H ranges from 0 to 1,000 (metres).
- Building quality (Q) – this indicator indicates the quality of existing buildings in a research area; the value of Q is measured by a category value (1 for entirely poor and 7 for entirely good).
- Urban activity intensity (I) – this indicator measures the spatial vitality of a particular area, which can be reflected by activities in social media; the value of I ranges from 0 to the maximum value of the variable.

Also, as a control indicator of existing condition analysis, transportation stations (S) which reflect on-site transportation conditions, are often collected and analysed in the DAD process.

In DAD, these indicators are analysed and visualized based on data from different sources, such as social media, mobile phone signals, OpenStreetMap, and so on. Each control indicator provides urban planners and designers with information concerning a specific section of the site. Different kinds of data are introduced in section 3 of this chapter.

Table 6.1 Examples of control indicators and control alternatives

Control Indicators	F	T	I	S
Description	Urban fabric	Land-use type	Urban activity intensity	Transportation station
Exemplified control alternatives	Building (1) Open space (0)	Residential () Commercial (c) Education (E)	Range from low to high	Metro station (M) Bus station (B) Railway station (W)
Data category	Geo-information Map data	Map data	Geo-tagged Social media Data mobile Phone signal	Map data Traffic trajectories

2.3 Step 2: Spatial Parameter Extraction (Site Evaluation and Stimulation of the Urban Design Scheme)

A prominent task in urban case studies is how to quantify the urban information. As a quantitative planning and design methodology, DAD makes it possible for planners to analyse essential urban information at a more accurate and systematic level. Urban data archives can be generated and used as a gene pool for urban redevelopment design. Similarly, with existing condition analysis, KFs and the control indicators are extracted. Taking the control indicators of urban fabric (F), land-use type (T), urban activity intensity (I), and transportation stations (S) as an example – notably, DAD terms control alternatives (f, t, i, s) as the optional value(s) of control indicators, which can be found in Table 6.1 – the relationship between control alternatives and indicators is shown as follows:

$$V_F = \{f_1, f_2 \ldots f_m\} \tag{6.1}$$

$$V_T = \{t_1, t_2 \ldots t_n\} \tag{6.2}$$

$$V_I = \{i_1, i_2 \ldots i_p\} \tag{6.3}$$

$$V_s = \{s_1, s_2 \ldots s_q\} \tag{6.4}$$

where V_F, V_t, V_i, V_F are the control alternative set, and m, n, p, and q are the specific number of control alternatives for each control indicator, whose values vary according to site conditions.

Each spatial unit (U), which is a building, a community or an area, can be regarded as a four-dimensional coordinate defined by control indicators as U_k (f_k, t_k, I_k, s_k). A city in the urban data archive is a data set of research units according to their geo-information. The data set could be generated and visualized in ArcGIS to make a series of diagrams.

A street quality evaluation system is also applied in DAD, based on the theory and methodology of street-view image assessment (Li et al. 2016; Tang et al. 2016). With the help of Google, an assessment system was established to evaluate the street-view image in aspects like space accessibility, public space, green space, and so on. A set of control

Indicators (SQ_{ab}) is defined, where 'a' is the label of each evaluation factor and 'b' is the label of each city. The value of SQ_{ab} is supposed to be 1 (for satisfied) and 0 (for unsatisfied); that is, $SQ_{ab} = \{0,1\}$.

In the evaluation process, trained evaluators (urban planners and planning students) look through a series of street-view images and submit their evaluation (0 or 1) for each image according to the criteria. As the development of image identification and generative adversary networks (GAN) progresses, computers are likely to take over this process soon.

2.4 Step 3: From Analysis to Urban Design (Output of Planning and Design Results)

As mentioned before, DAD is not only a study tool kit for urban spaces and the built environment, it is also a methodology guiding urban design. With the help of the existing condition analysis and spatial parameter extraction, planners can conduct the urban design process in four steps by:

- attaining an overall perspective towards the design area based on studies on a master plan and relative regulations;
- identifying the key problems of the design area, then figuring out the main tasks in following urban design according to the existing condition analysis and spatial parameter extraction;
- determining design guidelines and zoning regulations for the area after defining the dominant developing direction; and
- tailoring a dynamic urban design proposal for the area with the possibility for future upgrades.

The urban design process of the case study will follow these steps, which shows a typical usage scenario of the DAD methodology.

3. APPLICATION OF DAD APPROACHES: URBAN REDEVELOPMENT DESIGN FOR THE PANYU-XINHUA AREA, SHANGHAI

3.1 The Panyu-Xinhua Area

The Panyu-Xinhua Area is located in Changning, Shanghai, where there are plenty of well-preserved historical buildings and attractive public spaces. This area has a strong sense of local culture and urgent issues are faced in the urban redevelopment process, making it representative for testing out the existing condition analysis and spatial parameter extraction approaches of DAD.

Basic situation and problems

After a preparatory study of the Panyu-Xinhua Area, a basic image was developed of its strengths and weaknesses. Well-preserved historical and cultural buildings such as the Shanghai Film Center (the host venue for Shanghai International Film Festival, SIFF) and the L.E. Hudec Museum (former residence of the famous Hungarian architect) are

easy to find on this site, but their surroundings comprise chaotic parking and unsustainable development. Several public spaces and green areas were constructed and used in past decades; however, a great number of them have been the subject of poor conservation and are isolated from each other. Also, as the host venue of SIFF, the Shanghai Film Center and its surrounding environment fail to meet the standards of modern spatial quality required by film festivals throughout the twentieth century.

Master Plan of City of Shanghai and Related Regulations
As a historical area located in the heart of Municipal Shanghai, the Panyu-Xinhua Area is under the control of the Shanghai master plan released by the Shanghai Municipal Bureau of Planning and Land Resources Administration (2016a, 2016b) and several other related regulations released by governmental agencies such as the Shanghai Municipal Transportation Commission (Shanghai Municipal Bureau of Planning and Land Resources Administration, Shanghai Municipal Transportation Commission 2016). Calling for a more human-orientated and culture-motivated Panyu-Xinhua Area, three key elements were extracted to guide the following research and design process: (1) give a positive response to the rapid development of information and communication technologies (ICTs) and data technology; (2) improve the spatial quality of historical buildings and primary public spaces; and (3) set up a smart service system adding more convenience to the daily life of residents.

To respond the requirements of the master plan and relevant regulations, and to deal with the pressing issues facing the Panyu-Xinhua Area, the DAD methodology needs to work with traditional tool kits used by planners to analyse in an accurate and technology-based way and to design on a human-centred basis.

3.2 Methodology in Practice

Working on the research and redevelopment project in Shanghai gave an excellent chance to test out the DAD methodology in the real world. Thanks to the rapid development of ICTs in China and the positive data environment, this project was able to be conducted smoothly.

Data sources
Multiple sources of data are used in the DAD application, including big data, open data and traditional data (Long and Shen 2015). In this case, data were collected, analysed and visualized in this research; for instance, taxi trajectories from Didi, bicycle trajectories from Mobike, geo-tagged data from Flick and Weibo and land-use records from OpenStreetMap were all used. In addition to data from these Internet service providers, information was collected in traditional ways from the Community Office. The type, source and what kind of analysis they were used for are listed in Table 6.2.

Existing condition analysis of the Panyu-Xinhua Area
Spatial usage and vitality (urban fabric, land use and activity intensity) Since most of the buildings in our design area are well preserved and of good quality, and building height is not a key factor, we chose urban fabric (F), land-use type (T) and activity intensity (I) as the three key factors. Studies of these factors and their control indicators helped us gain

Table 6.2 Data sources

Control indicators	Data	Source
Urban fabric	Urban fabric	Openstreetmap
Land-use type	Land use	Openstreetmap
Commercial index	Land use	Openstreetmap
Residential index	Land use	Openstreetmap
Aging index	Population of age groups	Community office
Urban activity intensity	Weibo POI	Weibo
	Flickr POI	Flickr
Transportation station	Rail station	Openstreetmap
	Metro station	Openstreetmap
	Bus station	Openstreetmap
Traffic condition	Taxi trajectories	Didi
	Bike trajectories	Mobike
Street view image asssessment	Street view image	Google/Baidu

a comprehensive understanding of the Panyu-Xinhua Area. Data from OpenStreetMap (an online platform for spatial data-sharing) were imported into ArcGIS to visualize the situation of the urban fabric, land use, living and commercial parameters (based on the land-use information). Accordingly, the Panyu-Xinhua Area has a typical urban fabric in Shanghai as a historic community which is under the redevelopment, motivated by capital and governmental decisions.

The land-use diagram (Figure 6.2) shows that this site is highly mixed use, including education, culture, residential, commercial and green space. A later study of the living and commercial parameters shows the land-use tendency of each block and suggests the potential for redevelopment. The prevalence of residential land use in almost every block required a human-centric design focused not only on upgrading significant spaces but also the daily life of residents, while the unbalanced business development along Panyu Road, the main street, looked forward to a systematically data-based plan (Figure 6.3).

Data from social media can be used to indicate the pattern of human activities in a defined space. In this case, we utilized the data from Weibo and Flickr to study the pattern of activities of domestic residents and tourists as well as foreign visitors. As can be seen in the Weibo and Flickr diagram (Figure 6.4) which indicates the urban activity intensity in our site, the vitality of space varies acutely between different blocks. Compared with the rest, the following parts are much more active: the west and north edge, which is the Yan'an Road Viaduct (Weibo); the south-east corner surrounding metro station (Flickr); the inner core – L.E. Hudec Museum (Weibo and Flickr); and the internal core space – Shanghai Film Center (Weibo and Flickr). As discussed, several public spaces have been planned, designed and constructed in the Panyu-Xinhua Area. However, they are fully utilized by residents and visitors according to the data from Weibo and Flickr. It was an urgent task to think about how to take advantage of these potential spaces in a smarter manner.

Traffic trajectories (vehicles and bicycles) In the traditional transportation research process, traffic is always recorded by counting the number of vehicles or bicycles at one point

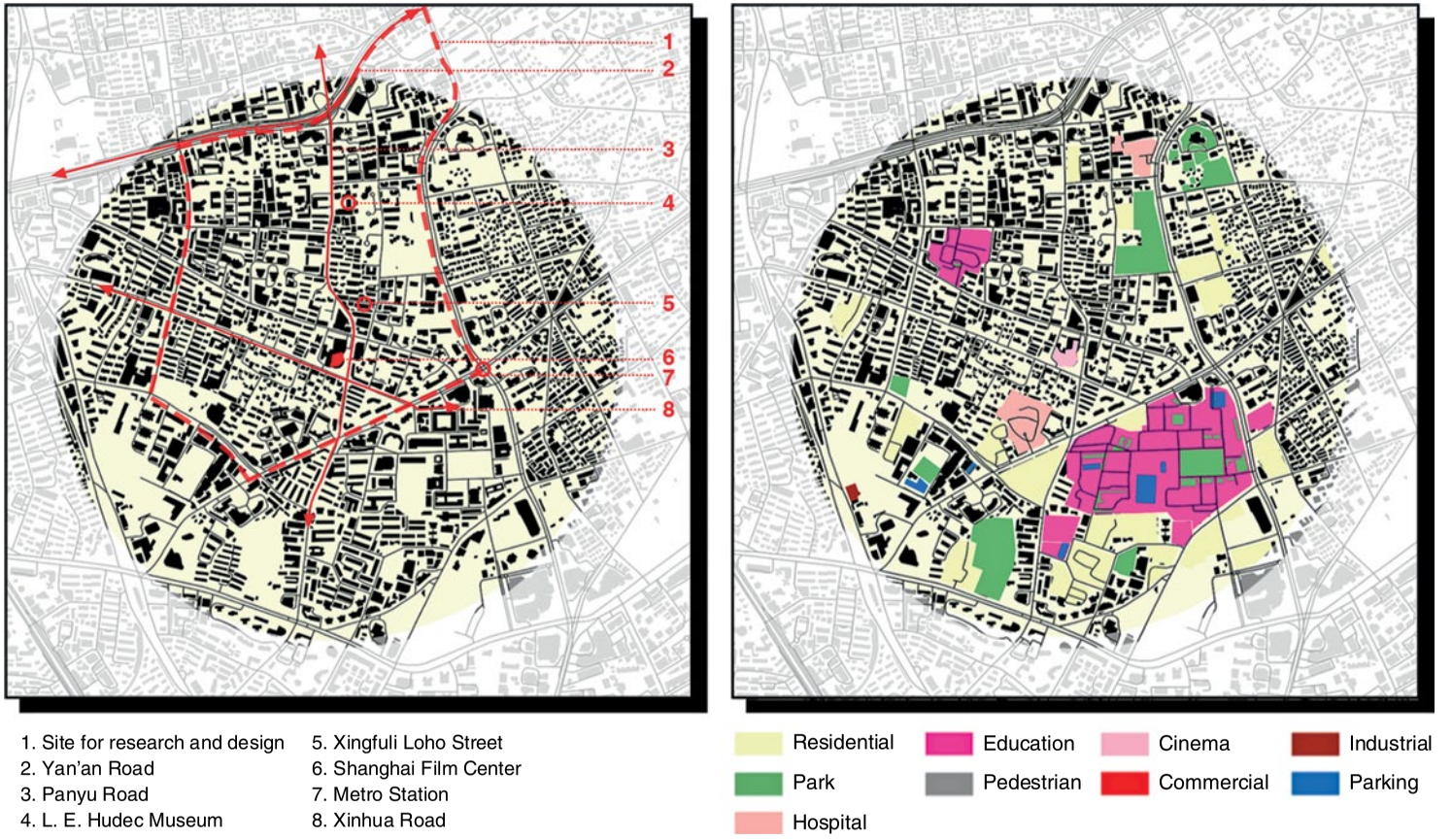

Figure 6.2 Diagrams of urban fabric (left) and land use (right)

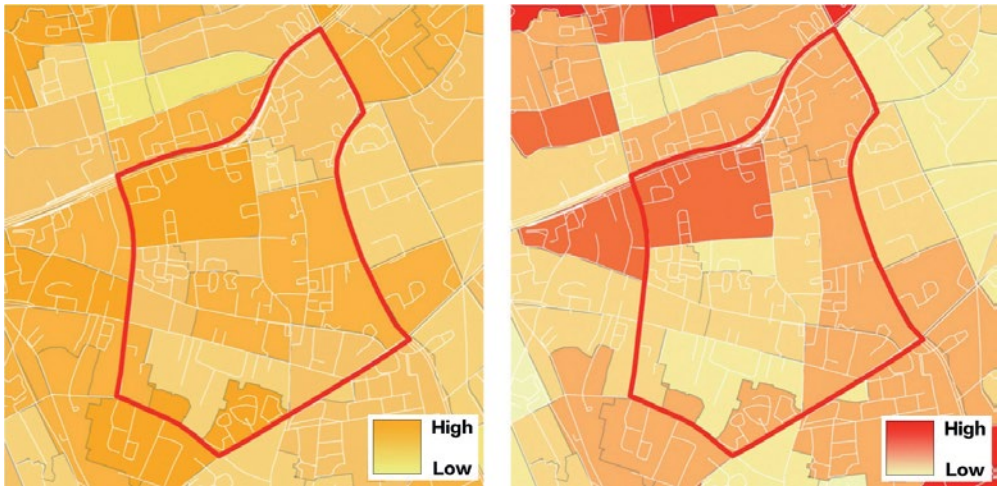

Figure 6.3 Diagrams of residential (left) and commercial (right) land use

at one time, which is insufficient for designs. However, vehicle-mounted global positioning systems (GPS), car sharing platforms such as Uber and Lift, taxi platforms such as Didi and bicycle-sharing platforms such as Mobike, OFO and Bluebike, contribute together to form a positive data volume which could be read and analysed on DAD platforms, where planners capture the flow of vehicles and bicycles to compare different means of transportation and comprehend the mechanism behind this phenomenon.

It is well known that Didi and Mobike are popular in Chinese cities, especially in Shanghai, and both are used as characterizations of taxi and bicycle usage respectively. With the help of these two leading companies, taxi trajectories and Mobike trajectories were collected and analysed in GIS to work out the traffic intensity in different blocks. As can be found in the taxi trajectories diagram (Figure 6.5), on either weekdays or weekends, the taxi usage intensity differs across Panyu Road, the main street in the site. This situation is similar to the Mobike usage intensity, as shown by the Mobike trajectories diagram (Figure 6.6). The Mobike, however, show significant differences between weekdays and weekends, which could imply different user types, such as residents on weekdays and visitors on weekends. Comparing these two diagrams, there also exist several places enjoying high-usage intensity both on weekdays at weekends, for example, the metro station, the Shanghai Film Center, Xinfuli Loho Street and the L.E. Hudec Museum, which could also influence the results of geo-tagged social media data analysis.

Word cloud Apart from verifying spatial vitality, data from social media and search engines can also be used to understand public concern about a particular area. By calculating the search frequency of Google or Baidu, or using the key world semantic analysis of Twitter or Weibo, researchers could easily focus on the main character or the theme of the site. During the process of site analysis, the creation of a word cloud can help researchers and planners better understand the site in a fast and humanistic way, since the data are bottom-up and collected from each space participant (Figure 6.7).

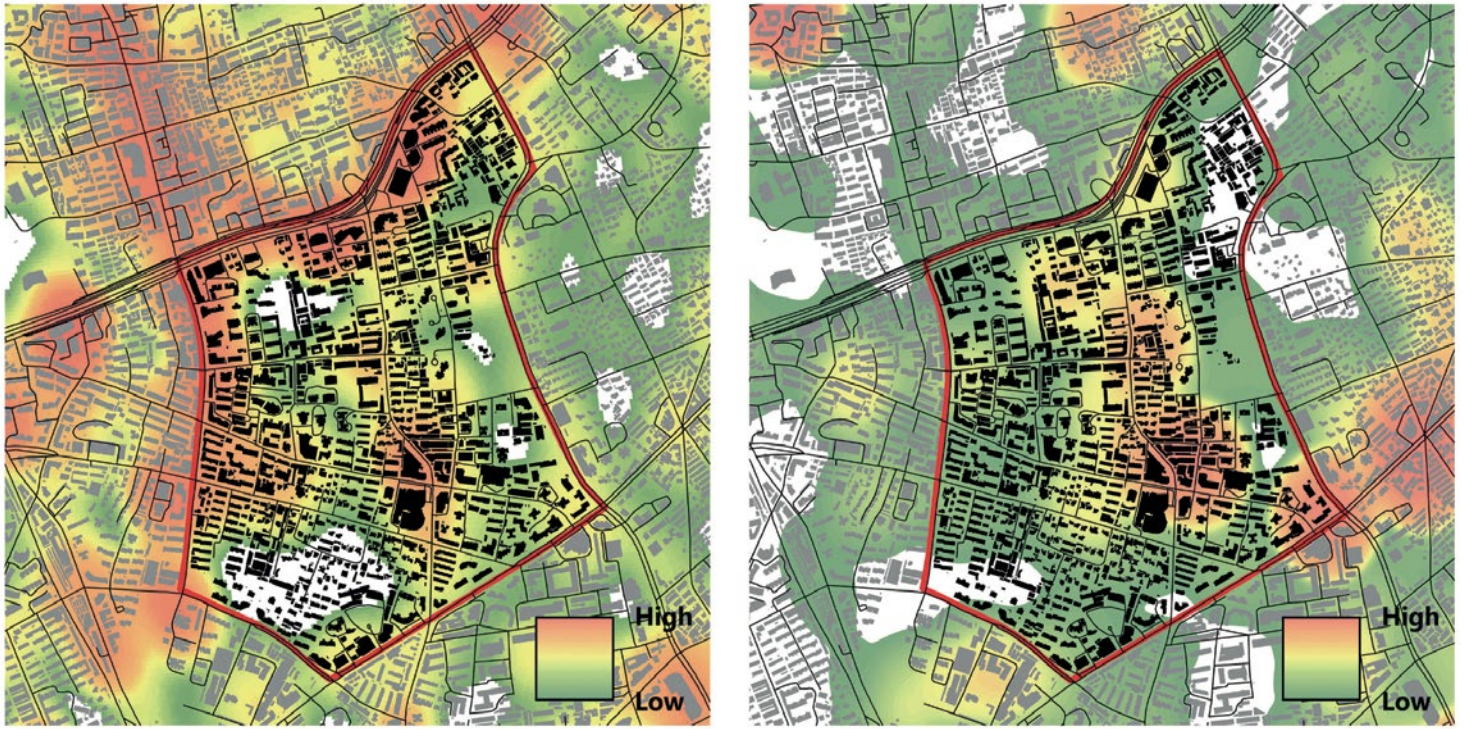

Figure 6.4 Diagrams of geo-tagged data analysis of Weibo (left) and Flickr (right)

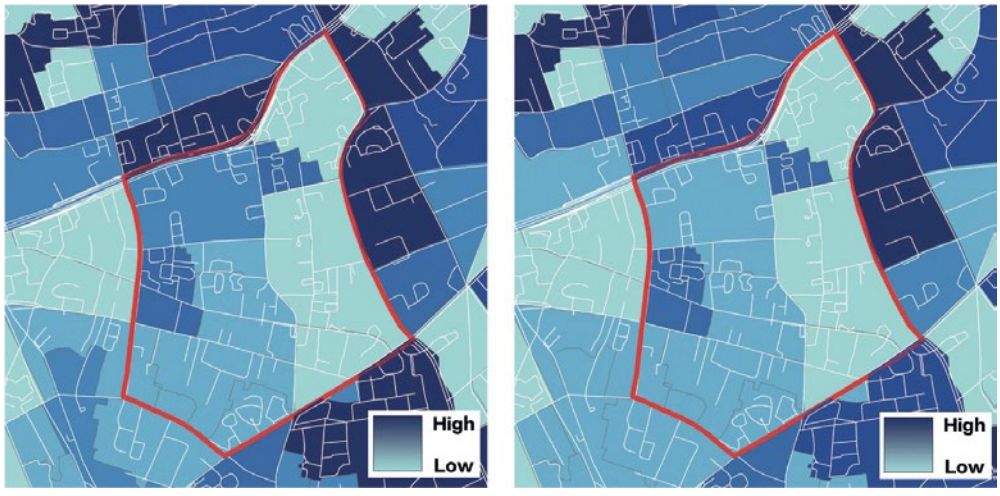

Figure 6.5 Taxi trajectories on weekdays (left) and weekends (right)

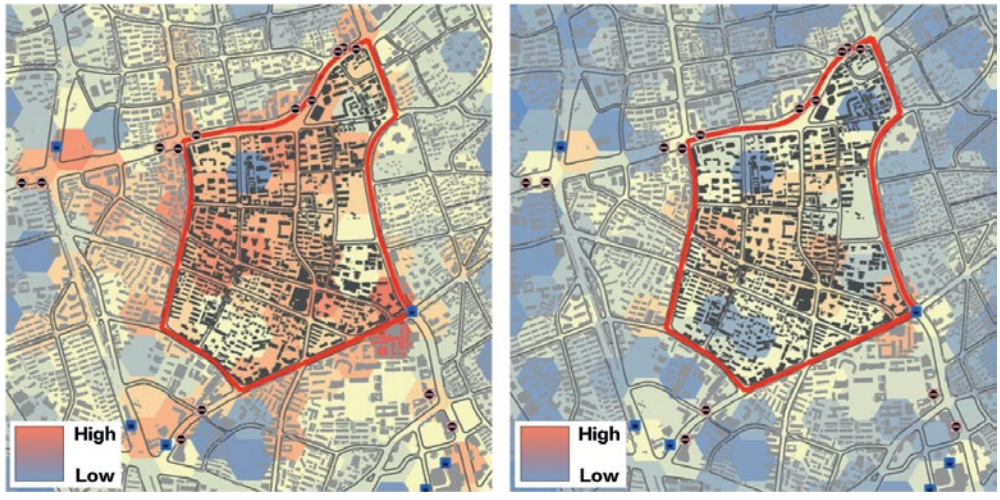

Figure 6.6 Mobike trajectories on weekdays (left) and weekends (right)

Based on the search frequency data mined from Baidu, the top search engine in China, a series of keywords are extracted from searching results, which could indicate what people are concerned most about in the Panyu-Xinhua Area. The top five keywords are listed in Table 6.3.

As shown in Table 6.3, cultural events such as the film festival and historic spots such as the L.E. Hudec Museum were searched at a high frequency, suggesting that the planners and designers should take upgrades of these places into consideration. Keywords such as 'delicious food' and several others unlisted also suggested the site is a combination of culture, history and daily life.

Figure 6.7 Word cloud

Table 6.3 Top five key words in the word cloud

电影节	番禺路	美食	邬达克	新华路
Film festival	Panyu Road	Delicious food	L.E. Hudec	Xinhua Road

Spatial parameter extraction and comparison study

Urban data archive (urban gene pool) After an overall study of the existing situation of the Panyu-Xinhua Area, comparative research was conducted with the data from OpenStreetMap and street-view images from Google following the methodology introduced in section 2. An urban gene pool was built up by analysing and visualizing the data, including four aspects (urban fabric, land-use type, transportation stations and urban activity intensity) of essential information about the host venues for top-level film

festivals around the world, for example, Cannes, Berlin and Moscow.[2] Next, a circular research range was set in each city, which was centred at the host venue with a diameter of 1 kilometre. As indicated in Figure 6.8, these communities where venues are located enjoy significant differences in their natural and social environment, block size, transportation accessibility, and so on. Despite the differences, this study revealed a common problem that almost all these neighbouring areas of film festival venues are facing, which is the limitation of the spatial influence by the events. We can observe from the diagrams (Figure 6.8; for each site, urban fabric, land-use type, transportation stations and urban activity intensity are presented from top to bottom) that the activities are concentrated within limited areas around the venues. However, given their location advantage, these neighbouring areas enjoy the privilege of future development motivated by the film festivals and related industry. This is one of the key points that has to be taken into consideration in the subsequent planning and design process.

Street quality evaluation A series of street-view image assessments was undertaken by planners and well-trained professional students (Figure 6.9). The whole assessment system consists of a list of evaluation parameters, which have been widely recognized in the measurement of space quality, such as the walking environment, the building environment and open spaces (detailed in Figure 6.9) (Li et al. 2016; Tang et al. 2016). Each parameter is measured on a scale from 0 to 1, then the average value is calculated and presented in Figure 6.9, with the highest value in each parameter coloured orange. As suggested by the results, the Panyu-Xinhua Area in Shanghai takes the lead in building environment, community environment and street sanitation, while the walking environment is not good enough and needs more effort to improve the quality of public spaces and the street landscape compared with widely acclaimed host venues, such as Cannes.

3.3 Main Tasks of Redevelopment Design of Panyu-Xinhua Area

After understanding the basic situation and preliminary problems, the master plan and relevant regulations, and the existing conditions and the urban archive, three critical issues had been extracted and summarized to guide the subsequent planning and urban design procedures:

- improve the unsatisfactory space quality in and around the Shanghai Film Center and its lack of urban vitality;
- systematize the disorganized and underused public and green spaces in the Panyu-Xinhua Area so that residents (especially for the elderly) and tourists can make better use of them; and

[2] As the main host venue for SIFF, the Panyu-Xinhua Area is particularly characterized by film culture and cinephilia. Therefore, the host city and venues for the top ten film festivals worldwide are chosen as the urban gene pool for the Panyu-Xinhua Area for comparison and reference: Berlin, Germany; Cannes, France; Karlovy Vary, Czech Republic; Venice, Italy; San Sebastian, Spain; Moscow, Russia; Montreal, Canada; Warsaw, Poland; Tokyo, Japan; Locarno, Switzerland; and Tallinn, Estonia.

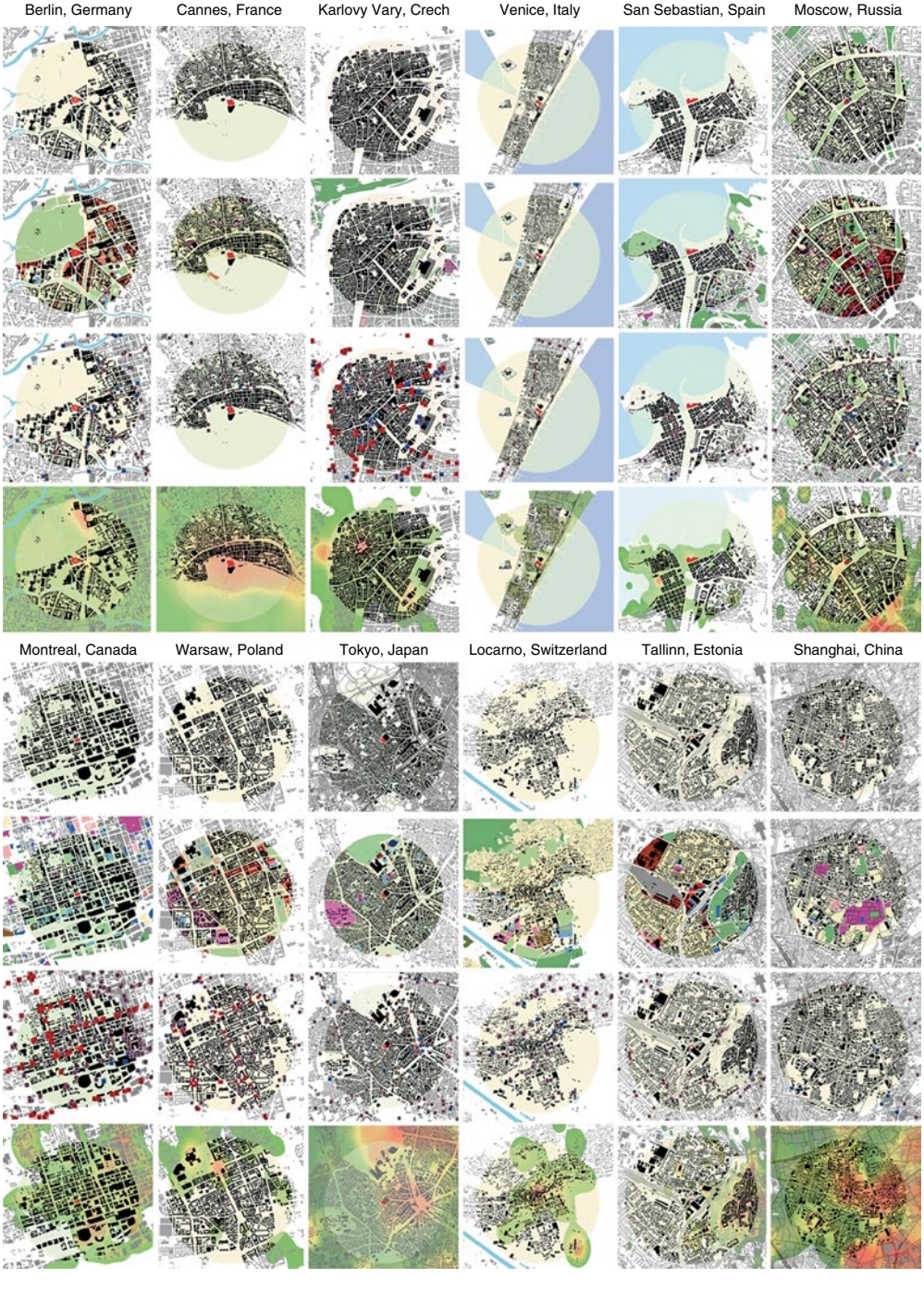

Figure 6.8 Urban data archive of the host venue for top-level film festivals

Figure 6.9 Google Street View image assessment of host venue for top-level film festivals

- connect the daily life of residents and experience of visitors to the new development of ICTs and data technologies.

3.4 Urban Redevelopment Design for the Panyu-Xinhua Area

Systematic and human-centric design strategies were adopted to deal with the difficult and complicated issues facing this site. After thorough research and analysis, a series of design strategies were applied as follows (Figure 6.10):

- Linear spaces themed with the Shanghai International Film Festival were connected by the Panyu Interactive Film Street (Figure 6.11) with human-scale streets and interactive amenities. To spread the vitality of film events, film-related spaces were designed alongside the Panyu Road, such as the SIFF Exhibition Platform and the Film Communication Center. The Shanghai Film Center, Xingfuli Loho Street, L.E. Hudec Museum, Film Communication Center, Shouxin Plaza Complex were connected to the newly programmed SIFF Exhibition Platform and Interactive Energy Center by a 5-metre wide walkable and bicycle-friendly path. The surrounding environment of the Shanghai Film Center and L.E. Hudec Museum were also improved to satisfy the requirements of the redevelopment.
- The Xinhua Public Space System (Figure 6.12), a loop of open spaces, greens, parks and squares, was organized based on the results of the activity intensity study and site analysis. While the Panyu Interactive Film Street is an ambitious programme for culture and history activation, this loop could be considered as an infrastructure system supporting the daily life and tourism of this whole area. Furthermore,

Figure 6.10 Aerial image of the urban redevelopment design

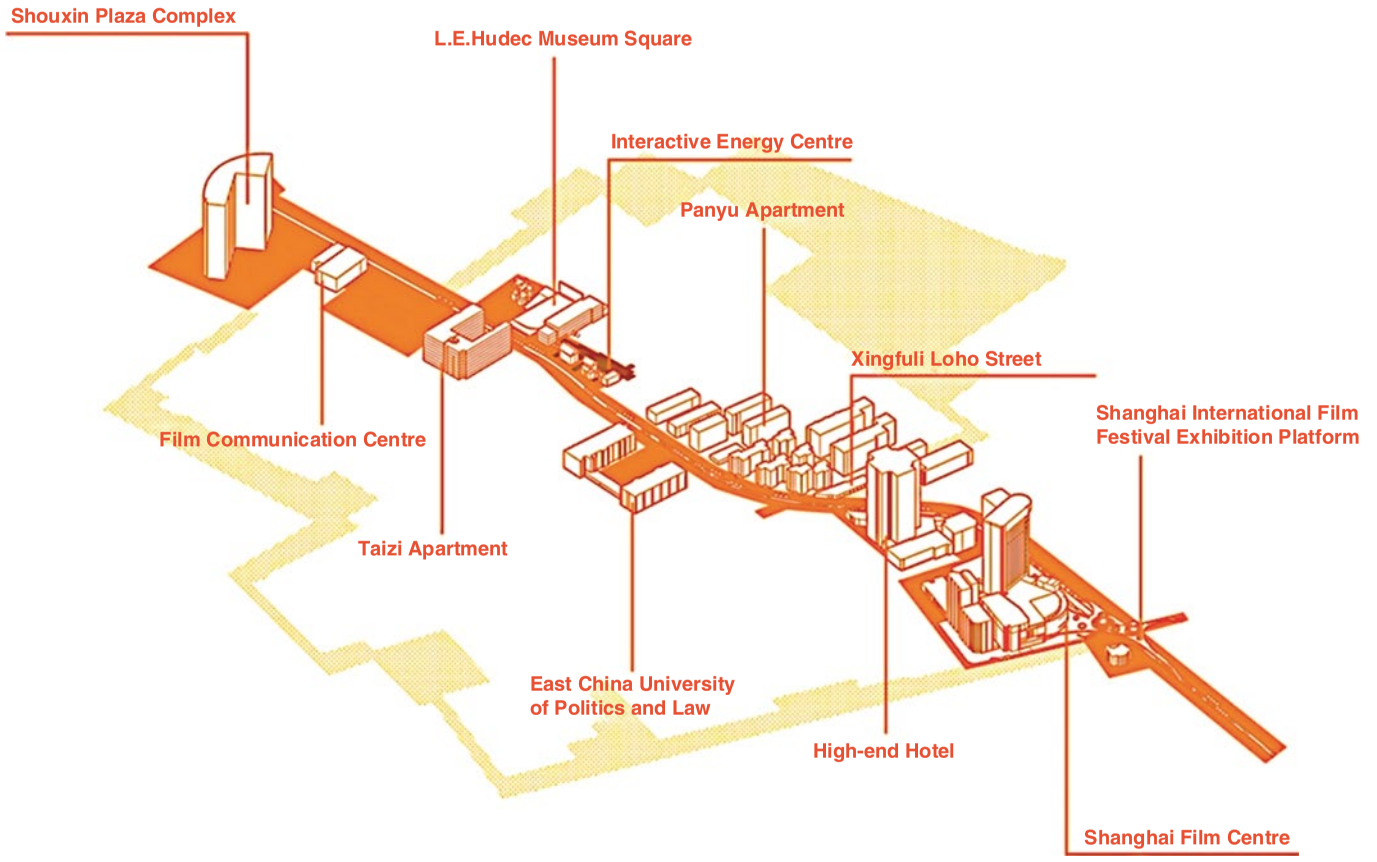

Figure 6.11 Panyu Interactive Film Street

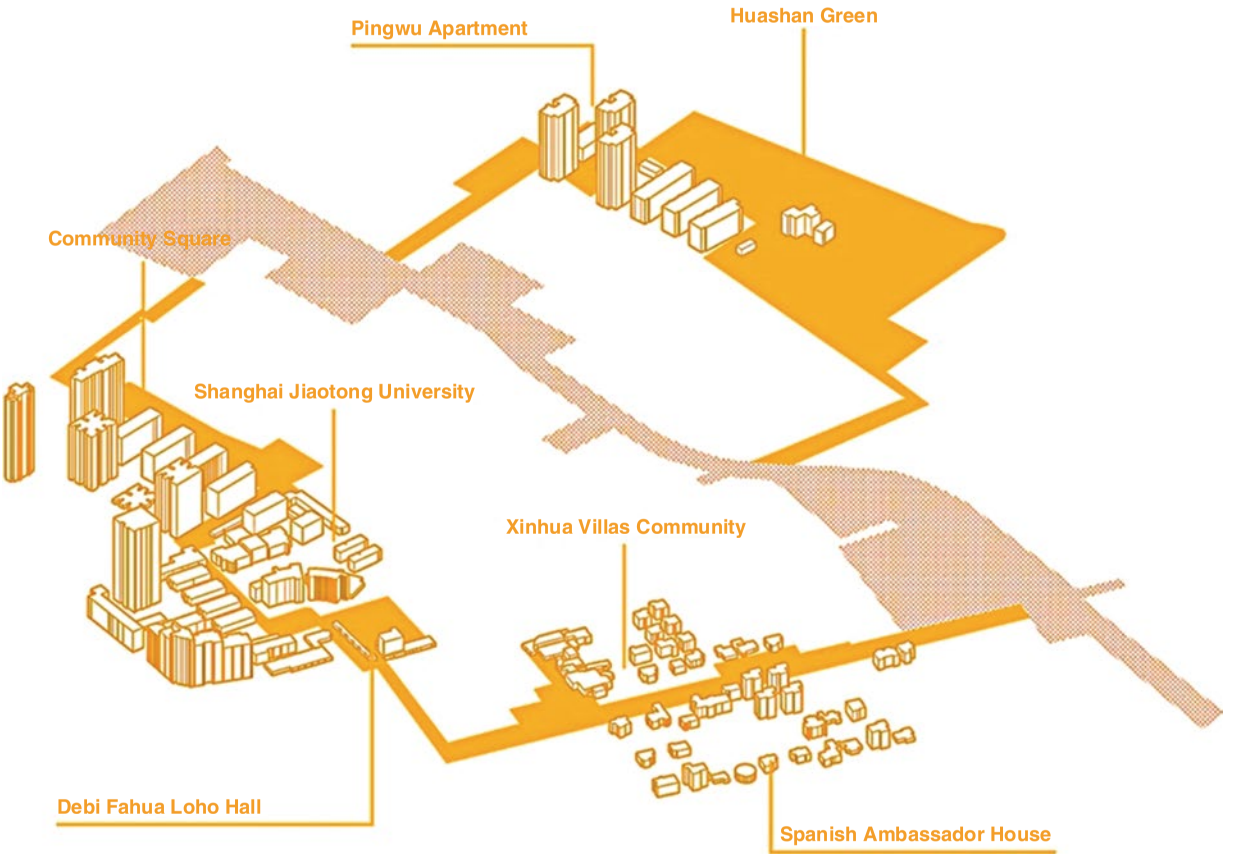

Figure 6.12 Xinhua Public Space System

necessary amenities, green and service spaces would improve the living and visiting experience while activating the underused spaces.

- A series of interactive hubs were placed on the Panyu Interactive Film Street and Xinhua Public Space System, which could promote new means of interaction between people and space. Information boards, mobile kiosks, interactive vapour generators and other facilities not only provide the places with more interest, but also communicate with users to satisfy their demands and improve their experiences. Sensors inserted in these hubs are also collecting data from the environment and users to support dynamic design in the future.

4. EVALUATION

By reviewing the DAD method and applying it to the field project, its advantages and future-orientated values are clearly illustrated. As a thematic design and an entry in the Shanghai Urban Design Challenge competition, the urban redevelopment design for the Panyu-Xinhua Area used the DAD method to seek breakthroughs in analysis and design methods, and won a Featured Achievement Award in November 2017. An evaluation by different users, for example, urban planners, officers and citizens, was collected after the competition.

From the perspective of urban planners/designers, compared with traditional planning methods, the DAD method applied in this project largely expanded the research dimensions of planners and helped them to discover new problems and their optimal solutions. Conventional approaches to urban design are relatively limited and only focus on a specific period and certain aspects of the issues, leading to an urban design which is difficult to evolve dynamically over time with the changing environment. However, the DAD method can find more comprehensive problems during multiple time periods, making the dynamic process of planning possible. For example, it can detect the conditions of traffic flows on the road at different times (such as working days and weekends, morning and evening, and peak hours and off-peak hours) through real-time detection and comprehensive analysis, and more specifically, it can support the improvement of the non-motorized traffic system.

Moreover, in the design of the Panyu-Xinhua Area, much attention was paid to the possible changing situation of the site in Shanghai at different stages of development according to the program analysis phase based on the DAD method. Planned and designed after estimating the dynamic environment, a large number of sensors for different purposes will be installed and deployed in the site simultaneously, which will collect different kinds of site data and transfer this information to planners to ensure the possibility of rapid adjustment of the design in the future.

Also, compared with traditional planning methods, which are usually limited to qualitative data collection and analysis, the DAD method is more objective and supportive of quantitative comparison and analysis. It can also discover the space hotspots in the site through geo-tagged social media data analysis combined with the prediction of new potential hotspots to organize holistic public space systems. It can build a case gene pool through spatial parameter extraction of similar spaces in different cities, which is more intuitive and convincing for case comparison and reference. Both have contributed a great

deal to the accomplishment of the urban redevelopment design for the Panyu-Xinhua Area.

From the perspective of city officers, the competition they organized offers the urban planning authority an opportunity to promote the organic process of urban redevelopment in historic districts, as well as the improvement of the urban environment which, in the long run, will make Shanghai an extraordinary global city. It is also worth mentioning that the combination of the DAD system and a carefully selected urban design programme of great influence and public attention is going to form a prominent brand of creative urban planning in Shanghai, which is a win-win interaction, officially recognized by the Featured Achievement Award in Shanghai Urban Design Challenge, between academia and the government.

As for citizens who are directly or indirectly involved in the redevelopment project in the Panyu-Xinhua Area, the application of the DAD method takes full consideration of people-orientated urbanism and public participation through the design of the human-scale urban fabric, the interaction between data collection and their everyday life (through the interactive information board, for example), and so on. Those who benefit most are elderly people, who constitute a high proportion of the total population in this area. As the diverse spatial demands of citizens are gradually satisfied through the implementation of the DAD system, we will finally witness a new urban lifestyle in the digital age.

5. CONCLUSIONS

By reviewing the history and development of the relationship between data and design, as well as summarizing the progress of new data environment, this chapter introduces a new quantitative planning and design methodology termed data augmented design, which was proposed by Long and Shen in 2015. Data augmented design provides a new supporting platform for the planning and design process, ranging from field investigation, existing condition analysis to future forecasting and scheme design.

For the analysis and design phases of DAD, the chapter focuses on two key tool kits of DAD research: existing condition analysis and spatial parameter extraction, followed by the introduction of methods and tools for each approach. To better present DAD and evaluate the effectiveness and efficiency of DAD methodology, the chapter introduced a case study of the urban redevelopment design of the Panyu-Xinhua Area. By evaluating the data collection, data analysis and urban design phases of DAD, we reach the conclusion that urban planners, officers and citizens could all benefit from the application of DAD.

Potential applications of DAD lie in three areas: planning and design support, future estimation and public participation. As a planning/design support system, DAD can be applied in urban planning and urban design projects of different scales and improve the accuracy and systematism of the planning and design process. Based on the urban data archive provided by DAD, researchers can work out the different development phases of similar cities, summarize the common issues facing cities and forecast the future development of cities. As a platform generated and empowered by data, DAD can serve as a tool for monitoring, communicating and engaging communities, which could be used by planners, developers, officers and citizens.

While highlighting the merits of DAD, there are still issues that need to be improved in the near future. First, as the spatial distribution and condition of key urban factors are dynamic, the DAD framework needs to be updated accordingly. More efficient and convenient methods for analysing data need to be put forward. Second, although the volume of data is booming currently, more open data of high quality are still required. To improve the accuracy and resilience of the system, a more significant amount of data needs to be provided. Based on this, emerging technologies such as machine learning could be applied to orientate future urban development. While there has been rapid progress in the IoT and individual sensors, the DAD system has the potential to contain more information to support urban planning, urban design and decision-making in our cities, and develop into a more accessible and portable data system in the future.

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