The Research and Co-creation Model for Urban Interaction Design and Practices

Yuyao Zhou(✉) and Nan Jiang

Department of Information Art and Design, Tsinghua University,
Beijing 100084, People's Republic of China
{zhouyyl7,jiangnl7}@mails.tsinghua.edu.cn

Abstract. The city is the basis of people's life, carrying the behavior and interaction of residents every day. With the rapid development of information interaction technology, the city is paying more and more attention to Human-oriented and Human-Computer Interaction (HCI). The Smart City is a new city form developed in such a new technology environment. This paper focuses on applying the methods of HCI to the construction of smart city. We analyze related cases and create an element model of Urban IxD, and then get the operation framework of urban innovation. After that, the operation framework is applied to co-creation workshop. Finally, based on stakeholder discussion, the models of city co-creation are built. These models and frameworks are intended as a common design model to help builders to discover design opportunities and create appropriate solutions for urban innovation.

Keywords: Urban IxD · Smart city · HCI · Urban innovation
Co-creation

1 Introduction

Needs and functions of development of cities are constantly evolving with the development of social economy and information technology. City information has experienced three stages: network, digitization and intelligence. The smart city is regarded as the stage of advanced urban development that matches the knowledge economy. This is the inevitable rule of urban developed to a certain stage, people-oriented, innovative, interactive and sustainable development is important concept.

In November 2008, IBM's Chairman, CEO and President Sam Palmisano, during a speech at the Council on Foreign Relations, outlined a new agenda for building a "Smarter Planet" [1]. In this background, the global boom of "Smart City" started to emerge. The smart city concept integrates information and communication technology (ICT), and various physical devices connected to the network (the Internet of things or IOT) to optimize the efficiency of city operations and services and connect to citizens [2]. The whole city will be a multi-dimensional interactive place where people and objects interact with each other, the interaction between people and the environment, and the transmission of objects and data are sent in a tangible and intangible space. At present, there is a great effort to build smart cities in China and abroad, and many countries have formulated and implemented many strategies, and also emphasized the

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concept of co-creation. Organizations such as MindLab in Denmark and Nesta in the UK, for instance, emphasized the need to implement co-production processes as the only viable solution to the growing complexity and wicked nature of issues tackled by public authorities [3].

The traditional HCI solves the relationship between human, machine and interface. In the context of the city began to expand to space. Terry Winograd said that "interactive design is about building an interactive space for people's lives, not just an interface that people interact with". This paper takes the concept of Urban Interaction Design (Urban IxD) as the research direction, which is about the interaction between people and the urban environment. Urban IxD is not only about the coming together of various disciplines in addressing urban developments, but also about finding new relations between professional designers, academics, policy makers and citizens [4].

At present, in the background of smart city, HCI and Service design are new concepts for exploring the development of the human-oriented city, which lacks unified understanding and overall guidance framework. This paper focuses on how to make use of various organizations and methods in the HCI field to create urban innovation schemes. We collected different characteristics of urban innovation cases, analyzed the relevant elements of each case, and then used the territory map to summarize the Urban IxD's factor model and analyze the operational model. In recent years, we have been organizing workshops on urban co-creation, and we have used the operation mode to get the validity of the model. Finally, we summarize the co-creation model of stakeholders.

2 Related Work

2.1 Theoretical Research

The initial concept of a smart city started with cities utilizing communication technologies to deliver services to their citizens and evolved to using information technology to be smarter and more efficient about the utilization of their resources. Initially, resources were limited to fields that were tangible, mainly energy and mobility systems. In recent years, however, not only what can be done with information technology has changed significantly, but also the resources and areas addressable by a smart city have broadened significantly [5].

Among the most important standards, ITU has recently published the Smart-Sustainable Cities Focus-Group (SSC FG) results, which demonstrate among others the 10 types of smart services that a smart city can deliver: Smart Water, Smart Energy, Smart Transportation, Smart Healthcare, Safety/Emergency, Education and Tourism, Smart Waste Management, Smart Buildings, e-government and e-business [6]. Many new research projects around the world are beginning to rise. It started with the IBM Smarter Planet Initiative [7], quickly followed by the MIT City Science program [8] and Trinity's Smart & Sustainable Cities initiative [9], all addressing vital aspects of this vibrant field. The form of co-creation is also very popular in urban innovation. Urban Living Labs (ULLs), in fact, have become a trend in cities all over the world. The term is used to refer to a wide variety of local experimental projects of a

participatory nature. The aim is to develop, try out and test innovative urban solutions in a real-life context [10]. Brazil has set up Network of Smart and Human Cities (RBCIH) to put together members from academy, private initiative and local government [11]. At the same time various data platforms are the foundation for building smart cities. Smart city uses different types of electronic data collection sensors to supply information which is used to manage assets and resources efficiently [12]. Like online collaborative sensor data management platforms are on-line database services that allow sensor owners to register and connect their devices to feed data into an on-line database for storage and allow developers to connect to the database and build their own applications based on that data [13]. The city of Santander in Cantabria, northern Spain, has 20,000 sensors connecting buildings, infrastructure, transport, networks and utilities, offers a physical space for experimentation and validation of the IOT functions [14].

2.2 Case Study

Our research method starts from the case, summarizing the characteristics of existing projects, form a regular research framework and model. We selected four different characteristics of the case (Product, Open source, Service, Participation). The overall two categories, the first two obtain data from products, the latter two is to guide you how to city innovation.

Case1: Copenhagen Wheel
The "Copenhagen Wheel" is designed by the MIT Senseable City Lab of the Massachusetts Institute of Technology [15]. The wheel of Copenhagen transformed the traditional bicycle into electric bicycle, and installed mobile sensors on the bicycle to collect all kinds of data in user's travel process. As you ride, the sensing unit in the Copenhagen Wheel is capturing information about your personal riding habits as well as information about your surroundings. Access this data through your phone or the web and use it to plan healthier bike routes and to achieve your exercise goals. You can also share your data with friends, or with your city. Thereby it contributes to a fine-grained database of environmental information from which citizen can all benefit. The project focuses on how people travel, including products, hardware and Apps, which further improves urban traffic and environment by collecting user data.

Case2: Smart Citizen Kit
Citizen Kit is an Arduino based sensor kit that provides sophisticated sensor network tools to citizens, enabling the measurement of levels of air pollution, noise pollution or air humidity [16]. The project was originally developed within the Fab Lab Barcelona at the Institute for Advanced Architecture of Catalonia and crowdfunded via the Goteo and Kickstarter crowdfunding platforms. With its relatively low-cost model the Smart Citizen Kit sees itself as acting as a bridge between more typically technical and non-technical citizens, both seeking to solve environmental challenges in unconventional ways through better monitoring. The kit exists of an open source hardware device, a website where the data is being collected, an API and a mobile app. It connects people with their environment and their city to create more effective and

optimized relationships between resources, technology, communities, services and events in the urban environment.

Case3: Civic Service Design

Civic Service Design (Tools + Tactics) was produced by the Service Design Studio at the NYC Mayor's Office for Economic Opportunity [17]. It refers to the practice of creating, better understanding, and improving upon programs at any stage; it uses "civic service design" to mean applying the tools and methods of service design to government-run or funded programs. The goal for service design is to make public services as effective and accessible as possible for all New Yorkers. The project emphasizes the use of design methods to promote the government's thinking on project goals. The use of design methods for government decisions is rare, which is more conducive to the government's strategy to meet the needs of citizens.

Case4: App MyCity

App MyCity is a contest for the world's best urban app [18]. Awarded every year at the NewCities Summit, it rewards new mobile applications that improve the urban experience, connect people, and make cities more fun, fair, vibrant, and sustainable places. The project is hosted by an international non-profit organization called NewCities. The format of the competition is novel, and it is a low-cost way for the organization to obtain high value solutions. The participated citizens can also show their own ideas through the competition. If the scheme is adopted, the mutual win can be achieved.

We get the real and effective data from the four actual cases and organize it, and based on this we can get the following characteristics of the factors. The specific methods, forms and outputs of urban innovation were found out, as shown in Fig. 1.

	Copenhagen Wheel	Smart Citizen Kit	Civic Service Design	AppMyCity
Stakeholders	Government+Citizen +Organization	Citizen+Community +Organization	Government+Citizen +Organization	Citizen+ Organization
Organization	Copenhagen government+MIT Senseable City Lab	Fab lab+Institute for Architecture of Catalonia	NYC+Citi Community	New Cities Foundation
Technology	Product manufacturing、Software、ICT、Data	Arduino、Software、ICT、Data	Open data、Design thinking	Data、Code、Organizational strategy
Approach	Co-creation	Crowdfunding	Hackathon	Competition
Output	Data	Open source data Participatory tools	APP, Website, Service	APP
Field	Mobility	Environment	Public service	Lifestyle

Fig. 1. The elements of four typical cases

By extracting the important elements in the case, we can draw the following territory map. The main focus of this model is on how to represent the elements of Urban IxD in the three dimensions of HCI.

3 Core Elements of Urban IxD

3.1 Territory Map

One of the ways we analyze the project is by having them create "territory map" of the project space because it mediates interaction between all elements.

As shown in Fig. 2, the HCI domain consists of three main dimensions: Design, Computer Science and Cognitive Psychology. The design includes concepts such as interaction design, user experience, participatory design and visualization. Design can inspire more creative urbanization programs and more ways to lead people step by step. Computer science includes the technology needed to build a smart city. Technology plays a key role in building a smart city and technology makes more efficient use of physical infrastructure (roads, built environment and other physical assets) through artificial intelligence and data analytics to support a strong and healthy economic, social, cultural development [19]. Sustained technological innovation is an inexhaustible motive force for the development of a smart city, but technology is only the realization means of smart city, not the ultimate goal. Cognitive psychology is mainly concerned with the user requirements, user experiences and user feelings in the city. Seligman defines the well-being theory [20] as a theme of positive psychology. He defines five factors needed for humans to flourish: positive emotion, engagement, meaning, relationships and achievement. Focusing on user psychology can further promote the effectiveness of urban innovation.

The combination of design and technology will produce output, and the output of urban innovation will be widely ranging from policy formulation and strategic planning to products and data in life. Both design and cognitive psychology are concerned with stakeholders. There are many different types of groups in the city, and it is because of the co-creation that we can produce smart cities which are in the interest of the group. Computer science and cognitive psychology together lead to the approach. There are various approaches of urban innovation, in order to create common motivation and goals for everyone. Deakin defines the smart city as one that utilizes ICT to meet the demands of the market (the citizens of the city), and that community involvement in the process is necessary for a smart city [21]. This shows the importance of technology, user needs and co-creation.

3.2 Operation Framework of Urban IxD

After studying the factors of HCI and urban innovation, the paper analyzes the operational framework of urban innovation. The interactive design method is combined with the elements of urban innovation to obtain the following five steps, as shown in Fig. 3.

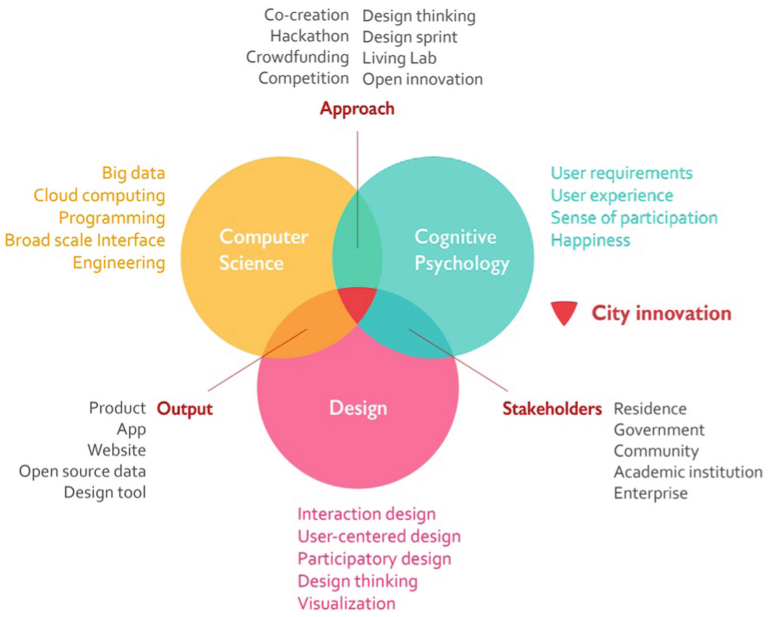

Fig. 2. Analysis of factors of Urban IxD

Citizens' participation is the foundation for urban innovation. Citizens have a stronger sense of presence, more participation and autonomy, and innovative services from enterprises and governments have been continuously stimulated. Data is the foundation of information, and now residents can also be one of the data sources. The whole process includes five steps. The first step is to determine the background of the project, explore the functional features of different scenarios using space, or explore the needs and emotions of different users based on people. The second step is to identify the specific fields of the project, and we summarize 6 fields that cover different aspects of life: Mobility, Live and Play, Production, Consumption, Management and Infrastructure, Community and Health. Every field has its own system and interoperability with each other, which constitutes a huge network system of smart city. The third step is to start thinking about ways to achieve urban innovation. Such as living lab to provide specific scenarios for everyone to create, and design thinking provides a mode of thinking to guide people to think about innovation. The fourth step is the specific form of output. The final result of smart city is varied. It can be a macro policy plan, or a specific product innovation. From the design level, product or service design are two main forms to change people's life. Either a large product or small one involves the technology and the popularization of the public. From the citizen's own mobile phone to get the living data or release a small cost kit, which is an instance of getting a data in a wide range from a micro view. The final step is to achieve two goals from the project: improving the lifestyle and behavior or improving the feelings between the residents and the residents, residents and the city.

Foundation：Citizen& Data		
First step (Setting up the project background)	Background	**Time / Space / People** **time / space**:Exploring the connection between the smart city and the creation space from the perspective of urban planning **people**：Exploring the development of smart city from the life needs and emotional needs of urban residents
Second step (Identify the areas of problem solving)	Fields	1.Mobility 2.Live and Play 3.Production 4.Consumption 5.Management and Infrastructure 6.Community and Health
Third step (Approach we need)	Approach	Design thinking, Design sprint Living Lab, Open innovation
Fourth step (Forms of project output)	Output	Strategic planning, Product, App, Open source data, Tool
Fifth step (The purpose of the project)	Emotional	1. lifestyle and behaviour 2 .Improving the feelings between the residents and the residents, residents and the city

Fig. 3. Operation framework of Urban IxD

4 Co-creation Workshop

Through the workshop, we practice the above operating framework. In 2014–2018, three typical cases were selected to illustrate. The cases focused on community, space and city respectively.

4.1 Creative Community

In 2014, we organized the first workshop about the creative community, it had attracted more than 40 people from government agencies, social organizations, business circles, IT experts and design professional teachers and students to participate. The design of the six teams are based on Internet communication technology such as Internet of things, sensor network and so on, so as to form a new management form community based on large-scale information intelligent processing.

Each team presents a different design object: the design of electronic waste recycling platform, the prototype design of community old-age self-help, the design of remote control robot, Babel Tower breaker Bracelet design, the design of the joint

office, commercial exhibition and creative communication space design and the design of city pet dog intelligence community.

From the outputs of the workshop, the proposal of the creative community is a transformation from emphasizing technology as the core to emphasizing the service of technology as the core. From the outputs of six groups, there were three groups aimed to strengthen the emotional connection between residents and residents. The other three groups aimed to improve the relationship between the residents and the city. These outputs are based on community resident demands, solving the problems of people's livelihood as the theme, optimizing the life style of the people for the direction, exploring the establishment of model of social construction innovation, optimizing existing resource allocation, mobilizing more people to participate in social construction. There are two main forms of output: online + offline platform and product as a medium.

4.2 Co-creation Space

In 2015, we organized a co-creation space workshop. With the theme of "Co-working Space", we explored the community building rules and creation models in co-working. This workshop is divided into seven groups using the same format as the creative community workshop we made before. According to the community needs, each group eventually explored different styles of co-working spaces based on their occupations or hobbies, including "Beautiful Village" Co-working Space, "DIY Jewelry" Co-working Space, Crowdfunding Platform, Designer "No. 3" community, Integration of Innovation Investment Space, Financial Services Space and Youth Space.

Unlike the previous urban design workshop, this workshop took space and time as the starting points, explored the relationship between smart city and co-working space from a more macroscopical perspective of urban planning. Seven groups are no longer focused on products to create communities, but for specific space design. Design involves factors such as economy, management, culture, technology, capital and function. There are many forms of space, which are dominated by people, dominated by regions and dominated by function.

4.3 Future City Innovation Workshop

We recently organized the 2018 Future Cities Workshop in collaboration with MIT. This workshop adopts the methods and tools of Design Thinking to co-create in the form of teamwork. The workshop summarizes the key issues of eight member companies and regroups the questions of each company. From the user perspective, the workshop summarizes Mobility, Living and Health, Working and Production, Commercial, Management and Infrastructure, Culture and Play six cities innovation direction, and participating in the workshop member companies together to derive and summarize the innovation implementation paths in all fields. The six topics correspond to the results of the mobile business scene for the business scene, smart cultural town, smart park one-stop service, new business scenarios, infrastructure staff office, cultural town real-time service information.

The special feature of urban innovation lies in the complexity and spatial attributes of the urban system. It is understood from two dimensions: the first is the dimension of human beings, including those who live in cities, the managers of cities, the construction and operation of communities, and the organizations that work in cities, cities, providers, and governments. The second is the spatial scene dimensions: from big to small, city and city clusters, area (including the new area and characteristic town), plot/single building.

From the results of these urban workshops, we can see that they are based on the time, space and people backgrounds, aimed to improve the relationship between urban residents and residents, or between urban residents and the city. Urban residents are people who often live in the city and have a sense of identity and belonging to the city. The participation of residents in urban planning refers to the urban residents' attempts to influence and promote urban planning decisions and to share the process of urban planning. In view of the elements of the concept, the subject of participation refers to all non-governmental organizations, residents, and government. Participation object refers to the process of participating in urban planning related activities; the way of participation can be either organizational participation or spontaneous participation.

Nowadays, the city is no longer simply a physical city that only exists for survival. The development of information technology brings all kinds of possibilities to all of you. Every discipline and every dimension is added to the urban construction. The interaction between the Internet and people constitutes a very important foundation for a smart city or a future urban development. Through organizing the city's co-working workshop, we hope to gather people from different professions to design the idea of smart city. The workshop is more conducive to the stimulation and collision of your mind, and also can help a single field of thinking transformed to a comprehensive view of the system.

5 Discussion and Future Work

Urban IxD is to apply the research and practice of HCI to the background of smart city. An important feature of this is that it brings together working groups that are already different from each other, cooperate with interdisciplinary and institutional partners, and emphasize the importance of citizens.

Figure 4 based on the relationship between the three important stakeholders in the city, we analyze the creation model of urban innovation. The key to creating collective wisdom is that under the guidance of the urban development strategy, the government and enterprises pay attention to the needs of citizens and social innovation, and the citizens participate actively as data sources. This operating system must be simultaneously top-down and bottom-up.

Citizens at the bottom, is the main body to build smart cities. The city not only provides residents with the physical space of their dwelling, but also the spiritual space attribution of residents' feelings. At the highest level, the government is the co-ordinator of a smart city. It is the government's responsibility to choose a combination of long-term planning and current conditions in line with the local model of construction path. Enterprises are in the middle, and as a professional company, their

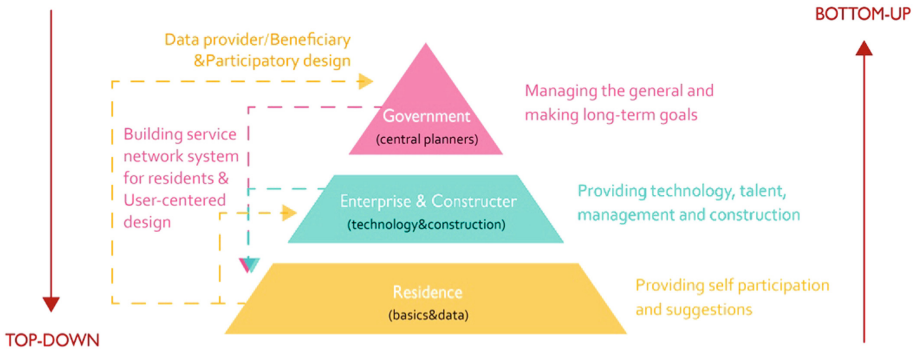

Fig. 4. Co-creation model between stakeholders

involvement in promoting smart city development not only opens up new businesses and markets for the company, but it also makes up for the government's lack of technical and professional knowledge. The three help each other and work together to promote the development of smart city.

After this, we still have other valuable things to do:

- We have done a lot of city workshops, then we can consider doing more city innovation practice projects. Getting more data and information from the project to refine the model to make it even more instructive.
- Although smart city is a very broad concept, urban interaction is a good point for us to get involved in. Then we can put forward our own concept to improve the application of design at all levels.

6 Conclusion

In order to apply HCI to smart city, this paper starts from the concept of Urban IxD, summarizes the factor model of urban interaction through case studies, develops the application framework of urban interaction in urban environment, and applies it to urban workshops. Finally, from the point of view of stakeholders, we discussed the value of co-creation. We practice and confirm the relevant method, so that we believe the conclusion have the guiding significance. We will continue perfecting and verifying our conclusion and pay attention to development and promotion of creativity of innovation participant. Also, we will develop more distinctive products and services for urban innovation.

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References

1. Smart Planet. https://en.wikipedia.org/wiki/Smarter_Planet
2. Peris-Ortiz, M., Bennett, D.R., Pérez-Bustamant Yábar, D.: Sustainable Smart Cities: Creating Spaces for Technological Social and Business Development. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-40895-8
3. Bason, C., Mygind, J., Sabroe, R.: Co-production Towards A New Welfare Model. MindLab, Copenhagen (2013)
4. Brynskov, M., Bermudez, C., Fernandez, M., Korsgaard, H.: Urban Interaction Design: Towards City Making (2014)
5. Schleicher, J.M., Vögler, M., Inzinger, C., Dustdar, S.: Towards the internet of cities: a research roadmap for next-generation smart cities, pp. 3–6 (2015)
6. Anthopoulos, L., Janssen, M., Weerakkody, V.: Smart service portfolios: do the cities follow standards? pp. 357–362 (2016)
7. IBM Smart Planet. http://www.ibm.com/smarterplanet/us/en/
8. MIT media lab. http://cities.media.mit.edu/about/initiative
9. Smart & Sustainable Cities. https://www.tcd.ie/research/themes/smart-sustainable-cities/
10. Steen, K., Van Bueren, E.: Urban living labs: a living lab way of working (2017)
11. Pereira, G.V., Bernardes, M.B., Bernardini, F.: Building a reference model and an evaluation method for cities of the Brazilian network of smart and human cities, pp. 580–581 (2017)
12. Hamblen, M.: Just what is a smart city? 1 October 2015. computerworld.com
13. Boyle, D., Yates, D., Yeatman, E.: Urban sensor data streams: London 2013. IEEE Internet Comput. **17**(6), 1 (2013)
14. Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., Oliveira, A.: Smart cities and the future internet: towards cooperation frameworks for open innovation. In: Domingue, J., Galis, A., Gavras, A., Zahariadis, T., Lambert, D., Cleary, F., Daras, P., Krco, S., Müller, H., Li, M.-S., Schaffers, H., Lotz, V., Alvarez, F., Stiller, B., Karnouskos, S., Avessta, S., Nilsson, M. (eds.) FIA 2011. LNCS, vol. 6656, pp. 431–446. Springer, Heidelberg (2011). https://doi.org/10.1007/978-3-642-20898-0_31
15. Copenhagen Wheel. http://senseable.mit.edu/copenhagenwheel/
16. Smart citizen kit. http://waag.org/en/project/smart-citizen-kit
17. Civic service design. www.nyc.gov/servicedesign
18. Smartcityhub. https://medium.com/smartcityhub/what-is-the-city-of-the-future-what-means-smart-5ebbab137967
19. App mycity. https://newcities.org/appmycity/
20. Seligman, M.E.P.: Flourish: A Visionary New Understanding of Happiness and Well-being. Free Press, New York (2011)
21. Deakin, M.: From intelligent to smart cities. In: Deakin, M. (ed.) Smart Cities: Governing, Modelling and Analysing the Transition, p. 15. Taylor and Francis, Abingdon (2013)