A New Paradigm of Addressing the Complexity of Entrepreneurial Community Design Leveraging Augmented Reality

Ke Ma, Yixiang Zhang, and Jing Cao(✉)

College of Design and Innovation, Tongji University, Shanghai, China
{suta, zyx2929}@tongji.edu.cn,
caojing.tongji@gmail.com

Abstract. Confronting the complex community design challenges, we demonstrated a novel paradigm of addressing the complexity by leveraging Augmented Reality incorporating information visualizations and the CityScope tangible interface. We next deployed CityScope Shenzhen Bay (CSB) as a practical case to quantify the entrepreneurial vitality of the Bay Area community. CSB incorporates information visualization toolkits, tangible interface for the rapid community design together with the simulation matrix of the community performance, which creates a crowd-sourcing platform to engage diverse stakeholders into the design and decision-making process towards the complexity of establishing an entrepreneurial community.

Keywords: Community design · Augmented reality · Tangible user interface · Information visualization · CityScope

1 Introduction

The late two years witnessed the transformative advances of community innovation. Design practices have built up new prototypes of entrepreneurial communities in high-performance and livable cities. Diverse start-ups, labs, services, and talents bring proactive techniques, knowledge, and creativity into communities to create innovative interventions [1]. However, emerging practices have increased the complexity of designing prototypes of networked urban systems and the underlying services. Community curators are seeking for a novel paradigm to address the challenges induced by disruptive entrepreneurial interventions.

We demonstrated a new scheme to empower community stakeholders first to understand the networked situations through quantitative information visualizations and afterward collaboratively sketch the prototype of the target community assisted by the CityScope tangible interface [2]. Meanwhile, real-time simulations can present multi-objective validations, for instances, the diversity and proximity, on the following performances of the community [3]. It is, therefore, feasible to foresee how interventions can improve the situations and optimize the design work before deploying entrepreneurial interventions. We set out to create the impact of reducing the thresholds

C. Stephanidis (Ed.): HCII 2019, LNCS 11786, pp. 192–201, 2019.
https://doi.org/10.1007/978-3-030-30033-3_15

of participating in urban planning activities and engaging diverse stakeholders into the decision-making process of co-creating a consensus of community values.

To exemplify the scheme as an empirical and generalizable solution, we developed "CityScope Bay" (CSB) as a case to represent the systematic framework, scenario-based interaction design, and user practices. See Fig. 1. This research concentrates the gaze on the Bay Area located at the Nanshan District in Shenzhen in China which comes into a characteristic entrepreneurial community gathering numerous enterprises and talents. The purpose of building CSB upon this community is to interpret the entrepreneurial conditions in terms of the networked distribution of diverse categories of enterprises and behavioral patterns of entrepreneurs. Furthermore, CSB gives rise to the rapid prototyping of an initialized entrepreneurial community for multi-users to devise the composition and arrangement of indispensable enterprises.

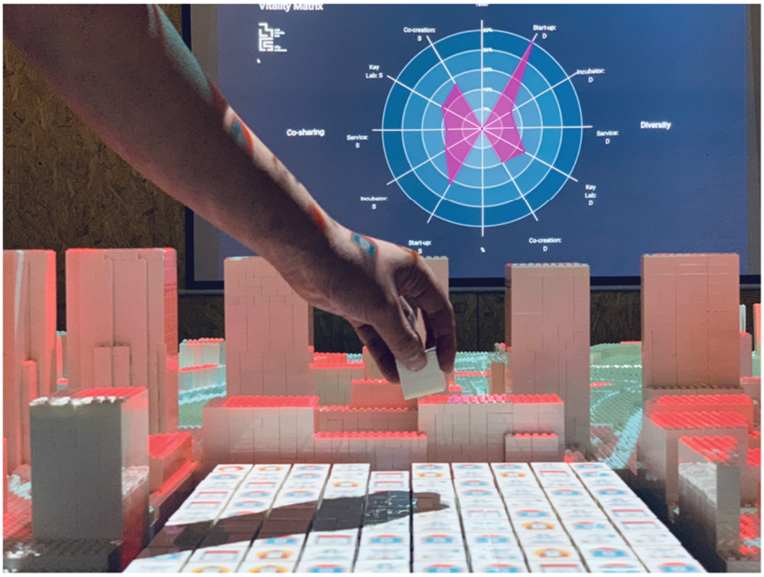

Fig. 1. The tangible user interface and simulation matrix of CSB. A user is manipulating a LEGO module to modify the distribution of entrepreneurial enterprises for community prototyping.

We exhibited CSB at an Open Entrepreneurship Summit in Bay Area, which gathers city managers, community curators, entrepreneurs, and consumers to investigate the future community design and the according lifestyle. In the exhibition, we operated focus group study in which users with specific propositions collaboratively discussed the proposals of designing a novel community aiming at creating either diverse or co-sharing capabilities. Participants manipulated the iterative design decisions on CSB tangible interface which simultaneously represents the distribution and arrangement of enterprises. Figure 2 illustrates the design process of one focus group. Additionally, a validation matrix performed the real-time simulation of the scores on indicators of diversity and co-sharability. Ultimately, each group reached an agreement for the design task and presented the outcome to other audiences. We collected design outcomes as well as simulated scores from three focus groups and yielded out a preliminary analysis. This paper next presents the extensive design work and technical framework of CSB. We also published a website to the public for disseminating recent activities of CSB. An online video of CSB for readers is available via the link[1].

The remainder of this paper is organized as follows: Sect. 2 introduces our method of developing CSB from information visualization, tangible interface, and technical implementation, respectively. In Sect. 3, we demonstrate the community design outcomes from focus groups and evaluate the impact of utilizing CSB as an efficient platform to accomplish complex community design tasks. Finally, Sect. 4 presents conclusions and future work.

Fig. 2. The working process of one focus group at the exhibition. Users are discussing to conclude the design proposition and collaboratively testing design decisions with CSB.

2 Method

CSB incorporates three core modules: (1) information visualization toolkits, (2) CityScope tangible interfaces for prototype design, (3) community performance simulation matrix. Figure 3 demonstrates the scheme and technical framework of CSB. Three modules constitute an iterative architecture for organizing and transferring

[1] https://youtu.be/QoVmoLbToVw.

heterogeneous information from internal systems and user actions. Information visualization toolkits provide visual interpretations promptly projected onto CityScope tangible interface. Users' manipulations of interactive LEGO constitutes instantly corresponds with the mathematical simulation matrix to provide users with versatile indicators of community performance at present.

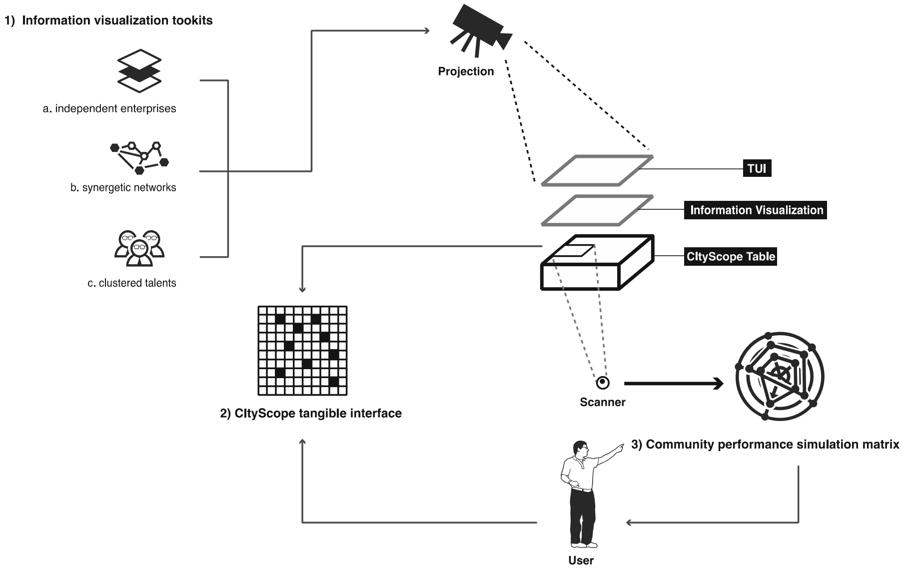

Fig. 3. The conceptual schematic and technical framework of CSB.

2.1 Information Visualization Toolkits

Visualizing heterogeneous data provides the understanding of entrepreneurial conditions to help stakeholders recognize the advantages and issues in the target district. In this case, we identified "Entrepreneurial Vitality" as an indicator for quantifying, analyzing, and visualizing the representations of vitality with regard to three typical scenarios: (1) independent enterprises, (2) synergetic networks, (3) clustered talents showcased in Fig. 4. CSB projects and maps information visualizations onto a LEGO-constructed physical model to achieve the intuitive experience rather than a two-dimensional screen. This paper published the visualizations online as a video[2] capturing the animations for every scenario.

First, we aim to depict the distribution pattern of independent enterprises classified into five primary types: start-up, co-creation space, incubator, service platform, and key lab. With the raw data collected from Open Data Platform certificated by Shenzhen Government [4], we distilled the metadata for each type of enterprises to form a data model. Afterward, with the assistance of the Open API service of Mapbox [5], geographic information is affiliated with each entity such as land, building, and road.

[2] https://youtu.be/bJkc1Ucu6mw.

Then, we filtered and marked all the valid location points inside the target region on the map and consequently circumscribed buildings that probably galvanized by innovative enterprises. Color encodings are virtually useful for differentiating the classification of enterprises. To visualize dynamic impacts that independent enterprises are generating to the surroundings, we designed animations for temporary presentations.

Second, our research further investigated network associations among current resources which aggregate to create a new type of innovative products and services. To figure out the potential combinations of enterprises, the algorithm extracts the key competitiveness of all the enterprises into keywords and automatically associate the enterprises with high-probability relevance to drive new kind of innovation assisted by the Google Knowledge Graph Service [6] and manually defined restrictive rules. Moreover, the algorithm visualizes each networked relationship as a graph to present speculative predictions of the innovation and underlying resources.

Third, despite the analysis of the vitality of enterprises, our research looked into the behavioral pattern of clustered talents, which reflects the vitality property. We highlighted three groups of people: high-tech talents, service providers, and college students according to the demographic features in Bay Area and visualized dynamic traces of distinct clusters in the visual form of continuous scatter flow. To implement this, we collected GPS traces data of the target user group provided by Open Street Map [7] and visualized the dataset through the GPX viewer open-sourced library [8].

Fig. 4. Visualizations for three identified scenarios. (A) independent enterprises, (B) synergetic networks, (C) clustered talents.

2.2 CityScope Tangible User Interfaces for Prototype Design

CityScope, a tangible visualization and simulation tool, provides the interface to engage community stakeholders in urban intervention design. City Science researchers from MIT Media Lab and global collaborators have been developing CityScopes to simulate the impact of interventions in planned communities and expedite collaborative consensus among stakeholders. As one affiliated member of the City Science Network, City Science Lab @ Shanghai[3] in cooperation with MIT Media Lab harbors the aspiration of transforming insights and techniques into remarkably innovative values in

[3] http://www.makeinteractions.com/lab.html.

China. This lab gathers research scientists, urban designers, and entrepreneurs to create sustainable, livable, and entrepreneurial communities by leveraging quantitative simulations and analysis beyond the urban interface. City Science Lab @ Shanghai developed a slew of CityScopes for addressing urban interventions in heterogeneous scales. Figure 5 lists out three additional CityScopes. CSB is the community-scaled CityScope developed by City Science Lab @ Shanghai with the support from open-sourced CityScope repository on GitHub [9]. CSB comprises a 3D model of physical buildings constructed by LEGO bricks, projections for visualizations and simulations onto the model or a vertical screen, a tangible interface for simultaneous interaction with digital information by manipulating semantic LEGO modules, and a CityIO server for processing algorithms and communications.

We selected a district with 1/16 size of the entire 3D model as the tangible interface to simulate the community design process. The interface is divided into a ten by ten grid where each grid can place a four by four LEGO module. Next, we assigned semantic information representing six types of enterprises (start-up, co-creation space, incubator, service platform, key lab, and commercial space) to the LEGO modules. Figure 6A illustrates the grid interface filled with manifold enterprise modules recognized by iconic symbols. Furthermore, CSB cultivates CityScope scanner under CityScope table to capture the grid of recognizable LEGO bricks encoded by six color types (see Fig. 6B) respectively correlating with equivalent enterprise counterparts. Real-time video frames are processed by the Computer Vision algorithm [10] to interpret one hundred color-tagged LEGO modules as semantic enterprises. Figure 6C records the operation of recognizing color types of the LEGO grid system. Therefore, CSB can record the changing distribution of LEGO modules and immediately refresh the interface representing enterprises. This mechanism empowers users to make rapid and iterative design decisions upon the distribution pattern via flexible manipulations of LEGO modules.

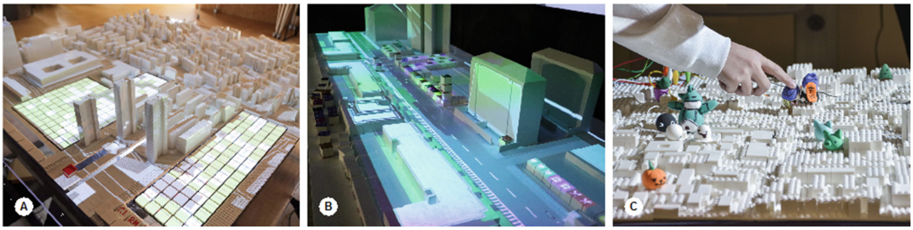

Fig. 5. A collection of CityScopes for heterogeneous urban scales developed by City Science Lab @ Shanghai. (A) CityScope Siping Community (http://www.makeinteractions.com/CSSiping.html), (B) CityScope LivingLine (http://www.makeinteractions.com/CSLL.html), (C) CityScope High School (http://www.makeinteractions.com/CSHS.html).

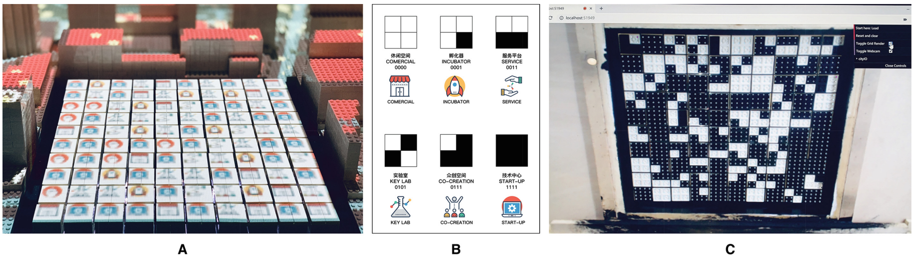

Fig. 6. The tangible interface of CSB. (A) LEGO modules, (B) color types and respective semantic encodings, (C) the LEGO grid system detected by Computer Vision recognition algorithm.

2.3 Community Performance Simulations

CSB provides the scientific simulation of the community performance, which reflects the evaluation of specific indicators towards users' design outcome. In this case, we identified two indicators which are diversity and co-sharing to quantify the entrepreneurial vitality of the focus community. As the tangible interface can calculate the quantities and locations of each type of enterprise via CityScope scanner and LEGO grid system, we defined a mathematical formula to figure out the quantitative scores specific to two indicators. A Radar Map named as "Vitality Matrix" visualizes the measures respectively for six axes (Fig. 7). Each side of the matrix depicts the differences among six types of the enterprise, while comparisons of two symmetric points on the same axis distinguish the performances upon two indicators. Advantageously, users can view the consequences of the recent decision and consider suitable design actions before the next iteration.

$$rmse_{ij} = \sqrt{\frac{1}{5}\sum^{5}\left(\frac{num_{ijk}}{24} - coef_k\right)^2}$$

$$c_k = \left(\sum_i \sum_j rmse_{ijk}\right)^{-1}$$

i: row coefficient
j: column coefficient
k: area type
num_{ijk}: number of k-type area in the 5 * 5 matrix centered on the grid of i rows and j columns lattice
$coef_k$: the ideal ratio coefficient of the k-type area in the 5 * 5 matrix region
$rmse_{ij}$: root-mean-square error of the i-row j-column lattice
c_k: average co-sharing coefficient of k-type area

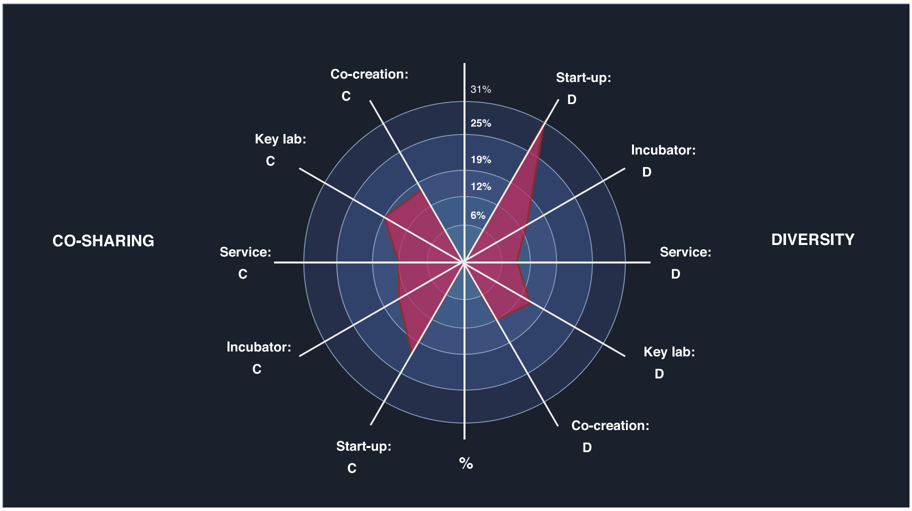

Fig. 7. The Vitality Matrix depicting the community performance of comparative indicators: (1) Co-sharing, (2) Diversity.

3 Evaluation

For evaluating the performance of CSB applied in user scenarios, we picked up three typical design patterns from the focus group study. Final design outcomes from three groups (A, B, C) are yielded out and visualized in Fig. 8. The visualization consists of two sections in which the left grid depicts users' decisions upon the distribution of five types of entrepreneurial entities and the associated commercial amenity while the right Vitality Matrix quantifies scores regarding two indicators: co-sharing and diversity specifically for five counterparts. The intermediate table shows the exact ratios in percentage terms.

We set out to provide preliminary reasonings and interpretations for each group considering the design proposition during the focus group study. Reading the matrix, group A was inclined to create a balanced diversity where five counterparts relatively share equivalent percentage. On the other hand, they tended to increase the co-sharing capability of co-creation spaces and key labs. Nevertheless, group B highly concentrated on the co-sharing performance of three kinds of community-sourced amenities, which are co-creation space, key lab, community service platform. The purpose of the given distribution is to strengthen the openness and accessibility of spaces, technologies, and business. The last group claimed no particular preference for a single indicator. They were aiming to establish a start-up-centered community; consequently, co-creation spaces and key labs are supposed to offer superior incubation service for advanced knowledge and technology.

This paper presents three samples among various possibilities of utilizing CSB for rapid community prototyping with explicit design propositions. Moreover, participators can collaborate to propose promising distribution patterns and finally approach

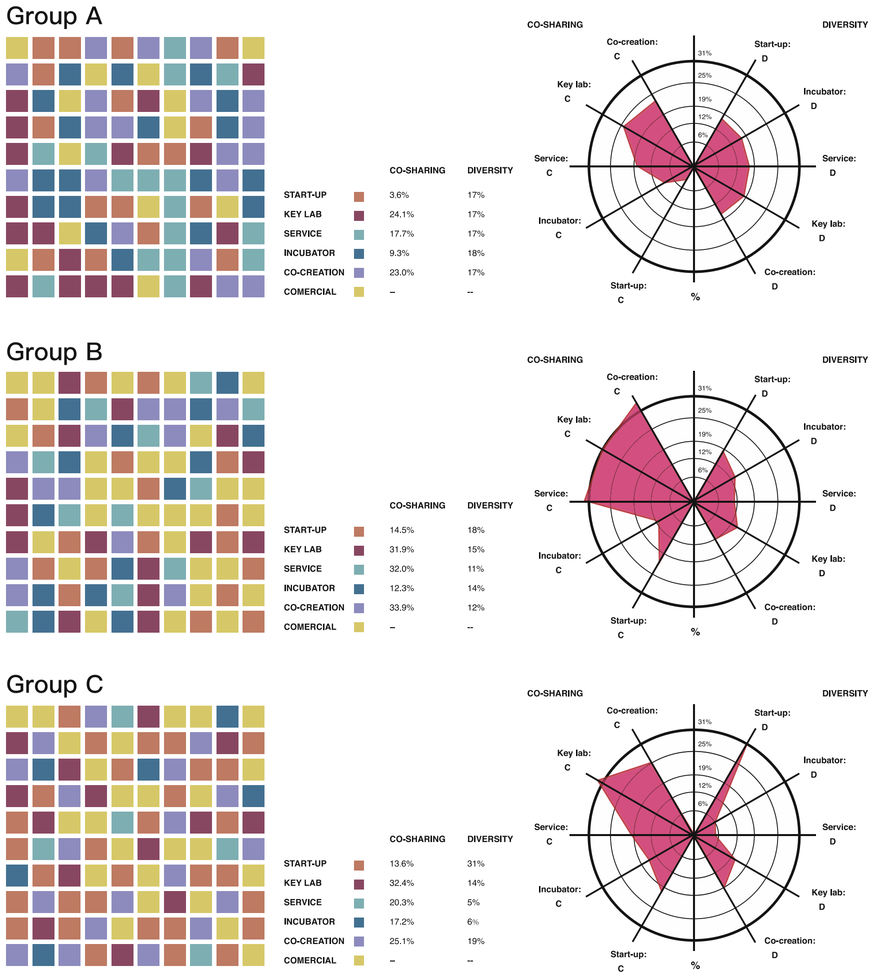

Fig. 8. Three representative design outcomes of group A, B, C from the focus group study.

preferred agreements through precise and quantitative evaluation of proposals calculated by Vitality Matrix. It is advantageous for design spaces that require participatory cooperation to conclude design-makings by multiple stakeholders. Interactive and computational medium effectively galvanize the working process and deliverables. CSB possesses the applicable viability of deploying as a public service in entrepreneurial communities similar to Bay Area community. The community curator can organize workshops and seminars to gather viewpoints from stakeholders, which would serve as a persuasive approach to reach consensus rather than individual disparity.

4 Conclusions

Confronting the complex community design challenges, we demonstrated a novel paradigm of addressing the complexity by leveraging information visualizations and the CityScope tangible interface. To validate the viability of our method, we deployed CSB as a persuasive case to quantify and visualize the entrepreneurial vitality of the Bay Area community. Using multidimensional information visualization toolkits, CityScope tangible interface for and the performance simulation matrix, CSB creates a crowd-sourcing platform to engage diverse stakeholders into the design and decision-making process towards the complexity of establishing an entrepreneurial community from the initial point. This paper distilled three representative design patterns from outcomes of the focus group study to preliminarily evaluate the applicable possibilities towards collaborative design spaces. Our research urges on design practices empowered by the tangible interface and computational evaluation into the innovative community design filed.

Acknowledgments. This work was supported by the Experimental Pedagogy Research Program (Virtual Reality Product Design and Usability Evaluation for Media and Communication Design Discipline, Grant 1400104024). The authors would like to thank Junye Lin, Xinda Guo, Chaoran Chen from College of Design and Innovation, Tongji University for the help of system development as well as doctoral researcher, Ariel Norman, and Ryan Zhang for research instructions.

References

1. Lou, Y., Ma, J.: Growing a community-supported ecosystem of future living: the case of NICE2035 living line. In: Rau, P.-L.P. (ed.) CCD 2018, Part II. LNCS, vol. 10912, pp. 320–333. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-92252-2_26
2. Grignard, A., et al.: Cityscope andorra: a multi-level interactive and tangible agent-based visualization. In: Proceedings of the 17th International Conference on Autonomous Agents and MultiAgent Systems, International Foundation for Autonomous Agents and Multiagent Systems (2018)
3. Alonso, L., Zhang, Y.R., Grignard, A., Noyman, A., Sakai, Y., ElKatsha, M., Doorley, R., Larson, K.: CityScope: a data-driven interactive simulation tool for urban design. Use case volpe. In: Morales, A.J., Gershenson, C., Braha, D., Minai, A.A., Bar-Yam, Y. (eds.) ICCS 2018. SPC, pp. 253–261. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-96661-8_27
4. Shenzhen OpenData Platform. http://opendata.sz.gov.cn. Accessed 18 June 2019
5. Mapbox API Service. https://docs.mapbox.com/api/maps/. Accessed 18 June 2019
6. Google Knowledge Graph Service. https://developers.google.com/knowledge-graph/. Accessed 18 June 2019
7. Open Street Map GPS Traces Service. https://www.openstreetmap.org/traces. Accessed 18 June 2019
8. GPX Viewer Library on GitHub. https://github.com/evrignaud/gpx-viewer. Accessed 18 June 2019
9. CityScope GitHub Repository. https://github.com/CityScope. Accessed 18 June 2019
10. CityScope Javascript Scanning Library. https://github.com/CityScope/CS_cityscopeJS. Accessed 18 June 2019