3D city models and pedestrian flow data analysis system for shopping street revitalization

Eri Kawanago, Koutarou Ishizaki, Nobuaki Nagai and Yuji Yoshimura

CODESIGN TOKYO

NEC

NEC Solution Innovators, Ltd.

UNESCO

United Nations
Educational, Scientific and
Cultural Organization

City of Design
KOBE

Member of the UNESCO
Creative Cities Network
since 2008

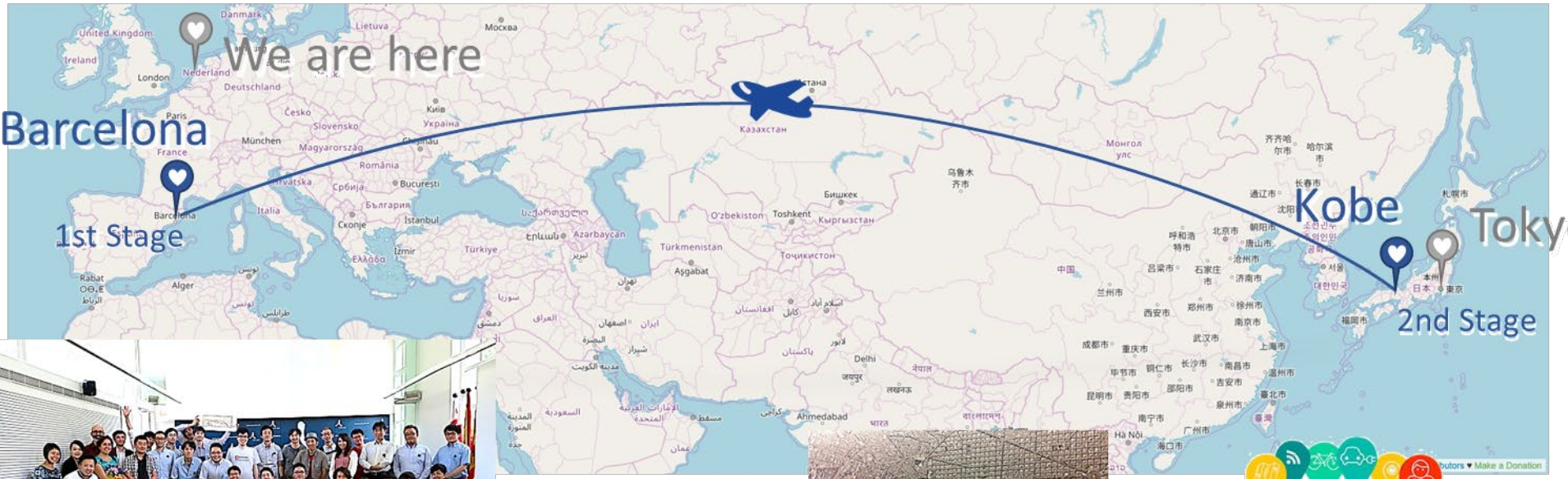
Outline

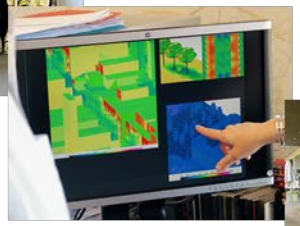
1. Introduction
2. Methodology
3. Data collection
    - 3.1. 3D city model
    - 3.2. Pedestrian flow data
4. Analysis and result
5. Future plan
6. Conclusion

CODESIGN TOKYO

1. Introduction – about our project

Kobe x Barcelona World Data Viz Challenge 2016 - 1st stage in Barcelona





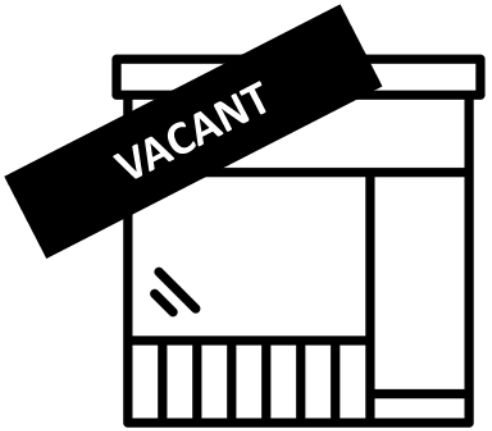
BCN Smart City
http://smartcity.bcn.cat/en/bcn-smart-city.html

CODESIGN TOKYO

1. Introduction – about our project

Kobe x Barcelona World Data Viz Challenge 2016 - 2nd stage in Kobe
Our challenge is to tackle the social issue by using **data**.

Aging building
Security deterioration
Population decline
Economic slump



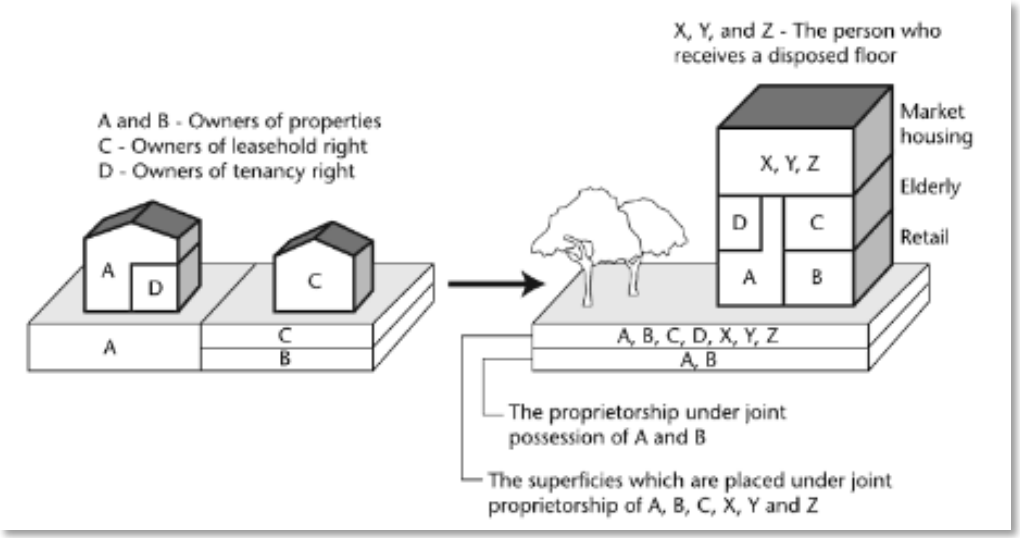
Regional culture decline
A decrease in tax revenues
Unemployed
Slackness

The problem provided by Kobe city was
retail vacancies on shopping street.

CODESIGN TOKYO

1. Introduction – about our project

Damage to the hybrid rubber shoe industry in Nagata Ward
Source: City of Kobe



The exchange of property rights in accordance with the provision of the Urban Redevelopment Law, 1969
Source: Edgington (2011) Reconstructing Kobe: The Geography of Crisis and Opportunity

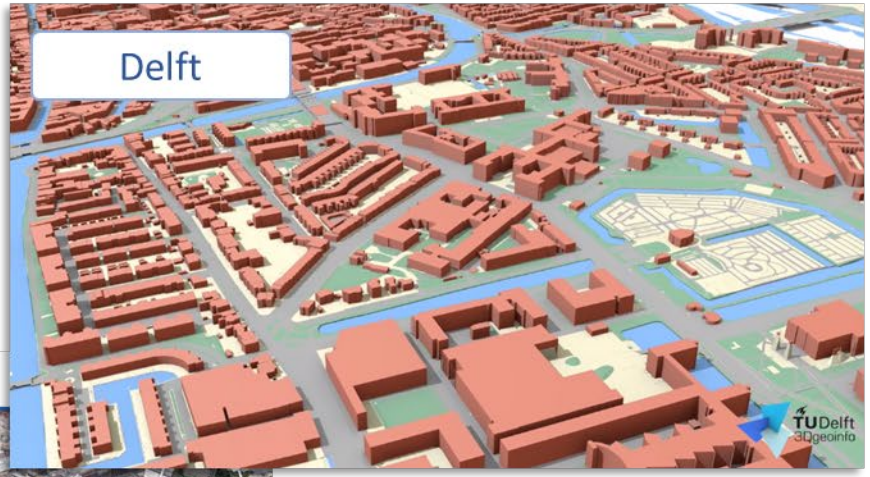
High-rise condominiums and shopping street
Source: Photographs by Kawanago

CODESIGN TOKYO

1. Introduction – research question

How can local government utilise 3D city models to solve social issues which differ by the context of each city?

Source: Berlin Business Location Center



Source: TU Delft

Source: City of Helsinki

CODESIGN TOKYO

1. Introduction – existing use cases

Biljecki et al. (2015) identified 29 use cases of 3D city models

- Estimation of the solar irradiation
- Energy demand estimation
- Aiding positioning
- Determination of the floorspace
- Classifying building types
- Geo-visualisation and visualisation enhancement
- Visibility analysis
- Estimation of shadows cast by urban features
- Estimation of the propagation of noise in an urban environment
- Urban planning
- Volumetric density studies
- Visualisation for communication of urban information to citizenry
- Reconstruction of sunlight direction
- Understanding SAR images
- Flooding
- Emergency response
- Radio-wave propagation
- Lighting simulations
- Computational fluid dynamics
- Estimating the population in an area
- Visualisation for navigation
- Routing
- Forecasting seismic damage
- Change detection
- Automatic scaffold assembly
- Facility management
- 3D cadastre
- Forest management
- Archaeology

CODESIGN TOKYO

Biljecki F, Stoter J, Ledoux H, Zlatanova S, and Çöltekin A (2015). Applications of 3D City Models: State of the Art Review. ISPRS International Journal of Geo-Information, 4(4): 2842-2889.

1. Introduction – things to solve

Local governments are often faced with problems when they introduce innovative technologies:

1. Lack of professional staff

2. Low budget

3. Local consensus building

CODESIGN TOKYO

2. Methodology – Our approach

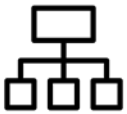
1. Social issue

Determine a social issue to solve and have **an INNOVATIVE project**

2. Data collection

Find available data in combination with 3D city models to suit the social issue **at LOW COST**

3. System Development



Develop a system to integrate all data to analyse **as a PROTOTYPE**

4. Analysis

Analyse the data to find a solution and **SHARE it with stakeholders**

5. Local consensus and implementation

Build local consensus with beneficial analysis results and **implement on a LARGE-SCALE**

stakeholders

CODESIGN TOKYO

3. Data collection

3D geometric model with semantic information

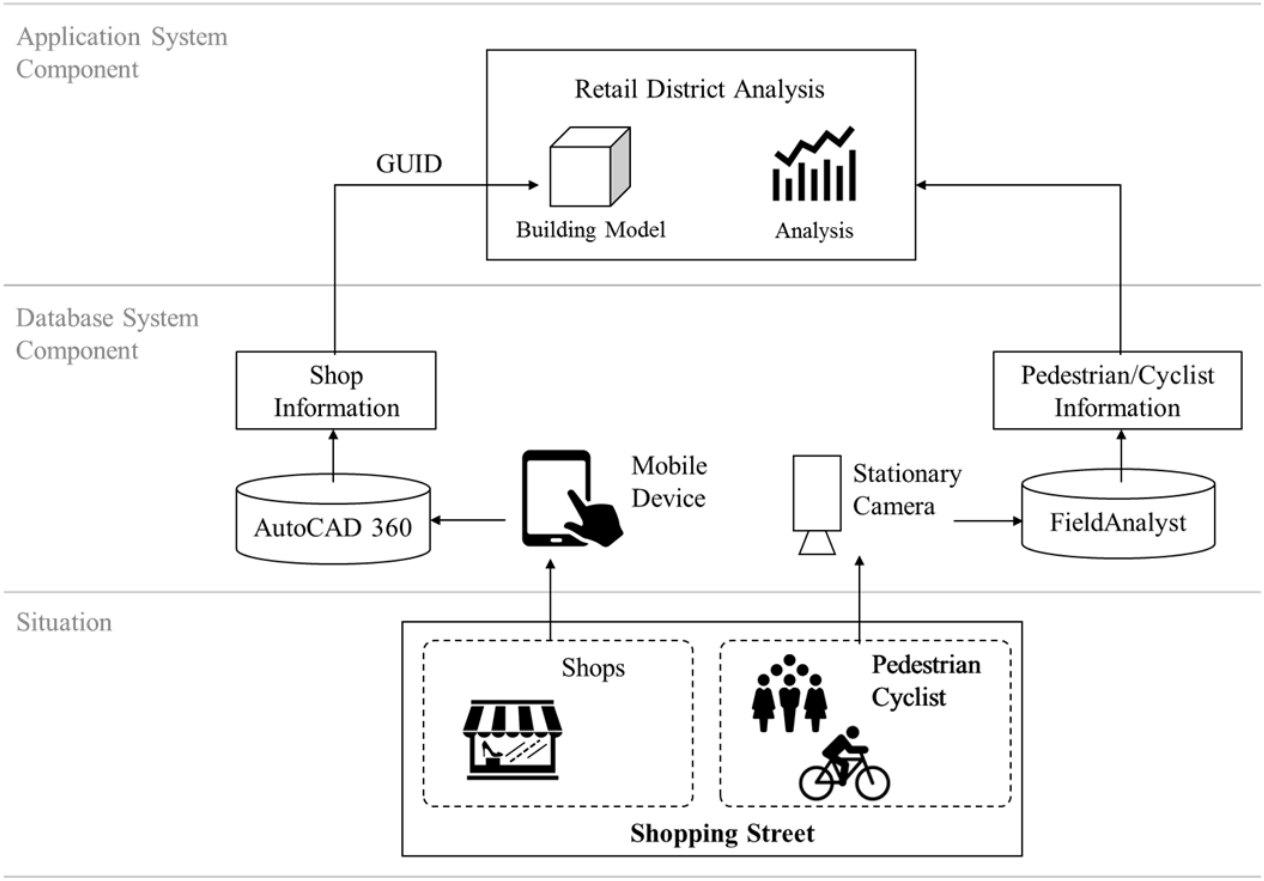


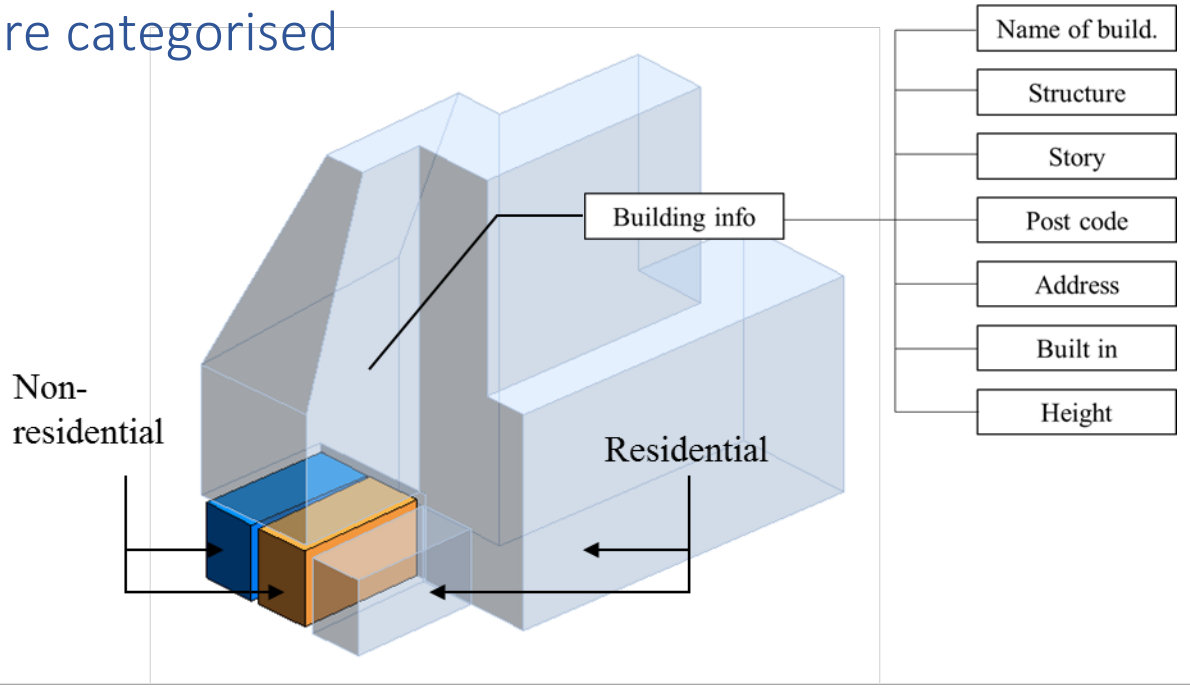
Image / video data

CODESIGN TOKYO

3.1. 3D City Models - Building information

3D geometric model with semantic information

- Each building model is equivalent to **LOD1** (volumetric 3D block models) with **semantic detail** of functional building use
- The share of the **non-residential and residential use** are categorised



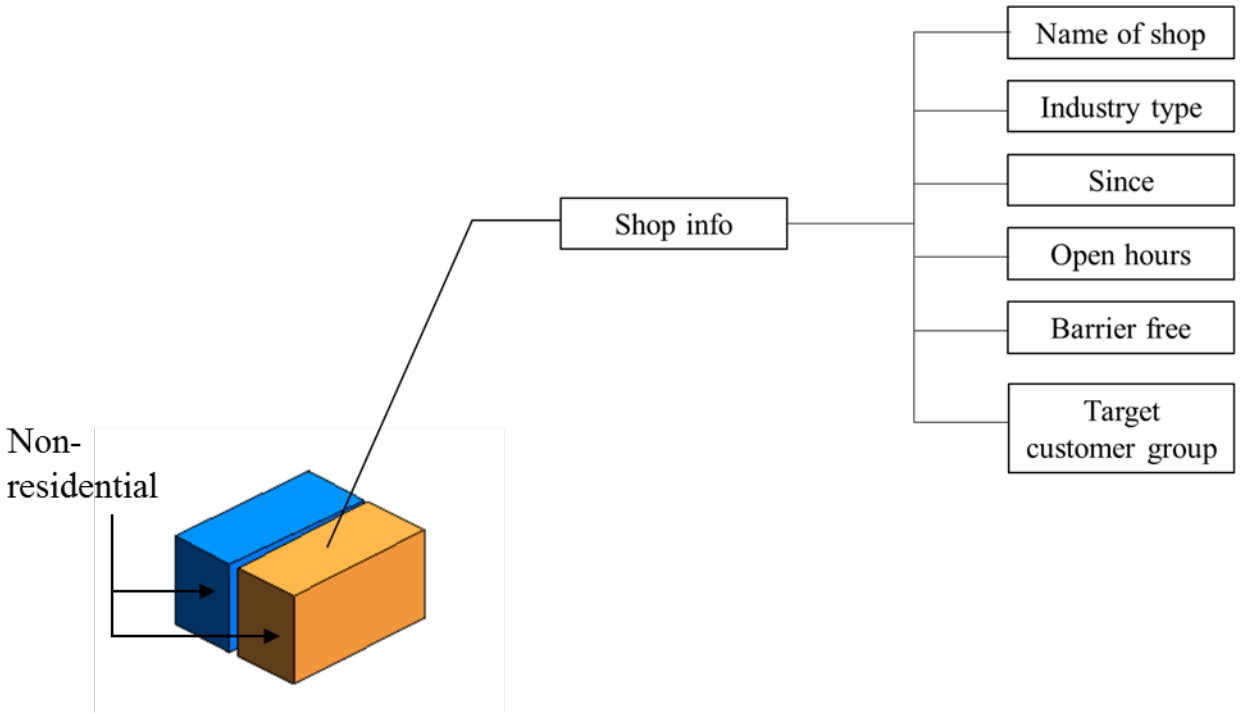
Reference:
Biljecki F, Ohori K A, Ledoux H, Peters R, and Stoter J (2016). Population Estimation Using a 3D City Model: A Multi-Scale Country-Wide Study in the Netherlands. PLoS ONE 11(6): e0156808. doi:10.1371/journal.pone.0156808.

CODESIGN TOKYO

3.1. 3D City Models - Shop information

3D geometric model with semantic information

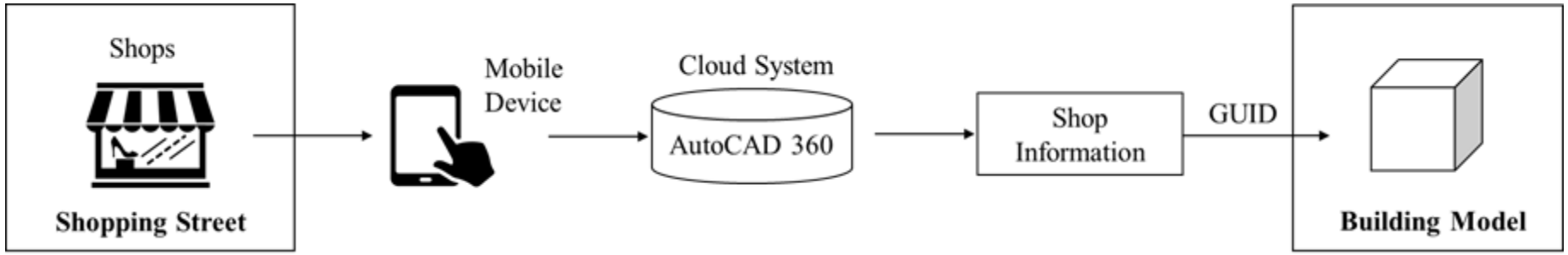
- We focused on **non-residential space** which is associated with shopping domain
- **Shop information**, such as name, industry type, open hours, target customer group etc., is stored as semantic data of a building model



CODESIGN TOKYO

3.1. 3D City Models - field survey

- The field survey was carried out on **cloud environment to collect shop and building information**
- After the survey, the information was extracted to a database which is associated with a building model by **GUID**

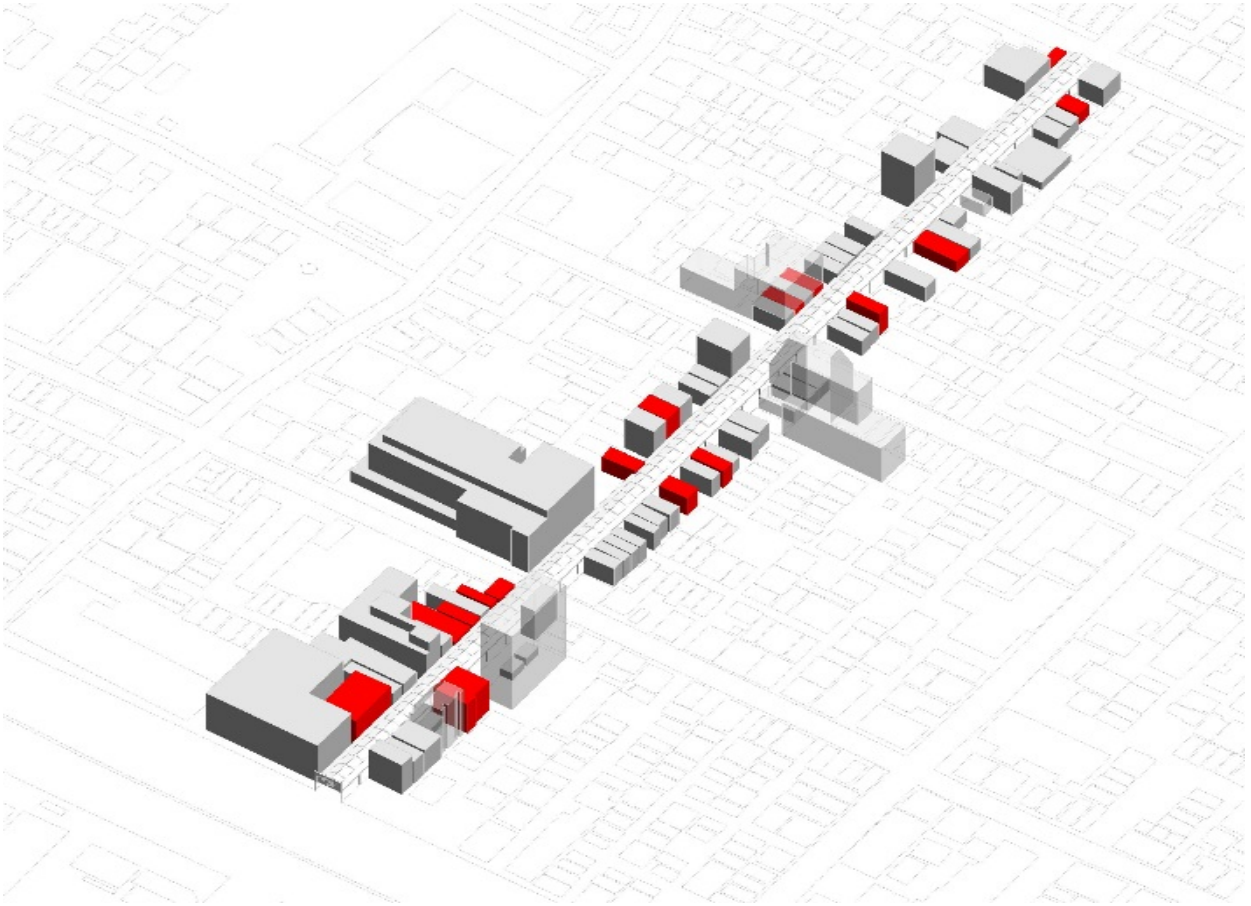


CODESIGN TOKYO

3.1. 3D City Models - Visualisation

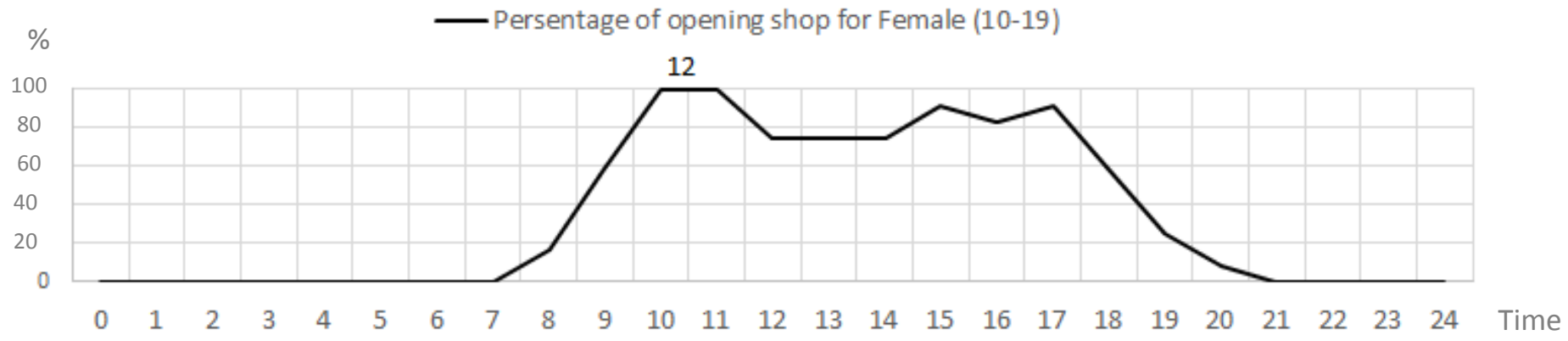
3D geometric model with semantic information

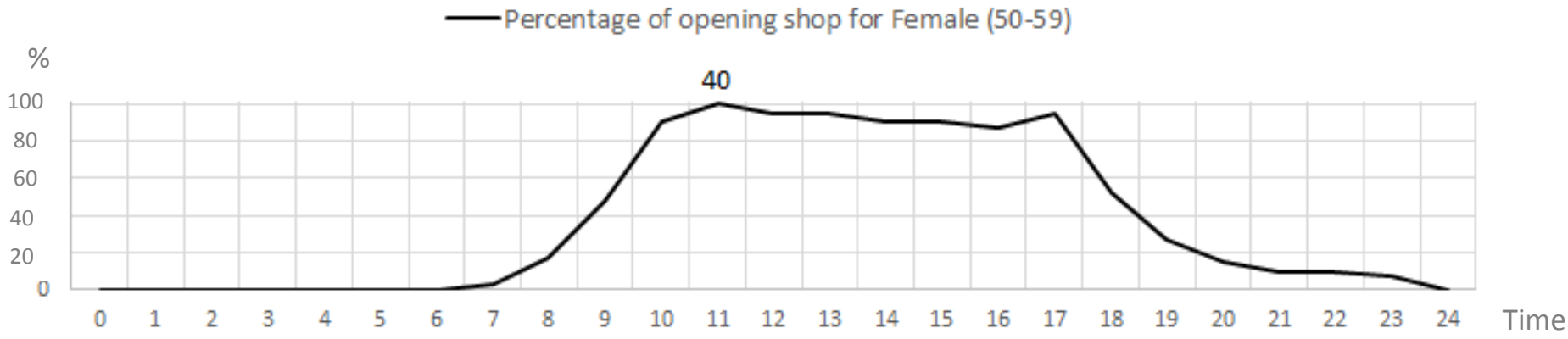
- The retail vacancies on shopping street are **visualised by using semantic data** of a building model



CODESIGN TOKYO

3.1. 3D City Models - Analysis of shop information

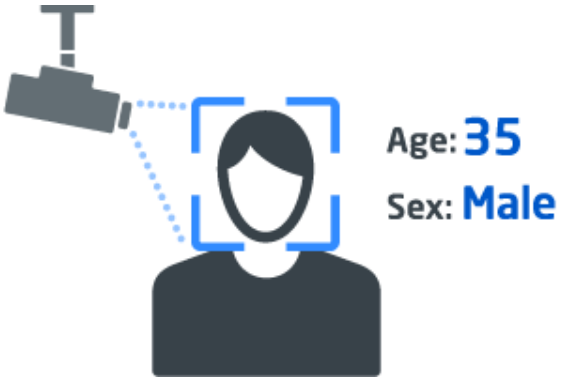




CODESIGN TOKYO

3.2. Pedestrian Flow Data – System structure

- Pedestrian flow data was collected by FieldAnalyst (NEC Solution Innovators, Ltd.)
- The **age** and **gender** of people are detected from captured images
- To meet a need of considering **privacy concerns**, FieldAnalyst **records only analysis results without any images**

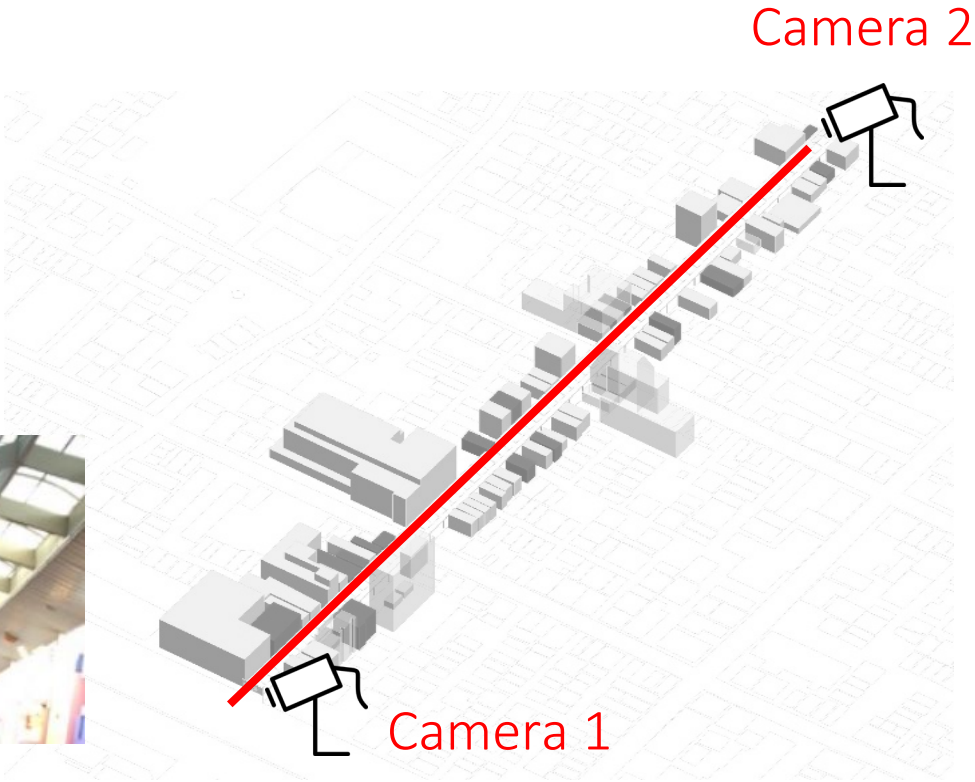


Field Analyst (NEC Solution Innovators, Ltd.)
https://www.nec-solutioninnovators.co.jp/en/sl/fieldanalyst/index.html

3.2. Pedestrian Flow Data - Installation

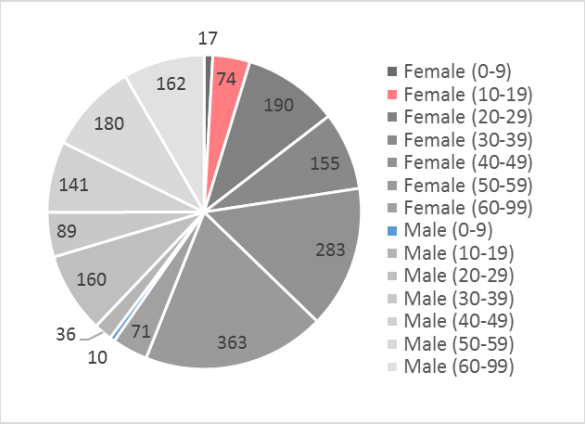
- Two stationary cameras were installed at the start point and end point of the shopping street

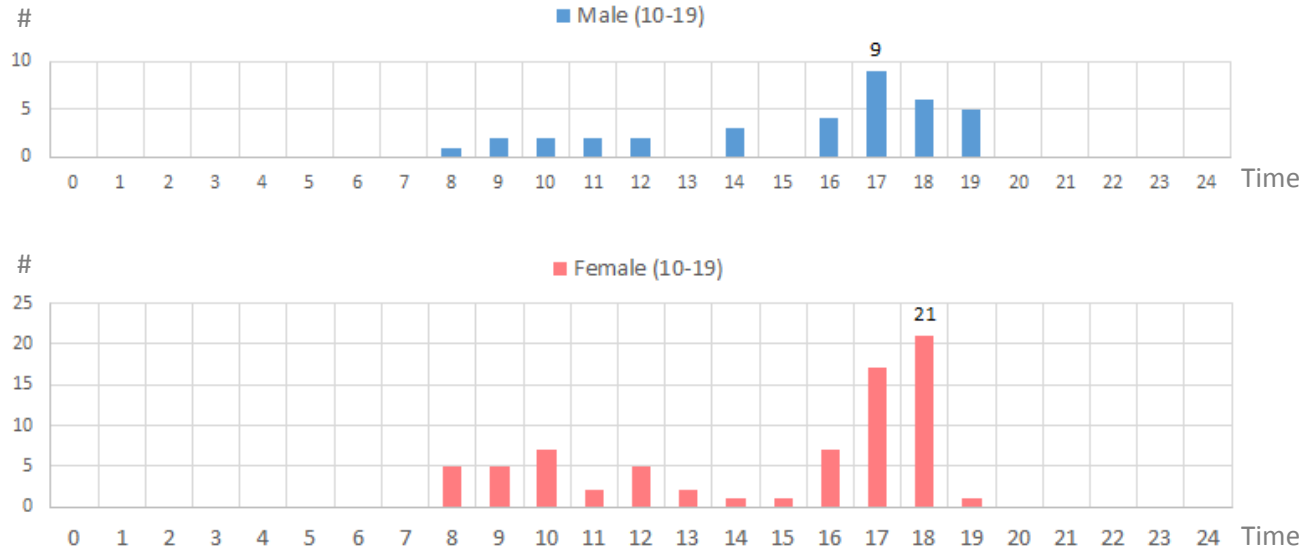
Image / video data



CODESIGN TOKYO

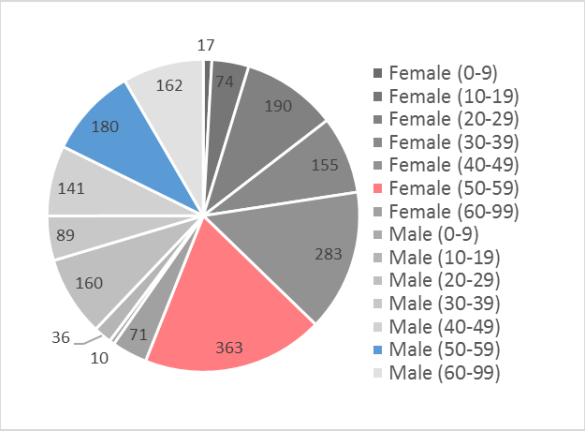
3.2. Pedestrian Flow Data - Analysis

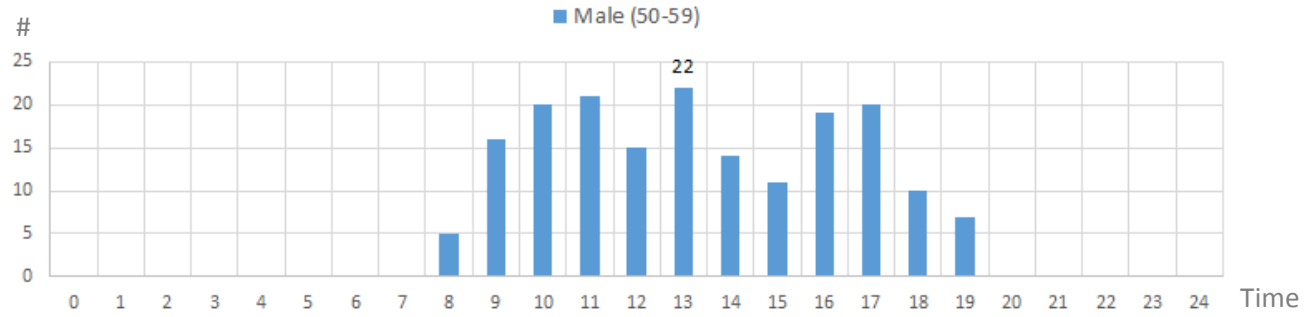


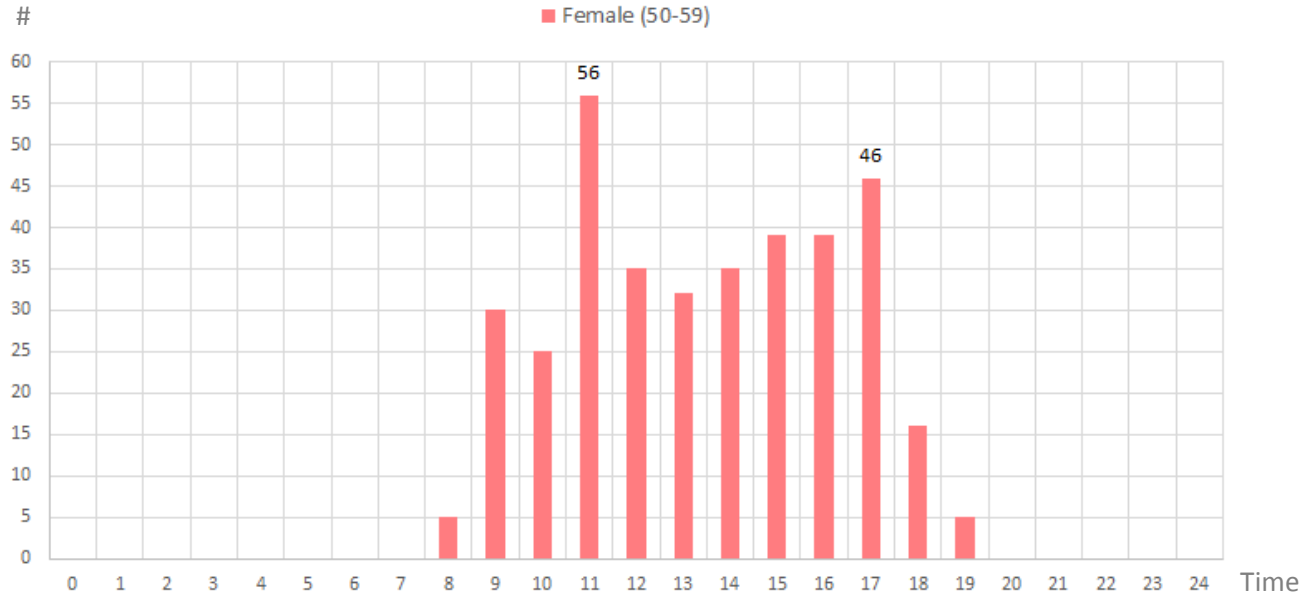


CODESIGN TOKYO

3.2. Pedestrian Flow Data - Analysis

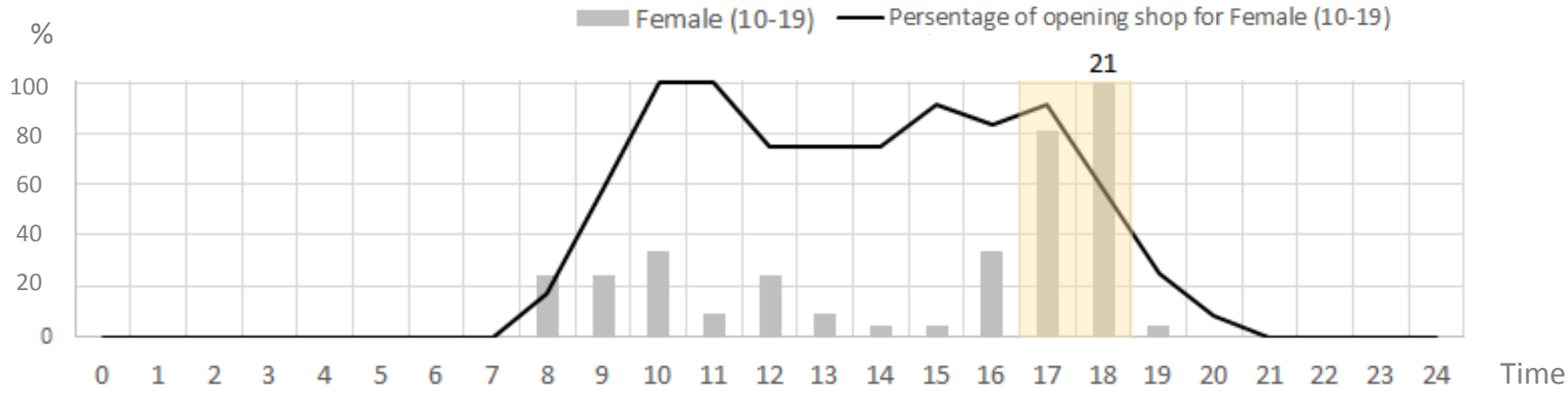


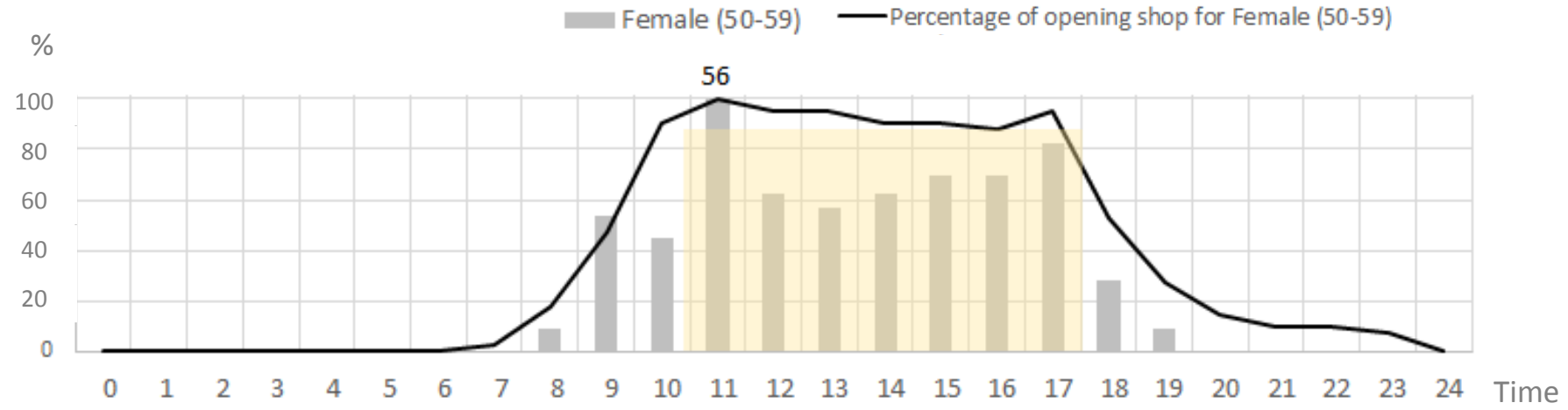




CODESIGN TOKYO

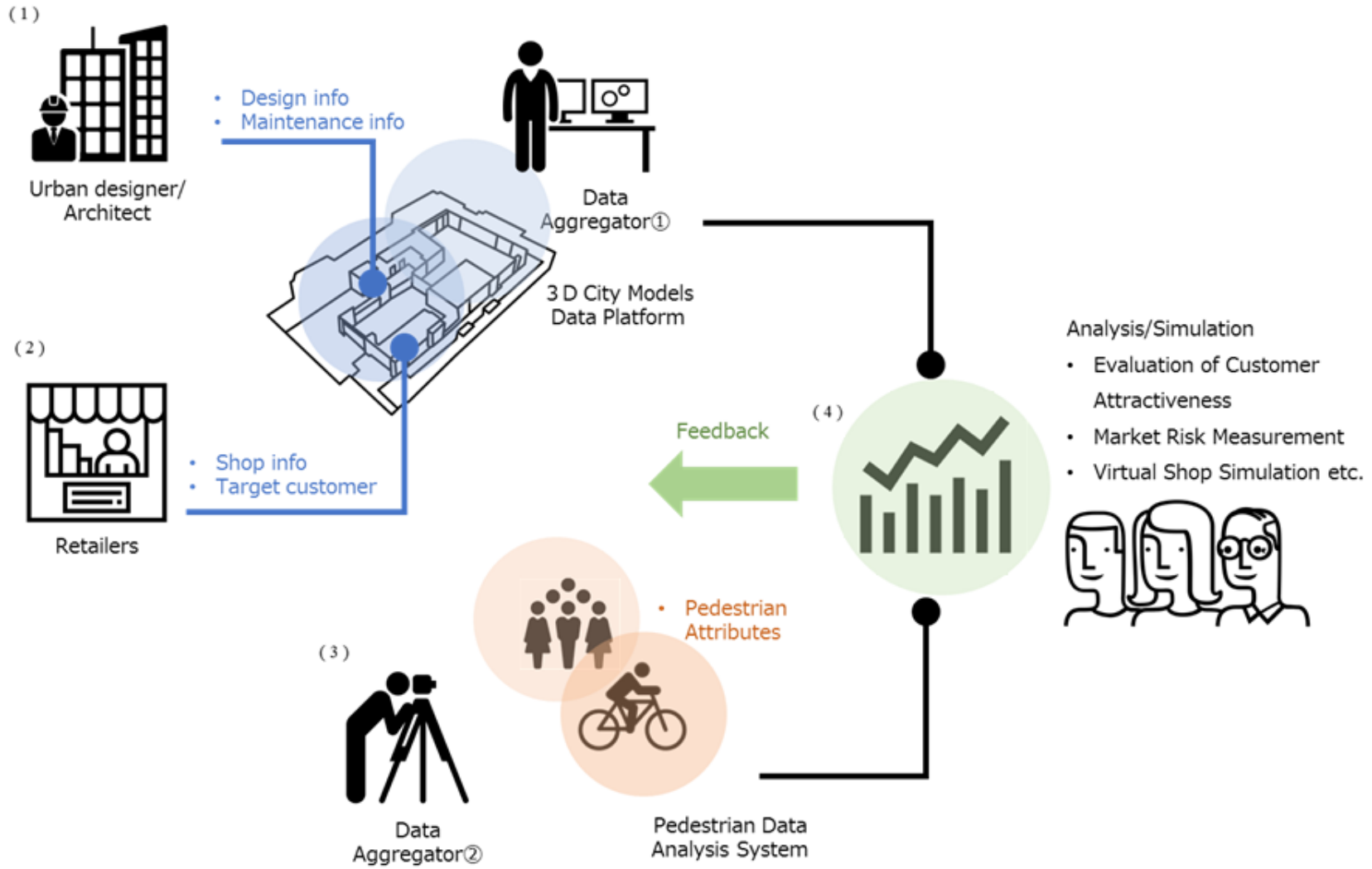
4. Analysis and result





CODESIGN TOKYO

5. Future plan



CODESIGN TOKYO

6. Conclusion

Our results indicate that

- 3D city models can give insights for us to revitalize shopping street in combination with other available consumer data

Things to investigate in the future:

- Test with standard format, such as CityGML, IFC
- Examine how to extract data of target area from existing 3D city models and input them into the analysis system.
- Examine how to shift from low LOD into high LOD

CODESIGN TOKYO

Thank you for your attention.

Eri Kawanago
Managing Director
CODESIGN TOKYO
kawanago@codesign-tokyo.jp