

Research Project 2203C

Development of walkable city evaluation method

Project leader: Tomohiro Ichinose (Faculty of Environment and Information Studies, Keio University)

Project members

Research system

- Members

Tomohiro Ichinose (PL) (Keio Univ.), Rumiko Iwasada (journalist), Masanobu Kii (Kagawa Univ.), Kenji Doi (Osaka Univ.), Keisuke Matsushashi (NIES), Shunsuke Managi (Kyushu Univ.), Akinobu Murakami (Univ. of Tsukuba), Akinori Morimoto (Waseda Univ.) (eight people in total)

- Special researchers

Yusuke Ito (Waseda Univ.), Hiroshi Iwasaki (Chiba Univ.), Teppei Osada (Utsunomiya Univ.), Aya Kojima (Saitama Univ.), Takeru Shibayama (TU Wien), Kayo Tajima (Rikkyo Univ.), Azusa Toriumi (Univ. of Tokyo) (seven people in total)

- Observer

Urban Development Promotion Division, City Planning Bureau, Ministry of Land, Infrastructure, Transport and Tourism

Research background

Project proposal

- Japan faces a rapid population decline and accelerated aging, prompting efforts to create more compact cities. However, simply making the city compact is not enough. In 2019, an advisory panel established by the Ministry of Land, Infrastructure, Transport, and Tourism recommended initiating urban revitalization with a focus on creating "comfortable towns that encourage people to walk." This approach aims to maintain city vitality and enhance appeal, leading to the launch of the "Machinaka Walkable Promotion Program" in FY2020. As of January 2023, 346 cities across Japan have submitted proposals to promote walkability. This study's objective is to elucidate a cross-sectional evaluation method for walkable cities. By examining pioneering examples in Europe and the United States, we intend to develop an assessment method tailored to the unique characteristics of Japanese cities.

We Do!

We do! Building a walkable city

ワクワクする
市民が活躍・
交流する
舞台づくり

できるところから
やってみよう
Let's challenge!

人に優しい空間・
ちょっと寄れる
雰囲気づくり

世界中の多くの都市で、街路空間を車中心から”人中心”の空間へと再構築し、沿道と路上を一体的に使って、人々が集い憩い多様な活動を繰り広げられる場へとしていく取組が進められています。これらの取組は都市に活力を生み出し、持続可能かつ高い国際競争力の実現につながっています。

近年、国内でも、このような街路空間の再構築・利活用の先進的な取組が見られるようになりました。しかし、多くの自治体では、将来ビジョンの描き方や具体的な進め方など、どう動き出せば良いのか模索しているのが現状です。

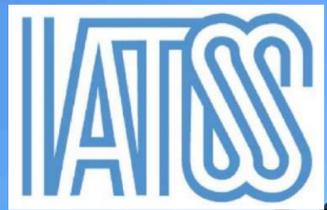
このような背景のもと、国土交通省では街路空間の再構築・利活用に関する様々な取組を推進しております。

Field survey results in FY2020–FY2022

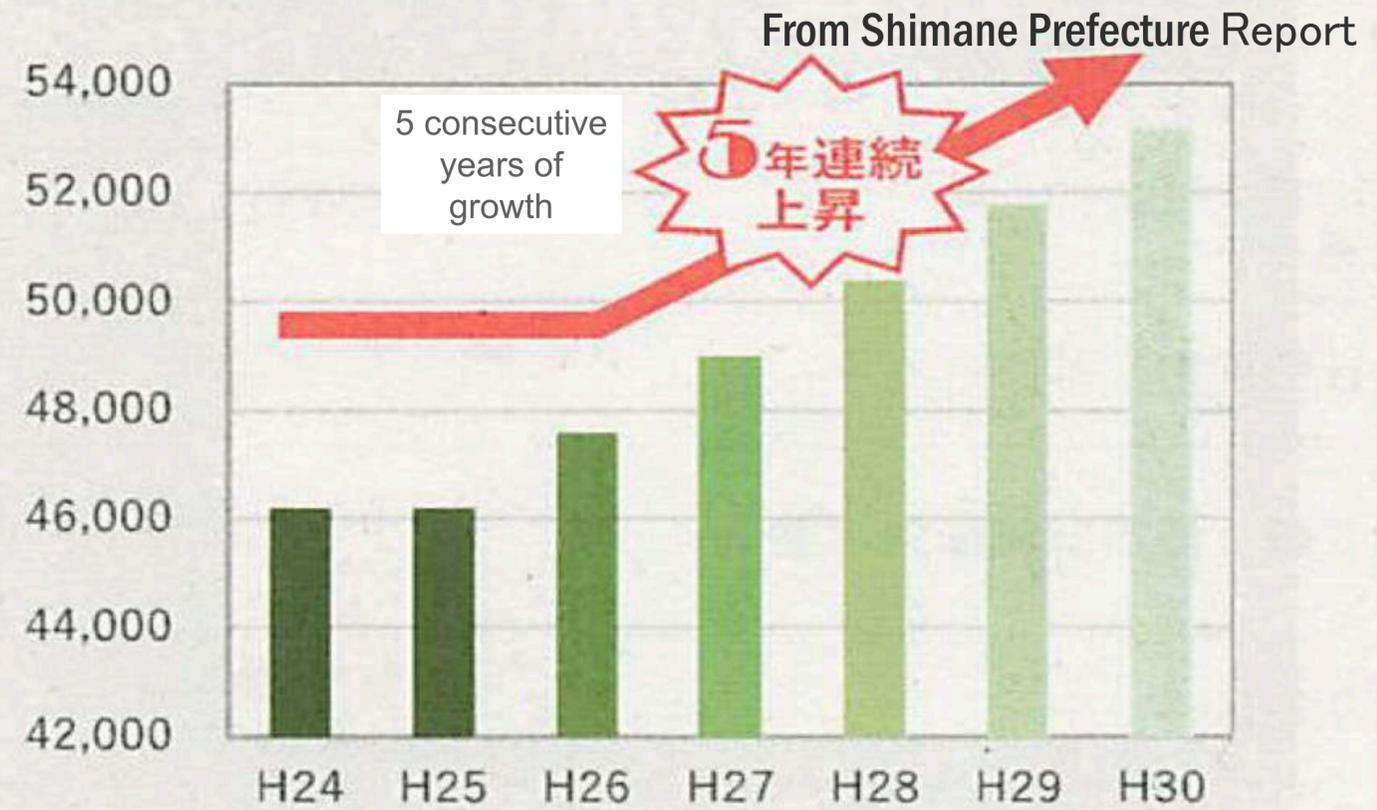
Overseas survey conducted in FY2022 due to COVID-19

- Sep. 2020: Matsue City, Izumo City (Shimane Pref.)
- Nov. 2020: Oita City, Tsukumi City (Oita Pref.)
- Jul. 2021: Matsuyama City (Ehime Pref.)
- Sep. 2021: Takamatsu City (Kagawa Pref.)
- Feb. 2022: Beppu City (Oita Pref.)
- Aug. 2022: Vienna (Austria), Paris (France), Barcelona (Spain)
- Sep. 2022: Boston, New York City (USA)

Shared space in Izumo City

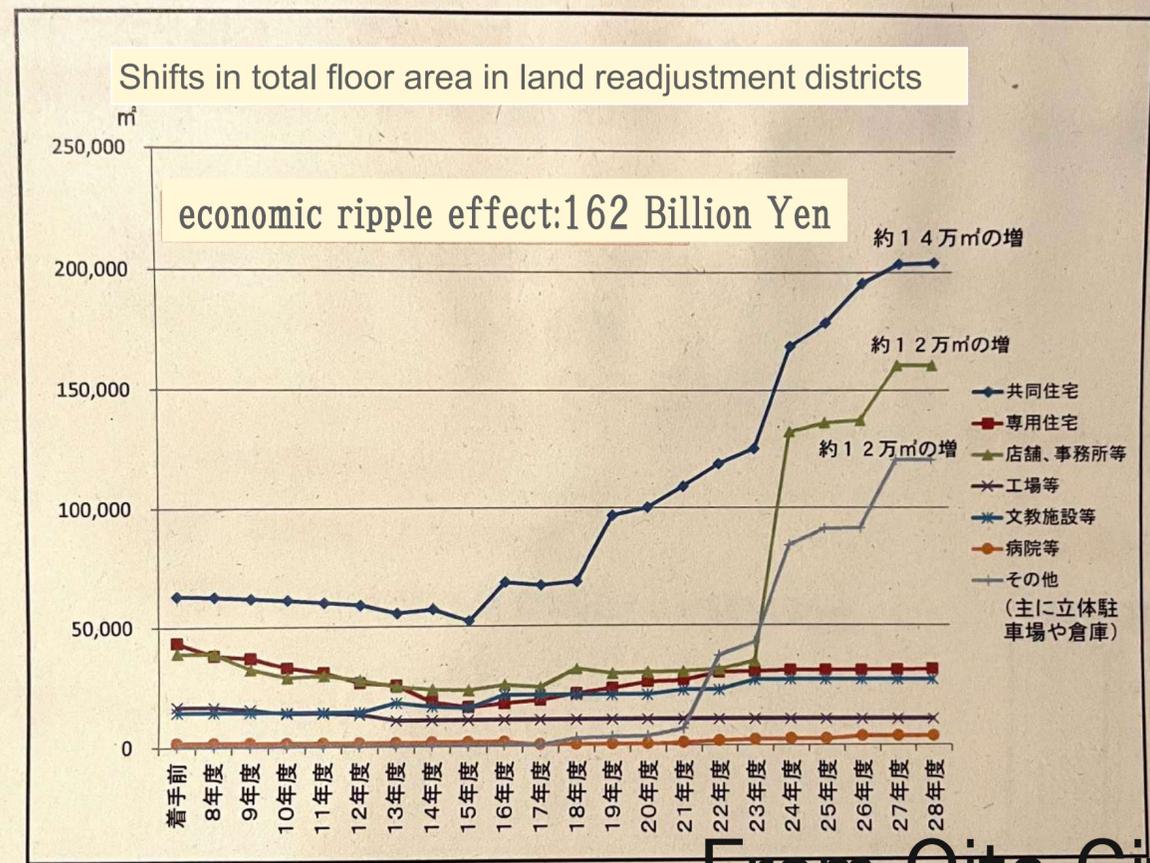


《Standard land price along road》





Oita Ikoi no Michi





Field survey in Matsuyama City

Pedestrian traffic has increased!

Pedestrian traffic volume has doubled compared to before adjustment.



The area is now bustling!

On the widened sidewalks, on every third Sunday of the month, a market event is held by the local shopping street, and the area is crowded with many people, including families.





Takamatsu City Marugamemachi Shopping Street

Current status of pedestrian traffic in central city areas based on camera measurement

From Takamatsu City Report

- ◆計画期間1年目：目標値を大きく上回る結果に → 瀬戸内国際芸術祭開催年でもあったため次年度以降の推移を注視することとした
- ◆計画期間2年目：新型コロナウイルス感染拡大の影響下においても目標値達成 → カメラの精度の検証





Beppu City Kannawa Hot Spring



ふれあいウォーク

<https://www.gokuraku-jigoku-beppu.com/entries/beppu-hatto-walk>



要予約 毎月 第2土曜 1週間前までに要予約 除外日:12/28~1/3、7/25~8/15
 身体障がい者の方(毎回5組以内)対象で、「竹瓦かわい路地裏散歩」に準じたコースを巡ります。※介助者同行をお願いします。



Vienna



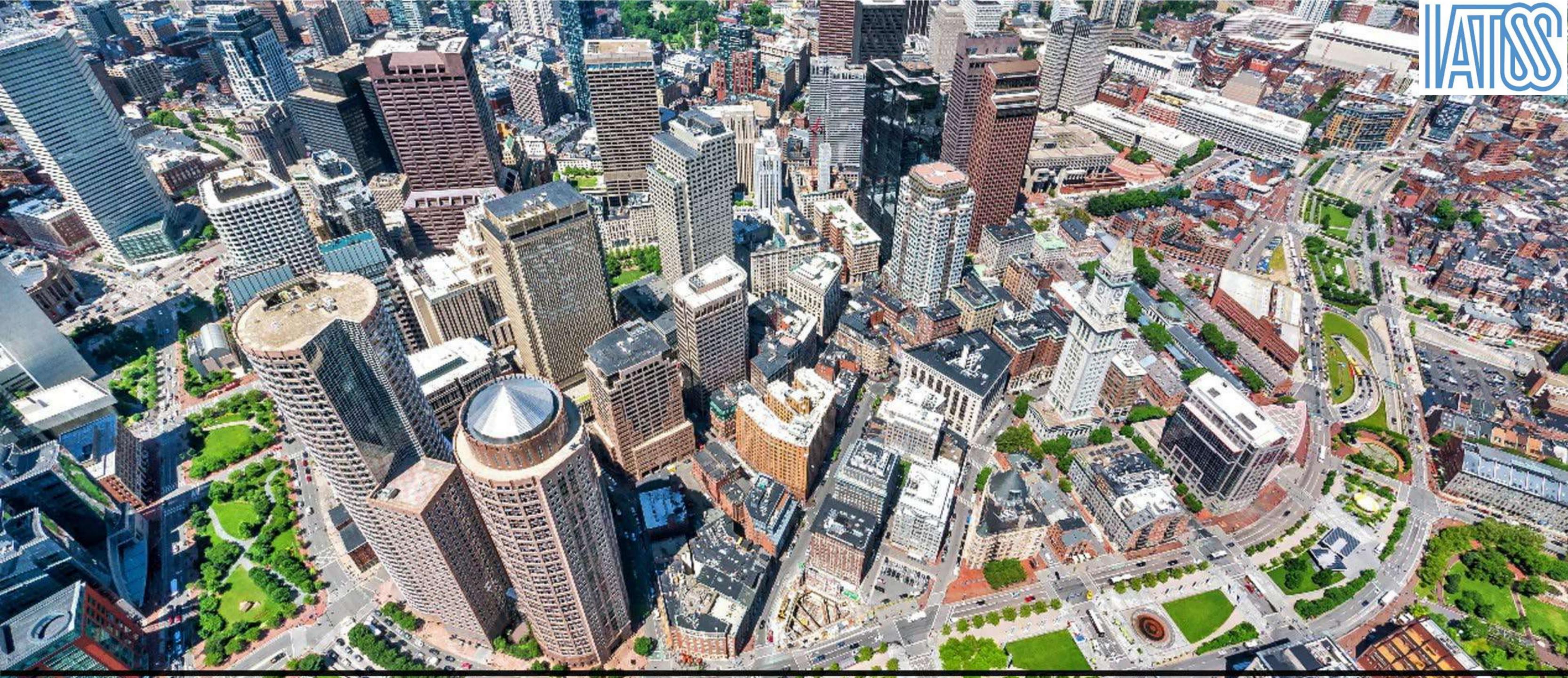
Paris City Center



The High Line, New York City



Times Square, New York City



Central Artery (I-93) and Rose Kennedy Greenway





写真提供:Rose Kennedy Greenway Conservancy



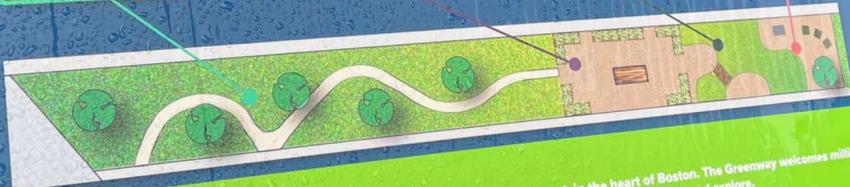
photo courtesy:Rose Kennedy Greenway Conservancy



DEWEY DEMONSTRATION GARDENS ON THE GREENWAY

These gardens are filled with plants creating a thriving, urban ecology, and include raised Edible Garden beds, a Rain Garden of native plants of the Northeastern U.S. and an experimental Urban Orchard. Designed to support a vibrant plant and insect community and showcase plant diversity in an organically maintained landscape, the Demonstration Gardens provide an opportunity to observe sustainable techniques useful in your own home gardens. The goal is to create a visually appealing, dynamic and four-season landscape while providing an educational environment for sustainable and ecological urban gardening practices. Please take a stroll on the paths and explore the gardens!

Pollinator Garden 	Edible Garden 	Rain Garden 	Urban Orchard 
---	---	--	---



THE GREENWAY

The Greenway is the contemporary public park in the heart of Boston. The Greenway welcomes millions of visitors annually to gather, play, unwind, and explore.

The Greenway Conservancy is the non-profit responsible for the management and care of The Greenway. You can help The Greenway and join our valued family of supporters by texting Greenway to 44321 to give.

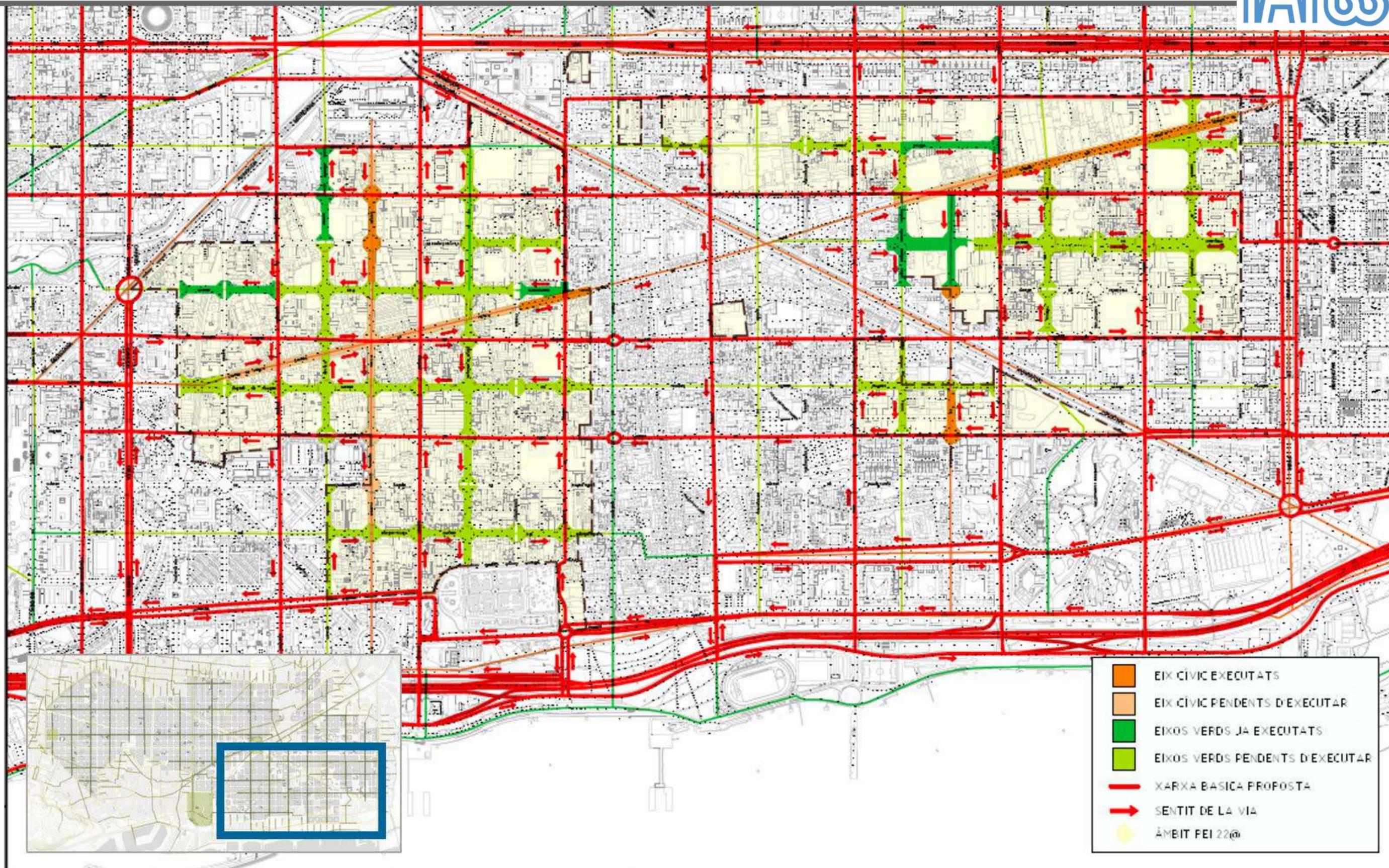


NEW URBAN ROAD NETWORK

Green Axis
-Pedestrians
-Bikes (no bikelane)

Mobility Axis
-Public Transport
-Private vehicles
-Bicycles (bikelane)
-No parking lane

Secondary streets
-Private vehicles
-Parking lane

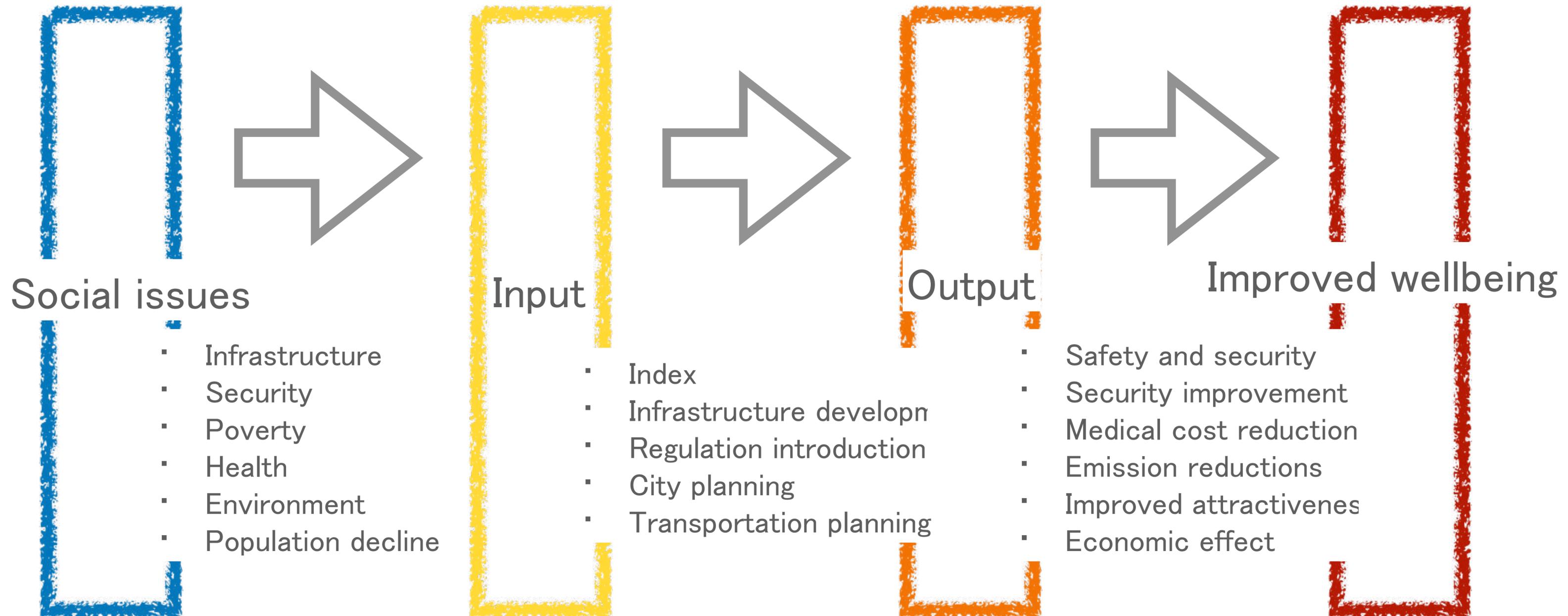






What is the aim of “walkability”?

Organization of inputs according to social issues and outcomes



Walkability index with different scales

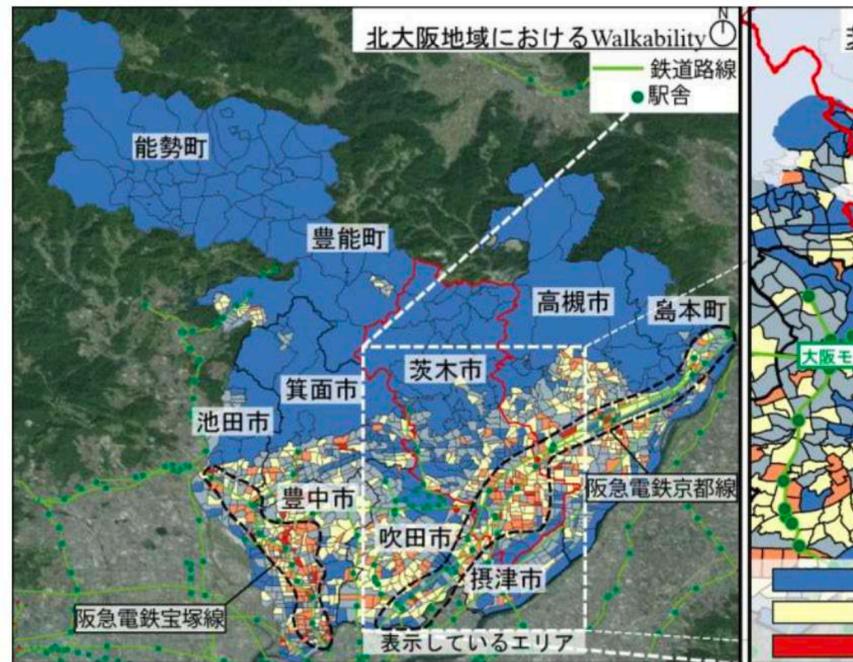
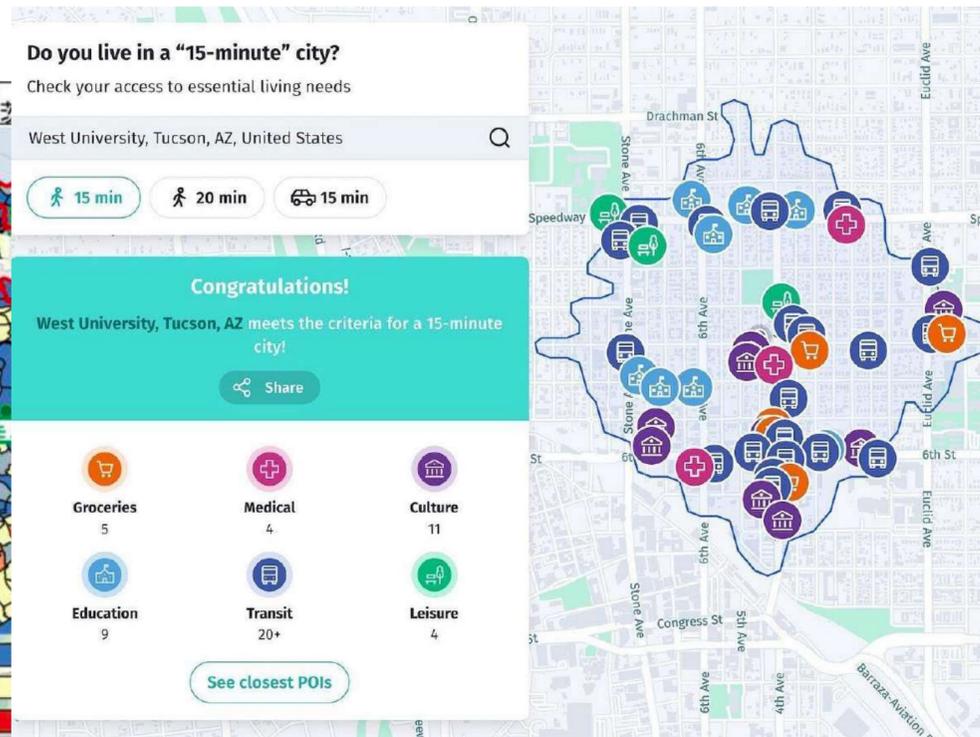


Fig.5 北大阪地域における居住エリアのウォークアビリティ [注13]

Kato and Kanki, 2017



<https://www.15minutecity.com>



Fig. 6. Kentlands has explorable pedestrian scaled streets with varied architecture and landscape (Michael Southworth; with permission)

Southworth 2005

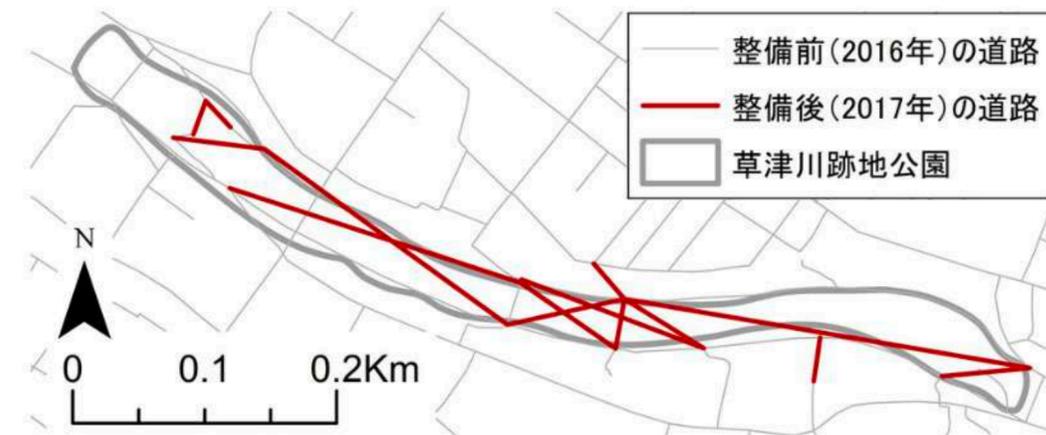


図4 草津川跡地公園内の2 時期の道路ネットワークデータ

Kanai et al. 2019

City

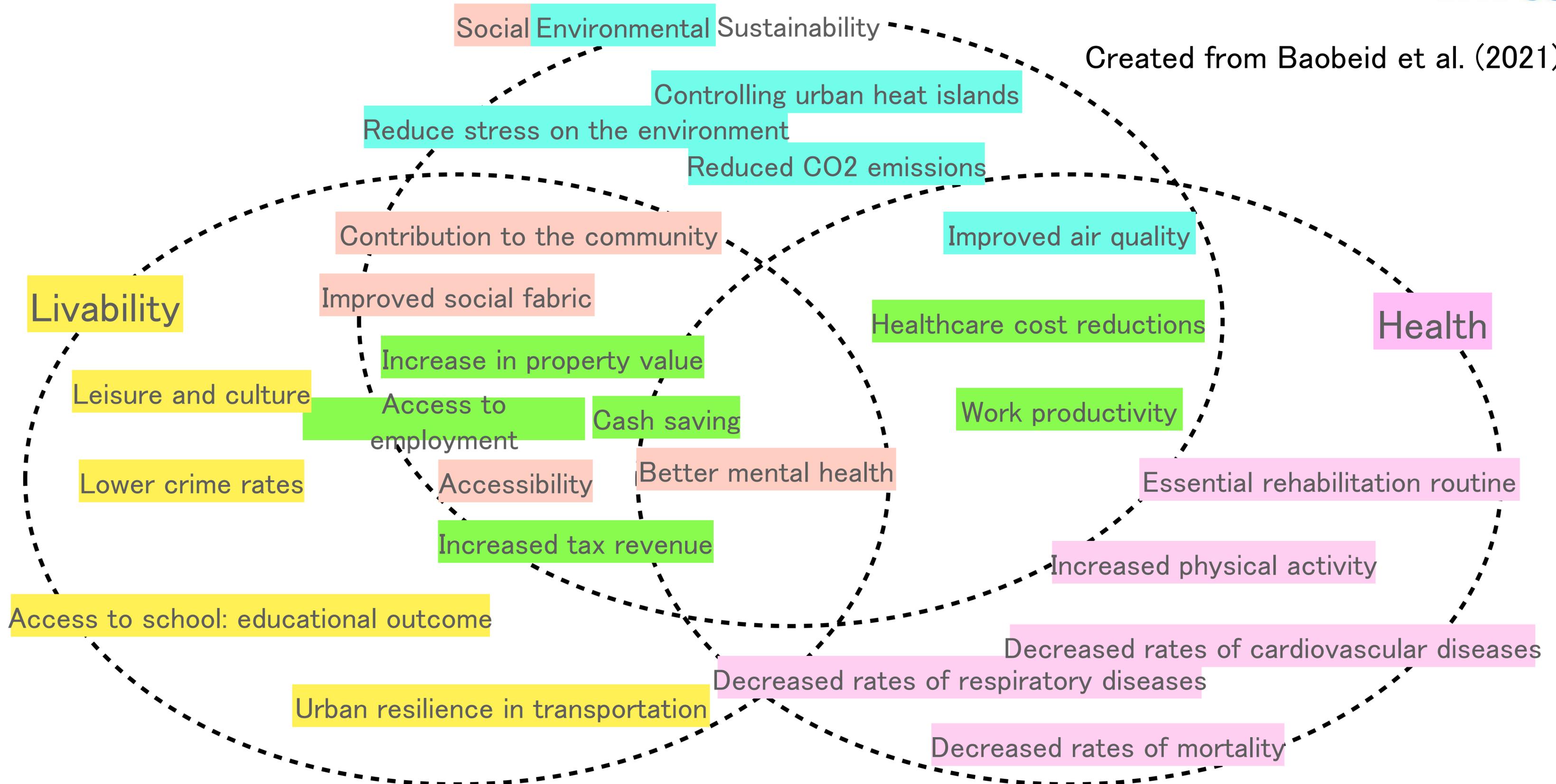
Block

Road structure



Framework for evaluating walkability

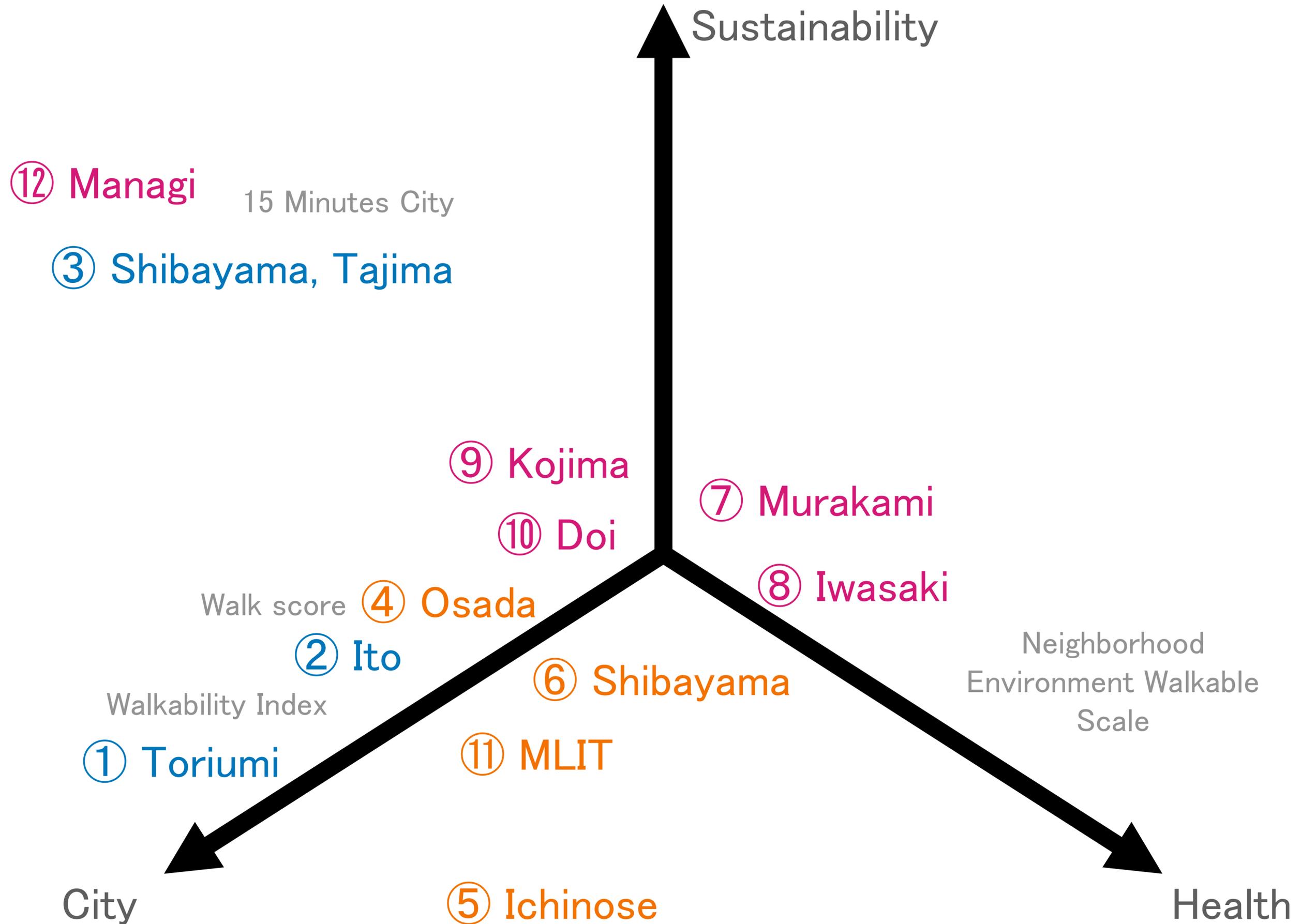
Created from Baobeid et al. (2021)



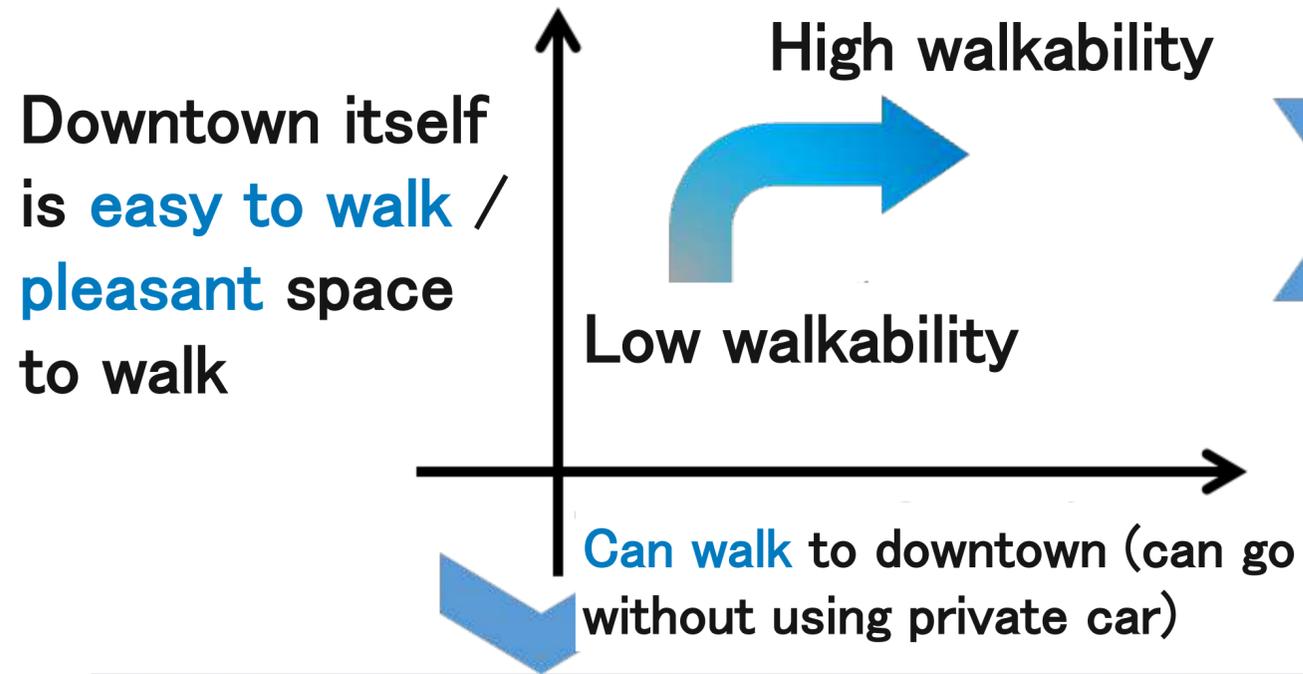
Walkability evaluation method

Created from Maghelal and Capp (2011)

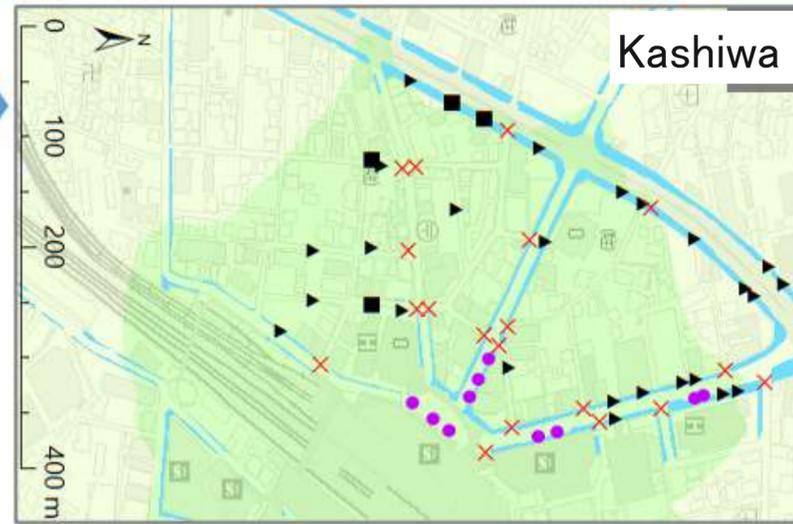
Objective	Subjective	Distinctive
Based on geographic information and traffic surveys	Perceptual, self-reported, and GPS-based tracking	Based on observation
Mixed land use, sidewalk width, and street connectivity	Interview survey (qualitative)	Invisible relationships
Architectural environment analysis	Quantitative and quantitative surveys via GPS	New methods
Quantitative; need to meet objectives	Walking habits	



Evaluation of walkability (Azusa Toriumi)



Walkability in street space (field observation)



5 minutes from station, 10-minute range (downtown)

— Sidewalk × Narrow street access on sidewalk

▲ & ■ Parking lot entrance ● Bus stop

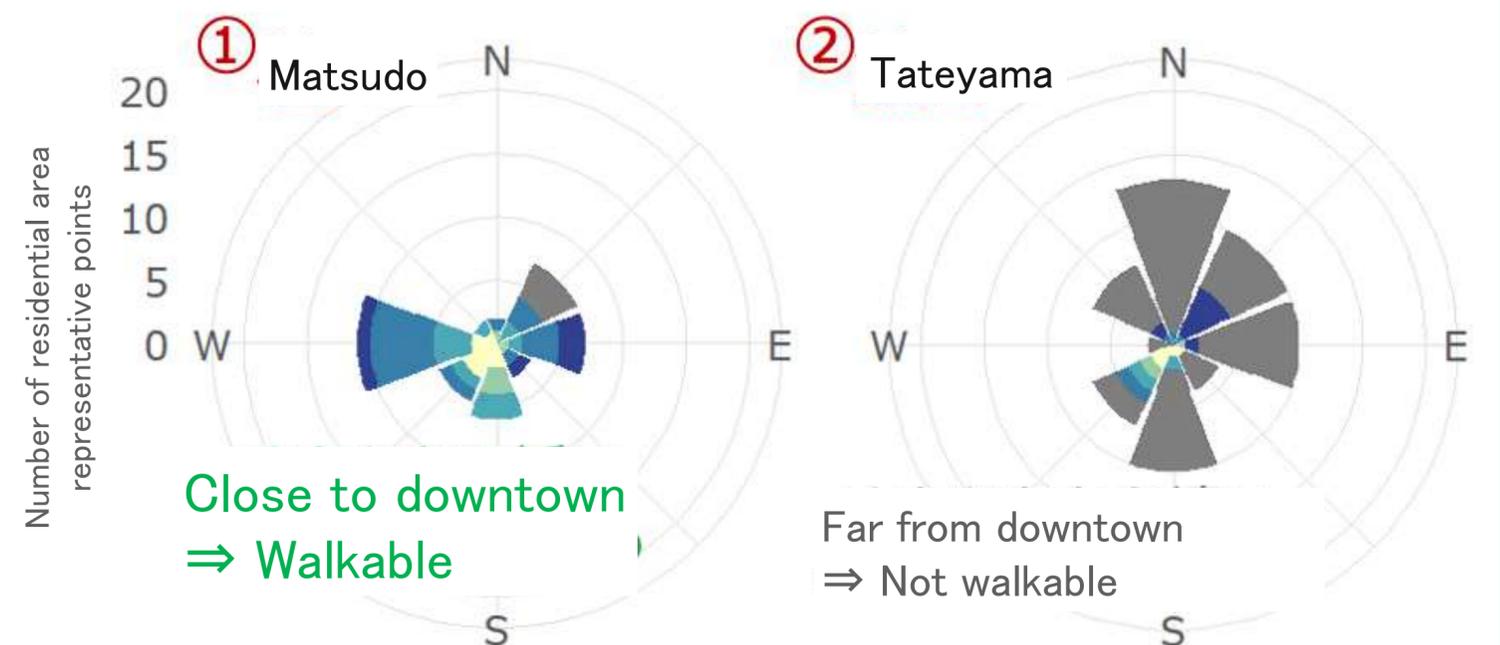
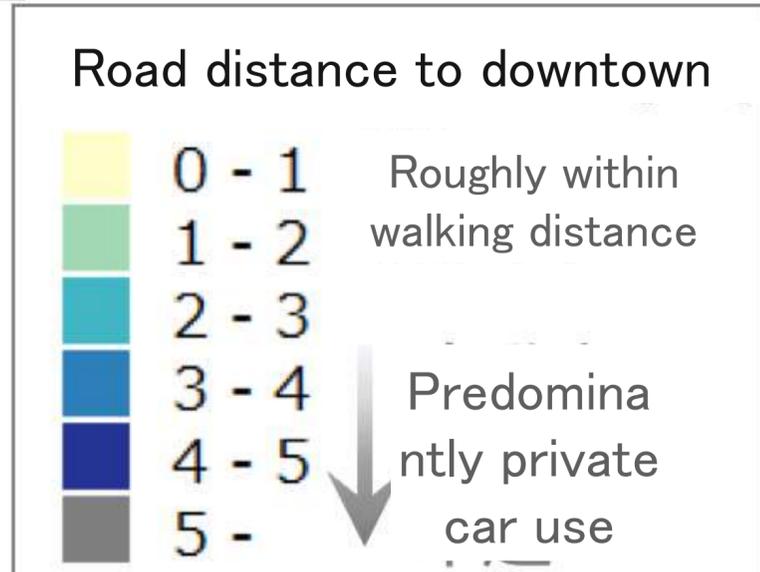
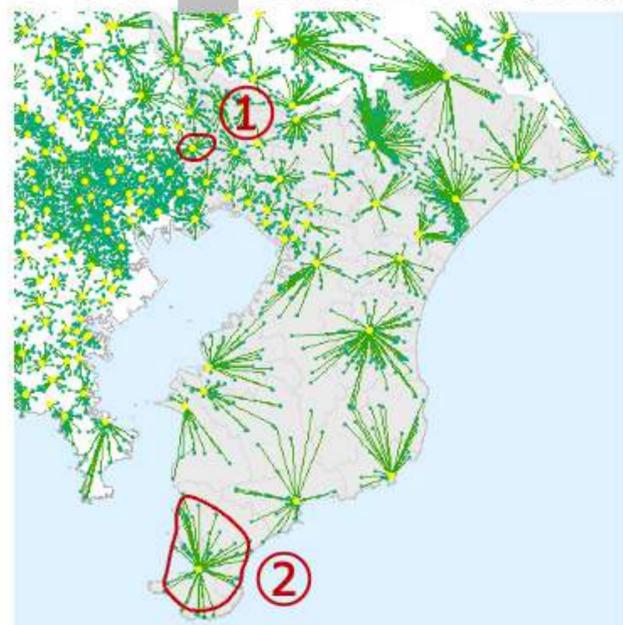
Pedestrians stop, detour, and run at small distances to cars entering from parking lot entrances and narrow streets
⇒ Difficult to walk

Innovations of structures that maintain continuity of sidewalk are an issue

(c) Esri Japan, ZENRIN CO.,LTD.

Walkability from perspective of urban structure (analysis using GIS)

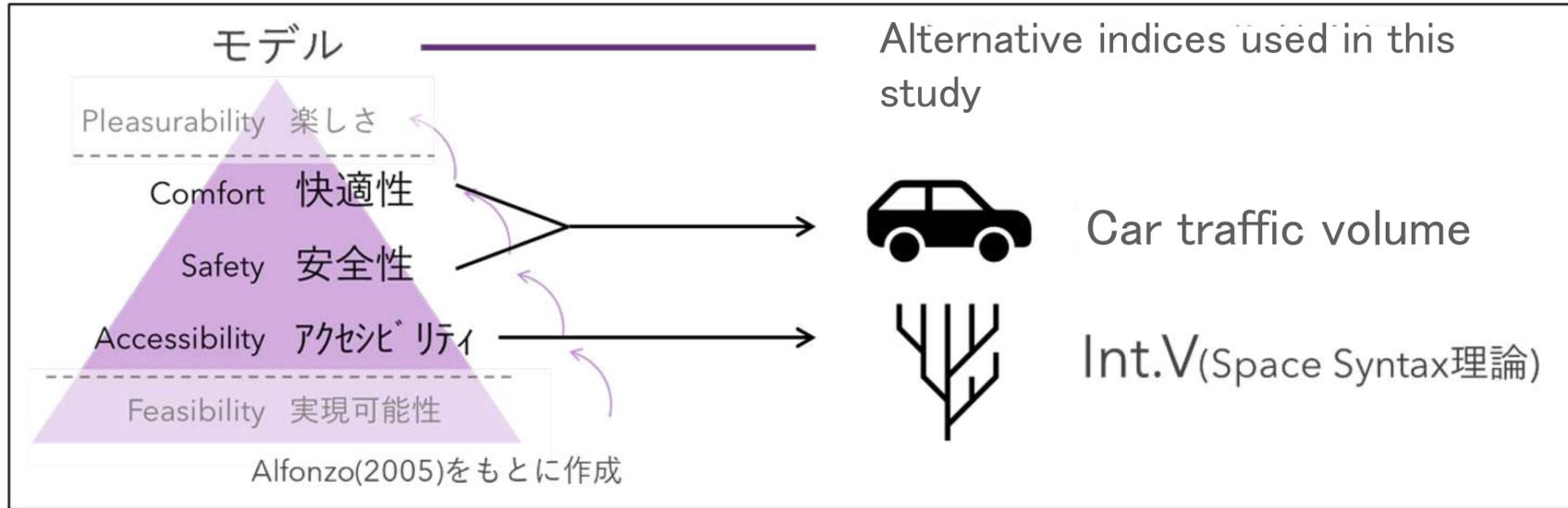
Downtown and residential area representative points



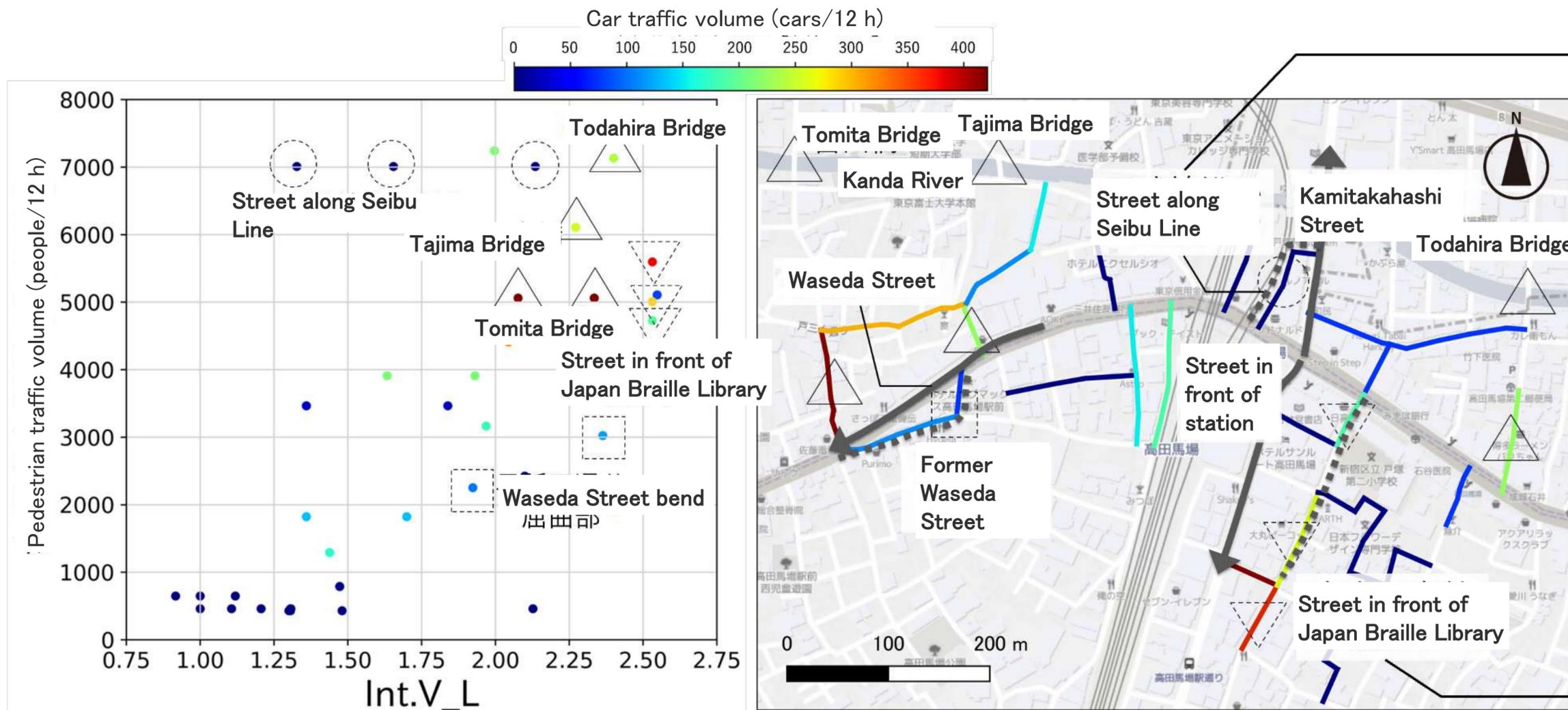
Close to downtown
⇒ Walkable

Far from downtown
⇒ Not walkable

Evaluations using HLC / Space Syntax / car traffic volume (Yusuke Ito)

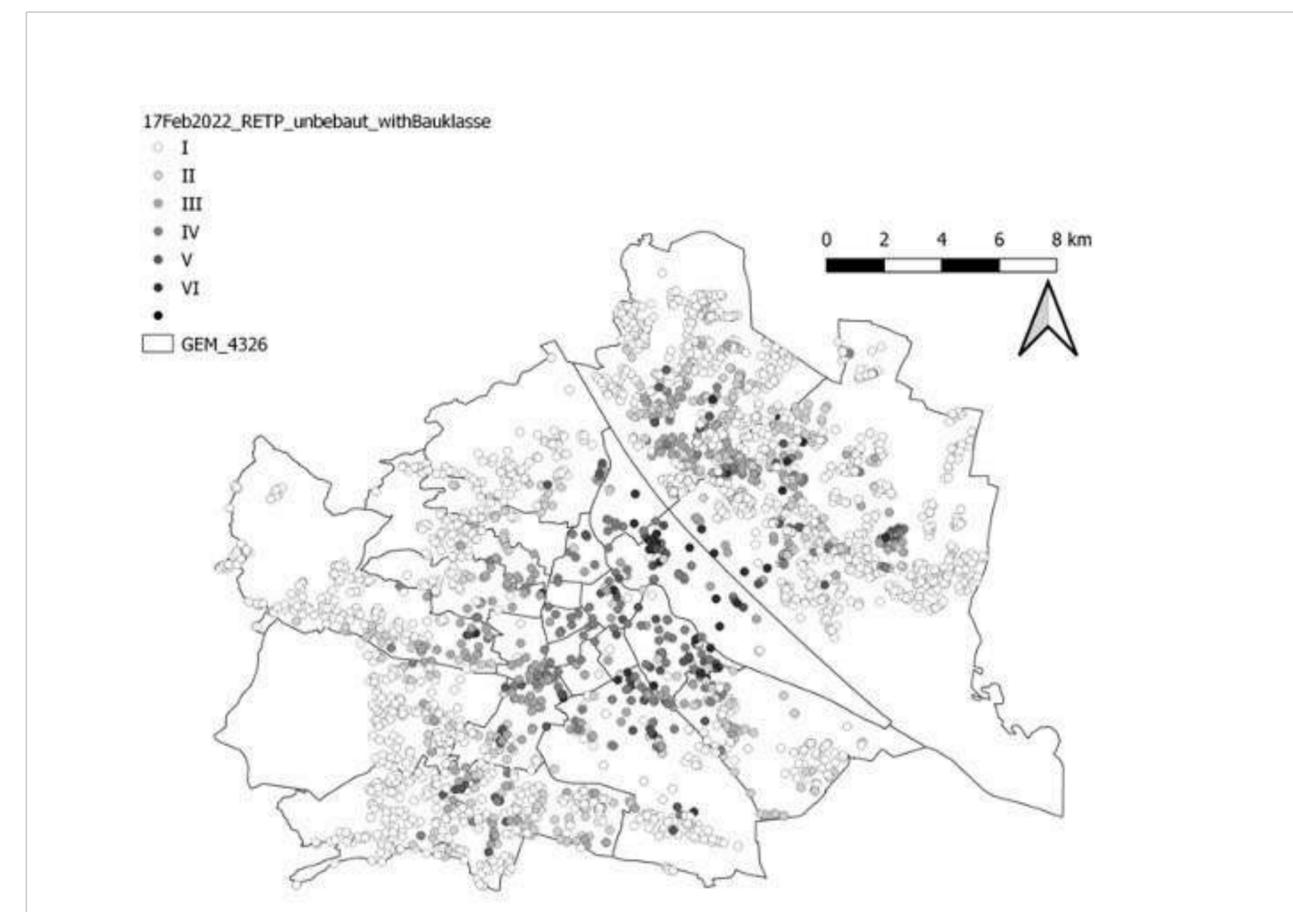


- ▶ Presence of old roads due to HLC, $Int. V \propto$ Walking demand
- ▶ Side road leading to the bridge over the Kanda River has a large amount of pedestrian and car traffic volume
- ▶ Among the old roads, the street in front of the Japan Braille Library has a large amount of car traffic volume and lacks safety and comfort



Relationship between land transaction price and walkability: Data-driven research using government open data (Takeru Shibayama, Kayo Tajima)

- Narrowed down land transaction price data in Vienna from 1973 to 2021 (about 58,000 cases) to about 3,450 vacant land transactions after 2010
- Obtained 17 candidate explanatory variables, including building regulations (height regulations), public transportation service levels, road surface (pavement, etc.), trees, actual land use, land diversity index, number of restaurants, etc. Spatially combined with land transaction price data using GIS
- Hedonic approach used to conduct multiple regression analysis with three patterns: (a) all data, (b) stratified by building regulations, and (c) stratified by land use. Quantitative study of explanatory variables that affect the valuation of walkability through land transaction prices
- Influence of road pavement surface (aesthetics such as stone pavement, road greening, walkable area, etc.), number of trees, and amenities (number of restaurants) are more strongly influenced in low-rise residential areas than high-rise areas and commercial/industrial areas
→ Various parameters that have been discussed in the (English) literature on walkability are more strongly reflected in land transaction prices in low-rise and residential areas
- Population density is more strongly reflected in land transaction prices in areas where high-rise building construction is possible



結果を“Exploring government open data: understanding contributions of better walkability to real estate pricing” by Norihiro Miwa, Takeru Shibayama, Kayo Tajima として WCTR (World Conference in Transportation Researchers) 2023 へ投稿 (2022年末)、2023年2月に Accept(AB) 学会発表採択 + 国際誌への推薦対象との通知あり

Measurement using an infrared sensor (Utsunomiya City) (Teppei Osada)



<Overview of equipment used>

PYRO-Box : PYRO-Box: designed, developed, and manufactured by Eco-Counter (France), detects heat radiated from human body and counts traffic volume

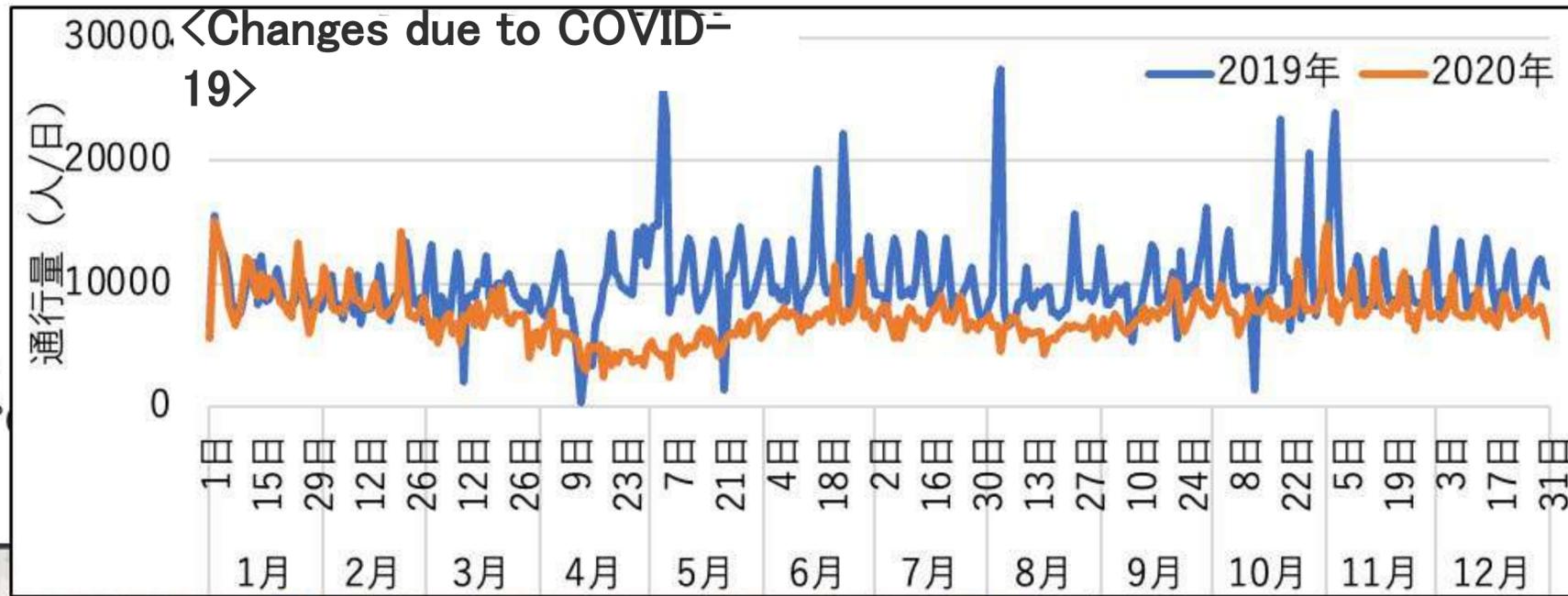


Dimensions: 23 × 10 × 18 cm
 Mass: 2.6 kg, water resistance IP166
 Operating temperature range: -40 degrees to +50 degrees

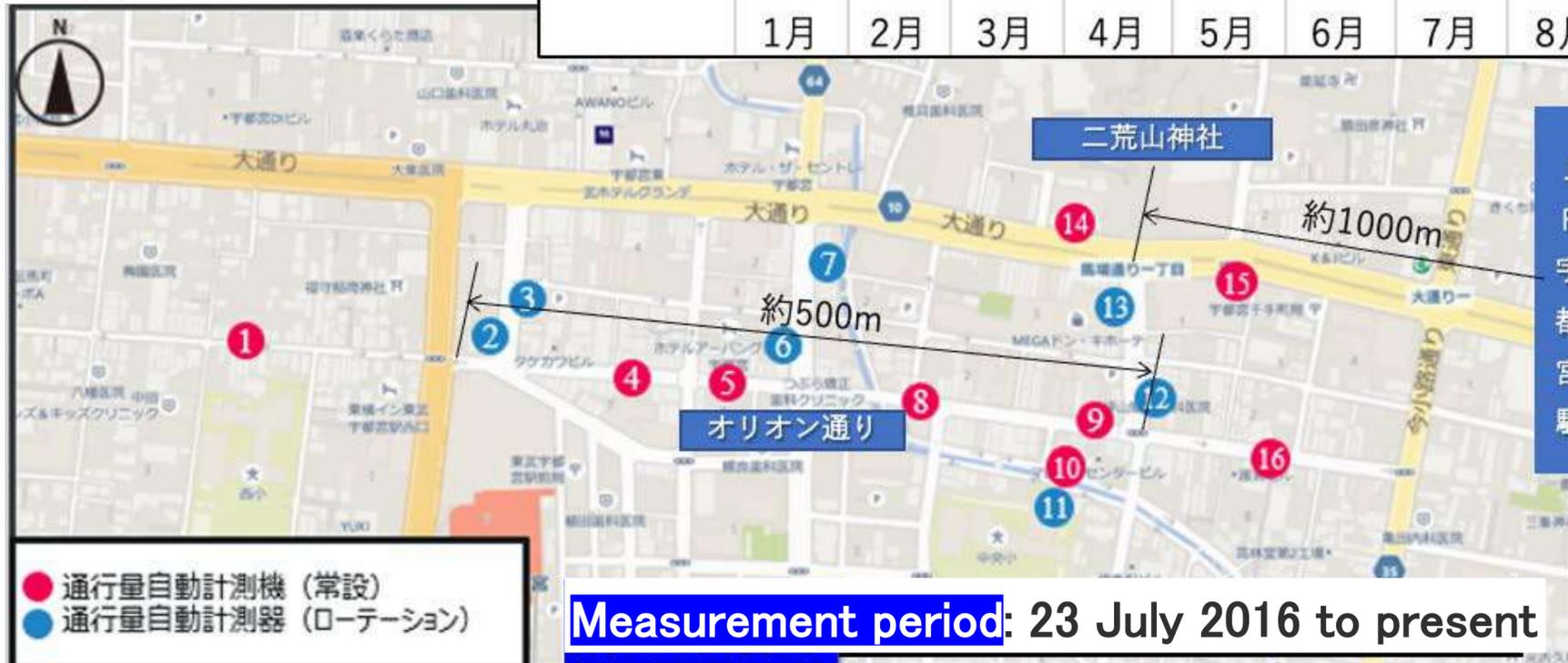
<Effects of opening base facilities>



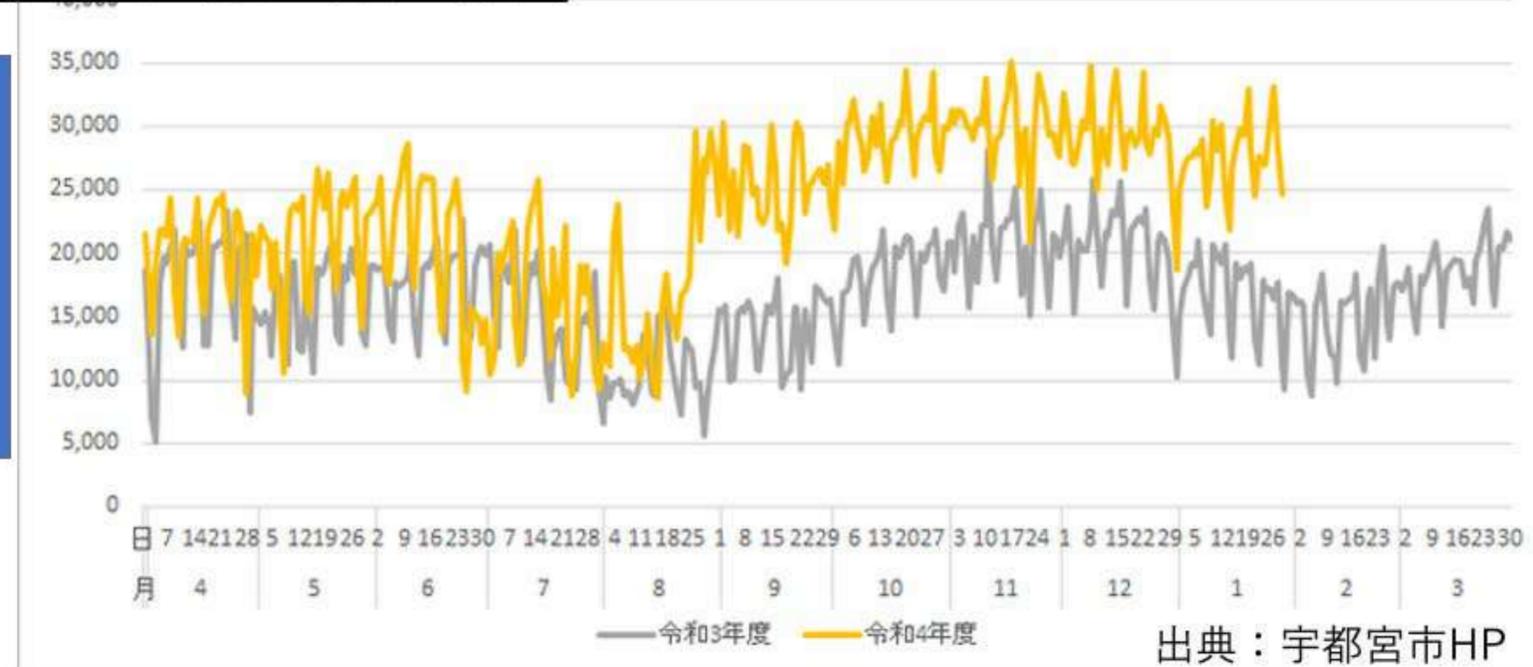
提供：宇都宮市



<Measurement point>



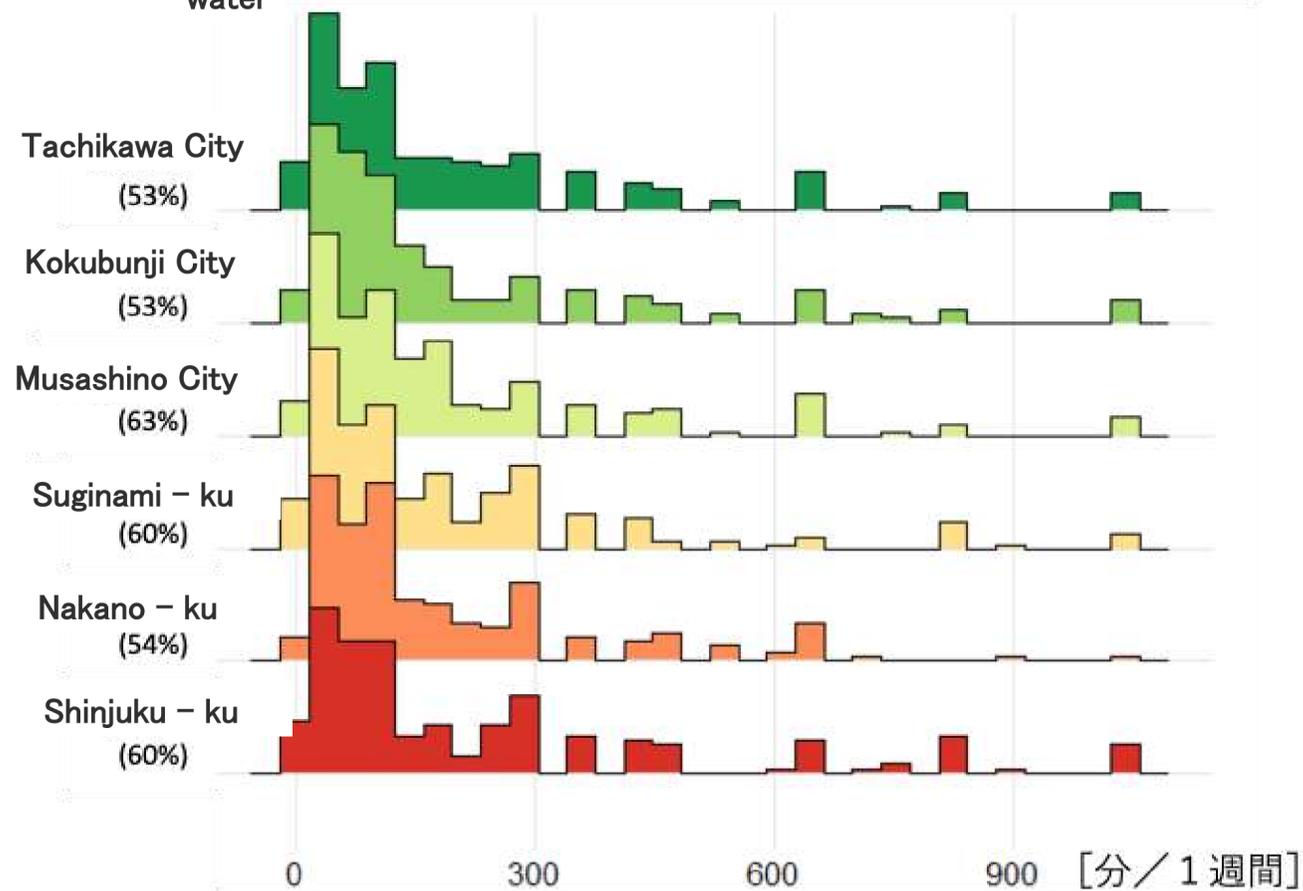
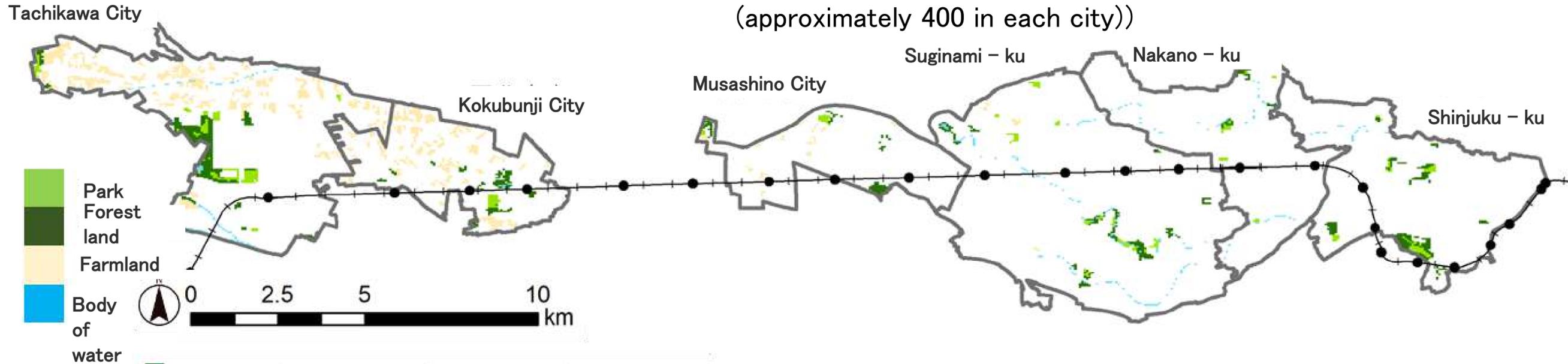
都宮駅(東口東西自由通路)の通行量
 測定のため、看板などの障害物により、計測されないことがあります。



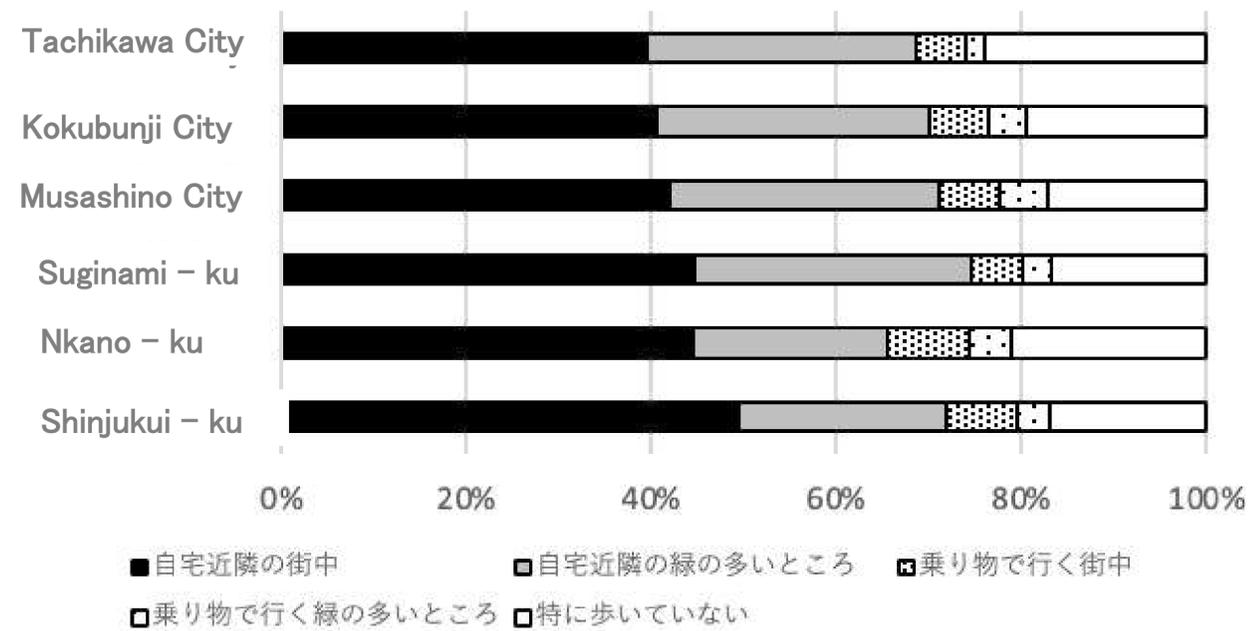
出典：宇都宮市HP

Walkability evaluation during the COVID-19 pandemic (Tomohiro Ichinose)

Implementation period: 14–22 March 2022 | Target area: six cities along Chuo Line | Number of valid respondents: 2,446 people (approximately 400 in each city)



Histogram showing length of time spent walking during leisure time
Created for respondents who walked at least one day a week, percentage in parentheses



Locations usually walked during leisure time (multiple answers allowed)

Impression is that walking to work or school does not have much effect on the frequency and length of walking during leisure time.

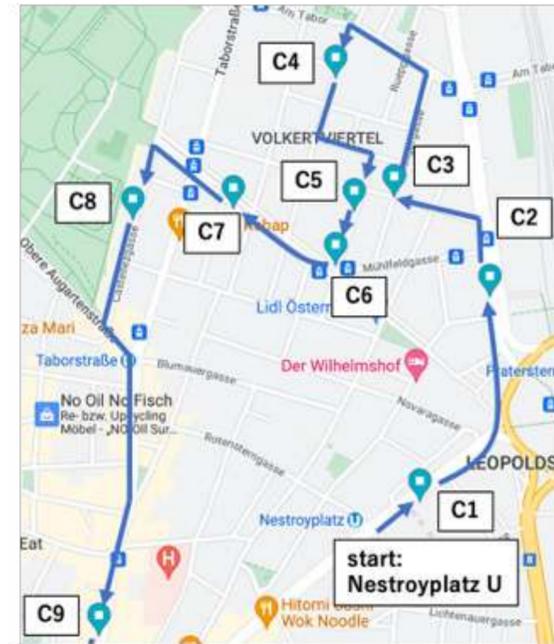
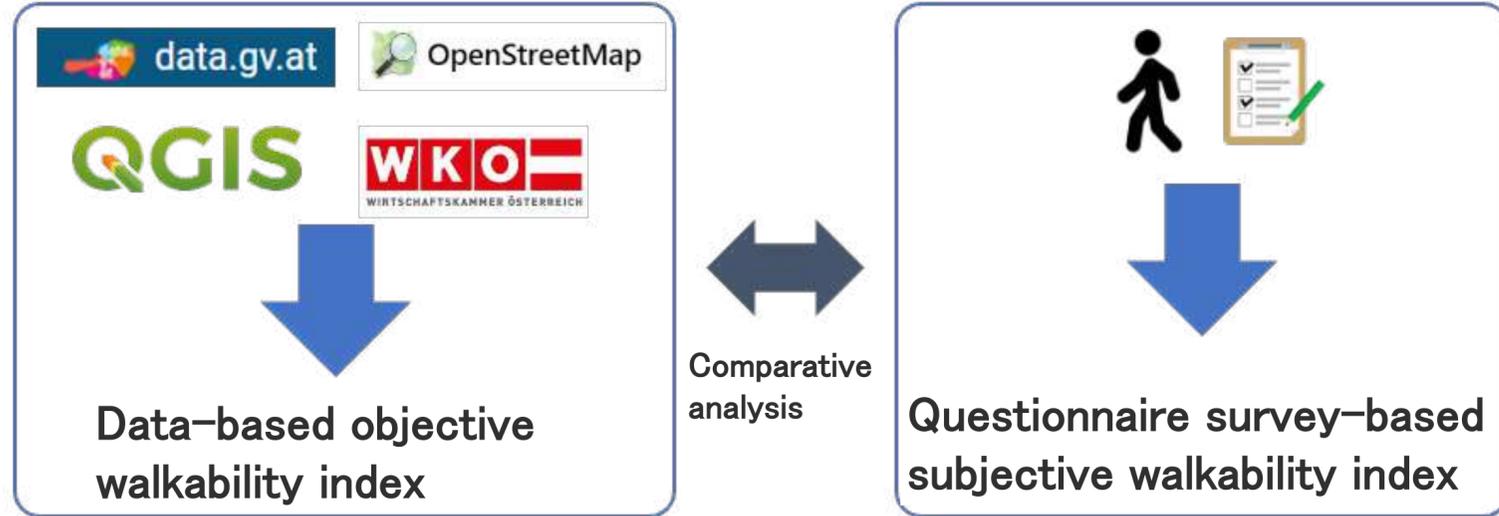
Characteristics of each municipality are described below

- Shinjuku-ku: Highest number of people who walk for 90 minutes or more. Many people walk around neighbourhood. Not much nature, but fair number of amusing things to look at.
- Nakano-ku: No long walks, and walking frequency is also low. Little attractive nature, and nothing particularly fun to look at.
- Suginami-ku: Average area. Between Shinjuku City and Musashino City in terms of town and green space evaluation.
- Musashino City: Highest number of people who walk the most and who walk for about 60–90 minutes. Atmosphere of town and green spaces are most regarded.
- Kokubunji City: Tachikawa City: Many people do not walk much. Large amount of attractive nature, but no fun things to look at or buildings.

Comparative analysis of objective and subjective walkability (Takaji Shibayama)

Questionnaire survey conducted near centre of Vienna

Analysis framework



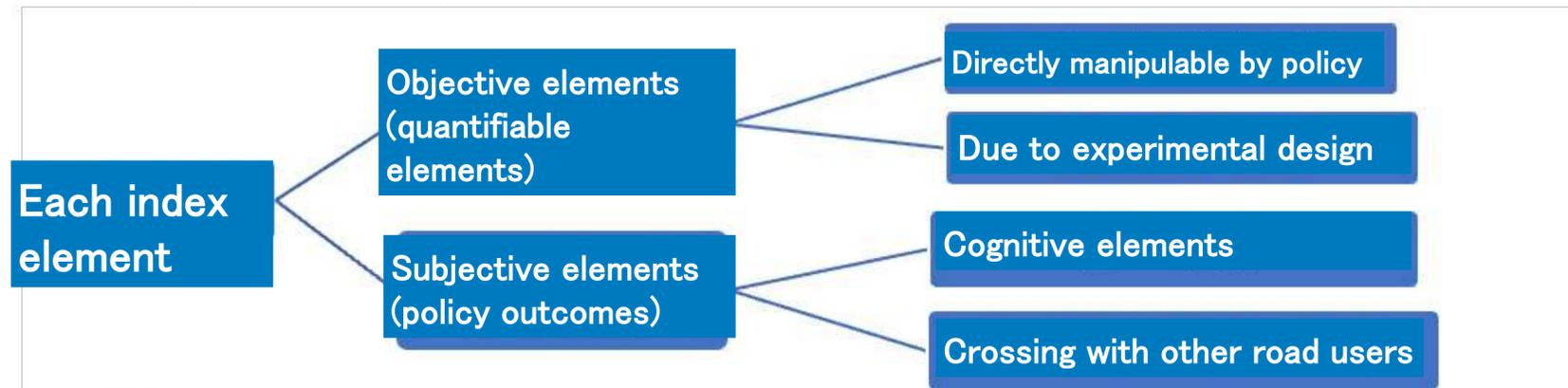
78 subjects were asked to actually walk on designated street for about one hour, and a subjective 'walkability evaluation' was obtained from the questionnaire

Classification of walkability index

Categorising components of walkability from perspective of civil engineering and urban planning

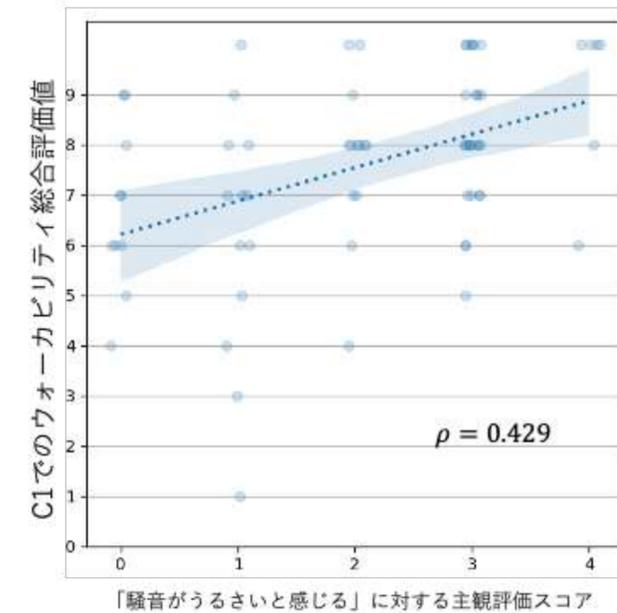
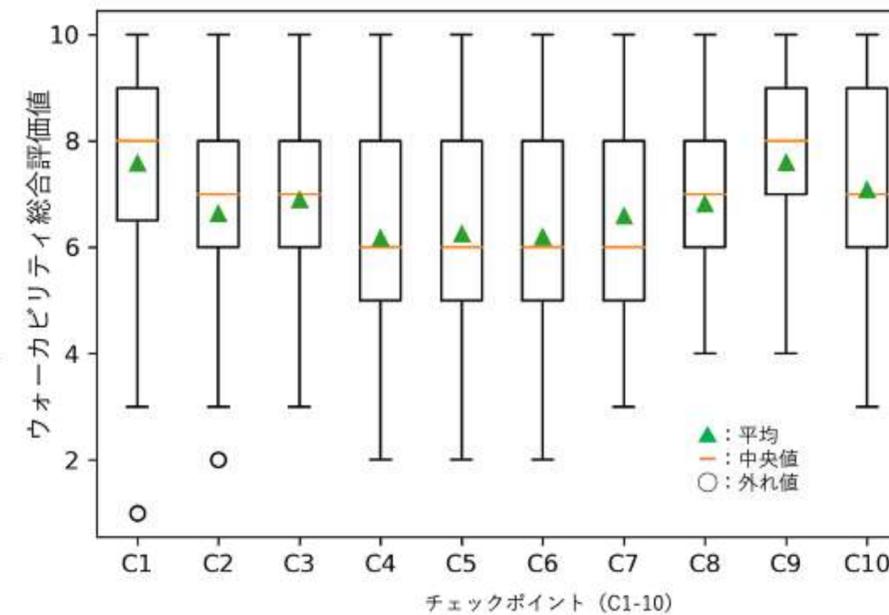
Index type	Element
Civil engineering indices	Sidewalk surface, sidewalk width, road traffic volume, cleanliness, on-street parking, noise obstacles
City planning indices	Store facilities, information boards, rest areas, security

Breakdown of each element of the index is also classified from an objective-subjective perspective



Elements systematically classified from civil engineering-urban planning × objective-subjective perspectives

Comparative analysis



Identification of individual factors that affect subjective walkability

Environment and usage at Marunouchi street parking

Analyse effects from multiple perspectives, such as space usage surveys based on people flow data, thermal environment surveys, user awareness questionnaire surveys, and sales trend surveys
(Akinobu Murakami)



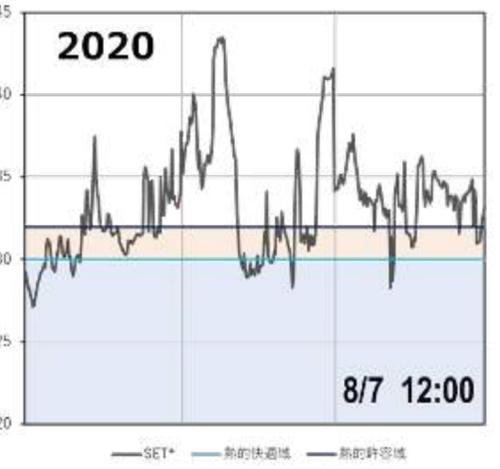
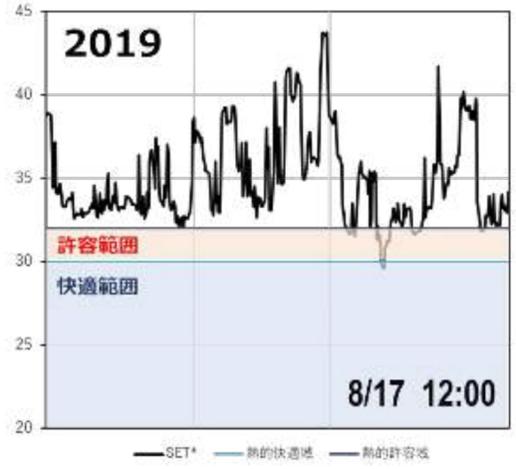
Awareness survey

90% of respondents agreed with making in a Marunouchi Naka-dori a permanent outdoor plaza, and 93% agreed with expanding outdoor store seating to the street. (visitor questionnaire)



Thermal environment survey

観測日時：2020/8/6~8/9, 8:00~20:00
 観測概要
 西立観測・移動観測/気温・湿度・放射(グローブ熱)・風速・放射(6方位)/全射観測像システムによる観測

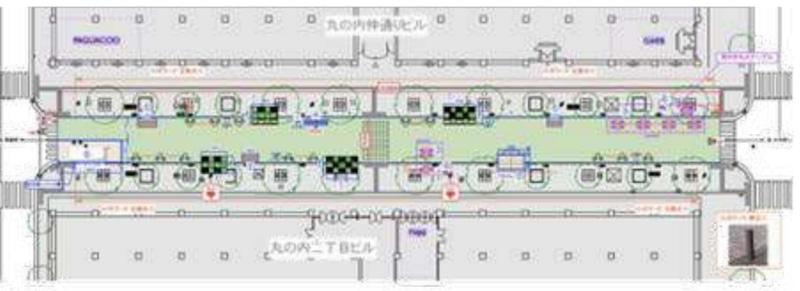
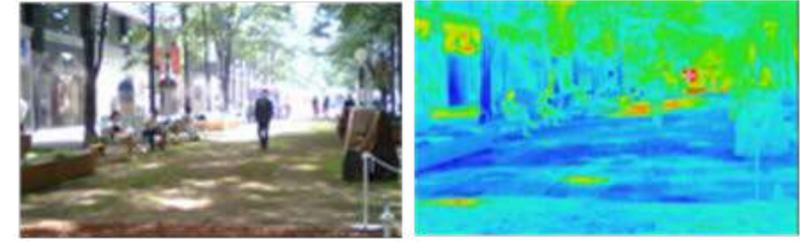
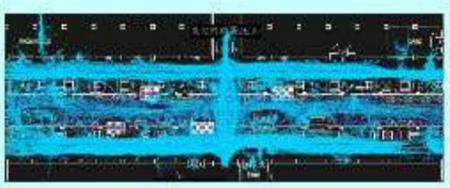


Sales trend survey

Sales increased at restaurants with expanded outdoor seating compared to all months prior to initiative.
 Store A: Sales 224%
 Store B: Sales 119%



People flow data analysis



熱的許容範囲：SET* 18°C~32°C

これにより人が受ける熱的ストレスを評価できる。この範囲を逸脱する場合は、通行人が大きな熱的ストレスを受けている状態と判断できる。

2019 8.0% → 2020 42.8%

熱的快適範囲：SET* 20°C~30°C

これにより通行人が感じる熱的な快適性を評価できる。この範囲では熱的に快適な状態であると判断できる。SET*が30°C~32°Cの範囲は、熱的には許容できても快適ではないと判断できる。

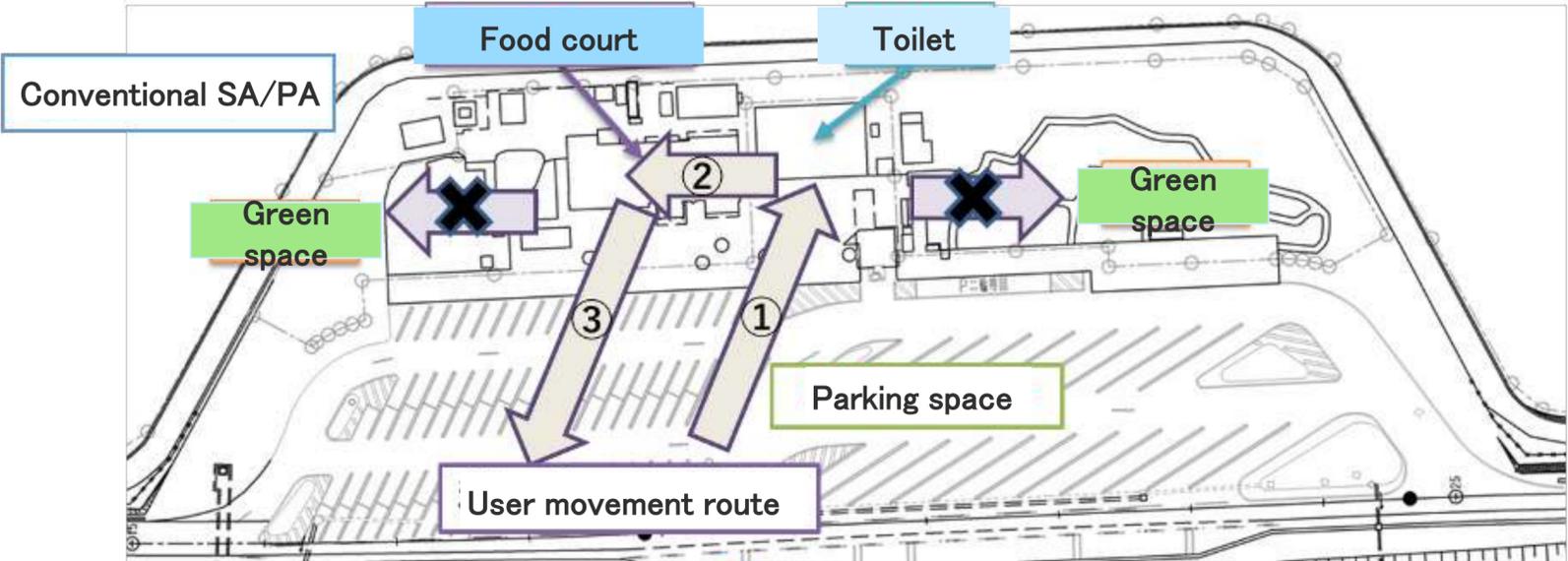
2019 0.7% → 2020 14.7%



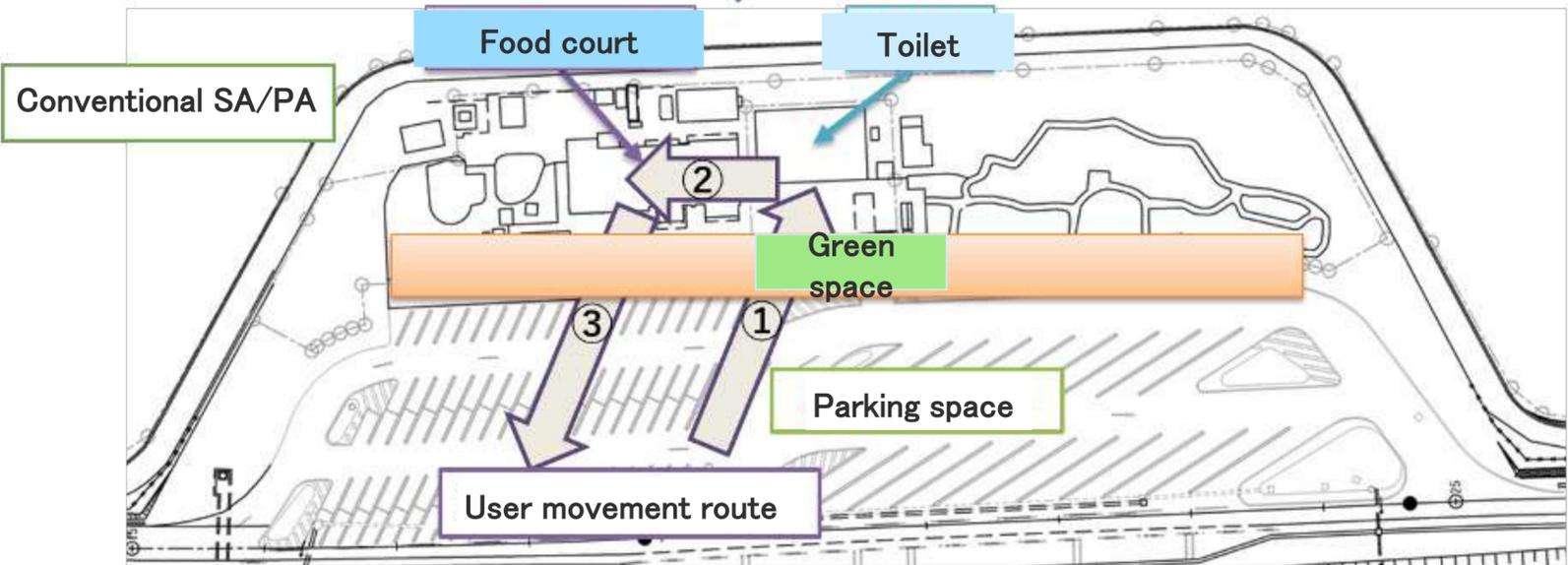
- Not only was the number of thermally safe sections increased, but also a thermally comfortable space was created
- Areas with higher thermal comfort (cooler places) had longer stays

Highway PA design that incorporates the concept of zero-order prevention (Hiroshi Iwasaki)

Green space design that incorporates concept of zero-order prevention → Usual use → Unconsciously enjoying effects of green spaces



Placing green areas on line based on concept of zero-order prevention



What is zero-order prevention?

Health promotion that improves environment and leads to health without individual effort

Reference: Primary prevention; Health promotion based on individual efforts

* 1 Ministry of Health, Labour and Welfare / Health Japan 21 (Second) Basic Plan for 10 years from 2013



Noro PA that incorporates zero-order prevention

Placing green space on route of normal environment → Unconsciously having contact with greenery → Enjoying effect of greenery → Relieving stress → Effective in preventing driving-related accidents

Potential of spatial evaluation using pedestrian expressions and gestures (Aya Kojima)

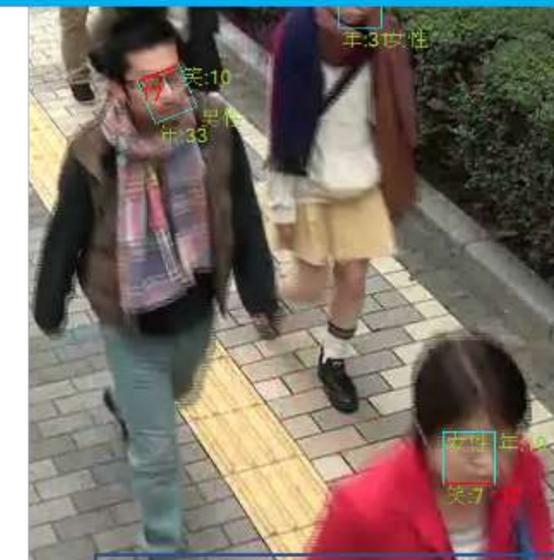
- Charles Darwin

‘**Facial expression** is **inherited** regardless of learning or culture’

The Expression of Emotion in Man and Animals, 1872

➤ Meaning and judgment of a smile are not influenced by race or life experience

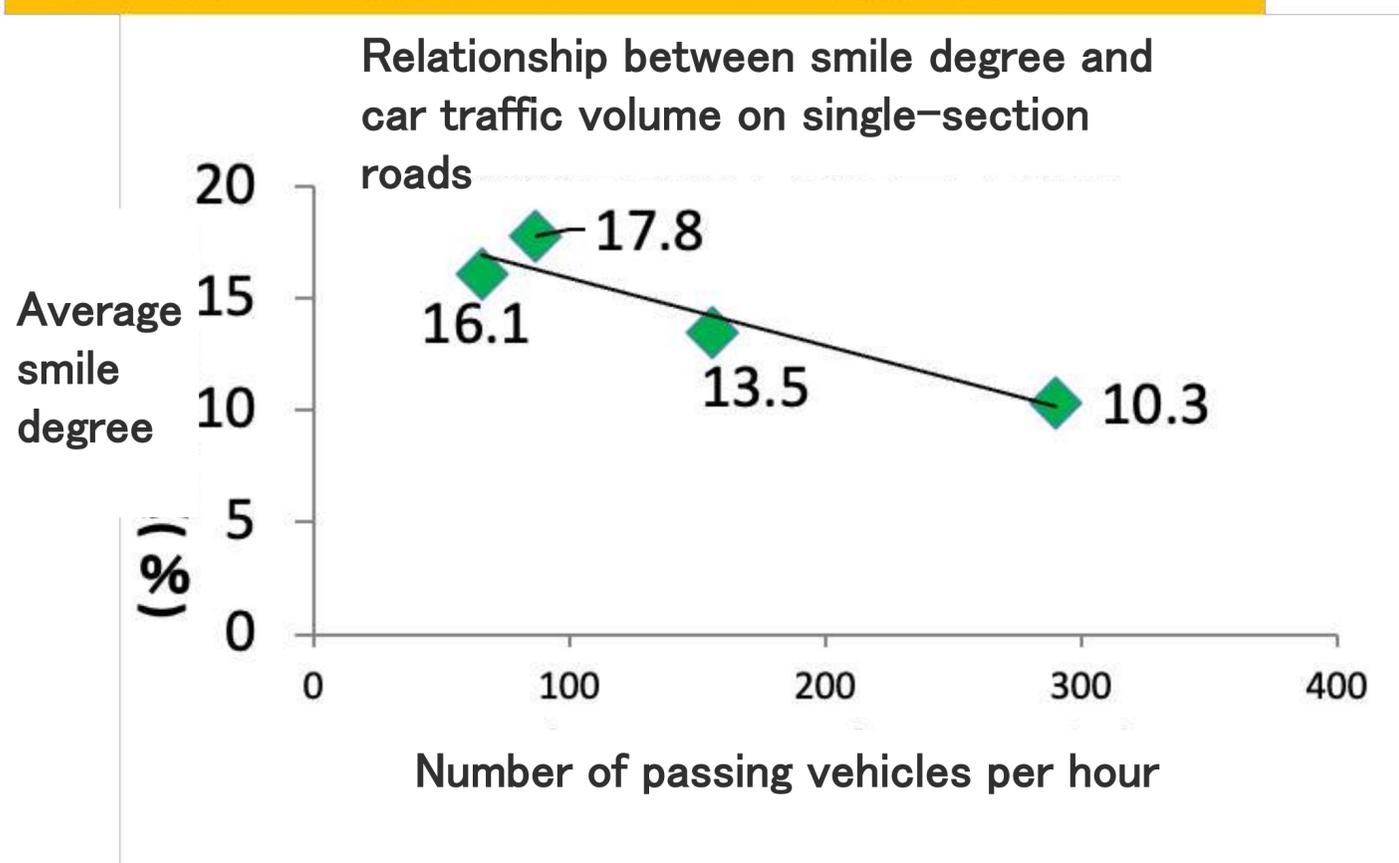
Walking space evaluation system



ID number	Smile degree
Age	Sex

◆ Average smile degree (%)

Observation survey on street in front of train station in Saitama



Relationship between smile degree and sidewalk width increase

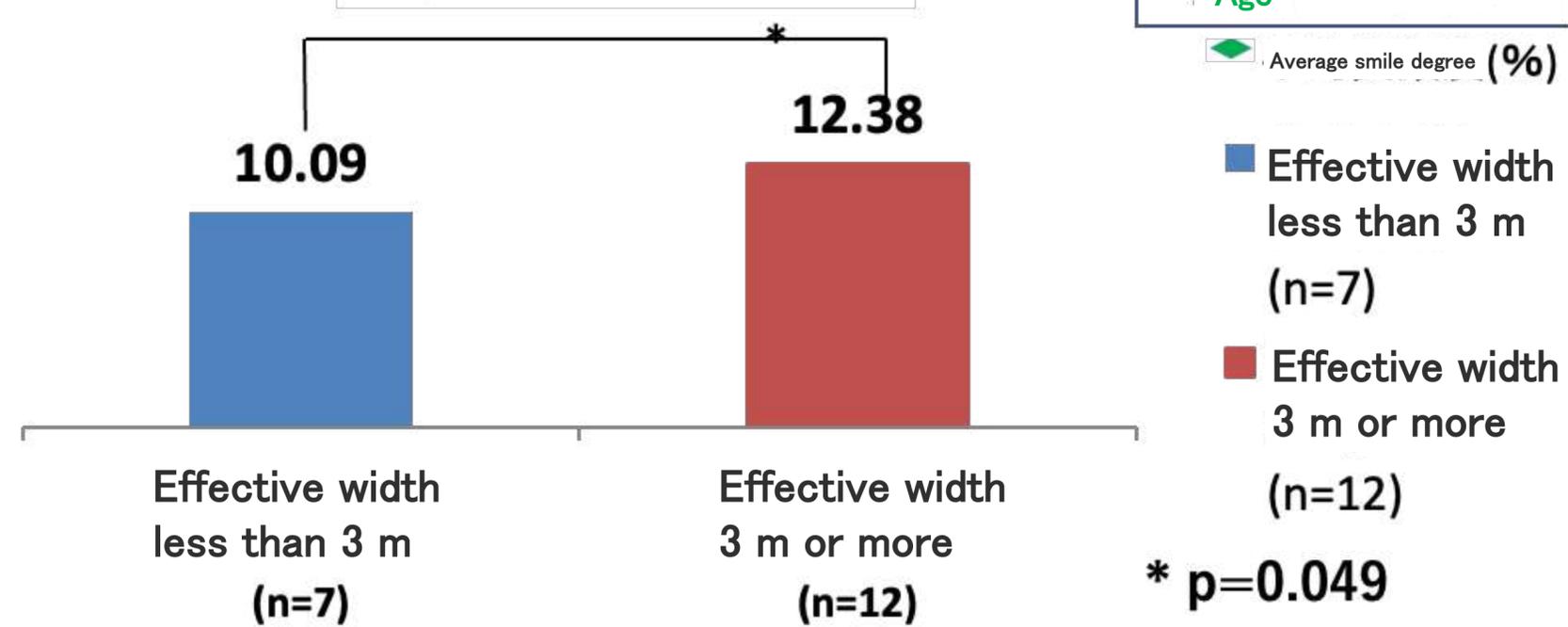
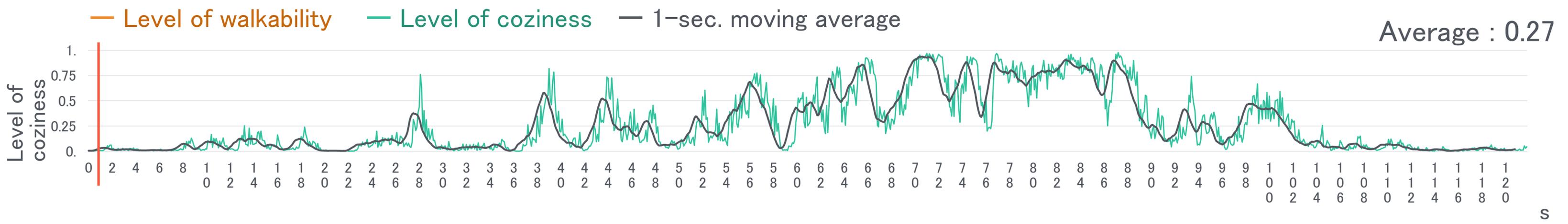
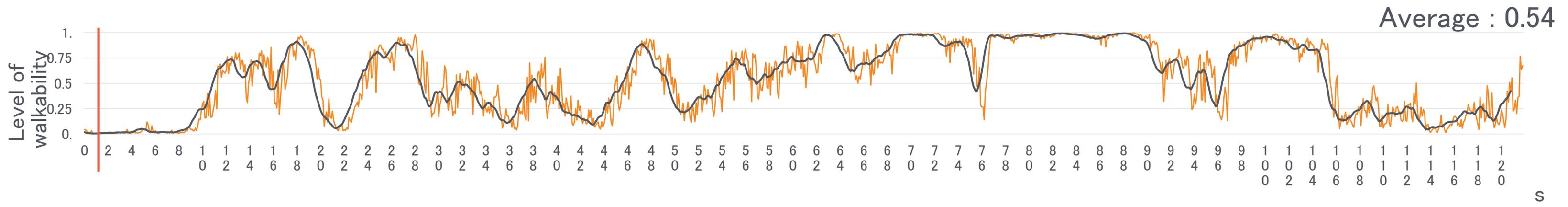


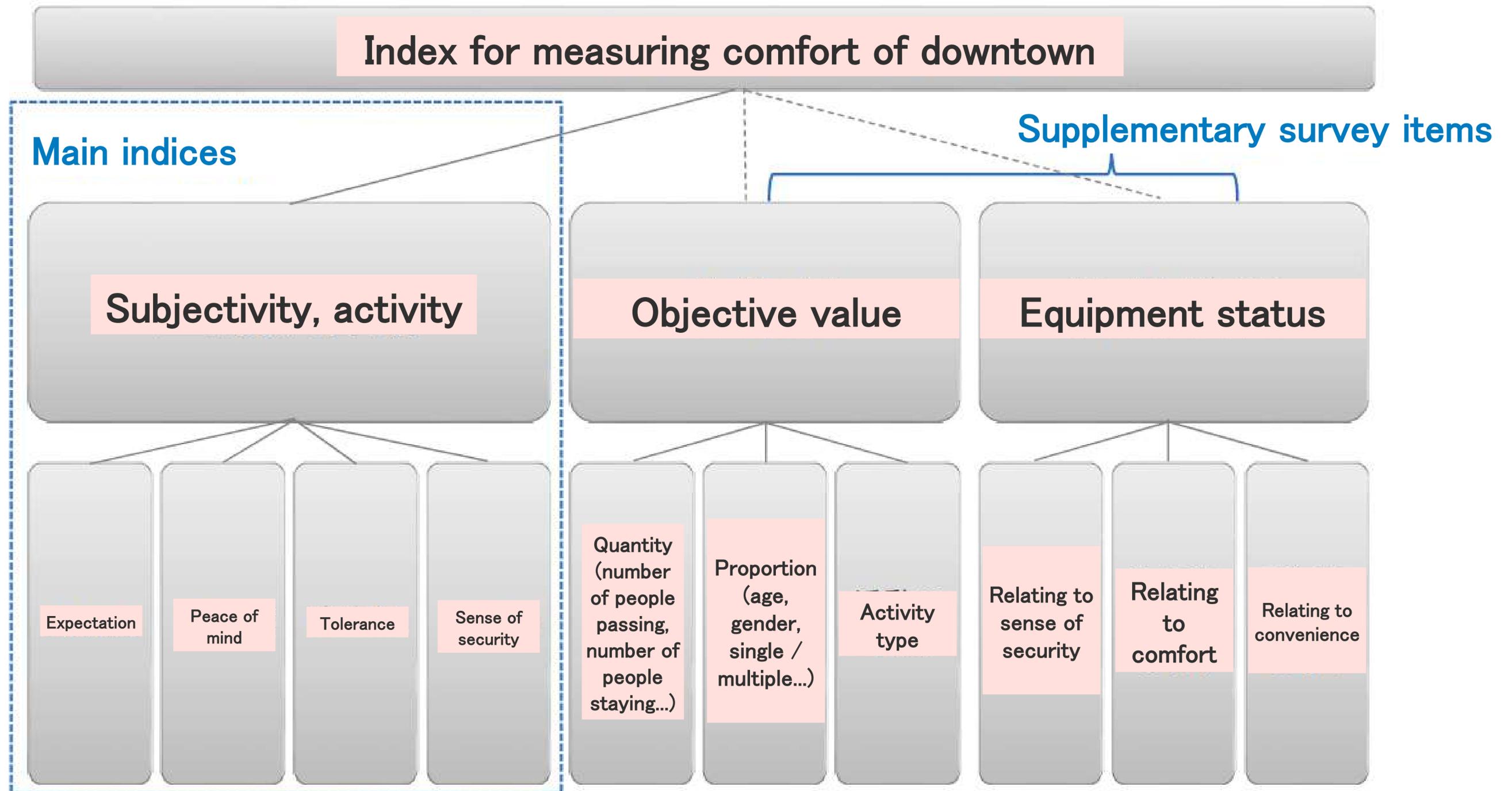
Image evaluation using AI (Kenji Doi)

Results of walkability / coziness evaluation



3. Composition of indices

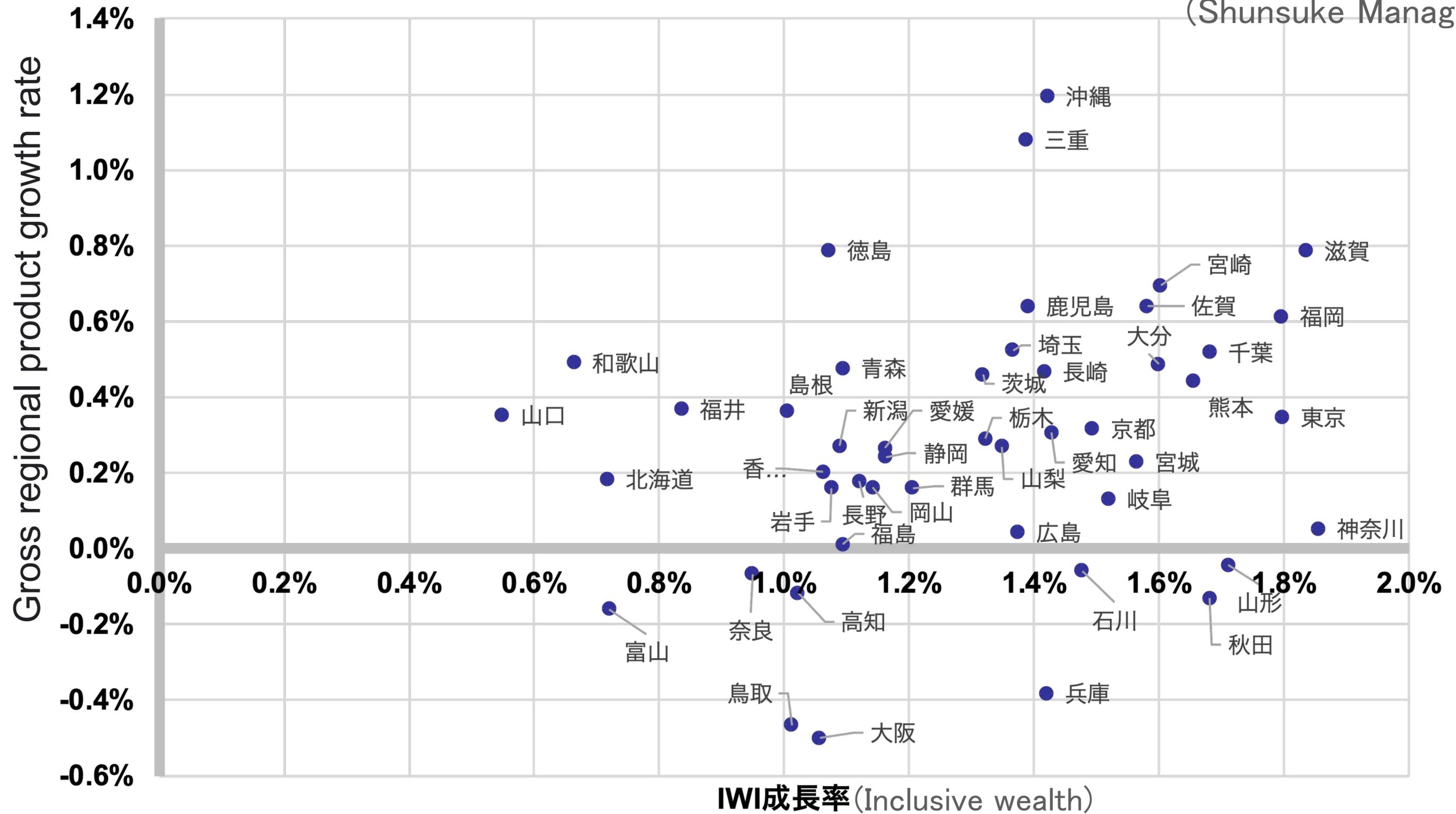
Material under consideration

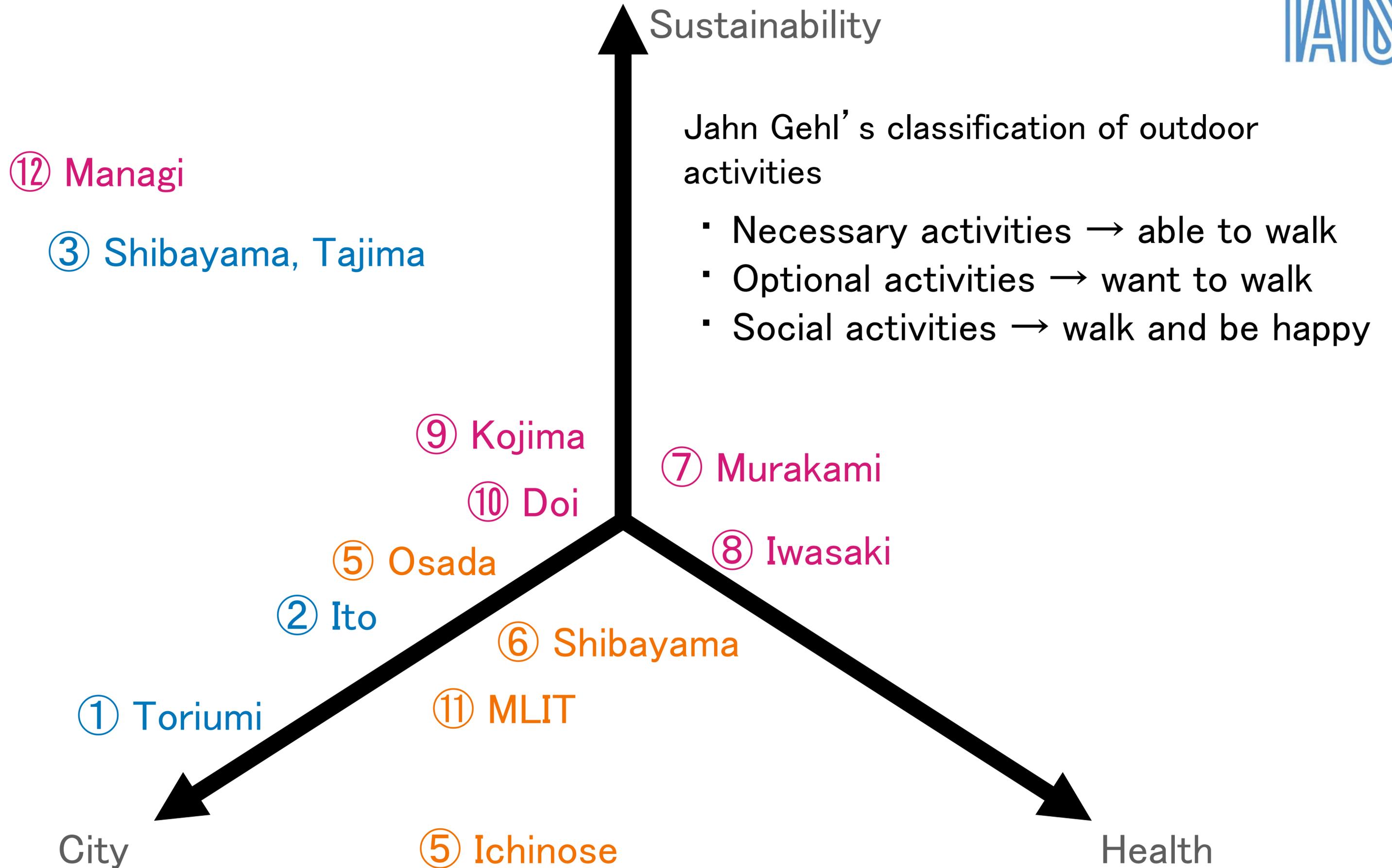


- Space is evaluated in terms of the ‘main indices’ of subjectivity and activity.
- Objective values and equipment status are collected as ‘supplementary survey items’, but not included among evaluation indices.

Growth rate of local wealth and growth rate of local production

(Shunsuke Managi)





Summary of FY2022 (third year)

What kind of walkability index is used depends on input and outcome

- The concept of “Walkability” is being discussed in the context of health improvement and urban planning
- Ultimate outcome is achievement of well-being, but there are various requirements
- Diversity in walkability indices around the world is due to social issues of each locale
- The framework of walkability was demonstrated, and walkability index was organized
- We were able to present new indices along with evaluations based on existing indices
- Declining population and revitalization of central urban areas are the most significant challenges in Japanese cities



公益財団法人 国際交通安全学会

International Association of Traffic and Safety Sciences