🏆 *reviewed paper*

Rethinking the Smartness of Cities: Microclimatic Performance of Public-Private Transition Spaces in Dense residential Areas of Tokyo

Carina Kurz

(DI Carina Kurz, TU Graz, carina.kurz@student.tugraz.at)

DOI: 10.48494/REALCORP2026.1095

1 ABSTRACT

Urbanization and climate change demand new forms of urban resilience to promote livable environments. Many cities respond with Smart-City strategies that prioritize digital efficiency and data-driven optimization. Even citizen-oriented approaches remain largely technology-mediated, overlooking the ecological potentials embedded in daily life and underestimating how directly residents contribute to environmental performance.

This research highlights Public–Private Transition Spaces (PPTS) in low-rise & high-density residential areas of Tokyo as a human-centered alternative. Situated between private homes and the public street, these small spaces emerge through everyday actions of residents, such as positioning plants, objects and various boundary elements. Together, these practices and the material elements produce spatial forms that foster ecological performance as well as social interaction.

A case study combining detailed mapping of PPTS and their components with surface-temperature measurements under humid subtropical conditions reveals measurable cooling effects. These findings show that simple practices by residents can generate tangible ecological benefits without relying on digital tools.

By demonstrating the ecological value of plants within PPTS, this research reframes everyday spatial production as a form of vernacular climate practice. The study thus expands Smart-City discourses from standardized and technology-oriented solutions toward a human-centered, bottom-up urbanism and supports planning strategies that recognize small everyday spaces as vital components of livable urban environments.

Keywords: transition spaces, microclimate, smart-city, low-tech, everyday practice

2 INTRODUCTION

The smart city is presented as a solution to urban challenges such as climate change and densification, promising more sustainable, inclusive, and resilient environments that improve quality of life. Measures such as optimizing mobility flows, improving waste management, conserving resources, and reducing energy consumption are intended to reduce the environmental impacts and make life more convenient. However, the emphasis on the "smart" use and networking of technologies has been criticized for remaining technology-centric and focusing on digital infrastructures and data-driven solutions, while ignoring the needs and agency of residents. When people are included at all, they appear mainly as users of apps or consumers of the city, without a meaningful active role in shaping urban life.

Fig.1: Examples of PPTS in T1 (own photographs)

By questioning the limitation of urban smartness to technological systems, PPTS in dense residential areas of Tokyo present a human-centered alternative. As products of everyday practices, ecological and social qualities become visible in the material composition and continual adaptation of these spaces through use and care.

In this research PPTS are defined as: "the area between the façade of the building with the front door and the property boundary to the street" (Kurz, forthcoming). As private area belonging to the building plot that is visible to the public, PPTS are vital urban links mediating between private and public realms with social and spatial meaning. Their composition includes various boundary objects such as walls or fences, daily items like household and gardening tools, bicycles or cars and above all vegetation and potted plants with ecological potentials.

In the extremely dense urban fabric of Tokyo, where the heat island effect is pronounced and green space is scarce, PPTS can act as ecological resources on the microscale. Emerging from everyday spatial practices, these spaces demonstrate how low-tech, resident-managed configurations can contribute to microclimatic regulation without relying on technological infrastructures.

Against this backdrop, this article poses the following question:

To what extend do public-private transition spaces generate ecological value in dense residential areas of Tokyo as practice-based low-tech urban smartness?

This paper highlights the ecological performance of small, often underestimated spaces resulting from everyday spatial practices. By making microclimatic contributions of daily actions visible, it presents PPTS as a form of bottom-up, low-tech urban smartness that does not depend on digital infrastructures. Situated within the broader discussion of smart cities, the paper aims to broaden current views on urban smartness by demonstrating that the capacities for resilient urban environments are already present in these informal and hybrid spaces.

3 THEORY, STATE OF THE ART

There is no universal definition of what constitutes a smart city. This opens up the possibility to rethink prevailing perspectives that focus on the "intelligent" use and networking of technologies and digital systems as a key response to contemporary urban challenges. Townsend (2014) emphasizes the potential of digital tools, but simultaneously warns against a mindless implementation of smart technologies. Instead of efficiency and control, focus should be put on people and communities as central actors in urban development.

Building on this, Radulova-Stahmer (2020) introduces "smart spaces" arguing that energy efficiency and the qualitative experience of urban environments depend not only on digital infrastructures but fundamentally on spatial organization and design. However, the considerations remain structural and top-down without thinking of human agency.

Research on the postdigital city criticizes the impact of technology on urban everyday life. The subordination of urban space and human activity to automated, system-driven processes results in a homogenization and abstraction of space, where residents are additional data sources rather than active producers of space (Alvaro-Sanchez, 2022; Lefebvre, 1991). This suggests a need to reconsider where digital technologies are necessary and where they can have a counterproductive impact on future urban development.

In their study of participatory smart city initiatives Cardullo and Kitchin (2019) find that inclusive and empowering citizen involvement remains difficult to achieve in practice. Rather than as active decision-makers with authority, citizens are often integrated as contributors within technologically predefined governance frameworks. In contrast the city of Barcelona is presented as best-practice-example for its open and participatory city model that involves citizens in decision-making processes through a digital platform (Galič, Schullenburg, 2021). While this represents a shift toward citizen-oriented governance, participation is still embedded in digital structures, limiting the consideration of human agency in everyday practice.

Regarding the continuing dependence on technological systems, Saxe (2019) draws attention to the high resource consumption required to manage the increasing complexity of smart cities. By questioning the necessity of ever more new technologies she calls for a refocus on established, low-tech principles and practices as response with challenges of today.

Urban interfaces have been identified as significant mediators of spatial transitions (Dovey and Wood, 2015), where social practices contribute to placemaking processes, personal belonging and the creation of spatial identity (Muminovic, 2014). Previous studies in Japan demonstrate that the appropriation of street edges by residents, through the placement of objects and plants (Aoki, Yuasa, 1993), contribute to fostering social cohesion and improving the quality of the built environment (Jonas, 2007).

In contrast, research on greened balconies in (sub)tropical India demonstrates the effectiveness of potted plants in contributing to thermal regulation and improved indoor climate conditions (Ahmed and Rahman, 2024).

Current smart city research frames urban climate resilience as a mainly technological and data-driven challenge, that is largely directed from top-down, with little human agency. While micro-scale urban greening and everyday spatial practices have been studied separately, it remains underexplored how residents actively shape urban space and its ecological potential through low-tech, everyday interventions. This paper addresses this gap by examining how resident-managed, low-tech spatial practices in PPTS in dense residential areas of Tokyo contribute to local temperature regulation, thereby thinking microclimatic performance as a form of everyday urban smartness.

4 METHOD AND CASE STUDY

To assess the ecological performance of PPTS a detailed spatial mapping with focus on plants and floor surface materials was conducted in the first step. The results were subsequently combined with surface temperature measurements and analyzed using heat maps to make microscale cooling effects and thermal patterns visible.

The case study is carried out in 3-chome Taishido, a residential neighbourhood in the livable district of Setagaya in western Tokyo, and builds on a prior study by the author (Kurz, forthcoming). This earlier study presented a typology of PPTS and their distribution across the neighbourhood. Based on this analysis, areas with a high concentration of vital PPTS, characterized by frequent occurrences of plants and objects, were selected as focus areas for the in-depth investigation due to their presumed potential for ecological effects. As active PPTS mainly occur in connection with single-family houses, other residential building types were not considered.

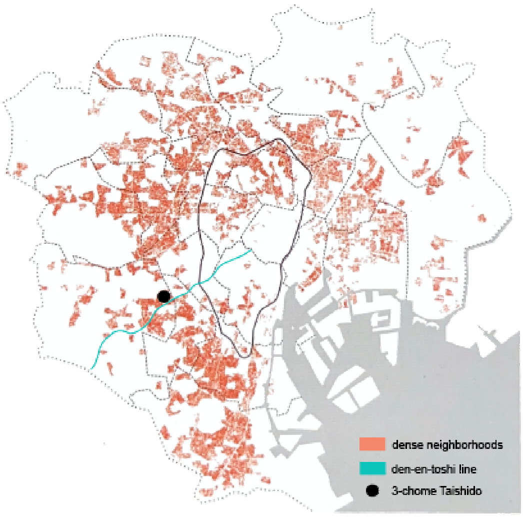

Fig. 2: Map of Tokyo + 3-chome Taishido (own illustration based on Almazan, 2021)

4.1 Spatial Mapping

The focus spot T1 comprises 18 PPTS of varying sizes and shapes, associated with houses of different ages. Only a few PPTS are empty, but the majority is actively used and show clear signs of everyday life. A comparison with older images from Google Maps during the investigation period reveals a decline of bigger trees over time, reflecting ongoing redevelopment processes in which older houses are replaced by newly built structures. Due to the high building density, trees of all sizes tend to appear individually rather than in extensive stands. Bushes and shrubs are highly prevalent, primarily as hedges. Potted plants are the most common feature, appearing in a wide range of configurations, including single pots, small and large clusters or mixed arrangements with in-ground vegetation.

Editors: M. Schrenk, C. Beyer, T. Popovich, J. Ryser, D. Mawlood
ISBN 978-3-9504945-5-6

Fig. 3: Map of 3-chome Taishido with focus spot T1 for case study (own illustration)

Ground surfaces are predominantly sealed, with concrete, plaster, or tiles being the most common materials. In contrast, permeable surfaces such as gravel and unsealed ground, including grass and soil, are rare

Fig.4: Configurations of PPTS in T1 (own illustration)

4.2 Surface-Temperature

To ensure comparability, surface temperatures of different materials were measured both in the immediate vicinity of plants and in areas without vegetation using a laser infrared thermometer. The previously prepared spatial map of the PPTS was overlaid with the measured temperature points in QGIS and evaluated as a heat map using interpolation. As the focus is on the effectiveness of plants and the visualization is based on interpolated values, the interpretation of the heat map primarily considers individual measurement points with their immediate surroundings, and does not assume extensive thermal transitions.

The measurements were conducted on a hot and humid late-summer day on August 25th, 2024 between 11:20 and 12:10 with very sunny weather condition. Air temperature and relative humidity measured 27.4 °C and 80% at the beginning of the survey and increased to 37.5 °C with a relative humidity of 54% by the end of the measurement period.

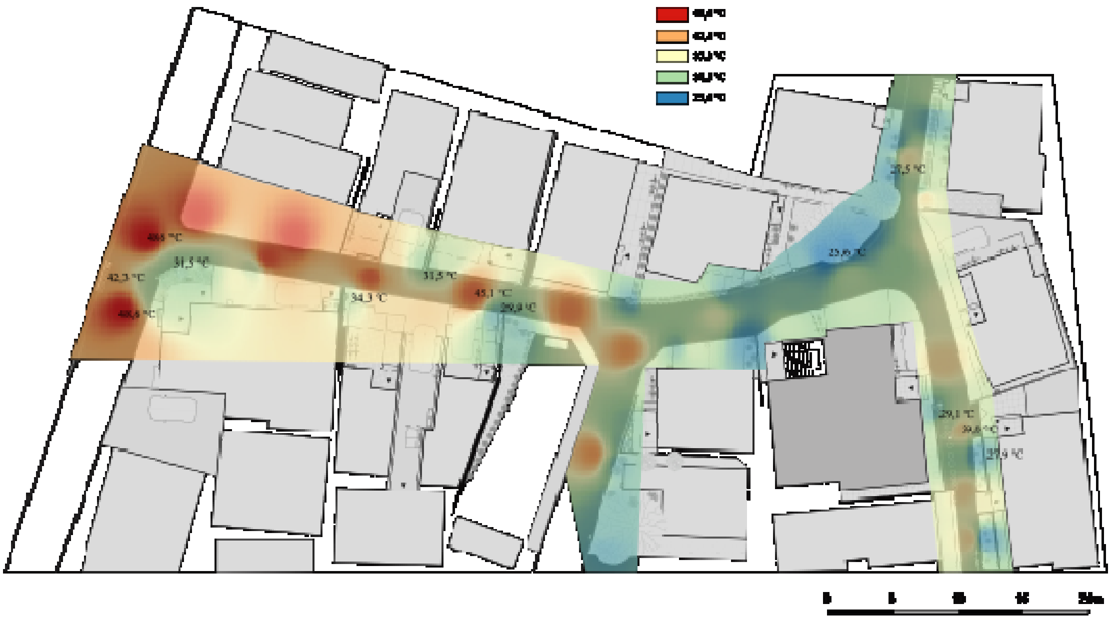

Fig.5: Configurations of PPTS in T1 with Heatmap (own illustration)

The map reveals distinct clusters of warm and cool areas. Particularly high surface temperatures occur where vegetation is entirely absent. The highest measured temperature reached 48.6 °C on the asphalt roadway, while the lowest temperature of 25.6 °C was recorded in the shade of a large tree. In areas with planted vegetation, clear temperature differences become apparent. Notably, even small clusters of potted plants exhibit distinctly cooler surface temperatures.

Although a difference is not directly evident from the map, an asphalt surface located in the shade of a potted plant measured 42.3 °C, whereas the immediately adjacent asphalt surface exposed to direct solar radiation heated up to 48.6 °C. The absence of a clearly defined cool spot on the map may be due to the extremely heated surrounding, which is still cooled by almost 4.5 degrees in the shade of the potted plants.

Surface materials also respond differently to solar exposure. Sealed surfaces show broadly similar response patterns, with asphalt and white gravel reaching the highest temperatures. Concrete, paving stones, and tiles exhibited slightly lower surface temperatures, while small areas of spontaneously growing grass were significantly cooler. Nevertheless, in combination with potted plants cooler temperatures could be recorded with any material.

In areas with a higher presence of in-ground vegetation, a spatial extension of cooler zones can be observed, even if these effects are not immediately perceptible to pedestrians. In contrast, the cooling effect underneath a large tree was clearly noticeable during the measurements due to their dense foliage. The cooling impact on the street and its immediate surroundings was measurable and is also visible in the map. The surrounding vegetation also seems also seems to further extend the cooling effect

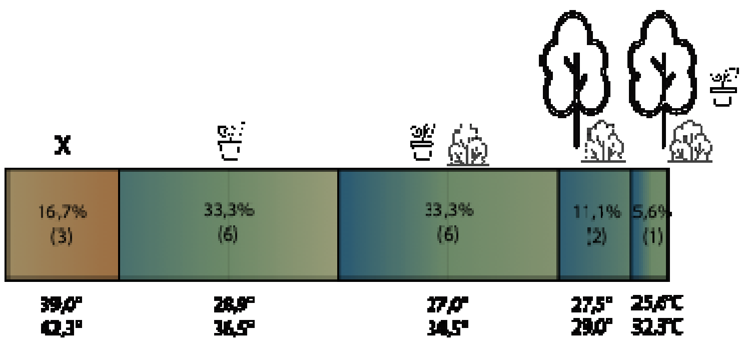

Fig.6: Combinations of plants in PPTS and temperature ranges in T1 (own illustration based on icons)[1]

[1] Icons made by DinosoftLabs and Freepick from www.flaticon.com

asphalt	48,6	42,3
concrete	39,0	34,3
asphalt	39,0	34,0
earth		29,1
weed	31,5	

Table 1: Surface-temperature table (own table based on icons)[2]

As can be seen from the heat map, the diagram (Fig. 5) also shows temperature differences between PPTS depending on the presence of plants. It is not surprising that the coolest temperatures were recorded in zones with in-ground vegetation, especially with trees. However, the coolest surfaces in the shade of potted plants did not show a large temperature difference to surfaces of in-ground vegetation.

The temperature range is very low in empty spaces and areas with in-ground vegetation, presenting a consistency of temperature. Whereas the highest temperature range occurred at PPTS with potted plants, pointing out a lower effect and consistency of temperature. In terms of the heat map, areas with lots of plants also have more consistent and cooler temperatures.

The effect of potted plants becomes also visible in the table (Table 1), presenting temperature differences on different surfaces exposed to sun radiation or shaded of potted plants.

5 CONCLUSION

By illustrating the microclimatic capabilities of public-private transitional spaces, this article positions PPTS as a human-centered alternative to technology-oriented approaches to urban resilience in the context of the smart city discourse. The results not only show measurable surface temperature reductions in areas with in-ground vegetation, but also temperature differences of up to 5–6 °C on identical materials in the presence of potted plants. This reveals that even small, resident-managed arrangements of plants contribute to localized thermal regulation in dense residential environments. PPTS are thus not merely decorative extensions of the private realm, but spaces in which human action creates tangible ecological value through maintenance, care and decision-making.

While the gained information is based on a single case study conducted on one hot summer day and the focus is primarily on surface temperature, they point to promising directions for future research. Comparative studies across different neighborhoods and measurements as well as the integration of spatial configurations could further deepen the understanding of PPTS as socio-ecological systems.

By making their microclimatic performance visible, this research recognizes PPTS as integral components of climate-responsive and livable cities and encourages a shift in perspective toward simple, existing solutions grounded in everyday care and use.

6 ACKNOWLEDGEMENTS

The author gratefully acknowledges the support received through the Marietta Blau Grant from the

Austrian Federal Ministry for Women, Science and Research, and the Erzherzog Johann Grant from the Styrian Chamber of Commerce.

7 REFERENCES

AHMED, Farhana and RAHMAN, Sarder Mohammad Hafijur: Thermal performance of green balconies of residential buildings: A Case Study in Wari, Dhaka. International Journal of Science and Research Archive. Vol 13, Issue 2 (2024), 2981-2989.

ALMAZAN, Jorge + Studiolab: Emergent Tokyo: Designing the Spontaneous City. San Francisco: Oro Editions, 2022

ALVARO-SANCHEZ, Sandra: Practiced, Conceived and Lived Space in the Postdigital City. ESTOA Journal of the Faculty of Architecture and Urbanism, Vol. 11, Issue 22 (2022), 47-58.

AOKI, Yoshitsugu and YUASA, Yoshiharu: Private Use and Territory in Alley-Space: Hypotheses and Tests of Planning Concepts through the Field Surveys on Alley-Space Part 1. Journal of Architecture, Planning and Environmental Engineering 449 (1993), 47–55.

CARDULLO, Paolo and KITCHIN, Rob: Being a 'citizen' in the smart city: up and down the scaffold of smart citizen participation in Dublin, Ireland. GeoJournal, Vol. 84 (2019), 1-13.

[2] Icons made by DinosoftLabs and Nadiinko from www.flaticon.com

DOVEY, Kim, and WOOD, Stephen: Public/Private Urban Interfaces: Type, Adaptation, Assemblage. Journal of Urbanism: International Research on Placemaking and Urban Sustainability 8, no. 1 (2015), 1–16.
FLEMING, Amy (2020, January 15): The case for ... making low-tech 'dumb' cities instead of 'smart' ones. The Guardian. accessed: 17 October 2025, https://www.theguardian.com/cities/2020/jan/15/the-case-for-making-low-tech-dumb-cities-instead-of-smart-ones
GALIČ, Maša and SCHULLENBURG, Marc: Reclaiming the Smart City: Toward a New Right to the City. Handbook of Smart Cities. Cham, Springer International Publishing, 2021.
HOLLANDS, Robert: Will the Real Smart City Please Stand Up? City, Vol.12 (2008), 303-320
JONAS, Marieluise: Private Use of Public Open Space in Tokyo A Study of the Hybrid Landscape of Tokyo's Informal Gardens. Journal of Landscape Architecture 2, no. 2 (2007), 18–29.
KITAYAMA, Koh et al.: Tokyo Metabolizing. Tokyo: TOTO Publishing, 2010
KURZ, Carina: Reimaging Space: The Potential of Public-Private Transition Spaces as a Contribution to Livability in Dense Urban Environments. Lisbon – Livable Cities: AMPS Proceedings Series, forthcoming
LANDESZENTRALE FÜR POLITISCHE BILDUNG Baden-Württemberg: Smart City – Die Stadt der Zukunft? Technologie in der nachhaltigen Stadtentwicklung, 2022, accessed: 4 January 2026, https://www.lpb-bw.de/smart-city.
LEFEBVRE, Henri: The Production of Space. Oxford, Basil Blackwell Inc., 1991
MUMINOVIC, Milica: Intensity and Identity of the place: the role of public-private interface in Nezu, Tokyo, NAJUA: Architecture, Design and Built Environment, Vol 28 (2014), 381-381
RADIVIČ Darko, and BOONTHARM, Davisi. small Tokyo. Tokyo: Flick Studio, 2012
RADULOVA-STAHMER, Radostina: Smart Cities brauchen Smarte Räume – Szenarien für die Zukunft eines energie- und ressourcenwirksamen Quartiers durch smarte Stadtgestaltung am Beispiel von Smart City Waagner Biro in Graz. Real Corp 2020: Shaping Urban Change Livable City Regions for the 21st Century (2020), 751-760
SAXE, Shoshanna (2019, July 16): Opinion | I'm an Engineer, and I'm Not Buying Into 'Smart' Cities. The New York Times. accessed: 17 October 2025, https://www.nytimes.com/2019/07/16/opinion/smart-cities.html
TOWNSEND, Anthony M.: Smart cities: big data, civic hackers, and the quest for a new utopia. New York, W. W. Norton & Company, 2014