

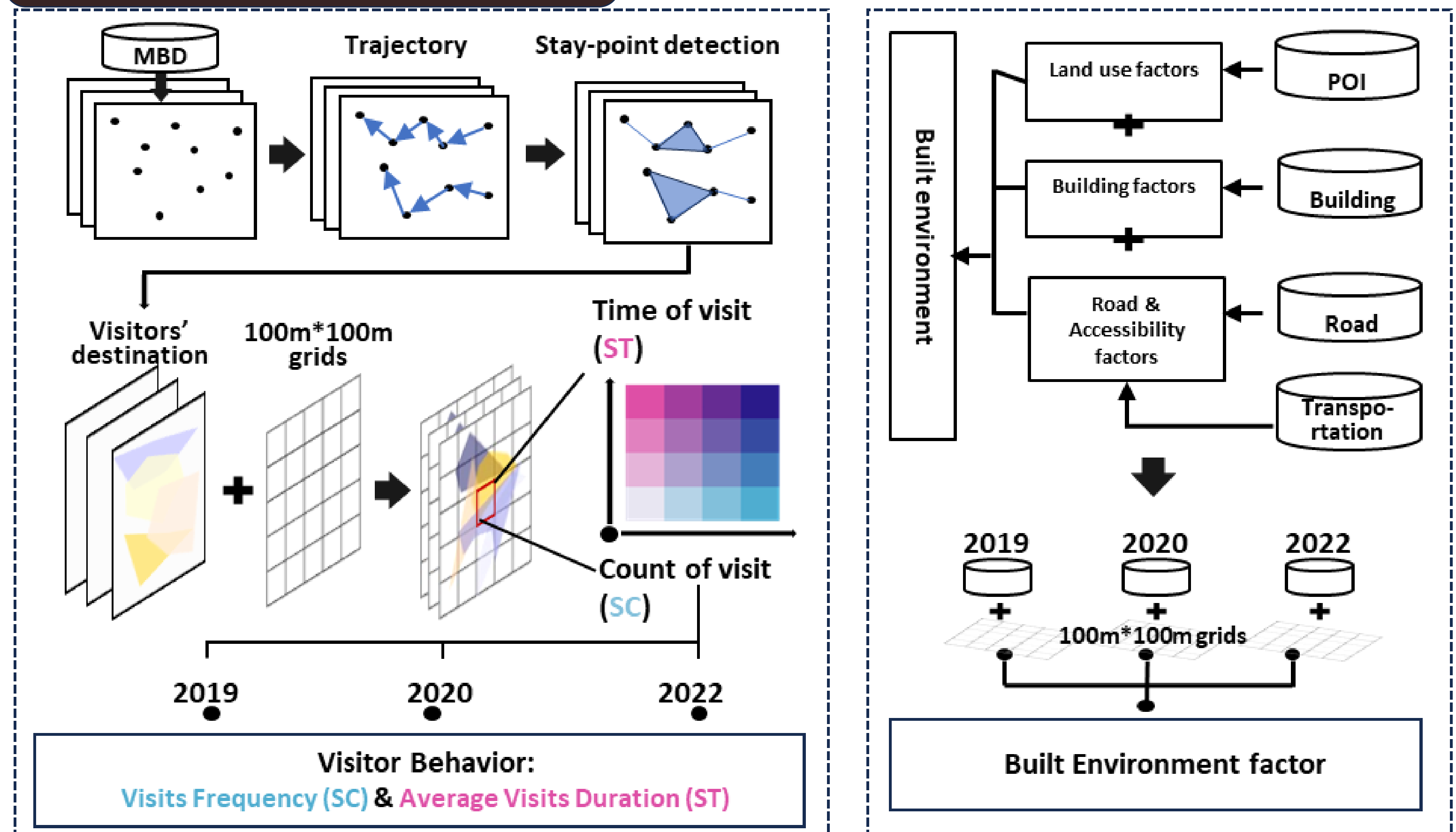
# Changes in visitor behaviour across COVID-19 pandemic: Unveiling urban visitation dynamics and non-linear relationships with the built environment using mobile big data

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## Introduction

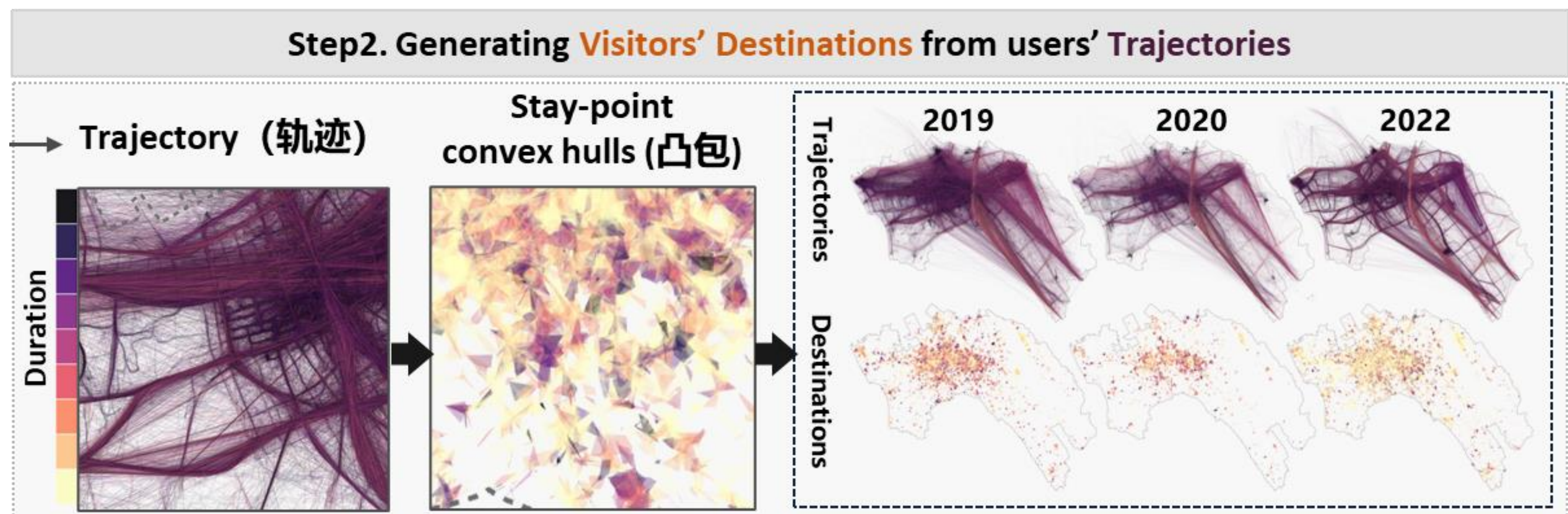
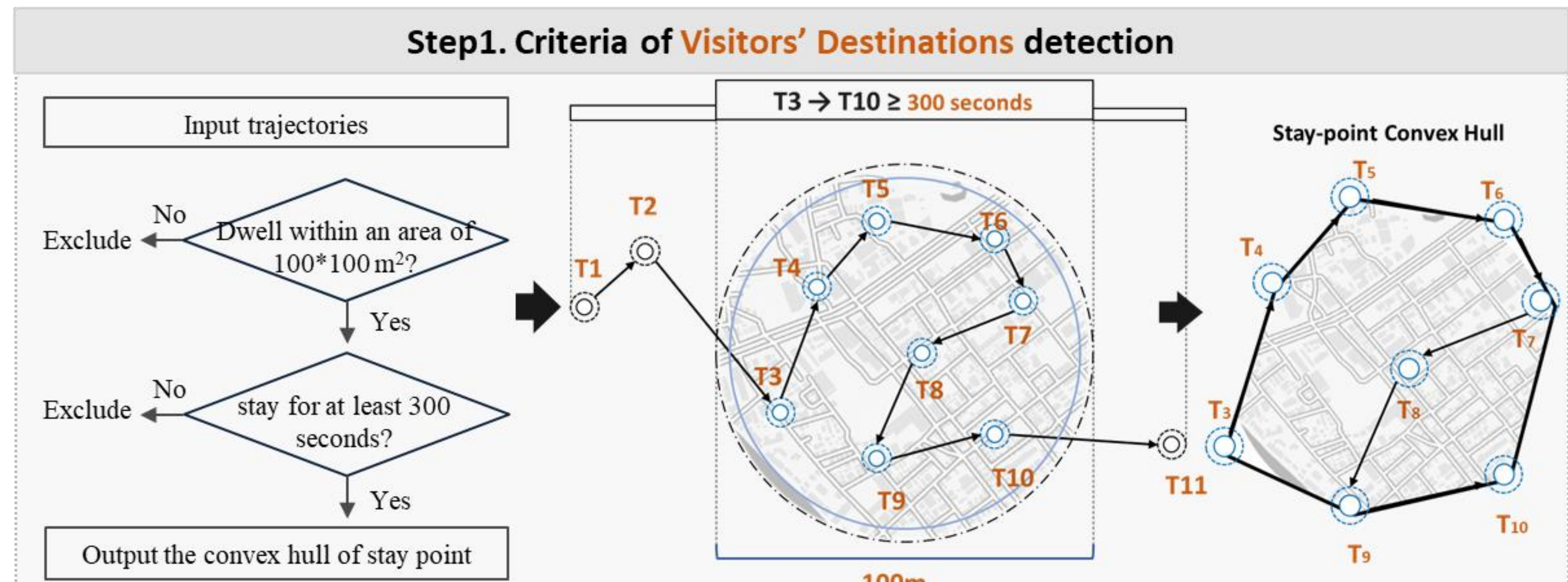
COVID-19 drastically impacted urban visitor behavior, but the non-linear relationships with built environments and its changes during COVID-19 remain underexplored. This study addresses the gap by analyzing mobile big data from Fukuoka, using XGBoost and SHAP-PDP. The findings highlight the dynamic nature of visitor behavior, informing urban planning and crisis preparedness.

## Research framework

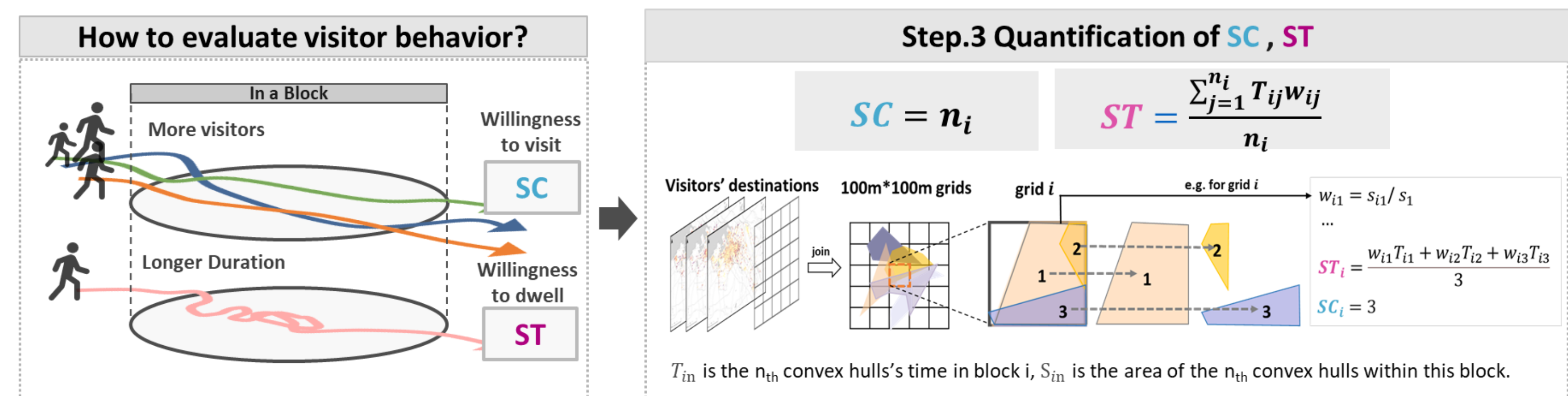


## Method

Local users in Fukuoka City were excluded to focus on visitors. A movement trajectory was created for each visitor, calculating time spent at locations. "Visitor destinations" were places where visitors stayed over 5 minutes within a 100-meter radius. These points were marked as stay points, and a convex hull was generated to represent the destination.

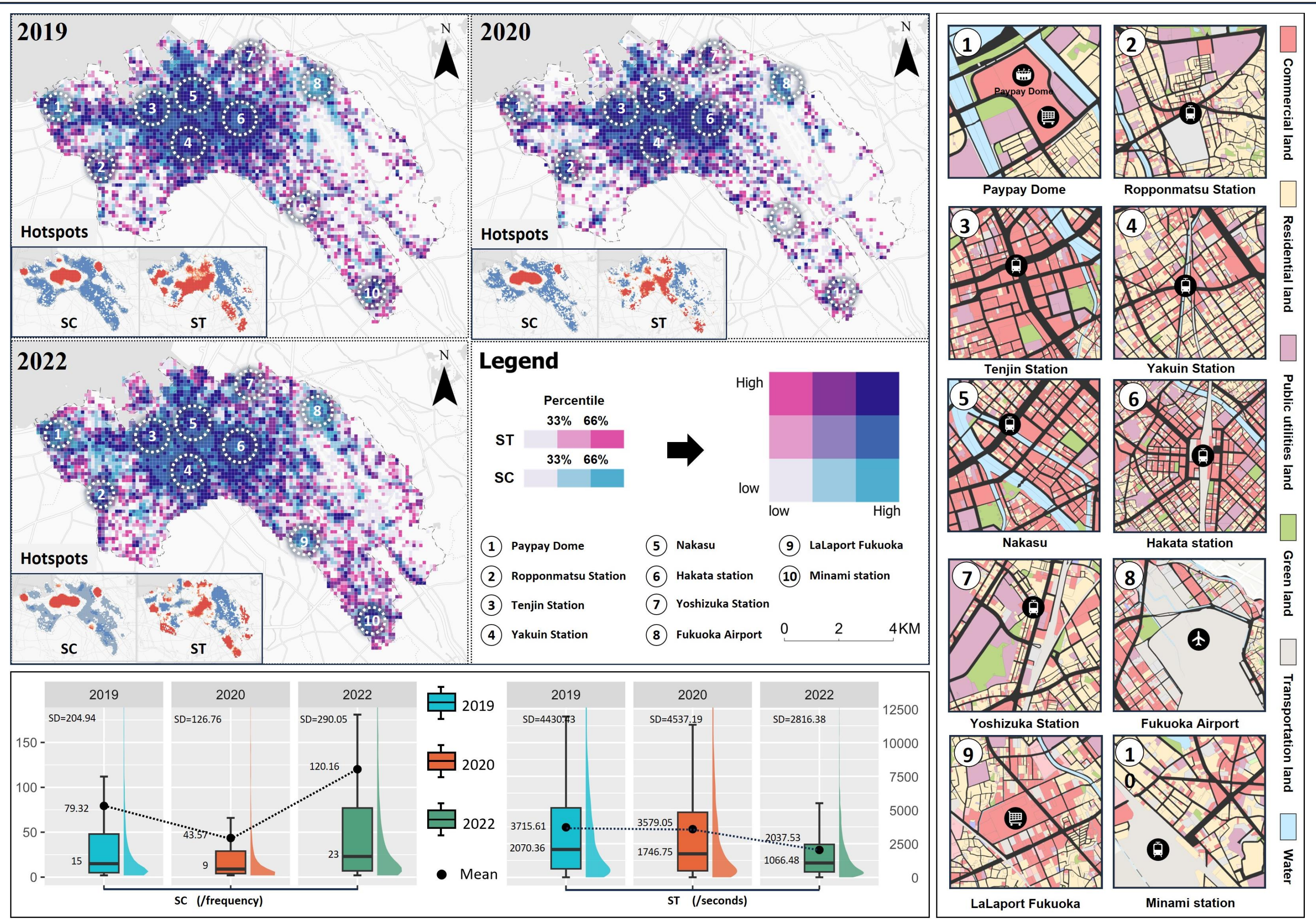


The visit frequency index **SC** is the number of convex hulls staying in the  $i$  th grid. The average visit duration index **ST** is the weighted average access time of the  $j$  th convex hull in the  $i$  th grid.



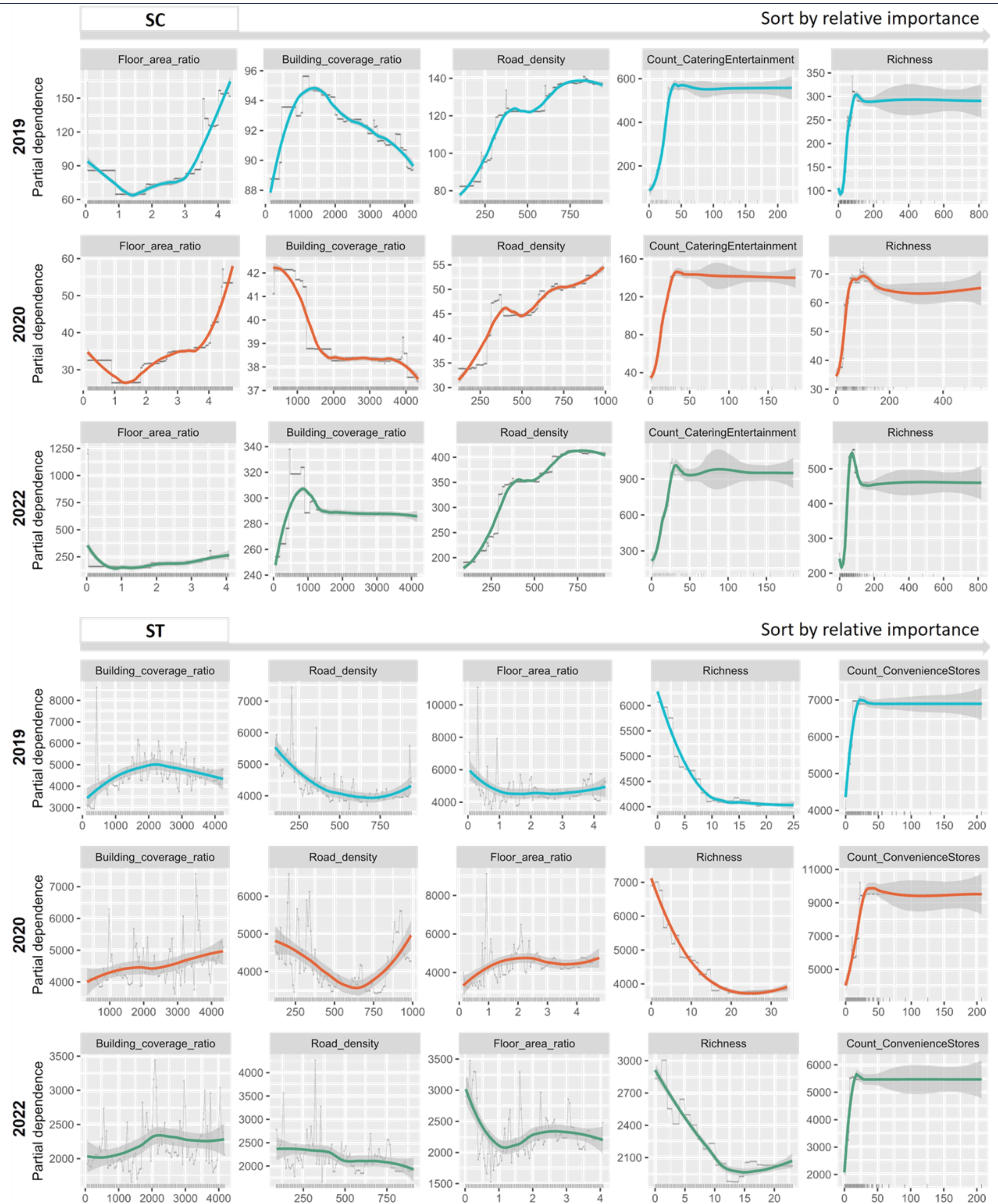
## Results

### Spatial patterns of the visit frequency (SC) and average visit duration (ST) for Fukuoka City.



Key areas include Tenjin, Hakata, Nakasu, transport hubs (e.g., Hakata Station), and new complexes like Paypay Dome and LaPort Mall. SC hotspots are around Tenjin, Nakasu-Kawabata, and Hakata stations. ST hotspots focus on southern Tenjin, Yakuin, and Ohori Park.

### The relationship between visitor behavior and built environment factors



For SC, floor area ratio, building coverage ratio, road density, number of catering/entertainment venues and POI diversity. Among them, floor area ratio and building coverage ratio show a non-linear relationship; For ST, the key factors are building coverage ratio, road density, floor area ratio, POI diversity, and number of convenience store POIs. Among them, floor area ratio, road density and building coverage ratio show a non-linear relationship. And the relationship changes during epidemic.