Spatial Analysis of Starbucks and BEP Stores in Seoul Examined by Subway Network

Keywords: subway, network, closeness centrality, Starbucks, spatial statistics

Extended Abstract

Interactions between Starbucks or bung-eo-ppang (BEP, fish-shaped pastry) stores and the subway network system in Seoul are analyzed with helps of network science and spatial statistics. A subway (metro or urban railroad) network is selected as a key urban transportation system due primarily to its punctuality. Two contrasting types of commercial stores were chosen for analysis--Starbucks and BEP stores. Starbucks represents global-franchise stores that prefer large retail spaces in fixed buildings, while BEP stores typically operate as mobile street-food vendors using small pushcarts. Despite their operational differences, both stores share the common characteristic of freedom on location selection without restriction imposed by Korea law. (Korea law enforces a minimum distance between near-by stores of same franchise stores.) For the measurement of how easy to access a specific station in a subway network, *closeness centrality* (CC) was selected as a quantitative indicator among various centrality measures.

Location data for subway stations and Starbucks stores were obtained from the Korea Government Public Data Portal [1], while BEP data were collected from "Daangn," i.e. community-driven app with a meaning of 'nearby you' in Korean [2], during the 2024-2025 winter period. The area of interest was limited within the city of Seoul, while CCs of subway stations were calculated by incorporating the entire metropolitan area of Seoul. Distributions of subway stations, Starbucks stores, and BEP stores, were plotted on the map of Seoul with a help of the OpenStreetMap project. (See Fig. 1(a) only for Starbucks. The other two are omitted.) The total number of Starbuck (BEP) stores is 622 (1648)—roughly 2.5 times larger number of BEP stores than Starbucks stores. The number of stores is counted within a circle centered at a given station by varying the radius of a circle and by moving the center location of a circle within Seoul, for the purpose of subway-oriented spatial analysis. A hotspot in the upper (lower) part, i.e., in the north (south) of Han river, corresponds to City Hall (Gangnam-gu district) in the heatmap of Fig. 1(a). Store distribution patterns for Starbucks and BEP are plotted in Fig. 1(b), as a function of CC. It reveals that subway stations and Starbucks stores are concentrated near the City Hall and Gangnam-gu district, while BEP exhibit a more dispersed distribution pattern rather than clustering. The numbers of BEP and Starbuck stores located within the circles are displayed in Fig. 2(a) by varying the radii of circles centered at subway stations. As the radius increases, the number of stores increases accordingly. However, in some region, the number of Starbucks stores increases more rapidly than that of BEP stores—Gangnam-gu district and City Hall.

For the numerical analysis, Pearson correlation coefficients (approximately 0.35 and 0.05 for CC-Starbucks and CC-BEP, respectively) and Jensen-Shannon divergence between two distributions were calculated (See Fig. 2(b) for Jensen-Hannon divergence), confirming the distinct characteristics between Starbucks and BEP stores. Spatial correlation analysis was conducted using Moran's I function by dividing the area of interest into circles centered at subway stations in order to focus on the subway accessibility. The values of Moran's I function with global and mesoscopic scales also revealed high contribution from a region near City Hall for Starbucks stores, while BEP stores did not. We can say that subway stations and Starbucks

stores positively interact with each other in Seoul with mild intensity, while the interaction between stations and BEP stores is less pronounced. This work was financially supported by Hankuk University of Foreign Studies Research Fund of 2025.

References

[1] Ministry of Public Administration and Security Public Data Portal, https://www.data.go.kr, all in Korean.
[2] The homepage address is https://www.daangn.com, all in Korean. English homepage is https://www.karrotmarket.com. Although some services are available in the web, almost all services are accessible by mobile app.

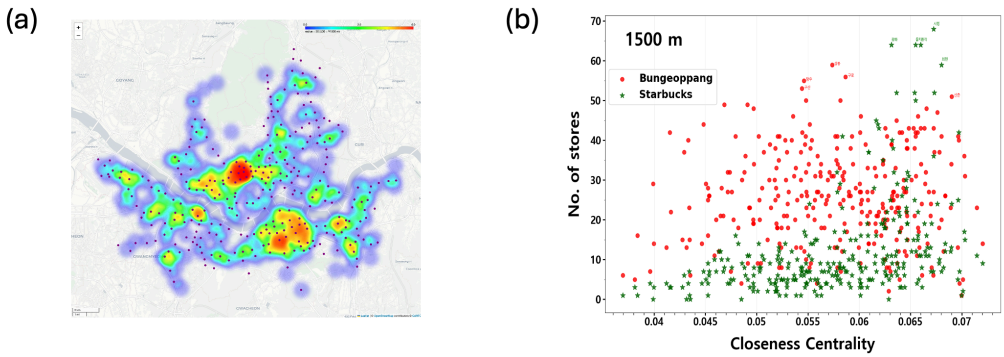

Figure 1. (a) Heatmap of Starbucks in Seoul. The two hotspots correspond to City Hall in the north of Han river and Gangnam-gu district in the south of the river. (b) Distribution diagram for Starbucks and BEP stores within the circles of the radii of 1500 m, as a function of CC of subway stations. More Starbucks stores are located near stations with high CC than BEP stores are; BEP stores distributed relatively evenly regardless of CC.

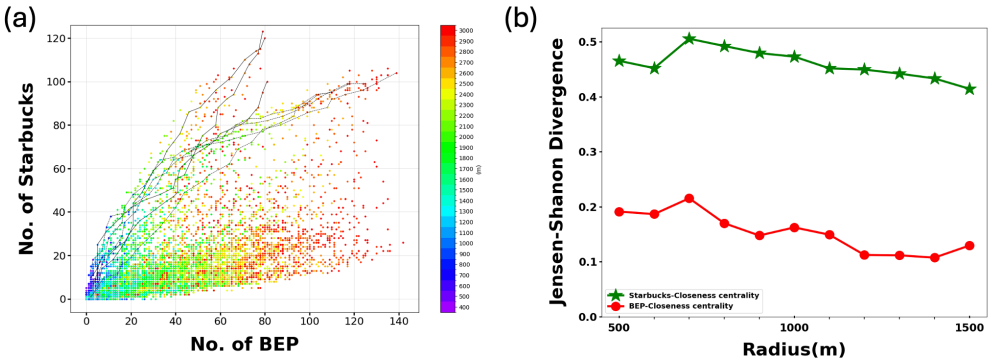

Figure 2. (a) Correlation diagram for the numbers of BEP and Starbucks stores located within the circles centered at all the subway stations in Seoul, by varying the radii of circles from 400 to 3000 m. The dots and lines going to nearly (80, 120) are for stores near in Gangnam-gu district, while those going to (140, 100) are near City Hall. These two regions have quite large number of Starbucks stores than BEP strores. (b) Jensen-Shannon divergence for the distribution between Starbucks (BEP) stores and CC of subway networks, depicted in the green (red) line. This indicates that the distributions for Starbucks and CC of subway network in Seoul are more similar than those for BEP and CC, hinting the dissimilarity between Starbucks and BEP.