

# Application of Geographic Information System (GIS) in Digitizing Hand-Drawn Mental Maps: An Exploratory Study

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**Abstract:** Geographic Information System (GIS) is a common and powerful tool for analyzing quantitative data with locational information and visualizing digital maps, but its potential for qualitative studies has not yet been fully explored. Based on a case study from Seoul, South Korea, this paper investigated how hand-drawn mental maps can be converted into GIS-created maps to gain a deeper understanding of people's perceptions of the 'imageability' of their neighborhood. The findings of this process also provide insights into the implications and limitations of Seoulo 7017, a regenerated public space in the area.

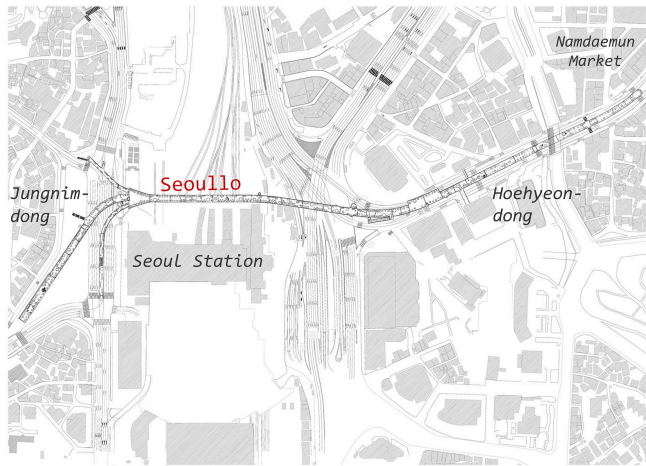
**Keywords:** Public space, imageability, perception, urban regeneration, Seoulo 7017 Skygarden

## 1 Introduction

As an exploratory study, this paper utilized GIS to read the 'fuzziness' of hand-drawn mental maps. Rather than selecting an existing research method and testing a specific hypothesis, it presents the steps taken and the findings obtained: understanding hand-drawn mental maps, extracting the map elements' keywords, digitizing the maps in GIS, and analyzing results of map collection in relation to the urban regeneration project of Seoulo 7017.

This study focuses on the Sogong-Hoehyeon neighborhood in Seoul, South Korea. This neighborhood is composed of four smaller administrative units called *dongs* (Sogong-dong, Hoehyeon-dong, Jungnim-dong, Myeong-dong) with an area of 326 hectares and approximately 21,000 residents. Located in the middle of Seoul, it is the city's oldest Central Business District and is known for its high proportion of commercial districts (55.9% of total zoning). The neighborhood is an important traffic center and contains significant cultural and historic buildings and areas. The concept and boundaries of the 'neighborhood' are borrowed from Seoul Metropolitan Government's 2030 Community Plan, which divided the city into 115 neighborhoods to create more practical plans based on citizens' daily living spaces.

The Sogong-Hoehyeon neighborhood was selected as the study area since it is full of 'imageable' elements, including the Seoulo 7017 Skygarden, a large-scale public space that was recently regenerated and may have impacted the whole neighborhood imageability. Seoulo 7017 is an elevated linear park built on a former highway overpass constructed in 1970. Opened in 2017, the regenerated park is one kilometer long with 17 walkways. One of the main goals of the Seoulo 7017 regeneration project was to connect the eastern and western sides of the neighborhood divided by Seoul Station. The eastern side of Seoulo 7017 (Hoehyeon-dong) is home to many commercial and business high-rise buildings with active pedestrian flows while the western side (Jungnim-dong) is a relatively inactive area. The park has seen an increase in visitors in the five years since it opened, but its effect on the perceived 'connection' of the neighborhood has not been thoroughly studied.



**Fig. 1:** Mass and void surrounding Seoullo 7017 show the clear difference in the size of blocks and buildings between the eastern and western sides divided by Seoul Station

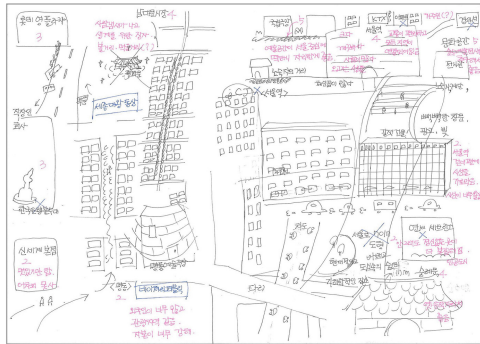
This study aimed to understand how neighborhood imageability is perceived and whether the regeneration project has achieved its intended effect. Imageability, a concept introduced by LYNCH (1960) refers to the quality of a physical object that makes it likely to evoke a strong image with an observer. NASAR (1998) argued that imageability is influenced not only by the level of imageability of a region's features but also by their qualitative likeability. Based on these thoughts, this research assumed that higher imageability, characterized by more imageable elements that are liked by people, leads to better outcomes.

## 2 Understanding Hand-Drawn Mental Maps

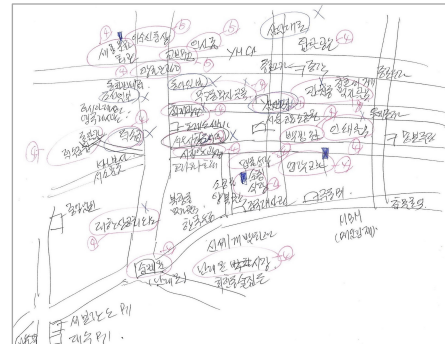
This research used mental maps drawn by people to study their perceptions of the neighborhood more directly. Ten participants from diverse groups of gender, age, and profession were recruited, and the mapping processes involved four steps:

- 1) Present mental mapping (black): Following the guideline of LYNCH (1960), participants were asked to draw a current map of the entire neighborhood with physical and visual figures they could think of immediately and write down the elements' names as if they take around the neighborhood or give an explanation to a stranger. Only the names of four dong were provided as a hint for the neighborhood boundary.
- 2) Present evaluative mapping (red): Borrowing the method of NASAR (1998), participants were asked to rate the likeability of elements that provoke certain feelings on a five-point Likert scale from 1 (very dislikeable) to 5 (very likable).
- 3) Past mental mapping (blue): Participants were asked to imagine they went back in time before 2015, not informed that it is when the Seoullo 7017 project started, and to mark or add any elements on their map they might have differently recognized in the past.
- 4) Follow-up interview: Participants were interviewed about their experiences, feelings, and opinions of the neighborhood and the Seoullo 7017 project and asked to provide reasons for their drawings.

The collection demonstrated how different people perceive and map out the neighborhood in various ways: some participants recalled the neighborhood with visually detailed figures (A) while others in words and names of elements in the notional grid (although the actual area is not in a strict grid form) (B). Some focused on a central landmark and drew its surroundings – Namdaemun (Sungnyemun) Gate (C), Namsan Tower (H), and City Hall Plaza (I) – while others used subway stations as their reference points in the form of connected circles (D) or double circles (G), depending on their personal experiences in the neighborhood.



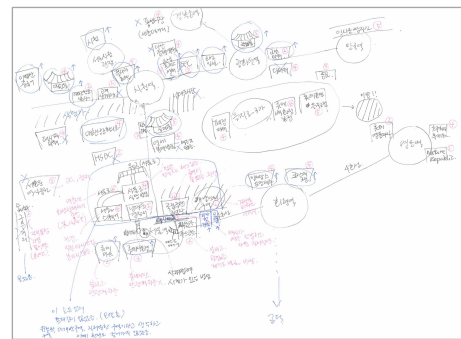
(A)



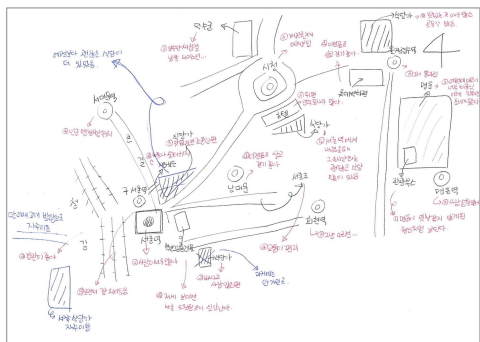
(B)



(C)



(D)

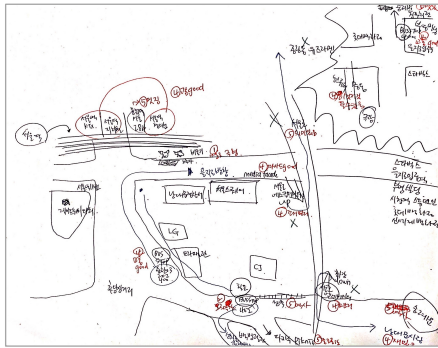


(E)

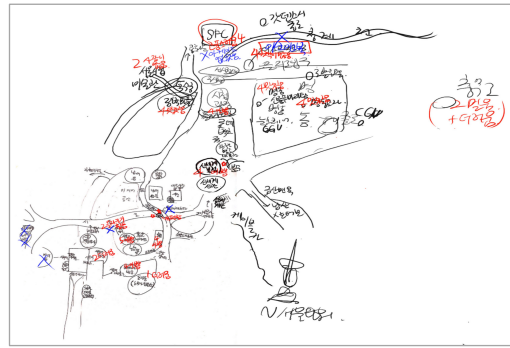


(F)

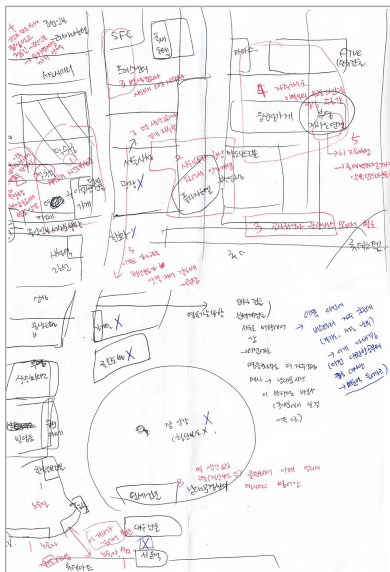
**Fig. 2:** Collection of ten hand-drawn mental maps. Texts are written in Korean.



(G)



(H)



(I)



(J)

Fig. 2 (continued)

A few landmarks were depicted in the map using icons rather than basic shapes, including Namdaemun Gate (Sungnyemun Gate), the old gate of the Joseon dynasty’s fortress wall and the first national treasure of South Korea (A, D), or Namsan Tower (N Seoul Tower), an observation tower located at the highest point in the city (F, H). Hatched areas often indicated a cluster of similar functions, such as food or shopping areas (D, E, J).

### 3 Keyword Categorization

Commonly imageable elements in the neighborhood were identified by collecting all the texts of ten maps. Informal, inaccurate, or vague names were taken intactly to deliver the original perceptions as possible. Among 470 texts, ‘Seoul Station’ was the most frequently occurring





## 4 Map Conversion in Geographic Information System (GIS)

Elements drawn on each hand-drawn map were converted in GIS into elements of different shapes, based on their seven categories (Table 1).

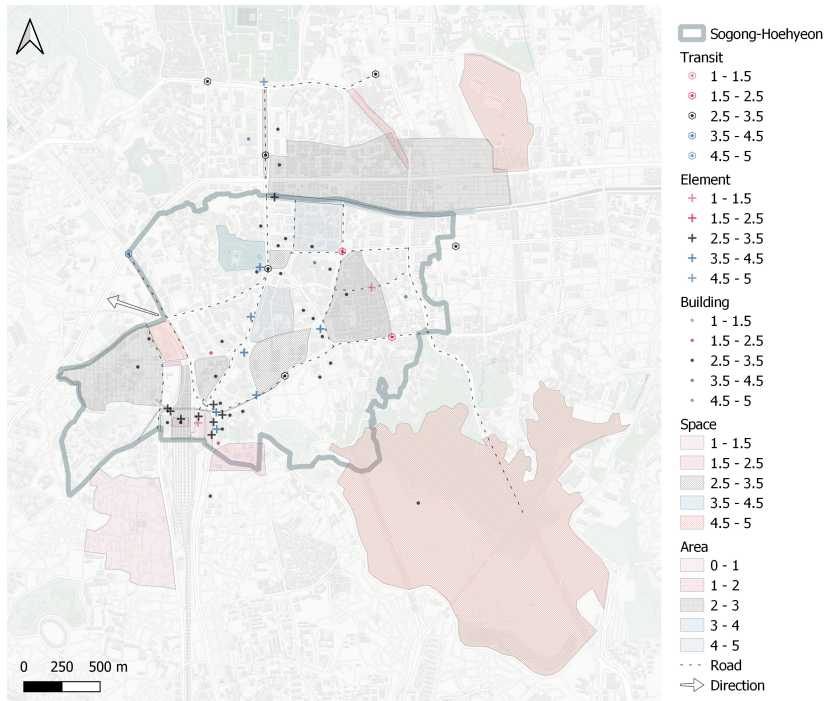
**Table 1:** Element categories and their form represented in GIS

Category	Form	Detail
Transit	Point	Honeycomb shape
Direction	Line	Arrow shape
Road	Line	Dotted line
Element	Point	Cross shape
Building	Point	Color-filled circle shape
Space	Polygon	Diagonal filled polygon
Area	Polygon	Dense filled polygon

The elements were marked on the corresponding positions in a real map based on Open Street Map (Figure 4). Then, all elements were consolidated from ten different maps to create a comprehensive map (Figure 5). The final map considered variations in thickness and color, as outlined by BERTIN (1983). The thickness of each element was determined based on its frequency across the ten maps, while the color was determined by averaging the likeability values. The map was created using the QGIS program.



**Fig. 4:** Overlay of hand-drawn map and real map



**Fig. 5:** Comprehensive map result

## 5 Discussion

By overlaying hand-drawn elements on the actual map and consolidating ten maps, areas emphasized or overlooked in people's perceptions were identified. For instance, parks and green spaces within the neighborhood, even Namsan (Nam Mountain), were not frequently mentioned despite their considerable area on the actual scale, except Deoksugung Palace and City Hall Plaza. The perceived boundaries of the neighborhood were found to differ from the actual boundaries in a way that mappers tended to zoom in on certain areas that they are particularly interested in while cropping the remaining areas. For example, surrounding area of Seoul Station had the most elements concentrated. Although being given the names of administratively defined neighborhood, people often mentioned elements that does actually not situate in the actual boundaries, indicating that the perceived boundaries were blurry and that people perceived the neighborhood only in relation to its surroundings.

Finally, it was possible to infer from the agglomerated map whether the aimed effects of Seoulo 7017 project were achieved, while 8 out of 10 respondents recognized the existence of the linear park in their mental maps:

- 1) Extension of the neighborhood boundary: The west side of the Sogong-Hoehyeon neighborhood used to be relatively unnoticeable in the past mental maps, however, existing elements in this area such as Yeomcheon-dong handmade shoe street and Seosomun History Park became more imageable in the present maps. This even boosted the increase of elements' likeability in this area. Likewise, some landmarks in the east side of Seoulo

7017 started to be perceived than before. In other words, the perceived boundary of the target neighborhood was extended by the regenerated public space. Several respondents said that they started to try a new walking route through many branches of the space.

- 2) Emphasis on existing elements near the regenerated public space: Seoulo 7017 made a lot of existing imageable elements near itself be rediscovered. Many responded that they used to not stay around the Seoulo 7017 or Seoul Station but move to other areas for their lunch or business meetings, assuming that there are few places worthy a visit. After the regeneration, however, they could recall more elements including decent restaurants, coffee stalls, and conference rooms.

## 6 Conclusion and Outlook

Utilizing GIS techniques in qualitative research has been under discovered until now and can expand the usefulness of the GIS tool. To this end, converting qualitative data into numerical data without altering its original nuances is the challenging part. Thus, this study aimed to infer implications and make suggestions with the help of GIS, rather than verifying validity. However, the limitation of this study remains that its categories and symbols used in this study were specific to the case and may vary in other regions and contexts. Future research can explore additional methods of map projection, such as rubber-sheeting map projection.

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