Identifying Urban Block Typology In Seoul Using Improved KMeans Clustering Method

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Introduction

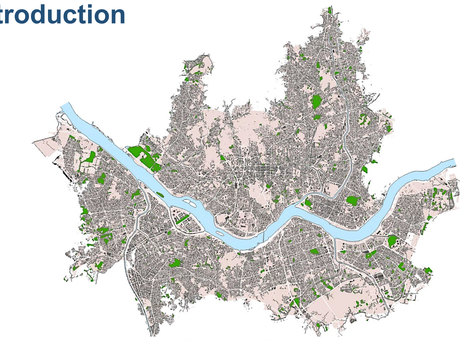


Fig 1. Map of Seoul

Seoul has rapidly grown in the last 600 years by focusing on the extension of urban districts and developments. It results in diverse urban form patterns which mostly originated from adjusting the total quantity of the land (Park et al, 2010). The lands in Seoul have been uniformly managed by their usage, not considering the regional features. Urban form studies have a relation with human settlements that enabled cities to build their characteristics and patterns from the urban components. Therefore, this study analyzed the morphological characteristics of urban blocks which are the fundamental unit that forms a city. This study aimed to identify urban block typology by investigating the unique and inherent common characteristics of the blocks in Seoul based on their homogeneity and variations. The data of urban block features were collected in the Geographic Information Systems (GIS) format and the variables were analyzed by Silhouette score and KMeans clustering. This study attempted to run clustering by steps ordered by distinct factors. The conventional clustering runs all variables at the same time, which results in complex groups that are difficult to discern the unique characteristics of each group. The improved clustering has advantages that facilitates the obvious classification which is helpful for identifying the typology of the objects.

Fig 2. Urban Blocks in Seoul

Seoul city covers an area of approximately 605.2 square kilometers including four hundred and twenty-six administrative Dongs in twenty-five self-governing Gus. As of 2023, about 9.4 million people are living in the city. This area includes 48,340 blocks regardless of their use. The fundamental unit for analysis is the urban block which is enclosed by streets.

Research Question: How to identify the urban block typology considering both expert knowledge and data-driven methods?

Keywords: Urban Form, Urban Blocks, Clustering, Typology

Data

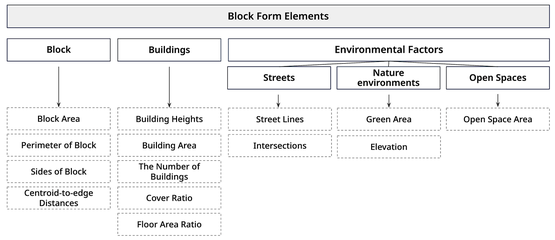


Fig 3. Block Form Elements

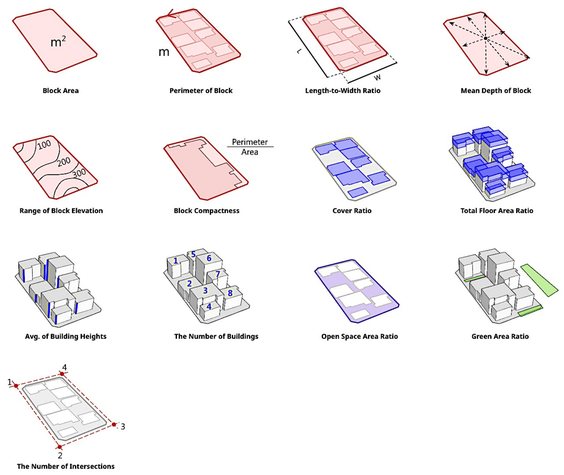


Fig 4. Diagram of Block Form Variables

Variable	Unit	Element	Description
Block Area	m^2	Block	Area of block enclosed by streets
Perimeter of Block	m	Block	The total length of the block's boundary
Length-to-Width Ratio	n/a	Block	Length of MBG / Width of MBG
Mean Depth of Block	m	Block	The average distance from the block's centroids to its edges
Block Compactness	n/a	Block	Perimeter of block / Block area
Cover Ratio	n/a	Building	Sum of building area / Block area
Total Floor Area Ratio	n/a	Building	Sum of Floor Area Ratio of all buildings in a block
Average of Building Heights	m	Building	The average height of buildings within a block
The Number of Buildings	n/a	Building	The total number of buildings within a block
Open Space Area Ratio	n/a	Open Space	Open space area / Block area
Green Area Ratio	n/a	Nature	Green area / Block area
Range of Block Elevation	m	Nature	The range of elevation within a block
The number of intersections	n/a	Street	The total number of intersections formed by adjacent streets

Table 1. Description of Block Form Variables MBG: Minimum Bounding Geometry

Methodology

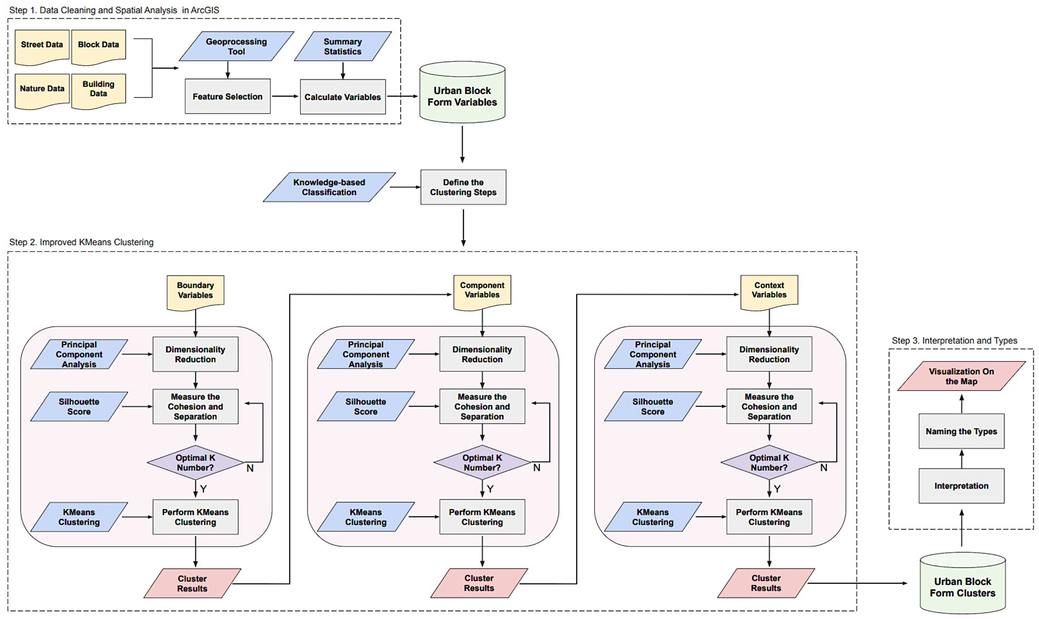


Fig 5. Workflow of Methods

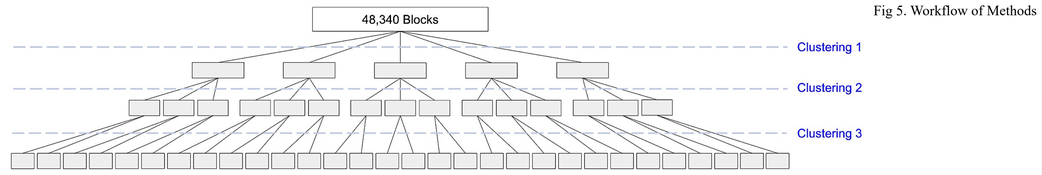


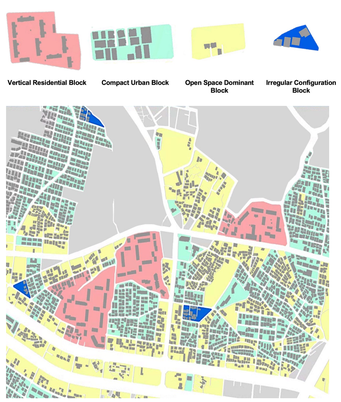
Fig 6. Diagram of Clustering Steps

STEP 1: Raw shapefile data was preprocessed in ArcGIS. Using the Geoprocessing Tool, the Spatial Join technique linked individual block form elements to their respective block polygons. The Summary Statistics function computed sum, mean, and proportion values for each element.

STEP 2: The Urban Block Form Variables were imported into Python. To enhance clustering efficiency, variables were systematically ordered into Boundary, Components, and Contexts based on morphological characteristics and human scale perception. K-Means clustering was performed for each group, with the Silhouette Score determining the optimal cluster number K.

STEP 3: The clustered results were imported into GIS, joined with block polygons, and visualized spatially. After interpretation, the cluster types were named. (Fig 5)

Expected Results



Type	Blocks
Vertical Residential Block	
Compact Urban Block	
Open Space Dominant Block	
Irregular Configuration Block	

Conclusion

Urban typologies and human lifestyles are historically intertwined, mutually influencing and shaping each other over time. Through the quantitative analysis of urban forms, this research provides a deeper understanding of the diverse urban block typologies in Seoul with varying local identities.

The framework of improved clustering that incorporates both expert knowledge and data-driven approach implies a significant potential for discovering urban block typologies. This study overcomes the limitation of conventional clustering and generates the typology in an effective way with unsupervised clustering. This research can contribute to urban planners and designers with valuable insights into the characteristics of urban block typologies, thereby helping decision-making regarding urban design policies, and urban development strategies.