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GeoAI Integration in Mapping Sustainable Urban Retail Property Locations

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Abstract

This study explores how sustainable retail locations can be achieved within the urban areas vis-a-vis the applications of GeoAI. The study develops conceptual framework on the integration of relevant datasets, tools, algorithms, and techniques for developing smart geo-spatial tools capable of aiding smart decisions on various activities including, retail real estate development, investment, occupation, and efficient urban centre planning. The study rests on three (3) broad underlying principles. That is: (1) retail consumers (directly or indirectly) control the retail property markets and retail property location performance (2) spatial behaviour of retail consumers can be scientifically assessed and scored based on interconnectedness of streets (that is, space syntax theory) through spatial configuration analysis and (3) historical data on retail property performance could help in predicting retail location performance and resilience index using predictive machine learning algorithms. The study argues that a rethinking of the distribution of physical retail spaces would be appropriate to ensure various classes of retail real estate are optimally positioned in locations that best meet the present needs of the stakeholders whilst considering the future implications of their actions.

Key words: Retail location, sustainability, GeoAI

1.0 Introduction

The integration of AI algorithms and GIS tools (GeoAI) has enhanced the power of geospatial analysis, visualisation, and prediction of the future location performance of various location-based activities, including retail activities and retail property markets within a given urban area. Based on this capacity and function, it can be argued that the applicability of GeoAI in exploring optimisation of retail property locations to attain a sustainable retail environment have been undermined. This is unconnected to the various factors and issues impacting on the present and future performance of urban retail spaces that have clouded effective and scientific decision making in real estate investment, development, and urban planning.

In the field of retail geography, achieving sustainable retail locations is crucial for the efficient utilisation of urban resources and spaces. To achieve sustainable retail property locations within urban centres, retail spaces within those locations must be optimally utilised and functional. In other words, ***a sustainable retail property location is an optimised state where retail spaces are utilised and function at the most efficient capacity to maximise both current and future usage of the retail spaces***. Therefore, a sustainable retail property location is one that generates optimal returns for investors and turnover for retailers while emitting the lowest (or no) carbon emissions from the interaction and navigation of retail consumers, suppliers, and other stakeholders. Achieving sustainability in retail location is highly complex and requires the systematic integration of various datasets, tools, and GeoAI algorithms. This complexity can be attributed to the dynamic nature of the retail property market and retail consumers, who significantly influence the performance of the retail property market. (Adebayo et al, 2022).

This study explores how sustainable retail locations can be achieved within the urban areas viz-a-viz the applications of GeoAI. The study develops conceptual framework on the integration of relevant datasets, tools, algorithms, and techniques for developing smart geo-spatial tools capable of aiding smart decisions on various activities including, retail real estate development, investment, occupation, and efficient urban centre planning. The study rests on three (3) broad underlying principles. That is: (1) retail consumers (directly or indirectly) control the retail property markets and retail property location performance (Adebayo et al, 2019: Orr et al, 2022)

(2) spatial behaviour of retail consumers can be scientifically assessed and scored based on interconnectedness of streets (that is, space syntax theory) through spatial configuration analysis (Hillier and Hanson, 1989) and

(3) historical data on retail property performance could help in predicting retail location performance and resilience index using predictive machine learning algorithms.

The study argues that a rethinking of the distribution of physical retail spaces would be appropriate to ensure various classes of retail real estate are optimally positioned in locations that best meet the needs of the diverse retail consumer base. Consequently, stakeholders' decisions pertaining to retail real estate should be guided by retail consumers' choices to achieve retail location optimisation and success in retail real estate businesses.

This paper addresses the following questions:

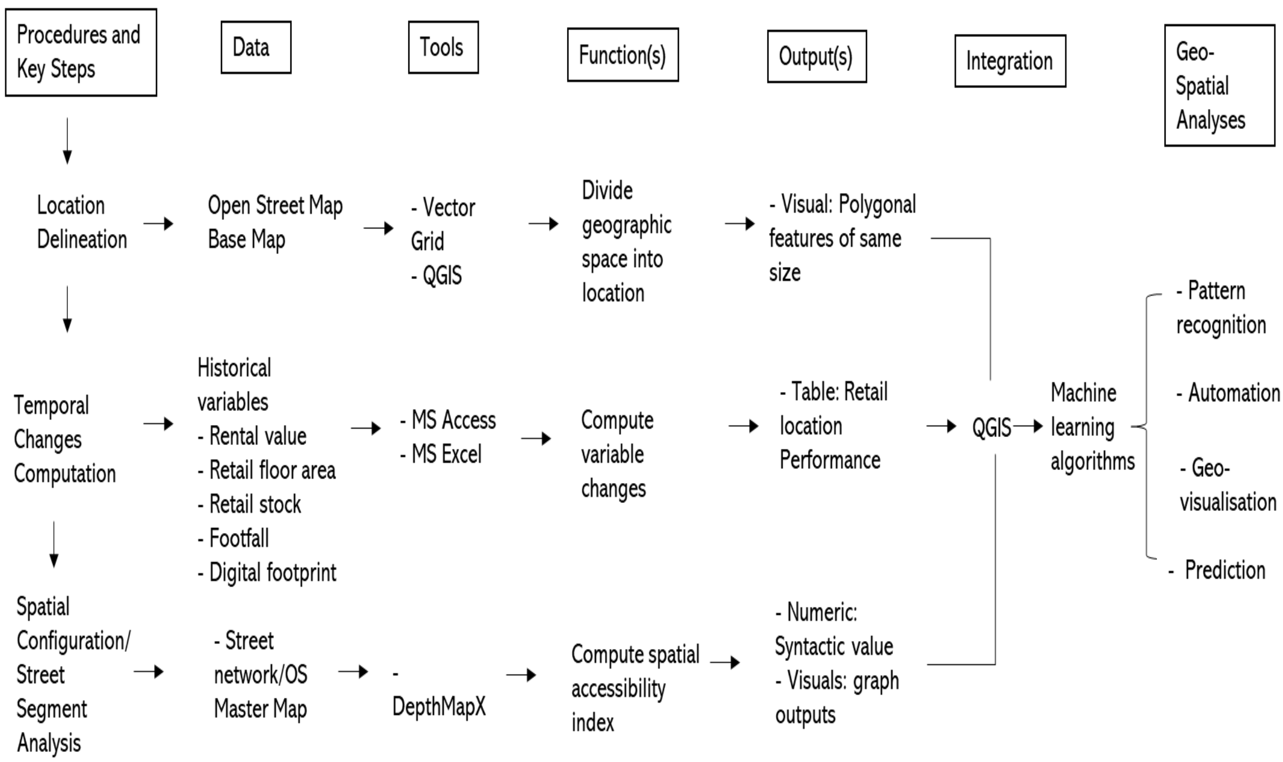
1. How can sustainable retail locations be achieved through the lens of GeoAI application?
2. What are the relevant datasets, tools, and spatial algorithms useful in mapping sustainable retail property locations?
3. How can these datasets, tools, and algorithms be integrated for smarter indication of optimal locations for various activities within urban centres?

The study contributes towards the sustainable future of commercial real estate digitisation and innovation. As such, it would enhance efficiency in decision-making around real estate investments, development, strategic management, and urban planning.

2.0 Method: Procedure and Data

The method relies on geo-spatial integration and analysis of varying datasets. Figure 1 present schema of procedure and integration relevant datasets, tools, functions, and AI algorithm for mapping sustainable retail property locations in given geographic space.

Figure 1: Procedures & Integration of data, tools, functions, AI algorithms for Mapping Sustainable Retail Locations.



Source: Research work (2024)

The key required procedure in this method includes.

i. location delineation of urban area under investigation: This involves delineating geographic area using vector grid tool in QGIS.
ii. Computation of retail property market variable changes to map location performance. The computation would rely on mapping historical changes overtime through table relation analysis using MS Access and MS Excel.
iii. Street network analysis vis-à-vis spatial configuration of street segment using DepthMapX. This analysis generates syntactic value of integration (spatial accessibility index) and visual graph outputs. And
iv. Integration of varying datasets in QGIS for geo-spatial analyses, including, pattern recognition, automation, geo-visualisation and prediction of data and outputs.

The datasets require for this investigation are:

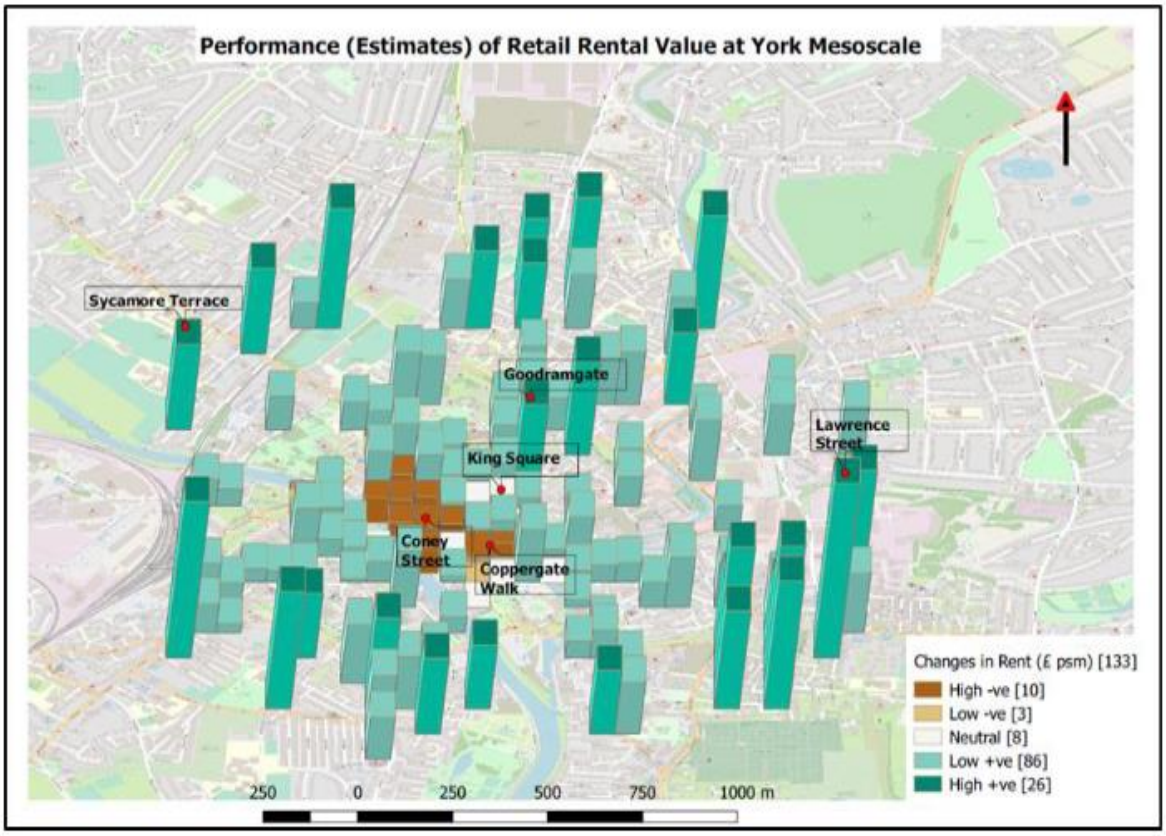
i. Temporal and historical data of retail real estate variables such as, rental values, retail space/floor area, consumers footfall counts, consumer digital footprints and any other similar datasets that meet the following criteria:
   a. Contains location attributes, that is, geographic reference points such as, address, coordinates values etc.
   b. Data must be temporal to permits computation of location changes in performance.
ii. Base Maps such as, Google maps, Open Street Map and other similar raster base map to support visualisation and delineation of urban spaces into vector locations in GIS. And

iii. Street network data: OS Master Map, OS road data etc. capable of indicating street connectivity for spatial configuration (accessibility) computation.

3.0 Initial Analyses, Outputs and Discussion

To analyse the future location performance of urban retail spaces, the study relies on machine learning algorithms to estimate the relationships between spatial accessibility index and historical changes in retail property market variables. Additionally, the study utilizes the QGIS interface to visualize outputs. Figure 2 below presents an example of visual output (map) of the future location performance of retail spaces within the pilot urban area (City of York). The visual representation indicates the future economic performance of various locations based on retail property market changes in relation to the spatial accessibility index configured based on space syntax principles (Hiller and Hanson, 1989)

Figure 2: Future Estimates of City of York Retail Locations



Source: Adebayo (2020)

Figure 2 presents a snapshot of understanding the future location performance of the urban area based on the underlying principles of this study. Specifically, the spatial behaviour of retail consumers can be scientifically assessed and scored based on the interconnectedness of streets (using space syntax theory) through spatial configuration analysis. Additionally, historical data on retail property performance could help in predicting retail location performance using predictive machine learning algorithms. The output has the potential to indicate the optimum location for retail real estate investment, development, and occupation. This will aid in smart decision-making that supports the efficient utilisation of urban spaces for more sustainable planning and strategic management of urban areas.

While this project is ongoing research, the study anticipates that the successful integration of compatible datasets, GIS tools, and AI-machine learning algorithms would be fundamental towards aiding stakeholders' decisions on retail spaces. The successful integration of these tools will support data-driven decisions capable of signalling economic, social, and environmental impacts of stakeholders' actions on retail real estate within an urban area. Similarly, ongoing projects would establish smarter means of planning commercial retail real estates to maximise their present status while also considering future consequences of stakeholders' actions and decisions.

References

Adebayo, A. (2020) *Retail Property Market Performance of Cities: An investigation of the relationship between spatial configuration of consumer movement and changes in retail stock and rental value at Leeds, Newcastle and York*; Published PhD Thesis, Northumbria University Newcastle UK. Available Online via: https://nrl.northumbria.ac.uk/id/eprint/44585/

Adebayo A., Greenhalgh P., Muldoon Smith, K (2019) 'Investigating Retail Property Market Dynamics through Spatial Accessibility Measures,' *Journal of European Real Estate Research*, https://doi.org/10.1108/JERER-01-2018-0009

Adebayo, A., Greenhalgh, P., Muldoon-Smith, K., and Oyedokun, T. (2022). "Towards Attaining Sustainable Retail Property Locations: The Relationships between Supply, Demand, and Accessibility of Retail Spaces" *Sustainability* 14, no. 7: 3846. https://doi.org/10.3390/su14073846

Hillier, B., and Hanson, J. (1984). '*The social logic of space'*. Cambridge, UK: Cambridge University Press.

Orr, A. M. & Stewart, J. L., (2022) Property use diversity and spatial accessibility within urban retailing centres: drivers of retail rents, *Journal of Property Research*, 39 (4), 365-392, DOI: 0.1080/09599916.2022.2046138