Application of 2SFCA Model to Identify and Analyses Spatial Access Disparities to Digital Retail Outlets in Kolkata.

A DISSERTATION

Submitted in partial fulfilment of the

requirements for the award of the degree

of

MASTER OF SCIENCE

in

REMOTE SENSING & GIS

by

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in this dissertation entitled **"Application of 2SFCA Model to Identify and Analyse Spatial Access Disparities to Digital Retail Outlets in Kolkata"** in partial fulfilment of the requirements for the award of the Degree of Master of Science in Remote Sensing & GIS submitted to the Department of Earth Sciences and Remote Sensing, JIS University, Kolkata, is an authentic record of our own work carried out during a period of **August 2025 to March 2026** under the supervision of **Dr. Ratnadeep Ray, Department of Earth Sciences and Remote Sensing**.

The matter embodied in this dissertation has not been submitted by us for the award of any other degree or diploma of this or any other University/Institute.

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ABSTRACT

The spatial distribution of digital retail outlets plays a critical role in shaping urban service equity, yet their accessibility patterns remain understudied within Indian metropolitan contexts. This study employs a network-enhanced Two-Step Floating Catchment Area (2SFCA) model to quantify and analyse spatial access disparities to digital retail outlets across the Kolkata Municipal Corporation (KMC). Geocoded outlet locations were assembled from multi-source digital databases and field validation, and population demand was represented at the ward level using recent demographic datasets. Road-network travel distances were computed to generate variable catchments, enabling the derivation of outlet-to-population ratios in the first step and aggregated accessibility indices in the second step. Spatial interpolation and cluster analysis were applied to detect statistically significant high- and low-access zones. The results reveal strong spatial heterogeneity, with high-accessibility clusters concentrated along major commercial corridors and transport-rich central wards, while peripheral and socio-demographically dense zones exhibit pronounced service deficits. Model outputs indicate that accessibility variations are driven by disproportionate outlet clustering, uneven population distribution, and network impedance effects. The study demonstrates the operational suitability of the 2SFCA framework for measuring digital service accessibility in complex urban settings and provides an evidence-based foundation for targeted infrastructure interventions and equitable service planning in Kolkata.

ACKNOWLEDGEMENTS

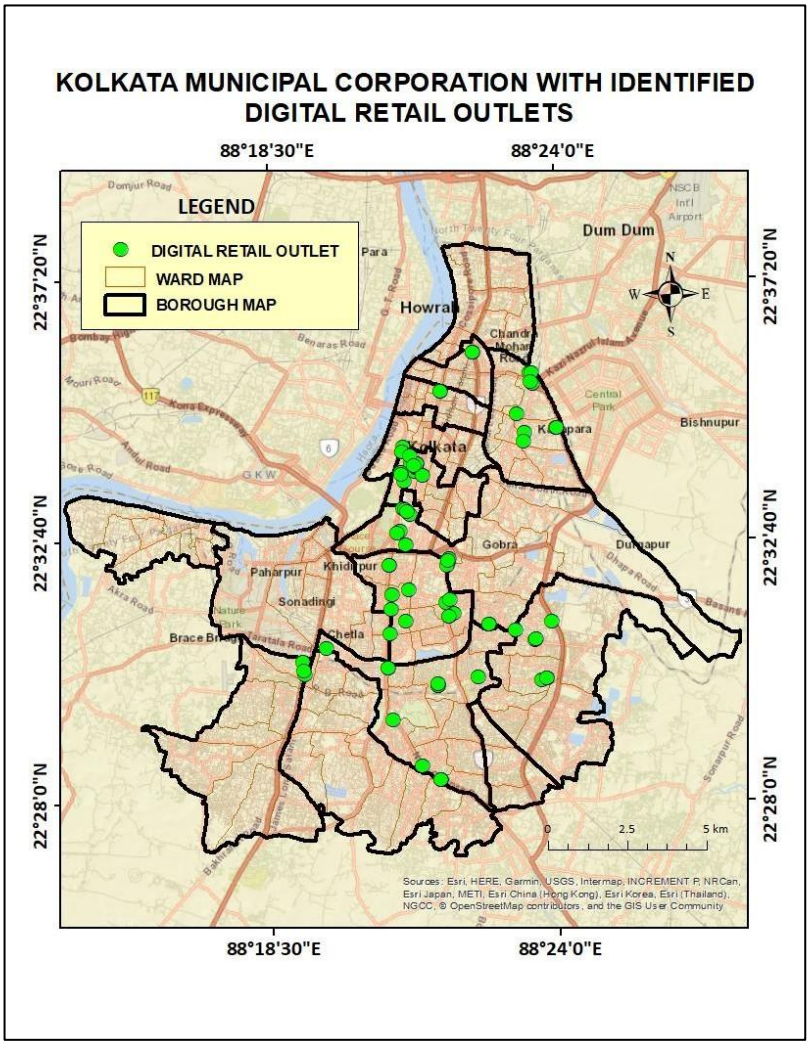
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INTRODUCTION

Digital retail outlets—such as electronic service hubs where people can buy or access products like refrigerators, air conditioners, televisions, mobile phones, laptops, and other digital appliances—have become an important part of modern urban life.



In a large metropolitan area like Kolkata, the distribution of such outlets is not always equal. Some neighbourhoods have several well-connected electronic shops and service centres, while other areas may have only a few or none at all.This study is important for several reasons. First, Kolkata is a large and socio-economically diverse city, which makes accessibility patterns complex. Second, digital appliances are not luxury goods anymore; they are necessary for daily life, digital education, financial activities, and household functioning. Third, identifying areas with low accessibility can help policymakers, planners, and private companies improve service coverage and reduce spatial inequalities. By understanding where digital service hubs are lacking, more balanced urban planning decisions can be taken. Overall, this research provides a structured approach to measure how equitably digital retail outlets are distributed in Kolkata and how these patterns affect different communities. The findings of the study will contribute to a more inclusive urban planning process and support the development of strategies that ensure equal access to essential digital appliances and services for all residents.

JUSTIFICATION OF THE TITLE

The title of this study is justified because it directly reflects the main purpose, method, and problem addressed in the research. Kolkata is a large metropolitan city where digital retail outlets—such as showrooms and service points for electronic goods (fridge, AC, TV, mobile phone, laptop, etc.)—are not evenly distributed. These outlets act as important service hubs that support household needs, digital lifestyles, and urban consumption patterns. However, some neighbourhoods have many such outlets within close reach, while other areas—especially the fringes—have very limited access. This uneven distribution creates spatial access disparities, meaning people in different locations do not enjoy equal opportunities to reach these services.

To study this inequality scientifically, the Two-Step Floating Catchment Area (2SFCA) model has been selected. The title highlights this because the 2SFCA method is central to the research. The model is widely used for accessibility studies because it combines two crucial factors:

1. **Supply** – the number and capacity of digital retail outlets.
2. **Demand** – the population living around these outlets.

It also includes travel distance, which makes accessibility calculations more realistic than simple straight-line measures. By mentioning the model clearly in the title, the study signals a strong methodological foundation, showing that accessibility will be analysed using a proven spatial technique rather than general observation.

The inclusion of "Identify and Analyse" in the title is also appropriate because the study does not only measure accessibility—it also interprets the results, maps patterns, and highlights areas with high, medium, and low access. This helps urban planners, retailers, and policymakers understand where new outlets may be needed and where service gaps exist.

Finally, specifying "in Kolkata" makes the title location-specific. Kolkata's heterogeneous population, old city structure, mixed land use, and varying levels of urban development make it an ideal area for studying spatial disparities. Therefore, the title accurately conveys the study's focus on accessibility, its scientific methodology, and its geographic scope, making it both precise and meaningful.

LITERATURE REVIEW

1. Introduction

Digital retail accessibility has become an essential research domain as cities increasingly rely on electronic goods hubs such as outlets selling refrigerators, air-conditioners, televisions, smartphones, laptops, and other consumer electronics. These outlets form a crucial part of urban service infrastructure, influencing digital inclusion, consumer mobility, and economic participation. A growing body of literature focuses on the spatial distribution of such services and the challenges of unequal accessibility across urban regions.

Studies examining service accessibility often rely on Geographic Information System (GIS) techniques due to their capacity to capture spatial patterns, model transportation networks, and quantify demand–supply relationships. Proximity-based methods, such as Euclidean distance, have historically been used to determine how close or far populations are from essential services (Luo & Wang, 2003). Although useful, straight-line distance fails to account for real travel constraints or population pressure on services. This limitation motivated the shift toward more advanced accessibility models.

A significant advancement in accessibility research came with the development of the Two-Step Floating Catchment Area (2SFCA) model, introduced by Luo and Wang (2003). The model quickly became one of the most widely applied spatial accessibility tools because it incorporates both distance decay and supply-to-demand ratios. Numerous studies applied the 2SFCA model to healthcare accessibility, showing how travel thresholds, service capacity, and population sizes influence access (Luo & Qi, 2009; Delamater, 2013). Variants such as the Enhanced 2SFCA (E2SFCA), Modified 2SFCA (M2SFCA), and Kernel Density 2SFCA further improved precision by integrating distance weighting and variable catchments.

Beyond healthcare, accessibility studies expanded to education, financial services, public transport, supermarkets, and digital infrastructure. Research by McGrail (2012), Talen (2018), and Mao et al. (2020) emphasizes that service accessibility varies significantly across socio-economic and spatial boundaries. This evidence shows that urban residents do not enjoy equal access to essential services—even within small geographic areas.

However, despite extensive work on urban service accessibility, very limited research examines accessibility to digital retail outlets or electronic goods hubs. Consumer electronics stores play a major role in digital participation, online-shopping integration, and technology adoption, yet existing literature barely addresses their spatial inequities. In rapidly urbanizing societies like India, where the shift toward digital lifestyles is accelerating, the lack of accessibility to such outlets can deepen the digital divide.

2. Research gap of the study

1. Digital retail outlets remain underexplored within accessibility studies.

2. Indian metropolitan contexts—especially Kolkata—lack spatial accessibility research beyond traditional public services.

3. No study has applied the 2SFCA model to evaluate access to electronic goods hubs, despite the model's proven effectiveness.

3. Aim of the Study

The aim of this study is to understand how accessible digital retail outlets are across Kolkata, and to find out whether this access is equal or unequal among different wards.

1. To measure spatial accessibility: Understand how easy or difficult it is for residents to reach digital retail outlets.

2. To identify spatial disparities: Find which wards have high access and which have low access.

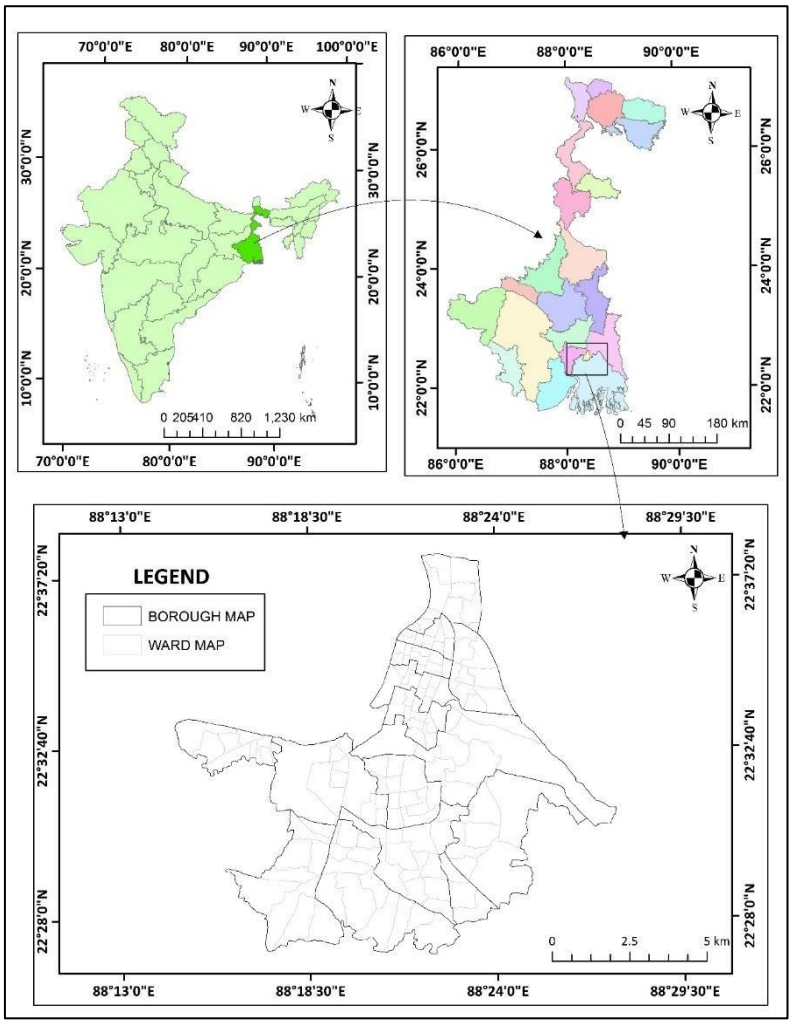
3. To use the 2SFCA model: Apply a realistic model that includes distance, supply of outlets, and population demand.

4. To locate underserved areas: Detect the wards that have fewer digital facilities compared to population needs.

5. To support digital inclusion: Ensure equal access to digital services for all socio-economic groups.

STUDY AREA

The present study has been carried out in Kolkata city, which is the capital of West Bengal, India and one of the largest metropolitan cities in eastern India. The city is located between 22°28′ N to 22°37′ N latitude and 88°18′ E to 88°24′ E longitude, and it lies along the eastern bank of the Hooghly River. Kolkata forms the core of the Kolkata Metropolitan Area (KMA) and plays a major role in the social, economic, and digital development of the region.



The city is served by a dense network of roads, metro rail, suburban rail, and bus routes, which strongly controls the movement of people and access to services. However, despite this well-developed transport system, spatial accessibility to digital retail outlets varies widely across different parts of Kolkata due to traffic congestion, population pressure, and unequal facility distribution.

Because of its large population, mixed land use, strong transport network, and uneven distribution of digital retail outlets, Kolkata provides an ideal setting for applying the Two-Step Floating Catchment Area (2SFCA) model. The model is used in this study to measure spatial access and identify underserved and well-served areas of digital retail services.

DATA SET AND METHODOLOGY

Introduction

The rapid growth of digital retail services in Indian cities like Kolkata has reshaped urban consumption but also highlighted unequal access across different areas and social groups. Kolkata's diverse urban landscape—from affluent planned townships to dense traditional neighbourhoods and low-income fringes—creates significant disparities in digital retail accessibility, influenced by infrastructure, transport, and connectivity gaps.

Traditional distance-based measures fail to capture the true accessibility to digital services, but the Two-Step Floating Catchment Area (2SFCA) method offers a better approach by considering travel time, service capacity, and population demand. Applying 2SFCA in Kolkata reveals spatial patterns of accessibility, identifying underserved areas and highlighting how urban form and socioeconomic factors affect digital inclusion.

Given the rising importance of digital retail post-pandemic, including fintech, e-logistics, and EV charging, ensuring equitable access is crucial for inclusive economic participation. The 2SFCA model thus provides valuable insights and

practical guidance for planners and policymakers to improve digital retail service distribution and reduce spatial inequalities in the city.

1.1 Dataset and Data Collection

Accessibility is a multidimensional concept that reflects how easily people can reach essential services within an urban environment. In rapidly expanding metropolitan regions like Kolkata, accessibility to digital retail services and supporting infrastructure is unevenly distributed due to historical settlement patterns, transport systems, socio-economic variations, and spatial inequalities. To capture these variations, this study integrates GIS-based Euclidean distance modelling, cost-distance analysis, Weighted Linear Combination (WLC), and the Two-Step Floating Catchment Area (2SFCA) method. These multi-criteria and spatial analytical approaches enable a comprehensive understanding of how different urban facilities contribute to overall digital retail accessibility.

Five key facilities were selected based on their functional role in supporting digital transactions, mobility, and infrastructural connectivity within the city:

· **Banks / ATMs – financial transaction points**

· **Bus Stops – primary public transport nodes**

· **Metro Stations – high-speed intra-urban connectivity**

· **Railway Stations – regional and suburban linkage**

· **Car-Charging Points – emerging digital & EV-support infrastructure**

Each facility type influences digital accessibility differently; therefore, the study develops individual distance surfaces, reclassification schemes, weighted scoring, and integrated accessibility indices to derive a final spatial pattern of accessibility variation within Kolkata Municipal Corporation (KMC).

Data Collection Table

Data Collection

Dataset	Dataset Name	Data Format	Source	Purpose / Role
Administrative & Base Layers	Kolkata Municipal Corporation Boundary	Polygon	KMC GIS	Projected to WGS 84 / UTM Zone 45N
	Ward Boundaries (144 units)	Polygon	KMC	Used for spatial aggregation and final accessibility mapping
	Road Network	Polyline	OpenStreetMap (OSM)	Cleaned, topology corrected, projected
Facility (Point) Dafasets	Banks / ATMs	Point	Proxy for digital financial transaction points	Geocoded, topology corrected, snapped to road network
	Bus Stops	Point	Public transport nodes supporting physical accessibility	Geocoded, topology corrected, snapped to road network
	Metro Stations	Point	Rapid transit connectivity points	Geocoded, topology corrected, snapped to
	Railway Stations Car-Charging Points	Point	Emerging and suburban connctivity	Geocoded, topology corrected, snapped to

1.2. Methodology

This study uses a Geographic Information System (GIS)-based spatial analysis approach to evaluate accessibility patterns across Kolkata. Relevant spatial datasets, including transportation and public service facilities, were collected from secondary sources and processed in a GIS environment. The data were georeferenced, projected into a suitable coordinate system, and analyzed using spatial techniques. Accessibility maps were generated to identify the spatial distribution of services and to assess variations in accessibility across different parts of the city. The results were then interpreted to understand the existing accessibility conditions and spatial inequalities within the study area.

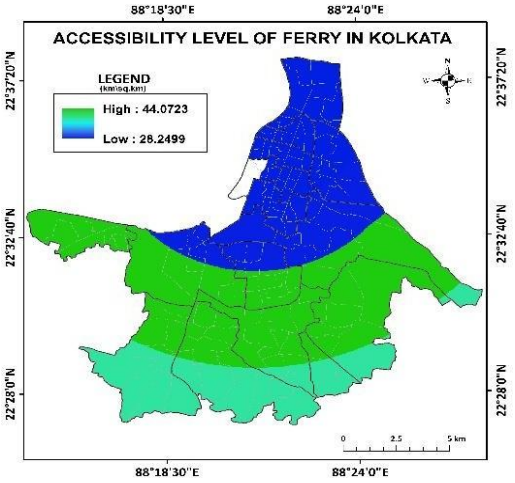
1.2.1. Euclidean Distance: -

Euclidean distance is the straight-line distance between two points in a plane or 3D space. It is calculated using the Pythagorean theorem:

Input Data: Identify the reference feature (point/line/polygon) from which distance is to be measured and ensure data is in a projected CRS (metre units).

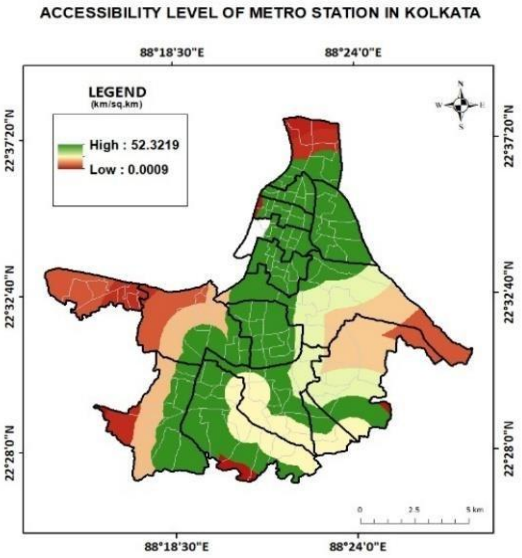
Distance Calculation: Apply the Euclidean Distance/Proximity tool, which uses the Pythagorean formula to compute the straight-line distance from each cell/location to the nearest feature and outputs a distance raster.

i) Euclidean Distance from ferry:



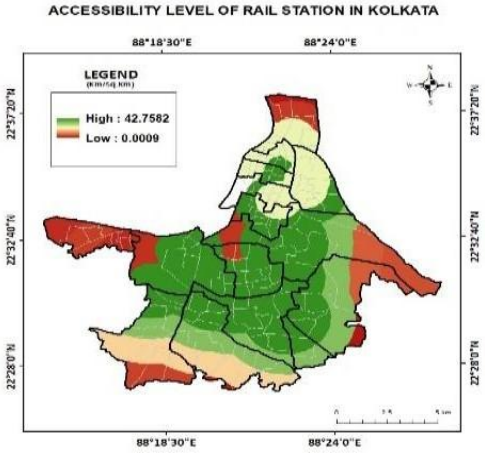
The map shows the spatial accessibility of ferry services in Kolkata, classified from high to low. Areas shown in blue represent high accessibility (closer to ferry ghats), with values around 44.07 km/sq.km, mainly concentrated in northern and central river-adjacent zones. The green to light-green areas indicates moderate to low accessibility (farther from ferry routes), with minimum values around 28.25 km/sq.km, mostly in southern and peripheral regions of the city.

ii) Euclidean Distance from metro:



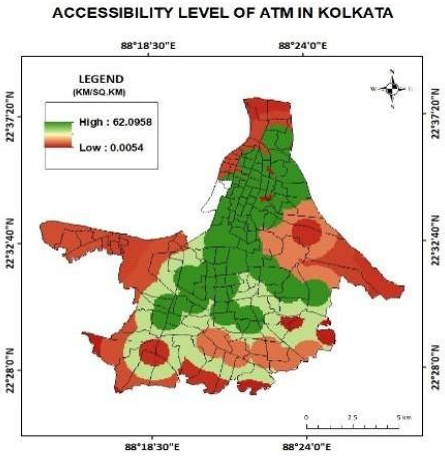
The map shows the Euclidean distance–based accessibility to metro stations in Kolkata. Areas close to metro stations have high accessibility (green), while distant peripheral regions show low accessibility (orange–red). Central and southern Kolkata exhibits better metro coverage, whereas the outer fringes remain poorly accessible, indicating the need for improved transit connect.

iii) Euclidean Distance from rail:



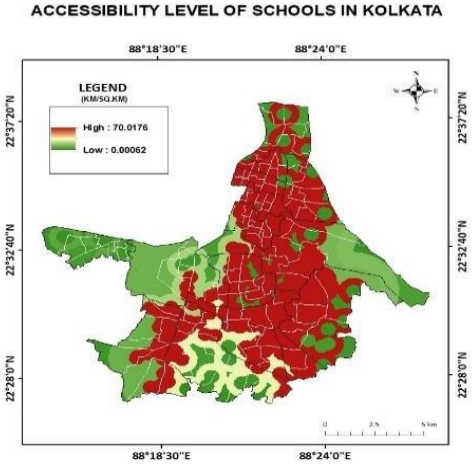
The map illustrates the railway station accessibility across Kolkata, categorized from high (green) to low (red) accessibility. Areas in central and southern Kolkata show high accessibility (up to 42.76 km/sq.km), indicating closer proximity to major and suburban rail stations. Conversely, the northern fringe and western/eastern peripheral regions appear in red and orange, representing low accessibility (as low as 0.0009 km/sq.km), where rail connectivity is limited or distant.

iv) Euclidean Distance from ATM:



The map displays the spatial accessibility of ATMs across Kolkata, ranging from high (green) to low (red) accessibility. Central Kolkata shows high accessibility zones (up to 62.09 km/sq.km), reflecting dense ATM availability. In contrast, the outer and peripheral areas appear in red shades, indicating low accessibility (as low as 0.0054 km/sq.km), where ATMs are sparse and services are less reachable.

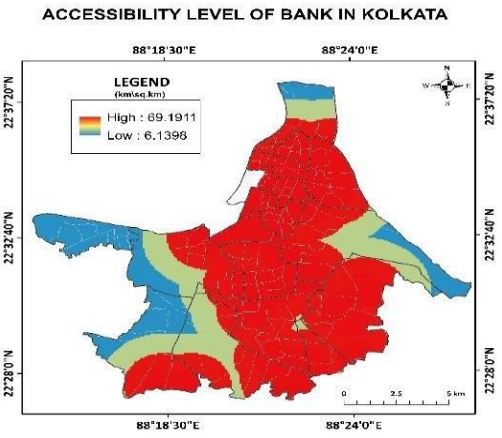
v) Euclidean Distance from School:



The map depicts the spatial accessibility of schools in Kolkata, showing a gradient from high accessibility (green) to low accessibility (red). Peripheral western, southern, and southeastern zones display high accessibility values (up to 70.0176 km/sq.km) due to dense school presence. In contrast, central and northern wards fall into the low-accessibility range (around 0.00062 km/sq.km), indicating sparse school facilities and greater distance from residential areas.

vi) Euclidean Distance from Bank:

The map depicts the bank accessibility levels across Kolkata, ranging from high (blue/green) to low (red) values. The western, southern, and eastern peripheral wards show high accessibility (up to 69.1911 km/sq.km), indicating closer proximity to bank branches. In contrast, most of the central and northern parts of Kolkata fall under the low-accessibility zone (as low as 6.1398 km/sq.km), reflecting fewer banks or greater distance from banking services.



1.2.2. ROAD NETWORK ANALYSIS: -

Road network analysis of Kolkata examines the connectivity, accessibility, and efficiency of the city's roads using GIS tools. It identifies major corridors such as EM Bypass, NH-16, NH-12, and central Kolkata streets, highlighting traffic bottlenecks, highly connected junctions, and poorly accessible peripheral zones. The analysis helps understand travel time, shortest paths, service areas, and overall mobility patterns to support urban planning and transport management.

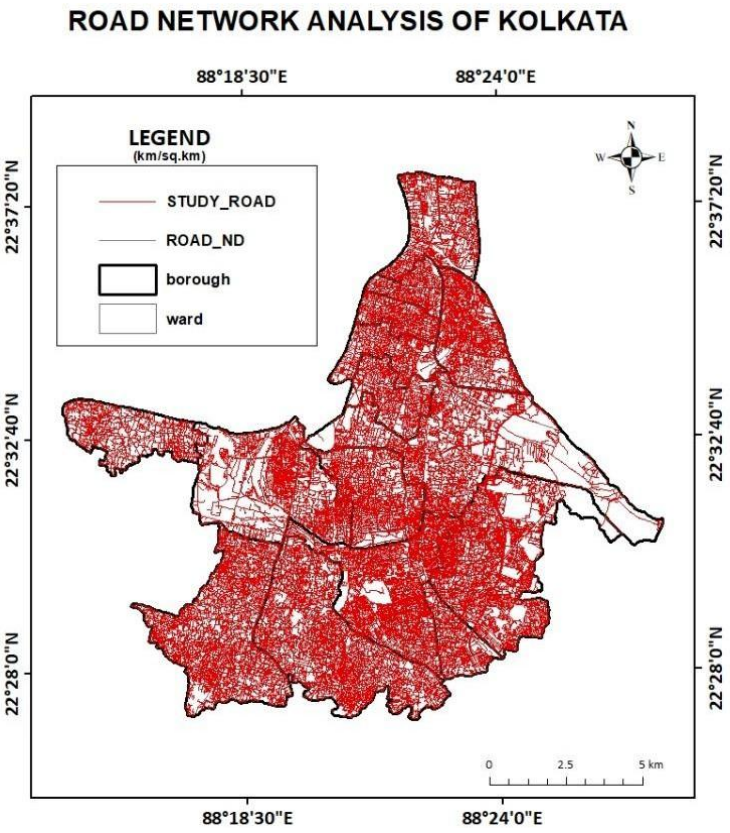
1. Data Collection: Road layers from OSM/KMC; ward boundary and key facility locations added.

2. Network Preparation: Clean topology; build network dataset with nodes, edges, distance/time attributes.

3. GIS Analysis: Apply Shortest Path, Service Area, OD Matrix, and Closest Facility tools to assess connectivity.

4. Mapping & Interpretation: Identify high/low accessible areas and major corridors for planning.

The map illustrates the spatial distribution and density of Kolkata's road network. The red lines represent the study roads, showing a highly dense and interconnected network in the central, northern, and southern parts of the city. Major borough and ward boundaries are outlined, highlighting variations in road concentration across administrative units. Overall, the map depicts a well-developed urban road system with dense connectivity in built-up areas and comparatively lower density toward the city's fringes.



1.2.3 OD Cost Matrix:

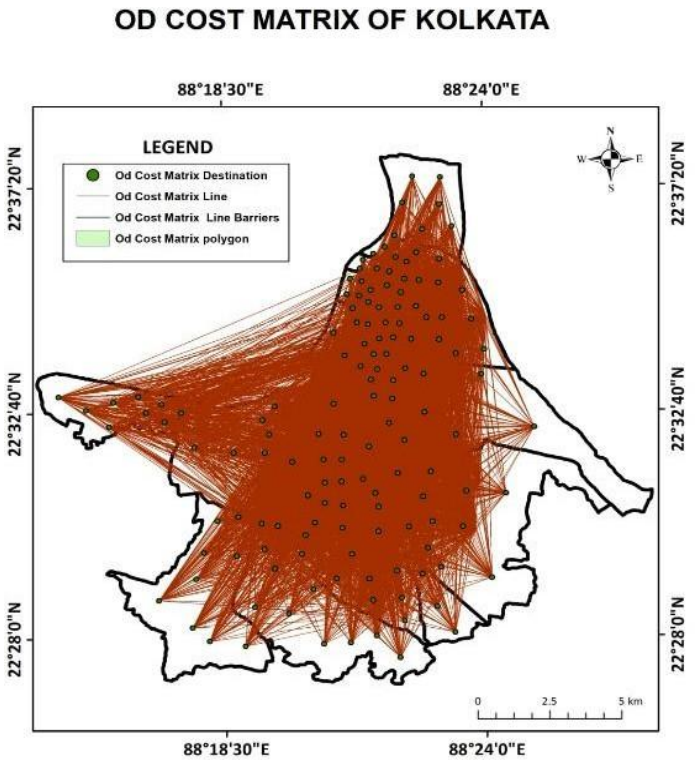
The OD Cost Matrix was constructed using the road and multimodal transport network of Kolkata (bus, metro, rail). The matrix estimates the least-cost travel time between:

- Origin: Ward centroids (demand points)
- Destination: Digital retail outlets (supply points)

Steps Used

1. **Network Dataset Creation**:
   Road segments were assigned travel impedance values based on average speed:
   - Major Arterial Roads: 30–40 km/hr
   - Local Roads: 10–15 km/hr
   - Walkable Links: 4–5 km/hr
2. **Multimodal Integration**:
   Metro stations, bus stops, and rail stations were connected to the road network as linear nodes with transfer penalties.

3. **Cost Matrix Computation**: Using ArcGIS Network Analyst, a travel-time matrix was generated for every ward-digital outlet pair.



4. **Interpretation**

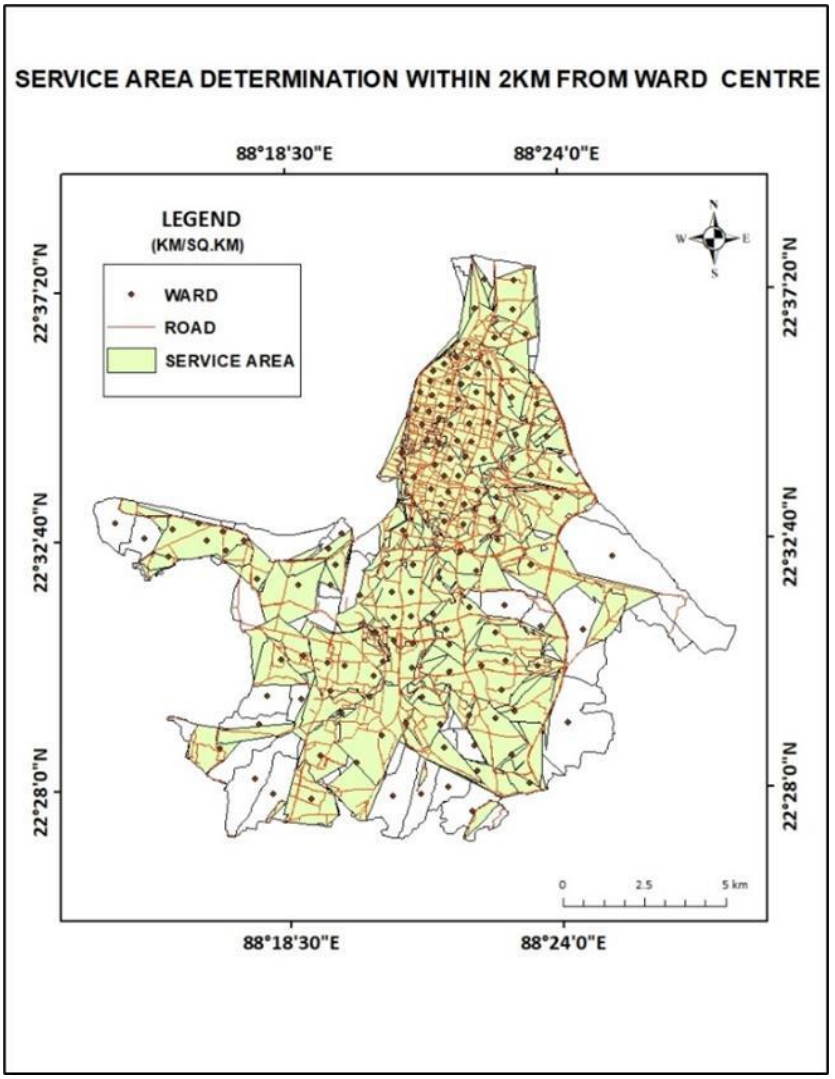
The OD cost matrix clearly shows:

- High connectivity in central, south, and SE Kolkata.
- Sparse connectivity northwards beyond Dunlop and Baranagar.
- Peripheral wards show higher travel impedance (darker OD lines).

1.2.3 Service Area Calculation (Within 2 km): Service area analysis was carried out using the Network Analyst extension in ArcGIS to evaluate the spatial accessibility between digital retail outlets and ward centres within a 2 km network distance.

1. Service Area from Ward Centres to Digital Outlets

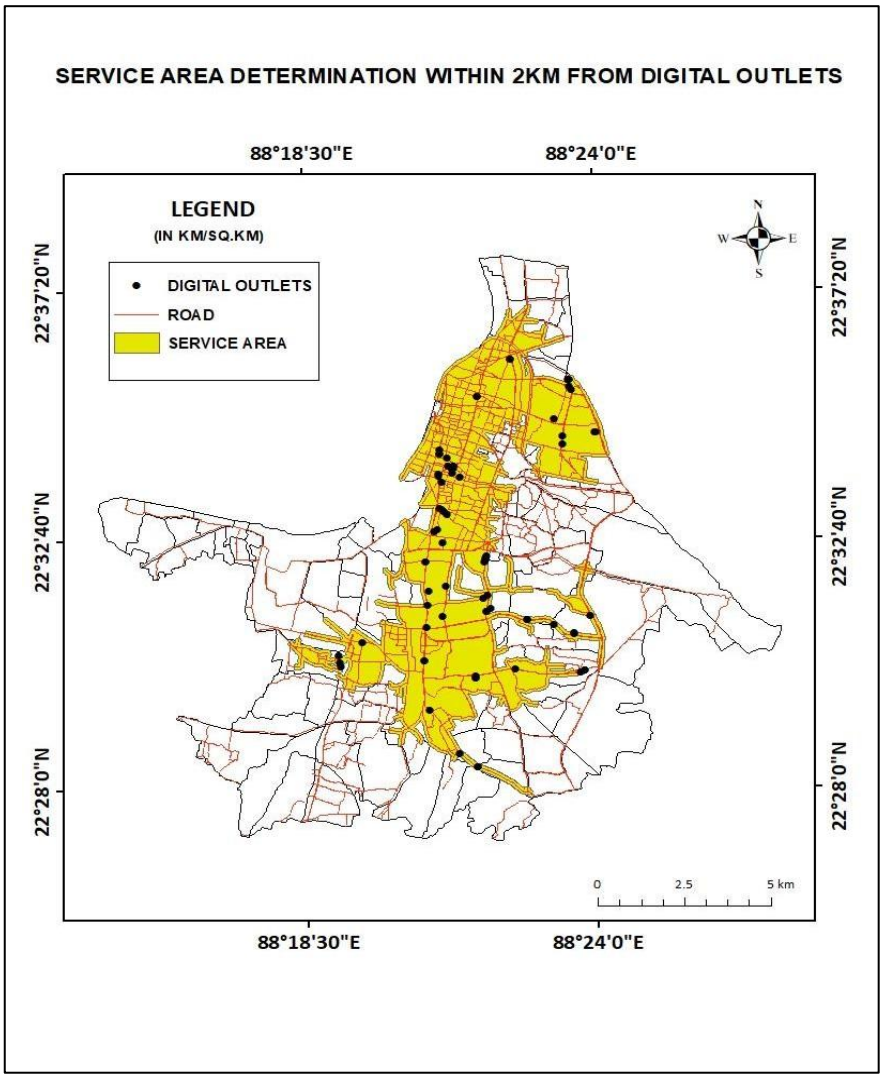
In the first stage, ward centres were considered as the origin points, and a 2 km service area was generated along the road network. This analysis represents the maximum distance that residents from each ward can travel to reach the nearest digital outlets within a reasonable. The output map shows that most of the central wards fall within the 2 km service coverage, indicating good accessibility to digital outlets, while several peripheral wards remain outside the service area, highlighting areas with limited access to digital retail services.



2. Service Area from Digital Outlets to Ward Centres

In the second stage, digital outlets were treated as service facilities, and a 2 km service area was generated from each outlet along the road network. This analysis indicates how many ward centres are served by individual digital outlets within the defined

distance threshold. The results reveal that digital outlets located in the central and well-connected parts of the city serve a larger number of wards, whereas outlets in the outer parts of Kolkata serve fewer wards, due to lower road connectivity and larger travel distances.



Significance of Service Area Analysis:

- Identifying well-served and underserved wards
- Measuring spatial accessibility to digital retail services

Thus, the service area analysis provides a strong spatial foundation for assessing access disparities and digital retail service coverage in Kolkata.

1.2.5. Weight Vallue Analysis:

Weighting is critical for accessibility modelling. Following the decay-based allocation similar to gravity models, weight values were assigned based on distance-decay from the OD matrix.

Weighting Scheme Adopted

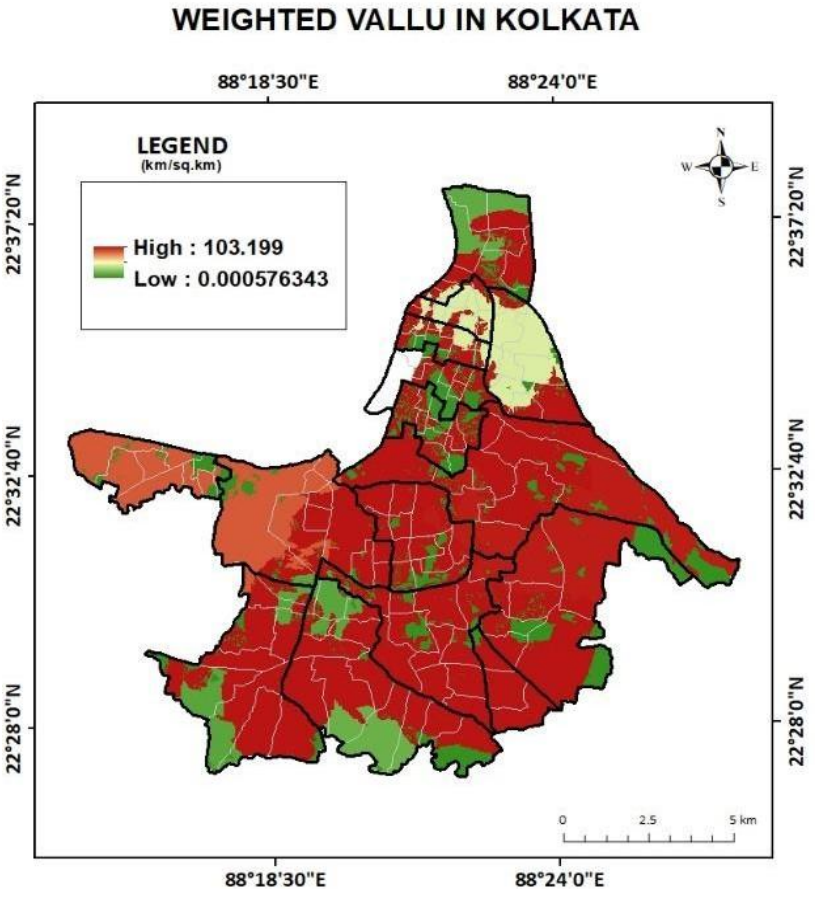
Travel Time (min)	Weight Value
0–10	1.00
10–20	0.75
20–30	0.50
30–40	0.25
>40	0.10

Procedure

1. OD travel times were normalized.
2. Each OD link was assigned a weight based on its travel-time class.
3. Digital retail outlets within 10 minutes received full weight; outlets beyond 40 minutes received minimal influence.
4. Weighted supply-demand ratios were computed for each supply point.

The map shows:

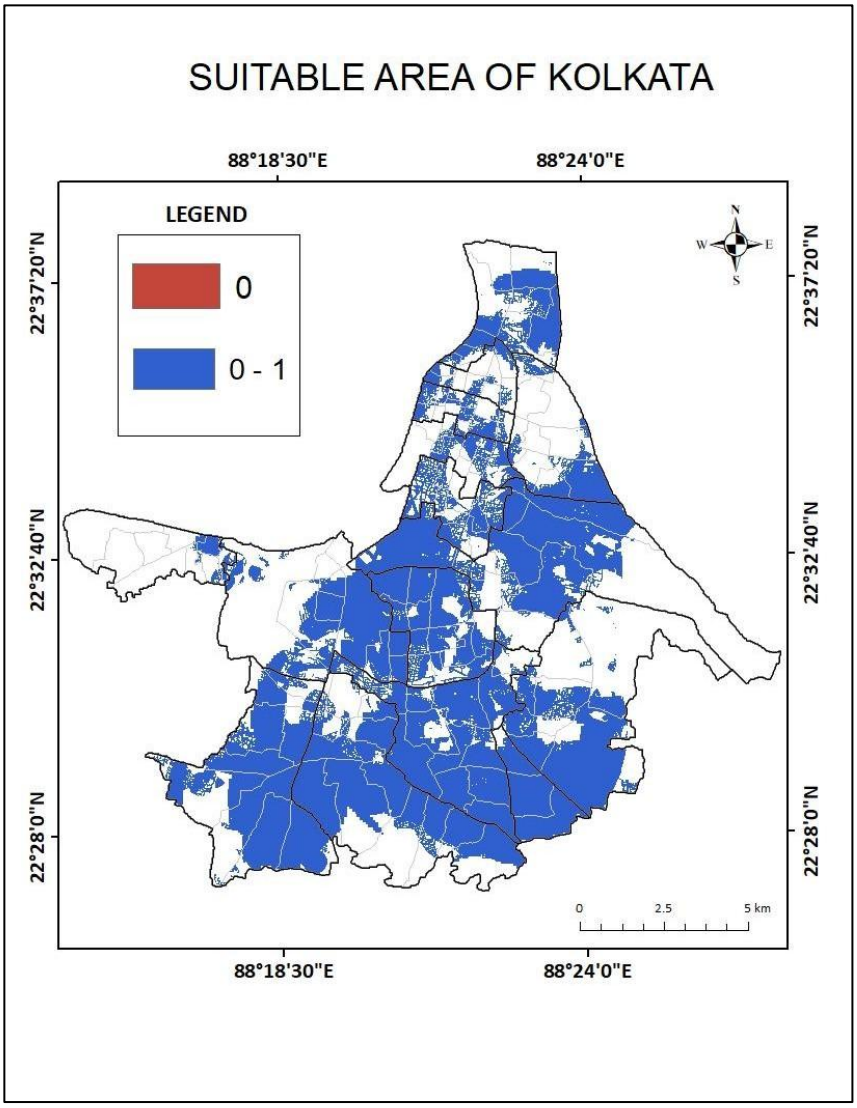
- High weighted zones in central and eastern Kolkata.
- Medium weights along the EM Bypass and Behala.
- Low weights in peripheral northern/southern wards.



1.2.4. Suitable Site Selection:

.Suitable site selection was done in ArcGIS to find the most appropriate areas for setting up new digital outlets in Kolkata. This analysis was based on the results of accessibility and location–allocation analysis.

Different thematic layers such as road accessibility, service coverage, and demand distribution were used for this process. These layers were converted into raster format and given suitable weight values based on their importance. Then, all layers were combined using the Weighted Overlay method in ArcGIS.



The final output map shows two classes:

Suitable area (0–1) – shown in blue colour

Non-suitable area (0) – shown in white colour

The result clearly shows that most of the central, southern, and eastern parts of Kolkata are highly suitable for new digital outlets due to good road connectivity and high demand. The non-suitable areas are mainly found in low-accessibility zones.

This suitable site selection map helps in proper planning and decision-making for setting up new digital outlets in the study area.

1.2.5. Location–Allocation:

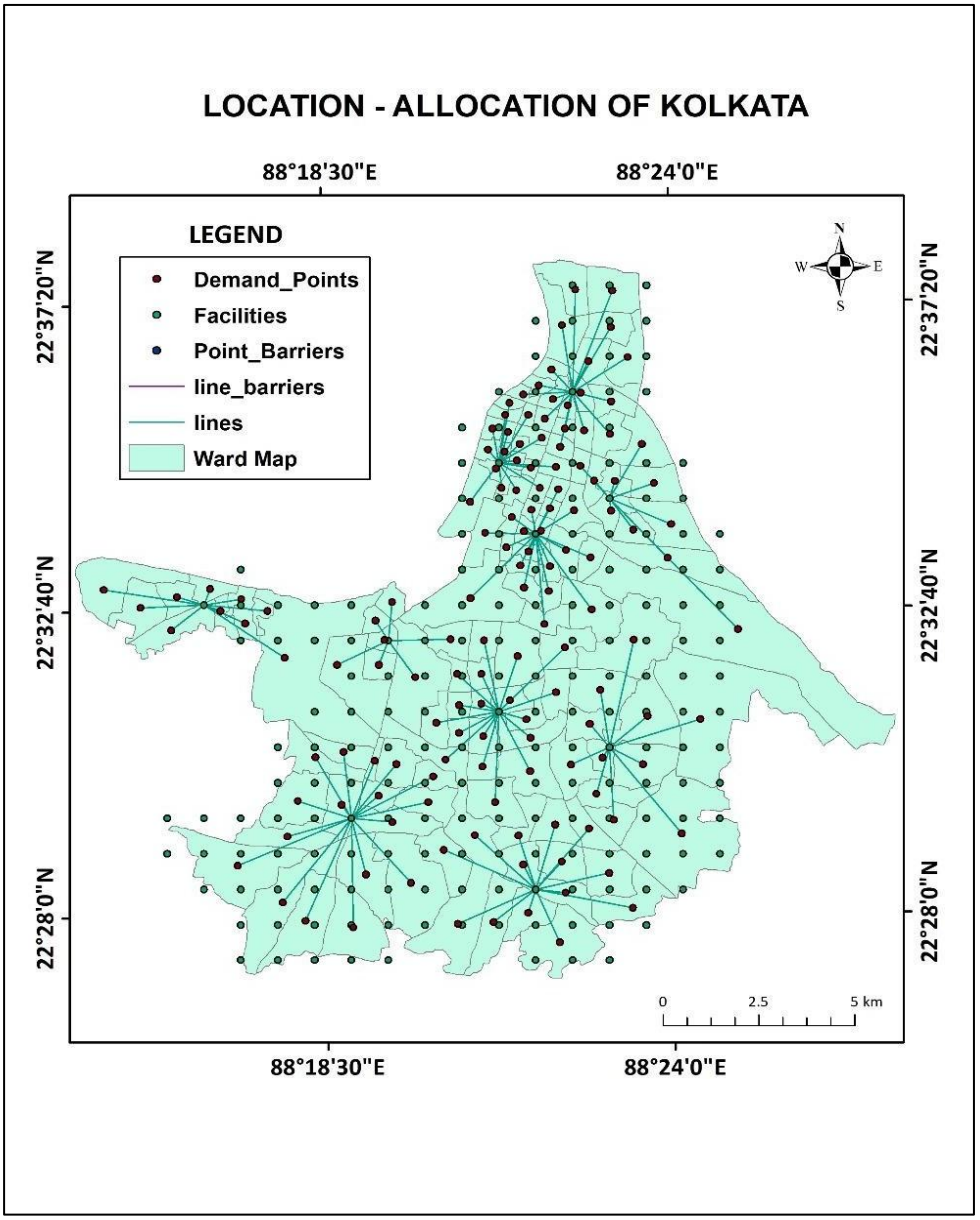
In this study, the Location–Allocation model was applied using ArcGIS Network Analyst to identify the optimal locations for establishing new digital outlets in the Kolkata Municipal area.

Significance of the Analysis:

- Efficient service delivery
- Reduced travel time and cost
- Improved accessibility

The output of the Location–Allocation model generated
Optimally located facilities (green points)

Allocated demand points (red points)



Service connection lines, showing the shortest path between each demand point and its nearest facility. The spatial distribution of service coverage across the Kolkata Municipal area.

The results clearly indicate that the proposed digital outlets are evenly distributed across high-demand zones, ensuring maximum population coverage with minimum travel distance. Areas with higher demand density received a greater number of facility allocations, whereas low-demand areas showed fewer allocations.

Thus, the Location–Allocation model proved to be a highly effective tool for identifying the most suitable locations for new digital outlets in Kolkata.

1.2.8.Relative Accessibility Calculation

The accessibility of digital retail outlets was calculated using the Two-Step Floating Catchment Area (2SFCA) method. This approach is widely used in transportation and urban planning to assess the relative accessibility of service points based on supply, demand, and travel time. The process includes two main steps:

Step 1: Supply-to-Demand Ratio

$$R_j = \frac{S_j}{\sum_{k \in \{d_{kj} \leq d_0\}} D_k \cdot W_{kj}}$$

Where:

- R_j= Supply-to-demand ratio at digital retail outlet j
- S_j= Supply capacity at outlet j
- D_k= Population at demand location k
- W_{kj}= Distance-decay weight between $k$and j
- d_0= Catchment threshold (30 minutes)

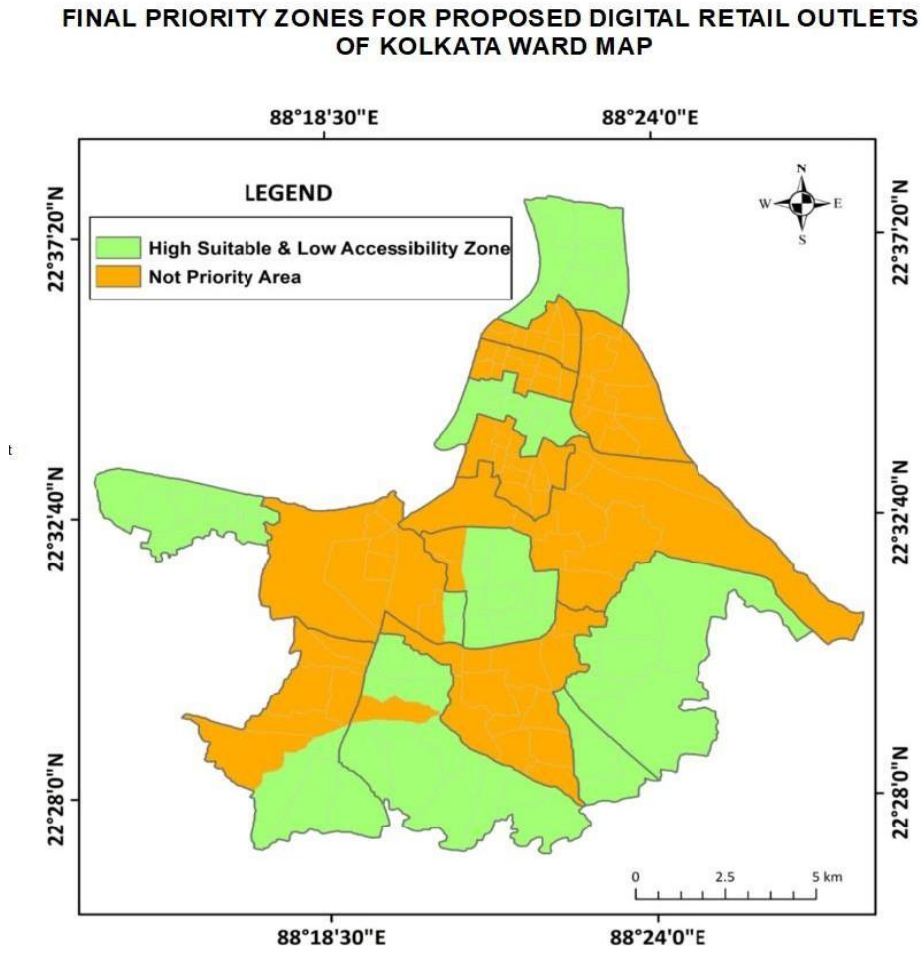
This calculation accounts for the number of potential consumers (population at demand locations) within a given travel time of 30 minutes, weighted by the ease of access (i.e., travel time) to the digital retail outlet.

2: Accessibility Score at Ward Level

$$A_i = \sum_{j \in \{d_{ij} \leq d_0\}} R_j \cdot W_{ij}$$

Where:

- A_i= Accessibility score of ward i
- R_j= Supply-to-demand ratio at outlet j
- W_{ij}= Distance-decay weight between ward $i$and outlet j
- d_0= Catchment threshold (30 minutes)



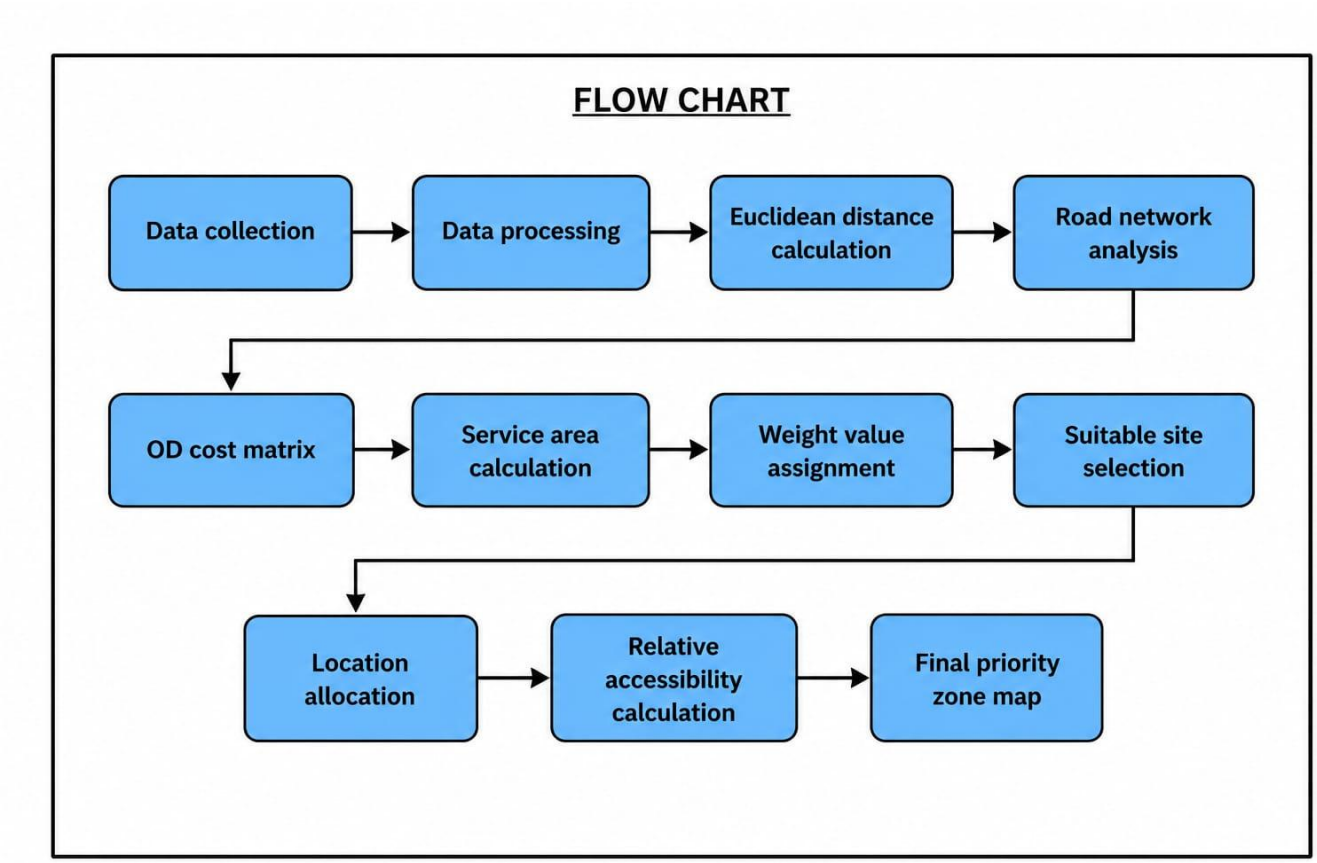
Results and Interpretation:

The map identifies two categories of zones for proposing new digital retail outlets in Kolkata. The **green areas** represent **High Suitable & Low Accessibility Zones**, meaning these wards lack sufficient digital retail services but have high suitability based on population, road connectivity, and service demand. These are the **priority areas** where new outlets should be established.

The **orange areas** are **Not Priority Zones**, indicating wards that already have adequate digital retail accessibility or lower suitability for new outlets. These areas do not require immediate intervention.

Overall, the results highlight that service gaps exist mainly in the **southern and peripheral parts** of Kolkata, where setting up new outlets will significantly improve spatial accessibility and service equity.

Flow Chart Of The Entire Methodology:



RESULT

One of the major outcomes will be the identification of digital retail "hotspots" and "coldspots." Hotspots are expected to emerge in central commercial districts, well-planned residential neighbourhoods, and zones with high consumer purchasing power, whereas coldspots will likely appear in the peripheral, informal, or socio-economically weaker areas with poor infrastructural support. These patterns will not only validate the role of market-driven locational decisions but also underline the structural disadvantages faced by marginalized communities. The findings will therefore support strategic interventions aimed at achieving balanced retail accessibility.

Another outcome of the study will be a detailed inventory of digital retail outlets categorized by type, service capacity, and functional characteristics. This inventory will be useful for both researchers and urban planners, offering an updated spatial registry that captures the complexity of Kolkata's digital retail landscape. Additionally, the study will recommend potential locations for new digital retail outlets based on spatial gaps identified through the accessibility model. These recommendations will be grounded in empirical evidence and can guide decision-making processes for private and public stakeholders seeking to expand digital retail infrastructure.

CONCLUSION

The present study sets out to investigate spatial access disparities to digital retail outlets in Kolkata using the Two-Step Floating Catchment Area (2SFCA) model. Through extensive data collection, spatial modelling, and contextual interpretation, the study aims to reveal how digital retail services are unevenly distributed across Kolkata's complex urban landscape. As cities around the world increasingly adopt digital service infrastructures, understanding accessibility becomes central to ensuring inclusive urban development. Kolkata, with its intense socio-spatial diversity, serves as an apt case demonstrating both the opportunities and challenges of digital transformation.

The study's outcomes will not only offer insights into the structure of Kolkata's digital retail ecosystem but also support policymakers, planners, and digital service entrepreneurs in making equitable and strategic decisions. Beyond its immediate application, the research contributes to broader theoretical discussions on spatial justice, digital inclusion, and urban infrastructure planning. Ultimately, the study underscores the need for spatially informed, equity-driven strategies that can guide Kolkata toward becoming a more inclusive, digitally empowered metropolitan region.

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