Engineering

E-ISSN No : 2581-6195 | Volume : 9 | Special Issue | May 2026

# GEOSPATIAL ASSESSMENT OF URBAN SERVICE ACCESSIBILITY FOR SMART CITY PLANNING: A CASE STUDY OF DAVANAGERE CITY, KARNATAKA, INDIA

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Access Online

Article DOI:
10.5281/zenodo.21427879

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How to Cite:
Yashvanth S S, Syed Ashfaq Ahmed & Madeeha Arif (2026), Geospatial Assessment of Urban Service Accessibility for Smart City Planning: A Case Study of Davanagere City, Karnataka, India, International Educational Journal of Science & Engineering (IEJSE),Vol: 9, Special Issue, May 2026 477-481

## ABSTRACT

This study investigates the spatial accessibility of essential public service facilities in Davanagere city through the application of geospatial techniques. The analysis considers three critical categories of urban services, namely healthcare facilities, educational institutions, and fire stations, in order to examine their spatial distribution and accessibility within the municipal boundary. A Geographic Information System (GIS) based buffer approach was adopted to delineate service coverage areas, employing standard threshold distances of 1 km for hospitals, 500 m for educational facilities, and 2 km for fire stations. The individual service buffers were subsequently integrated to produce a composite accessibility layer, and service-deficient zones were identified using spatial overlay analysis.

The results indicate that approximately 47.44% of the total urban area is adequately served by at least one essential facility, where as 52.56% of the area remains underserved. The spatial patterns reveal a pronounced concentration of services in the central parts of the city, while peripheral zones exhibit notable accessibility deficits. These findings highlight the presence of spatial disparities in infrastructure distribution and underline the necessity for more balanced urban planning interventions.

The study demonstrates the capability of GIS based spatial analysis in systematically identifying service gaps and supporting evidence based decision making. The outcomes provide valuable insights for urban planners and policymakers to enhance service accessibility, optimize infrastructure placement, and promote equitable and sustainable urban development within the framework of smart city initiatives.

**KEYWORDS:** Geospatial Analysis, Accessibility, Urban Planning, GIS, Smart City, Service Coverage

## INTRODUCTION

Rapid urbanization has substantially altered the spatial configuration of cities, resulting in increased pressure on essential public service systems such as healthcare, education, and emergency response infrastructure. Ensuring efficient accessibility to these services is a key requirement for sustainable urban development and forms a central objective of smart city initiatives. However, accelerated and often unregulated urban expansion frequently leads to an uneven spatial distribution of infrastructure, thereby creating disparities in service availability across different urban regions.[1]

In this context, geospatial technologies, particularly GIS, have gained prominence as effective tools for examining spatial patterns and evaluating accessibility to urban services. GIS based analytical approaches facilitate the integration of spatial datasets with quantitative techniques to assess service distribution, coverage extents, and deficiency zones.

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Among these, buffer based accessibility analysis is widely adopted for delineating service influence zones and identifying both adequately served and underserved areas within urban environments.[2,3]

Davanagere city, an important and rapidly developing urban center in Karnataka, has witnessed significant growth in terms of population and infrastructure expansion. Despite this progress, the spatial distribution of essential public service facilities requires systematic evaluation to ensure equitable access for the urban population. Identifying the extent of service coverage and recognizing underserved regions is crucial for informed urban planning and efficient resource allocation.

The present study aims to evaluate the accessibility of key public services, including hospitals, educational institutions, and fire stations, within the municipal limits of Davanagere city using GIS based techniques. The analysis focuses on delineating service coverage areas and identifying gap zones through spatial methods, thereby providing a scientific basis for enhancing infrastructure planning and supporting sustainable and smart urban development.

## MATERIALS AND METHODS

### Study Area

The study was conducted in Davanagere city, situated in the central region of Karnataka, India. The city represents a rapidly developing urban center characterized by significant growth in population and infrastructure. The spatial extent of the study is defined by the municipal boundary of Davanagere, encompassing an area of approximately 78 square kilometers. The urban landscape comprises a heterogeneous mix of residential, commercial, and institutional land uses, making it an appropriate setting for assessing the spatial accessibility of essential public services.

### Data Sources

The analysis is based on spatial datasets compiled from open source platforms and available administrative records. The primary datasets utilized in this study include:

- Municipal boundary of Davanagere city
- Geolocation data of healthcare facilities (hospitals)
- Educational institutions (colleges and universities)
- Fire station locations
- Road network data for base mapping

All datasets were processed and analyzed within a GIS environment. To ensure spatial consistency and accuracy in distance based analysis, all layers were projected into a common coordinate reference system (UTM projection). The integration of multi source spatial data enables a comprehensive assessment of urban service accessibility.[4]

## METHODOLOGY

The methodological framework adopted in this study is centered on GIS based spatial accessibility analysis of essential public services. The workflow comprises data preprocessing, buffer based accessibility modeling, integration of service coverage layers, and identification of underserved areas.

Initially, all spatial datasets were pre-processed and transformed into a uniform projection system to facilitate accurate spatial computations. The locations of hospitals, educational institutions, and fire stations were mapped within the defined municipal boundary. Accessibility assessment was carried out using a buffer based approach, which is widely applied in spatial accessibility studies to delineate service influence zones.[2] Standard service distance thresholds were defined based on commonly accepted urban planning guidelines, wherein buffer distances of 1 km for hospitals, 500 m for educational facilities, and 2 km for fire stations were applied. These buffer zones represent the potential service coverage areas accessible to the urban population.

Subsequently, the individual buffer layers were integrated to generate a composite service coverage layer representing the cumulative accessibility of essential services. To eliminate spatial overlaps and obtain a unified representation, the merged buffers were dissolved into a single continuous polygon.

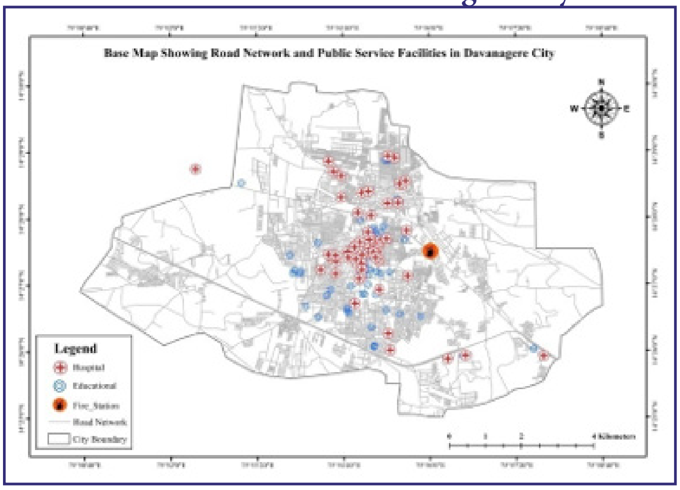
To identify service deficient regions, spatial overlay analysis was performed using the erase operation. The municipal boundary served as the reference layer, and the combined service coverage layer was subtracted to delineate areas lacking adequate access to essential services.

Finally, geometric calculations were conducted to quantify both the total service coverage area and the extent of gap areas. The results were expressed in terms of area (square kilometers) as well as percentage of the total study area, enabling a clear evaluation of spatial accessibility patterns.

## RESULTS

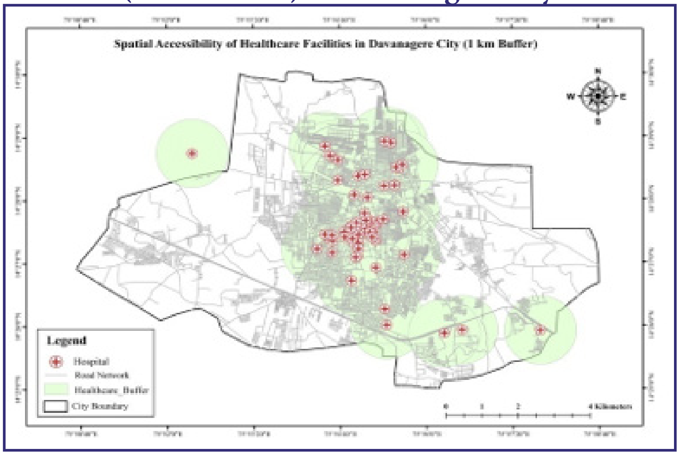
The spatial accessibility of essential public service facilities in Davanagere city was evaluated using GIS based buffer and spatial overlay techniques. The analysis provides a detailed understanding of the distribution and coverage of key urban services, namely healthcare facilities, educational institutions, and fire stations, within the municipal boundary.

**Fig. 1: Base map showing road network and public service facilities in Davanagere city**



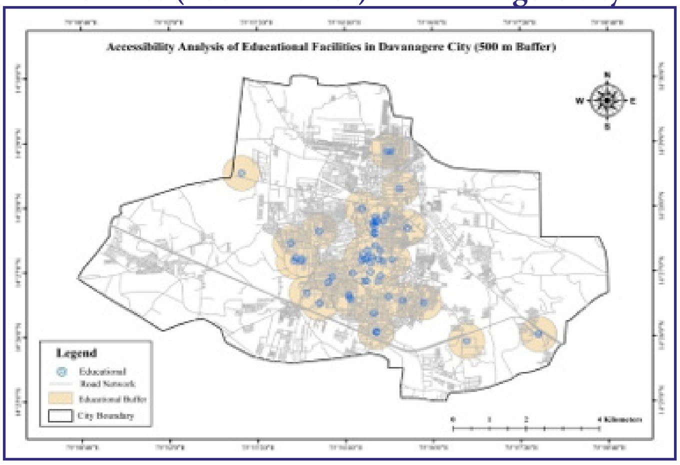

The spatial distribution of public service facilities across the study area is illustrated in Figure 1. The accessibility assessment of individual services reveals a non-uniform spatial distribution across the study area. The buffer zones delineated for hospitals (1 km), educational facilities (500 m), and fire stations (2 km) indicate that service coverage is predominantly concentrated in the central urban zones, where infrastructure development is comparatively dense. In contrast, the peripheral and fringe areas exhibit noticeably lower levels of accessibility, reflecting spatial imbalances in service distribution.

**Fig. 2: Spatial accessibility of Healthcare facilities (1 km Buffer) in Davanagere city**



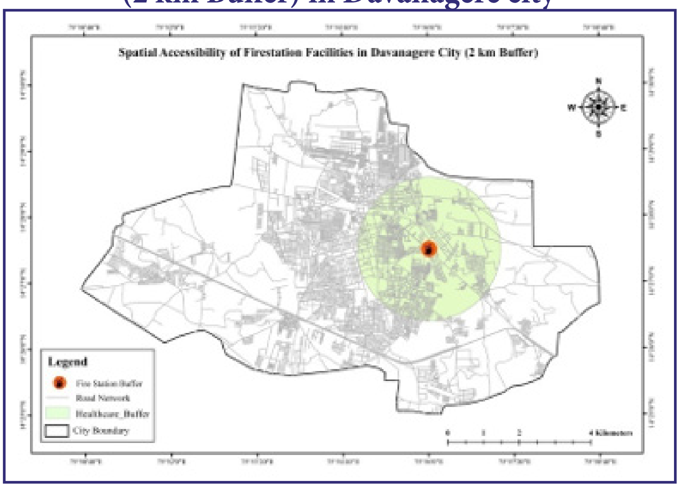

The accessibility pattern of healthcare facilities is depicted in Figure 2.

**Fig. 3: Accessibility analysis of Educational facilities (500 m Buffer) in Davanagere city**



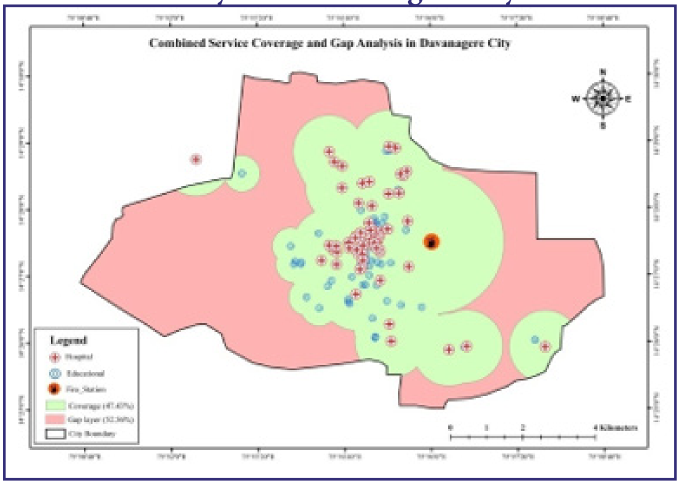

The spatial coverage of educational institutions is presented in Figure 3.

**Fig. 4: Spatial accessibility of Fire station facilities (2 km Buffer) in Davanagere city**



The service coverage of fire stations is illustrated in Figure 4. The integrated service coverage layer, derived through the merging and subsequent dissolution of individual buffer zones, represents the cumulative accessibility of essential services. The analysis indicates that approximately 37 square kilometers, corresponding to 47.44% of the total municipal area, is effectively covered by at least one of the selected public services.

**Fig. 5: Integrated service coverage and gap analysis in Davanagere city**




The integrated service coverage derived from combined buffer analysis is illustrated in Figure 5. Further spatial delineation using the erase operation enabled the identification of service deficient zones within the study area. The results show that nearly 41 square kilometers, accounting for 52.56% of the total area, fall outside the defined service coverage zones. These gap areas are primarily concentrated in the outer and less developed parts of the city, highlighting significant accessibility deficiencies.

**Table 1: Service coverage and gap area statistics of Davanagere city**

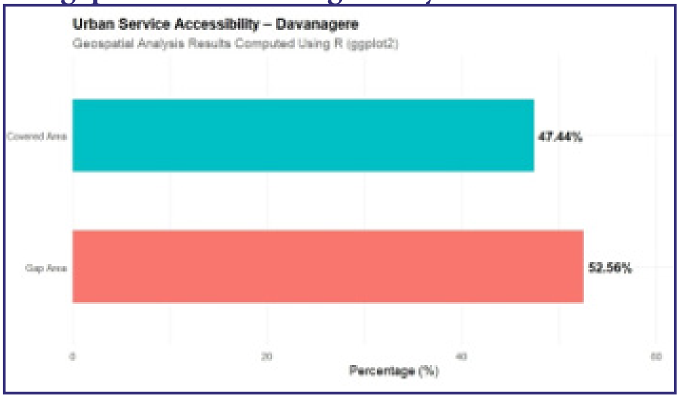
**Service Coverage Analysis – Davanagere City**

Geospatial Accessibility Assessment

| Category | Area (sq.km) | Coverage (%) |
|---|---|---|
| Covered Area | 37.00 | 47.44 |
| Gap Area | 41.00 | 52.56 |

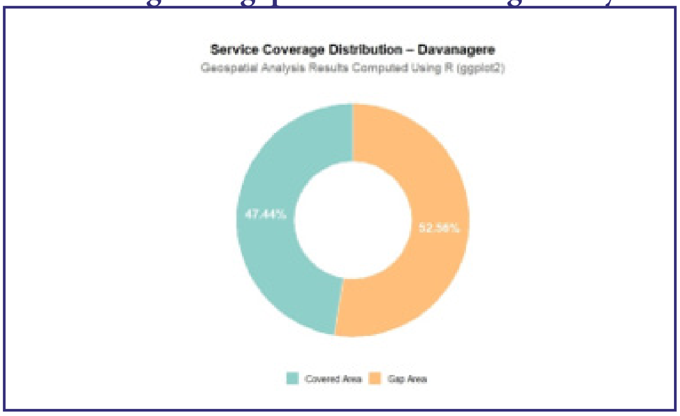
The quantitative assessment of service coverage and gap areas is summarized in Table 1.

**Fig. 6: Comparative analysis of service coverage and gap areas in Davanagere city**




A comparative representation of coverage and gap areas is shown in Figure 6.

**Fig. 7: Proportional distribution of service coverage and gap areas in Davanagere city**




The proportional distribution of service coverage and gap areas is illustrated in Figure 7.

Overall, the results demonstrate that a substantial proportion of the urban area lacks adequate access to essential public services. The observed spatial patterns indicate a concentration of facilities in specific zones, leading to pronounced disparities in accessibility across different parts of the city.

## DISCUSSION

The findings derived from the spatial accessibility analysis clearly indicate a pronounced spatial imbalance in the distribution of essential public service facilities within Davanagere city. The higher concentration of healthcare, educational, and emergency service infrastructure in the central urban zones, coupled with reduced accessibility in peripheral areas, reflects a commonly observed pattern in rapidly urbanizing regions where infrastructure development is unevenly distributed.[1]

The quantitative results further reveal that only 47.44% of the total municipal area is adequately served, whereas 52.56% falls within service deficient zones. This substantial proportion of underserved areas suggests that a significant segment of the urban population may experience limited access to critical services such as healthcare, education, and emergency response. Such disparities can adversely affect living standards, public safety, and the overall sustainability of urban systems.[3]

These observations highlight the critical role of geospatial technologies in urban planning and infrastructure management. GIS based accessibility assessment provides a robust analytical framework for identifying service gaps and evaluating spatial inequities in service distribution. By enabling the visualization and quantification of coverage and deficiency zones, geospatial analysis supports evidence based planning and facilitates the prioritization of infrastructure development in underserved regions.[2]

Moreover, the results reinforce the importance of accessibility analysis within the broader framework of smart city development. Smart city initiatives emphasize efficient service delivery, optimized resource utilization, and equitable distribution of urban infrastructure through the integration of advanced technologies. The identification of significant service gaps in Davanagere city indicates the necessity for strategic planning interventions aimed at improving infrastructure allocation and enhancing urban resilience.[8]

Overall, the study underscores the need for a balanced and inclusive approach to urban development. Addressing the identified service deficiencies through targeted planning measures and optimized resource allocation can substantially improve accessibility and contribute to the long term sustainability and functionality of urban environments.

## CONCLUSIONS

This study demonstrates the effectiveness of GIS based spatial analysis in assessing the accessibility of essential public service facilities within Davanagere city. The results indicate that only 47.44% of the total urban area is adequately served, while 52.56% remains outside the defined service coverage zones, highlighting a considerable spatial imbalance in infrastructure distribution.

The analysis reveals a clear concentration of service facilities in the central urban regions, whereas peripheral and newly developing areas exhibit comparatively lower levels of accessibility. This spatial disparity emphasizes the need for more systematic and equitable urban planning strategies to ensure uniform access to critical services such as healthcare, education, and emergency response.

The study highlights the significance of integrating geospatial techniques into urban planning frameworks to support informed decision making. The identification and quantification of service gap areas provide a practical basis for prioritizing infrastructure development and improving the allocation of urban resources.

In summary, the findings of this study contribute to a better understanding of spatial accessibility patterns and offer valuable insights for promoting balanced, efficient, and sustainable urban development in alignment with smart city objectives.

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