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CASE STUDY

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Geo-informatics for rationalization of parts, sections, and polling stations: A case study of Kannan Devan hills plantation village in Idukki district, Kerala

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ABSTRACT

Place is also considered the most important factor in efficient organization, preparation, and management. Public health services, such as hospitals, fire departments, schools, and other emergency service centers, may offer low-cost, high-quality service to individuals by choosing the right venue. The nearest facility is a tool that can locate the nearest facility. Geospatial technology is an effective tool for locating public service sectors, thereby increasing use and reducing distance. The primary objective of the research is to reduce the distance between the segment and the Polling station (PS). For the rationalization of parts sections and PS study, Kannan Devan Hills Plantation (KDHP) village in Devikulam Taluk has been selected. There are 132996 (28 % of the total voters) and 57 (33%) PS in the Devikulam Election Office. Both parts (hamlets) moved less than 2 kilometers to the PS, according to the election office survey. In fact, however, most of the PS are located far from the hamlet. In nature, the landscape is extremely rugged, and transport services are almost nonexistent.The situation during the rainy season is still pathetic. It is difficult for voters, especially older people, to turn out. This is because of poor geographic experience in selecting PS. To find solutions for these issues, the closest facility review is used to reorganize sections, segments, and PS. Via GPS analysis, all parts and PS are collected. Roads were created using Google Earth web applications. During the field survey, local people and polling booth officers, especially school teachers and Anganwadi teachers, are highly involved in raising awareness. This study reduces the travel distance from 301.81 km to 112.25 km, thereby reducing the number of PS from 57 to 54.

KEY WORDS

Network; Closest facility; PS; Optimum location; GIS

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Introduction

In operations analysis, facility position optimization is a classical research field in which problems associated with the "best" location of various types of facilities are examined across different settings and under various constraints [1]. The design and optimization of the combined location-inventory are extremely essential for deteriorating items [2]. A strategic decision challenge emerging in contemporary supply chain management is the facility location-allocation problem [3]. It plays a major role in daily activities, and the use of Remote Sensing, the Global Positioning System (GPS), and the Geographic Information System (GIS) for spatial information is no exception. In the current scenario, geoinformatics is a technological blessing and is even more important for a developing nation like India [4]. For local, regional, and state-level planning, action plan implementation, infrastructure development, disaster management, and business development, spatial knowledge is critical for making specific decisions. There is a rapid increase in the knowledge and use of geo-informatics technologies and the power of spatial information systems explicitly tailored to decision-making or sustainable resource management [5]. Growing the use of spatially referenced data to help a large range of decisions at all levels of society will be a major challenge over the next decade. Using an effective, efficient, and widely available infrastructure, both thematically (across environmental, economic, and institutional databases) and hierarchically, data could be easily transported and easily incorporated spatially (from local to national and eventually to global levels). Given the rapid growth and use of geo-informatics technologies in the planning and implementation of many development projects, there has been a considerable increase.

By providing a forum for efficient planning, coordination, and decision-making, geospatial technology plays an important role. It is the appropriate technological solution that provides an appropriate location for service sectors and raises issues of spatial distribution, such as travel distance. Place is also considered the most important factor in efficient organization, preparation, and management [6]. Public service facilities, such as hospitals, fire stations, schools, and other emergency service centers, may offer low-cost, high-quality services to individuals by choosing the best venue. Place allocation is used to locate facilities and assign demand points to them. The nearest facility method helps determine the nearest facility centers and the best route between accidents and operational sectors.

Study Area

KDHP village is situated in the high Idukki district of Kerala in the Western Ghats, with an area of around 478 km^2 (Figure 1) [7]. The main occupation of this village is the cultivation of tea and its allied work, with almost 12,000 workers engaged in tea cultivation spread over 110 divisions. All estates have strong infrastructure facilities and are mostly managed by tea companies. This village's total population is around 68205, of which 31152 individuals are eligible to elect representatives of their people [4]. Although the villages have good primary schools and are linked to metalled roads, without considering location optimization, the planners assign election booths.

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For the pilot study called rationalization of parts and PS, Kannan Devan Hills Plantation village in Devikulam Taluk was selected. The total number of voters living in this village is 132996 (28% of total voters), and there are 57 (33%) PS [5]. All parts travelled just 2 kilometres to cast their ballots, according to the election office survey. In fact, however, most of the PS are located far from the hamlet. It is difficult for voters, especially older people. In nature, the landscape is extremely rugged, and transport facilities are almost nonexistent. The situation during the rainy season is still pathetic. These are all the factors that limit the proportion of votes. Virivara, for example, is a hamlet located in Mankulam village. Despite this, the residents cast their votes at the Lakshmi Estate Aided Primary School in Kannan Devan Hills Village, even though the polling station is nearly 10 km away from the hamlet, largely due to inadequate geographical planning in the distribution of polling stations.Taking this issue into account, this pilot study uses the nearest facility review. The database is created for the segment named 'voting position' and its PS. The GPS survey captures every segment and PS. During the field survey era, knowledge of local people and polling booth officers, particularly schoolteachers and Anganwadi teachers, was widely used [8]. Upon completion of the GPS survey, the points are connected to a database containing the complete section and PS information (Figure 2). The main objective of this study is to minimize the distance as much as possible, increase the percentage of voters, retain the cluster segment as is, decrease the number of PS in one school, and discover new PS locations.

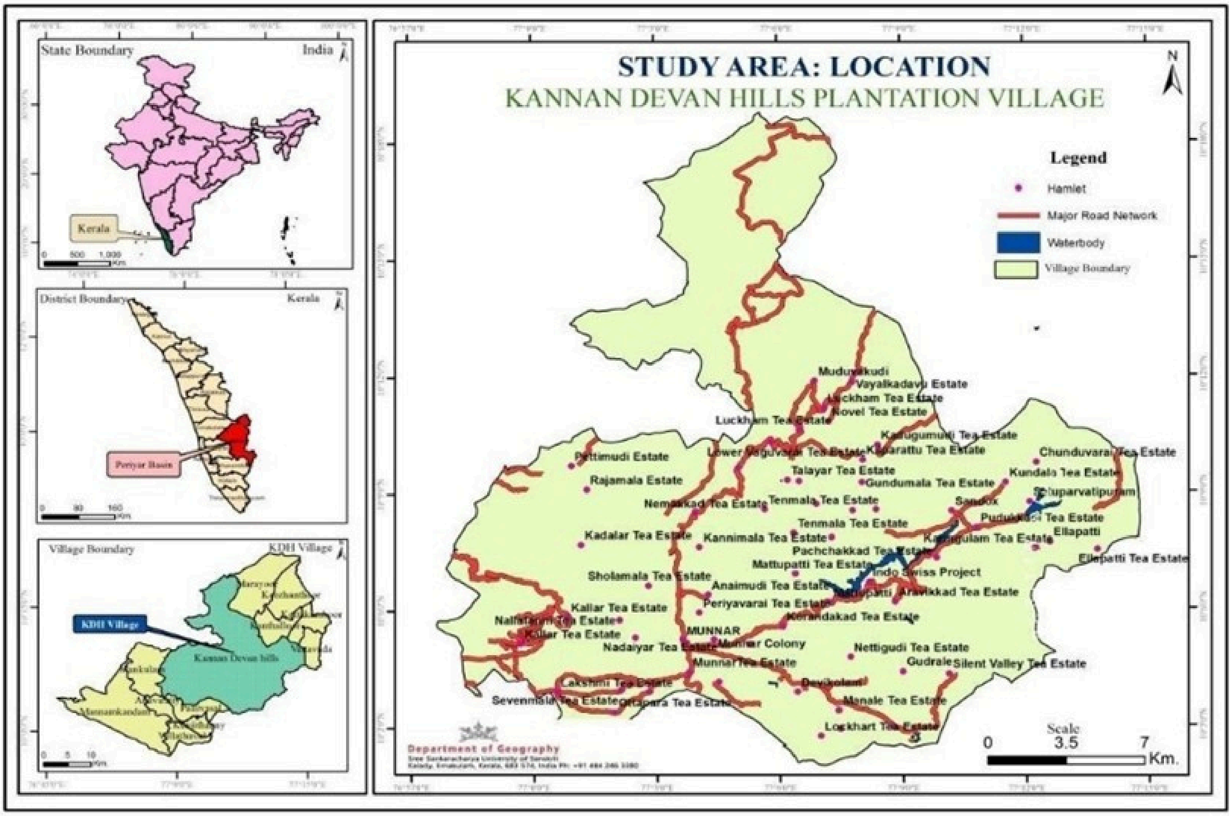

Figure 1. Study area: Location (Kannan Devan Hills Plantation Village).

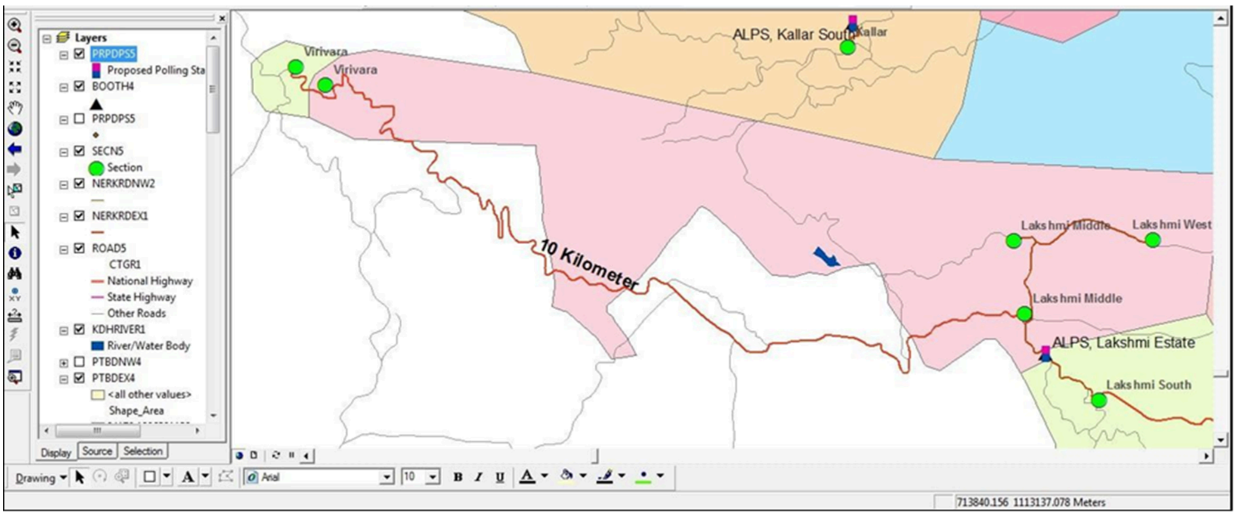

Figure 2. Spatial map showing a 10 km distance between the hamlet and the Lakshmi Estate polling station, highlighting the uneven distribution of polling stations.

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Aims and Objectives

The primary objective of the research is to reduce travel distance and congestion, and to raise the percentage of votes. The following goals are formulated to accomplish this.

- PS and section to find
- Knowing the present distancebetween the PS and the segment
- By optimizing PS positions to decrease the travel distance.

Methods and Methodology

- From 1:50,000toposheet, Vectorize road and Waterbody
- Vectorize Road Applications from the Google Earth Site
- Part, School,current PS, Anganwadi, and GPS Captured CommunityHall.
- Optimized PS or Alot
- Search Contiguity between PS and Parts
- Run the Closest Facility network analysisbetween PS and parts
- Compare the current distanceto travel and the proposeddistance to travel

Results and Discussion

Section

Section means the hamletor part of the hamletlisted in the KDH village election database, and the same is surveyed in the field using GPS.

PS

PS means the position allocated by the electiondepartment where peoplecast their vote. The PS position given is also surveyed via GPS [9].

Part boundary exists

The boundary that is drawn based on the specific section numberand its corresponding service PS is part of the boundary (Figure 3).

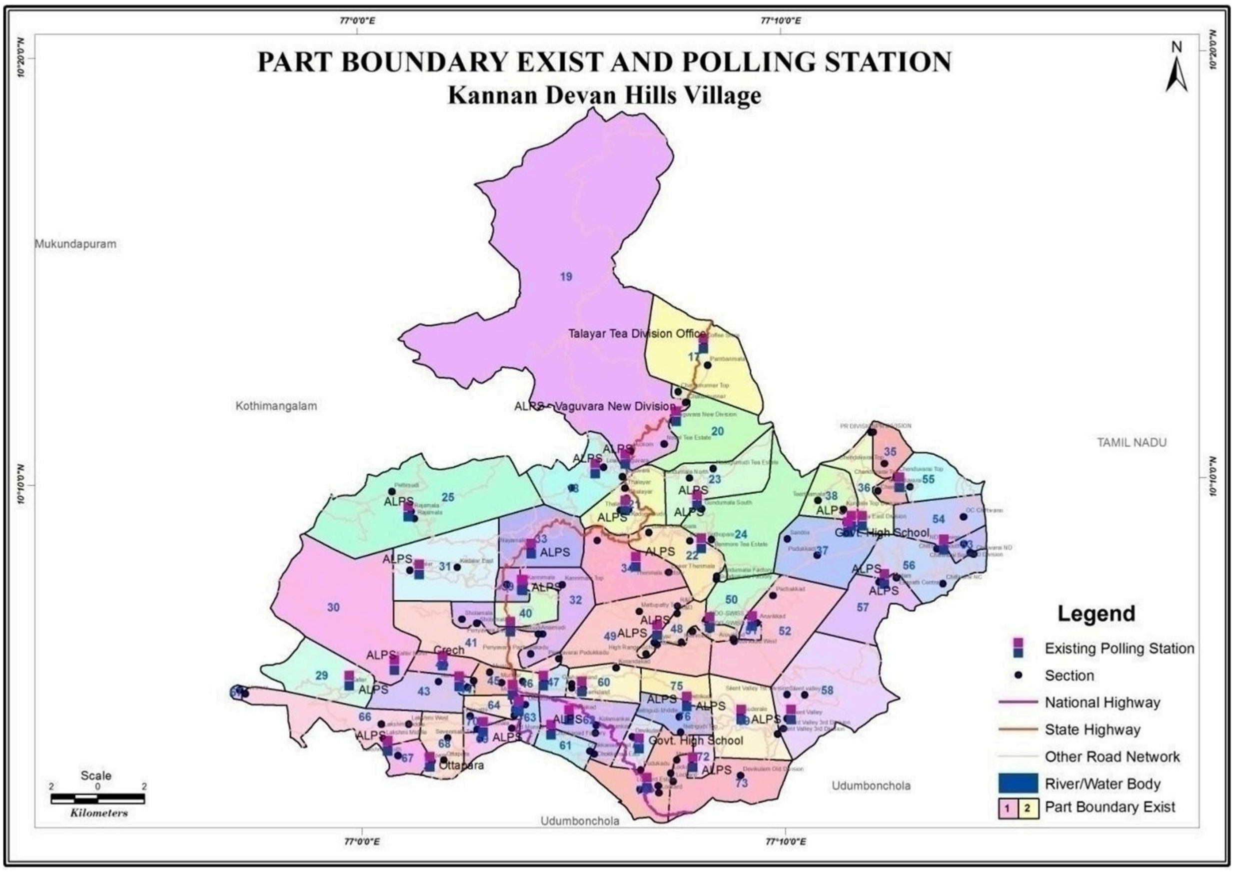

Figure 3. Part boundary exists and PS (Kannan Devan hills village).

Part boundary new

The new part of the boundary is the proposed boundary that replaces the present condition. The new section of the border was drawn based on the village boundary [10]. Only for this demarcation has the portion within a village boundary been considered. In other words, the cluster segment closeness of the section holds it as such without separation; connectivity between sections is checked; it is difficult to cross the water body, so it is viewed as a barrier and prevents new demarcation through a part boundary.

Allot PS

Allot PS means the proposed PS based on the circumference of a PS position and condition. The rule is that one portion should have one PS. Before a PS is proposed, the connectivity between the PS and the section is ensured. College, Anganwadi, Community Hall, and labour offices are used as PSs. On that basis, four forms of PS are suggested based on the present situation. They are the:

- Unchanged Remains
- Relocating
- Fresh Station of Polling
- PS removed

Remains unchanged

Remaining unchanged implies maintaining the new PS as such. The gap between the section and the PS is less than 2.5 km; the

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PS position and PS capacity are requirements that ensure the PS maintains it as such (Figure 4).

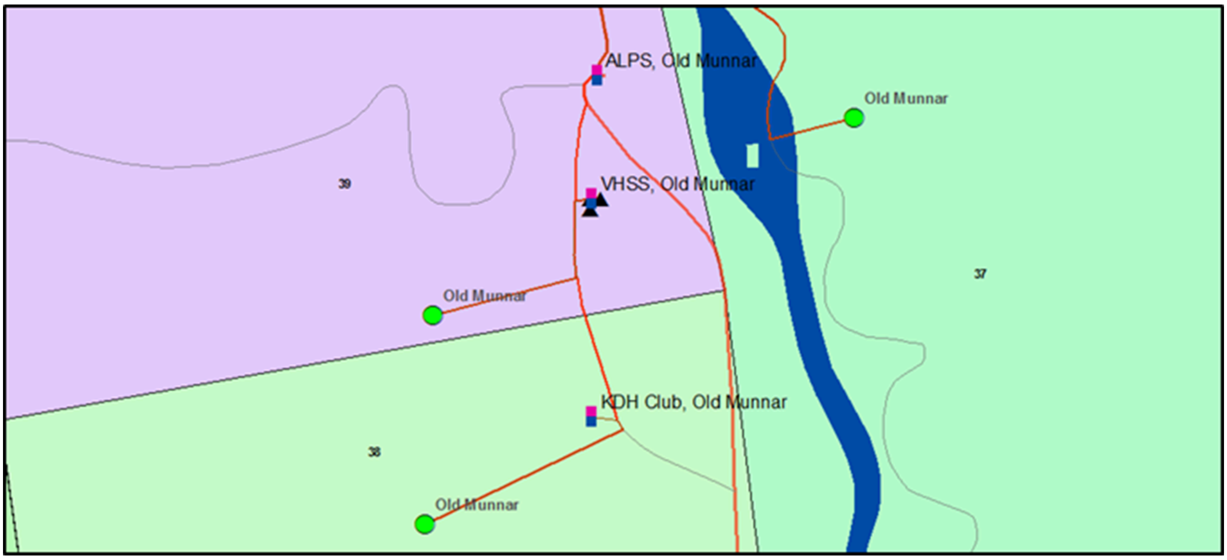

Figure 5. GIS map of Old Munnar showing polling stations, the road network, river boundaries, and the spatial distribution of nearby settlements.

New PS

Good options for PS are often available, but current polls might not be available for relocation to the nearest spot. PS is freshly suggested in this case.

PS removed

After the planned PS is finished, the remaining PS is withdrawn without any service. This is regarded as the PS that was deleted.

Contiguity PS

PS Contiguity means testing the relation between the segment and the PS. At this point, the Google Earth web application is used to identify missing roads that minimize the gap between the section and the PS. At this point, part boundary modification, allocated PS change, and search PS are all performed.

Search PS

Other parties do not have the option of locating PSs based on a single portion and a single PS. In this case, the specific portion is searched in the field to find a PS from any source. It is surveyed using GPS and used as a PS if detected. Path validation at this stage has also been carried out.

Network exists

From Google Earth and Survey of India 1:25,000 toposheets, the road network is vectorized. The types of roads included are metal roads, mud roads (used for everyday movement) at some extensions, and link roads for sections and PS (100 meters only).After completing the topology rules for road vectorization, such as must not have dangles and points must be covered by lines, confirm the perfection of the road and build the final road [12]. To operate the network, this final route, the current section, and the current polling will be incorporated. In the network, the nearest facility analysis technique is applied. Here, the segment serves as an incident layer, and PS operates as a facility layer. The section part number and the serviced PS part number are provided. After completing this study, the distance exceeding 2.5 km is checked in real time. When modifying the connection road or discovering new roads in the field and in the Google Earth web application, it is possible to reduce the distance [13]. If any update is carried out on the road network, the same topology is reapplied, and the nearest facility analysis is also performed, with the duration measured.

Update section

After completing the new part boundary, the segment's part number is updated to match the new part boundary number.

Finalize PS

After completing the PS quest and road validation, Finalize PS is run. The part without PS is now used to locate PS using the PS source scan [14]. If no good source is found in the area, the section should be directed to the nearest acceptable PS. The PS portion and part boundary have therefore been revised based on the optimum distance (Figure 6).

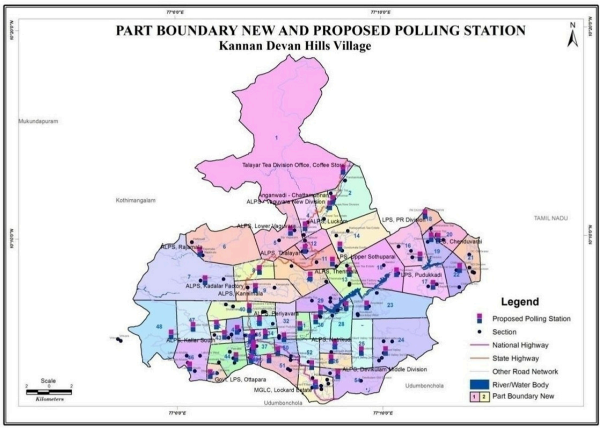

Figure 6. Part Boundary new and proposed PS (Kannan Devan hills village).

Network new

The route that is used for network life is used in this study. The proposed PS and chapter are involved in operating new networks; the nearest facility analysis is applied. This review adopts the new part number and PS part number section (Table 1-3). The derived result is rigorously verified in real time. It aims to find new ways to minimize travel distance by identifying new buildings suitable for PSs and by addressing missing road

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networks. If a suitable alternative is found, it is modified in all sources, and the closest facility to all sections and all PS components is re-run after the PS search is complete, which is known as road network finalization. The derived result indicatesthe distance between the segment and PS. The travel distance from 301.81 km to 112.25 km is reduced (38 %) from that study. The number of PSs also decreased from 57 to 54 at the same time (Figure 7-9).

Table 1. PS status.

SL No..	PS Type	Number
1	Remains Unchanged	38
2	Relocate PS	13
3	New PS	3
4	Removed PS	6
Total		60

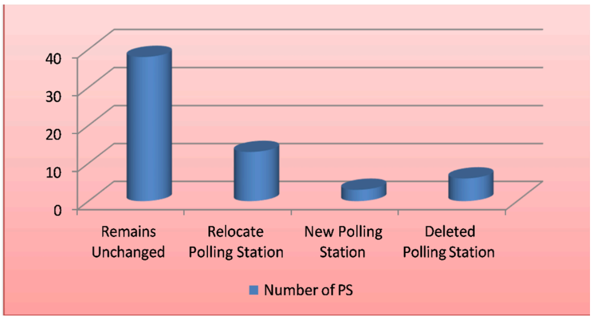

Figure 7. Number of PS.

Table 2. Comparison between the existing PS and section, and the proposed PS and section.

SL No	PS Type	Exist PS and Section	Proposed PS and Section	Difference
1	Total Section	131	129	-2
2	Total PS	57	54	-3
3	Total Travel Distance	301.81	189.31	-112.5 (38%)
4	< 2.5	48	25	23

Table 3. Type of resource used as a PS.

SL No	Source	
1	Anganwadi	4
2	Community Hall	4
3	Tea Office	1
4	School (Private and Public)	45
Total		54

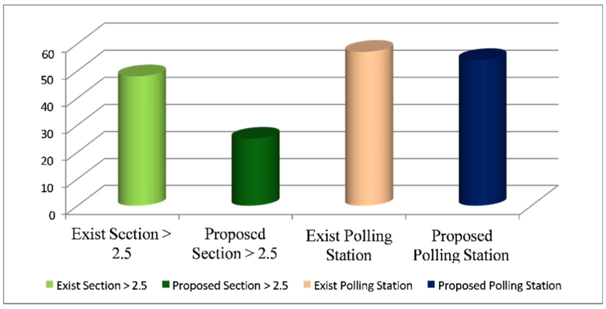

Figure 8. Bar chart comparing four categories, highlighting variations in values across different groups using distinct colored columns.

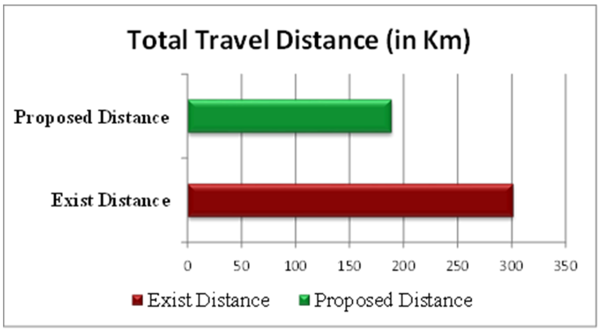

Figure 9. Total travel distance (in km)

In the part bordering the new demarcation phase and the proposed PS, the Mankulam village parts are avoided due to a village dispute. The spatial positions of current and new PSs are shown in section maps (Figure 3). As such, 38 PSs remained among the 54 PSs. In the sector, the search PS identified 16 new PSs. Among the 16 sources, 13 are replaced by the new PS, which we call a PS relocation.

The remaining three PSs serve as new PSs (Table 1). 45 schools, mainly aided lower primary schools, 4 community halls, 4 Anganwadi, and one coffee shop office are used as PSs in this pilot study (Table 3) [15]. The derived results are shown in Tables 2 and 3 for the current and new conditions.

The complete KDHP village segment is 131, according to the election department, with 57 PSs. The overall distance between all sections and PSs is approximately 302 km, with 48 (37%) sections traveling more than 2.5 km to cast their ballot (Table 2). These statistics reflect current conditions based on KDHP village election settings.

Taking these figures into account, the location optimization process was carried out using the village's geospatial technologies and geographic settings [16]. The derived results show that the total travel distance has been reduced from 302 km to 189 km (35% reduction), which is a fantastic result that clearly shows the current problems in the allocation of PS locations (Figure 9) [17]. The number of current PSs and section numbers has decreased from 57 PS to 54 PS (-3) and from 131 sections to 129 sections (-2) at the same time (Table 2). Travel distance sections of more than 2.5 km have decreased from 48 to 25 (Figure 8). These are some of the excellent features of the position-optimization method.

Conclusion

Public service facilities, such as hospitals, fire stations, schools, and other emergency service centers, may offer low-cost, high-quality service to individuals by choosing the best venue. By offering a forum for efficient planning, coordination, and decision-making, geospatial technology, including GIS, GPS, and remote sensing, plays an important role. As a study place, the KDHP village in Devikulam Taluk was selected. In this analysis, using geospatial-based rationalization of Pieces, Sections, and PS, current position issues in election-based PS and Sections were identified, and solutions were proposed. Network analysis: The Closes Facility is run, and current and new conditions are compared. According to the report, the travel distance was reduced by almost 37 %, and the PS and Section numbers were also reduced. These findings clearly show that, in allocating PS and sections, some planning gaps exist. The percentage of votes, particularly among older people and those living in areas with weak road networks and poor transport services, would decrease under these conditions of exit. Geospatial implementation and geographic awareness of the corresponding position would undoubtedly yield better solutions than any other technology to increase voting

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percentages and satisfy all parts of the demand. Other service-based sectors, especially Cell Phone Tower locations, Fire Station locations, school locations, etc., can also be optimized and coordinated using the same technology.

Disclosure Statement

The Authors declare that there is no conflict of interest.

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