MEASURING GEOGRAPHICAL ACCESSIBILITY TO PRIMARY HEALTH CENTERS IN CHAMARAJANAGARA DISTRICT

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Abstract:

The spatial pattern of health care facilities is concerned with the arrangement of the facilities across a geographical space. This could be in response to series of locational factors such as: easy access to facility from other nearby settlement, availability of approachable roads, mode of transport or impediment like water bodies, forests, rugged terrain and others. Health care decisions are strongly influenced by the type and quality of services available in the local area and the distance, time, cost, and ease of traveling to reach those services. This paper demonstrates a method for estimating the geographical accessibility to PHC's. Network analysis in GIS, is used to determine the travel distance and travel time to closest healthcare via road network. This analysis is applied to approximately 430 villages in Chamarajanagara district allowing geographical access to be linked to local populations. The population is not distributed uniform across villages, the village centroids were considered as a demand points, and the PHC facilities were considered as supply points. The study concludes that Chamarajanagara and Gundlupete taluks are having good number of health centers to serve the local people, while as Yelanduru and Kollegala taluks are serving more people with relatively less number of health centers.

Key Words: Geographical Accessibility, Network Analysis, Centroids, Population, Healthcare Etc.

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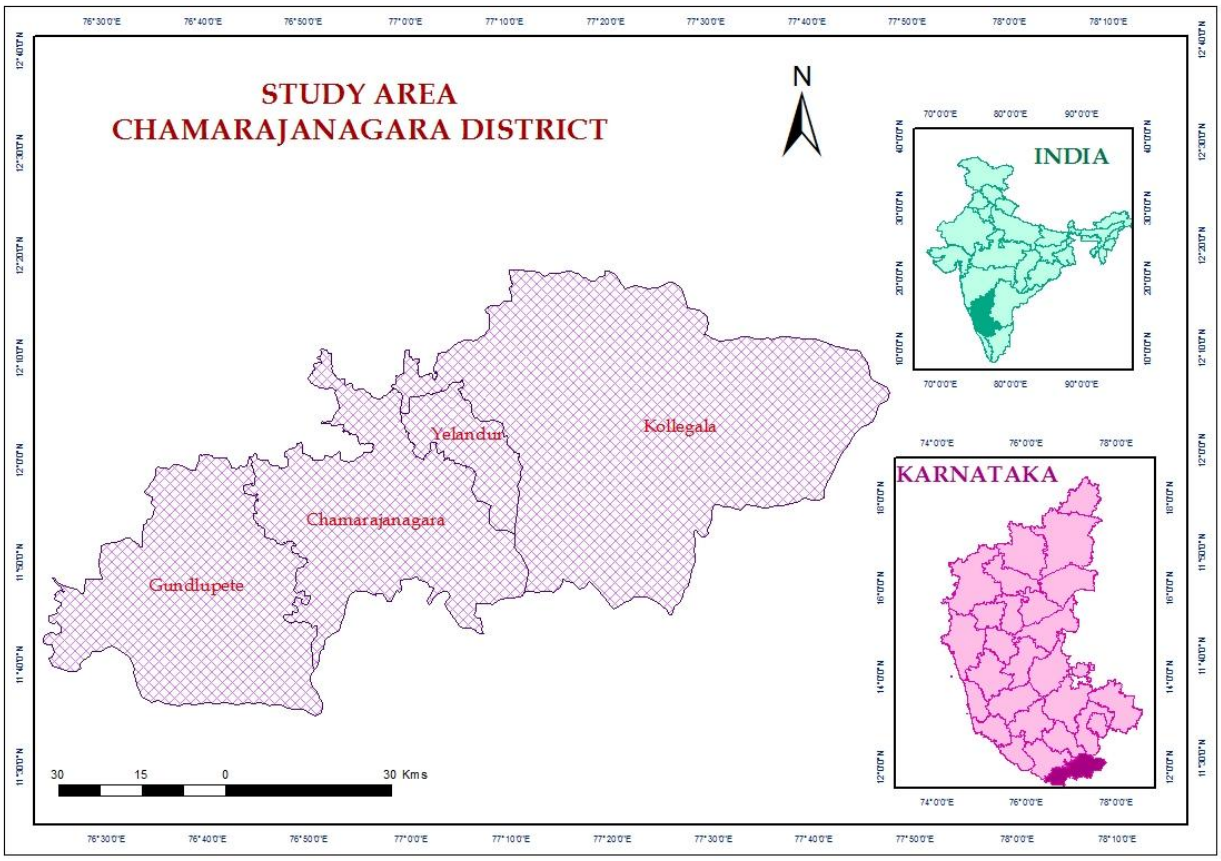
1. Introduction:

Primary health care (PHC) is an imperative strategy to providing "health for all" and is widely acknowledged as a universal solution for improving population well-being in the world (World Health Organization and UNICEF1978). Accessibility coverage determines how physically accessible resources are for the population (Tanahashi T 1978). Distance and Time are both important factors of accessibility. The World Health Organization recommends using travel time, rather than distance, to assess geographical accessibility. The vast differences in geography and transportation infrastructure amongst and within countries make measures of distance to health facilities difficult to compare (WHO 2001). In the case of accessibility coverage, the maximum capacity of the services is limited by the number of people who can reach and use it (Tanahashi T 1978).

Geographical accessibility is a topic that has preoccupied medical geographers for quite some time (Quah 1977). They have tried different methods to evaluate accessibility. Many authors have used basic cartographic methods to map the availability of healthcare facilities and highlight potential inequalities (Knox 1979). They have also used sophisticated mathematical models to understand the effect of distance on geographical accessibility of healthcare facilities (Mitropoulos et al 2006; Knox 1979; Koening 1980; Joseph and Bantock 1984) and statistical methods to reveal the existence of factors or barriers that affect the access of population to healthcare services (Guagliardo 2004 for an interesting review of these models and statistical methods). For example, Vedia Dokmeci and collaborators (Dokmeci 2002; Dokmeci and Ozus 2004; Şentürk et al 2011) have investigated the distribution of different types of healthcare facilities (hospitals, physician offices and pharmacies) in Istanbul. Using a regression analysis, they found that the most important factors that influence the distribution of these health care facilities are population income and education level. Moreover, they found that, while state hospitals are more evenly distributed, private hospitals tend to concentrate in high-income districts (Şentürk et al 2011).

2. Study Area:

Chamarajanagara is the Southern district in the state of Karnataka, India. The study area lying between 76° 24´ and 77° 43´ East longitudes and 11° 32´ and 12° 16´ North latitudes. It has Geographical area of 5101 Sq. Kms. Chamarajanagara district is consisting of 4 taluks: Chamarajanagara, Gundlupet, Kollegala and Yelanduru with 16 hoblis. As per 2011 census, the population of the district is 10, 20,962. It constituted 845669 rural and 175293 urban populations in 2011. The district is ranked 17th in area and 26th in population of the state. It contains 1.82 percent of the total population of the state, and it was 1.96 percent in 2001.



Map 1

3. Methodology

To investigate the geographical accessibility to primary health centers, three main types of data are required: the location of health centers, location of the population and road network system. Data on road network and associated speed limits was collected to measure travel distance and travel time between Primary Health Centers and village Centroids. For the network analysis the road network of the district has been converted into network dataset. Depending upon the road hierarchy and characteristic, roads were allotted an average vehicular speed (Km/hour). National Highway – 50, State Highway – 35, District Roads – 30, Village Roads – 25 and Pedestrian – 06. Travel time has been calculated using the following formula Length/Speed*60. Length of the roads has been divided by the speed of the roads and it is multiplied by 60 (Minutes). On the basis of the speed, travelling time and travelling distance closest facilities both in terms of distance and time were calculated. Since the population is widely scattered throughout the village, it is difficult to measure considering different points in a village, hence the village centroids were considered as a demand points, and the PHC facilities were considered as supply points. The closest route has been generated both in terms of distance and time. The population of different shortest routes of PHC's has been calculated. The generated data were presented in the form of maps and tables and figures. To analyze the geographical accessibility travel distance has been categorized into 3 divisions such as, 3 Kms, 3 to 6 Kms and Beyond 6 Kms. Likewise, travel time to reach PHC's from the village also categorized into 3 divisions, below 20 min, 20 – 40 min and beyond 40 minutes.

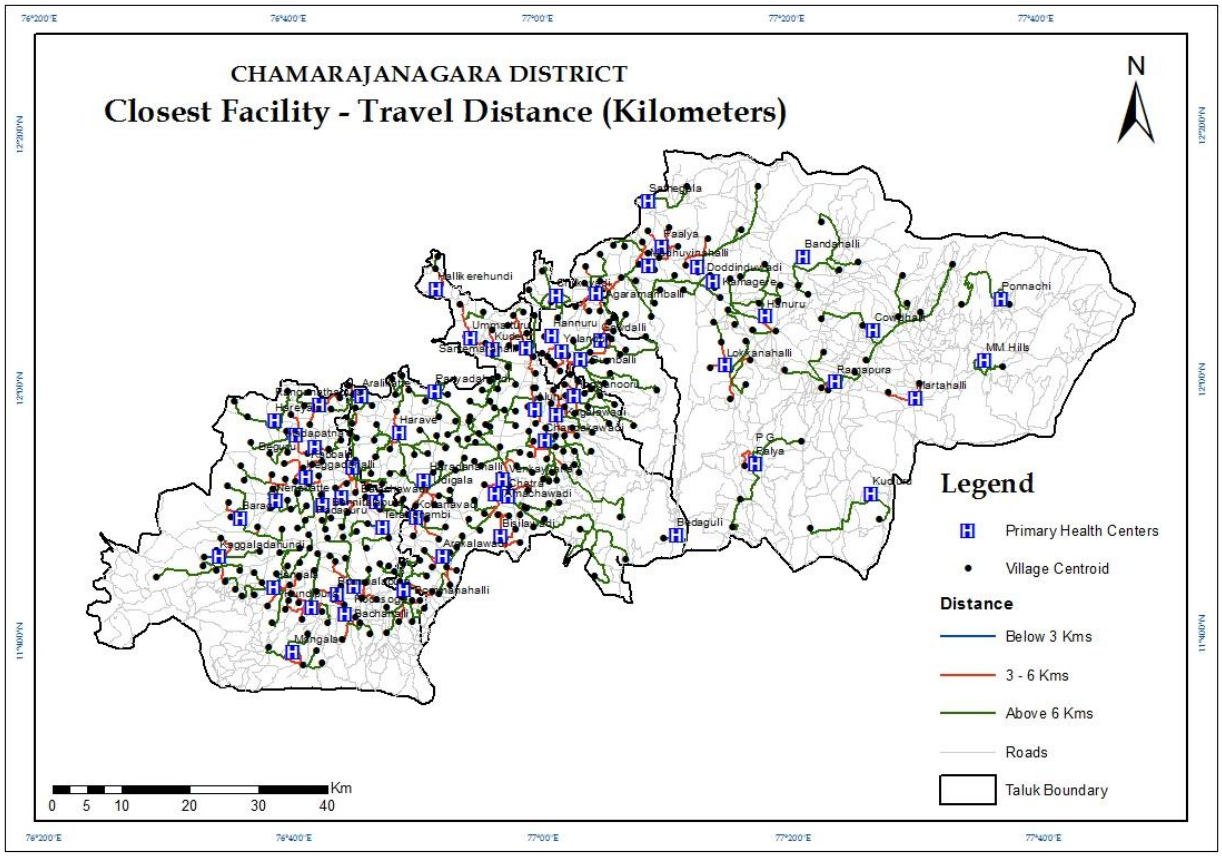
4. Results and Discussions:

(a) Closest Facility Analysis (Distance and Time):

Accessibility can be assessed by either measuring the distance from residence to the health care facility or by estimating travel time. In some cases perceived distance or perceived travel time could also be considered (Arcury et al 2005; Love and Lindquist 1995).

The closest facility solver measures the time and distance of traveling between demand point and supply point and determines which are nearest to one other. When finding closest facilities, one can specify how many to find and whether the direction of travel is toward or away

from them. Once we have found the closest facilities, can display the best route to or from them, return the travel cost for each route, and display directions to each facility. Additionally, one can specify an impedance cutoff beyond which ArcGIS Network Analyst should not search for a facility. The two most common types of distance measure used for determining spatial accessibility in the literature are the Euclidean distance (more often known as straight line distance) and the Manhattan distance (distance along two sides of a right-angled triangle, the base of which is the Euclidian distance). Ingram (1971) suggests that the Manhattan network distance measure is more appropriate than Euclidean distance in measuring gridded road network in urban areas. But Apparicio et al (2008) argues that the shortest network travel time is more accurate than any other distance measures. Spatial accessibility to service facilities from population points have been determined using travel time (Burt and Dyer 1971), where travel time is often calculated using the existing road network, the distance is converted to travel time by using a suitable conversion algorithm and the travel time is also dependent on the mode of transportation used (Sallahuddin Ahmad 2012). In the study area the shortest route distance and travelling time from the PHC to settlement centroid has been calculated.



Map 2

Table 4.1: Closest Facility from PHC's to Village Centroid

	Minimum	Maximum	Average	SD
Travel Distance (Kms)	0.24	29.49	6.50	4.07
Travel Time (Minutes)	0.68	70.51	17.61	10.10

Source: Compiled by Author

Travel distance to the health centers from village via road network is measured using the closest facility tool in ArcGIS according to the procedure. Table 4.1 shows the minimum, maximum, average and average travel distances and travel time (Measured in Kilometers and Minutes) to the nearest villages from primary health centers in the study area. It can be seen that the total length of travel distance from village centroids to the primary health centers ranges between 0.34Kms (Aralikatte) to 29.49Kms (Mukanapalya). Some residents have to travel up to 30 Kms to reach the PHC. The travel time to the PHC's from village centroids ranges between 0.68 (Aralikatte) minutes to 70.51 (Honnegowdanahalli) minutes. Average travel time to reach the PHC in the district is 17.61 minutes.

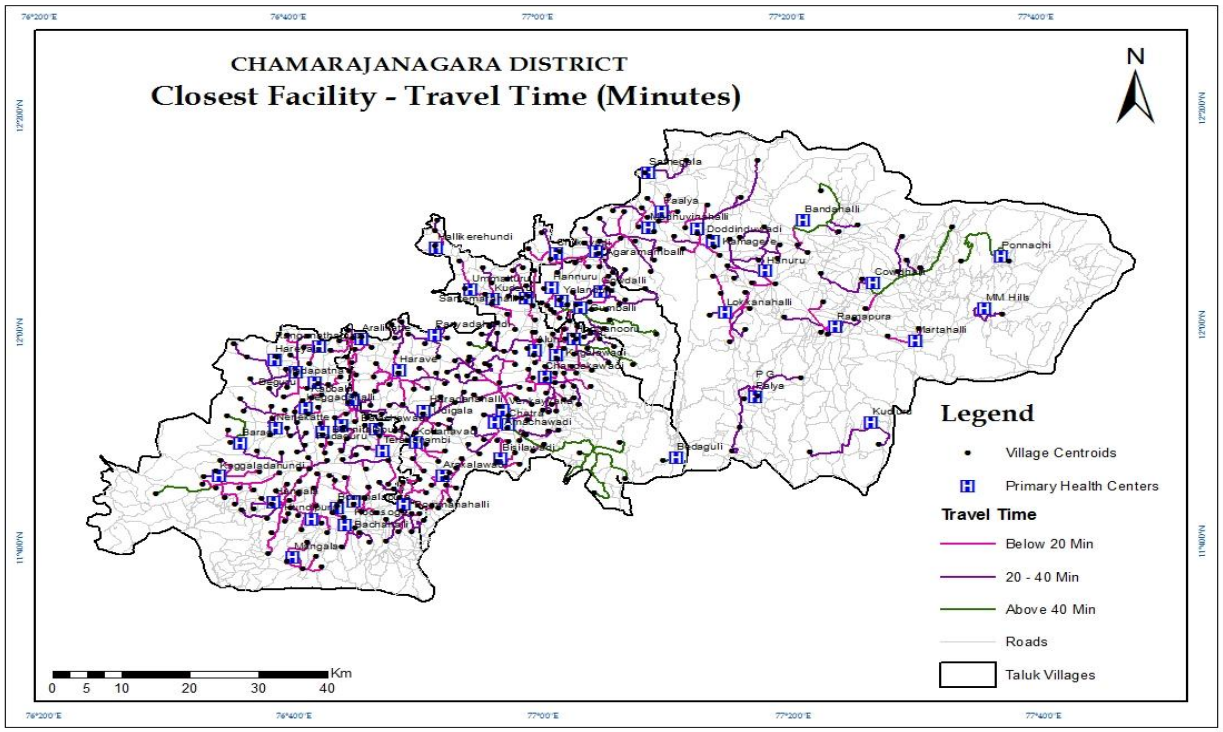
Table 4.2: Closest Facility - Distance

Distance	No of Villages	Cumulative % of Villages	Population	Cumulative % of Population
Below 3 Kms	67	15.58	169876	16.64
3 – 6 Kms	152	50.93	418660	57.65
Beyond 6 Kms	211	100	432255	100
Total	**430**		**1020791**	

Source: Compiled by Author

Table 4.2 provides the cumulative percentage of villages and its population located within zones of specified distances from primary health centers. The data revels that majority of villages (50.93 percent) with 57.65 percent of the total population have to travel the distance of below 6 kilometers to reach the closest PHC. About 49.06 percent of villages consisting of 42.34 percent of total population are being served beyond 6 Kms. About 15.58 percent of populations of 16.64 percent of villages are easily accessible to health centers within the distance of 3 Kms.

Specific service areas based on travel distance from PHC's to village centroid has been presented in map 2.



Map 3

Table 4.3: Closest Facility - Time

Distance	No of Villages	Cumulative % of Villages	Population	Cumulative % of Population
Within 20 Min	294	68.37	740365	72.52
20 – 40 Min	121	96.51	251873	97.20
Beyond 40 Min	15	100	28553	100
Total	**430**		**1020791**	

Source: Compiled by Author

Travel time (measured in minutes) to the closest health care facilities from village centroids via road network is derived from the measured travel distances. Table 4.3 shows that the majority of the population i.e. 72.52 percent has to travel below 20 minutes to reach the PHC. Up to 40 min, 97.20 percent of population can access the closest PHC. Only about 2.79 percent population of 3.48 percent of the villages in the district has less access to PHC as they have to travel for the time of beyond 40 minutes.

5. Conclusion:

It is one of the basic human rights to get adequate and easy access to health care service at the time needed. Network analysis is the best suited method to portray the true geographical accessibility to the health centers. Because Service area is delineated on the basis of time and distance and it is helpful to calculate the travelling time and traveling distance from demand points (Village Centroids) to service or Health Centers. In reality, absolute equal spatial accessibly is not always achievable but it is possible to plan and build a system of health care facilities in such a way so that it allows the highest spatial accessibility for a maximum number of the population. In study area more than half of the population is easily accessible to healthcare centers within the mean travel distance and travel time. Whereas, remaining population have to travel beyond 6 Kms of travel distance or Above 20 minutes of travel time to the health centers. Chamarajanagara and Gundlupete taluks are having good number of health centers to serve the local people, while as Yelanduru and Kollegala taluks are serving more people with relatively less number of health centers.

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