ASSESSMENT OF NEIGHBORHOOD PARKS USING GIS TECHNIQUES IN SHEIKHUPURA CITY

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ABSTRACT: Neighborhood Parks have great influence in the sustainability of any city and its accessibility with respect to public is a key factor in measuring the healthy demographic profile. This paper focuses on spatial distribution pattern of 11 existing neighborhood parks within the Sheikhupura city on the basis of road network accessibility. Accessibility has been measured on the basis of standard walk time impedance taken as 60 meters/ minute from residences to the parks. GIS network analysis based on connected road network dataset has been performed to calculate different time zones on the basis of impedance factor. The results showed that existing parks are serving less than 11% out of total population. The comparative statistical analysis also carried out using standard impact buffer distance of 0.5 miles which raised questions upon spatial distribution pattern as well as number of parks in the city. GIS techniques and methods provided helpful tools in analyzing accessibility of existing park facilities. The output can be used by decision making authorities to formulate plans for suitable park locations in the city.

Key words: Accessibility, Spatial Distribution, Neighborhood Parks, Walk Time Impedance, GIS.

INTRODUCTION

Parks and open spaces play a great role in enhancing the life quality of urban areas (Tajima, 2003). Neighborhood parks are considered as the basic unit in parks system and play a major role in enhancing the air quality of their surrounding area. It also improves the recreational and informal activities of the peoples living at their immediate neighborhood (McDonnell et al., 2010; Thomas Graceffa Associates, 2008).

Service area of these parks is generally considered as 10 minutes walking time or half mile radius (Park Classification City of Ottawa, 2013). Neighborhood Parks plays vibrant role in socializing the peoples and providing them recreational areas for gathering and other healthy activities (Oh and Jeong, 2007).

Sheikhupura city is taken as the study area in this research which, spatially, do not have well distribution pattern of urban parks. Parks in Sheikhupua city only constitutes 16 hector area which constitute only 0.25% of the study area. Existing parks in study area usually range in size between 0.25 to 9 acres which fulfills the definition of neighborhood parks (Park Classification System, 2009).

Without the spatial distribution measure, serviceability of the parks cannot be defined or judged precisely. GIS and spatial analysis are helpful in determining that to how much degree the distribution of urban parks facility is equitable (Ahmad and Lakhan, 2012; Ahmad et al., 201; Tsou et al., 2005). In previous studies serviceability of the parks have been measured on the basis of the indices such as total parks area, number of parks and income level of peoples (Mladenka and Hill, 1997; Omer, 2006). These indices or statistics do not reflect the actual served area and population by the parks (Oh and Jeong, 2007).

Euclidian or buffer distance technique is also used widely in measuring the population serviceability which do not produce actual results and show overestimated served population (O'Neill et al.,1992).

This research emphasis on the spatial distribution of urban parks and actual accessibility of pedestrians to urban parks on the basis of spatially referenced road network/ pedestrian network analysis. Analysis has been performed on the basis of walk time impedance. This study also explicates the comparison between the results calculated on the basis of actual pedestrian network accessibility and proximity analysis.

Accessibility: Accessibility is the easiness with which people access their desired destinations (Gregory et al., 2009). It is also the relative nearness of one place to the other (Pooler, 1995). Accessibility is actually about the relation of public facilities locations (Tsou et al., 2005).

OBJECTIVES

- To set up a geometrically corrected and classified road network dataset that can represent the real time network connections.
- To establish neighborhood parks accessibility zones on the basis of walk time impedance.

- To assess existing neighborhood parks accessibility with respect to calculated served areas and population.

MATERIALS AND METHODS

Study Area: Shaikhupura is an industrial city in the province of Punjab about 35 km northwest of Lahore in Pakistan. It is located at 31° 42' 36" N Latitude and 74° 08' 00" S Longitude (Collins Maps, 2012). All existing park facilities and urban population of Sheikhupura city has been covered by the study area which is comprised of 16 Union Councils (UCs). The population growth rate of Sheikhupura city from 1998 to 2012 is 1.87% as per Punjab development statistics report 2012 (Punjab Development Statistics, 2012). Study area is comprised of almost 16 (14 urban, 2 rural) UCs which covers the entire population and existing park facilities of city. UC 14B has comparatively larger area in which more than 70% area is open and undeveloped, that is why only the developed part of this UC has been incorporated in the study area to perform the GIS analysis. 6 out of 11 parks are located in UC no. 63, while there are many UCs which do not have any park facility.

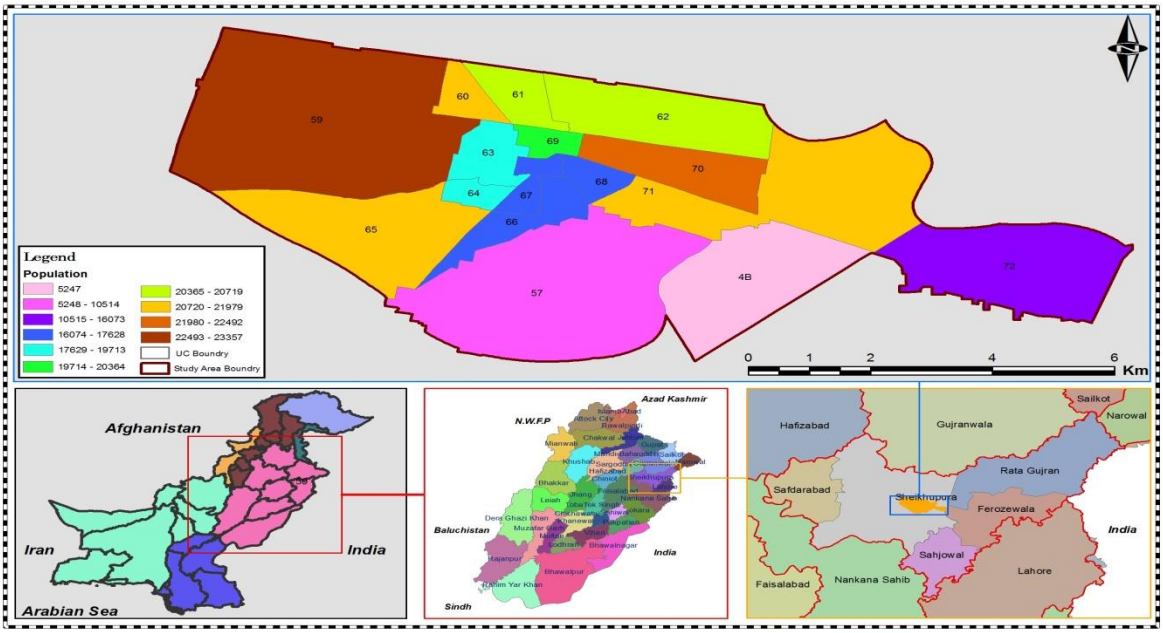

Fig.1 Location/ Population density map of the study area

Road Network: In order to build geometrically corrected network dataset, the edge–node topology was incorporated into the base network shapefile. Geometric errors were removed through topological rules that represent the network properties. Standard walk speed of 60 meter/ minute was incorporated into the GIS data to calculate travel time along edges. Road Classification was done using the road inventory survey data based upon right of way and runtime functionality of every link.

In order to calculate the travel time following formula was used:

$$S = v \times t$$

Where,
S = Length of road segment in meter (m)
v = Travel speed in meter per minute (m/min)
t = walk time in minute (m)

After populating the attributes with impedance (time, distance), network dataset representing real time network connections was built using Network Analyst Extension in ArcGIS 9.3 software.

GIS ANALYSIS

Neighborhood Parks Accessibility: Service area of the neighborhood parks in a network is usually the area that includes all the feasible streets that lies within the access of specified impedance (Time, Distance or Cost). Service area of three minutes for a specific point feature comprises of all the streets that can be travelled upon within 3 minutes from that point.

Service area network analysis has been carried out in this study to establish neighborhood parks accessibility zones on the basis of impedance. The travel time values derived on the basis of walk speed against every edge were taken as impedance. Accessibility zones of 0 to 3 min, 0 to 5 min and 0 to 10 min walk time were established which included all the streets categorically according to the specified time range. All the accessibility zones were derived against existing neighborhood parks that were represented in the form of point data in GIS.

Calculation of Served Area and Population: Served area is calculated by overlaying different layers in GIS data framework. Served population is calculated by the following formula:

Population Density = (Total Population of the City) / (Total Area of the City)

Where,

Total population of the study area were taken as **296023** persons

Actual Served Population = Population Density x Area

RESULTS AND DISCUSSION

The road network was classified into five major classes including trunk road, primary road, secondary road, local road and streets according to the Punjab Geometric Design Manual (PGDM). These classes were based upon link functionality and right of way. Figure 2 shows the road hierarchy of the study area.

The road network dataset was prepared through network analyst extension. The network dataset included Fnode, Tnode, F and T Minutes and one way restriction attributes to depict real time network linkage of the study area. Network dataset along with edge-node topology and link directions is shown in the figure 3.

The figures 2 and 3 shows complex road network geometry and hierarchy depicting real-time network connections.

Figure 4 shows a wide variety of land-use available in the study area which can be useful to derive trip generation and attraction zones for park commuters. This data can be useful for the suitability analysis to allocate new locations for future park development. Figure 4 also shows that there is not a single park exist in south eastern part of the city which is an industrial.

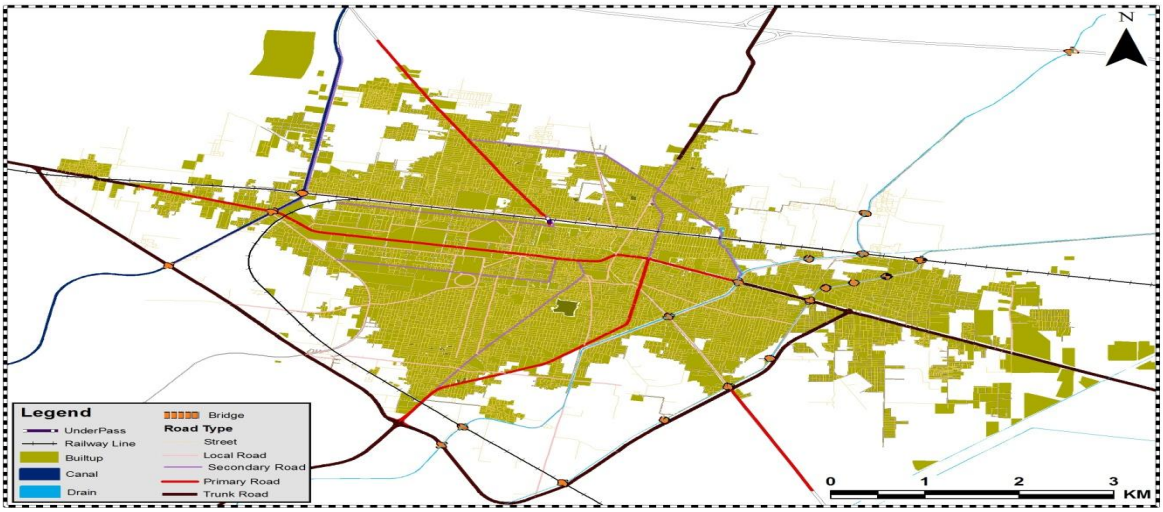

Fig.2 Road network hierarchy

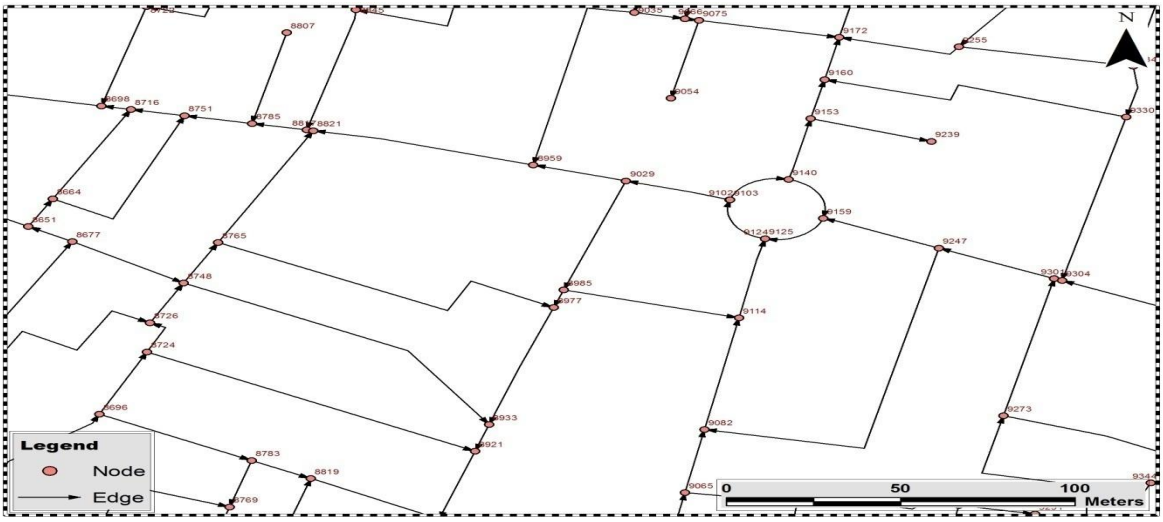

Fig.3 Road network dataset

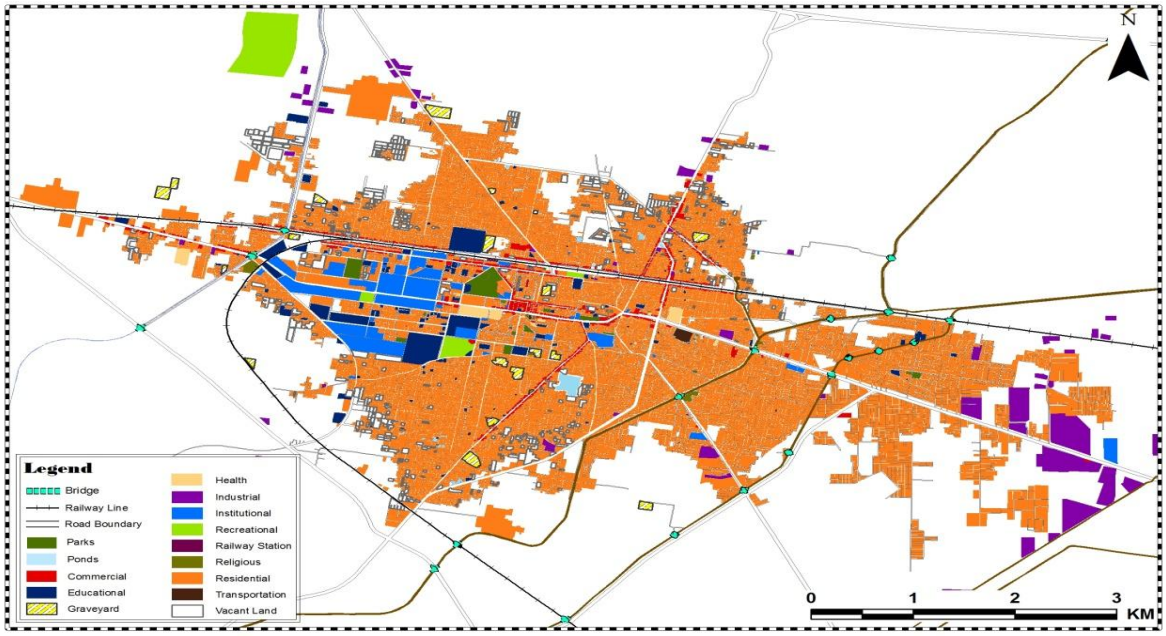

Fig.4 Land-use of Sheikhupura city

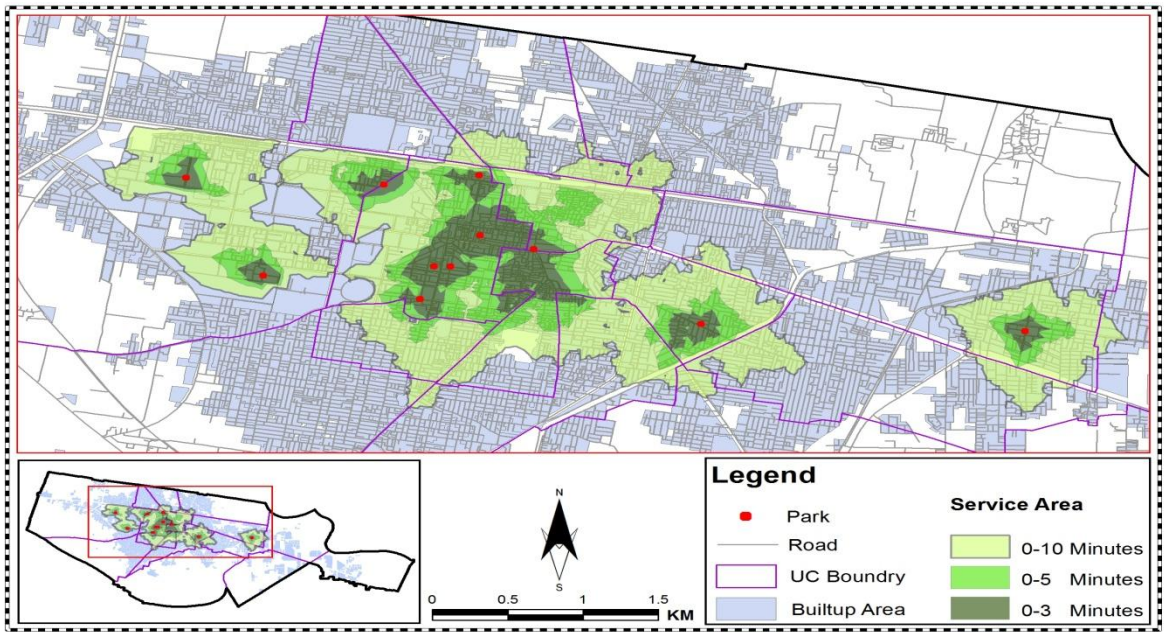

Fig.5 Served area by parks

In figure 5, concentric service areas show the variance of accessibility levels against the impedance value. These service areas can be used to calculate how much land, population, or the amount of anything else is situated within the neighborhood or constituency.

Figure 6 shows that more area and population is being served by taking standardized buffer distance of half mile for neighborhood parks than calculated on the basis the road network analysis (DiChiara & Koppelman, 1982). This is because simple buffer methods include the areas which are not accessible in actual due to the non availability of pedestrian network, while in pedestrian accessibility direct routes are barely difficult due to which accessing the parks takes more time than linear routes.

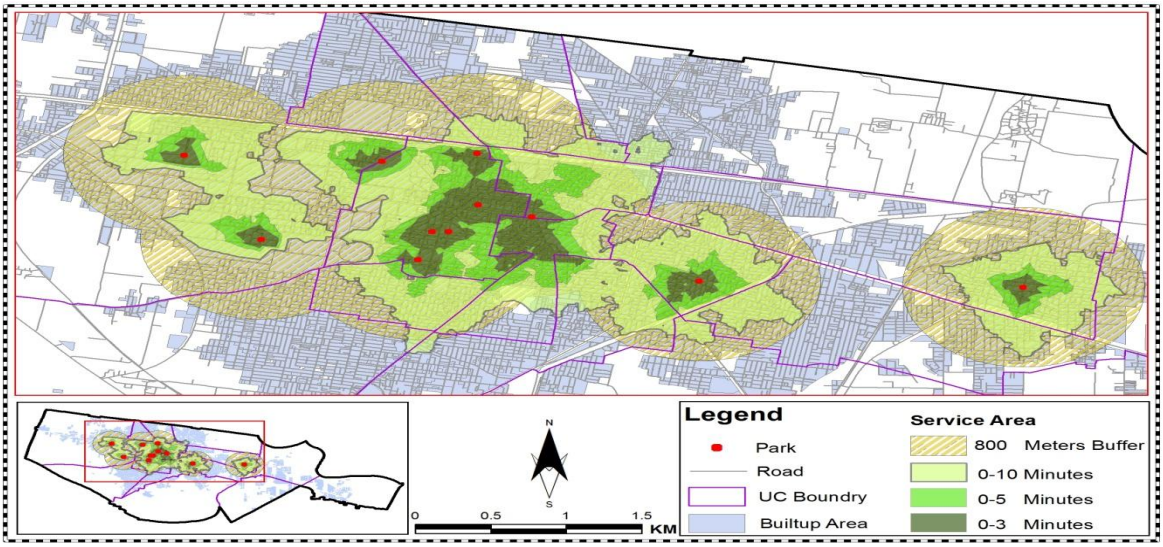

Fig.6 Served area comparison

Results in table 1 shows that population is partially served by existing park facilities with respect to minimum and maximum walking time limits. Most of the population in UC is unserved. For example UC no. 72 is completely unserved in the study area which means people living in this particular zone have no park facility to go to.

Table 2 below shows the percentage and comparison matrix of total population served with respect to standard accessibility buffer range of 800 meter and accessibility on the basis of road network for neighborhood parks. Table 2 also shows the served residential, commercial/ business and industrial area has also been incorporated because workers and visitors from commercial and industrial areas are also the major patrons of the parks.

The graph in figure 7 shows the variability of population distribution with respect to service area of existing parks. It is clear from the graph that red lines are the dominant participant which shows that most of the population is unserved with existing park facilities throughout the study area.

Table-1. Served area & population per UC

Union Council	No. of Parks	Total Population	PD/UC (Ha)	Parks Area	Total Area	SA (0-3) Mins	SA (0-5) Mins	SA (0-10) Mins	SP (0-3) Mins	SP (0-5) Mins	SP (0-10) Mins	Unserved Population	Unserved Area
				Hector					No. of Persons				
57	0	10514	10	0.0	1074.5	0.0	0.0	4.7	0	0	46	10468	1069.7
59	2	23357	17	4.3	1361.0	12.2	35.6	142.5	209	610	2445	20912	1218.6
60	0	21947	251	0.0	87.6	0.0	0.1	3.8	0	17	941	21006	83.8
61	0	20719	160	0.0	129.3	0.0	0.2	18.9	0	35	3034	17685	110.3
62	0	20594	48	0.0	427.1	0.0	0.0	7.7	0	0	373	20221	419.4
63	6	19324	146	10.4	132.5	46.8	83.0	118.3	6829	12102	17248	2076	14.2
64	0	19713	363	0.0	54.2	0.1	5.1	36.7	21	1854	13342	6371	17.5
65	0	21778	39	0.0	554.2	0.0	0.0	2.5	0	0	97	21681	551.7
66	0	17078	107	0.0	159.0	1.4	7.7	42.6	146	830	4573	12505	116.4
67	0	17216	234	0.0	73.5	14.9	28.4	54.7	3487	6653	12817	4399	18.8
68	1	17628	254	0.1	69.5	7.9	21.3	56.4	2005	5412	14304	3324	13.1
69	1	20364	352	0.9	57.8	4.2	21.0	54.5	1488	7409	19179	1185	3.4
70	1	22492	86	0.6	260.2	4.7	15.4	65.5	409	1327	5658	16834	194.8
71	0	21979	29	0.0	755.1	0.0	0.0	34.7	0	0	1010	20969	720.4
72	0	16073	26	0.0	614.3	0.0	0.0	0.0	0	0	0	16073	614.3
14B	0	5247	10	0.0	536.2	0.0	0.0	0.0	0	0	0	5247	536.2
Total	11	296023		16.2	6346	92.2	217.8	643.4	14594	36250	95066	200957	5702

*SP = Served Population *SA= Served Area

Table-2. Comparison matrix

Access Zone (Mins)	Total Served Area	Total Served Population	Total Served Area	Total Served Population
	(Ha)		(%)	
0 to 10	643.4	95066	10.1	32.1
0 to 5	217.8	36250	3.43	12.2
0 to 3	92.2	14594	1.45	4.93
Different Land use Service area				
Landuse Type	Total Area (Ha)	Service Area (%)		
		0-3 Minutes	0-5 Miutes	0-10 Minutes
Resedential	1453.9	3.5	8.8	26
Commercial	47.7	15.4	27.6	57
Industrial	167.0	0	0.10	0.7
Comparison B/W Buffer Distances and Road Network Service Area				
	Served Area (Ha)		Served Area (%)	
Total Area (Ha)	Buffer Distances	Calculated	Buffer Distances	Calculated
6346	1174	643.4	18.5	10.14

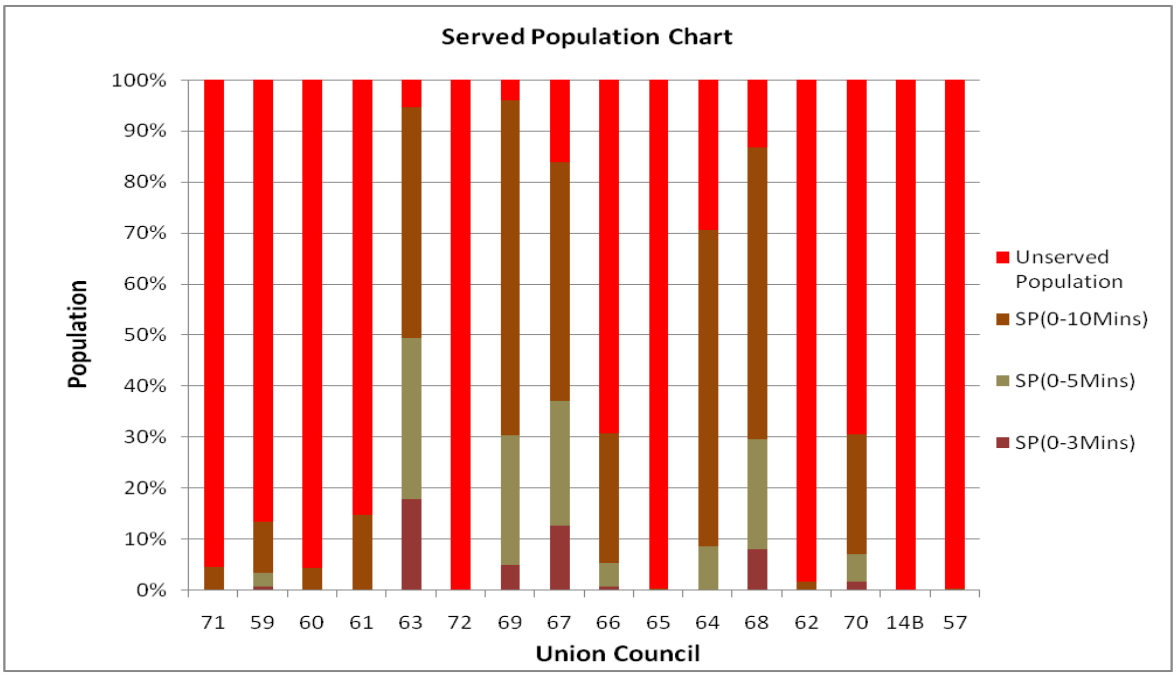

Fig.7 Service area comparison

Conclusions and Recommendation: Present study constitutes the ability of GIS in assessing the existing neighborhood park facilities in Sheikhupura city. Network service area analysis provided accurate results to examine the accessibility levels. More than 80 percent of the population remained unserved according to the calculated results which show the improper spatial distribution patterns of existing parks with respect to developed land-use. There is need to carry out a comprehensive study to introduce new neighborhood parks throughout the study area so that more people could be benefited.

It is recommended that advanced GIS suitability techniques integrated with Analytical Hierarchical Process (AHP) must be used to determine new locations for neighborhood parks keeping in view their spatial distribution pattern.

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