CITY AND REGIONAL PLANNING

Term Project Final Report

Selection of the Most Suitable Locations for Telecommunication Services in Khartoum

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Abstract

This project summarizes the applications of Geographic Information Systems (GIS) in the telecommunication sector. The study area is located in the South-eastern part of Khartoum City at AL-Maamora District. The main objectives of the study are to find the suitable locations for telecommunication services for the study area and design suitable plan for towers spacing. For this purpose, information about the study area was collected for the following items: 1) major towers length and offset 2) minor towers and their associated cable length. 3) streets 4) switches 5) building distribution, and 6) customer services. The resulting buffer suggested that the major towers should be ranged from 200 to 400 m apart depending on the geography of the area. One tower is expected to cover an area of approximately about 1000 m^2. The connected cables between towers and switches are of different length and size depending on the area of connection. This study highlights the importance of using GIS in telecommunication industry. It indicated that GIS may provide best location selection not for telecommunication services only, but also for other services needed in residential areas.

1. Introduction

To be competitive, telecommunications providers depend on a smoothly functioning work flow process that integrates information for marketing, demand forecasting, engineering, customer management, operations support, and fleet management. Although telecommunications providers generally have the same needs for information, how the work flow is organized can vary significantly from company to company.

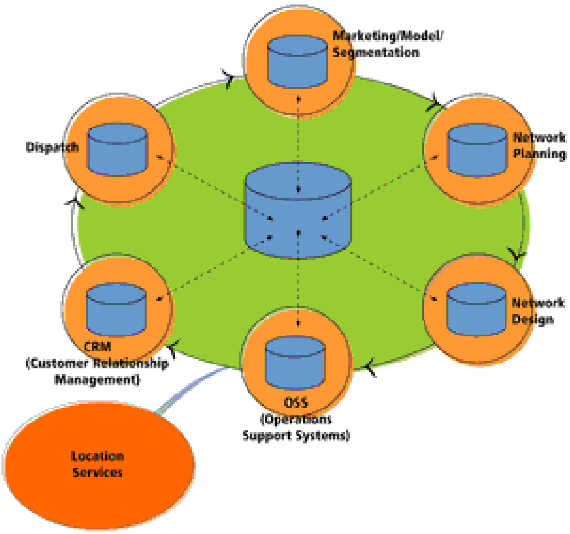

Figure 1: Typical overall work flow that is integrated into by Telecommunications companies.

In today's competitive telecommunications market, customer service is the number one differentiator for companies. Customer relationship management (CRM) applications improve the relationship between the company and its customers. Timely service provisioning, response to customer queries, and reporting on network performance are aspects of CRM. With GIS, call center operators can access all the information on a customer and the associated network based on location. Databases containing information on outside plant infrastructure, signal quality, and equipment can be integrated using GIS and made available using a corporate Intranet.

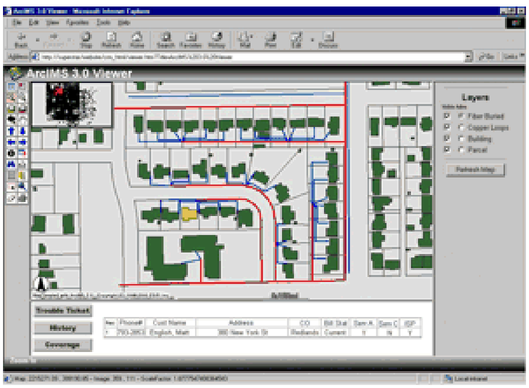

Figure 2 :Typical window of a GIS software of a company in which call center operators can access all the information on a customer and the associated network based on location.

Wireline Engineering

Wireline engineering systems are GIS applications that work with the design and geographic layout of a company's outside plant infrastructure. Engineering applications allow for quick review and modeling of network routes, automation of the work order process, and high volume cartographic output to support technicians in the field.

For many residents in developing cities, informal settlements are the sole avenue of access to shelter and basic services, however poor in quality. The need to improve the living conditions in such areas is once again receiving high priority on the international and national development agendas. Current approaches to settlement upgrading favor the adoption of community-based, participatory styles of planning and management. Upgrading inevitably also requires the use, in cooperation with local residents, of more traditional planning and design methods which depend in part on the ability to analyze the physical setting of a given settlement and prepare appropriate solutions to specific problems.

The GIS systems are designed in the modern age and they provide and enormous help in the decision-making at higher levels. It can also be found in the planning of infrastructure of cities and telecommunications networks, electricity, water and other networks and the development plans.

2. Background

The study of the potential of geographic information systems in supporting the urban governance process compels us to carry out this study. In essence, the work comprises of two main topics. The first will be about the information systems and GIS, the improvement and Importance of GIS to Urban Development. Secondly, the application of GIS in communication in Sudan will be taken as a case study.

2.1 Geographic Information System (GIS)

“A system of hardware and software that supports the capture, management, manipulation, analysis, and display of geographic information.”(Al-Ramadan, 2005). Geographic information data basically consist of two data component, namely:(1) locational data that describe features with exact location, and (2) descriptive attributes that describe defined features. Geographic feature could be manmade (e.g. buildings and roads) or natural (e.g. geological outcrops and rivers) (Al-Ramadan, 2005). In GIS an automated link between any given feature location and its descriptive attribute is established and maintained.

2.2. Layers concept in GIS

Geographic areas are consisting of many features. In GIS database, these features are represented as a number of related layers, where each feature is stored in a separate layer.

2.3. Source of geographic information

Generally remote sensing images such as aerial photographs and satellite images are the primary sources for spatial component of a GIS data base.

2.4. GIS components and functional elements

GIS consist of four components and four functional elements. GIS components are: Software, Hardware, Database and Users. Functional elements are: Data input, Data Management, Data Manipulation and analysis, and Data Output.

2.5 Geo-processing

Geo-processing is the processing of geographic information, one of the basic functions of a geographic information system (GIS). It provides a way to create new information by applying an operation to existing data. Any alteration or information extraction performed on data involves a geo-processing task. It can be a task such as converting geographic data to a different format, or it can involve multiple tasks performed in sequence, such as those that clip, select, and then intersect datasets.

2.6. The Improvement of GIS

According to Steven (1998) GIS was originally developed as an environmental technology. Tomlinson (1998) coined the phrase geographic information system in the early 1960s when he led a project to map Canada's natural resources. During the same decade, Edgar Harwood, a professor of civil engineering and planning at the University of Washington, wrote some of the earliest computer mapping software, founded the Urban and Regional Information Systems Association, and conducted a number of highly influential short courses and conferences (Chrisman, 1998, 2006, and Tomlinson, 1998). In the early 1990s, GIS began expanding into the business market, and as GIS became available on personal computers it became available for a much broader spectrum of business users (Castle, 1993). Industries with deep pockets and clear geospatial needs, such as public utilities, transportation companies, and logistics firms were early adopters.

GIS software was originally developed as a specialized, proprietary application, with its own arcane scripting and programming languages (e.g., the Arc/Info macro language, AML) which isolated it from mainstream information technology (IT). In many local governments and universities, central IT departments focused on mainstream database management systems and office automation applications (e.g., word processing and spreadsheets) leaving those with geospatial needs to support their own applications. This severely limited the pool of potential GIS managers, developers, and programmers. However, in the last five years commercial GIS software has been moving toward more mainstream software development platforms

3. Importance of GIS in the field of communications

1- Identification of the actual need of telephone lines in any area.
2 -Helps in providing the information needed to make the right decisions such as determining the locations and cable paths of telecommunications networks, wireless and fiber optic and mobile communication towers sites.

3 - To facilitate maintenance operations through information provided by topographic maps.

4 -Helps in determining the intensity of use and areas of suffocation.
5 – Provides enough information to get rid of the problem of overlap with other service projects.

6 – Helps in organizing complaints and customer assistance

4. Case Study

Selection of the most suitable locations for telecommunication services and how to develop works and study the region.

1- Length of the Towers and the distance between them

2- Column cables

3- Cable or Microwaves

4- The streets

5- Switches

6- Customer information

7- Buildings

8- Sectors

5. Analysis and processing of information: -

1- Tower is the primary conduit for communication and ranges in height from 200 m to 400 m depending on the nature of the area covered by the tower and covers an area of 1000 m (1 km)

2- Poles are used to connect the wires to homes and have a typical height of about 6m

3 - Cable is the carrier of the signal between the towers and the switches and are of different sizes

4 - The streets

5 - Switches are the link between towers and poles using the cable

6 - Information for various customers such as customer name, phone number, etc. ..

7 - Building numbers and dimension

8 - Sectors contains a collection of buildings to be connected to the network

8. **Explanation of components of the system tables and attributes: -**

1-Switches

Attributes of Switches

OBJECTID	SHAPE *	TYPE	linsh *	capcity_1 *	position
2	Point	<Null	<Null>	2	<Null>
15	Point	<Null	<Null>	<Null>	<Null>
16	Point	<Null	<Null>	<Null>	<Null>
18	Point	<Null	<Null>	<Null>	<Null>
20	Point	<Null	<Null>	<Null>	<Null>
21	Point	<Null	<Null>	<Null>	<Null>
22	Point	<Null	<Null>	<Null>	<Null>
23	Point	<Null	<Null>	<Null>	<Null>
24	Point	<Null	<Null>	<Null>	<Null>
26	Point	<Null	<Null>	<Null>	<Null>
27	Point	<Null	<Null>	<Null>	<Null>

Figure 3 : Attribute table for switches

2 – Columns

Attributes of Columns

OBJECTID *	SHAPE *	TYPE	CAPCITY	COODE
1	Point	sudan	15	<Null>
3	Point	sudan	15	<Null>
4	Point	sudan	15	<Null>
5	Point	sudan	15	<Null>
6	Point	sudan	15	<Null>
7	Point	sudan	15	<Null>
8	Point	sudan	15	<Null>
9	Point	sudan	15	<Null>
10	Point	sudan	15	<Null>
11	Point	sudan	15	<Null>
12	Point	sudan	15	<Null>
13	Point	sudan	15	<Null>
14	Point	sudan	15	<Null>
15	Point	sudan	15	<Null>

Record: 0 Show: All Selected Records (0 out of 1492 Selected) Options

Figure 4 : Attribute table for the columns

3-Towers

Attributes of Towers

OBJECTID *	SHAPE *	LENSH	NAME	WIGTH	CAMPANY	TYPE	AREA *
3	Point	<Null>	برج زين	<Null>	<Null>	<Null>	<Null>
10	Point	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
11	Point	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>

Record: 1 Show: All Selected Records (0 out of 3 Selected) Options

Figure 5 : Attribute table for towers

4- Cables

Attributes of Cables

OBJECTID	SHAPE *	LINSH	SIZE	TYB	CAPCIT	SHAPE_Leng
224	Polyline	<Null>	<Null>	<Null	<Null>	185.818864
225	Polyline	<Null>	<Null>	<Null	<Null>	74.678775
226	Polyline	<Null>	<Null>	<Null	<Null>	211.486901
228	Polyline	<Null>	<Null>	<Null	<Null>	335.152418
229	Polyline	<Null>	<Null>	<Null	<Null>	77.123901
230	Polyline	<Null>	<Null>	<Null	<Null>	152.340997
231	Polyline	<Null>	<Null>	<Null	<Null>	158.410219
232	Polyline	<Null>	<Null>	<Null	<Null>	89.360927
234	Polyline	<Null>	<Null>	<Null	<Null>	705.442282
235	Polyline	<Null>	<Null>	<Null	<Null>	178.409575
236	Polyline	<Null>	<Null>	<Null	<Null>	478.521476
237	Polyline	<Null>	<Null>	<Null	<Null>	90.858012
238	Polyline	<Null>	<Null>	<Null	<Null>	285.740884
240	Polyline	<Null>	<Null>	<Null	<Null>	1258.508719
241	Polyline	<Null>	<Null>	<Null	<Null>	37.206673
243	Polyline	<Null>	<Null>	<Null	<Null>	393.687208
244	Polyline	<Null>	<Null>	<Null	<Null>	21.676956
245	Polyline	<Null>	<Null>	<Null	<Null>	557.721997
246	Polyline	<Null>	<Null>	<Null	<Null>	14.467642
248	Polyline	<Null>	<Null>	<Null	<Null>	179.864389
249	Polyline	<Null>	<Null>	<Null	<Null>	584.130236
250	Polyline	<Null>	<Null>	<Null	<Null>	404.416145
252	Polyline	<Null>	<Null>	<Null	<Null>	155.712403
253	Polyline	<Null>	<Null>	<Null	<Null>	10.801527
254	Polyline	<Null>	<Null>	<Null	<Null>	227.700514

Record: 1 Show: All Selected Records (0 out of 152 Selected)

Figure **6** : Attribute table for Cables

5- Streets

Attributes of Streets

OBJECTID	SHAPE *	Name	Type	Enabled	SHAPE_Leng
3	Polyline	شارع أوماك	فرعي	True	93.933023
4	Polyline	شارع الرياض المشتل	فرعي	True	12.698489
5	Polyline	شارع الرياض النص / الكرمك	فرعي	True	12.671552
6	Polyline	الجزار	فرعي	True	12.395881
11	Polyline	<Null>	فرعي	True	1401.97574
12	Polyline	<Null>	فرعي	True	167.694107
14	Polyline	شارع المعمورة	فرعي	True	7.730199
15	Polyline	شارع مدني	رئيسي	True	657.798783
16	Polyline	شارع مدني	رئيسي	True	39.802851
17	Polyline	<Null>	فرعي	True	167.132083
18	Polyline	<Null>	فرعي	True	972.751346
19	Polyline	<Null>	فرعي	True	9.404313
20	Polyline	شارع الستين	رئيسي	True	1328.53179

Record: 1 Show: All Selected Records (0 out of 13 Selected)

Figure 7 : Attribute table for streets

6- Blocks

Attributes of Blocks

OBJECTID	SHAPE *	BlockNumb	SHAPE_Leng	SHAPE_Are	AREA__NAM
7	Polygon	81	3733.605855	815922.449	SECTOR_6
8	Polygon	84	2276.372629	193265.584	SECTOR_1
9	Polygon	79	2285.291141	332904.932	SECTOR_2
23	Polygon	<Null>	3187.343241	639550.562	SECTOR_3
24	Polygon	<Null>	1846.253168	159751.413	SECTOR-4
25	Polygon	<Null>	2400.599635	223046.751	SECTOR_5

Record: 1 Show: All Selected Records (0 out of 6 Selected)

Figure 8: Attribute table for blocks

7- Buildings

Attributes of Parcels

OBJECTID	SHAPE *	ROW_I	BLOCK_NO	HOUSE_	ouner_na	SHAPE_Leng	SHAPE_Area
5019	Polygon	37937	79	27	<Null>	73.964543	336.710196
5023	Polygon	39049	79	138	<Null>	73.060636	331.303955
5025	Polygon	39052	79	109	<Null>	67.660487	283.406376
5027	Polygon	39064	79	142	<Null>	72.452731	320.833832
5028	Polygon	39070	79	56	<Null>	71.081366	310.638977
5029	Polygon	39071	79	150	<Null>	65.833966	265.533184
5030	Polygon	39871	84	62	<Null>	70.113421	297.358784
5031	Polygon	39873	79	172	<Null>	68.052085	282.766114
5033	Polygon	39855	79	124	<Null>	69.653369	300.994384
5034	Polygon	39858	79	210	<Null>	74.970497	348.626437
5041	Polygon	39875	84	47	<Null>	76.903193	347.762628
5186	Polygon	38109	79	35	<Null>	64.815004	259.159295
5187	Polygon	38113	79	23	<Null>	73.072088	321.967015
5197	Polygon	38135	79	22	<Null>	75.023806	342.205062
5207	Polygon	38542	79	100	<Null>	66.763693	274.203606
5208	Polygon	40077	84	106	<Null>	70.843875	303.94866
5209	Polygon	40083	84	81	<Null>	67.223865	276.753017
5210	Polygon	40084	79	178	<Null>	69.272165	291.795693
5211	Polygon	40095	79	217	<Null>	74.257942	342.59512
5215	Polygon	40109	84	105	<Null>	73.847887	333.513941
5216	Polygon	41541	81	7	<Null>	99.363729	570.377929
5217	Polygon	41542	84	163	<Null>	73.969977	331.124616
5218	Polygon	41543	81	173	<Null>	81.597608	414.489807
5219	Polygon	41545	79	317	<Null>	69.314551	294.561191

Figure 9: Attribute table for buildings/parcels

8. Scheme of the system

The system consists of *towers* which send signals to the *switches* by *cable*, which in turn send a signal to the *columns* by cables and is linked to *home phone lines* by *columns* through copper wires. A schematic diagram of the system is shown in Figure 10.

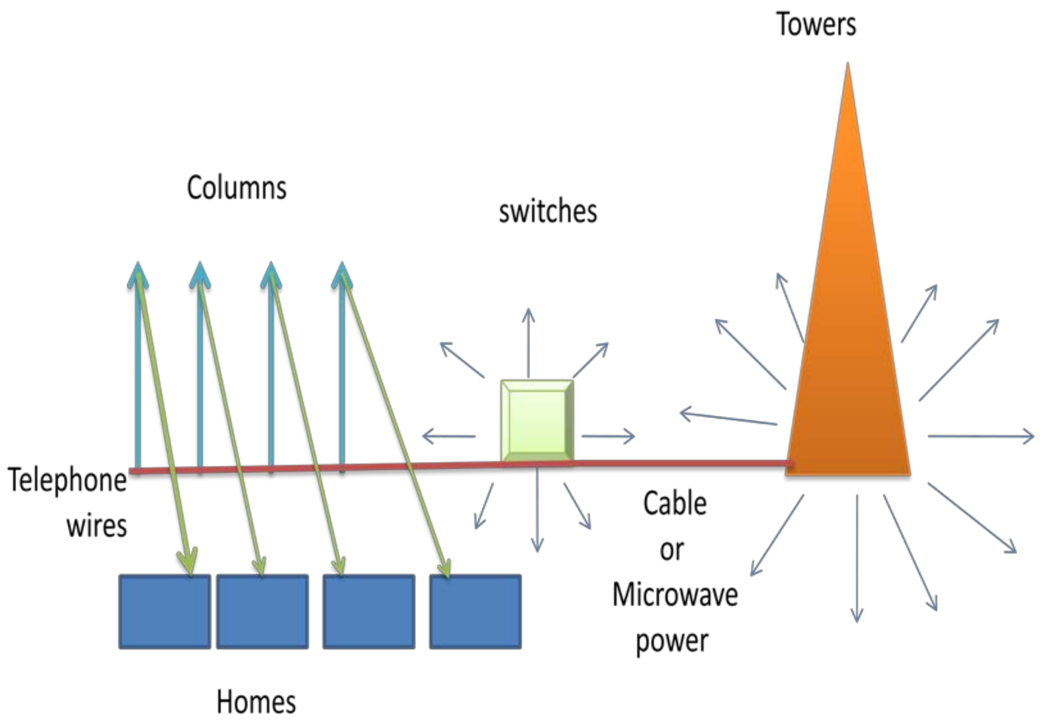

Figure 10 : Schematic Diagram of the Communication System

Satellite image as background

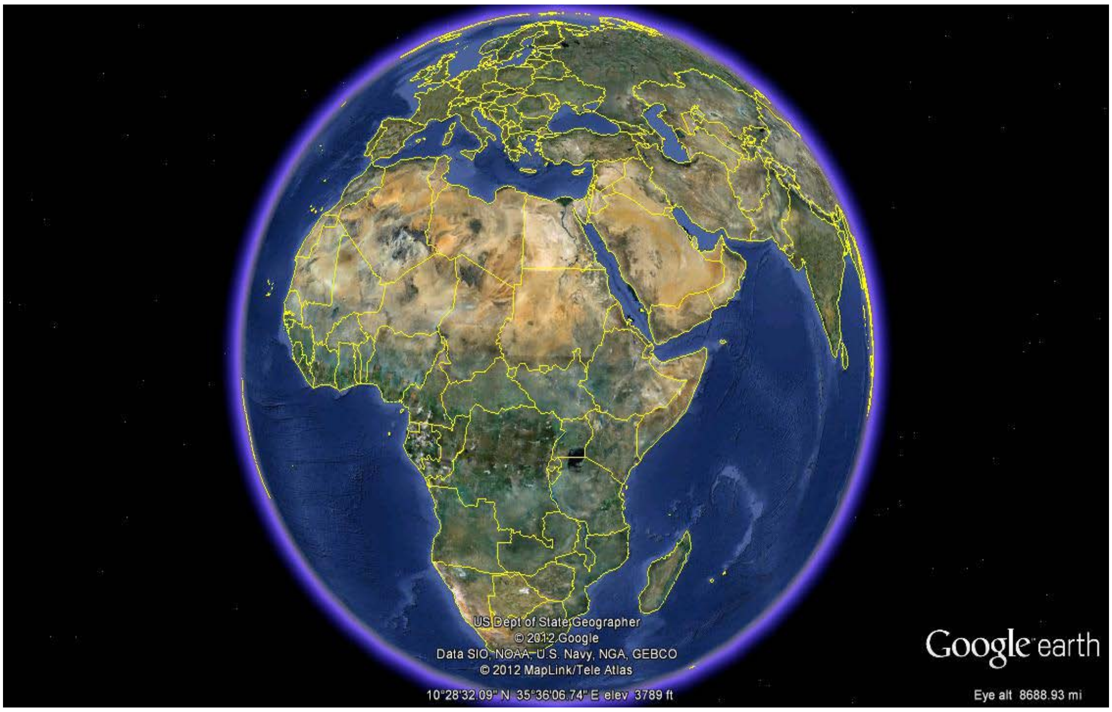

Figure 11 : Atlas showing the African Continent

Figure 12 : Map showing the Sudan Country

Figure 13 : Map showing the capital city of Sudan (Khartoum)

Figure **14** : Closer view of percel's arrangement of the study area

9. Schemes for some queries

Figure 11 is the plan that shows the buffer working and a query to know the development and distribution of the Towers, 500 meters from each other.

Figure 15 : Distribution of towers

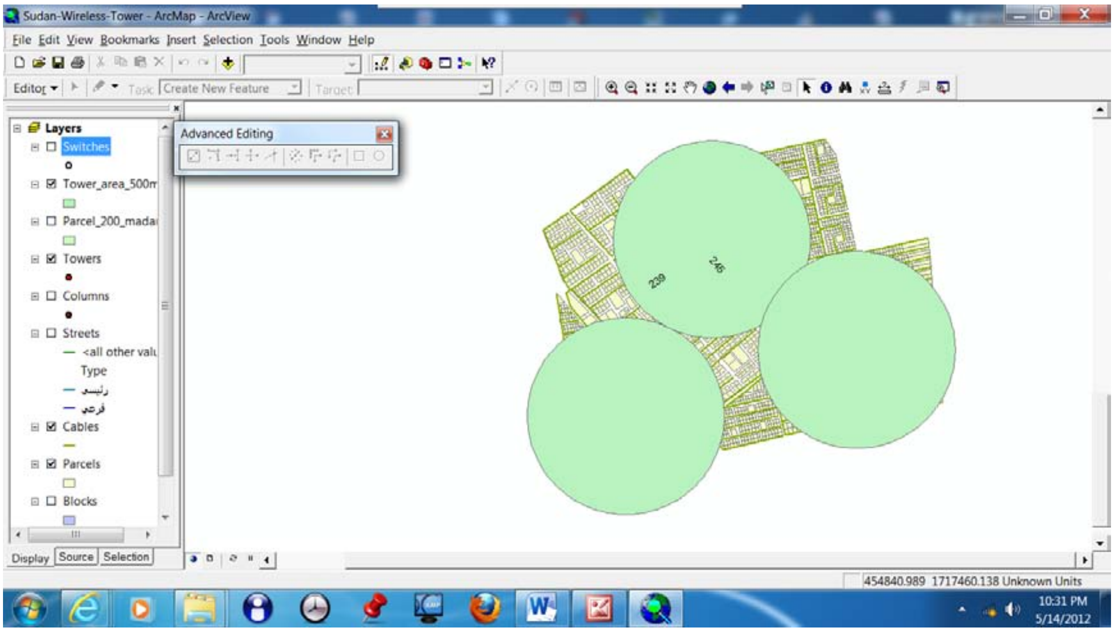

Figure 16 : Distribution of towers' coverage area

Figure 17 Work plan showing the distribution of the switches.

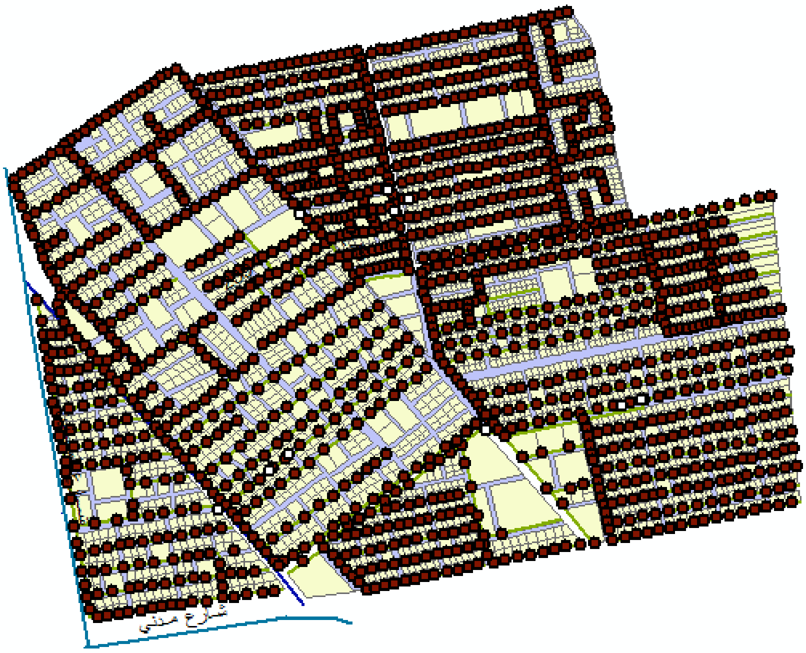

Figure :18 Distribution of Columns

Results

At the end of this study and after the analysis of the result, the following points are arrived at.

1 - Locating towers in the area concerned was confirmed possible

2 – Knowing the distance between the towers

3 - Used to determine the scope of Buffering was the signal for the towers was also define the scope of the switches and houses needed to take from that signal .

4 - The implementation of a set of queries such as selection of sites of towers

5 - A total of 3 towers, 10 switches, and 152 cables of different lengths should be provided in the case study considered in this project.

6 - The project has resulted in reduction of labor and overtime costs that would have been needed to carry out the actual work on site.

Conclusion: -

Upon establishment of the proposed system by geographic information systems and identification of all its components, a thorough analysis and processing such as building the following set of queries was achieved; distribution of, and the areas covered by the towers and switches as well as the distribution of cables/wires and poles. This study highlights the importance of using GIS in telecommunication industry. It can be concluded that GIS may provide best location selection not for telecommunication services only, but also for other services needed in residential areas.

Suggestion for Future Work

- Study to help in Identifying which customers would be out of signal if a switch is opened.
- GIS may be used to provide best location for selection of not only telecommunication services, but also for other utilities needed in residential areas of Khartoum city.

Reference:

1 - Al-Ramadan B, (2005). Introduction to GIS technology and its applications. Map Middle East. Vol.1.

2- Richard Sliuzas***;*** 2002; Opportunities for enhancing communication in settlement upgrading with geographic information technology-based support tools; Habitat International 27 (2003) 613–628

3- Ayman M. Nour ; 2011;The Potential of GIS Tools in Strategic Urban Planning Process; as an Approach for Sustainable Development in Egypt ; Journal of Sustainable Development