GIS based Electricity Distribution System Management

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Abstract

Integration of DGPS (Differential Global Positioning system) and GIS (Geographical Information System) become most advanced tool in the large-scale mapping and storing electrical distribution network in the GIS database for regulate and improve the electricity distribution. This project work aims to make an attempt to create large scale map and electricity distribution network for Al-Khoudh, Phase-7, Muscat, Oman using DGPS and GIS. This comprises GIS large scale mapping included a different range of steps like plotting the High tension (HT) and Low tension (LT) on the map. However, the attribute data like electrical assets are plotted on the map. In addition, GIS map produced with poles, feeder pillar boxes and corresponding data base was developed with manufacturers, nominal voltage, normal position, operating voltage, and phase designation. Finally query language in GIS platform used for to analyze the electrical distribution pattern in the study area.

Keywords: DGPS, Electrical distribution network, GIS data base, Spatial query

1. Introduction

The power industry is the one of the highly invested government sectors provides the power distribution to end users. However, this sector faced with many problems particularly delivering spatial information in analogue platform. Praveen Kumar Rai (2016)[1] analyzed changes in the electrical asset features using DGPS and GIS in Bhadohi region, India. Govindaraj and Nailwal (2013)[2] used GIS and GPS for creating consumer index, and energy audit data base for electricity distribution system management. Kanmani and Sureshbabu (2014)[3] studied electrical energy transmission from sub stations to analyze customer demand using GIS. Madhan Kumar and Loganathan (2015)[4] GIS can be efficiently deployed in managing energy audit, load forecasting and asset management. Sachin Bajaj and Amol Adhave (2016)[5] has focused on GIS

based electricity distribution network particularly underground electricity distribution network for Aurangabad city, India. Hence the following study is intended to visualize the role of DGPS and GIS in electrical distribution system management. The power industry anticipating the keep track of all information such as electric substation, circuits, high tension and low-tension power lines, transformers, feeder pillar boxes and corresponding database such as manufacturers, nominal voltage, normal position, operating voltage and phase designation under one platform likely to be database to large scale maps for efficient management of electrical distribution and customer fulfilment.

2. Study Area

The Al- Khoudh, Phase-7, urban fringe of Muscat, Oman is selected for present study. The study area is outskirt of Muscat and numerous construction and developmental activities undergoing in the study area. This study area contains 184 parcels. It is located between 620350.251, 2611499.260 and 621019.151,2611400.009 The study area is surrounded by well-developed urban fringes such as Al-Seeb and Mawaleh. The area is well connected with Muscat by express highway **(Fig 1).**

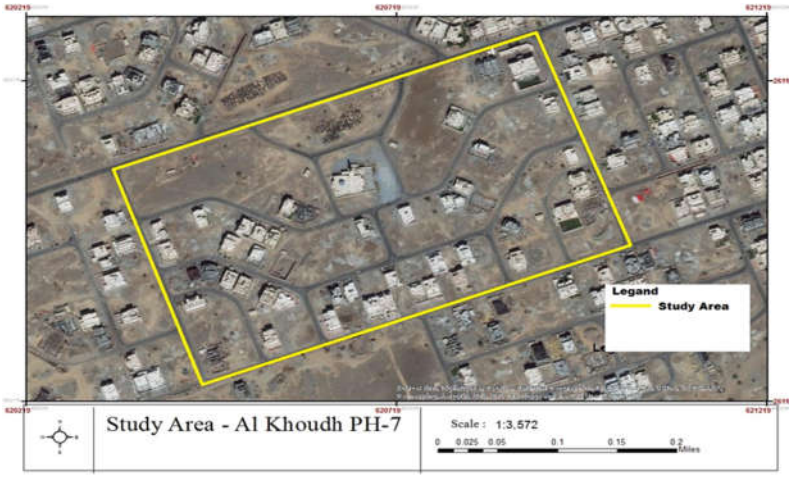
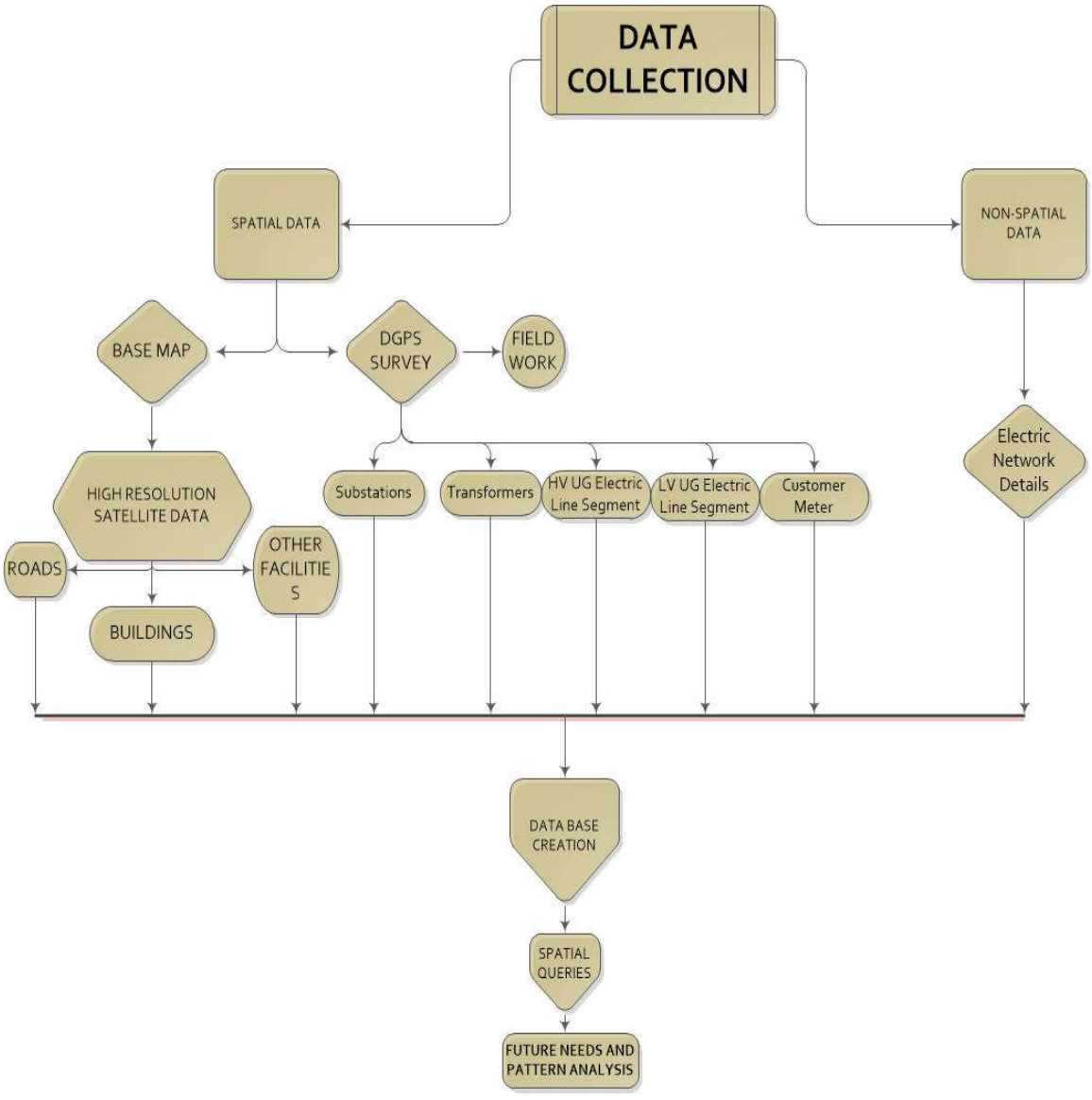


Fig. 1 Study area map

3. Materials and methods

The open-source satellite image used to extract the building and road network to prepare large scale map for proposed study area **(Fig 2).** DGPS survey conducted for finding precise location of substations and transformers, High voltage and low voltage power lines as well as customer meter. In addition, the attribute information such as location ID, manufacturer, manufacturing year, nominal voltage, operating voltage,

phase designation and serial number were collected from the electrical distribution authority of Muscat. Subsequently, data base was created in Arc GIS 10.1. Finally, spatial queries used for to analyze the future needs and electrical distribution pattern of the study area.



Flow chart. 1 Flow chart shows the methodology of present study

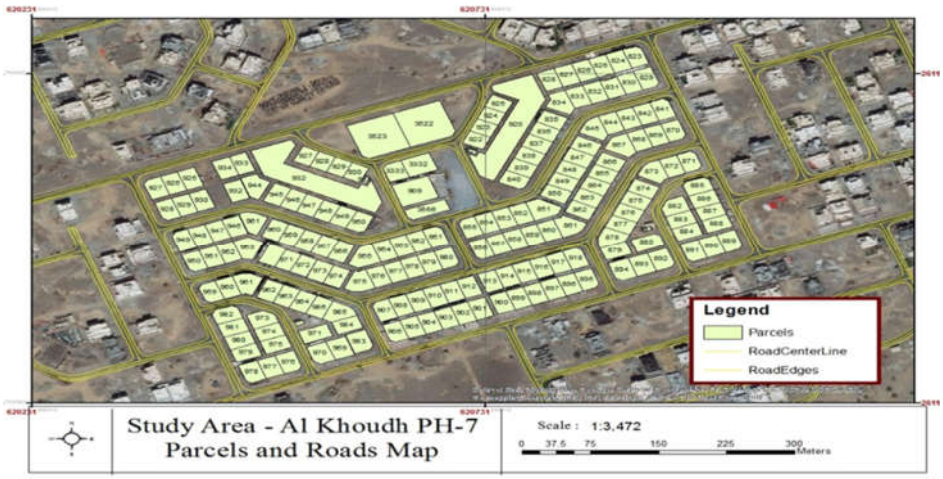


Fig. 2 Parcels and roads in the study area

4. Results and Discussion

The main advantage of electrical asset database is to maintain the consumer indexing record and consumer indexing is to enhance the efficiency of distribution system in terms of quality and technical and distribution loss, and to encompass the functions of different disciplines into the mainstream of operational hierarchy through wide networking. In this study a database for each asset indication the exact geographical location is created during a survey of electrical Low Voltage and High voltage underground segments, the line length, Substation and consumption details are documented. From **Fig 3** shows that study is consist of only underground electric transmission and it is categorized into two types based on voltage supply like High voltage and low voltage line segment, as well location of transformers and substation geographically referenced and located in the map. There are 42 buildings are constructed in the study area, remains are plots. These buildings are categories into residential, commercial, and religious buildings.

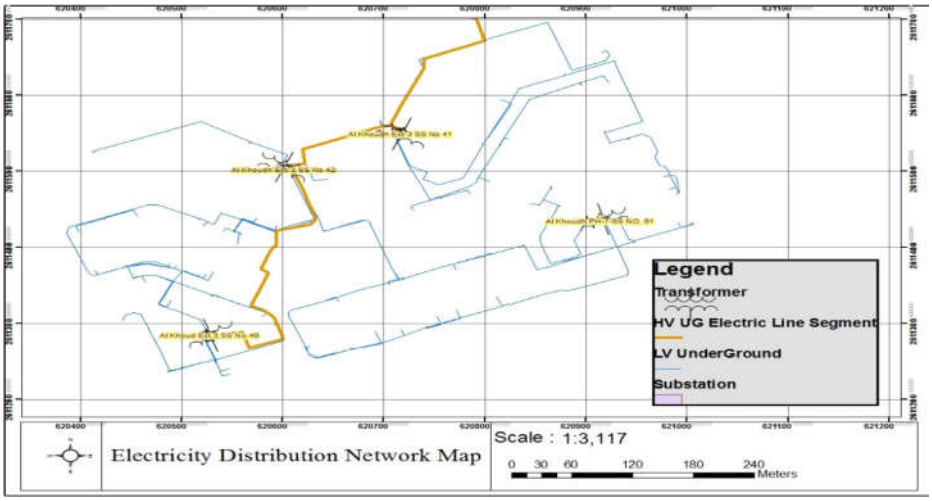


Figure 3 shows the different electric line segment in the study area

From **Fig 4**, the result displayed was based on the average consumption rate of the households within the study area. Based on the level of consumption, it clearly shows that most of the households within the area of interest were classed as residential houses. The results displayed show the variation in the energy consumption rate within the area. As represented in the map displayed, nearly 17 building consumption rate reaches 3050-5000 KWH and 23 buildings consumption rate reaches 1145-3050. This is because of the various types of electrical appliances used by different households within the area. However, the Buildings show in red color shows consumption rate of 5000- 27500 KWH because these buildings are identified that Masque and Tea shop. So High consumption rate is marked in that buildings. From **Table 1** it was perceived that HVUG Electrical line length is 806.548 m and LVUG line is 6095.411 because the study area mostly occupied by residential buildings. There are 4 substations and four transformers operating in the study area. In those 3 transformers supplies nearly 1000 KVA electrical power, however one transformer Al Khoudh PH-7 SS NO. 91 supplies 2000 KVA because it feeds or supplies electrical energy for many customers as shown in the map (**Fig 5)**

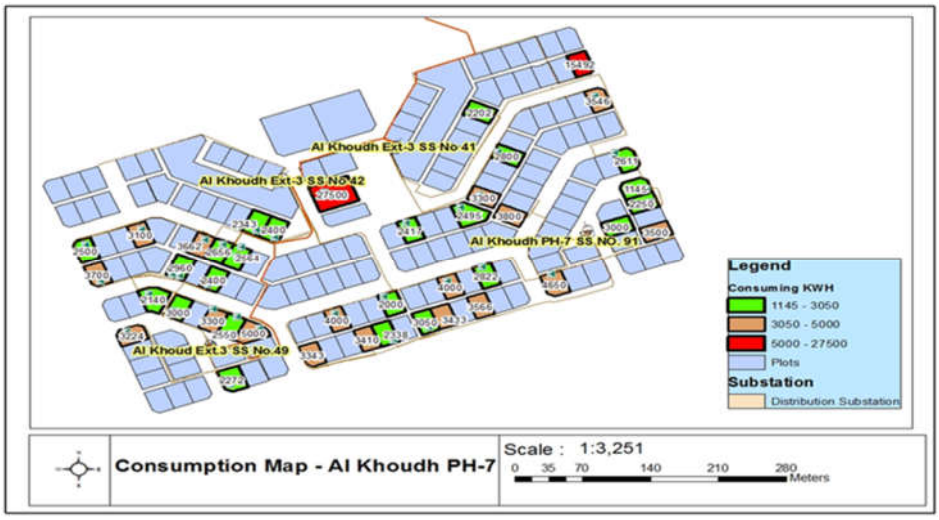


Figure 4 shows the different categories of electrical consumption in the study area

Features	length (M)			
HVUG Electric Line Segment	806.548			
LVUG Electric Line Segment	6095.411			
	Name	**No. of Transformer**	**Rated KVA**	
Substations	Al Khoudh Ext-3 SS No 42	1	1000	
	Al Khoudh Ext-3 SS No 41	1	1000	
	Al Khoudh PH-7 SS NO. 91	1	2000	Feeds many customer
	Al Khoud Ext.3 SS No.49	1	1000	

Table 1 shows the different attributes of electrical distribution system.

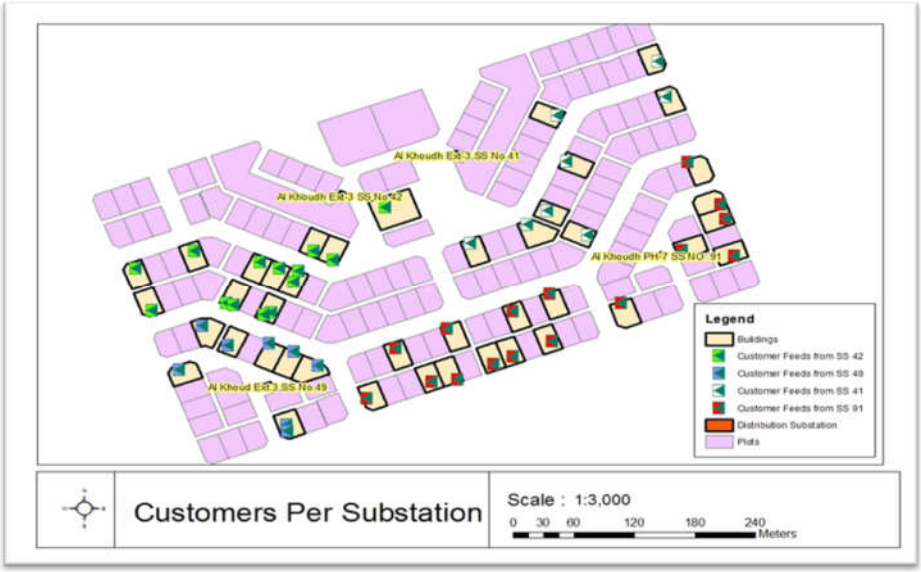


Figure 5 Customers per substation

Spatial query analysis in geographical information system (GIS) used for to retrieve the data from the attribute table and this system is flexible to update the data when it's required. **Fig 6** illustrates the customer connection form the main distribution system. 11 KV underground cables and 240 single phase LV underground cables were mapped using ground penetrating radar.

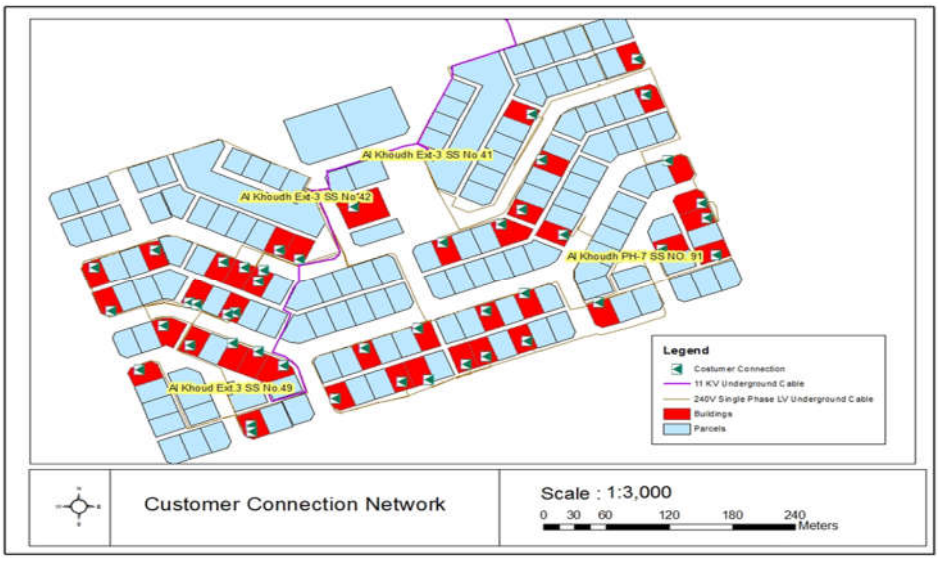


Figure 6 Shows the customer connection network

The integrated GIS based spatial and attribute data base has deployed for i. Monitoring the status of the Transformer and substation. ii. Retrieval of Geographical Information of the facilities. The spatial information would include coordinates (X and Y), and symbol representation, capacity, and location. iii. Arranging of facility replacement If any fault in underground electricity line. iv. Update the information system in the case whereby new facilities are to be installed. When new buildings are connected to the existing facilities, the information system can be updated.

5 Conclusion

GIS and DGPS plays very important role in the electrical system, which is very helpful for energy audit, electric load management, electrical network planning and analysis; determining the optimum and shortest path for power transmission lines; forecasting and predicting the amount of power needed in the coming future in the area which may help to arranging projects, identifying substation property requirements, control the demand growth of each electrical assets. This study is also very helpful to improve the electrical distribution system, identify the new substations and transformers for upcoming buildings in the study area. In this study, it is very well found that the continuous growing of new buildings leads an overload on the electrical system in Al-Khoudh, Phase-7. The main advantage of this project is to provide operational efficiencies and customer benefits that exceed traditional GIS and mapping boundaries. This study allows officials of electrical office to work on the latest technologies by relating the output to the location of load and feeder by providing better long term DTRs and distribution planning network.

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