Integration of Telecom Databases with Geodatabase Model for The Effective Telecom Network Management Through Geo-Informatics

Abid Hussain[1,*], Jamil Hasan Kazmi[1] and Mudassar Hassan Arsalan[2]

[1]*Department of Geography, University of Karachi, Karachi, Pakistan*

[2]*Institute of Space and Planetary Astrophysics, University of Karachi, Karachi-75270, Pakistan*

Abstract: A significant technological advancement and enhanced telecom networks, immensely evolving telecom industry around the globe. Very tough competition, financial and inventory controls have necessitated telecom companies to maximum utilization of installed telecom network and provide high quality of uninterrupted service to the customers. In this paper we describe the integrated geodatabase model offering solution to the problem of telecom operations, network infrastructure management, optimized network planning, and business operation in telecom sector. It is based on integration of telecom operations, business, parcel base data and base map of *Misri Shah* telephone exchange service area. Telecom data usually maintained by different department in scattered form consequently many operational and business related activities especially network planning and management requires optimized platform to handle all telecom issues systematically.

GIS is widely recommended to meet the requirements of telecom industry. A well designed rigorous GIS data models not only supports standard GIS functions but also supports to model telecom network up to port level competently. These models instantiated on the map provide a geographical representation of the physical telecom network and those supports several operational and business functions right from customer contact, service order, network planning, engineering and many other functional areas.

This paper will examine various techniques and methodologies for model telecommunication network and integration of databases for the effective management of telecom network infrastructure with spatial context of operational and business perspectives.

Keywords: Business & Customer Car, Customer Management System, Data Integration, Geodatabase, GIS, and Telecommunication Network.

1. INTODUCTION

Telecommunications industry has many features, ranging from Digital Subscriber Line to 3G broadband wireless technology on existing copper wire networks. The key parameters for develop, manage, and model telecom networks are quite complex and need to handle with sophisticated techniques. Telecom data of PTCL consists of CMS, Network and B&CC databases. These databases are key features of telecom networks while their geographic presentation is the pot of gold for PTCL to manage telecom network effectively. Telecom data is usually dispersed in different department based on their functions. CMS database is handled by operations, Network database managed by network planning and development department while B&CC database is controlled by finance department. In such circumstances telecom network management is quite complex process but integrated database model can easily serve this at single platform. Samorodov and Makarenko [1] stated that consolidation and integration of the data allows more efficient use of public resources reduce cost and increase the influence of politics. It is possible that modeling of telecom network by integrating CMS data, Network data, B&CC data and geospatial databases providing real picture of consumer segment, business conditions, network status and geographic distribution of telecom network at exchange level in geo-informatics environment. Yadav [2] explains that GIS technology in utility sector is emerging as an efficient planning and decision-making tool, and the ability of GIS is integrate common database operations make it different from other traditional information systems.

Today GIS with its fully equipped tools and Telecom Application enables telecom operators to model their infrastructure up to port level. The planners can create hypothetical designs to install the necessary telecom equipment's at the right places [3]. It also helps in determining customer locations, fault points, demand locations, business scenarios and spatial distribution of network assets. To meet these challenges, trends should be switch from standalone desktop applications to more integrated GIS with other databases of enterprise [4]. Keep in mind such scenarios research focusses on integration of telecom-GIS databases to handle it more effectively.

The purpose of this study is to offer an optimal integrated database model of telecommunication

*Address correspondence to this author at the Department of Geography, University of Karachi, Karachi, Pakistan; Tel: +92-345-2764477;
E-mail: abidbashi@gmail.com

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network through Geo-Informatics technologies which is still not applied properly in telecom industry of Pakistan. This study may be one of the initial study to provide a guide line for analyzing customers profiling, network management and portray status of OSP of PTCL at exchange level. Considering the facts and the study requirements it was worked out that the prime objectives of this paper would be:

1. To design an integrated geodatabase model for the effective management of telecom network in Pakistan

2. To develop a GIS framework that may handle foundation GIS layers, telecom network and consumer segment effectively.

a. Study Area

Study area is the service area of *Misri Shah* Telephone Exchange Karachi, installed by Pakistan Telecommunication Company Ltd (PTCL). It lies at DHA Phase-VI (administrative unit within Defense Housing Authority) which has a capacity of 30,000 connections and currently catering 26680 subscribers. Availability of parcel base data, customer details, B&CC data and network infrastructure details, it was mandatory to select the appropriate area where all relevant data can collect, integrate and model them to carry out optimal telecom network solution.

Figure **1** shows the study area of *Misri Shah* Telephone Exchange DHA-VI Karachi.

2. MATERIAL AND METHODS

Methodology mainly emphasizes integrate dispersed telecom databases and mapping of the local data models into a common data model. In the first step towards telecom-GIS integrated geodatabase model is to acquire data, create the appropriate database model that can capture and store the relevant pieces of information, consolidate relevant data using relate and join functions, and expand flexibly.

Figure **2** illustrates methodological process for integrated telecom-GIS database Model. This data model presents three main functionalities: i) to acquire, capture, store, present the data, and their relationships, ii) to define the necessary functionality to locate the geographic objects and their mappings and; iii) finally access available telecom integrated information based on standard database model for further required processes.

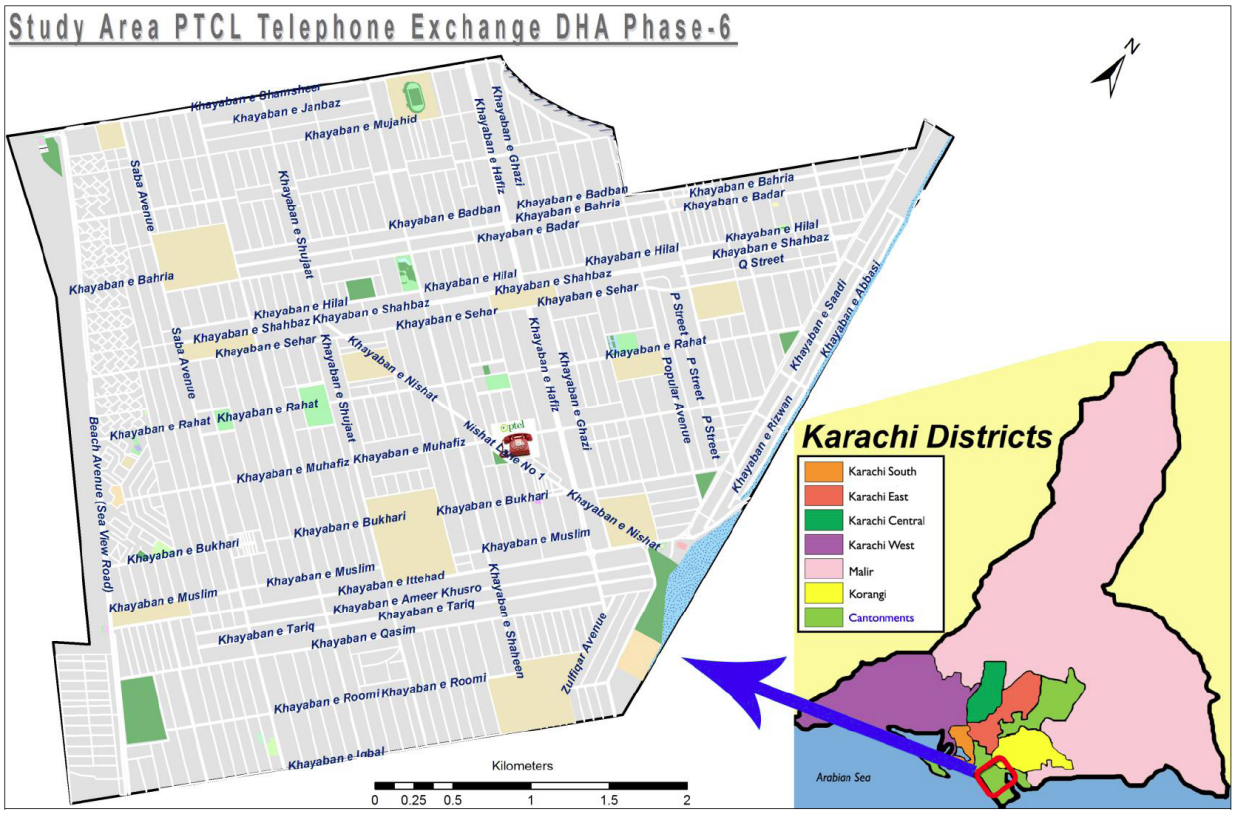

Figure 1: Study Area of *Misri Shah* Telephone Exchange DHA-VI Karachi.

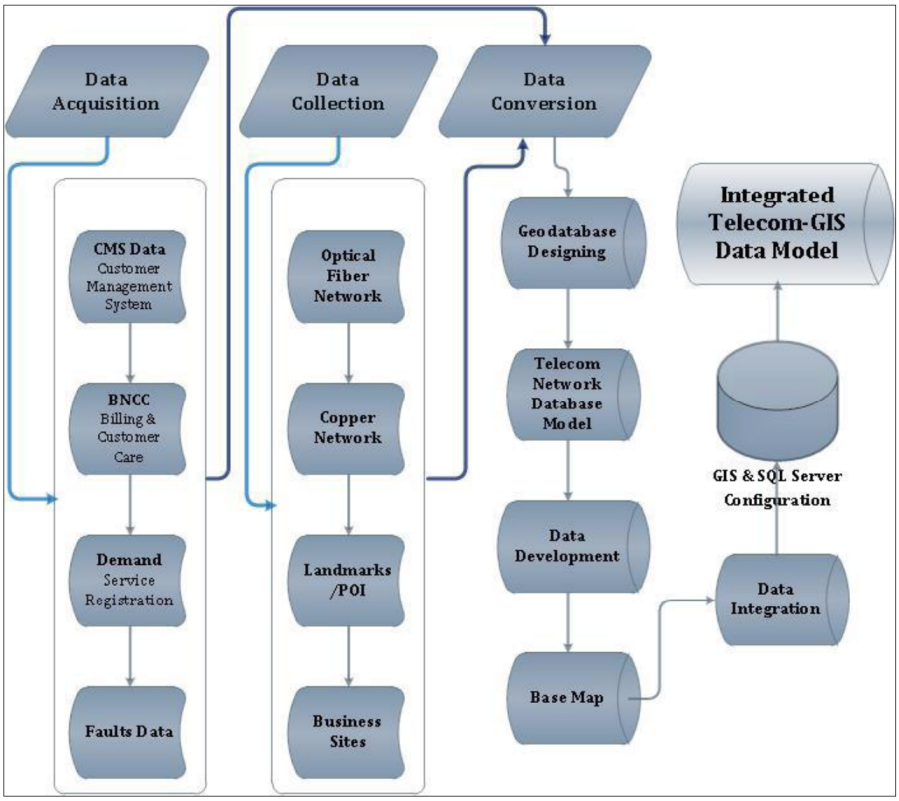

Figure 2: Flow chart determining methodological process for integrated telecom-GIS database Model.

a. Integrated Telecom GID Database Model output Assessment

At the outset of databases integration GIS techniques applied as part of this research for serving planning, design, operation and business needs of the telecom sector. Interfacing of integrated telecom GIS databases enabled to optimal utilization of telecom inventory and effectively compete in telecom industry with evolving techniques. Salient features expected to be met by the integrated database model are:

- Centralized all aspect of telecom network, finance and operations databases at single platform
- Portray geographic distribution of telecom network and subscribers precisely
- Localization of Cable faults
- Identify service demand
- Outside plant management, facility layouts and spatial representation of network connectivity up to port level
- Placement of cable routes, cable distribution, terminals, poles, and distribution points in the OSP
- Offer accessibility of all telecom databases to business and operation support (BSS/OSS) systems

The study strives to reveal integrated geodatabase model for telecom network consists of CMS, B&CC and network infrastructure. The input data defined in points, lines, and polygons which represent, landmarks, customer's locations, demand locations, road network, existing telecom infrastructure and parcel base addresses respectively. The input data processed in GIS through a series of analysis operations to produce maps representing the extent of OSP, customer profiling, and identify the lucrative areas of telecom service area. Based on this a precise understanding and extent of a problem could be approached to its resolution properly.

b. Geodatabase Design and GIS Development

i. Data Sources

Acquisition and collection of relevant data is important to conduct the study. Databases consist of spatial and non-spatial information at precise level. Data have acquired from several sources, and often at little or no cost. Some sources of information includes PTCL Network planning and development region

Karachi, PTCL Operation department, Billing data from finance department PTCL, Parcel base maps from DHA Karachi and high-resolution satellite image from Google. Essential surveys were also conducted to collect required information including landmarks, terminal locations and DP's, duct routes consisting cable/optical fiber routes, and for verification of network infrastructure throughout the study area. Subjected all datasets are the main sources of information to fulfill this study. Most of telecom data was not readily available in digital form so it was collected then converted into digital form and integrated with relevant databases.

ii. Geodatabase Modeling

Geodatabase storing geographic data and representing the real-world features that can be placed in a GIS to produce maps, perform interactive queries, display and execute analyses in defined geometric space. GIS provides the effective sharing of geographic data that allows two or more heterogeneous GIS to interoperate with one another [5]. In order to model telecommunication data it was mandatory to develop geodatabase model which focus mainly on data contents, data validation and modification rules and relationships among objects.

Figure **3** shows Telecom-GIS integrated database model. The challenges in the design of an integrated database model are the discrepancies among the databases and nonstandard databases. The collation of diversified spatial and non-spatial data requires standardization and a detailed database design [6]. Collected data transformed and analyzed in a usable format using various GIS software's to map different variables like Birkin, *et al*. [7] Highlighted that geo-visualization software's helps analyst to define variables to be mapped.

All database designing and modeling tasks carried out within the ArcCatalog application of ArcGIS where "Feature Datasets" created to contain all feature classes within file Geodatabase. In order to measure distances associated telecom features, data stored in a projected coordinate system which automatically maintains "Shape Length". In second step rules defined to maintain data standards and their relationship and finally database enabled to develop, analyze, manage and correspond within file geodatabase model. Compiled databases investigated, standardized and then linked with one another using join and relate tools of ArcGIS. Pispidikis and Dimopoulou [8] also suggest that the tendency toward the standardization of data, metadata and services, with the aim of creating common "Language" for the reading and the dissemination of information available, is a basic research area in the global scientific community.

Network data model have especially designed to model frequently used items like poles, DP's, cables, structures etc. It is very much essential for a Telco's to locate its inventories, network elements and its subscriber locations spatially [3]. Analysis operations performed in GIS on input processed data to produce

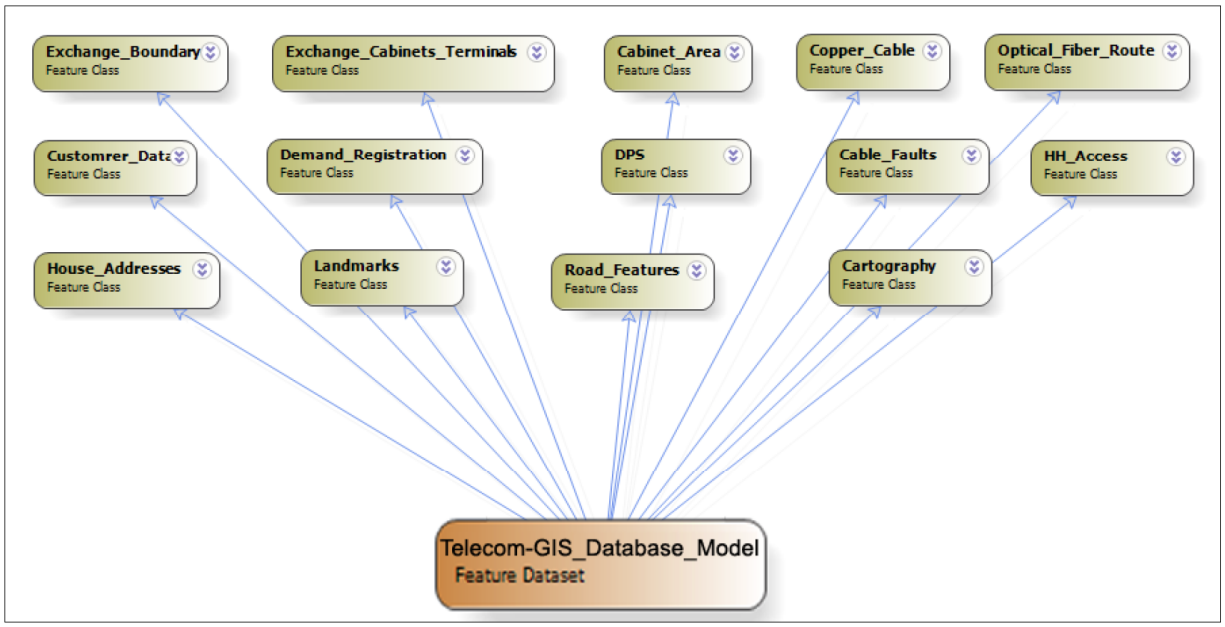

Figure 3: Telecom-GIS integrated database model.

new maps representing the extent of telecom network, customer profiling, demand in the area, status of network infrastructure, and identify the lucrative areas of telecom service area which enabled to precisely understand network issues and approach to its resolution properly.

b. Base Mapping

Misri Shah Telephone exchange extends at vast geographical area. In order to study spatial contexts of study area detailed base map has developed at parcel level. Road network in study area developed precisely to mark and identify house addresses accurately. Around 16000 housing units marked on the map to cover customer segment intensely. Figure **4** shows high-resolution base map of study area which portrays comprehensive view of study area for further study where collected information regarding telecom infrastructure can be create, analyze, manage and visualized using different techniques.

c. Telecom Network Preparation

Telecommunication network is the collection of wired infrastructure. It was mandatory to draw coverage area, cable routes, terminal location, distribution points, and indicate cable fault locations. Telecom network of PTCL can be categorized into two major categories, i) Optical Fiber network and ii) copper network.

Fiber cable from Central office caters 22 Optical Network Units (ONU) directly and 28 copper cabinets as primary cable. Fiber routes, terminal location and duct locations drawn on map and values assigned to each item. Around 100 Optical Fiber DP's collected and marked and 22 terminals also collected and marked in GIS to model fiber network properly.

Figure **5** displays spatial distribution of primary cooper network and optical fiber network. Copper network is backbone for PTCL and catering majority of subscribers. Copper network maps collected from PTCL drawn in ArcGIS to model network up to port level. Cable capacity and distribution have identified and digitized then integrated it with CMS database to combine network information in single database. Terminals and DP's location have collected through ground surveys while cable routes drawn from maps also verified in ground surveys. 75 terminals and 4060

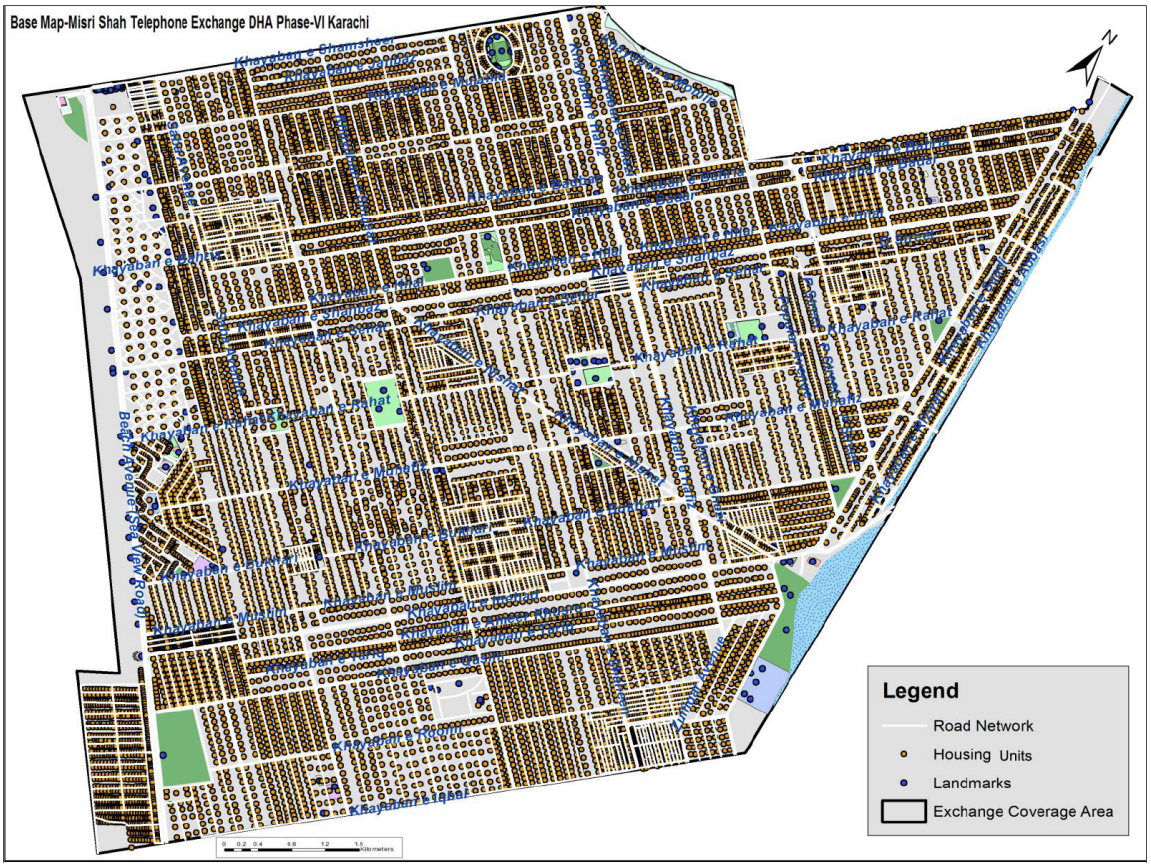

Figure 4: Base map of the study area.

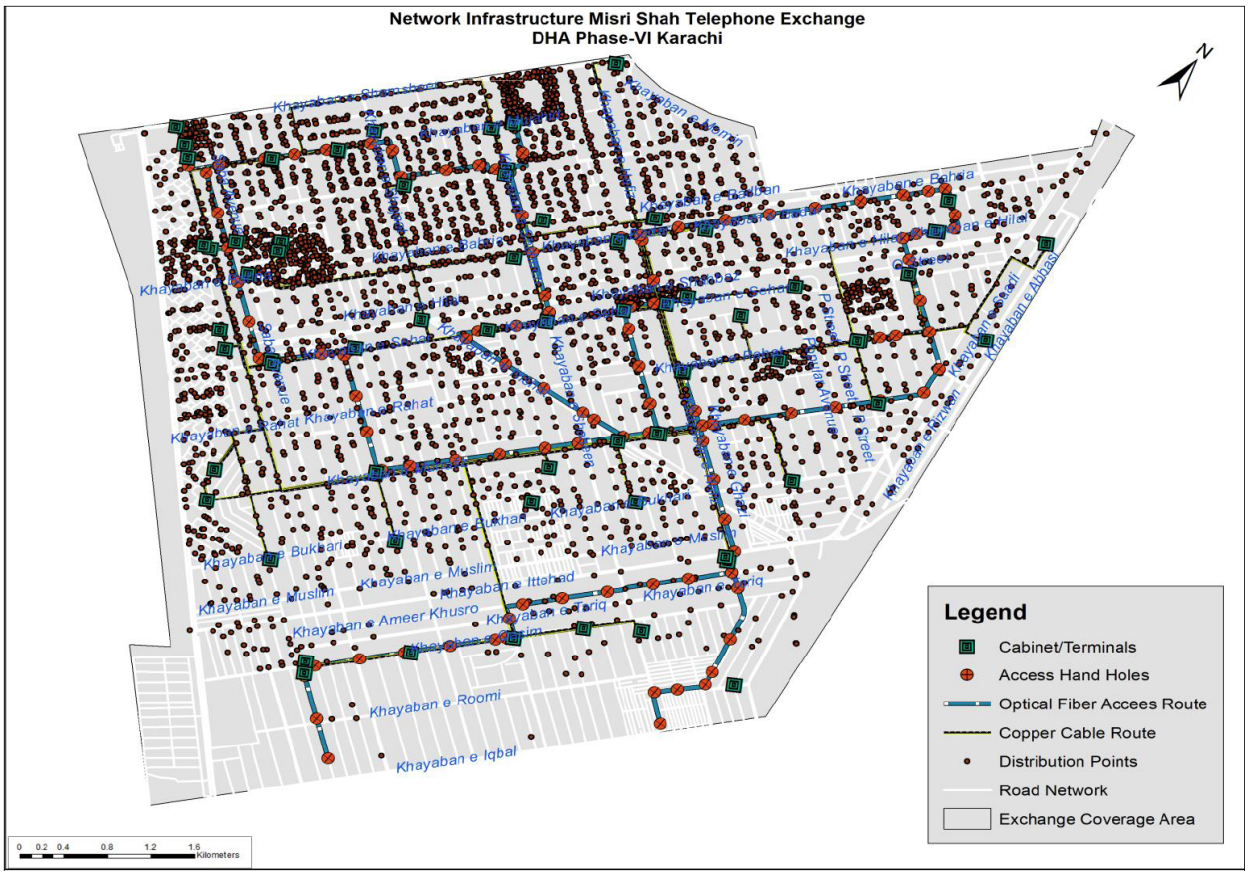

Figure 5: Spatial distribution of primary cooper network and optical fiber network.

DP's collected from ground survey and marked as point on maps carefully. It was necessary to find interrelated DP's and terminals hence codes assigned to DP's. CMS database then integrate to DP's data that provides complete details of customer as well as status of DP's. This data also provides nearest suitable point for new connections and revenue condition of each cabinet even up to DP level.

d. Integration of Databases

PTCL Telecom network has various problems including efficient network management, uneven network distribution and planning strategies respectively. Various factors are responsible for that including traditional analytical strategies, mismanagement, lack of geo-spatial knowledge, and legacy decision-making techniques. In such circumstances PTCL faces a host of problem. Parent and Spaccapietra [9] suggested that Information is usually stored in various databases, and disadvantages of using multiple independent databases within the same organization resulting incompleteness, inaccuracy and inconsistencies in data acquisition and duplication of efforts for data maintenance. In such cases integrated Telecom-GIS database model would help to talk each network segment in a meaningful way. Sampath [10] suggests that integration of facilities and customer data provides an excellent source of intelligence.

This model approached in three ways. At the lowest level, the goal is to enable one database to link from another DBMS. At an intermediate level, the goal is to support user-driven access of data from multiple systems where simultaneously user can manipulate data from several sources. Finally designed geodatabase model linked in ArcGIS and configure with SQL server where user can remotely access, update and perform many other functionalities into a logically unique database system.

This integrated database is fully capable of consolidated representation of telecom data, consumer segment, multiuser access, and enabled to update with a minimal efforts where all relevant telecom and geographic data could manipulate properly with range of feature classes in standard relational database format. Integrated database model is now equipped to offer fruitful new services, presentation of total number

of subscribers in its network, number of available terminals, identify the subscribers as per their reach from the service providing terminals, the nearest DP in neighborhoods from which a new connection can be provided.

Study comprises on Outside plant and consumer segment where integrated Telecom-GIS database model is an ideal foundation for Telco's to portray geographical representation of network, identify business lucrative areas, customer profiling, identify fault points, locate service demand, and potential of existing telecom network at a single platform.

3. RESULTS AND DISCUSSIONS

Network infrastructure of *Misri Shah* Telephone Exchange has a mixture of copper and Optical fiber networks. Outside plant comprises of one central office, 75 terminals, 4146 distribution Points, 26680 access lines, 2 Optical Fiber rings, 109 Hand Holes, and intense copper network respectively. In order to model OSP network with integrated telecom-GIS database model fundamental telecom aspects have studied and approached to optimal geodatabase model in Study area. Integration of all relevant databases not only enabled to analyze every segment of network, operational and business activities sophisticatedly but also provide multi users access to centralized database at single platform.

Results show that *Misri Shah* Telephone Exchange caters 26680 residential and commercial subscribers simultaneously through 53 Copper terminals and 22 ONU's. 175.9 km different capacity Copper cables feeds 53 cooper cabinets and 21.7 km optical fiber feeds 22 ONU's directly and feeds 28 copper cabinets as backbone primary cable. Copper network is although back bone of telecom industry of Pakistan but the main dilemmas of copper network is its primitive existence and poor planning.

Figure **6** represents geographical distribution of OSP, cable faults, service demand, customer concentration and customer profiling. One of the most important observations indicates that inadequate extent of fiber network and uneven distribution of copper network causing unsatisfactory provision of services. At

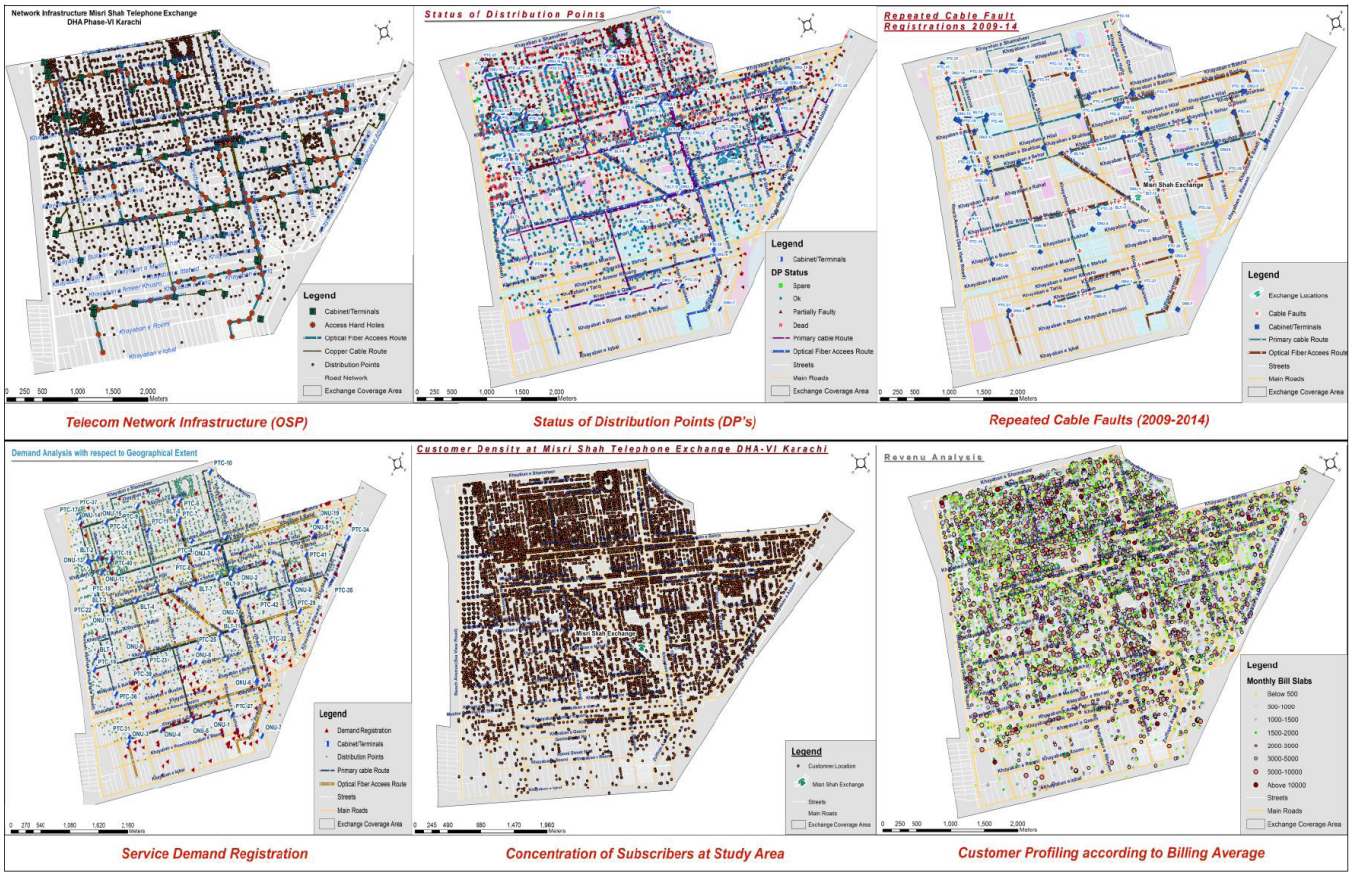

Figure 6: Displays Geographical distribution of OSP, cable faults, service demand, customer concentration and customer profiling in study area.

the same time fiber network serves smoothly and customer satisfaction level is also remarkable upon it.

Results show that concentration of network extends over area between *Khayaban-e-Shamsheer* in North to *Khayaban-e-Sehar* in south and *Commercial Avenue* in East to *Sea View* road in West and reasons are the primitive extent, high concentration of commercial activities and high-rise apartments at this specific area. It was observed that 54.5 percent network extends only at over 27 percent subjected area. Similarly 53 percent terminal, 63 percent DP's 45 percent Fiber network and 57 percent copper network coverage is at mentioned service coverage area due to its primitive extent and concentration of commercial activities.

Figures show that currently 50 percent (2025) DP's are fully functional while rests of DP's are partially faulty or damaged by rust. 497 DP's are dead that means 4970 connections escalated from network and important fact that 100 percent dead DP's belongs to copper network. On the other hand Optical Network DP's is 100 percent functional due to modernized network, proper placement and balanced planning. Geo-informatics techniques and proper spatial planning approach can overcome such network issues and capture market with appropriate network and operations management.

Faults in telecommunication network have bidirectional impact of maintenance costs and disgruntling of customer at the same time, so their prevention and quick elimination required to sustain in the market. Results shows about 2600 faults noticed in service area during 2009 to 2014 and ratio of faults are quite high around main roads spatially on copper network. Faults concentration is significantly high along *Khayaban-e-Hafiz* and *Khayaban-e-Muhafiz* where around 53 percent repeated faults noticed. Reason behind fault occurrence with high ratio is developmental activities along these roads. Another reason is the extent of service area at seaside where majority of outside plant get rusty quickly and moisture damaged them easily.

Consumer's behavior in the area shows that customer churn is negligible moreover; customer churn is particularly high in the communications industry, but figures in study area indicates that in 2009 numbers of subscribers were 25139 and this number increased to 26680 in 2014. 1140 connections demand have also registered at study area which means area has high potential of telecom market which is a positive sign for PTCL. Study area has high potential telecom business and currently generating PKR 40.7 million /month with above 26000 subscribers. Large number of high yield subscribers shows that there is high potential of telecom business at service area.

In this study various analytical techniques for integrated geodatabase model examined. Geo-informatics techniques not only permits to recognizing network condition and consumer segment but also identifies integrated complex conditions to sort out network analysis. Based on these analysis optimal network planning can be offer and that would be very productive to Telco's point of view.

Fruitful directions for future research on telecommunication network study, analysis, planning and expansion are vibrant. Integrated telecom services and applications are the demand of utilities and this study focused categorically explore ways to implementation of integrated GIS solutions to telecom industry. This integrated approach now and in the foreseeable future have advantages of lower operational costs, future proof network infrastructure, high potential of revenue opportunities and realistic picture for telecom services. Finally, it might be one of basic research on database integration and offer another path for further research focusing on implementation of integrated GIS in telecom industry.

4. CONCLUSION

Geo-informatics techniques are reliable for integration of Telecom datasets for network planning, to perform location-based queries, geographical representation of telecom network, find business areas, identify network gapes and telecom network management. Fruitful directions for future research on telecommunication network planning and expansion is vibrant. This study provides a conceptual framework to deal with telecom infrastructure through an integrated Telecom-GIS database model. To deal with market demand and trends in telecom network infrastructures, traditional planning approaches should switch with interrelated long-term strategic network planning, network management and Operation Support Processes.

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REFERENCES

[1] Samorodov I, Makarenko O. Using of GIS for the integration and visualization of local data for some Ukrainian problems. Digital Governance: From local data to European policies 2013; 47.

[2] Yadav SK. GIS in Power Sector Management. International Journal of Engineering 2013; 6: 759-66.

[3] Rajagopalan K, Thiruvengadachari S, Kishore P. An Enterprise GIS Solution for Network Support System-Network Expansion Plan 2014.

[4] Deshpande M, Jagadeesh KM. Telecom GIS: An Integrated Approach. Map India Conference 2003. Available from: https://www.yumpu.com/en/document/view/21474019/telecom-gis-an-integrated-approach

[5] Strauch J, Souza J, Mattoso M. A methodology for GIS database integration. In Proceedings of the IEEE Workshop on Knowledge and Data Engineering Exchange 1998; KDEX'98; pp. 151-59.

[6] Gosain AK, Rao S, Singh P, Arora A. Integration of Bio-Geo spatial database for selected watersheds in Himalayan region. Current Science Bangalore 2010; 98(2): 183-91.

[7] Birkin M, Clarke G, Clarke M, Culf R. Using spatial models to solve difficult retail location problems. In Stillwell, J., and Clarke, G. (Eds.) Applied GIS and spatial analysis. England: Willey 2004.

[8] Pispidikis I, Dimopoulou E. Web Development of Spatial Content Management System through the Use of Free and Open-Source Technologies. Case Study in Rural Areas. Journal of Geographic Information System 2015; 7(5): 527. https://doi.org/10.4236/jgis.2015.75042

[9] Parent C, Spaccapietra S. Database integration: the key to data interoperability 2000.

[10] Sampath N. Telecommunication in Rural Development for a Sustainable Economy, Map Asia 2002.

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