GEOGRAPHICAL INFORMATION STSTEM AS A TOOL FOR URBAN UTILITY GRIEVANCES

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Abstract

The intelligence of the electrical grid relies critically on geospatial data to represent and track the locations of numerous units within the connectivity model of the modern distribution system. GIS is extremely useful for important studies like network analysis, facility management, Public Grievances Redressal System, load management, theft detection etc.

This paper discusses on the limitations of the existing complain redressal system in our electrical network through E-Governance and how a G-Governance can exceed this limitations.

Electrical supply and service in India is characterized by inadequate access, low levels of services and low customer satisfaction. The level of services and access needs to be increased in order to improve public health and support economic development of the country.

Providing a satisfactory water supply service in our country still a challenging problem, irrespective of whether the people are residing in rural or in urban towns.

For the unsatisfactory electrical supply service situation the issues are many out of which two main issues are growing demand due to increasing population and secondly Grid maintenance. Therefore, no electrical supply system how well be engineered and installed can give service to community satisfactorily unless it is properly and effectively managed and maintained with proper care from source of electricity generation to house connection system.

Conceptual model of a GIS provides a useful way to visualize this entire electrical network as a set of map layers overlaid together on a base map or on a satellite image for effective grievance redressal system. Power company has to keep track of numerous poles, circuits, power lines, transformers with respect to their customer base and needs to perform load study analysis to manage power outages. Use of GIS has come in handy in organizing this information on map and integrating it with other company systems to ensure quality power supply and improve complains response time. Thus GIS plays an important role in maintenance and monitoring of electric system. The purpose of such application is to index all the consumers and categorize the complete consumer database with respect to their usage and unique electrical address on map.

The smart maps when so prepared contain detailed information about the type of land serviced by the utility, the precise location and engineering information of the distribution network equipment of the utility that are installed in the field in visual form to fulfil the facilities management needs, reducing loss of materials and avoiding duplications of designs. GIS can also be integrated with GPS for the transport management system which reduces complains response time remarkably. With the advancement of the mobile technology issues related to power outages can be informed to public through a SMS on their registered mobile number which have a more effective and definite reach than any print media. A Complain redressal mobile application can also be developed to help public register their complaints online.

Keywords: Power; GIS; G-Goverance; Grievances Redressal System

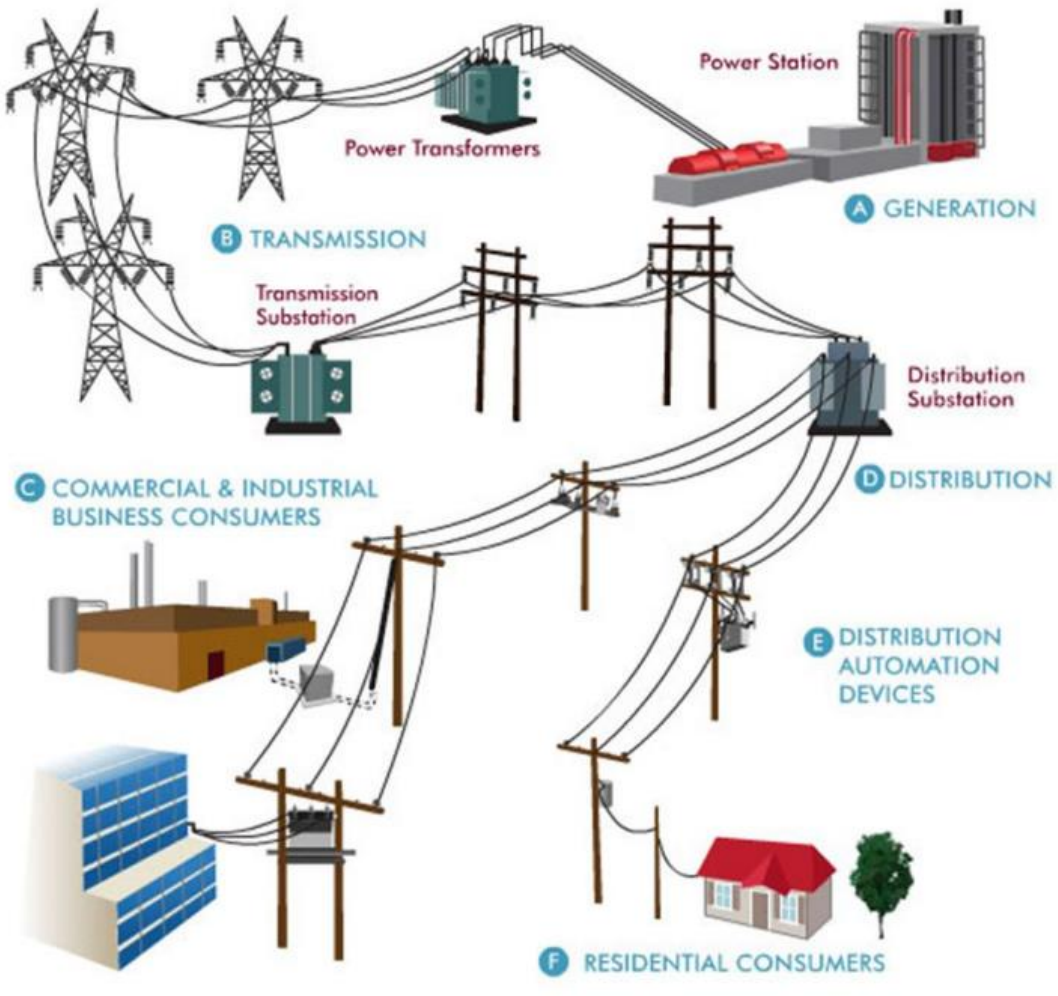
1. INTRODUCTION

An electric distribution utility uses a network of physical facilities to provide electric power and energy to customers connected to those facilities throughout a geographical area. Each component of the distribution system (i.e. asset) has a physical location and associated data so does each customer. In order to plan, construct, maintain, operate and manage the electric distribution network it is necessary to create, manage and utilize this geospatial data. A geographic information system (GIS) is a convenient and powerful way to collect, organizes, maintain and manage this geospatial data and display it on a geographic map.

However, with the use of GIS,information can be better organized on a computer system linking the database to map.A GIS as well can make the information easily updatable and accurate and hence cancater to the needs of maintaining large power infrastructure.

GIS can effectively manage information on the distribution of electricity tocustomers and information describing the attributes of each customer such as locationand electricity use. Electric companies are already finding GIS very useful inmanagement of distribution. The electric utility industry has realized that GIS is a valuable tool not only for mapping facilities but to improve decision making andbetter managing infrastructure. Although the needs and uses of GIS are slightlydifferent in the power sector than other industries, GIS can be just as valuable asinformation technology in the electric utility industry. Power industry keeps track of numerous poles, circuits, power lines, and transformers. Information of location, voltage, and distribution of electricity facilities can also be mapped in GIS. In automated mapping (AM),this facility helps the utilities to quickly create digital maps of their supply area usingthe digitization facilities of the software. These maps when so digitized containdetailed information about the land serviced by the utility, and the precise location andengineering information of the distribution network equipment of the utility that areinstalled in the field. In facilities management (FM), the digitized map files that are socreated with all the required intelligence built into them can now be used to satisfy the facility management needs. So, GIS in the field of electric power is used for the studyand analysis for electrical distribution system, analysis and design, applications arealso being developed for tackling problem of designing the electrical supply system for new residential development, for process automation in order to provide theircustomers with high quality attendance, to rebuild the design of work procedures inelectric utilities. GIS and GPS are also integrated for mapping and analysis of electric distribution circuits.

GIS can be used in distribution systems management for:
• Fault Management
• Routine maintenance can be planned.
• Network extensions and optimization
• Network reconfiguration
• Improved revenue management
• Supervisory Control and Data Acquisition (SCADA) can be integrated with GIS
• Rights of way and compensation



2. GIS IN INFORMATION RETRIEVAL

GIS play important role in information retrieval aspects. GIS allows quick and easy positioning of required nodes on a specific geographic area, search and selection of parts of electric power supply networks. The maps created by using GIS can be made as intelligent as one can imagine. For example, if anengineer needs to know the date of installation of a given transformer, on clicking on the transformer symbol the installation date can be retrieved. To know more complex information on the map, such as 'how many 11 KVA transformers wereinstalledor serviced in the western part of a city/town prior to a given date. The query facilities of the software will quickly processthis requirement, and show on the map only those transformers that qualify hisrequirement. If an electricity company wants to award a work contract of layingcable along a certain road, the GIS will return him the results of processingconsidering even all the bends and turns the road may have. The cable length so shownby the GIS will be precise and will therefore help them find the exact quantity of the cable that is needed.

3. DATA LAYERSIN GEOMATICS

While GIS keeps information on customers and power grid accurate and current for improving customer services,Remote sensing imageries can help in updating information on natural disasters. IRS series in India provides high resolution spatial images better than 5.8 mts. and CARTOSAT-2 with resolution better than 1 mtr for earth monitoring; there are also foreign satellites such as IKONOS, QuickBird, GeoEye providing spatial resolution better than 1mt with enhanced spectral bands. With the use of such images electrical engineers are able to identify even small features like electrical poles. Hence remote sensing plays a vital role for the preparation of database on landforms, landuse/land cover and related database. Integrating this information in GIS platform, now we are able to generate three dimensional terrain model (DTMs) of the area, which can be further updated with the multi-dated satellite images and aerial photographs for better visualization and site suitability analysis. Besides Remote Sensing the hottest stuff today in the power sector is Airborne Laser Terrain Mapping (ALTM) or Light Detection & Ranging (LIDAR) Mapping. Laser mapping produces data with accuracies equivalent to traditional GPS land surveys. But the laser mapping produces these elevation measurements at a rate much faster than traditional methods. Since laser mapping provides detailed and accurate elevation information, it can be used at places where access to the survey is limited or prohibited. LIDAR data due its typical characteristics is finding many new applications, which were not thought feasible hitherto with other data collection techniques. One such area is monitoring transmission lines. Long stretches of transmission lines can be mapped with speed to determine the exact location of the transmission towers, accurate topography of the corridor, and the encroachment by vegetation for modification and repair purposes. High resolution DEMs are suited for inspection surveys of power lines and identification of obstructions present in the corridors. For example,deformation caused by trees or illegal buildings standing too close to the power line path can be traces with the aid of geomatics. Their rapid detection and evaluation allows maintenance crews to react fast and to prevent disasters. Also, the inventory of damage after bad weather circumstances can be done easily from Laser DEMs. Data from GPS devices and mobile devices can also be updated to central GIS server to provide alternative ways for field crews to access and record data by developing cloud-based systems.

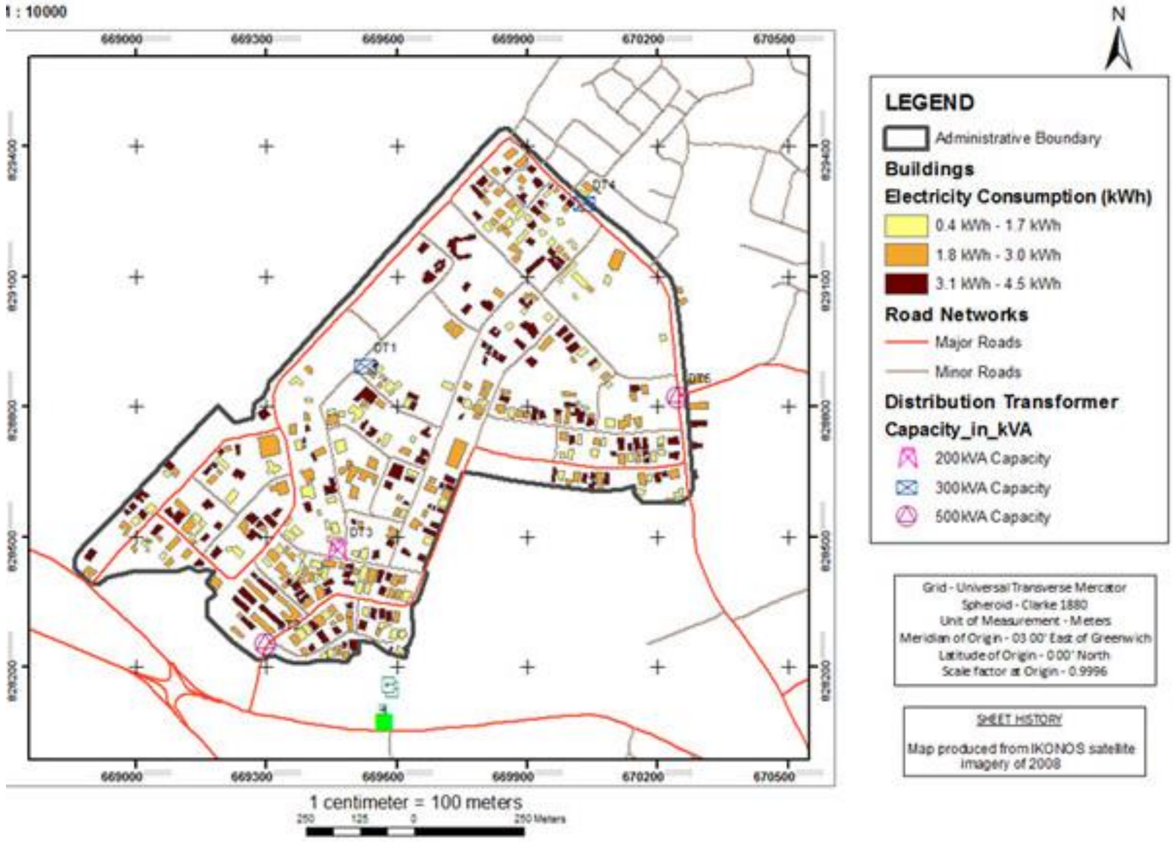
4. GIS IN INFORMATION PROCESSING

The Power Distribution Companies constantly engage themselves in updating their consumer geo-location data and the corresponding electrical network attributes. Geographical Information System (GIS) technology plays an important role in mapping the information of consumers and electrical network assets, on a geographical base map, to help define the consumer’s electrical connectivity. The attribute data of the distribution network is also collected in the process. The digital base map shows the important landmarks like roads, rivers,canals, rail network etc. which is necessary for easier identification of network assets and plan new distribution network. For better visualization, the vector map of the network can be overlaid on the digital base map ora satellite raster image. Information processing is a key to improve productivity and cutting costs of excess work. For example: GIS will allow to search and retrieve information stored on a server simply by pointing and clicking through user friendly menus or simple queries. GIS has a way of making work processes simpler through more productive use of time and information.

5. GIS FOR TRANSMISSION AND DISTRIBUTION PLANNING

The GIS overlays single line diagrams of the distribution network with updated customer, meter, and network for distribution planning, data analysis and reporting. The Transmission and Distribution losses can be reduced by using spatial data and also energy efficiency can be improvedby:

- Mapping installedmeters at all the transformation stages to check its last service period.
- Mapping Installed meters in the consumer’s premises for the creation of consumer database and consumer indexing.
- Mapping Installed electronic meters on all out going feeders and Distribution Transformer (DT’s).



A typical GIS application snapshot for Electric Network (Source: Dare-AlaoDamilola, Geospatial modelling of electricity distribution network)

- The feeder and DT meters record active energy, power factor and load information. The information can be downloaded to GIS system for quick decision making and improved distribution system.
- Energy received in each substation and outgoing feeders, energy billed and T&D losses at each feeder and DT can be properly accounted for total energy.

The distribution network with all its substations, feeders, DT and LT feeders can be mapped and geo-referenced with unique identification, thereby creating a database similar to consumer indexing. All the existing connections and consumer details can be graphically displayed on the GIS map linked to the database. So for every substation the elements can be viewed on the map like:
1. Name of the substation
2. Number of busses
3. Type of the substation
4. Transformer data
5. Capacitor storage
6. Load Demand data

Similarly, the elements for the transmission lines include:
1. Circuit type
2. Circuit length
3. Electrical data such as Resistance, Reactance, and Succeptance.
4. Additional information like material properties, etc.

6. GIS IN MAINTENANCE & MONITORING

A successful GIS implementation seamlessly integrates thespatial data with various utility applications - Customer Information System, Asset Management, Outage Management and Utility Billing System and provides interfacesfor cross-application and data portability. Availability of accurate GIS-based distributionnetwork map showing the geo-coordinates and network configuration is an importantprerequisite for analysis, planning, and optimization and load flow studies. Proper GPSsurvey and creation of an accurate digital base map for the distribution network isessential for a successful GIS implementation. The survey requires a GPS Base Stationata pre-determined location, aided by adequate number of GPS Rovers/ Receivers.Surveyors walk along the feeders and capture the spatial position of the Pole,Transformer, Feeder and Sub-stations. Let us assume that the engineer has to send acable jointer in the field who has to access a certain underground cable joint. Theengineer can take the digitized map file of the area, mark a small portion of that area inthe neighbourhood of the joint, and print that small part on a piece of paper. This printed map of that small area will show, to the jointer, the location of the joint with properdistance and bearing references to the nearby identifiable objects. With thesereferences so readily available with the jointer, his work will be easy and quick. There will be no need for him to have any guesswork or to constantly contact the office forknowing the joint location.

6.1 Load Forecasting:

Forecasting the amount of future load growth and to predict the location of load increment is called load forecasting. To perform spatial load forecasting techniques GIS technology provides an excellent platform which merge distribution system data with land-use and development data. Load forecasting is consisting of whole power, classified loads, load curve, and load distribution. To forecast the demand and the distribution of the load in power domain total power supply area should be divided into several sufficiently small areas based on the Geographic location which includes a number of demand points that indicate different customer loads. Each section gathers spatial data and forecasts the future load growth for every small area. Gathering spatial information can be performed on the geographic information system (GIS) platform. To forecast load growth for planning future system of a given geographical area, data such as current land use, transportation, infrastructure, slopes and urban centres are required along with the location of new expected load additions. Forecasting future load centres, prioritizing projects, identifying substation property requirements, control the demand growth with its rates and high load densities, are the benefits of load forecasting.

6.2 Site Identification

Suitability analysis in a GIS context is a geographic or GIS-based process used to determine the appropriateness of a given area for a particular use. The basic premise of GIS suitability analysis is that each aspect of the landscape as intrinsic characteristics that are to some degree either suitable or unsuitable for the activities being planned. Suitability is determined through systematic, multi-factor analysis of the different aspect of the terrain model inputs include a variety of physical, cultural, and economic factors. The results are often displayed on a map that is used to highlight areas from high to low suitability.

A GIS suitability model typically answers the question, "Where is the best location?" — Whether it involves finding the best location for a new transformer or a sub-station, a new housing development, or an underground electric cable network. For instance, authority searching a new distribution substation site may take into consideration distance to major roads and any upcoming or growing build up areas with respect to industrial, commercial or residential projects, and then combine the results with land use, population density, and consumer usage data to decide on the best location.

The remote sensing technology is being used for the identification of suitable sites for locating new electrical substation. The conventional method could not be directly adopted in theinaccessible areas of high mountains or where the water resource potential is high by means of intensive rainfall. Similarly geological, structural configuration isessential to study and understand the strength and weakness of the area so that the site will be allocated in the suitable terrain. For geological mapping, information on spectral reflectance and emissivity of the rocksinformation are very importantto understand the structural arrangements of disturbed strata (folds and faults), dynamic changes from natural events (e.g. floods; earthquakes), seek surface clues (such as alteration and other signs of mineralization) to subsurface deposits of ore minerals, oil and gas, and groundwater. This can be studied through various spectra of bands like hyper spectral and thermal infrared from various satellite sensors such as RADARSAT, Landsat, TM, Meteosat, ASTER etc. Remote sensing data available in the near infrared region (0.8 um - 1.1 um) provides a clear contrast between land and thewater. Satellite imagery may be used for the identification of catchment boundary, drainage network; perennial streams, land use and vegetation cover for these projects. Generating elevation contours and spotheights from topographic maps and satellite images from ASTER, CARTOSAT or SRTM and using capabilities of various GIS software maygenerate Digital Elevation Model (DEM) of these catchments. The catchmentboundary, drainage network and location of major habitation may be overlaid on these DEMs for further site suitability analysis.

7. GIS IN DISASTER MANAGEMENT AND FAULT MITIGATION

When a utility is faced with a natural disaster, tools such as an outage management system and distribution management system are traditionally leveraged to get service back up as quickly as possible. But as electric utilities confront disasters that impact increasingly larger and denser populations – from earthquakes to floods– its natural disaster management plan cannot begin the first day after the danger has passed: The urgent need to repair critical infrastructure and deliver power to customers is very crucial. The plan should first identify the resources a utility needs to forecast the disaster, prepare the network and customers for the impacts, and resolve outages and damage as quickly as possible. The two of the most prominent systems – GIS and weather forecasting technology – can work together to prepare the network for a disaster and recover in the aftermath.

7.1 SmartMaps

A GIS system provides one of the most important tools a utility needs when responding to a major disaster: enterprise-wide access to readily available, highly accurate mapping and data on real-time asset conditions. This becomes even more critical as an increasing number of utility workers retire from the workforce and with them decades of data including the thorough and historical understanding of the network and its risk points, walk out the door. This information may never have been captured digitally, but instead remains in the brains of a talented workforce or locked away on paper, with no efficient or systematic way of transferring the accumulated years of intuitive knowledge.

With an enterprise GIS system, information can be updated across the entire organization immediately. This is imperative not only for day-to-day operations, but especially when preparing for and responding to natural disasters. For example, as cyclone, fires, floods or other weather events are identified in a city, utilities can leverage their GIS to assess the risk to critical infrastructure and prepare for damage-related outages, as well as communicate with customers to help them prepare for extended outages and keep them informed on the progress of the restoration. Service can be adjusted to avoid added risk from damaged assets. These shutoffs can be isolated to minimize the number of affected customers because of the accuracy of the database and advanced network analysis tools. Similarly, the real-time data allows the utility to know where it can quickly restore service or how to reroute services around damaged assets in the meantime to keep the electricity, gas, internet, and water on.

The mapping and asset identification benefits of the GIS system are just as important after a disaster hits. For instance, if a plane or helicopter is surveying damage overhead and spots a downed utility pole, the GIS can tell the worker the size and type of the pole, what equipment is on it and how customers downstream may be affected by the damage. This is powerful information for a utility working hard to reroute or reconfigure the network to get customers back online, or at least manage expectations as to when reliable power is running again.

Enterprise GIS helps utilities prepare for and respond to major disasters by ensuring data is both highly accurate and easy to rapidly share

This asset data is also important for damage assessment by helping to determine the amount of material lost and the associated cost. A utility can compare the needs to the materials it already has in stock to get things back up and running, or make a specific request of nearby utilities.

7.2 Collaboration during disaster

Combination of accurate weather forecasts and a GIS system can also be a tremendous asset to the community. Utilities may share data with fire authorities, emergency management groups, and public officials who assist them in planning and response. With large-scale disasters that require public safety crews to assess large numbers of threats, this data can be an indispensable tool for helping decision-makers triage the most critical areas and deploy resources.

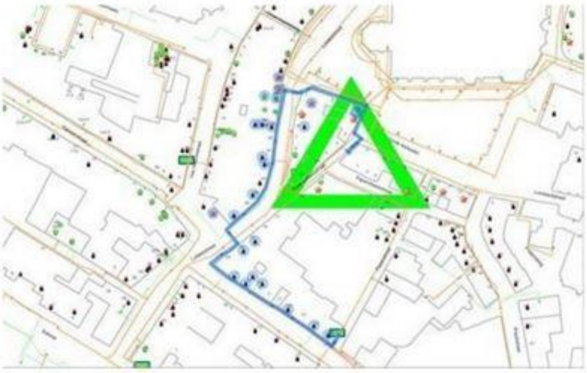
7.3 Accessibility during the cyclone

Weather forecasting and GIS data is not as valuable if crews can't access it during a disaster because communications infrastructure is damaged or overloaded. Now more than ever, utilities are working to ensure that crews can access the GIS database via a mobile device, as well as record and update data safely and securely.

A variety of solutions are in production to provide alternative ways for field crews to access and record data, including greater use of mobile devices and developing cloud-based systems for uploads and downloads. Workers are now able to access and uploaddata wherever they can connect to a wireless internet or mobile network. This increases the security of data and the efficiency of crews by reducing the time to report in and collect new data and assignments. A flexible field crew can stay in the field and respond to new jobs as they come in. This is a huge advantage during disaster response – when every minute counts.

Hence GIS system can help us to:
- Identify threats to electric power systems
- Propose measures to reduce risks to electric power facilities
- Develop a response plan that integrates with capabilities of emergency response organizations
- Allocate the responsibilities of electric utilities during disaster recovery
- Organize information of an incidents

A fire happened in transformer due to electrical fault



GIS map shows a location of fault

8. MOBILE GIS BASED COMPLAIN REDRESSAL SYSTEM

Digital technology has become integral to our lifestyles. We buy our clothes, read our news, reserve our taxis, and check our bank accounts all from the web—and sometimes we do it all from our mobiles. However, many of us still get our utility bills in the post, and pay by cash or cheque.Utilities lag behind retail and communications in the adoption of digital technologies. Very few of social media users use social media services to communicate with their utility companies.

However, rising costs and competition have begun to push utilities toward digital operating models. Utilities have sought to expand digital migration, the movement of customer interactions away from traditional channels and into the digital space. This lowers costs while improving customer satisfaction.

8.1 Digital Approach:

The main component of electric utilities identified in India is Customersand Cost. These are the issues to which utilities must respond to succeed in the new environment.

8.1.1 Customers :

Digitally proficient users make up an increasing chunk of utilities' customers. Utilities' customers range from retiring Baby Boomers to young adults, who all increasingly expect the companies they use to keep up with them in the digital space. Companies that do not risk are being found outmoded and unwieldy. Furthermore, even customers who do not explicitly demand digital interactions are more satisfied when companies connect with them over digital channels.

8.2.2 Costs:

Tightening environmental regulations and oversight are squeezing utilities' margins. Increase in fuel costs hasfurther bump electricity prices. With rising prices per consumers, authority's profit margins are squeezed. Digital communications can help utilities cut costs andimprove customer satisfaction; thiswill decrease customer aversion to price increases.

While this new environment poses challenges for utility industries, Digital technologies can help utilities compete by cutting costs, moving from commodity to branded services and revolutionizing the customer experience.

8.2 Digital Strategies:

To adapt to the new environment, three areas of strategy can be identified to help utilities attract customers to these digital offerings and improve each interaction. These strategies, focused on Technology, Operations, and Incentives, will help utilities cut operating costs, increase customer satisfaction, and improve relations with regulators.

- In the technology space, utilities first need multiple and high-quality digital offerings across mobile, web and social media channels.
- Operations strategies focus on integrating these digital offerings within the utility and marketing them effectively.
- Incentives strategies focus most directly on how to get customers to use the available digital platforms.

8.2.1 Technology-Focused Strategies

Utilities will need to focus on how to best use the expanding digital technologies available to them. To improve the quality of their digital offerings, utilities should approach the wide variety of technological options from a customer's perspective. Three interactive factors maximize impact of these digital offerings:

8.2.1.1 Channel

Offer a wide variety of functionalities across web, mobile, and social media channels to suit different needs, and allow for easy transition among them. Make sure that traditional channels are still available if desired, or for complaints and emergencies. Think about what users need and how they communicate when deciding what capabilities to include in each prong of the multichannel customer service approach.

8.2.1.2 Content

Keep messaging consistent across channels and think about likely customers questions. Consider smart FAQ’s and place most-trafficked content in highly visible locations. Utilities should be judicious in communications to avoid spamming customers, and should focus on actively engaging customers instead of talking at them.

8.2.1.3 Functionality

Customers will embrace digital channels because of ease of use and seamless integration with their lifestyles. Integrate channels to allow for fast transfer among them. Utilities should employ simple interfaces and navigation.

8.2.2 Operations-Focused Strategies

In addition to developing top-tier digital offerings, utilities need strategies for deployment and advertising. Digital offerings cannot thrive without strong operating models to support them.

8.2.2.1 Partnerships

Utilities can partner with banks on automatic bill pay and tracking, while partnerships with online financial organization platforms like ‘Paytm’can integrate mobile bill-pay with their financial tracking. Utilities can make service start/stop/transfer easy by working with the other government authorities like Indian postal service to sync it with changes of address. Telephone companies can plan to enable pay-by-text/SMS or some USSD based services.

8.2.2.2 Customer Awareness

Once a utility has platforms such as online chat and mobile applications in place, each customer interaction, such as help desk calls or bill notices, must ensure that customers know about these offerings and their benefits. Customer education marketing decreases uncertainties and increases familiarity with digital channels.

8.2.2.3 Targeted Advertising

With customer segmentation and their current geo-location, utilities can advertise their cutting-edge technology and user-friendly brand on regional and segment-specific platforms on the web or in mobile app. Segmentation reduces costs by allowing for surgical advertising. Tailored, thoughtful messages improve customer perceptions and relationships while spreading knowledge of new, branded digital offerings.

8.2.2.4 Complaint Redressal:

Early complain redressal mechanism becomes utmost important for any utility during the time of hazards or during atechnical failure in the system. In such scenario it becomes very important to have a robust mode of communication facility with the utilities. In power sector it requires to inform the type of complaint along with the location. GIS based application is the only available solution here, which provides all the parameters required to file a complaint.

To name few important ones:

1. Name of the complainant
2. Name of the defaulter
3. Registered mobile for a given utility- this will directly give all the information related to complainant
4. Nature of complain- i.e. Billing, extension of load, Non-release of connection, Disconnection, Reconnection of service, Meter related complaints, Interruption in power supply, Quality of power supply, Delay in any service from licensee, Safety related complaints, Breach of rules and regulations by licensee.
5. Location of fault –complainant can give the exact locating through smart maps or through Lat./Long instead of giving address or tentative area.
6. Geo-tagged Photographs -to show the severity of the problem.
7. Help Required- this can help the authority to act accordingly based on priority

On the engineer end they have the access to: Probable cause of electric failure through smart maps and probable solution based of artificial intelligence through latest technology.

8.2.3 Incentive-Focused Strategies

Even with easy-to-use digital platforms and advertising pushing customers towards digital channels, customers may need an additional pull to make the leap. Financial incentives will pay for themselves in reduced operating costs.

8.2.3.1 Passed-on Savings

When switching to online bill pay and start/stop/transfer saves the utility money, a portion of this can be given back to customers as an incentive.

8.2.3.2 Discounts

Incentives to refer anapp to a friend or online transactions incur only one-time costs and help generate a critical mass of digital customers. Pay early discounts, thank customers for cutting down on utilities average accounts receivable time and allow the utility to keep less operating cash on hand.

8.2.3.3 Online communities

Besides financial incentives, utilities can reduce costs, empower customers, and gather buckets of data with an interactive online space for customers to answer each other's questions, learn ways to save, and chat with members of their community.

9. CONCLUSIONS

Natural disasters will only have greater impacts as our population continues to grow, especially in urban areas. By further analysing historic weather events, utilities' outage management can take more predictive elements into consideration.
As utilities examine all of their resources when preparing and planning a natural disaster response, enterprise-wide systems with real-time information, like GIS and weather conditions, will likely always play a central role. As the industry moves to integrate more systems and more historical data, our picture of the past will not only become clearer, but so will our path ahead for faster service and restoration after the disasters.
The digital strategy articulated here across technology, operations, and incentive spaces can help utilities adapt to the rapidly changing energy environment providing rapid services and solutions to the problems. These approaches will help improve collections, customer services while maintaining relations with authorities.
This will also led to increase on-time payments, reduce call centrevolume, and decreasedefections by improving the customer experience and overall satisfaction.

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