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Electricity Consumption using Big Data Analytics

Prof. Sandhya A. Awate[1], Rahul Chaurasia[2], Pratiksha Kirolkar[3], Minal More[4], Prerna Ingale[5]
Professor, Department of Computer Engineering [1]
Students, Department of Computer Engineering[2,3,4,5]
A. C. Patil College of Engineering, Mumbai, Maharashtra, India

Abstract: *This paper focuses on using big data analytics to analyze the electricity consumption patterns of 500 consumers(residential) in a particular area over 24 months. The data was obtained from MESB and analyzed to understand the trends in consumption better. The analysis was used to create visualizations and graphs that helped to identify the consumption patterns of individual users as well as the overall trends in the area. Using the Power BI tool, a dashboard is created to showcase the results. The dashboard provides valuable information such as the top 10 consumers and average consumption values by user. This information can be used by utility companies to identify areas where consumption is high and to develop strategies to reduce overall electricity consumption. This study demonstrates the value of big data analytics in understanding complex patterns and identifying opportunities for energy savings.*

Keywords: Consumption, Analytics, Electricity, Visualizations

I. INTRODUCTION

Currently, electricity is used in every home for various tasks, including watching television, charging smartphones, using an electric light bulb, and other things. Electricity has become an essential part of our daily life. It powers our homes, businesses, and industries, and has enabled us to achieve unprecedented levels of comfort, convenience, and productivity. However, this growing dependence on electricity has led to a significant increase in its consumption, placing enormous pressure on energy resources and the environment. As a result, it has become imperative to analyze and control the supply and demand of electricity, to ensure its sustainable use and reduce the impact of its production on the environment.

In recent years, there has been a noticeable rise in electricity consumption, driven by the increasing use of electronic devices, appliances, and industrial machinery. This trend is expected to continue in the coming years, with the growth of emerging markets and the adoption of new technologies, such as electric vehicles and renewable energy systems. To meet the growing electricity demand, utility companies are exploring new ways to optimize energy production and distribution, while minimizing waste and reducing emissions.

To achieve this goal, big data analytics has emerged as a promising tool for analyzing electricity consumption patterns and identifying opportunities for energy savings. By analyzing large volumes of data generated by smart meters and other monitoring devices, utility companies can gain insights into the behavior of individual consumers, as well as the overall trends in consumption. This information can be used to develop targeted strategies for reducing energy use, promoting energy efficiency, and managing peak demand.

The paper aims to present a study on the electricity consumption patterns of 500 residential consumers in a particular area over 24 months, using big data analytics. The data was obtained from the MSEB and analyzed to identify trends in consumer behavior.

II. LITERATURE SURVEY

The development [1] and application of advanced measurement systems and power distribution information collection systems, user-side data has increased geometrically. This paper used the PCA method for dimensionality reduction followed by K-means clustering to create different classes. Finally, they used the entropy weight method to create an energy efficiency assessment. Based on the PCA algorithm, the dimensionality reduction and extraction of electricity behavior characteristics are realized, and the k-means algorithm is used to divide users into 5 categories, and the

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electricity consumption characteristics of different categories of users are analyzed. This paper only conducted research on about 1 month of data. More data could be assessed in order to find different trends.

Visualization [2] as a means of big data management is the new century revolution. Data flowing into businesses is increasing rapidly. Businesses are receiving and collecting a huge amount of data more than they need. Therefore, they need to turn all this raw information into useful resources for understanding the data behavior. Big data management starts with the collection of data. For the energy sector, it can be difficult because of the lack of standardization in the generated data from the smart meters across Qatar. This leads to the problem that data cannot be efficiently merged into the database. A specific benchmark needs to be set to give meaningful results that give true insight into the data. After data collection, visualization of the 'insights' takes place to turn the collected data to useful visualizations. Some challenges faced by Qatar during electricity consumption are: Meeting the need for speed, Understanding, Addressing, Displaying, meaningful results, Dealing with outliers of the electricity companies. In this study, we have identified that Qatar electricity organizations need an effective application. The project was built just on the past data and did not mention any real time database.

A BDA (Big Data Analytics) model [3] was developed to trace and monitor household electricity consumption based on common BDA models. The model not only provides required information but also makes predictions about future consumption patterns. The analysis was done using descriptive and predictive analytics, which enabled consumers to view, track, compare and plan their electricity consumption.

Consumers can use the information provided by the model to optimize their electricity usage and reduce their bills. Additionally, the model can help them to plan their energy consumption better and make informed decisions about the use of energy-intensive appliances.

III. PROPOSED SYSTEM

The proposed system for this project report involved analyzing and predicting electricity consumption based on 500 consumer data from the Maharashtra State Electricity Board (MSEB) over a period of two years. The need for electricity consumption was a critical issue, and the analysis of the data provided insights into consumption patterns, which could help in better energy management.

The first step in the proposed system was to sort the data and then conduct a thorough analysis. The analysis involved identifying patterns and trends in the data, as well as any anomalies that may have existed. Once the analysis was complete, the next step was to use the insights gained from the analysis to predict future consumption patterns.

To create visuals for the project, we used the Power BI tool. This allowed us to create dynamic and interactive visuals that helped us to communicate the insights gained from the analysis and predictions effectively.

3.1 Methodology

The project followed a certain process. This process was divided into five steps or layers that acted as the methodology for the research. Each layer had a specific role to play in the project and was interconnected with the other layers.

- **Data Source:** This layer was the very first stage for building our project where we looked for electrical consumption data from MSEB and Kaggle. We couldn't find much-related data on Kaggle, so we did an inquiry about the data at MSEB Office. The information obtained from this process was used as input for other processes. This data first went through various data analytics techniques, and then we used processed data into a data analytics model for training and testing. So that we could get consumption pattern and predictions as an output.
- **Data Exploration:** In this layer, we explored the data we received from the first stage. Since this raw dataset may have consisted of null values that could hinder the accuracy of the model, we checked for them first.
- **Data Pre-processing:** Data pre-processing was the concept of changing the raw data into a clean data set. The dataset was pre-processed in order to remove missing values, noisy data, and other inconsistencies before executing it to the algorithm.
- **Data Analytics:** Data analytics related to electricity data involved the use of various techniques and tools to analyze and understand the patterns and trends in electricity consumption. Data analytics techniques were used

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to analyze the collected data and extract meaningful insights. This could help in identifying areas where energy consumption could be reduced and optimizing energy usage in homes.

- **Data Visualization:** Data visualization was the process of presenting information or data in a graphical or pictorial format that made it easier to understand and interpret. Data visualization techniques included charts, graphs, maps, tables, and diagrams, and these could be customized to fit different types of data and user needs. With the rise of big data, data visualization had become even more important as it allowed users to easily explore and communicate insights from large datasets

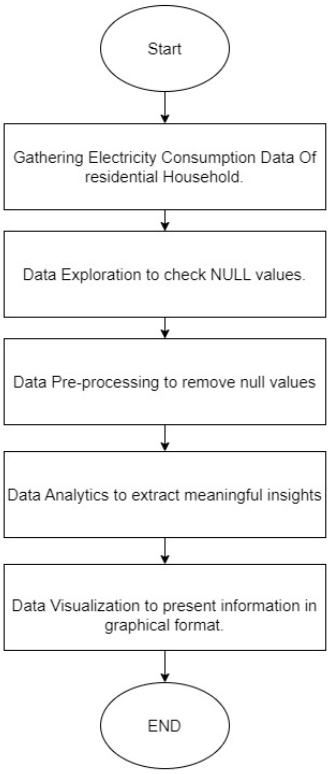

Fig. 1 Flowchart

IV. RESULT AND ANALYSIS

Project consist of three sub-modules:

4.1 Consumption Analysis

Analyzing electricity consumption is an essential task that can help in understanding the usage patterns of consumers. Furthermore, the analysis enabled us to identify the highest and lowest consumers of electricity based on their usage patterns. This information can be used to develop targeted strategies to promote energy efficiency and reduce overall consumption.

4.2 Prediction

The Prophet model developed by Facebook has been used to forecast electricity consumption data. This model has been proven to be a reliable and accurate tool for predicting time series data.The Prophet model requires minimal manual effort and can handle messy data with ease, which makes it an ideal choice for forecasting electricity consumption data. The model is robust to outliers, missing data, and sudden changes in the time series, which ensures that the forecasts are accurate and reliable.The parameters of the Prophet model have been fine-tuned to meet the specific needs of our project. This allows us to make accurate forecasts that can be used to optimize energy consumption.

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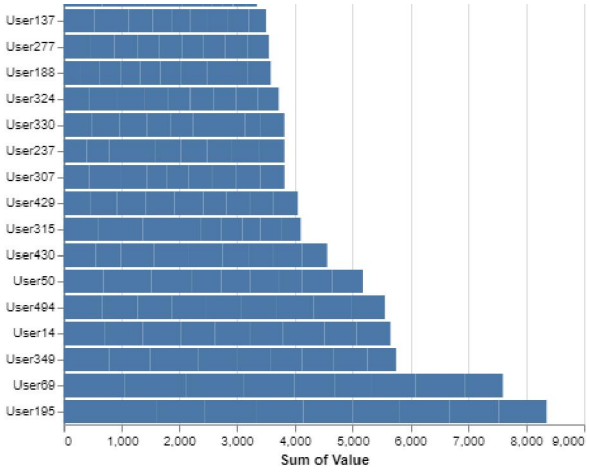


Fig. 2 User's Consumption in ascending order

We have predicted the consumption value for the next 10 months. This ensures that the forecasts are based on a sufficient amount of data and are therefore more accurate. The prediction is only for the start of each month since our dataset only contains monthly data. This means that the forecasts are not as granular as daily or hourly forecasts, but they are still useful for predicting overall trends in electricity consumption.

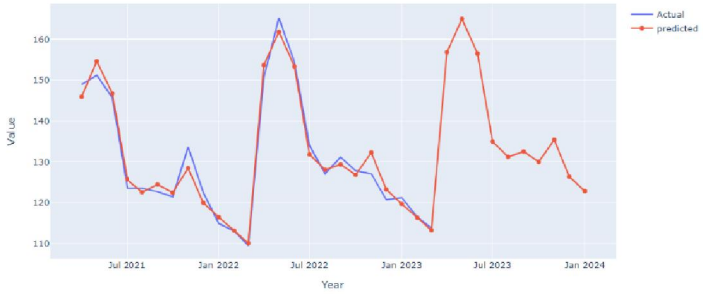
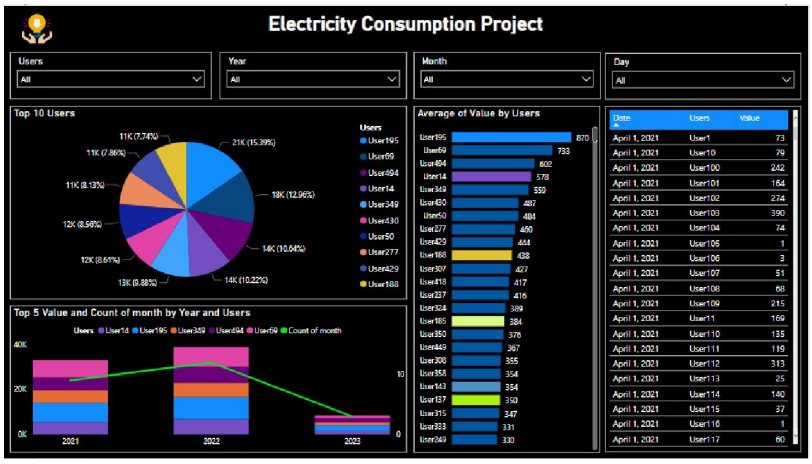


Fig. 3 Prediction for the next 10 months

4.3 Power BI

The electricity consumption was analyzed using the Power BI tool. The dashboard created enabled us to gain a better understanding of the patterns and trends in the data. The dashboard showed the top 10 highest consumers of electricity, which helped in identifying the areas where energy consumption was highest. This helped in devising strategies to reduce energy consumption in these areas.



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The inference that could be derived from this output was that there were certain households in a specific area that consumed significantly more electricity than others. In addition, the dashboard also displayed the top 5 values and counts of months by year and users. This gave a clear idea of the months in which energy consumption was the highest and the users who consumed the most electricity. Furthermore, the dashboard also showed the average value by user, and the year-wise visuals could be displayed to identify the trends in electricity consumption over the years. This helped in understanding the factors that influenced energy consumption and identifying areas where energy efficiency measures could be implemented.

V. CONCLUSION

In conclusion, our research paper has successfully developed a consumption and prediction model that can be utilized to forecast electricity consumption for the next few months. The model, developed using the Prophet algorithm, has shown reasonable forecasting accuracy, which can be used to draw inferences about the demand-side increase and to help bolster the supply side of the equation.

We have also developed a dashboard using the Power BI tool that can provide insights into the electricity consumption patterns, such as the top 10 consumers, the top 5 values and counts of months by year and users, and the average values by user. These insights can be leveraged to strategize policies and optimize energy usage in homes.

Although the current model has been developed using a limited dataset, we have shown that it can perform even better with more data. Overall, our research provides a strong foundation for future studies on electricity consumption prediction and optimization.

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