Analytical review of AC Distribution in the Delhi Region based on Climate change and Development

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Abstract - Due to the rising temperatures and humidity along with a rise in income levels throughout the world as well as the growing acceptance of air conditioners as a utility and necessity rather than a luxury product, the air conditioning (AC) sector is predicted to see enormous development. Analysis of AC sales in the region of New Delhi, India is the main focus of this study. Not much research has been conducted on Air Conditioner distribution in a region. This paper aims to analyze the sales of the Delhi region which has 969 counters, over 5 years (2018-2022). The development process involves the Extraction of Data from the MNC followed by cleaning, removing the outliers, then data analyzing the data, and finally plotting important charts to conclude our findings. Tools like Python, Pandas, and Matplotlib were extensively used. Data Cleaning and Data visualization are important aspects of any research and plots of Year vs Counter, Channel vs Sales, etc. are plotted. The Top 5 companies on the basis of ACs sold were found out Voltas, Daikin, Hitachi, LG, and OG, and factors like temperature and Development were used to determine why the sales in West Delhi were the highest amongst the other three zones (South, North, East). The product prices of 3Star & 5Star windows, as well as split Ac, were analyzed which gave us an idea of why Voltas is the front runner in selling the maximum ACs in Delhi. Other Factors like Income, Tourism rise in population can be considered for future research.

Key Words: Air conditioner, New Delhi, Sales, LG Voltas, Daikin, Analysis

1.INTRODUCTION

The term "air conditioning" is frequently used to refer to the machinery employed in the process of eliminating heat, cold, and moisture from the inside of a populated place. With the aid of a gaseous refrigerant, a conventional air conditioner employs a mechanical device called a "heat pump" to transport heat between the interior and outdoor units. Heat is transferred from the interior exchanger to the outside exchanger via an air conditioner. The outdoor unit's compressor liquefies the refrigerant while cooling to remove heat. Conversely, while heating a room, heated pressure gas produced by the outside unit's heat exchanger and compressor is condensed to heat the air. The system may rotate between these two cycles to provide cooling and heating. Due to the rising temperatures and humidity levels throughout the world as well as the growing acceptance of air conditioners as a utility rather than a luxury product, the air conditioning (AC) sector is predicted to see enormous development. Through the projection period, it is also projected that the advent of technologically sophisticated air conditioners, such as air conditioners with inverter technology and air purification technologies, would have a beneficial impact on the air conditioner market. The industry is also anticipated to be fueled by elements like the tourist and construction sectors' optimistic expansion. Demand for air conditioning systems is predicted to rise as a result of the growing population, which is likely to have a favorable impact on residential and commercial buildings. In 2020, COVID-19's spread disturbed the world's supply chain and market demand. So, examining a company's financial data in order to learn some things requires analysis. This study will focus on how different brands of ACs have performed in various parts of New Delhi India in 2018-2022 and identify the top-selling brands. The analysis will be used to identify the hotspot regions and thus give insights to the brands on where should the target regions be for future sales. Analyzing the Temperature and Development data and also the sales price data the findings were concluded.

2. LITERATURE SURVEY

Air conditioners are now a thing of necessity and not luxury. As the earth's temperature is increasing the demand for air conditioners is increasing day by day and this demand is going to increase exponentially because of various factors like improved lifestyle, increase in population, increase in temperature, etc. The demand for electricity will grow many folds and many researchers have worked on the increased supply of electricity with great accuracy, but the research done on Air conditioner sales in a particular region is very less.

[1] Garcia-Valle 2009 and co-authors worked on Controlling AC power usage which is a key component of demand response. Accurate AC load forecasting is needed for electrical utilities and end users with the development of demand-side management techniques and the smart grid. Big data analysis and its uses in power systems are introduced in this study. Following that, several load forecasting categories and approaches used in the context of big data analysis in power systems have been investigated. An LMA ANN was used for predicting the short-term load of a household air conditioner

[2] Anam Malik and coauthors in 2019 research Findings suggests that residential air-conditioning presents a significant demand response opportunity, approaching perhaps 9% of total peak demand in some circumstances.

[3] Assmus, G. and the authors tried to assess the effect marketing has on sales. The authors make an effort to evaluate what can be inferred about how advertising affects sales using econometric models. For different econometric models evaluating the effect of advertising on sales, the short- and

long-term advertising response as well as model fit are studied. Replication analysis, a type of meta-analysis, analyses the studies as flawed experimental replications.[4] Bin-Juine Huang along with coauthors 2016 talked about solar ACs.[5] B. R. Williams and his team The author talks about the delayed voltage line system and their effect and variation using different devices. [6] The authors did research on energy consumption and energy-efficient design in mid-rise and high-rise office buildings.

[7] Kumar J and co-authors worked on the challenges, opportunities, and development, of sustainable development in the electrical sector in India.

3. METHODOLOGY

Purpose: Initially we have to look at the sales trends of previous years and analyze them for a better understanding of the data. Large MNCs require this type of careful analysis so that they can target the regions for future sales.

A.   WorkFlow Setup

Fig1. The flow of work

B.   Tech Stack and Tools

Python is a good language for practical programming and quick learning. A programmer by the name of Guido van Rossum developed a robust high-level programming language. [8] For conducting standard data operations and analysis on such data sets, the Pandas library offers integrated, simple procedures. It seeks to serve as the core of Python's statistical computing system in the future.[9]A Portable Python Plotting Package. matplotlib is a portable 2D plotting and imaging package aimed primarily at the visualization of scientific, engineering, and financial data. matplotlib can be used interactively from the Python shell, called from python scripts, or embedded in a GUI application (GTK, Wx, Tk, Windows).

C.   Data Understanding

Data required for the research was collected from a reliable source (confidential) and different features were analyzed according to the demand and requirement of the research.
Preparation: The data in the .csv format was in raw form and had to be prepared for usage, further the data was cleaned, transformed, and certain unnecessary columns were dropped.

D.   Data Cleaning

You may determine what needs to be cleaned up or processed by looking at feature values until you find the range or distribution of values that is normal for each characteristic. Incomplete or missing data might include the erroneous data form for a column, the wrong measurement units for a certain column, or a lack of examples for a given class.

There are numerous major advantages to this data cleansing procedure, like:

1. By doing this, significant flaws and inconsistencies that are unavoidable when combining data from many sources into one dataset are removed.

2. Having data cleaning software would increase everyone's productivity since they will be able to simply extract the information they require from the data.

3. Happy customers and content employees result from fewer errors.

4. The capability to visualize the many functions, what your data is intended to do, and where it originates.

```
OG19                      30103
Godrej19                  17514
Croma19                    2241
Mitsubishi electric19     10876
Samsung19                  9167
Videocon19                  286
Hitachi19                 99555
IFB19                      2856
Haier19                   10136
Whirlpool19                9577
LG19                      64454
Carrier19                 29735
Kelvinator19                  5
Lloyd19                   32978
Onida19                    1266
Mitsubishi Heavy19         4379
Panasonic19               15426
Blue Star19               22252
Reconnect19                1300
Daikin19                  82515
Amstard19                  4398
Voltas19                 118876
dtype: int64
```

Fig 2. A closer look at sales data (2019)

All the registered AC brands in the Delhi region and sales data for the year 2019

Figure 3 shows the data cleaning process by dropping unwanted columns from the dataset and checking if any non-unique value exits

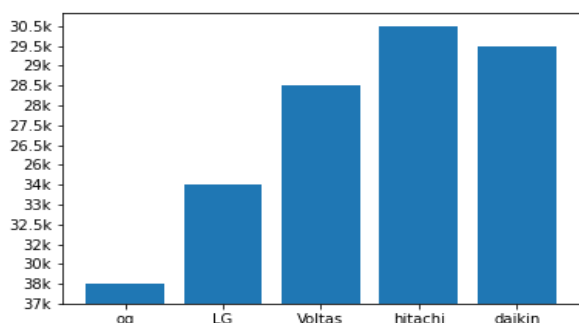| df.nunique()		df.isnull().sum()	
Sr.no	969	Sr.no	0
Dealer Name	719	Dealer Name	0
Sub Location	442	Sub Location	0
Location	146	Location	0
Area	5	Area	0
...		...	
Counter 21	370	Total Billing point	0
Counter 22	397	Selling Point	0
per capita income	0	per capita income	969
temperature 2018	0	temperature 2018	969
temperature 2018.1	0	temperature 2018.1	969
Length: 125, dtype: int64		Length: 140, dtype: int64	

Fig.3 Data Cleaning Process

Fig4. Prices of 3star and 5star AC

The above data is The Price data of BIG5 over the last 5 years of window AC and split AC. The sales of Daikin and hitachi has been always neck to neck.

The data in fig5 contains different regions of Delhi with the temperature of the last 5 years along with the development index
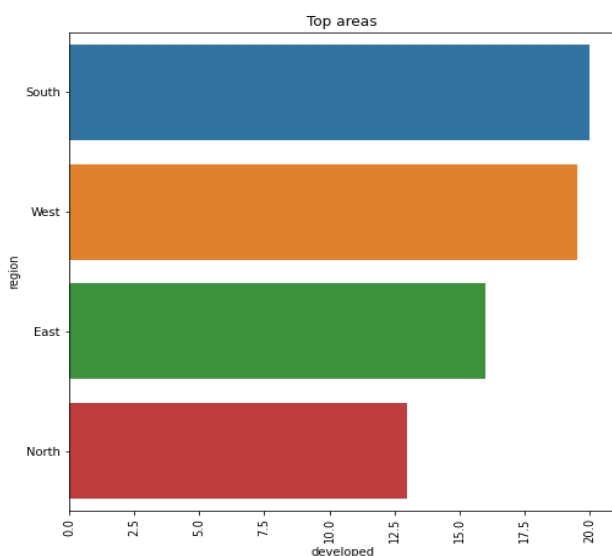

Fig 5 Temperature and Development Index

So, the data was evaluated, and there were no outliers or missing numbers, thus there's no need to deal with them in this set of data. We may use the fillna technique and the drop method to fill in any missing values and remove any outliers. If required, we can additionally normalize the data using the min-max scaler.

E. Data Visualization

The cleaned data were checked for redundancy and various graphs like pie charts, line graphs, and bar graphs for plotted for better understanding and assessment. The bar graphs plotted are of Channel vs Counter (total sales/year) of 2022.
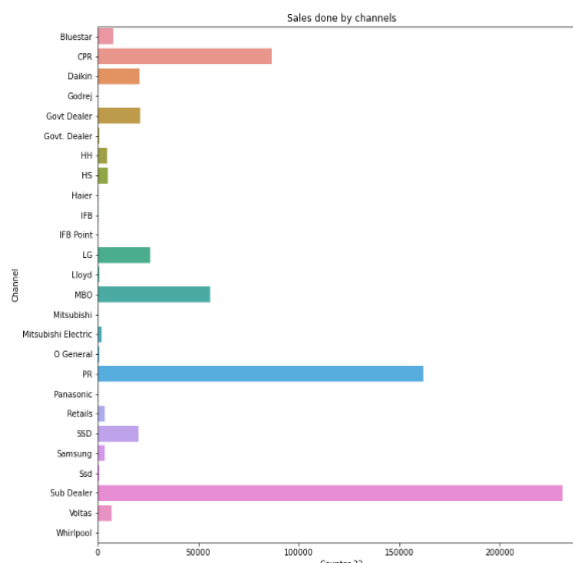

Fig6.Channel vs Sales (2022)

The pie chart is the company percentage share of the top 5 companies with respect to the no of counters or market penetration.
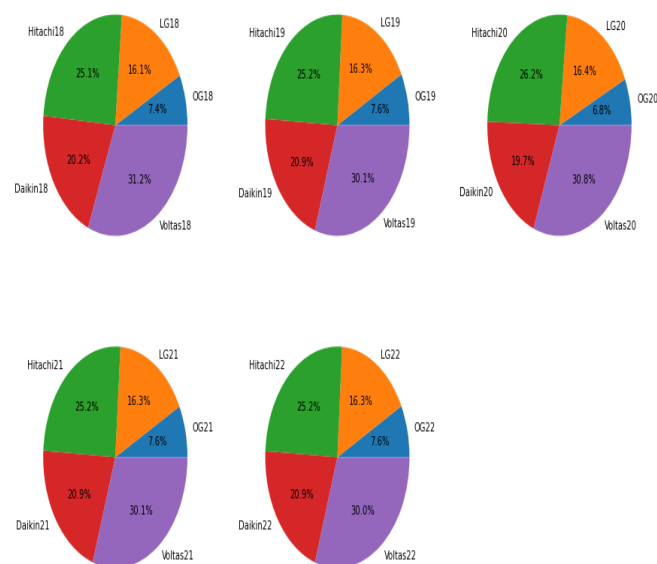

Fig.7 Pie Charts %share of BIG5

4. RESULTS AND DISCUSSION

After carefully analyzing the Sales data of the Last 5 years there has been a significant increase and from 2018-2022 the market has substantially expanded. In 2020 due to the covid-19 Pandemic and Lockdown, the sales in every sector hit a low but the following years i.e. 2021 and 2022 saw the market gaining the momentum it had in 2019, and in 2022(September) the sales even reached an all-time high and the values are expected to grow even more in the upcoming years.

The rise of the market can be based on a number of factors like

- Population increase
- Temperature rise
- Income rise
- New Construction
- Migration etc.

After careful study of the temperature and development data, we found that over the years the average temperature of the Delhi region has increased not by much but the range remained between 44-46 C(degree), and the mercury will touch an all-time high in upcoming years considering Global Warming.

- The major developed area in Delhi belonged to South Delhi Region and the sales data also verified that the sales are the least in South Delhi.
- West Delhi and North Delhi are upcoming developing regions and the significant sales are backed by sales data.
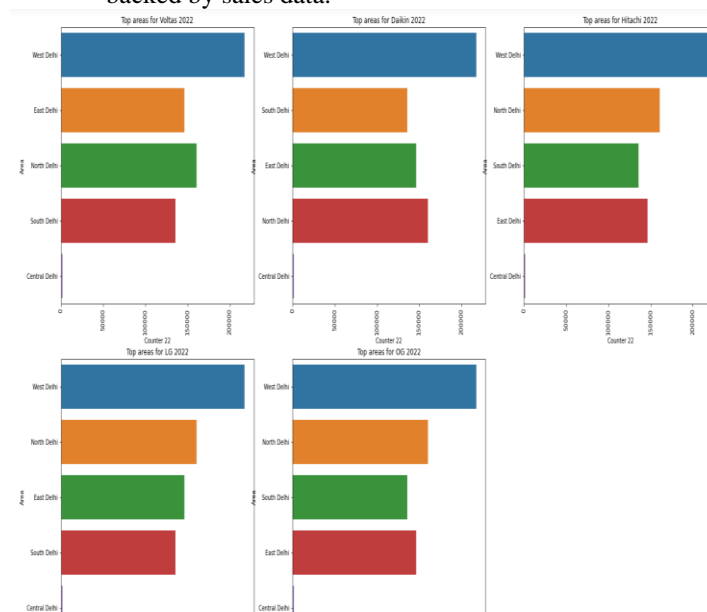

Fig8. Area-wise distribution of Big5

- As in all years 2022 shows the same trend with West Delhi and North Delhi the major regions of AC sales in Delhi.


```
dft.mean()

2018          44.201318
2019          44.646202
2020          44.419147
2021          43.771085
2022          44.130775
developed      0.531008
```

Fig9. Area-wise distribution of Big5

- The average overall Temperature in Delhi hasn't risen significantly but the development index is just above 50% which signifies that the Delhi market has huge potential in terms of sales.
- After looking closely at the development index, South Delhi has the most developed regions, and thus the sales are also less in that region telling us that the market has saturated compared to other zones.

Fig 10 below is the graphical representation of the sales achieved by the BIG5 over 2018-2022(September) Voltas has been the clear winner followed by Hitachi and Daikin showing their dominance in the Delhi region.
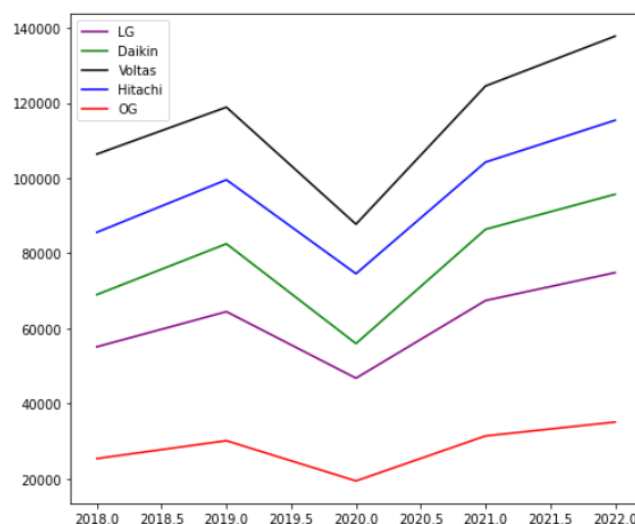

Fig10. Counter wise distribution of Big5

By Looking at the prices of AC, The BIG5(LG Voltas Daikin Hitachi OG) gave the Delhi population very competitive prices over the years. Voltas' low selling price and high brand value (Tata subsidary) make it the biggest player in the market with nearly 20% market share. Not only the prices are affordable but Voltas is known for its aggressive marketing too. They targeted west Delhi and North Delhi and their strategy yielded fruitful results. Daikin is the only AC-centric brand, and a very close competitor of Hitachi (one of the world's largest Ac brands). Both the brands adopted the same strategy as Voltas and focused on the developing regions of Delhi which resulted in great sales numbers.

5. CONCLUSION

There was a rise of 13% in 2019 in comparison to 2018, for 2020 due to the pandemic the sales dropped about 25%. After some relaxation in 2021 on the base of 2019 sales there was an increase of 5% and again an increase of 15% in 2022(till September). The average development index of Delhi shows that Delhi has a huge unexplored market and careful planning with reasonable prices and brand respect will help in a great sales boost. Voltas with its reputation and affordable prices is the market leader in both 3Star and 5-star categories followed by Daikin and Hitachi.

6.FUTURE SCOPE

Many factors like income per family, location, migration, and tourism also contribute to the sales of AC in a region, and can these factors can be used for future works.

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