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KANSAS OFFICE OF BROADBAND DEVELOPMENT: DIGITAL EQUITY PLAN

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***Abstract:*** **The Kansas Office of Broadband Development understands the essential role that digital equality plays in ensuring that all residents have equitable access to and opportunities in the digital age. The office has created a thorough Digital Equity Plan to address the growing demand for fair access to broadband services and digital resources. The objective of this study is twofold: firstly, to gain insights into the current state of broadband connectivity in different states, and secondly, to identify factors that influence broadband adoption and usage within these states. By understanding the factors driving regional differences in broadband usage, policymakers can devise targeted interventions to bridge the digital divide and promote digital inclusion.**

*Index Terms*—Availability, Broadband, Connectivity, Digital divide, State, Usage

# **INTRODUCTION**

Broadband internet access has become an integral part of modern society, enabling individuals and businesses to connect, communicate, and access a vast array of online resources. Policymakers are increasingly prioritizing broadband access due to the growing risk of the digital divide leaving rural communities at a disadvantage. In the United States, the Federal Communications Commission (FCC) has estimated that a minimum of 9.3 million residents in rural areas lack sufficient broadband service [1]. However, there exist significant disparities in broadband connectivity across different regions and states within the United States. Understanding these disparities and their underlying factors is essential for policymakers and researchers to develop targeted strategies that promote equitable access and utilization of broadband services [2].

In this exploratory data analysis (EDA) project, we focus on examining and comparing broadband usage across various states within the United States. By analyzing a comprehensive dataset sourced from Microsoft and the Federal Communications Commission (FCC), we aim to uncover regional variations in broadband adoption and usage patterns.

The objective of this study is twofold: firstly, to gain insights into the current state of broadband connectivity in different states, and secondly, to identify factors that influence broadband adoption and usage within these states. By understanding the factors driving regional differences in broadband usage, policymakers can devise targeted interventions to bridge the digital divide and promote digital inclusion.

The dataset we utilize contains a wealth of information, including broadband availability, speed, subscription rates, and other relevant socioeconomic indicators for different states. By employing rigorous statistical techniques and data visualization methods, we will explore the relationships between these variables, uncovering patterns, trends, and potential correlations.

This analysis will not only provide a comprehensive overview of broadband usage in different states but also shed light on the impact of various socio-economic factors on internet adoption and utilization. Factors such as income levels, education, population density, and infrastructure quality can significantly influence broadband access and usage patterns. By quantifying and understanding these relationships, policymakers can develop targeted policies and initiatives to address the unique challenges faced by different states.

Furthermore, this EDA project aims to contribute to the existing body of academic research on broadband connectivity. By providing a detailed analysis of regional variations in broadband usage, we can expand our understanding of the underlying factors that contribute to the digital divide. This knowledge can inform policy discussions, academic research, and industry practices, leading to evidence-based interventions that enhance broadband accessibility and utilization nationwide.

This EDA project focuses on comparing broadband usage across different states within the United States. By analyzing a comprehensive dataset, we aim to uncover regional disparities in broadband adoption and usage, identify key influencing factors, and provide valuable insights to policymakers, researchers, and industry stakeholders. By understanding the nuances of broadband usage at the state level, we can work towards developing targeted strategies that promote equitable access and bridge the digital divide across the nation.

# **Related Work**

The term "broadband" commonly refers to communication technologies that offer high-speed, continuously available internet connections to numerous residential and small-business users. The presence of broadband infrastructure is crucial for the knowledge economy. Accessible and affordable broadband plays a significant role in fostering innovation, enhancing productivity, stimulating economic growth, and attracting foreign investments. Without the successful spread of broadband, the provision of advanced IP-based services like IP telephony and IP video would be unattainable [3].

* Paper1

However, only in localities located in smaller towns do the results likely to support the presence of a substitution impact between modern broadband technologies and low-skill jobs. The findings frequently support the presence of a job polarization impact in medium-sized communities**. Low-skilled workers**, whose regular duties were initially automated, are now reallocating to the tertiary sector, where new jobs have been created, as in a process of destruction and creation. Additionally, the model predicts that broadband quality has a positive relationship with **high-skill occupations** in smaller communities and a negative relationship with them in larger communities.

With the help of this article, we demonstrate that there is a complicated set of mechanisms at play in the relationship between broadband quality and **income** or **unemployment**. There are both positive and bad impacts. According to our findings, broadband quality can be viewed as a tool to increase digital inclusion and decrease the digital divide between people and territories, with a favorable impact on the decline in unemployment in smaller and medium-sized municipalities, where high-skill jobs are more prevalent and low-skill jobs are more prevalent.[6]

* Paper2

Factors of broadband development and the design of strategic policy framework

* Technologies and methodology for the **Measuring Broadband** American program are created in collaboration with a technical solutions contractor, broadband suppliers, academic researchers, independent researchers, consultants, consumer organizations, other cooperative stakeholders.
* The FCC takes strong measures to ensure the privacy and confidentiality of volunteers. All mobile data is collected without unique identifiers or information such as name, age, or other **demographic** information that could pose risks of identifying a particular volunteer.[7]
* Paper3

Broadband Adoption Rates and Gaps in U.S. Metropolitan Areas

* The adoption trends of broadband are examined by the authors, who then utilize a descriptive analysis to pinpoint the causes of the discrepancies in **adoption rates**.
* The report compares broadband adoption rates across several demographic groups, including age, race, income, and education level, using data from the U.S. Census Bureau and the Federal Communications Commission (FCC).
* Additionally, they look at the accessibility of broadband infrastructure, such as fast internet and mobile devices, in various localities. To pinpoint the elements that contribute to the variations in broadband adoption rates, the authors use descriptive statistics and regression analysis. [8]

# **Method**

Exploratory data analysis (EDA) is a crucial phase in any research investigation. The main objective of conducting exploratory analysis is to scrutinize the data's distribution, identify outliers and anomalies, and guide the focused testing of your hypothesis [4]. It also offers visualization tools to generate hypotheses and gain a better understanding of the data, typically through graphical representations. The purpose of EDA is to aid analysts in recognizing natural patterns within the data.

Exploratory Data Analysis (EDA) can be broadly categorized into two techniques: graphical and non-graphical. These techniques are used to gain insights, discover patterns, and identify potential relationships within the data. Let's discuss each technique in detail:

**1. Graphical Techniques:**

Graphical techniques involve the visual representation of data using plots, charts, and graphs. These techniques are effective in conveying complex information in a concise and intuitive manner. Some common graphical techniques used in EDA include:

1. Histograms
2. Box plots
3. Scatter plots
4. Heatmaps
5. Bar charts

**2. Non-Graphical Techniques:**

Non-graphical techniques involve the use of statistical measures, numerical summaries, and descriptive statistics to explore the data. These techniques focus on quantifying the properties and characteristics of the data. Some common non-graphical techniques used in EDA include:

1. Descriptive statistics
2. Correlation analysis
3. Summary tables
4. Statistical tests:
5. Data transformations

Both graphical and non-graphical techniques complement each other in EDA. Graphical techniques provide visual representations to aid in pattern recognition, while non-graphical techniques offer quantitative measures and statistical insights into the data. By employing a combination of these techniques, analysts can effectively explore and understand the underlying patterns, trends, and anomalies in the data.

**3. PowerBI**

Power BI Desktop, along with Power Query Editor, facilitates the automation of the entire data extraction, transformation, and loading (ETL) process within Power BI. The Power Query Editor keeps a comprehensive log of all actions performed [5].

**3.1 PowerBI for Exploratory Data Analysis (EDA)**

Power BI is a powerful business intelligence tool developed by Microsoft that offers a wide range of capabilities for data analysis, visualization, and reporting. While Power BI is primarily known for its data visualization features, it also provides robust functionalities for conducting Exploratory Data Analysis (EDA).

1. **Data Import and Transformation**:

Power BI allows users to import data from various sources such as databases, Excel files, CSV files, and web services. The Power Query Editor, an integral component of Power BI, enables data transformation and preparation before analysis. It provides a user-friendly interface to perform tasks like cleaning data, removing duplicates, filtering, merging tables, and creating calculated columns. These data preparation steps are essential for conducting EDA effectively.

2. **Data Visualization**:

Power BI offers a wide range of visualization options to represent data in an interactive and visually appealing manner. Users can create various charts, graphs, maps, and tables to explore patterns, trends, and relationships within the data. The visualizations are highly customizable, allowing users to adjust colors, labels, and formatting to enhance clarity and understanding. Power BI also supports interactive features such as drill-through, filtering, and slicing to dive deeper into the data during EDA.

3**. Data Exploration and Analysis**:

Power BI provides interactive tools and features to explore and analyze data during EDA. Users can apply filters, sorting, and grouping operations to segment and aggregate data based on different criteria. Power BI also supports calculated measures and columns, enabling users to perform mathematical calculations, create new metrics, and derive additional insights. Users can leverage features like cross-filtering and cross-highlighting to investigate relationships between variables and identify patterns or outliers.

4. **Advanced Analytics**:

Power BI integrates with advanced analytics tools and languages such as R and Python. Users can leverage these tools to perform advanced statistical analyses, predictive modeling, and machine learning algorithms. This allows for more in-depth EDA, including complex statistical tests, clustering analysis, regression modeling, and forecasting.

5. **Interactive Dashboards and Reporting**:

Power BI allows users to create interactive dashboards and reports to present and share their EDA findings. Dashboards provide a consolidated view of key metrics and visualizations, allowing users to monitor real-time data and track performance. Reports offer a comprehensive narrative by combining visuals, text, and additional insights. Users can collaborate and share their findings by publishing dashboards and reports to the Power BI service or exporting them in various formats for wider dissemination.

Power BI is a comprehensive tool for conducting Exploratory Data Analysis (EDA). It offers data import and transformation capabilities, a wide range of visualization options, interactive exploration and analysis features, integration with advanced analytics tools, and the ability to create interactive dashboards and reports. These features make Power BI an asset for data professionals and analysts seeking to gain meaningful insights and uncover patterns in their data through EDA.

**3.2 Data Acquisition**

The dataset encompasses a diverse range of states within the United States, providing a comprehensive representation of broadband usage across the country. Acquire the dataset on broadband usage from reliable sources, such as Microsoft and the Federal Communications Commission (FCC).

The dataset used for this exploratory data analysis (EDA) was sourced from the Federal Communications Commission (FCC) and contains several attributes pertaining to broadband availability and usage in different regions. The dataset includes the following attributes: "ST" represents the state where the data was collected, "COUNTY ID" is a unique identifier for each county, "COUNTY NAME" specifies the name of each county, "BROADBAND AVAILABILITY PER FCC" indicates the level of broadband availability in each county according to the FCC's metrics, and finally, "BROADBAND USAGE" presents information on the actual usage of broadband services in these areas.

Through conducting EDA on this dataset, we can gain valuable insights into the state of broadband connectivity across various counties and states. By analyzing broadband availability, we can identify regions with limited access to high-speed internet, which could have implications for the digital divide and access to online resources. Moreover, by exploring broadband usage patterns, we can better understand how communities utilize internet services and potentially discover trends or disparities in digital engagement. This dataset offers a valuable opportunity to explore and understand the current landscape of broadband infrastructure and usage, enabling policymakers, researchers, and stakeholders to make informed decisions and bridge the digital gap, ensuring equitable access to the digital world for all citizens.

**3.3 Data Cleaning**

In this section, we conduct an initial assessment of the dataset to identify potential data quality issues, such as missing values, inconsistencies, or duplicates.

The data cleaning address missing values by employing appropriate techniques, such as imputation, removal of rows with missing values, or treating missing values as a separate category, based on the specific variables and the proportion of missing values. It also involves verifying the consistency and accuracy of variables, including variable names, data formats, and coding schemes.

**3.4 Data Transformation**

Create derived variables or aggregates as required to provide additional insights. For instance, aggregating broadband usage data at the state level from state-level data can facilitate state-level comparisons and analysis. In this step, we use means as the statistical measures for the aggregation.

**3.5 Exploratory Data Analysis (EDA) in Power BI**

Exploratory Data Analysis (EDA) is a crucial step in any data analysis project, as it helps you understand the dataset, identify patterns, and uncover insights. Power BI is a powerful tool for visualizing and exploring data, providing various visualization techniques to analyze and present your findings effectively. In this section, we will discuss how to conduct EDA in Power BI, focusing on pie charts and line graphs for aggregating continuous data.

### **3.5.1 Importing the dataset.**

Start by importing the cleaned and transformed dataset into Power BI. Power BI supports a wide range of data sources, including Excel spreadsheets, CSV files, SQL databases, and more. Use the appropriate data source connector to import your dataset and ensure that it is properly loaded into Power BI.

### **3.5.2. Data modeling**

Power BI's data modeling capabilities allow you to define relationships between tables or variables if applicable. This step is crucial when working with multiple tables or datasets that have related information. By establishing relationships, you enable accurate and efficient analysis across different tables or variables. Use the "Manage Relationships" feature in Power BI to define and manage these relationships.

## **3.6 Development of dashboard**

1. **Line Graph:**

The line graph section of the Power BI dashboard will illustrate the trends in the difference between broadband availability and usage metrics of each state compared to Kansas over time. This visualization will allow users to observe how each state's metrics differ from the benchmark over different periods, providing insights into variations in broadband adoption and utilization.

1. **Bar Chart:**

In the bar chart section, the dashboard will display the absolute differences in broadband availability and usage metrics of each state compared to Kansas. By presenting this data in a bar chart format, users can easily compare the magnitudes of these differences, helping them identify states with the highest and lowest gaps from the Kansas benchmark.

1. **Pie Chart:**

The pie chart section will showcase the percentage distribution of states based on their positive or negative differences in broadband availability and usage compared to Kansas. This visualization will provide a clear picture of how states are distributed concerning their performance relative to the benchmark.

1. **Filled Map:**

The filled map section will visualize the spatial distribution of positive and negative differences in broadband availability and usage across different states. The map will use color-coding to highlight regions with varying degrees of improvement or lag compared to Kansas, enabling users to grasp spatial disparities at a glance.

By utilizing the differences in broadband availability and usage metrics between each state and Kansas as the data for the visualizations, the Power BI dashboard will provide a comprehensive and interactive platform to explore and analyze the relative performance of states compared to the Kansas benchmark. This approach will empower stakeholders to identify areas for improvement, make informed decisions, and take targeted actions to bridge the digital divide and promote equitable access to broadband services nationwide.

# **Results**

This chapter presents the findings and outcomes of the data analysis and visualization process conducted in this project. This chapter provides a comprehensive account of the insights gained from the Power BI dashboard, which was developed to explore broadband availability and usage across different states in America, with a focus on comparing the metrics to the benchmark data for Kansas. The dashboard visualizations, including line graphs, bar charts, pie charts, and filled maps, offer a detailed understanding of the disparities and trends in broadband connectivity throughout the country. By subtracting broadband availability and usage of all states from that of Kansas, the delta analysis has been used to shed light on how states perform relative to the benchmark, enabling stakeholders to make informed decisions and bridge the digital divide. In this section, we present an overview of the key results obtained from the dashboard, highlighting the significant findings that contribute to our understanding of the broadband landscape in America and the implications for policy formulation and equitable access to internet services.

A screenshot of a graph

Description automatically generated

Figure 1: Overview of the broadband availability and usage across all state in 2019

A close-up of a chart

Description automatically generated

Figure 2:Overview of the broadband availability and usage across all state in 2020

Figures 1 and 2 showcase the first and second pages of the Power BI dashboard, respectively, illustrating average broadband availability and usage metrics across all states for the years 2019 and 2020. The dashboard's visualizations, encompassing line graphs, bar charts, pie charts, and filled maps, provide insightful representations of the broadband landscape in America.

The analysis involved computing the differences in broadband availability and usage metrics for each state concerning the corresponding benchmark values of Kansas. This approach allowed stakeholders to identify states performing above or below the benchmark, offering valuable insights into regional disparities and trends. The findings from the dashboard offer a comprehensive overview of how states have evolved in terms of broadband connectivity over time and enable a nuanced understanding of the factors influencing variations in adoption and utilization.

By presenting the average broadband availability and usage metrics for the years 2019 and 2020, the Result chapter highlights any notable changes in broadband adoption and usage trends during this period. The chapter emphasizes the significance of the observed variations, as they provide crucial information for policy formulation and decision-making to bridge the digital divide. The implications of the results are discussed in-depth, along with recommendations for promoting equitable access to internet services nationwide.

Throughout the Result chapter, the Power BI dashboard serves as a powerful tool to explore the intricate patterns within the data, enabling stakeholders to make data-driven decisions and implement targeted interventions to address disparities in broadband accessibility. The chapter concludes with a comprehensive summary of the key findings, outlining their contributions to the field and the potential avenues for further research in the domain of broadband connectivity and equitable internet access.

A screenshot of a graph

Description automatically generated

Figure 3: Delta plot with kensas as benchmark in 2019

A screenshot of a graph

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Figure 4: Delta plot with kensas as benchmark in 2020

The Result chapter presents the comprehensive findings and outcomes derived from the analysis and visualization of broadband availability and usage data across different states in America. The primary focus of this analysis was to compare the broadband metrics of each state with the benchmark data from Kansas, using a delta approach. The research utilized Power BI to develop an interactive dashboard, facilitating the exploration of broadband trends, disparities, and performance variations. Figures 3 and 4 showcase the delta plots, illustrating the differences between broadband availability and usage metrics across all states compared to the Kansas benchmark.

Figure 3 displays a bar chart illustrating the absolute differences in broadband availability for each state during the year 2019 in comparison to Kansas. Positive values indicate states with higher availability than Kansas, whereas negative values denote states with lower availability. The height of each bar corresponds to the magnitude of the difference, facilitating swift identification of states with significant deviations from the benchmark.

Figure 4 portrays the delta plot for broadband usage in the year 2019, visualized using a bar chart. This visualization presents the absolute differences in broadband usage metrics for each state concerning the Kansas benchmark. Positive values signify states with higher broadband usage rates than Kansas, while negative values indicate states with lower usage. Similar to Figure 3, the height of each bar represents the extent of the difference, enabling stakeholders to pinpoint states exhibiting notable contrasts from the benchmark.

The analysis of the delta plots offers valuable insights into the relative performance of each state concerning broadband availability and usage when compared to the Kansas benchmark. States with positive values in the delta plots have surpassed the benchmark, indicating commendable progress in broadband adoption and utilization. Conversely, states with negative values suggest disparities in broadband connectivity, highlighting areas that may require targeted interventions and support.

The comparison between delta plots for different years (e.g., 2019 and 2020) allows for the examination of temporal trends in broadband performance. Analyzing changes in the magnitude of differences over time enables the identification of patterns and improvements in broadband adoption and usage, providing a comprehensive understanding of the evolving broadband landscape across the United States.

A map of the united states

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Figure 5: broadband usage across all states in 2019

A map of the united states

Description automatically generated

Figure 6: broadband availabilty across all statein 2019

A map of the united states

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Figure 7: broadband usage across all states in 2020

A map of united states

Description automatically generated

Figure 8: broadband availability (FCC) across all states in 2020

The visual representations of the delta plots were accomplished through Figures 3 and 4, showcasing the absolute differences in broadband availability and usage metrics for the year 2019 using bar charts.

Additionally, Figures 5 and 6, as well as Figures 7 and 8, were utilized to depict the delta plots for broadband availability and usage in 2019 and 2020, respectively. These visualizations employed filled maps with a gradient color representation. In the filled maps, states were color-coded based on the magnitude of the difference between their broadband availability and usage metrics and the Kansas benchmark. The color gradient ranged from red (indicating the highest positive difference) to light colors (representing the lowest negative difference).

Figure 5 showcased the delta plot for broadband availability in 2019. States shaded in red exhibited higher availability than Kansas, while the lightest colors indicated lower availability relative to the benchmark. In Figure 6, the delta plot for broadband usage in 2019 was displayed using the same filled map with a gradient color scheme. States shaded in red demonstrated higher usage than Kansas, while the lightest colors represented lower usage compared to the benchmark.

Similarly, for the year 2020, Figure 7 illustrated the delta plot for broadband availability, and Figure 8 presented the delta plot for broadband usage. The filled maps depicted the disparities between each state's metrics and the Kansas benchmark. Red colors on the maps denoted higher broadband availability and usage, while lighter colors indicated lower values relative to the benchmark.

The filled map with gradient color representation provided a visual insight into the disparities in broadband availability and usage across states. The color gradient allowed stakeholders to discern the relative performance of each state concerning the Kansas benchmark. Darker colors (e.g., red) signified substantial positive differences, indicating states with superior broadband performance. On the other hand, lighter colors suggested negative differences, highlighting areas that may require interventions to improve broadband adoption and usage.

The Result chapter, enriched by the filled map delta plots, offered an in-depth exploration of the spatial disparities and trends in broadband connectivity across America. This analysis enhanced our understanding of regional variations in broadband access and utilization, thereby guiding policymakers and stakeholders in formulating targeted strategies to bridge the digital divide and ensure equitable access to high-speed internet services nationwide. The comprehensive insights gleaned from the delta plots are valuable for evidence-based decision-making and fostering inclusive connectivity throughout the nation.

# Conclusion

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Overall we would like to conclude that this insights can inform targeted interventions and policy decision to bridge the digital divide, ensuring equitable broadband connectivity and fostering a digitally inclusive society.

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