

Impact of Digital Data Visualization Technologies on Business Decision-Making in Big Data Analysis

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ABSTRACT

Big Data is the term used to describe a large amount of information gathered from various resources of organized (structured), semi-structured, and unstructured data types which is difficult to assess with standard methods and resources. Computer based visualization provides users with communication of analyzed information to help them to make data driven business decisions. Data visualization is the process of presenting copious quantities of data graphically. In this method, data are presented in a graphical form, which is easy for the user to understand a sequence of events. This is a term for an interface that the user and computer make use of together, that the process of storing, processing, and presenting gigabytes of data takes place on some number of technologies. Visualization tools — frontend tools — and data processing and storage tools — backend tools. Visualization is about improving accuracy and the way the data is presented. We have many traditional techniques for visualizing data. Although they cannot see the possibilities of big data. The content can be displayed in images - charts, graphs, animations, images moving. Appropriate visualization of big data can impact how an organization can find hidden insights, better decisions, and automate business processes. The importance of large data visualization; procedures to be undertaken in selecting a visualization tool; categorization of the tools based on different criteria all form part of this study.

Keywords: digital data visualization, tools and approaches for digital data visualization, big data, big data analysis.

1. INTRODUCTION

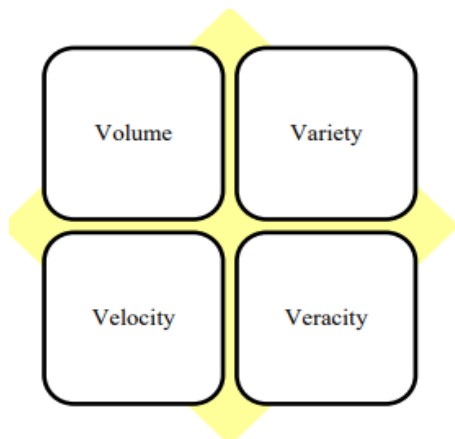


Fig 1: Features of Big Data

Big Data is the vast amount of information gathered from multiple sources, including semi-structured, unstructured, and structured data types. Big data is growing in volume because of the widespread availability of digital data sources like computers, smart phones etc. The volume and variety of big data will continue to rise quickly due to the advancement of digital technologies. Complicated data cannot be sufficiently analyzed by traditional digital data analysis methods to yield meaningful information.

- **Volume:** Today, many of these businesses now oversee petabytes (PB), exabytes (EB), zettabytes (ZB), and yottabytes (YB) of digital data.
- **Variety:** There are a variety of formats in which digital data comes, such as text files, audio files, video files, images, semi structured emails, and unstructured chat logs.
- **Velocity:** Large data analysis needs to be done quickly to obtain the ability to get timely information.
- **Veracity:** Care on analysis-based information ought to lead to many judgments since the data provided ought to be true and accurate.

2. BACKGROUND

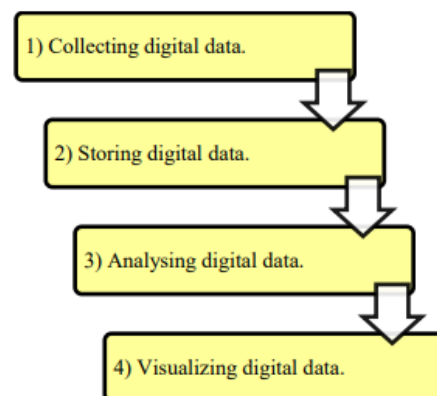


Fig 2: Steps in Big Data Analysis

A brief description of the steps involved for big data analysis is the step of gathering, storing, analyzing, and visualizing the data. Each of these procedures is equally important to the

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firms. However, every procedure has a separate task to achieve. Big data features (Fig 2) explain what companies have; big data analysis explains how companies can utilize them to their advantage. Big data analysis helps with a ton of other things — like forecasting revenue, developing new products, making good decisions, and understanding client behavior. In this analysis, different instruments are used. Front end tools are those that is used to picturize the data that we have studied, and the backend tools are those which is used to store and process data.

2.1 SIGNIFICANCE

- There are dissimilar sources that businesses are using to collect digital big data. Any company may have diverse types of data that they need depending on their business. Organizations may be integrated with data on students, clients, goods, services, sales, finances, and patients. The data to be preserved is heterogeneous, coming from many sources and in different formats, making it difficult to preserve digital data uniformly. Digital data analysis is crucial to retrieve relevant information from large datasets, The data presented for simple communication is graphically represented on the analyzed data. Depending on their business, any company may require distinct types of data. Data on students, clients, goods, services, sales, finances, and patients may all be integrated by organizations.

3. LITERATURE REVIEW

The increasing complexity of data and technological breakthroughs are reflected in the development of data visualization technologies. The static charts and graphs of the early tools were frequently updated manually. On the other hand, dynamic, interactive aspects of contemporary digital visualization tools let users examine data in real time. Advances in computing power, data storage, and software technology have propelled this trend.

3.1 HISTORICAL PERSPECTIVE AND CURRENT TRENDS

- **Initial Developments:** It is the mid-18th century inventions of William Playfair for the creation of bar and line charts which first led to study in data visualization (Playfair, 1786). These early visualizations were limited by their static representations as well as their lack of interactive qualities, however they certainly rooted the coaxing of quantitative data into forms that could be grasped. These early graphics formed the basis of learning to understand data distributions and trends. Development of bar and line charts are credited with inspiring early study in data visualization (Playfair, 1786). Despite their limitations due to their static representations and lack of interactive aspects, these early visualizations played a crucial role in converting quantitative data into forms that could be understood.

- The basis for comprehending data distributions and trends was established by these early graphics. Using statistical graphics was used by Florence Nightingale to promote more hygienic conditions in hospital. Some of the first examples of the use of data visualization to impact public policy were the polar area diagrams, better known as her Nightingale roses.
- **Digital data visualization's emergence:** With the emergence of digital technologies data visualization has gone far more advanced. With programs such as Microsoft Excel (which is interactive and dynamic) and later utilizing specialist platforms such as Tableau and Power BI (Few, 2009; Tableau, 2023), interactive and dynamic visualizations can be created. These tools—features like filters and drilldowns made it easier to explore data in a more sophisticated way. First, the idea of interactive dashboards (in which users can work with and change data in real time) was introduced by digital technologies. are credited with inspiring early study in data visualization (Playfair, 1786). Despite their limitations due to their static representations and lack of interactive aspects, these early visualizations played a crucial role in converting quantitative data into forms that could be understood.
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- **Innovative Visualization Technologies:** The fusion of data visualization technologies with artificial intelligence (AI) and machine learning (ML) is one recent development. According to Chui et al. (2018), artificial intelligence (AI) can be used to automate extraction insights, anomaly detection, and predictive analytics, all of which can improve decision-making.
- Virtual reality (VR) and augmented reality (AR), two more contemporary visualization technologies that provide immersive experiences with data exploration, are also available. Through three-dimensional interactions, these technologies enable users to comprehend complex datasets more intuitively, as demonstrated by research by Dodge et al. (2015).

4. RESEARCH METHODOLOGY

To ensure validity and reliability of the study, one has to use a strong research design when taking a look at how data visualization affects corporate decision making. The approach selected should be tailored to specific goals and questions that the research tasks and to specific setting of the technology sector. This research involved proposing a study plan, which we describe here. Qualitative research methodology will be used in this study's research design. plan for this research. This study's research design will use qualitative research

methodology.

4.1 Research Objectives

- **Evaluate the Effects of Big Data Analysis on Data Visualization Tools:** This assessment aims to investigate how digital data visualization technologies assist in processing and understanding of some big institutional datasets.
- **Determine the Advantages of Tools for Data Visualization in Business Decision-Making:** What are the benefits that data visualization tools offer to the corporate decision makers?
- **Examine the Difficulties and Restrictions of Using Data Visualization Technologies:** Assess and understand the common impediments and constraints companies face when deploying digital data visualization technologies and executing them.
- **Examine and contrast the efficacy of various data visualization tools:** Cooperatively evaluate the features, usability, and effects of the different data visualization tools on big data analysis.
- **Recognize the Views and Experiences of Users with Data Visualization Tools:** To collect and evaluate user feedback for learning about the experiences and satisfaction levels of users of data visualization tools.

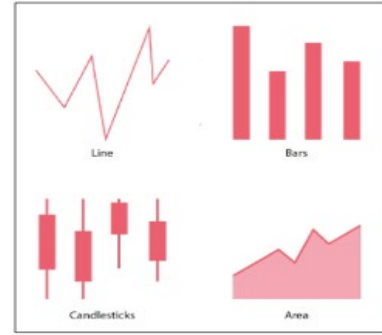
5. ANALYSIS AND CATEGORIZATION

The information gathered from the chosen sources was divided into themes and topics, such as best practices, data visualization types, and advantages. Key findings and insights were able to be synthesized through an organized and thorough analysis of the literature made possible by this categorization.

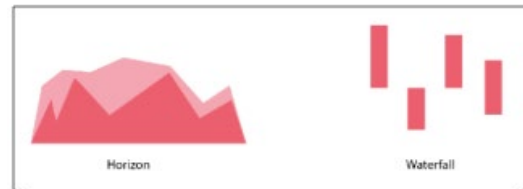
5.1 TYPES OF DATA VISUALIZATIONS

Data visualization is the key to convert raw data into visions which can be used into practice. It allows us to interpret complex information in such a way that it is efficient for analysis, decision making, and the public alike. In this investigation we analyze popular types of data visualization and demonstrate their benefits.

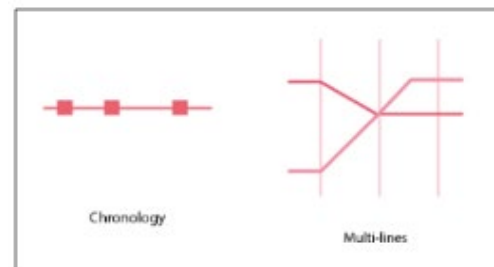
1. **Line:** Data points are displayed on a continuous line in line charts, which illustrate trends for a time frame or between variables.
2. **Bars:** Rectangular bar charts are used to display data, which facilitates cross-category value comparison.
3. **Candlesticks:** Financial data is shown on candlestick charts, which show price changes over a given time limit.
4. **Area:** Area charts display cumulative data trends by filling the space beneath the line, making them resemble line charts.



5. **Horizon Charts:** It is used for observing enormous datasets because they condense data in a compact manner.



6. **Waterfall:** A waterfall chart illustrates cumulative effect of sequentially introducing positive and negative numbers.
7. **Chronology Charts:** It displays the temporal sequence of events or data points by displaying them in chronological order.
8. **Multiline Charts:** It helps in doing and displaying comparisons of several data series on a single graph.



Every one of these categories of data visualization provides a different angle on the data, enabling users to customize their presentations according to the features of their data and the messages they want to deliver.

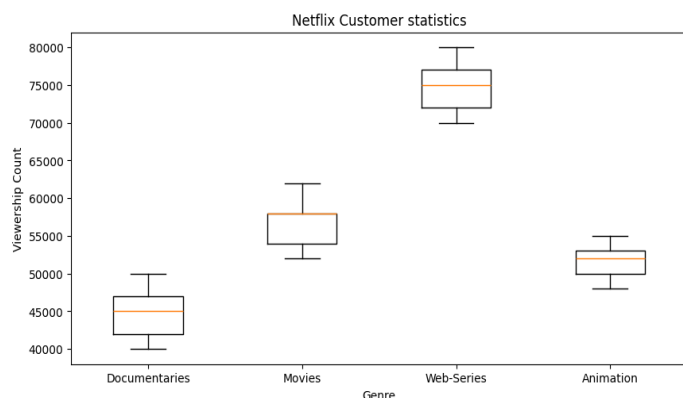
6. CASE STUDIES AND REAL-WORLD EXAMPLES

One cannot emphasize how important data visualization is to the variety of enterprises that exist today. Organizations in a variety of industries, including retail, entertainment, healthcare, technology, and transportation, are utilizing data visualization to shed light on their decision-making procedures. With the help of this game-changing tool, they can make data-driven decisions that significantly affect company operations, strategies, and consumers' overall experiences. In this investigation, we explore the tremendous impact of data

visualization, as demonstrated by case studies and real-world examples that highlight its importance in forming the modern business and innovation environment.

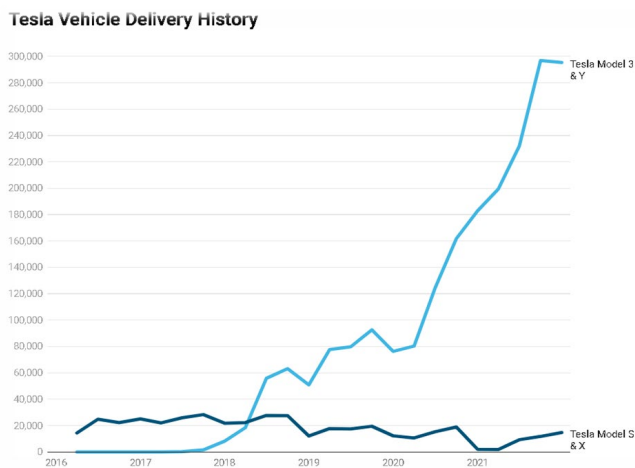
6.1 Content Strategy of Netflix

Netflix makes a lot of decisions about its content strategy using data visualization. To decide which television series and films to create or buy, they examine viewership statistics, user reviews, and watching patterns. Visualization technologies facilitate the identification of patterns, comprehension of audience preferences, and efficient resource allocation, resulting in the production of well-liked original material such as "Stranger Things." The following Box plot shows viewership statistics of specific genres.



6.2 Tesla Vehicle Delivery History

A line graph, sometimes called a line chart, illustrates developments and patterns over a given period. Consider this actual example of the delivery history of Tesla vehicles since 2016. This line graph makes the exponential growth of the Model 3 and Y very evident whereas Tesla's Model S and X deliveries have been steadily declining.



Line graphs work best when displaying comparative contrasts and trends. These graphs can be used in Revenue Operations to

show trends in sales over time. Include several lines that highlight certain products together with the growth or decline in their sales.

7. FINDINGS

After conducting an extensive literature search and analyzing real-world case studies, this paper has identified numerous important conclusions that highlight the importance of data visualization in business decision-making. These results shed light on the benefits of data visualization, the variety of visualizations that are used, and the best practices that support their efficacy:

7.1 Improved Understanding: Data visualization makes difficult data easier to understand for all parties involved. The constraints of raw data are overcome by visual representations, which let people understand complex information more naturally.

7.2 Effective Communication: By acting as a universal language, visualizations make it easier to communicate data-driven insights to a wide range of people. Between technical experts and decision-makers, they provide a bridge.

7.3 Prompt Decision-Making: In the hectic environments of contemporary business, prompt decision-making is critical. Data visualization speeds up the assimilation and comprehension of data, allowing for quick reactions to changing market situations.

7.4 Recommended Practices for Efficient Visualizations: These comprise putting emphasis on simplicity and clarity in the design of the visualization, making sure that it is relevant to the goals of decision-making, involving users through interaction, keeping design elements and labeling consistent.

7.5 Real-world Impact: Data visualization has revolutionized decision-making processes, as demonstrated by case studies from a variety of industries, including marketing, supply chain management, healthcare, and finance. These illustrations demonstrate the usefulness of data visualization in promoting corporate performance.

7.6 Ethical Considerations: In data visualization, inclusion and accessibility have become crucial moral requirements. Because it increases the impact of data-driven insights, making sure visualizations are accessible to all users, regardless of ability, is both morally right and practically sound.

The combined results of these studies highlight the fact that data visualization is a strategic advantage for firms rather than just a plain tool. Companies looking to fully utilize data visualization in their decision-making processes might refer to the best practices this evaluation found as a set of guidelines.

8. BEST PRACTICES IN DATA VISUALIZATION

To produce insightful and useful representations that aid in decision-making, best practices in data visualization approaches and techniques are essential. The following are important best practices:

Table -1: Best Practices

Sr. No.	Best Practices	Description
1.	Clarity and Simplicity	Keep visualizations straightforward to convey information effectively.
2.	Relevance	Focus on data that aligns with decision-making objectives.
3.	Interactivity	Enable users to explore data through interactive features.
4.	Consistency	Maintain uniform design elements for user comprehension.
5.	Accessibility	Ensure inclusivity for all users, including those with disabilities.
6.	Appropriate Chart Types	Select suitable chart types for data representation.
7.	Data Storytelling	Craft a narrative to guide viewers through insights.
8.	Use of Color	Employ color purposefully and avoid overuse.
9.	Data Labels and Annotations	Include clear labels and explanations.
10.	Effective Use of Space	Optimize space without overcrowding
11.	Scale and Axes	Choose accurate scales and label axes clearly
12.	Testing and Feedback	Gather user feedback to refine visualizations
13.	Mobile-Friendly Design	Ensure accessibility on mobile devices
14.	Performance	Optimize speed, especially for large datasets
15.	Data Source Transparency	Provide information on data sources and limitations.

Following these guidelines will help you produce data visualizations that facilitate decision-making, effectively communicate insights, and offer a simple and intuitive user experience.

9. IMPACT OF DATA VISUALIZATION

Effective communication, well-made decisions, and organizational success are all greatly impacted by data visualization. Data visualization helps to make better judgments by providing decision-makers with an easy-to-understand and clear representation of the facts. Trends, patterns, and anomalies are easier to identify because complex data is simplified. With greater knowledge comes the ability to make better informed decisions, which leads to more accurate and successful decisions being made by decision-makers.

It serves as an all-encompassing language that transcends boundaries and conveys meaningful ideas to a diverse audience. Accessing and comprehending the visual narrative derived from intricate data is effortless for stakeholders with varying levels of data literacy. Improving communication within companies as well as with partners and clients promotes consensus on crucial-issues.

Visualization is a critical element in enhancing organizational effectiveness. It assists businesses in identifying areas that require improvement, optimizing processes, and grabbing growth opportunities. Visualizations of key performance indicators (KPIs) provide businesses with up-to-date information that allows them to react swiftly to changing market situations. As a result, companies that employ data visualization usually see cost savings, better efficiency, and a competitive edge.

In conclusion, data visualization stimulates improved decision-making, makes it easier for stakeholders to communicate effectively, and boosts organizational performance. It uses visual insights to provide businesses with the advantage they need to succeed in today's data-driven environment.

10. CONCLUSION

In today's data driven corporate world – data visualization is crucial to understanding, communicating, and analyzing complicated data. It gives the firm the flexibility to make the transition into changing conditions. Best practice helps to create effective visualizations through engagement, consistency, relevance, accessibility, and clarity.

Ethics, accessibility and inclusivity foster trust and case studies are illustrated through examples based in future real-life situations. That is why data visualization is always needed, it sparks creativity and efficiency. The next research work is to enhance moral frameworks, customization, and communication.

In today's world, the amount of available data is growing exponentially at rapid rates and simply storing it is no longer enough for businesses to gain a competitive edge.

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