

**UNDERSTANDING THE CONCEPTS AND APPLICATIONS OF DATA
VISUALIZATION, REAL TIME ANALYTICS AND EFFECTIVE USE OF TOOLS
AND TECHNIQUES IN VARIOUS BUSINESS DECISIONS**

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Abstract: Organizations are accumulating a growing volume of data daily. To use this abundant supply of information, an increasing number of people must engage in data evaluation and information science. Data visualization significantly enhances the exploration of data, understanding of its structure, and discovery of new insights. Consequently, the rising interest in data science and analytics is accompanied by an increasing interest in data visualization and exploratory data analysis. We will delineate how current data visualization techniques are effectively used across various phases of the data science process. In many instances, visualization is advantageous; however, more study will be required for other categories. The extensive array of frameworks and apps for data visualization has promoted their use in data science. We shall delineate the distinctions among the libraries and apps presently accessible. Regrettably, a significant disparity persists between advancements in visualization research over recent decades and the functionalities offered by widely used tools and data science applications. While fundamental charting tools are often accessible, more sophisticated visualization approaches have seldom been included as new features so far.

Keywords:*Data, Visualization, Tools and Techniques, Data wrangling, Principles*

I).INTRODUCTION: In recent years, data science has emerged as a significant scientific discipline. Data science is characterized as a "concept to integrate statistics, data analysis, machine learning, and associated methodologies" to "comprehend and analyze real-world phenomena using data" Data science encompasses more than just statistical data analysis; it involves the multidisciplinary amalgamation of methodologies from mathematics, statistics, computer science, and information science. Data science necessitates the use of domain knowledge for the analysis and interpretation of data and findings. Research in data visualization is mostly influenced by the contemporary use cases encountered by users while handling data. The challenges and assignments faced by data scientists are, inherently, a valuable resource for advancements in data visualization research. Conversely, data scientists often use data visualizations to interpret data. Recent results from interviews with data professionals indicate that data scientists often adhere to a consistent process, whereby many phases can be seen. Each level has distinct issues for data management. At the outset of the process, data wrangling is seen as a crucial and laborious component. Data wrangling includes, among other tasks, data processing, cleansing, and combining. Data visualization approaches facilitate the rapid identification of data deficiencies such as missing values, anomalies including duplicates or outliers, and other irregularities at this stage. Subsequently, data scientists must comprehend the available data and assess its applicability for modeling. Data visualization facilitates comprehension of data structure, identification of correlations and clusters, and selection of data subsets appropriate for modeling.

II). CONCEPTUAL AREA OF DATA VISUALIZATION TOOLS:The present surge in data science significantly enhances data visualization strategies used by consumers across several areas. This has resulted in the development of several new data visualization tools and packages. Numerous libraries are open-source and integrated into programming environments like as Python, R, and JavaScript. Notable examples of such libraries are Matplotlib (Python), ggplot2 (R), and D3 (JavaScript). Open source solutions provide significant advantages since data scientists can depend on a vast community for guidance and assistance, along with access to an extensive array of libraries and plugins. Particularly for Python, there are libraries for high-performance computing, numerical analysis, regression modeling, and data visualization, which are consistently updated and maintained. Conversely, comprehensive, independent visual analysis programs have been progressively developed in recent years. Applications like Tableau, Microsoft Power BI, and Quick provide accessible data visualization and visual data exploration for people without expertise in programming, data manipulation, or visualization design. Standalone applications are

often commercial since they need substantial maintenance and ongoing development. Data visualization and visual analysis are increasingly recognized and used across several fields, with numerous consumers and domain experts using these tools.

III).OBJEJCTIVES OF THE STUDY:

- ❖ To analyze the present relevance of data visualization & real time analytics tools and techniques in various business decisions.
- ❖ To determine how various data visualization techniques are used across various phases of the data science process.

IV).REVIEW OF LITERATURE:

Visual analytics has emerged as a powerful approach for analyzing and visualizing large-scale, complex data across various domains. It combines interactive visualization techniques with computational analysis to enable effective exploration of trends, patterns, and relationships in time-oriented and high-dimensional data (*Aigner et al., 2007; Pezzotti, 2019*).

The integration of visual analytics in real-time analytics has become crucial for transforming raw data into actionable insights, supporting critical decision-making processes in enterprise environments (**Ramadhan,W., &Niam,I2024**). In different domains, visual analytics employs diverse tools and techniques.

In cyber security, graph methodology and network analytics are heavily used to identify criminal relationships and detect fraudulent transactions (*Damasevicius et al., 2020; Lokanan, 2022*). For scientific data exploration, a combination of information visualization and scientific visualization techniques is utilized to balance analytical effectiveness and computation time (*Wong et al., 2014*).

In the context of Internet of Things (IOT), various chart types and visualization tools are employed to generate real-time knowledge from continuous data streams across multiple sectors like healthcare, energy, and smart cities (*Protopsaltis et al., 2020*).

The design of visual analytics systems is evolving towards more user-centric approaches. The concept of analytical representation (AR) has been proposed to formally abstract user requirements and desired analytical trails, independent of the actual visualization design (*Shi.C2021*).

This approach aims to leverage domain knowledge and optimize both the analysis blueprint and visualization design. As the field progresses, there is a growing need for more

sophisticated visualizations that deeply engage with educational theories, especially in learning analytics contexts (*Vieira et al., 2018*).

Future trends in visual analytics include the integration of artificial intelligence and immersive technologies, which will further enhance the ability to derive insights from complex, large-scale datasets across various domains (*Ramadhan & Niam, 2024*).

V).DATA VISUALIZATION INSTRUMENTS: AN EXTENSIVE EXAMINATION:

Data visualization tools are software programs intended to assist users with creating interactive and dynamic representations of data, so facilitating understanding, analysis, and communication of findings. These innovations let users convert intricate data into clear and compelling visual representations, enhancing decision-making and narrative communication.

VI).CATEGORIES OF DATA VISUALIZATION INSTRUMENTS:

- ❖ **Business Intelligence (BI) Tools:** These instruments provide an extensive framework for data analysis, reporting, and visualization. Examples include *Tableau, Power BI, and Qlik View*.
- ❖ **Data Science and Machine Learning Instruments:** These instruments are intended for sophisticated data analysis, modeling, and visualization. Examples include Python libraries such as *Matplotlib, Seaborn, and Plotly*, with *R packages such as ggplot2 and Shiny*.
- ❖ **Cloud-based Data Visualization Tools:** These tools provide web-based platforms for data visualization, emphasizing user-friendliness and collaborative features. Examples include *Google Data Studio, Microsoft Power BI, and Tableau Online*.

VII). PRINCIPAL ATTRIBUTES OF DATA VISUALIZATION INSTRUMENTS:

- ❖ **Data Connectivity:** The capability to establish connections with diverse data sources, including databases, spreadsheets, and cloud storage services.
- ❖ **Data Preparation:** Attributes for data cleansing, transformation, and aggregation to ready data for visualization.
- ❖ **Visualization Alternatives:** A variety of visualization formats, including charts, graphs, maps, and interactive dashboards.
- ❖ **Interactivity:** The capacity to analyze, refine, and investigate data instantaneously.
- ❖ **Collaboration:** Functions for sharing, discussing, and cooperating on visualizations with others.

- ❖ **Narrative Construction:** Instruments for developing narratives and presentations centered on data findings.

VIII).PREVALENT DATA VISUALIZATION INSTRUMENTS:

- ❖ **Tableau:** A premier business intelligence tool for data visualization and analytics.
- ❖ **Power BI:** A Microsoft business analytics solution that provides data visualization and business intelligence functionalities.
- ❖ **D3.js:** A widely used JavaScript toolkit for creating dynamic, interactive data visualizations inside web browsers.
- ❖ **Matplotlib:** A popular Python package for generating static, animated, and interactive visualizations.
- ❖ **Plotly:** A Python module for generating interactive, web-based visualizations.
- ❖ **Google Data Studio:** A complimentary, web-based tool for data visualization and reporting.
- ❖ **QlikView:** A business intelligence platform for data visualization, reporting, and analytics.
- ❖ **Sisense:** A cloud-based business intelligence tool for data visualization and analytics.

IX).OVERVIEW OF DATA VISUALIZATION TECHNIQUES:

Data visualization techniques are methods used to represent data in a graphical format, making it easier to understand, analyze, and communicate insights. These techniques help to uncover patterns, trends, and correlations in data, facilitating informed decision-making and effective storytelling. In this section, we will delve into various data visualization techniques, their applications, and best practices.

1. Bar Charts

Bar charts are a popular visualization technique used to compare categorical data across different groups. They consist of rectangular bars of varying lengths, with each bar representing a category and its corresponding value.

a) Types of Bar Charts:

- ✓ **Vertical Bar Charts:** Used to compare categorical data across different groups.
- ✓ **Horizontal Bar Charts:** Used to compare categorical data across different groups, with a focus on the category labels.
- ✓ **Stacked Bar Charts:** Used to display the contribution of each category to a total value.

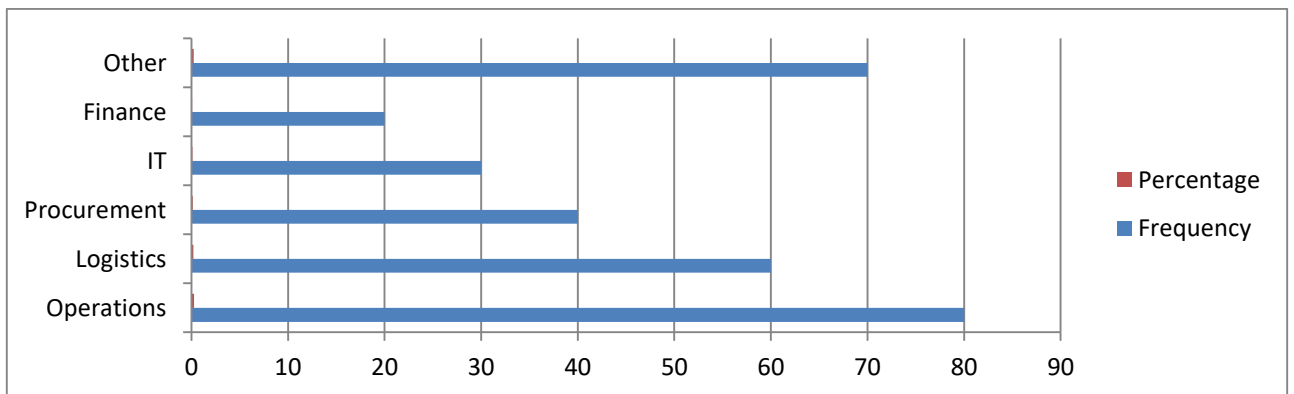
Let us consider the example of 300 respondents from organization who are holding different positions. Representation of this data in multiple charts

Table: 1 Respondent's from Organization –Holding Different Positions

Designation	Frequency	Percentage
Manager	120	40.0%
Executive	60	20.0%
Staff	90	30.0%
Other	30	10.0%

Interpretation: In this above table it explains the frequency of the different position of designation of the respondents how they are responding in different parameters we are considering here one example for representation of the data.

Chart: 1

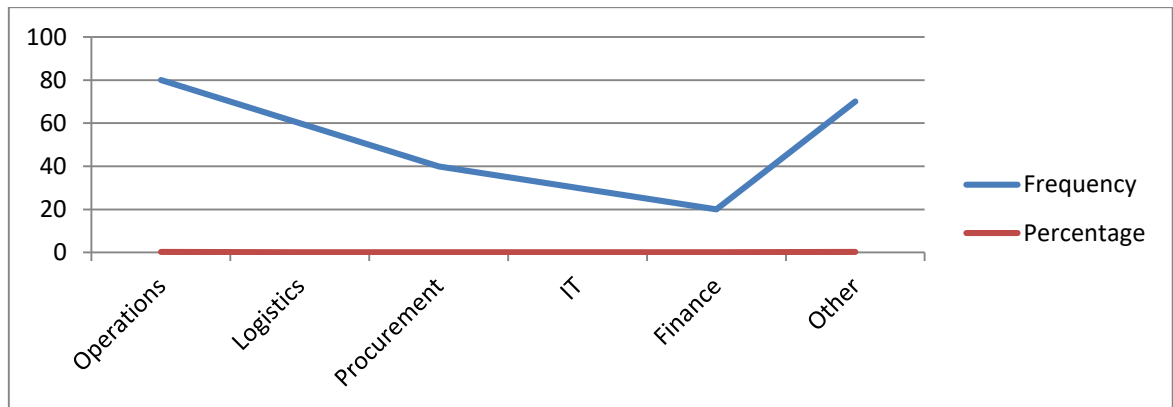


2). Line Charts

Line charts are used to display trends and patterns in data over time or across different categories. They consist of a series of connected points, with each point representing a data point.

b)Types of Line Charts:

- ✓ **Simple Line Charts:** Used to display a single series of data.
- ✓ **Multiple Line Charts:** Used to compare multiple series of data.
- ✓ **Area Charts:** Used to display the cumulative total of a series of data.

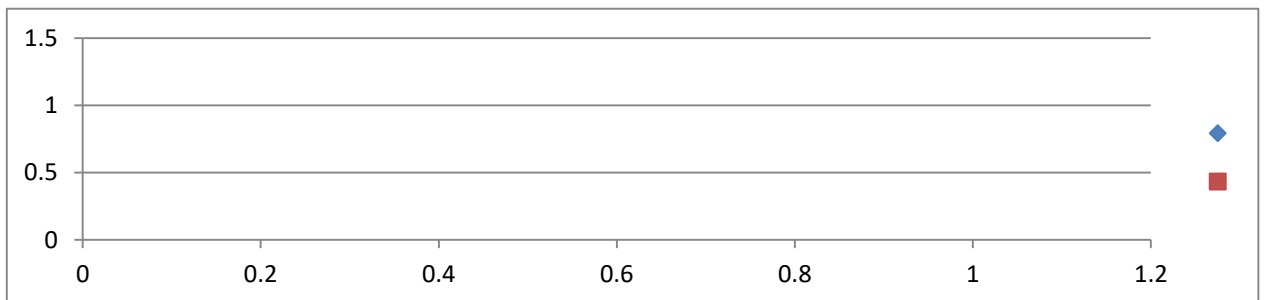
Chart: 2 Respondent's from Organization –Holding Different Positions

3). Scatter Plots

Scatter plots are used to visualize the relationship between two continuous variables. They consist of a collection of points, with each point representing a data point.

c) Types of Scatter Plots:

- ✓ **Simple Scatter Plots:** Used to display the relationship between two variables.
- ✓ **Bubble Charts:** Used to display the relationship between three variables, with the size of the bubble representing the third variable.

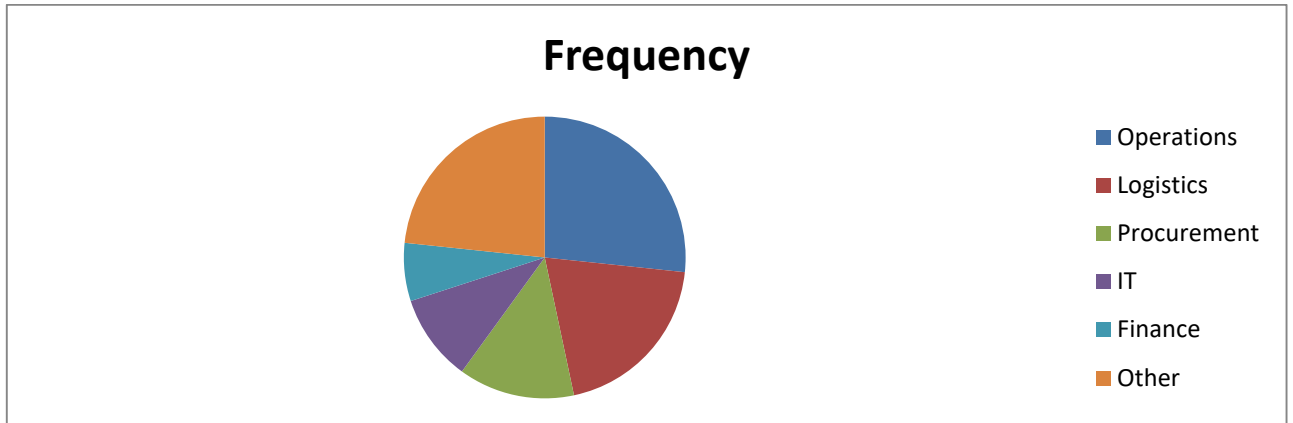


4). Pie Charts

Pie charts are used to display the proportion of each category in a dataset. They consist of a circular chart divided into sections, with each section representing a category.

d) Types of Pie Charts:

- ✓ **Simple Pie Charts:** Used to display the proportion of each category.
- ✓ **Donut Charts:** Used to display the proportion of each category, with a hole in the center.



5). Heat maps

Heat maps are used to display the relationship between two categorical variables. They consist of a matrix of colored squares, with each square representing a data point.

e) Types of Heat maps:

- ✓ **Simple Heat maps:** Used to display the relationship between two categorical variables.
- ✓ **Clustered Heat maps:** Used to display the relationship between two categorical variables, with clustering applied to the data.

6). Tree maps

Tree maps are used to display hierarchical data, such as organizational structures or file systems. They consist of a series of nested rectangles, with each rectangle representing a category.

f) Types of Tree maps:

- ✓ **Simple Tree maps:** Used to display hierarchical data.
- ✓ **Squarified Tree maps:** Used to display hierarchical data, with each rectangle sized according to its value.

7). Sankey Diagrams

Sankey diagrams are used to display the flow of data between different categories. They consist of a series of arrows, with each arrow representing the flow of data.

g) Types of Sankey Diagrams:

- ✓ **Simple Sankey Diagrams:** Used to display the flow of data between different categories.
- ✓ **Stacked Sankey Diagrams:** Used to display the flow of data between different categories, with each category stacked on top of the other.

8). Network Diagrams

Network diagrams are used to display the relationships between different entities, such as people, organizations, or devices. They consist of a series of nodes and edges, with each node representing an entity and each edge representing a relationship.

h) Types of Network Diagrams:

- ✓ **Simple Network Diagrams:** Used to display the relationships between different entities.
- ✓ **Weighted Network Diagrams:** Used to display the relationships between different entities, with each edge weighted according to its strength.

9). Geographic Maps

Geographic maps are used to display data that is geographically referenced, such as population density or climate data. They consist of a map with overlaid data, such as points, lines, or polygons.

i) Types of Geographic Maps:

- ✓ **Simple Geographic Maps:** Used to display geographically referenced data.
- ✓ **Heat map Geographic Maps:** Used to display geographically referenced data, with a heat map overlay.

10). Interactive Visualizations

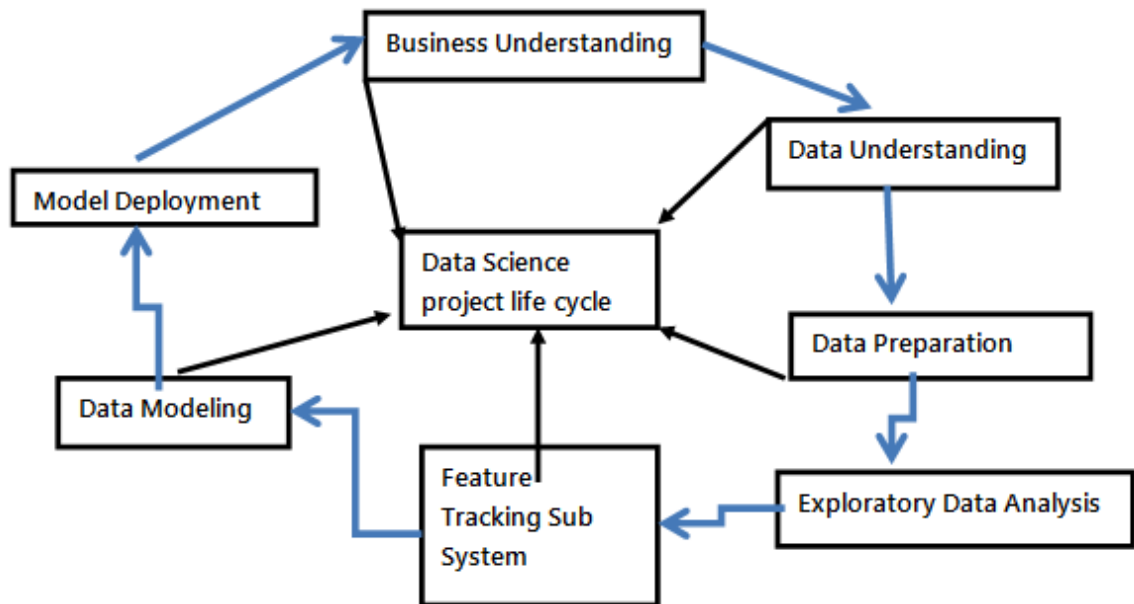
Interactive visualizations are used to enable users to explore and interact with data in real time. They consist of a range of visualization types, such as bar charts, line charts, and scatter plots, with interactive features such as filtering, drilling down, and hovering.

j) Types of Interactive Visualizations:

- ✓ **Dashboards:** Used to display a collection of visualizations and enable users to interact with the data.

- ✓ **Storytelling:** Used to create a narrative around data insights and enable users to interact with the story.

X). DATA VISUALIZATION TOOLS AND TECHNIQUES USED IN BUSINESS MODEL CONSTRUCTION:



Explanation of the Diagram: The above diagram depicts the data science project life cycle which includes understanding business objectives and collecting data various sources i.e primary and secondary sources .Performing data preprocessing which includes data cleaning, data transformation and exploratory data analysis where analyzing trends and patterns in the data. By using various data visualizations tools we can graphically represent various insights drawn from the data which enable the organization to take data driven decisions which directly impacts its performance

XI).TOOLS AND TECHNIQUES USED IN VARIOUS FIELDS:

i) *Data Visualization Tools and Techniques in Finance:*

Data visualization is essential in finance, allowing experts to examine and convey complex financial data insights efficiently. In finance, commonly used data visualization technologies include Tableau, Power BI, D3.js, Matplotlib, and Plotly. These instruments facilitate the development of interactive dashboards and reports, the temporal analysis of financial data, and the visualization of price fluctuations and trade trends in financial markets. Methods include time series analysis, candlestick charts, bar charts, scatter plots, heatmaps, treemaps,

Sankey diagrams, and network diagrams are often used to represent financial data. These strategies assist finance professionals in acquiring profound insights into financial data, hence enhancing decision-making and promoting efficient communication of intricate financial data insights to stakeholders. Data visualization is used in several financial applications, such as financial analysis, risk management, portfolio management, trading, and compliance. The advantages of data visualization in finance include expanded insights, improved communication, more productivity, superior risk management, and a competitive edge. By using appropriate tools and methodologies, finance professionals may enhance corporate profitability and secure a competitive advantage in the marketplace.

ii) *In the area of Marketing:*

Data visualization is an essential element in marketing, allowing professionals to understand and convey intricate marketing data insights efficiently. In marketing, prominent data visualization solutions include Tableau, Power BI, D3.js, Matplotlib, and Plotly. These instruments are used to generate interactive dashboards and reports, assess consumer behavior, and illustrate marketing campaign efficacy. Bar charts, line charts, scatter plots, heat maps, and tree maps are often used to visualize marketing data. Data visualization is used in several marketing applications, such as customer segmentation, campaign analysis, market research, and social media monitoring. Through the analysis of consumer behavior and demographics, marketing experts may develop tailored marketing strategies. Data visualization facilitates the assessment of marketing campaign efficacy, enabling optimization and enhancement. Moreover, data visualization facilitates the analysis of market trends and consumer behavior, so allowing educated marketing choices. Social media monitoring serves as a crucial use of data visualization in marketing, enabling real-time analysis of social media participation and sentiment.

The advantages of data visualization in marketing are many. It assists marketing professionals in acquiring profound insights into consumer behavior and demographics, facilitating enhanced decision-making. Data visualization facilitates the optimization and enhancement of marketing initiatives, resulting in heightened efficiency and effectiveness. Moreover, data visualization simplifies several marketing analytical duties, liberating time for more strategic endeavors. Utilizing data visualization, marketing professionals may enhance corporate profitability and get a competitive advantage in the marketplace.

iii) In the area of Human Resources:

Data visualization has become an essential instrument in contemporary Human Resource Management (HRM). By converting raw data into visually engaging forms, HR professionals may derive useful insights, make educated choices, and propel strategic projects.

Bar charts and histograms may be used to compare staff turnover rates across departments or to examine the distribution of employee tenure. Line charts are optimal for observing temporal changes, such as tracking staff productivity trends or the progression of employee satisfaction levels. Pie charts are effective for illustrating proportions, such as the distribution of personnel among various demographics or the allocation of staff expenses. Scatter plots may elucidate correlations between variables, such as the link between employee performance and tenure, or the association between employee happiness and engagement. Heat maps may illustrate data density and discern trends, such as evaluating staff absence rates by department and month. Funnel charts may monitor the advancement of a process, such as the recruiting funnel or the employee on boarding experience.

Widely used data visualization technologies like as Microsoft Power BI, Tableau, Google Data Studio, and Python libraries (Matplotlib, Seaborn, Plotly) enable HR teams to develop interactive dashboards, reports, and visualizations customized to their particular requirements.

The advantages of data visualization in human resources are many. It aids data-driven decision-making, boosts employee experience by revealing areas for improvement, supports strategic planning by detecting trends and risks, and improves communication by rendering complicated data more accessible to stakeholders. By using data visualization, HR teams can fully harness their data, enhance business results, and foster a more data-driven, employee-focused company.

iv) In the area of Logistics:

Data visualization has emerged as a powerful tool in the logistics industry, transforming complex data into actionable insights. Data visualization enables logistics professionals to get a thorough understanding of their operations, identify trends, and make informed decisions that improve productivity and promote customer satisfaction. Maps may illustrate geographical variations in delivery schedules, identify areas of strong or low demand, and optimize delivery routes. Line charts may track variations in critical performance parameters over time, including shipping costs, delivery times, and fuel

consumption, so enabling the identification of seasonal trends or the impacts of specific events. Bar charts enable the comparison of performance metrics across many locations, transportation modes, or time periods, aiding in the identification of enhancement possibilities. Scatter plots may clarify correlations between variables, such as the relationship between distance and delivery time or the impact of weather conditions on shipping delays.

Dashboards consolidate much visualization into a one, interactive interface, providing a comprehensive view of logistics operations and enabling real-time tracking of essential performance measures, like on-time delivery rates, inventory levels, and transportation costs. By using data visualization, logistics teams may improve supply chain visibility, identify potential disruptions, and execute proactive measures to mitigate risks. This leads to improved decision-making, increased operational efficiency, and ultimately, a stronger customer experience.

v) In the area of aircraft:

Revolutionizing the operations of airlines and aerospace industries. Through the visualization of intricate data, industry experts may acquire profound insights, make judicious judgments, and enhance operational efficiency. Maps can display air traffic trends, pinpoint congested areas, and improve aircraft paths. Line charts may monitor trends in important performance metrics, including on-time performance, fuel consumption, and maintenance expenses, facilitating the detection of seasonal fluctuations or the effects of certain events. Bar charts facilitate the comparison of performance data across various airlines, aircraft types, or routes, assisting in the discovery of improvement opportunities. Scatter plots may elucidate correlations between variables, such as the association between aircraft speed and fuel consumption or the influence of altitude on engine performance. The aviation sector can enhance safety, efficiency, and customer happiness via data visualization. Airlines can detect possible safety hazards, enhance flight schedules, save fuel use, and mitigate delays. Furthermore, via the analysis of passenger data, airlines may customize services to meet individual tastes, enhance baggage management, and optimize check-in procedures. Ultimately, data visualization enables the aviation sector to make informed choices that foster a more sustainable and lucrative future.

vi) In the area of Health Care:

Data visualization has transformed the healthcare sector, enabling professionals to make informed choices that enhance patient outcomes and streamline healthcare delivery. By converting intricate data into visually engaging forms, healthcare practitioners may acquire profound insights, discern patterns, and make educated judgments. Line charts may be used to monitor patient vital signs over time, discern patterns, and discover abnormalities. Bar charts facilitate the comparison of patient outcomes across various treatment groups or healthcare professionals, assisting in the discovery of beneficial therapies. Scatter plots may elucidate correlations between variables, such as the association between age and illness risk or the influence of lifestyle choices on health outcomes. Heat maps may illustrate regional disparities in illness prevalence or healthcare resource consumption, facilitating targeted treatments and resource distribution. Healthcare firms may increase patient care, optimize operational efficiency, and save costs via data visualization. Data visualization may facilitate the identification of high-risk patients, enhance resource allocation, and augment diagnostic accuracy. Moreover, data visualization may facilitate the assessment of treatment plan efficacy, surveillance of disease outbreaks, and recognition of new healthcare trends. Ultimately, data visualization enables healthcare workers to make informed choices that increase patient outcomes and improve the overall quality of treatment.

vii) In the area of sports:

Data visualization has revolutionized the sports industry, transforming the way teams, coaches, and fans analyze and understand the game. By visualizing complex data, teams can gain deeper insights, make informed decisions, and enhance performance.

For instance, line charts can track player performance over time, identify trends, and detect potential areas for improvement. Bar charts can compare player statistics across different seasons or leagues, enabling the identification of top performers and team strengths and weaknesses. Scatter plots can reveal correlations between variables, such as the relationship between a player's speed and agility or the impact of weather conditions on performance. Heat maps can visualize player movement on the field, identifying areas of high activity and potential tactical advantages.

By leveraging data visualization, sports teams can optimize player recruitment, develop effective training plans, and make strategic decisions during games. Additionally, data visualization can be used to create engaging fan experiences, such as interactive dashboards that provide real-time statistics and insights. Ultimately, data visualization empowers sports teams to make data-driven decisions that lead to improved performance, increased fan engagement, and greater success

XII). CONCLUSION

The study asserts that data visualization is essential in several fields, greatly improving businesses' ability to analyze and use data. Data visualization facilitates pattern discovery, decision-making, and narrative by converting intricate data into comprehensible and informative graphics. The incorporation of interactive tools has enabled users without sophisticated technical skills to analyze data comprehensively, hence promoting data-driven initiatives across finance, marketing, healthcare, logistics, and other sectors. Nonetheless, despite the extensive accessibility of visualization tools, a disparity persists between avant-garde research and the capabilities provided by conventional programs. As the discipline progresses, forthcoming trajectories indicate the integration of artificial intelligence and immersive technology, offering more advanced visual tools that cater to user requirements. These technologies will facilitate informed decision-making and promote involvement and innovation across several sectors.

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