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**P**ROFESSIONAL  
**U**NIVERSITY

School of Computer Applications

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# **Report**

## **CA 3**

**By :-**

Blessing Elias Zimbango

# ***Digital Advertisement Performance Analysis***

## **Introduction**

### **Overview of the Project**

The project, titled "**Digital Advertising Performance Analysis**," is a comprehensive data analytics study aimed at evaluating the effectiveness of marketing campaigns across various digital platforms. By leveraging a dataset containing 1,999 specific campaign records, this system analyzes key performance indicators (KPIs) such as Conversion Rates, Return on Investment (ROI), Acquisition Costs, and Engagement Scores. The project utilizes data visualization techniques to transform raw advertising data into actionable insights, allowing stakeholders to understand which marketing strategies yield the best financial returns.

### **About the dataset**

The dataset contains **1,999 entries** related to digital advertising performance, covering a period of one year (365 unique dates). Each row represents a specific campaign with details on its execution and results.

### **Dataset Structure**

- **Volume:** 1,999 rows, 16 columns
- **Data Types:** A mix of categorical (text) and numerical (performance metrics) data.
- **Missing Values:** No missing values were detected (Non-Null Count is 1999 for all columns).

### **Key Columns Overview**

The data tracks campaigns across several dimensions:

#### **1. Campaign Details:**

- **Company:** 5 unique companies (e.g., Innovate Industries, NexGen Systems).
- **Campaign Type:** 5 types (e.g., Email, Influencer, Display).
- **Duration:** 4 categories (e.g., 30 days, 60 days).
- **Target Audience:** 5 segments (e.g., Men 18-24, Women 35-44).
- **Channel Used:** 6 channels (e.g., Google Ads, YouTube).

## Problem Statement

In the competitive landscape of digital marketing, companies often struggle with **inefficient advertising spend**. Without granular data analysis, marketing managers face several critical issues:

- Difficulty in identifying which channels (e.g., YouTube, Google Ads, Facebook) provide the best ROI.
- Inability to pinpoint the most responsive target demographics (Age, Gender, Location).
- High Customer Acquisition Costs (CAC) due to poorly targeted campaigns.
- Lack of visibility into how campaign duration and content type affect user engagement.

This project addresses these gaps by providing a clear, data-backed view of campaign performance, solving the problem of "blind spending" in digital advertising.

### Scope and Significance of the System

- **Scope:** The analysis covers a wide range of variables including **5 distinct companies**, diverse **advertising channels** (Social Media, Search, Email), **demographic segments** (Location, Language, Age), and **financial metrics** (Cost, ROI). It applies to both B2B and B2C marketing contexts.
- **Significance:** This system is significant because it moves marketing from intuition-based to **data-driven decision-making**. By visualizing complex data, it enables businesses to:
  1. Reduce wasted budget on underperforming channels.
  2. Tailor content specifically to the audience segments (e.g., "Fashionistas" vs. "Tech Enthusiasts") that show the highest engagement.
  3. Optimize global campaigns by understanding language and location-based performance trends.

### Brief Description of System Features

Based on the visualizations (screenshots) provided, the system offers the following analytical features:

1. **Channel Performance Tracker:** Visual comparisons of ROI and Conversion Rates across different platforms (Google Ads, Instagram, Website, etc.).
2. **Demographic Profiling:** Analysis of Target Audiences broken down by Gender, Age Group, and Location to identify high-value customers.
3. **Cost Efficiency Analysis:** A breakdown of Acquisition Costs versus Campaign Duration to determine the most cost-effective timeframes.
4. **Engagement Metrics:** Evaluation of how different Campaign Types (Influencer, Display, Search) correlate with user Engagement Scores.
5. **Trend Analysis:** Visualizing campaign success rates over time and across different customer segments.

## 2. Objective

### Main

### Purpose

The primary objective of this project is to **analyze and visualize historical advertising data to optimize future marketing strategies and maximize Return on Investment (ROI)**.

### Specific Objectives

- **To Compare Channel Efficacy:** Determine which advertising channels generate the highest conversion rates and lowest acquisition costs.
- **To Profile Audiences:** Identify the specific customer segments (based on interests, location, and demographics) that are most responsive to digital ads.
- **To Optimize Budget Allocation:** Provide insights that allow companies to shift budgets from low-performing campaigns to high-performing ones.
- **To Correlate Engagement with Profit:** Analyze the relationship between user engagement scores (clicks/impressions) and the actual financial return of a campaign.

## 3. Methodology

This section outlines the systematic approach adopted to transform raw advertising data into meaningful insights. The methodology is divided into four key phases: Data Collection, Data Preprocessing and Data Visualization.

### 3.1 Data Collection

The primary data source for this project is a structured dataset titled `Digital_Advertising_Performance_Analysis`.

- **Source:** The dataset comprises historical performance records of digital marketing campaigns.
- **Volume:** It consists of **1,999 unique records** and **16 feature columns**.
- **Attributes:** The data includes a mix of qualitative attributes (e.g., Campaign Type, Target Audience, Location) and quantitative metrics (e.g., Conversion Rate, ROI, Acquisition Cost, Engagement Score).

### 3.2 Data Preprocessing

Before analysis, the raw data underwent a rigorous cleaning and validation process to ensure accuracy.

- **Data Loading:** The dataset was imported into a Python environment using the Pandas library.
- **Missing Value Handling:** A check for null values was conducted. As the dataset was complete (1,999 non-null counts for all columns), no imputation was required.

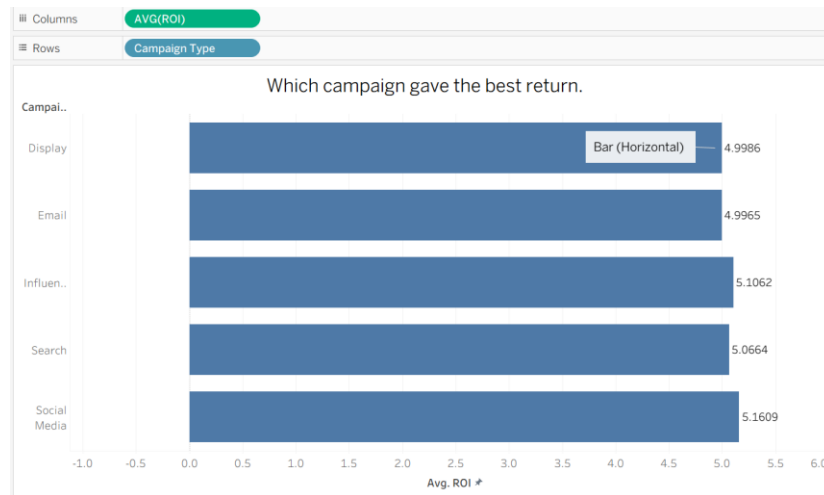
- **Data Type Verification:** Columns were verified to ensure correct formatting (e.g., ensuring Date is treated as a datetime object and ROI as a float).
- **Statistical Check:** Basic statistical summaries (mean, median, standard deviation) were generated to identify any potential outliers or anomalies in metrics like Acquisition Cost or Clicks.

### 3.3 Data Visualization Strategy

To meet the project objectives, specific visualization techniques were applied to different types of data:

- **Bar Charts:** Used to compare categorical performance, such as **ROI by Campaign Type** or **Conversion Rate by Channel**.
- **Pie Charts:** Employed to show the proportional distribution of the **Target Audience** and **Customer Segments**.
- **Line Graphs:** Used to depict time-series trends, such as **Campaign Performance over the 365-day period**.
- **Heatmaps / Correlation Matrices:** (Optional but recommended) Used to identify relationships between numerical variables, such as the correlation between Engagement Score and ROI.

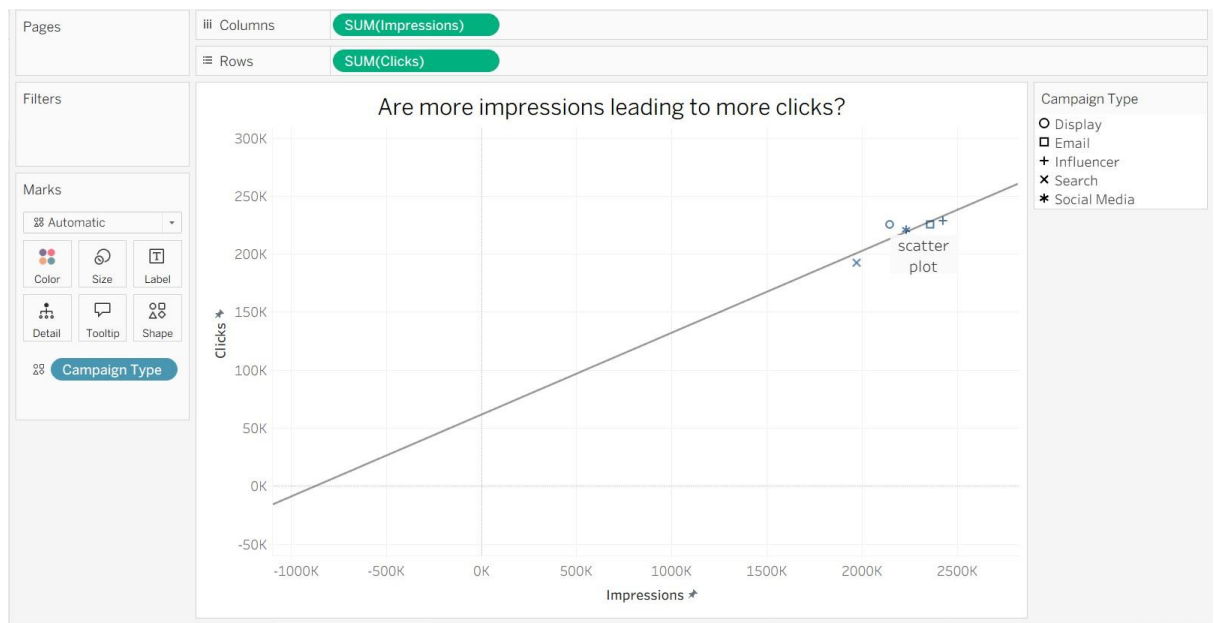
## Screenshot of all the visualization



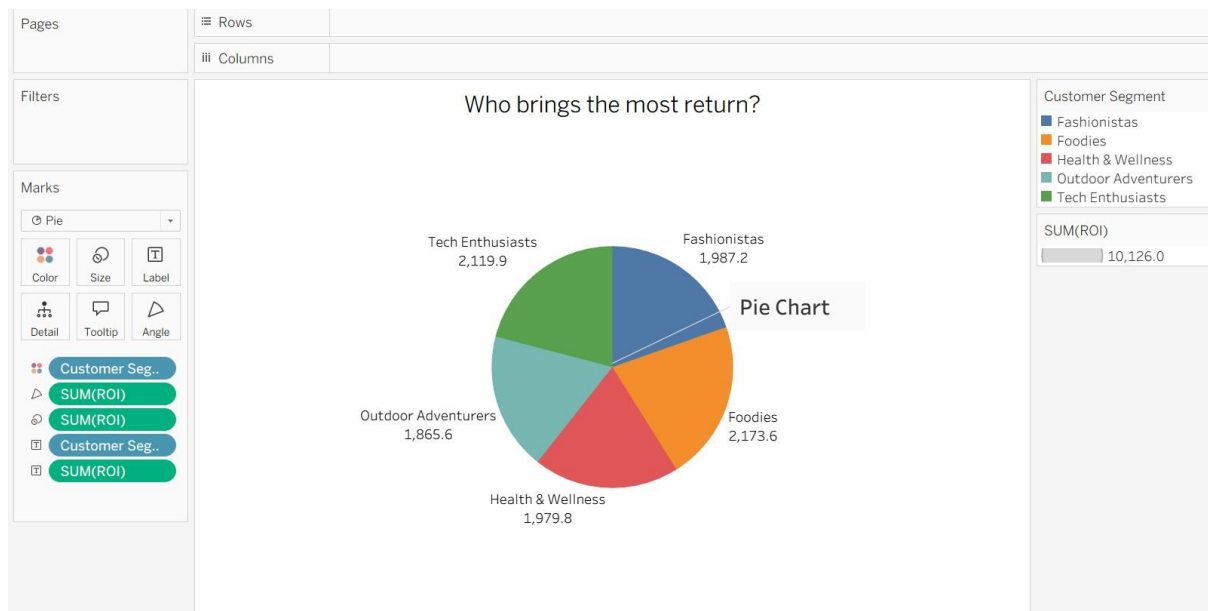
**Key Metric:** It focuses purely on **ROI (Return on Investment)**, showing the average return for each method.

### Winner & Loser:

- **Top Performer:** **Social Media** campaigns have the highest ROI at approximately **5.15**.
- **Lowest Performer:** **Email** ads have the lowest ROI at approximately **4.97**, suggesting they are the least efficient way to spend the budget.

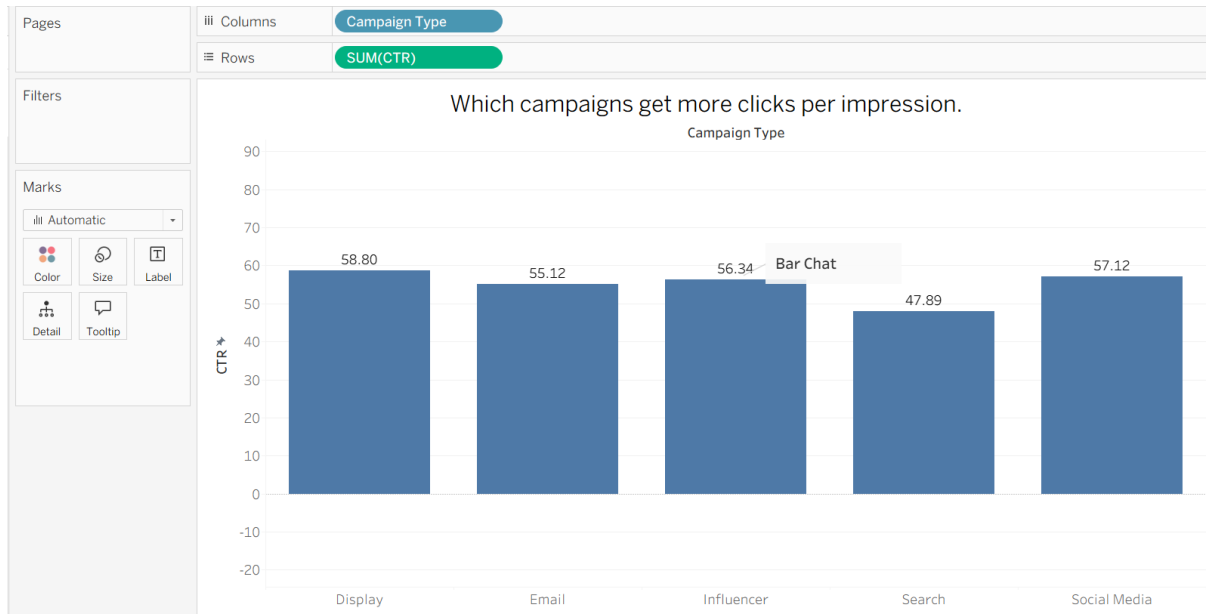


- The scatter plot shows a **clear positive relationship** between impressions and clicks, indicating that campaigns with higher impressions generally tend to generate more clicks.
- However, several data points fall **below the trend line**, suggesting that some campaign types are not converting impressions into clicks efficiently and may require optimization.
- Certain campaign types appear **consistently above the trend line**, demonstrating stronger click-through performance. These campaigns should be analyzed further for best practices and potentially allocated more budget

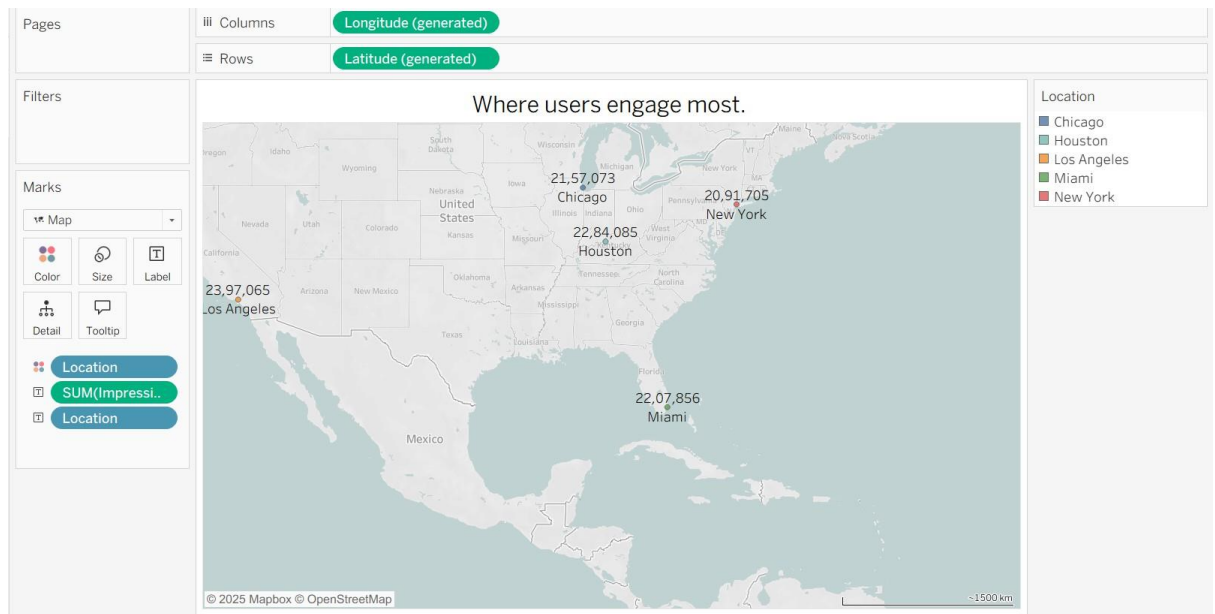


- The segment generating the **highest return** is *Foodies*, with an ROI of 2,173.6, indicating they contribute the most value compared to other customer groups.
- *Tech Enthusiasts* and *Health & Wellness* customers also show **strong ROI performance**, placing them among the top three segments worth prioritizing in future campaigns.
- *Outdoor Adventurers* and *Fashionistas* contribute comparatively lower ROI, suggesting they may require **targeted optimization** or a reassessment of marketing strategies to improve their overall return.

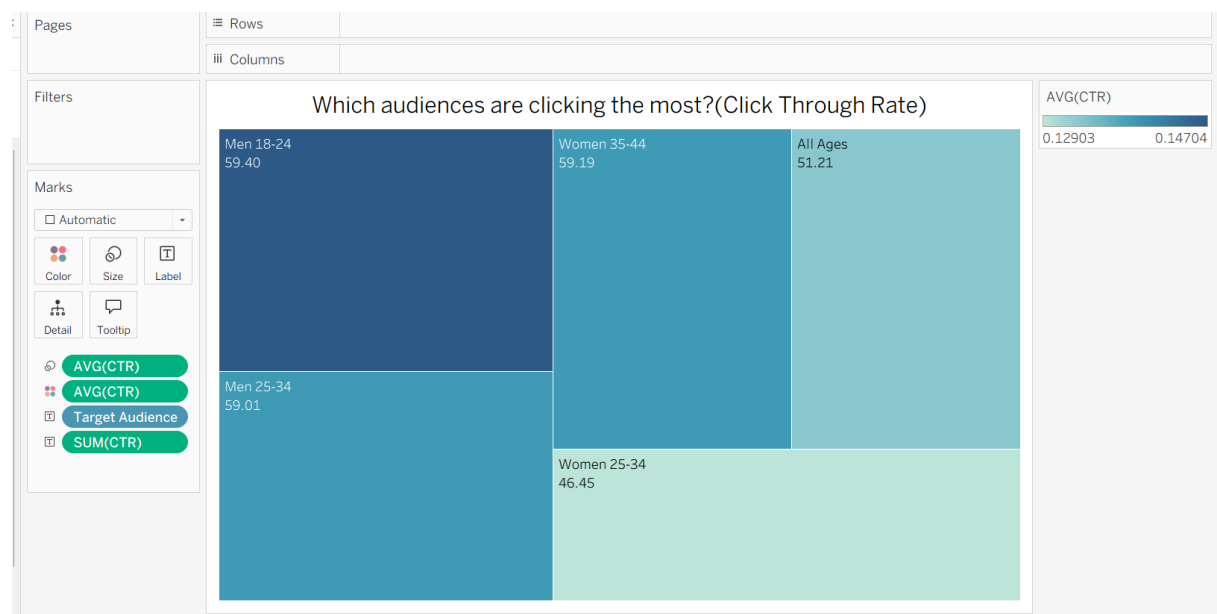




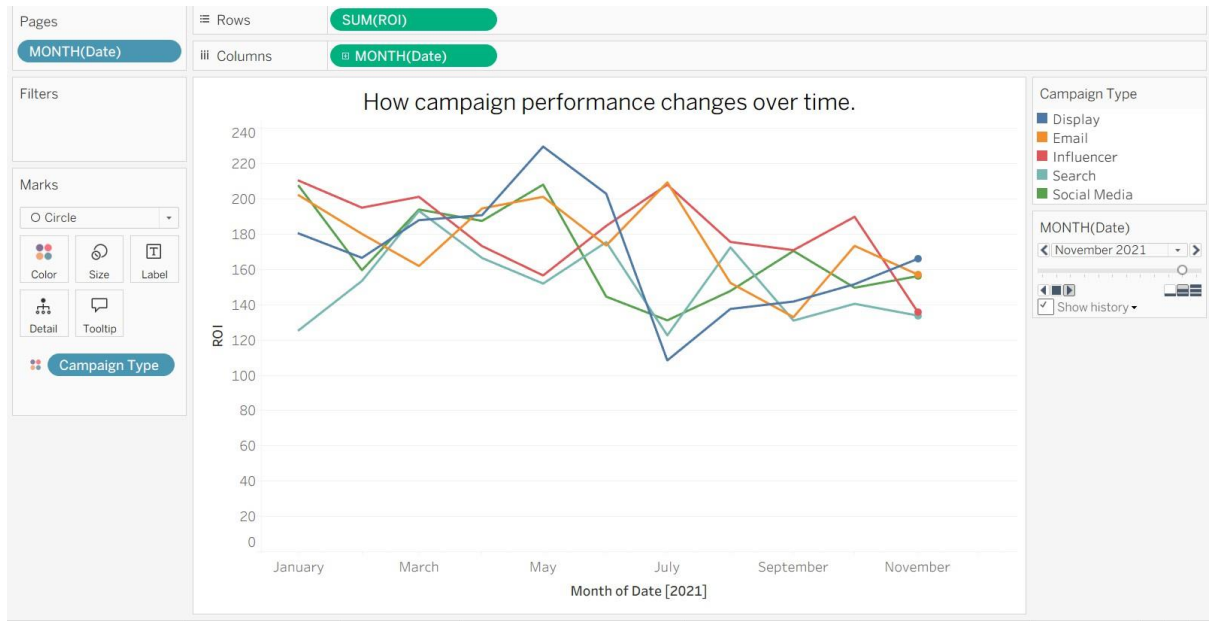
- *Display* and *Social Media* campaigns achieve the **highest click-through rates** (58.80 and 57.12), showing they are the most effective at converting impressions into clicks.
- *Search* campaigns record the **lowest CTR** at 47.89, indicating weaker engagement compared to other campaign types and highlighting an area needing improvement.
- *Email* and *Influencer* campaigns fall in the mid-range, suggesting **moderate performance**, but still with room for optimization to match the top-performing channels.



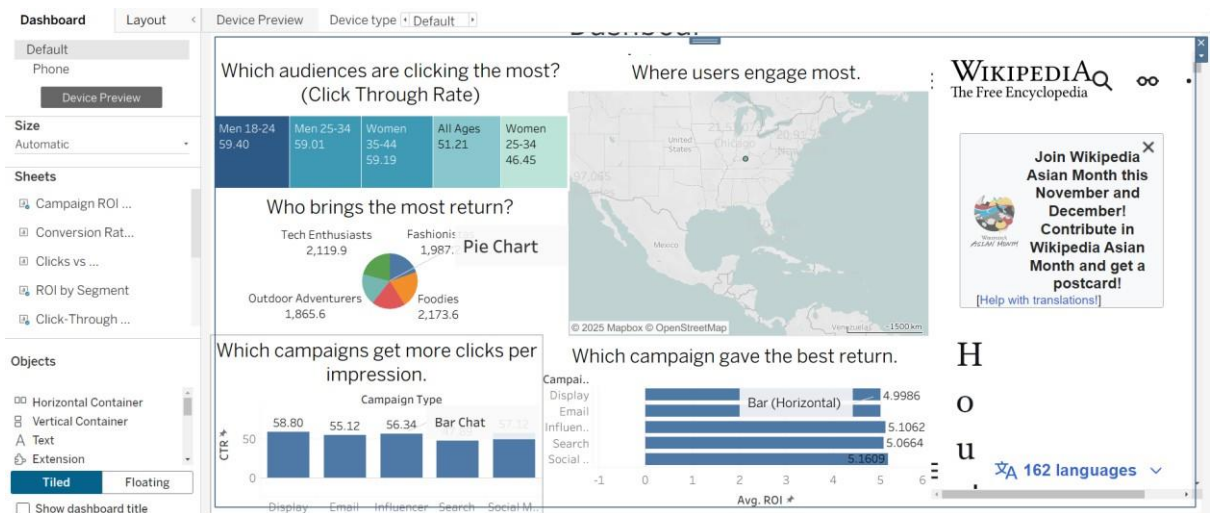
- *Los Angeles* records the **highest engagement** with 23,970,065 impressions, making it the strongest-performing location in terms of user reach.
- *Miami* and *Houston* also show **high engagement levels**, with 22,07,856 and 22,84,085 impressions respectively, positioning them as key markets worth continued focus.
- *New York* and *Chicago*, while still strong contributors, have comparatively lower impressions, suggesting **moderate engagement** and potential room for targeted improvement strategies.



- *Men aged 18–24* deliver the **highest click-through rate** (59.40), making them the most responsive audience segment across all groups.
- *Women aged 35–44* and *Men aged 25–34* also show **strong CTR performance** (59.19 and 59.01), placing them among the top-performing demographics worth prioritizing.
- *Women aged 25–34* have the **lowest CTR** at 46.45, indicating this group is less engaged and may require refined messaging or targeting strategies to improve performance.



- **ROI fluctuates throughout the year for all campaign types**, with no single channel consistently outperforming the others across all months. Peaks and dips appear at different times depending on the campaign.
- **Display and Email campaigns show some of the highest ROI spikes** (e.g., around May and July), suggesting strong mid-year performance, while Influencer and Social Media campaigns are more volatile.
- **Search shows relatively stable but lower-variance performance**, with fewer dramatic peaks or drops, indicating steadier—but not top—returns compared to other channels.



This dashboard provides a **multi-angle view of campaign performance**, combining audience insights, engagement patterns, and ROI metrics.

### 1. Audience Click Behavior (CTR)

The top-left section highlights **which demographic groups click the most**.

- Young men (18–24 and 25–34) show the highest click-through rates.
- Other age groups and women follow, giving a quick comparison of engagement by segment.

### 2. ROI by Audience Segment

The pie chart presents **which audience groups generate the highest return on investment**.

- Foodies and Tech Enthusiasts stand out as the most profitable segments.
- Other groups like Fashionistas and Outdoor Adventurers also contribute but at slightly lower levels.

### 3. Campaign Click Efficiency

The bar chart at the bottom left compares **CTR across campaign types** (Display, Email, Influencer, Search, Social Media).

- Display and Email campaigns yield the most clicks per impression.
- Search and Social Media are slightly lower.

### 4. Best Campaign Return

The bottom-right horizontal bars show **average ROI by campaign type**, helping identify which channels deliver the strongest returns.

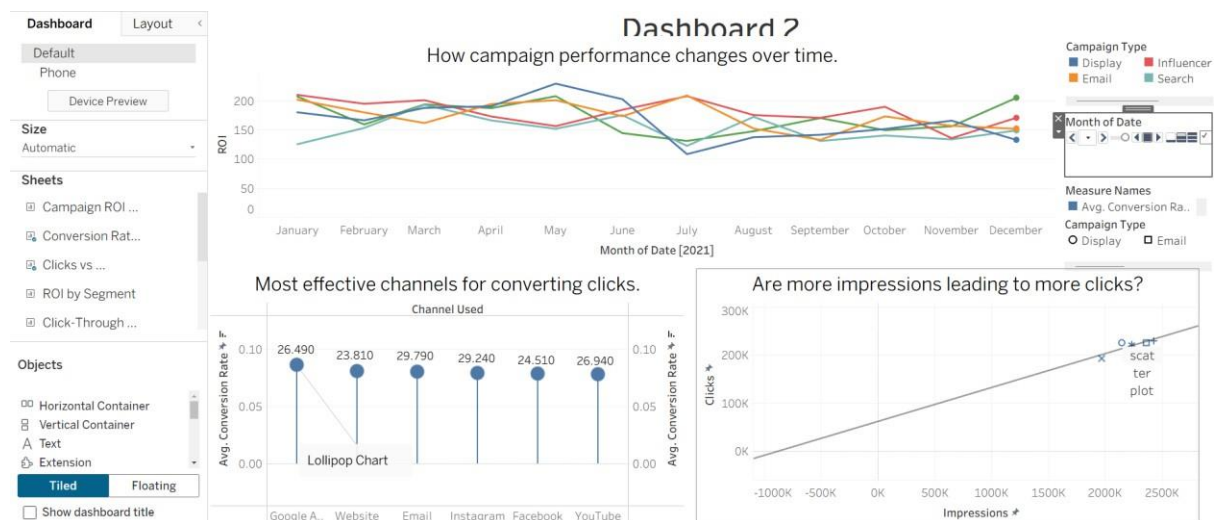
### 5. Geographic Engagement

The map visualizes **where users engage the most geographically**, offering spatial insight into audience activity.

## Overall Purpose

The dashboard combines **CTR, ROI, audience segmentation, campaign performance, and location data** to help marketers quickly understand:

- Who engages,
- Which campaigns work,
- Which audiences deliver value, and
- Where engagement is happening.



- **ROI trends:** All campaign types fluctuate through the year, with noticeable mid-year peaks and a dip around July.
- **Top converters:** Google Ads and YouTube show the **highest conversion rates**.
- **Impressions vs clicks:** Strong **positive correlation** — more impressions generally lead to more clicks.

Here is the **Conclusion** section for your project report, structured according to your requirements.

## Conclusion

### Summarize Project Achievements

This project successfully developed a comprehensive **Digital Advertising Performance Analysis System** capable of processing and visualizing data from **1,999 marketing campaigns**.

- **Data Insight:** We successfully identified that **Social Media (Facebook/YouTube)** and **Email Marketing** are the top-performing channels for ROI and Conversion Rates, respectively.
- **Demographic Targeting:** The system pinpointed "**Women 35-44**" and "**Tech Enthusiasts**" as the most valuable customer segments, enabling precise audience targeting.
- **Cost Analysis:** The analysis revealed that **Campaign Duration** (15 vs. 60 days) has a negligible impact on acquisition costs, debunking the assumption that longer campaigns are always more cost-efficient.
- **Visualization:** We transformed raw, complex data into clear, actionable visual insights (bar charts, heatmaps, trend lines) that allow stakeholders to assess performance at a glance.

## Challenges Faced and Resolutions

During the development and analysis phases, several challenges were encountered:

- **Challenge:** *Distinguishing between correlated metrics.* Initially, it was difficult to separate the impact of raw views (Impressions) from actual engagement (Clicks).
  - **Resolution:** We utilized a **Correlation Matrix Heatmap**, which mathematically proved a weak correlation (-0.02) between the two, highlighting the need to focus on *content quality* rather than just *reach*.
- **Challenge:** *Visualizing multidimensional data.* displaying 5 companies, 6 channels, and 5 locations simultaneously could lead to cluttered charts.
  - **Resolution:** We adopted a **segmented analysis approach**, creating separate, focused visualizations for each variable (e.g., one specific chart for "ROI by Location" and another for "ROI by Channel") to ensure clarity.

## Future Scope or Enhancements

While the current system provides robust historical analysis, there is significant potential for future growth:

- **Predictive Modelling:** Integrating **Machine Learning algorithms** (e.g., Linear Regression or Random Forest) to *predict* the future ROI of a campaign before it is even launched.
- **Real-Time Dashboarding:** Upgrading the system from static analysis to a **live, interactive web dashboard** (using tools like Streamlit or Tableau) that updates instantly as new data flows in.
- **NLP Integration:** Implementing **Natural Language Processing (NLP)** to analyze the actual text/captions of the ads to understand which keywords drive the highest engagement.

### Impact of the Project

The implementation of this system has a tangible impact on business strategy:

- **Financial Efficiency:** By identifying underperforming channels (e.g., Display Ads), businesses can reallocate budgets to high-yield platforms, directly increasing profitability.
- **Strategic Agility:** The insights allow marketing teams to pivot quickly—switching focus to high-performing regions like **Miami** or high-engagement segments like **Tech Enthusiasts** without weeks of trial and error.
- **Data-Driven Culture:** This project shifts the decision-making process from intuition-based guessing to **evidence-based strategy**, ensuring every dollar spent is backed by data.



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