**ANLY 5334 PROJECT**

**Statistical Methods for Business**

**Ad Performance Insights through Statistical Measures**

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# Introduction:

Digital advertising is a critical and evolving area, offering numerous platforms for ad displays. In this analysis, we compare two major digital advertising platforms: Facebook and AdWords. Using data from a recent marketing campaign, we examine key metrics such as ad views, clicks, conversions, costs, click-through rates, conversion rates, and cost per click, over several dates. This data reveals specific performance trends and patterns that can be leveraged to optimize advertising strategies.

We can derive actionable measures such as adjusting the ad spend, refining target audiences, and optimizing ad creatives to enhance campaign performance. This comprehensive analysis not only helps in identifying the most cost-effective platform for specific campaign goals but also assists in fine-tuning strategies to maximize the overall impact of digital advertising efforts. This campaign comparison serves as a foundational tool for marketers aiming to leverage digital advertising platforms to achieve superior marketing outcomes. ​

# Dataset Overview:

The dataset captures daily performance metrics of Facebook and AdWords ad campaigns over 365 days, making it time-series data. It includes variables such as the date of the record, campaign names, ad views, clicks, conversions, and financial metrics like cost per ad and cost per click. The dataset contains both categorical variables (e.g., campaign names and dates) and quantitative variables (e.g., views, clicks, and conversions). The scales of measurement present include nominal scales for campaign identifiers and date, and ratio scales for quantitative variables like ad views, clicks, and conversions, as well as derived metrics such as click-through rates (CTR) and conversion rates. These measurements allow for a comprehensive ad performance analysis, with quantitative data providing insights into engagement and conversions while categorical data helps identify campaign-level differences.

The dataset contains performance metrics for Facebook and AdWords advertising campaigns over a span of 365 days, making it time-series data. It includes both categorical and quantitative data points, detailing ad campaign views, clicks, conversions, and associated costs.

# Descriptive statistics- Graphical Displays

## Line Plot

A blue line graph with numbers

Description automatically generated

Figure 1: Line Plot for Facebook (views and clicks)

The line plot for Facebook illustrates significant fluctuations in daily views, represented by the blue line, suggesting variability due to marketing campaigns or seasonal trends. The orange line depicting clicks is much lower and nearly flat, highlighting a low click-through rate despite high viewership. This discrepancy suggests potential for targeted strategies to enhance ad engagement and improve conversion rates.

A green line graph with numbers

Description automatically generated

Figure 2: Line Plot for AdWords (views and clicks)

AdWords, shown by the green line, maintains high and steady views throughout the year, indicating consistent exposure and reach across the platform. The purple line for clicks, though also low, indicates a slightly better click-through rate compared to Facebook, suggesting more effective engagement with the audience. This consistent performance supports AdWords as a reliable choice for campaigns needing stable reach and modest engagement improvements.

## Bar Chart

A blue and orange squares

Description automatically generated

Figure 3: Total Conversions by Platform

This graph compares annual conversion rates across Facebook and AdWords, revealing Facebook's markedly higher efficiency with nearly twice the conversions of AdWords. The data suggests Facebook's ad targeting may be more effective or its user base more receptive to ads. Despite AdWords' lower performance, it remains critical for specific campaign goals and may reach different user demographics effectively.

## Scatter Diagram

A diagram of a graph

Description automatically generated with medium confidence

Figure 4: Scatter Diagram Facebook Ad Clicks vs Conversions

The scatter diagram for Facebook demonstrates a broad distribution of data, with conversions reaching as high as 18 for a range of clicks, indicating a potent conversion capability. The trend line’s steep slope suggests a strong positive correlation between clicks and conversions, signifying that Facebook's advertising may benefit from superior targeting or more compelling content that resonates with its audience. This robust performance underscores Facebook’s potential to maximize conversion rates effectively.

The AdWords scatter diagram presents a tightly grouped cluster of data points, where conversions vary minimally, mostly ranging from 3 to 9, despite a wide range of clicks. The trend line shows a moderate positive correlation, pointing to a consistent but slow growth in conversions relative to the increase in clicks. This indicates that while AdWords is effective in generating conversions, there might be room for optimization, particularly in enhancing ad targeting or refining the content to boost conversion rates further.

A graph with green dots and red line

Description automatically generated

Figure 5: Scatter Diagram Adwords Ad Clicks vs Conversions

## Box Plot

A diagram of a website

Description automatically generated with medium confidence

Figure 6: Distribution of Clicks for Facebook and Adwords Campaign

This box plot illustrates the differences in click distributions for Facebook and AdWords over a year, highlighting each platform's user engagement patterns. Facebook's data show a tighter clustering of daily clicks, suggesting a more consistent engagement compared to AdWords, which exhibits a broader range with peaks suggesting days of intense activity. These insights are critical for advertisers to optimize campaign strategies, tailor budget allocations, and enhance overall campaign effectiveness based on expected click variability and audience reach.

## Cost Efficiency Comparison

A graph of a bar chart

Description automatically generated with medium confidence

Figure 7: Cost Efficiency Comparison

The analysis of advertising costs shows that Facebook is more cost-efficient than AdWords, with lower average costs per ad, click, and conversion. Specifically, Facebook's cost per conversion is substantially lower at $7.48 compared to AdWords' $22.57, indicating a higher return on investment. Given these findings, Facebook emerges as a more economical choice for digital advertising, offering better engagement and conversion efficiency during the observed campaign period.

## Side by Side Bar Chart

A graph of blue and pink bars

Description automatically generated

Figure 8: Side by side Bar Chart of Monthly Conversion Rates by Platform

This analysis highlights Facebook's effective conversion capabilities, as evidenced by the consistently taller blue bars representing higher monthly conversion rates despite fewer views. The data suggests that Facebook’s ad targeting may be more precisely aligned with the audience's interests, leading to enhanced engagement and successful conversions. This effectiveness makes Facebook a valuable platform for campaigns focused on achieving high conversion rates from a highly engaged audience.

A graph of a number of people

Description automatically generated with medium confidence

Figure 9: Side by side Bar Chart of Monthly Ad views by Platform

AdWords shows its strength in reach, with the red bars indicating it consistently garners more monthly views than Facebook, benefiting from its integration with a vast network and the search engine. The trend line suggests that while AdWords excels in exposing a broad audience to ads, its conversion rates are not as high as those seen with Facebook. However, its extensive reach makes it an excellent tool for increasing brand awareness and capturing a wide audience, which can be crucial for initial engagement phases.

## Pair Plot

The pair plot, or scatterplot matrix, displayed in this slide provides a detailed visualization of the relationships and distributions of key advertising metrics for both Facebook and AdWords. Diagonal histograms offer insights into single metrics like ad views, showing their frequency and variability, which is crucial for understanding engagement levels. Scatter plots adjacent to these histograms illustrate how variables such as ad views and cost per click correlate, indicating that higher visibility may increase expenditure on Facebook. For AdWords, similar scatter plots connect clicks to conversion rates, suggesting a direct relationship between increased engagement and conversion success. This multivariate analysis is invaluable for strategizing ad campaigns, as it highlights both strengths and weaknesses across various metrics, guiding budget allocations and tactical decisions to optimize digital advertising efforts.

A group of blue dots

Description automatically generated

Figure 10: Pair Plot of Key Metrics

## Heat Map

This heatmap displays correlation coefficients between key metrics of our Facebook and AdWords campaigns, where red indicates strong positive correlations and blue signifies negative ones. Notably, Facebook exhibits a robust positive correlation (0.87) between clicks and conversions, suggesting that increasing clicks could significantly enhance conversions; however, AdWords shows a weaker link (0.45) between these metrics, indicating that other factors also impact conversions. The data underscores the need for platform-specific strategies: enhancing engagement on Facebook and refining ad quality on AdWords to optimize overall campaign effectiveness and ROI.

A blue and red squares with white text

Description automatically generated

Figure 11: Correlation Heatmap of metrics

# Descriptive Statistics – Numerical Measures

## Central Tendency

The mean, median, and mode provide insights into the typical values of each metric.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metric** | **Mean** | **Std Dev** | **Min** | **Max** |
| **Facebook Ad Views** | 2,179.69 | 618.07 | 1,050 | 3,714 |
| **Facebook Ad Clicks** | 44.05 | 12.14 | 15 | 73 |
| **Facebook Ad Conversions** | 11.74 | 2.92 | 5 | 20 |
| **AdWords Ad Views** | 4,717.20 | 561.11 | 3,714 | 6,063 |
| **AdWords Ad Clicks** | 60.38 | 14.37 | 31 | 89 |
| **AdWords Ad Conversions** | 5.98 | 1.63 | 3 | 11 |

AdWords campaigns outperform Facebook in terms of daily views and clicks, consistently generating over 4,700 impressions and attracting a higher volume of interactions. Despite this broader reach, Facebook achieves nearly twice the conversions of AdWords, underscoring a significantly stronger engagement quality. These observations suggest that while AdWords excels in reach and interaction, Facebook's strategy yields a higher conversion rate, indicating more effective engagement with its audience.

## Variability

The standard deviation and range indicate the spread of the data.

|  |  |  |  |
| --- | --- | --- | --- |
| **Metric** | **Platform** | **Std Dev** | **Range** |
| **Ad Views** | Facebook | 618.07 | 2,664 |
| AdWords | 561.11 | 2,349 |
| **Ad Clicks** | Facebook | 12.14 | 58 |
| AdWords | 14.37 | 58 |
| **Ad Conversions** | Facebook | 2.92 | 15 |
| AdWords | 1.63 | 8 |

The data indicates that Facebook experiences greater variability in ad views and clicks compared to AdWords, likely stemming from differences in campaign targeting or fluctuations in daily user engagement. This variability extends to conversions as well, suggesting that Facebook might also encounter more significant shifts in user behavior or ad relevance. Such insights point to the need for potentially refining Facebook's advertising strategies to enhance consistency and effectiveness in user engagement and conversions.

## Derived Metrics

|  |  |  |  |
| --- | --- | --- | --- |
| **Metric** | **Platform** | **Mean** | **Std Dev** |
| **CTR** | Facebook | 2.20% | 0.93% |
| AdWords | 1.30% | 0.34% |
| **Conversion Rate** | Facebook | 27.15% | 4.16% |
| AdWords | 10.18% | 2.89% |

Facebook outperforms AdWords in both click-through and conversion rates, indicating a more efficient engagement and conversion strategy. In contrast, AdWords campaigns appear to prioritize generating impressions over interactions, leading to lower CTR and conversion rates. This suggests a fundamental difference in how each platform approaches digital advertising, with Facebook focusing on quality engagement and AdWords on broad reach.

## Insights and Recommendations

Facebook campaigns, known for their superior conversion efficiency, are best suited for objectives centered around deep engagement and high-quality leads. Conversely, AdWords campaigns, while offering extensive visibility, tend to lag in conversion quality, highlighting the potential for precise targeting and creative adjustments to bolster performance. To optimize Facebook's effectiveness, efforts should be directed towards minimizing fluctuations in daily conversions by dissecting influencing factors such as timing, demographic shifts, and ad content variations. For AdWords, refining targeting strategies and enhancing ad creatives could significantly improve both click-through and conversion rates, maximizing the platform's expansive reach. Strategic resource allocation should focus on boosting investment in Facebook to capitalize on its robust conversion capabilities, while leveraging AdWords for its strength in enhancing traffic and brand awareness. These tailored approaches can help ensure that each platform is utilized for its inherent strengths, optimizing overall campaign outcomes.

# Probability

* Pavan

# Distribution Analysis

* Wasim

# Hypothesis Testing

* Wasim

# Inference on Population Means using Z- test and T-test

* Mahesh

Inference on Population Variances using F test

* Mahesh

Inference on Population Variances using Chi Square test

* Mahesh

# Conclusion

This descriptive analysis highlights the strengths and weaknesses of Facebook and AdWords campaigns. Facebook shows superior performance in user engagement and conversions, while AdWords dominates in reach and volume. These insights provide actionable strategies to optimize ad performance and allocate resources effectively. Further analysis, including time-series trends and user segmentation, could deepen understanding and refine campaign strategies.