

Analysis and visualization of digital advertising data using EDA on payment point online bank applications

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Abstract: This research explores the effectiveness of digital advertising within Payment Point Online Bank (PPOB) applications using Exploratory Data Analysis (EDA) and data visualization techniques. With the rapid growth of internet users and online transactions in Indonesia, businesses face challenges in optimizing digital marketing strategies. By analyzing data from various digital ad campaigns, the study develops a comprehensive advertising dashboard to enhance decision-making and report generation. Key metrics such as cost, impressions, clicks, app installs, registrations, and purchases are examined to assess campaign performance. The dataset comprises advertising data, which includes campaign data (Region, Network, Device) and demographic data (Age and Gender) stored in spreadsheets. The total campaign dataset contains 20,151 rows, while the demographic dataset comprises 125 rows, collected from March to May 2023. Findings indicate that the majority of users (90%) access the application through mobile phones, while 10% utilize tablets. Regarding cost-effectiveness, the UAC_AppInstall campaign demonstrates the lowest Cost per App Install (CPI) at 3141 Rupiah, while the UAC_AppRegistration campaign has the most efficient Cost per Registration (CPR) at 8892 Rupiah and the UAC_AppRetention campaign boasts the most efficient Cost per Purchase (CPP) at 235 Rupiah. Moreover, regional analysis shows that areas like West Java, Jakarta, East Java, and Central Java have the highest acquisition rates, while the eastern regions of Indonesia face challenges due to lower internet accessibility and digital literacy. The study provides valuable insights for marketing teams to optimize their strategies, enhance targeting approaches, and improve the overall effectiveness of digital advertising campaigns.

Keywords: Data Analysis, Data Visualization, Digital Marketing Campaigns, Exploratory Data Analysis, PPOB Application

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Introduction

In the digital age, companies rely heavily on digital advertising for effective marketing. Indonesia's internet user count hit 210 million in 2022 [1], sparking a surge in online shopping interest [2]. Businesses are in a race to harness digital platforms for broader reach and impactful campaigns, fostering real-time connections between sellers and buyers [3]. Payment Point Online Bank (PPOB) stands out as a tech-driven solution for various financial transactions [4]. Initially user-friendly, PPOB has grown crucial due to swift tech advancements. PPOB operates entirely online, ensuring instant updates and transactions [4]. Global competition is fierce, prompting companies to run digital marketing campaigns. While Google Ads and Facebook Ads are common choices, the escalating competition drives up digital advertising costs. Hence, strategic budgeting is essential to avoid overspending without returns. To gauge platform effectiveness, analyzing digital ad campaigns through data visualization is key. This provides insights into the impact of marketing efforts.

Although the company has engaged in digital advertising campaigns, it still faces challenges in optimizing its marketing strategy. Issues include high customer acquisition costs, difficulty understanding customer behavior, identifying the right target market, and measuring the effectiveness of digital advertising campaigns. Problems also arise when the company's marketing department seeks performance reports on digital advertising; they struggle with interpreting data

due to the absence of a dashboard, hindering decision-making. An effective method to communicate detailed data in an easily understandable manner is through the use of data visualization. Therefore, analyzing and visualizing data become crucial steps for the company to maximize the performance of digital advertising campaigns and address these challenges effectively.

The research aims to create a comprehensive advertising data dashboard for streamlined report generation and faster decision-making. It also aims to gain a better understanding of customer behavior and evaluate the performance and impact of digital advertising campaigns by using data visualization and Exploratory Data Analysis (EDA) techniques.

Digital advertising encompasses marketing activities involving the sales, promotion, advertising, and pricing of products or services via online media [5]. Digital advertising plays a crucial role in modern marketing strategies [6], involving the non-personal presentation and promotion of ideas, goods, or services by specific sponsors in exchange for payment. Research indicates that digital advertising directly impacts sales. Research indicates that digital advertising directly impacts sales [7]. It has become a crucial part of marketing campaigns because of its wide reach and high effectiveness. Digital advertising is regarded as an effective and efficient strategy for promoting products because of its wide reach, flexible timing and location, and various marketing methods available. In contrast to traditional or conventional marketing limited by time, location, and user reach, digital marketing offers distinct advantages [8].

The bidding process in digital advertising platforms involves advertisers participating in auctions, and submitting bids for ad placement based on factors like relevance, ad quality, and bid value [9]. Different strategies can be employed in this process, such as CPC Bidding (Cost Per Click), CPM Bidding (Cost Per Mile), CPA Bidding (Cost Per Acquisition), and ROAS Bidding (Return On Ad Spend). These various bidding strategies cater to different advertising goals and objectives within the digital landscape [10].

Methodology

Data visualization is a method that uses computers to transform symbols into geometric shapes, enabling researchers to visualize computational simulations and enrich the process of scientific discovery, thus fostering a deeper and unforeseen understanding [11]. Data visualization is crucial in data analysis as it helps users depict patterns, trends, and relationships within the data. It serves various purposes, such as identifying market trends, forecasting future expenditures, and understanding customer behavior. Additionally, data visualization aids in communicating information in a more easily understandable way for everyone. The data visualization process comprises seven stages [12] acquiring, parsing, filtering, mining, representing, refining, and interacting.

Building upon the foundation of effective data visualization, Exploratory Data Analysis (EDA) stands out as a crucial process in the field of data analysis. EDA is a methodical approach to comprehending data and extracting valuable insights [13]. It encompasses the utilization of diverse data visualization techniques and statistical methods to guide users through the exploration of data, revealing intricate relationships between variables. Techniques such as histograms, scatter plots, box plots, and correlation matrices play a vital role in this exploration [13]. This process is instrumental in conducting initial investigations on data, unveiling patterns, identifying anomalies, testing hypotheses, and examining assumptions. Through the application of summary statistics and graphical representations, EDA aids users in discerning data distributions, spotting outliers, discovering missing values, and evaluating relationships between variables [14].

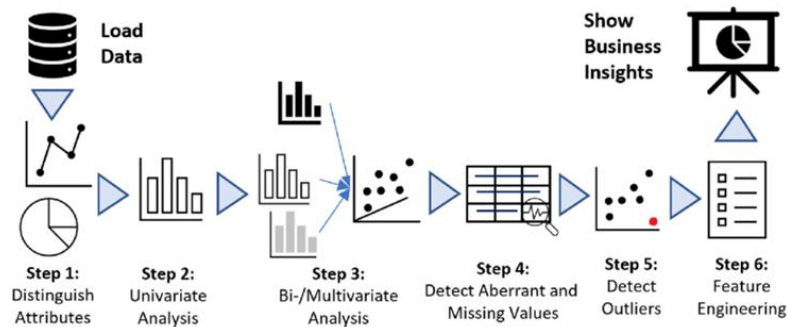


Figure 1. Exploratory Data Analysis Steps

Results and Discussions

In this study, the researcher conducted direct observations on the digital advertising campaign data of the PPOB application. The collected report data contains key objects necessary for data processing in this research, such as Channel, Network, Region, Gender, Age group, Cost, Impression, Clicks, AppInstall, Register, and Purchase. The collected data in the form of a dataset will undergo preprocessing using the Python programming language. This process involves managing/changing the data to clean missing values, remove noise, and ensure consistency. The total dataset for the campaign comprises 20,151 rows, with demographic data amounting to 125 rows collected within the timeframe from March to May 2023.

In this stage, Exploratory Data Analysis (EDA) is conducted, which is a process or activity to analyze patterns and trends in data that has undergone preprocessing in the previous stages. During this process, problem identification and the formulation of intriguing hypotheses are carried out through univariate and bivariate analyses, as well as the exploration of correlations among data points such as costs, registrations, sales, and others. The objective of this process is to provide deeper insights into the data, offering valuable information to management and relevant users based on the provided data and information.

1. What device categories do customers use the most?

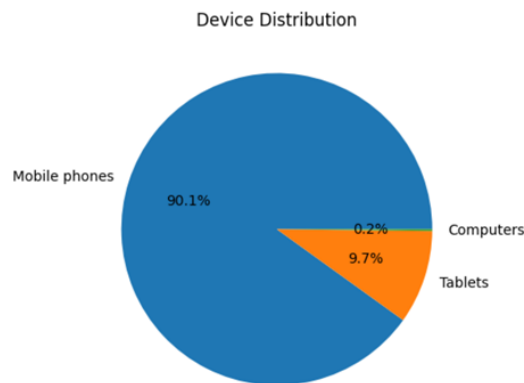


Figure 2. Device Distribution

[Figure 2](#) shows the proportion of users on each device revealing that the majority, accounting for 90%, access the application through mobile phones, while 9.7% utilize tablets. This aligns seamlessly with the marketing target, where customers are predominantly application users.

2. Which campaigns cost the most money?

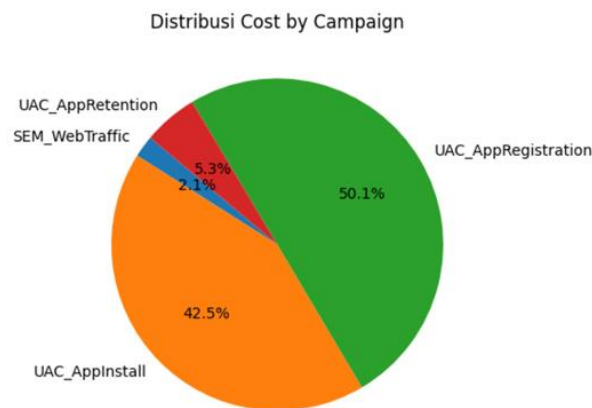


Figure 3. Cost Distribution by Campaign

[Figure 3](#), In terms of advertising cost the UAC_AppRegistration campaign incurs the highest expense, amounting to 50.1%, followed by the UAC_AppInstall Volume campaign with a cost proportion of 42.5%. The reasons behind the significant cost proportions in these two campaigns are not yet apparent at this stage.

3. Which campaign was most effective in generating conversions in terms of App Install, Registration, and Purchase?

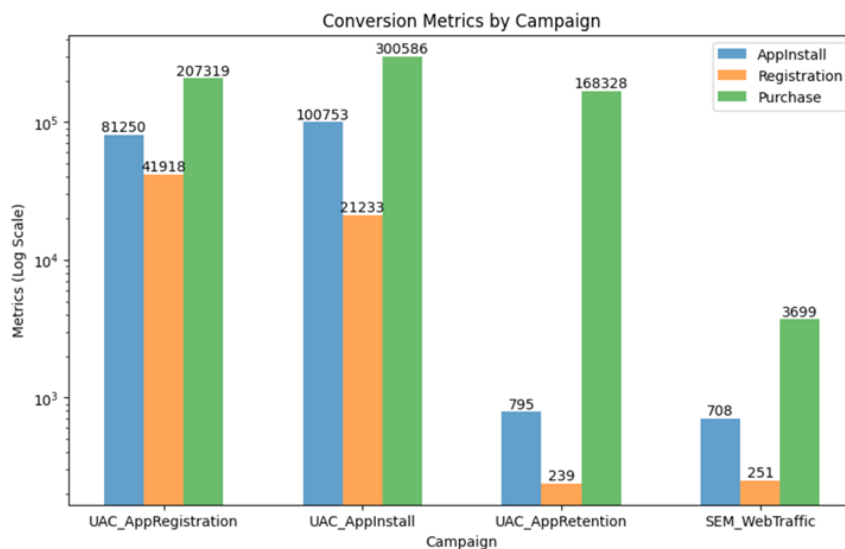


Figure 4. Conversion Metrics by Campaign

[Figure 4](#), it is known that the reason why more costs are incurred in both UAC_AppRegistration & UAC_AppInstall campaigns is because they generate the most App Installs, Registrations, and purchases. Another interesting finding is that the UAC_AppRetention campaign generates a lot of Purchases even though in terms of cost it is very small when compared to the other 2 campaigns.

4. Which campaign is the best in terms of cost-effectiveness?

Cost-effectiveness is measured to find out whether the campaign is good and healthy from the company's financial point of view. Then each campaign needs to be measured for effectiveness by calculating the costs incurred for each 1 conversion metric, For example: $\text{Cost} / \text{AppInstall} = \text{Cost incurred to get 1 App Install}$. $\text{Cost} / \text{Register} = \text{Cost incurred to get 1 Registration}$. $\text{Cost} / \text{Purchase} = \text{Cost incurred to get 1 Purchase}$.

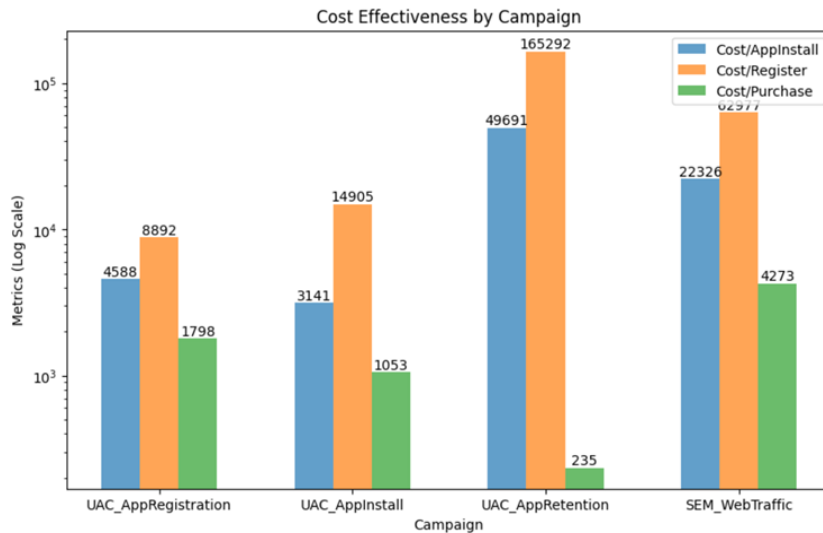


Figure 5. Cost Effectiveness per Campaign

Figure 5 provides insights from the cost-effectiveness analysis. The UAC_AppInstall campaign demonstrates the most efficient Cost per App Install (CPI) with a value of 3141 Rupiah, indicating that the cost incurred for one application installation is Rp 3141. The UAC_AppRegistration campaign exhibits the most efficient Cost per Registration (CPR), with the cost incurred for one registration being Rp 8892. For Cost per Purchase (CPP), the UAC_AppRetention campaign is the most efficient at Rp 235. However, it is crucial to note that in terms of CPI and CPR, this campaign is relatively expensive. Contrarily, the SEM_WebTraffic Campaign proves to be less effective and less efficient, as its CPI, CPR, and CPP are considered relatively expensive.

5. From which Network do users see ads, do App Install, Registration, and Purchase?

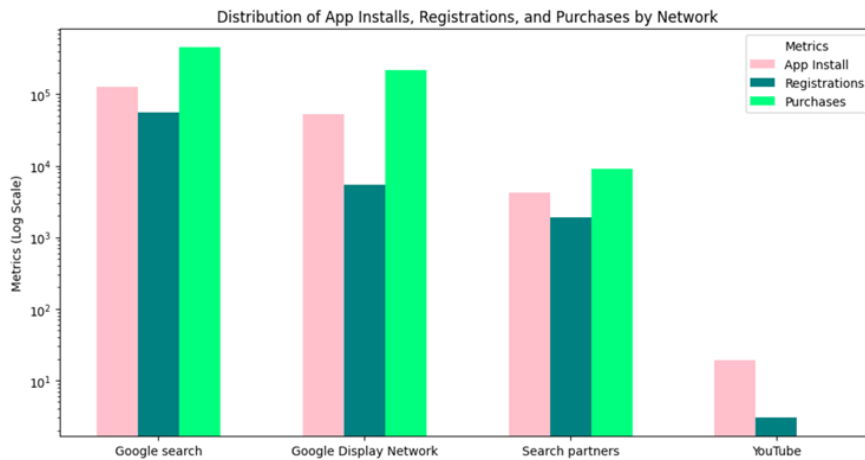


Figure 6. Conversion per Network

Figure 6, From the Network distribution analysis it is known that Google Search generates the most Installs, registrations & Purchases. This shows that many customers come by searching on search engines.

6. What is the cost-effectiveness of each Network?

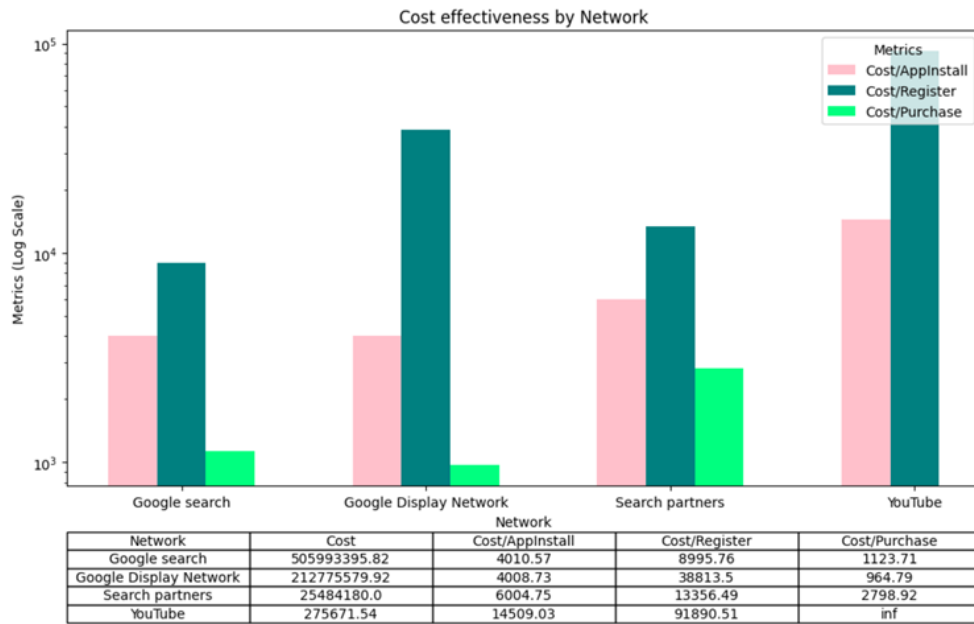


Figure 7. Cost-effectiveness per Network

In Figure 7, the cost-effectiveness analysis reveals valuable insights, Google search emerges as the most efficient overall performer among various networks. The Google Display Network proves to be relatively expensive in acquiring registrations but highly efficient in generating purchases, indicating its effectiveness in driving purchase outcomes. In contrast, YouTube stands out as the most inefficient or costly network, attributed to its high price per Install and registration. Additionally, it has not yet generated any purchases, making the cost per purchase incalculable.

7. Region Analysis: Which region generates the most registrations and purchases?

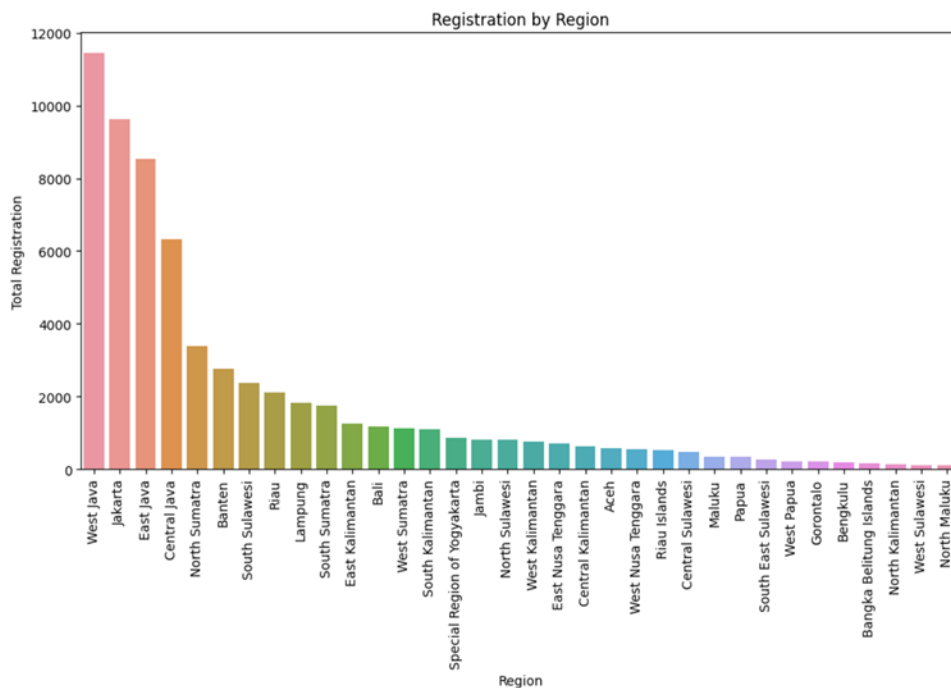


Figure 8. Number of Registration per Region

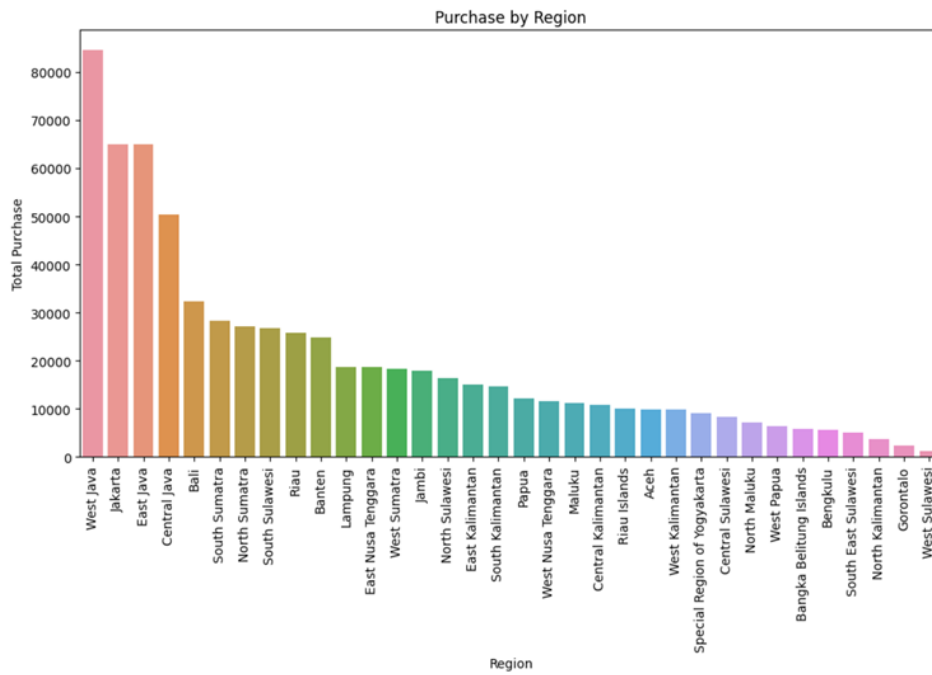


Figure 9. Number of Registration per Region

From Figure 8 and Figure 9, the region with the highest number of registrations and purchases is equally occupied by West Java, Jakarta, East Java, and Central Java. It can be concluded that these regions have the largest customer population and the market need for PPOB products is quite desirable. So that the campaign can be continued in these areas.

8. What is the cost-effectiveness of each region?

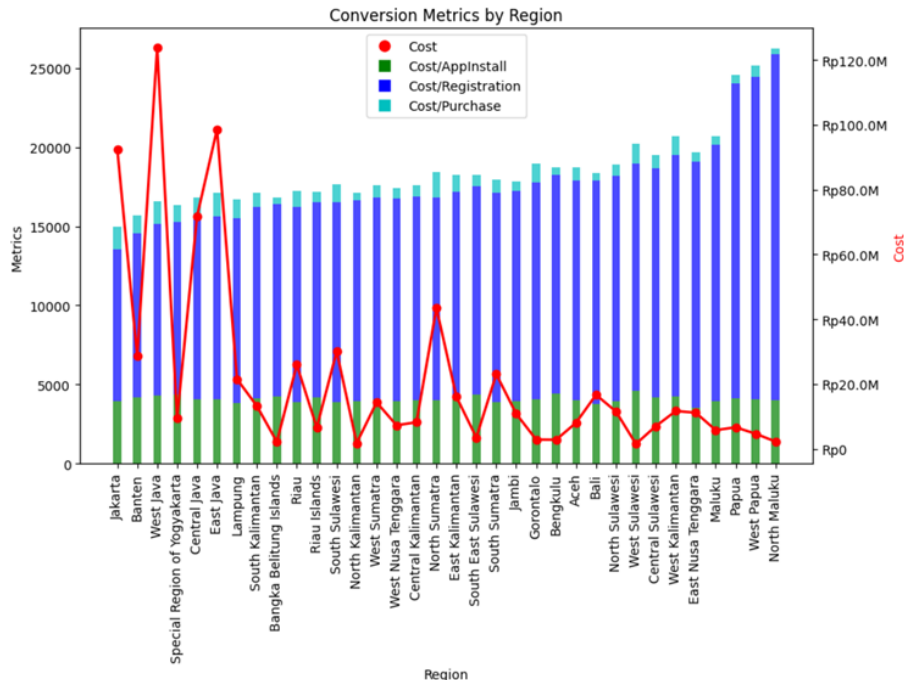


Figure 10. Cost-effectiveness per Region

Figure 10 measures which region has the most effective cost-effectiveness, a bivariate analysis can be conducted between the Cost and Region variables by measuring their cost-effectiveness. The results are known, Regions with the most effective cost-effectiveness include Jakarta, Banten, West Java, Yogyakarta, and Central Java. Although the cost-effectiveness is quite low in Banten

and Yogyakarta, the cost of advertising is also low, therefore, it is recommended that more advertising be done in these areas so that it can maximize new customer acquisition. If we look at the Eastern part of Indonesia, the acquisition cost is more expensive, especially in Sulawesi, Nusa Tenggara, Papua, and Maluku. It can be assumed that the digital understanding of the region is quite low, as well as limited internet access so there is not much market demand for PPOB products.

9. How Gender compares to campaign metrics

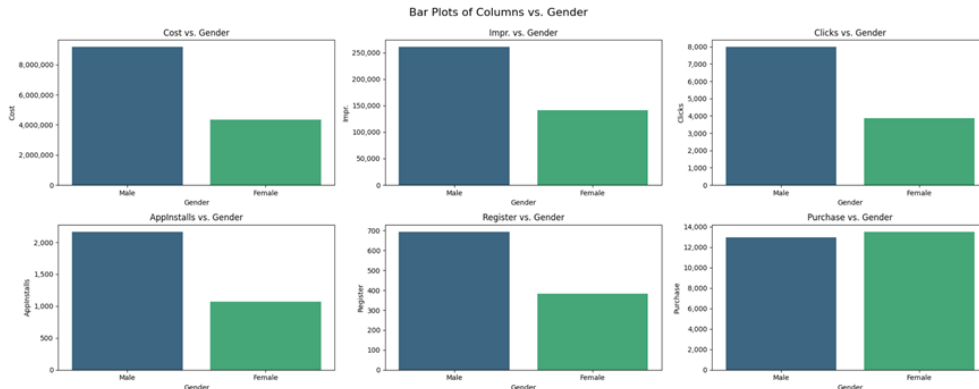


Figure 11. Gender compares to campaign metrics

Figure 11 shows that men are exposed to more advertisements than women. The number of purchases per registration is lower for males compared to females. Female customers tend to make more purchases than Males.

10. How does age group compare to campaign metrics?

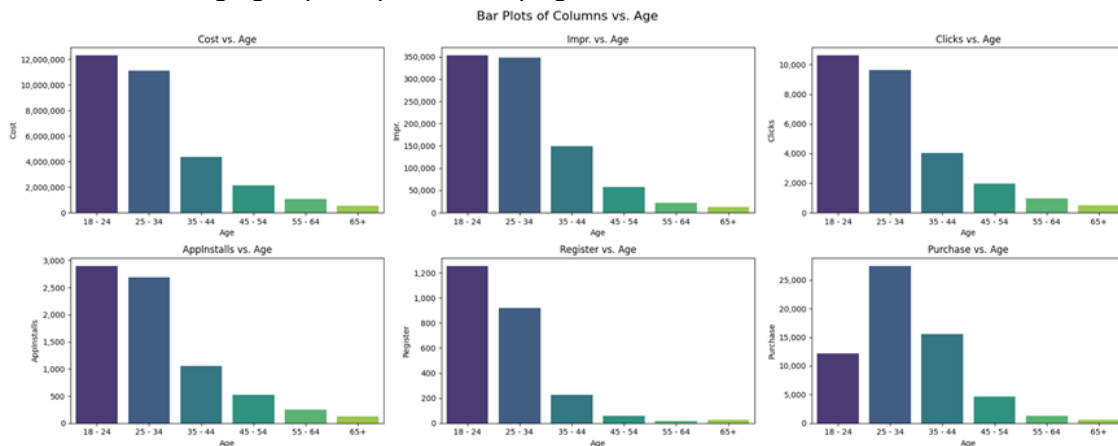


Figure 12. Age group compares to campaign metrics

Figure 12 shows that ages 18-24 & 25-34 are most exposed to ads. The number of AppInstalls & Registrations is highest in the age of 18-24. However, in terms of purchasing, ages 25-34 & 35-44 are higher than the age group 18-24, it can be concluded that the age group 18-24 does not have high purchasing power or financial capability compared to other age groups.

11. What is the correlation between the metrics and are there any interrelationships that affect the effectiveness of the campaign?

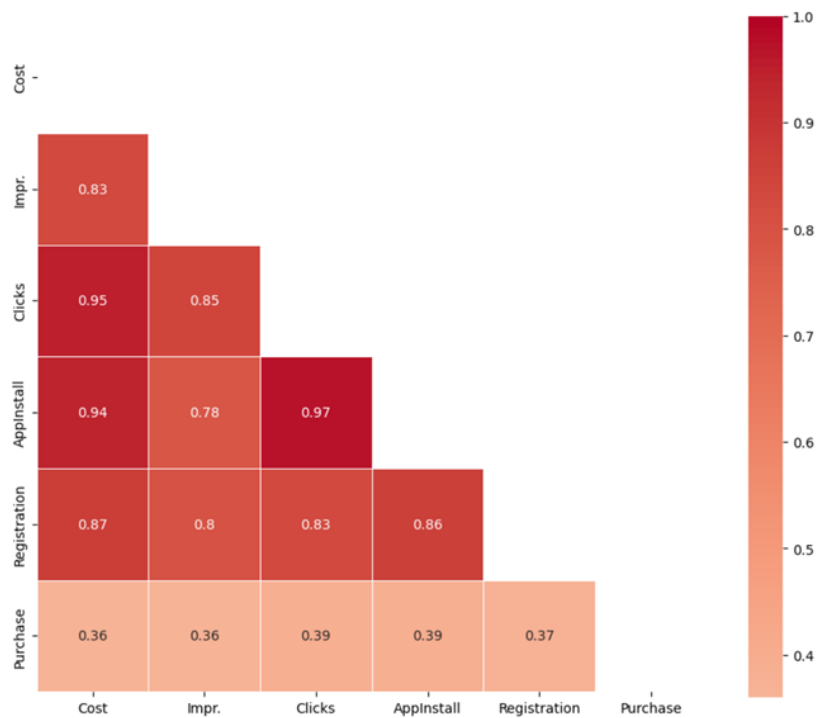


Figure 13. Correlation Matrix

Figure 13 shows a very strong correlation was found between Cost and Clicks, AppInstall, and Registration. This indicates that the more money spent, the more users will click on ads, install apps, and register. The correlation between AppInstall and purchase shows a positive value (0.39) but is quite weak, indicating that there is no guarantee that users who install automatically make a purchase. Likewise, the correlation between Registration and Purchase shows the same thing. The positive correlation between AppInstall and Registration is quite strong (0.86), this can be interpreted that users who do AppInstall tend to register. However, users who register do not necessarily purchase as shown by the positive value of the correlation between the two (0.37) is not strong enough.

Conclusion

Based on the research results employing the EDA method, several key findings have been unveiled. Mobile devices are predominant, accounting for 90% of users. While male customers dominate in terms of acquisition, women lead in transaction numbers. The age group of 18-24 is prevalent among customers, yet the purchasing power peaks in the 25-34 age range. Big cities like West Java, Jakarta, East Java, Central Java, and North Sumatra exhibit the highest acquisition rates, in contrast to the eastern part of Indonesia, where accessibility to the internet and digital literacy remains low.

Interestingly, the UAC_AppRegistration and UAC_AppInstall campaigns excel in generating acquisitions, but most purchases stem from retention campaigns with considerably lower costs. These insights are invaluable for marketing and management teams, providing a reference point to expedite decision-making, adjust campaign strategies, and refine targeting approaches based on the research findings.

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