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AI-Related Advertising on Facebook: Addressing Bias, Targeting Challenges and Regional Factors

Sera Singha Roy
sera.sroy@gmail.com

Tanya Linden
lindent@unimelb.edu.au

University of Melbourne
Parkville, VIC 3010 Australia

Abstract

It has been established by research and marketing firms that advertising on social media is due to its reach, cost effectiveness and range of media formats appealing to a range of target audiences. However, a campaign needs to be properly designed to reach the intended audiences and therefore be value for money. Therefore, the focus of this research is to evaluate the effectiveness of AI-related advertising campaigns, particularly in reaching their intended audiences, such as individuals with a declared interest in AI. This study addresses the under-explored area of how effectively these campaigns target and engage their intended demographic groups, revealing gaps and opportunities in current advertising strategies. A dataset of 5,528 AI-related advertisements was analyzed to evaluate the parameters of targeting precision, demographic distribution, and geographical variations. The analysis aimed to identify discrepancies in ad reach and effectiveness across different demographic segments and various geographical regions. The findings show a significant discrepancy between overall ad volume and targeted reach, with only 12.6% of ads directly targeting individuals interested in AI. Our findings reveal a distinct demographic skew in AI ad exposure, favoring males and the 25-34 age group. This gender disparity is particularly pronounced when targeting AI enthusiasts, raising concerns about potential bias in ad delivery. Significant geographical variations in ad performance were also identified, underscoring the importance of regional context in advertising strategies. The implications of these findings for advertisers are clear: more precise targeting is needed to engage AI-interested audiences effectively, algorithmic biases must be addressed to ensure equitable ad delivery, and contextual factors should be considered to optimize campaign strategies.

Keywords: Digital Marketing, Social media advertising, Social media analytics, Data Analytics, Facebook Analytics, Artificial Intelligence

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AI-Related Advertising on Facebook: Addressing Bias, Targeting Challenges and Regional Factors

Sera Singha Roy and Tanya Linden

1. INTRODUCTION

In today's contemporary digital landscape, advertising on social media plays a crucial role in modern marketing serving as a powerful tool for targeted advertising, customer engagement, and brand loyalty (Lulandala, 2022). Social media platforms like WhatsApp, Facebook, and YouTube offer advertisers the ability to reach potential customers 24/7, leveraging the platforms' extensive reach and user engagement. This in turn opens vast opportunities for brands to connect with consumers, build brand recognition, and ultimately drive sales (Mishra, 2017; Vitalis et al., 2023). The ability to precisely target demographics, track user engagement, and measure campaign effectiveness has solidified social media advertising as an essential element in the modern marketing mix (Sharma & Ashfaq, 2023). However, the effectiveness of social media advertising hinges on a deep understanding of demographic parameters and their profound influence on consumer behavior.

When considering platforms that excel in targeted advertising, Facebook emerges among the best choices due to its massive user base coupled with sophisticated targeting capabilities and diverse ad formats, providing businesses with optimal opportunities to reach potential customers (Kawaf & Istanbulluoglu, 2019). Advertisers can utilize Facebook's detailed and diverse targeting options to connect with specific demographics, interests, and behaviors, ensuring that their ads are seen by the most relevant audience (Risius & Ayding, 2018). Additionally, Facebook's advanced analytics tools provide marketers with capabilities to monitor campaign performance, and make data-driven decisions to optimize their advertising strategies (Adeleye et al., 2024).

Facebook's advertising reach extends to a wide array of fields, including healthcare, sustainability, entertainment, education, and even cutting-edge Artificial Intelligence (AI) tools. As AI is rapidly transforming various industries such as healthcare, finance, education, retail, and banking to name a few (Mungoli, 2023), we are observing a surge in advertising campaigns promoting AI products, services, and content (Marinchak et al., 2018). Throughout this study, the term "*AI-related advertising*" will refer to any advertisement that features AI products, services, or content. Examples of AI-related advertisements could range from an online competition to complete an AI coding challenge to a healthcare service utilizing AI chatbot services to help a patient recognize the seriousness of initial symptoms. However, the effectiveness of these campaigns in reaching their intended audiences remains underexplored. There is a need to better understand the optimal use of targeting strategies, the potential for algorithmic bias, and the influence of geographical and cultural factors on these campaigns for businesses to get the best outcomes and value for money (Whitelegge, 2016). This study investigates the targeting precision and demographic reach of advertising campaigns featuring AI-related content, as well as examining factors influencing campaign effectiveness across different demographics and geographical regions. The following research questions were posed.

RQ-1: To what extent does interest-based targeting influence the reach and effectiveness of AI-related advertising compared to other targeting strategies?

RQ-2: How do advertising strategies and broader societal factors intersect to shape the representation of different demographic groups within AI-related advertising?

RQ-3: How do geographical and contextual factors influence the performance of AI-related advertising campaigns across different regions?

2. BACKGROUND

Facebook advertising effectiveness is a multifaceted landscape, influenced by user demographics, ad content, and engagement metrics (De Silva, 2023). Research consistently demonstrates its impact on purchasing behaviors, particularly among younger demographics. For instance, research conducted in the Klang Valley area of Malaysia found a strong correlation between Facebook's influence and the effectiveness of digital advertising among youth, with socio-demographic factors such as age and

educational level playing a role in this relationship (Lin et al., 2024). Studies also highlight the positive correlation between Facebook's influence and digital advertising effectiveness, with sociodemographic factors playing a significant role. This effectiveness extends to national campaigns, where engagement metrics like likes, comments, and shares are key performance indicators, informing strategies for brand image enhancement and customer acquisition (Kolesnyk & Kostynets, 2023).

However, while research on Facebook advertising effectiveness is extensive, studies specifically examining campaigns involving AI-related products and services are limited. This gap is critical to address, given the unique challenges and opportunities presented by this rapidly evolving technological landscape.

Demographic parameters, such as age, gender, income, education, and occupation provide crucial insights into the specific needs, preferences, and purchasing behaviors of different customer segments (Dobscha & Ostberg, 2021). Gender is important as a social indicator of what is considered an expected role and behavior within the discussed context (Birknerová et al., 2018). It is also associated with prejudices and stereotypes, however these change with time. Research indicates that men and women have different perception of advertising materials, as well as different expectations in this area (Birknerová et al., 2018). It has been evident that income levels can influence responsiveness to marketing, with higher-income individuals potentially favoring luxury and exclusivity, while lower-income groups may prioritize affordability (Patino et al., 2014). In the healthy food market, for instance, socially responsible marketing practices are seen as long-term investments that enhance company value, with key demographic variables like gender and household income significantly affecting customer perceptions (Vržina & Pepur, 2021). Age groups must be considered during the design of marketing campaigns because there are significant differences in cognitive functions of young consumers compared to mature age consumers. As a result, different age groups behave differently in relation to persuasion delivered by advertising. Younger consumers are more skeptical of advertising whereas older audiences are more susceptible to promotional tactics (Phillips & Stanton, 2004).

Understanding of these parameters is paramount for crafting effective marketing strategies across various domains, including targeted marketing campaigns, product development, pricing strategies, distribution channels, and customer relationship management (Dobscha & Ostberg, 2021). Geographic parameters further influence social media marketing by adding layers of cultural nuances, local trends, and communication styles (Patino et al., 2014). Local trends and consumer preferences, often varying widely across regions, necessitate adapting social media strategies to reflect these nuances. The integration of geographic data with social media networks allows marketers to visualize and identify potential local connections between firms and customers, enhancing targeted marketing efforts (Fogarty, 2021). Finally, language and communication styles prevalent in different geographic regions should be carefully considered, ensuring messages are not only translated accurately but also culturally adapted for resonance with the local audience (Patino et al., 2014).

Previous research has highlighted the potential for algorithmic bias, particularly concerning underrepresented or marginalized groups. For instance, studies have found that online ad delivery can perpetuate gender stereotypes, with women more likely to see ads for caregiving roles and men for leadership positions (Rodgers & Nguyen, 2022). Similarly, research has uncovered racial biases in the delivery of housing and credit-related ads, with ads for arrest records more likely to be shown to Black users (Gao et al., 2023). This is particularly crucial for emerging technologies like AI, which carry their own set of societal implications and its impact on various sectors (Chander, 2024).

Furthermore, geographical and cultural context significantly influence advertising effectiveness. Scholars emphasize understanding local market dynamics, consumer behavior, and cultural nuances when developing global advertising strategies (Yu, 2021). In Saudi Arabia, for instance, global brands that incorporate local cultural cues related to Islamic values and family dynamics in their Facebook content see higher consumer engagement, illustrating the importance of cultural value congruence in social media marketing (Abuljadail & Badghish, 2021).This is particularly relevant for AI-related advertising, as the adoption and perceptions of AI technology can vary widely across different regions and socioeconomic backgrounds (Kelley et al., 2021).

Therefore, drawing upon existing research on targeted advertising, particularly on platforms like Facebook, is essential for framing the

investigation of AI-related advertising campaigns. This context highlights the need to examine potential biases, consider cultural nuances, and understand the unique challenges and opportunities presented by this rapidly evolving technological landscape through our study.

3. METHODOLOGY

The study employed quantitative research approach, which encompasses distinct stages devised to extract, process, analyze, and interpret the gathered data to discern nuanced insights into AI-related advertising on Facebook.

Data Collection

The data collection process involved accessing and extracting pertinent details from two primary datasets obtained from Facebook's developer platform, specifically Meta's Research Platform: the Ad Targeting dataset and the Ad Library dataset. These datasets provided comprehensive insights into the targeting criteria, ad creatives, and performance metrics of advertisements related to AI.

The Ad Targeting dataset (ad_targeting_dataset_ siep_aug_2020) (Meta Platforms, 2024) provides detailed information about the targeting criteria used for each advertisement on Facebook, including demographic parameters such as age, gender, location, and interests. These options are provided to the advertisers when they are creating their advertisement and specifying targeting criteria. The 'interest' field for each user is compiled by Facebook from pages liked by the user or from keywords associated with pages or apps the user uses. Data collection from this dataset began with the formulation of SQL queries designed to filter ads targeting interests related to AI. These queries were tailored to include specific keywords and phrases relevant to AI such as 'A.I.', 'Artificial Intelligence', 'Deep Learning' and so on. The Ad Library dataset (ad_archive_api) contains information about ad creatives and performance metrics, including

- ad creative body – texts that are displayed in an ad,
- spend – amount of money spent on running an ad,
- reached countries – countries that ran an ad
- regional distribution– regional distribution of people reached by an ad,
- demographic distribution – demographic distribution (age range and gender) reached by an ad,
- impressions – number of times an ad has been on the screen of users

Integration of the Ad Targeting dataset with the Ad Library dataset was facilitated using unique identifiers such as archive IDs, allowing for the correlation of targeting criteria with ad performance metrics. Data extraction from this dataset involved querying ads that were identified in the Ad Targeting dataset using prominent keywords related to AI such as 'A.I.', 'Artificial Intelligence', 'Deep Learning' and other synonyms. For instance, the following query provides us with the unique archive id and demographic distribution for each ad which are targeted to users interested in 'Artificial intelligence'. The column 'ds' represents a date stamp (e.g., 2021-11-03).

```
SELECT a.archive_id,
b.demographic_distribution
FROM {database}.{table} a,
{database}.{api_table} b
WHERE a.ds = b.ds AND  a.archive_id =
b.fbid
AND CARDINALITY( FILTER(
CAST(JSON_EXTRACT(include, '$') AS
ARRAY(MAP(VARCHAR, VARCHAR))), (x) ->
ELEMENT_AT(x, 'Artificial
 intelligence') = 'Interests')) > 0
```

Leveraging the expansive scope of the Ad Targeting dataset, which encompasses detailed targeting criteria utilized by advertisers, and the Ad Library dataset, containing comprehensive performance metrics, a robust dataset gathered from April 21, 2021 was compiled for subsequent analysis.

Data Preprocessing and Cleaning

Upon acquisition of raw data from the Ad Targeting and Ad Library datasets, data cleaning steps were undertaken to ensure the integrity and consistency of the dataset. These endeavors aimed at rectifying inconsistencies and addressing missing values. Using extensive SQL queries, the 'NULL' and missing values from the columns were removed to minimize data anomalies and enhance the overall quality of the dataset and therefore, the results.

Data Analysis and interpretation

A diverse array of analytical techniques was employed to extract meaningful insights from the processed dataset. Key performance metrics, including impressions, interest in AI, age, gender, and location, were subjected to comprehensive analysis to discern patterns, trends, and correlations. Leveraging both queries in SQL and visualization of the insights through graphs and plots, this research aimed to identify key patterns and relationships within AI-related advertising.

This study examines the influence of targeting strategies on the performance of AI-related advertising across various dimensions. We analyzed a final dataset of 5,528 AI-related advertisements to understand how interest-based targeting, demographic representation, and geographical context shape advertising outcomes. Our findings provide insights into the effectiveness of different targeting approaches and highlight potential biases embedded within current advertising practices.

RQ-1: To what extent does interest-based targeting influence the reach and effectiveness of AI-related advertising compared to other targeting strategies?

Our findings demonstrate that interest-based targeting significantly impacts the reach and effectiveness of AI-related advertising. A mere 12.6% of the analyzed ads (700 out of 5,528) were targeted based on consumers with declared interest in AI. However, these targeted ads achieved an average of 45,275 impressions, substantially surpassing the 28,764 impressions for ads targeting individuals without a declared interest in AI and the 30,855 impressions for ads targeted to audience irrespective of their interests as shown in Figure 1.

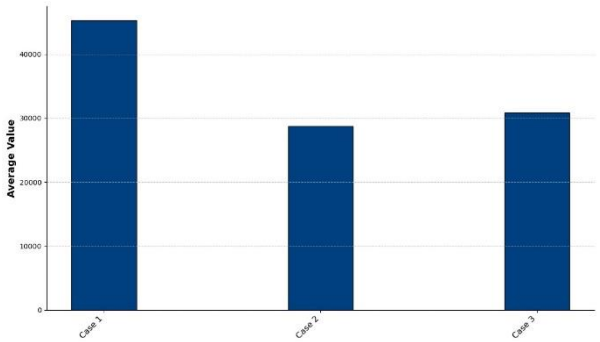

Figure 1 Comparison of impressions made by AI-related advertisements for targeted audiences. Legend: Case 1 - Ads targeted to audiences interested in AI, Case 2 - Ads targeted to audiences not interested in AI and Case 3 - Ads targeted to audience irrespective of their interests

Gender disparities were evident, with males representing a disproportionately larger share of the targeted audience (62.98% overall, 65.80% for targeted ads) compared to females (36.21% overall, 34.17% for targeted ads) as depicted in Figure 2 and Figure 3. The age group 25-34 exhibited highest exposure to AI-related ads with or without considering the audience interest.

The 18-24 age group shows a significant increase in exposure when advertisements are catered with respect to audience interest. This indicates a greater likelihood of engagement with AI-related content of ads when perceived relevance is high. Conversely, the 45-54 age group experiences a substantial increase in exposure when ads are not targeted as per audience interest. This observation presents an intriguing paradox: while this demographic may not actively express interest in AI, their passive exposure through untargeted campaigns appears to be substantial (Barbul & Bojescu, 2023). This could indicate an underlying receptivity to AI-related advertisements that is not captured through explicit interest-based targeting (Beauvisage et al., 2023).

Therefore, the results for RQ1 suggests that aligning advertising content with audience interests is crucial for enhancing campaign effectiveness (De Maio et al., 2020). Interest-based targeting holds significant potential for engaging a more receptive audience and maximizing the impact of AI-related advertisements (Sharma & Ashfaq, 2023).

RQ-2: How do advertising strategies and broader societal factors intersect to shape the representation of different demographic groups within AI-related advertising?

Analysis of demographic data reveals potential biases in the delivery of AI-related advertising. From Figure 4 we can observe that across all ads, the 25-34 age group exhibited the highest impression (28.7%), followed by the 18-24 (22.2%) and 35-44 (18%) age groups. Although 25-34 age group depicts highest impression on AI-related ads, a lot of potential in achieving a higher impression could be seen in the 18-24 and 35-44 age groups. Because of the gender disparity in ads targeting audience as discussed in RQ1, gender biases in impressions are observed due to the lower exposure of AI-related ads towards females. These findings raise concerns about potential biases embedded within ad delivery algorithms and strategies, thereby highlighting the broader representation issues within the AI industry (Kaplan et al., 2022; Lambrecht & Tucker, 2019). Both targeting methodologies and societal factors likely contribute to these disparities (Lambrecht & Tucker, 2019).

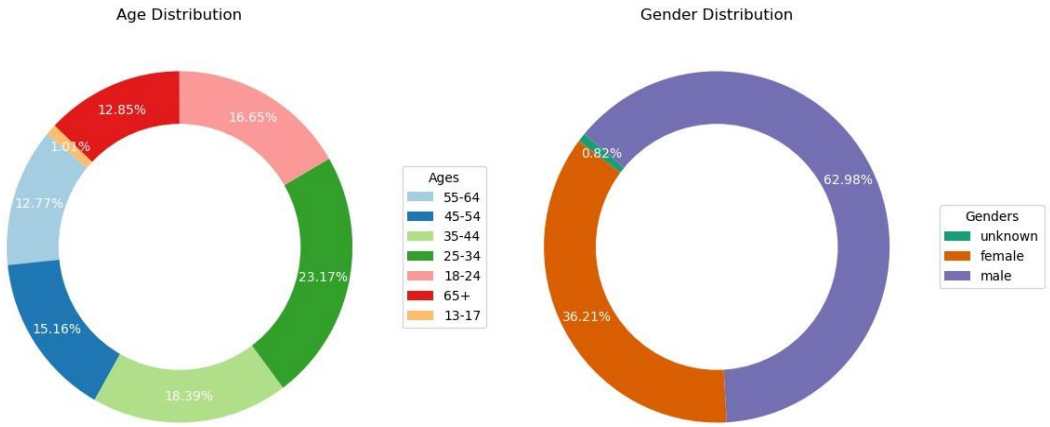

Figure 2 Demographic distribution of AI-related advertisement

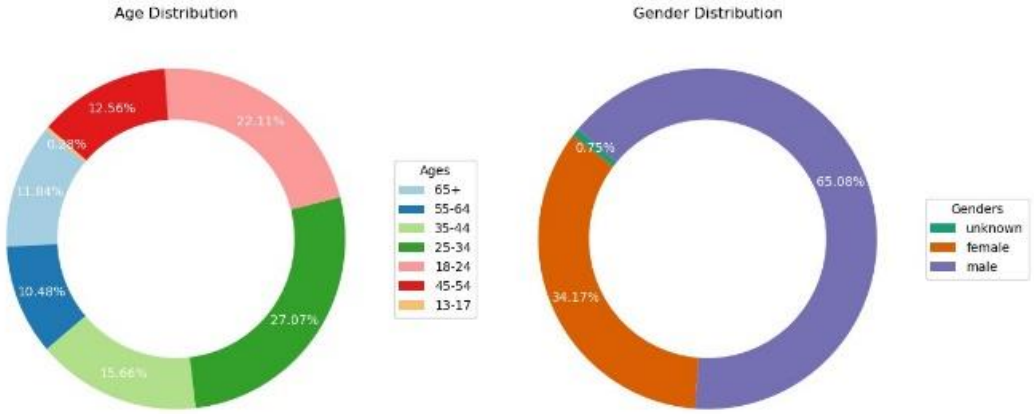

Figure 3 Demographic distribution of AI-related advertisement targeted towards interested audiences

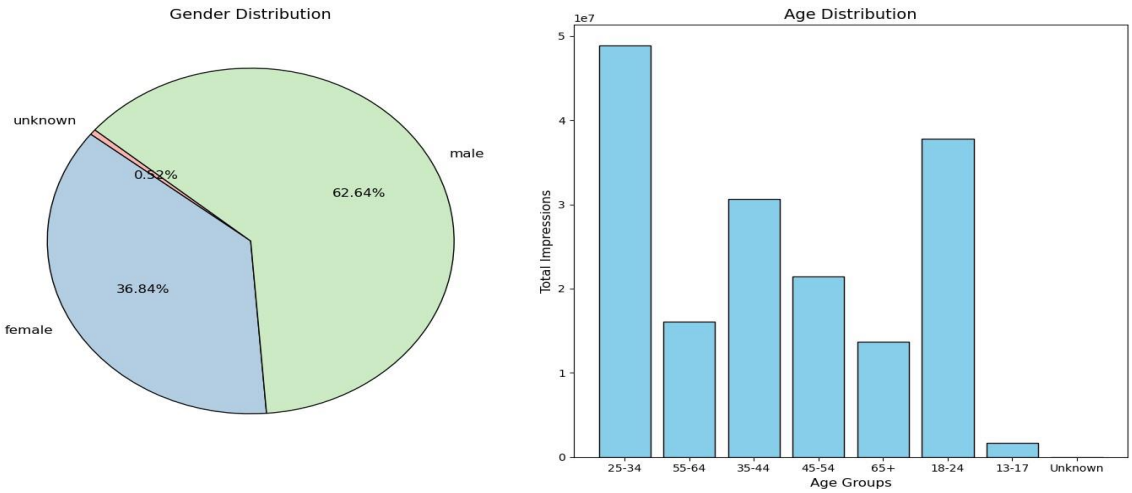

Figure 4 Depiction of impressions of AI-related ads over gender and age distributions

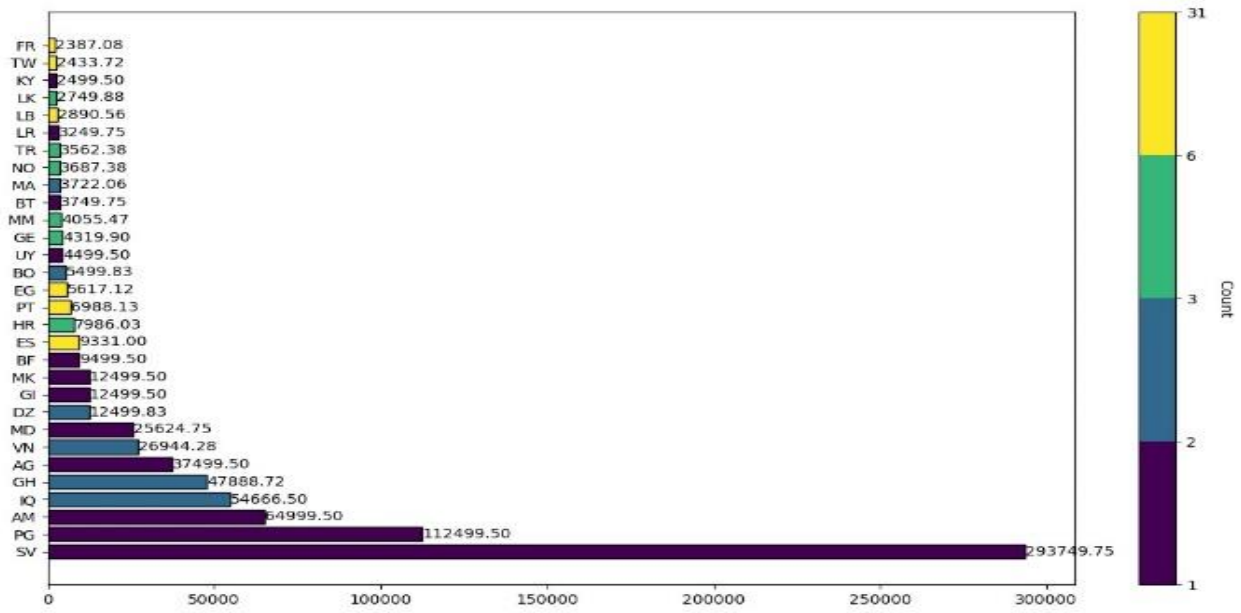

Figure 5 Top 30 countries (ISO Alpha-2 code) with highest impressions per ad

RQ-3: How do geographical and contextual factors influence the performance of AI-related advertising campaigns across different regions?

Geographical analysis reveals significant variations in ad impressions and reach across different countries. For instance, from Figure 5 we can observe that El Salvador and Papua New Guinea exhibited high impressions per ad but a lower overall ad count, suggesting a strategy focused on maximizing reach within a smaller, potentially niche audience. Conversely, France demonstrated lower impressions per ad but a higher ad count, indicating a focus on repeated exposure within a larger, more competitive market. These findings emphasize the importance of contextualizing ad performance data within the specific characteristics of each geographical region (Kannan, 2017). A nuanced, context-aware approach is essential for developing and implementing effective ad campaigns (Anderson et al., 2019). Advertisers must tailor their strategies based on regional market dynamics, understanding local contexts and audience behaviours to optimize ad performance (De Maio et al., 2020).

5. DISCUSSION

Interest based advertising implications

In answering Research Question 1, our findings underscore the significant impact of interest-based targeting on the reach and effectiveness of AI-related advertising. Although only 12.6% (700 out of 5,528) of the ads directly targeted individuals with a declared interest in AI, these ads achieved substantially higher impressions (an average of 45,275) compared to untargeted ads (30,855 impressions) and ads targeting individuals without a declared interest in AI (28,764 impressions). This demonstrates that targeted audience tend to view the advertisements featuring AI more frequently than untargeted audiences. This finding supports the importance of precise targeting in reaching audiences genuinely interested in AI-related products and services in line with the previous research (De Silva, 2023; Kawaf & Istanbulluoglu, 2019), emphasizing the multifaceted effectiveness of Facebook advertising influenced by user demographics and engagement metrics. Further research could benefit from other forms of engagement metrics such as sharing or click-rates.

However, the observed gender disparities in advertising reach raise concerns about potential algorithmic and strategic bias. Males represented a disproportionately larger share of the audience both overall (62.98%) and for targeted ads (65.80%) compared to females (36.21% overall and 34.17% for targeted ads). This finding is also consistent with past research which indicated that targeted advertising can perpetuate societal inequalities (Rodgers & Nguyen, 2022). The overrepresentation of males in AI-related advertising exposure, even when targeting those interested in AI, suggests that algorithmic

systems may amplify existing gender imbalances within the AI industry, as observed by (Lambrecht & Tucker, 2019). This finding also aligns with the study by (Kolesnyk & Kostynets, 2023), who highlighted the role of socio-demographic factors in digital advertising effectiveness.

It is important to point out that interest in AI in Ads Targeting Dataset relies on user engagement in the form of keywords or pages liked by users. Although the advertisers have an option to select their target audience based on their age, gender, interests, and behaviours, the "interest in AI" can vary across any age group or gender. For instance, an advertisement on healthcare enhancements through incorporating AI might not be appealing to a student who is healthy and learning a second language so their interests would be concentrated on other AI capabilities. Advertisements promoting new AI enhanced language courses would spark more interest in that user. Although demographic data and interest categories offer a reliable starting point, more robust approach involves considering contextual relevance, engagement with specialized communities and forums, content consumption patterns related to AI, and targeting based on self-reported skills. By incorporating these strategies, advertisers can reach more receptive audiences while respecting user privacy and fostering a more relevant and engaging online experience.

Demographic Representation and Algorithmic Bias

The demographic analysis, as per Research Question 2, further substantiates concerns about biases in AI-related advertising. The overrepresentation of the 25-34 age group (28.7% of impressions) and the underrepresentation of females across all ad categories suggest that both algorithmic and broader societal factors contribute to these disparities. This mirrors the findings of Lin et al. (2024), who found that socio-demographic factors such as age and educational level significantly influence digital advertising effectiveness among youth.

Research indicates that AI-advertising algorithms, potentially trained on historical data reflecting existing biases, may inadvertently perpetuate these disparities (Gao et al., 2023). This identified problem highlights the need for increased transparency and accountability in the development and deployment of such algorithms, particularly given the ethical implications of promoting emerging technologies like AI. This concern is echoed by (Kaplan et al., 2022), who advocate for ethical considerations in algorithmic decision-making processes.

As observed, the impact of algorithmic bias could lead to underrepresentation of certain demographic groups, therefore it is crucial for social media platforms to develop strategies to mitigate these biases. Suggesting potential mitigation methods requires significant transparency from social media platforms as well as enhancement of the current algorithms and development of new ones (which is beyond the scope of this study).

Geographical Context and Advertising Performance

The geographical analysis, as performed to answer Research Question 3, reveals the significant influence of context on AI-related advertising performance. Variations in ad impressions and reach across different countries highlight the need for tailored advertising strategies that consider local market dynamics, cultural nuances, and varying levels of AI adoption. For instance, El Salvador and Papua New Guinea exhibited high impressions per ad but a lower overall ad count, suggesting a strategy that focused on maximizing reach within a smaller, potentially niche audience. Conversely, France demonstrated lower impressions per ad but a higher ad count, indicating a focus on repeated exposure within a larger, more competitive market. These contrasting strategies demonstrate the importance of understanding regional differences in audience size, engagement patterns, and advertising saturation (De Maio et al., 2020). This emphasis on regional adaptation resonates with the findings of (Patino et al., 2014), who stressed the importance of considering cultural nuances, local trends, and communication styles in social media marketing. This aligns with the study by (Yu, 2021), who emphasized the need for culturally sensitive approaches in global advertising campaigns.

Practical recommendations for Advertisers

- Leveraging the interest-based targeting option - Facebook Ad Targeting Dataset provides options to the advertisers to select their audience from a range of demographic groups and interests. As pointed earlier in the paper, majority of advertisers do not specify their target audience based on their interests. Therefore, advertisers should align their ads with the audience with declared interest in AI.
- Opting inclusive strategies - Along with the most deserving group with declared interest, the advertisers could potentially target the consistently underrepresented groups

exhibiting relevant interests, thereby providing a pathway for the ads to reach them. The advertisers can also consider various ethnicities, gender and age groups in ad images and ad creative body. This will address the biases as well as a larger audience would be able to resonate with the ad.
- Localized campaigns – The advertisers should focus on adapting their advertising strategies with respect to the local trends rather than generalizing strategies for all regions.

Implications for Platform Developers
- Engagement with advertisers – Understanding from the viewpoint of advertisers will help the platform to understand their needs and therefore, develop bias mitigation strategies and to create a more inclusive and equitable advertising ecosystem.
- Opting transparency – The platforms should enable the advertisers to access their bias metrics in ad delivery system to promote transparency, trust, and accountability.
- Enhancing targeting options – The platform can introduce advanced targeting parameters such as user behavioural pattern, effect of trends on user impressions and contextual relevance, along with the existing parameters. This will enhance the understanding of the advertisers in selecting their target audience.

6. CONCLUSIONS AND FUTURE DIRECTIONS

This study performed an examination of the key dimensions of AI-related advertising on the Facebook platform, including targeting, demographic representation, and geographical performance. Our findings highlight the complex interplay of targeting strategies, societal bias, and contextual factors in shaping the landscape of AI-related advertising. While interest-based targeting proves effective in reaching interested audiences, the observed gender and age disparities raise concerns about potential biases embedded within ad delivery algorithms. Furthermore, the varying advertising performance across geographical regions highlights the importance of tailored approaches that account for local market dynamics and cultural nuances. These insights have significance for both advertisers and policymakers. Overall, this study provides the following key practical implications:
- For advertisers, enhancing target precision, leveraging audience interest and incorporating underrepresented groups will ensure better advertising strategies.
- For platform developers, addressing algorithmic biases, ensuring equitable ad distribution will mitigate the regional and gender biases.
- In terms of policies, encouraging transparency in ad delivery system will prevent and reduce unwanted social biases and ultimately improve the whole ad delivery system.

While this study provides valuable insights for AI-related advertisement strategies, some limitations must be addressed:
- Although, this study was based on Meta's robust Ad Targeting datasets, the findings may not be generalized to other platforms such as Twitter with differing target audience and engagement metrics.
- It was out of scope of this study to address the "black-box" nature of the ad-delivery algorithm, which may provide further deep understanding of how the ad-delivery system operates.
- The ad- targeting analysis can also depend on cultural and linguistic barriers which were not comprehensively addressed in this study.

Future research should address these limitations and further explore the interplay between targeting precision, demographic representation, and regional characteristics to develop more effective and inclusive AI advertising practices. Additionally, investigating the effectiveness of different messaging and creative approaches across diverse cultural contexts is crucial for ensuring inclusive and equitable representation within AI-related advertising. The role of other networking platforms such as LinkedIn on AI-related advertising should also be explored. As the influence of AI continues to evolve, it is necessary that we address the challenges and opportunities of AI-related advertisement to achieve a more transparent, responsible, and inclusive digital advertising ecosystem.

This study provided some valuable insights for advertisers seeking optimization strategies for their marketing campaigns of AI technologies. It also identified potential bias in advertisement delivery which advertisers need to consider when designing their campaigns. We examined how to reach the right audiences effectively and fairly, considering potential biases in the system. The ultimate aim of this analysis is to guide ethical and impactful advertising in this rapidly changing landscape.

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