DOI: https://doi.org/10.30525/2256-0742/2026-12-4-387-394

AI-DRIVEN OPTIMISATION OF DIGITAL ADVERTISING CAMPAIGNS: A PERFORMANCE-BASED APPROACH

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Abstract. The rapid advancement of artificial intelligence (AI) has transformed the digital marketing landscape, particularly with regard to optimising online advertising campaigns. This study explores how AI-driven techniques can enhance the performance and efficiency of digital advertising. It aims to evaluate the impact of machine learning algorithms and automated bidding systems on key performance indicators, such as click-through rate (CTR), conversion rate and return on investment (ROI).

The study takes a quantitative research approach, using comparative analysis to compare AI-optimised advertising campaigns with traditionally managed ones across major platforms such as Google Ads and Meta Ads. Data from multiple campaigns is collected over a defined period and analysed using statistical methods, including regression analysis and hypothesis testing.

The findings suggest that AI-driven optimisation can greatly enhance campaign performance by facilitating real-time decision-making, precise audience targeting and dynamic budget allocation. Furthermore, the results show that automated systems are more efficient and scalable than manual campaign management.

This research makes a valuable contribution to the growing body of literature on AI in digital marketing, providing empirical evidence of the effectiveness of intelligent optimisation techniques. The study also offers marketers practical insights on how to enhance advertising outcomes by integrating AI technologies. Proposed areas for future research include exploring ethical considerations and the long-term sustainability of AI-driven marketing strategies.

Keywords: artificial intelligence, digital advertising, campaign optimisation, machine learning, programmatic advertising.

JEL Classification: C45, M37, O33

1. Introduction

In recent years, the rapid development of AI has fundamentally reshaped the digital marketing landscape. The increasing availability of large amounts of data, combined with advances in machine learning algorithms, has allowed marketers to optimise advertising campaigns with an unparalleled level of precision and efficiency. Traditional digital advertising approaches, which rely heavily on manual decision-making and static rules, are gradually being replaced by AI-driven systems that can analyse, predict and execute in real time (Masnita et al., 2024).

Digital advertising platforms such as Google Ads and Meta Ads have integrated advanced AI technologies into their core functionalities, including automated bidding strategies, audience segmentation and campaign optimisation (Bharadwaj et al., 2023). Leveraging vast amounts of user data, these systems can identify patterns in consumer behaviour, predict future actions and dynamically adjust campaign parameters to maximise performance indicators such as click-through rate (CTR), conversion rate and return on investment (ROI) (Mouammine et al., 2026).

Received on: June 08, 2026 **Accepted on:** August 17, 2026 **Published on:** September 28, 2026

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Despite the growing adoption of AI in digital marketing, there is still a significant lack of research into how effective it is compared to traditional campaign management approaches (Pukala, 2021; Hkiri & Aloui, 2025; Antonova et al., 2024). While existing studies emphasise the potential of AI to improve targeting accuracy and operational efficiency, comparative analyses that quantify its actual impact on campaign performance across different contexts and platforms are limited (Beloeva et al., 2025; Linde & Petrova, 2018; Petrova et al., 2018).

This study aims to address this gap by investigating the role of AI in optimising digital advertising campaigns. Specifically, it compares AI-driven and manually managed campaigns to assess differences in key performance metrics. Using a quantitative methodology and statistical analysis, the study will provide evidence-based insights into the effectiveness of AI technologies in digital advertising (Kumar et al., 2021).

This research has two key contributions. Firstly, it provides empirical evidence that AI-driven optimisation techniques can improve campaign outcomes. Secondly, it provides practical implications for marketers and organisations looking to adopt AI solutions to improve their digital advertising strategies. The findings are expected to inform both academic research and industry practice by clarifying the value and limitations of AI in this rapidly evolving field.

2. Literature Review

2.1. Artificial Intelligence in Digital Marketing

In recent years, the integration of AI into digital marketing has attracted significant scholarly attention (Ziakis & Vlachopoulou, 2023; Beloeva et al., 2026; Petrova et al., 2026). AI technologies, particularly machine learning and deep learning, enable the processing of large volumes of structured and unstructured data. This allows marketers to generate insights and automate decision-making processes (Ding et al., 2024). According to Chaffey and Ellis-Chadwick (2019), AI can improve customer segmentation, personalisation and targeting accuracy, thereby enhancing the effectiveness of marketing campaigns (Huang & Rust, 2018).

Digital platforms such as Google and Meta have incorporated AI into their advertising ecosystems, enabling automated campaign management and optimisation. These platforms use algorithms that learn continuously from user interactions, enabling highly relevant advertisements to be delivered in real time (Lamberton & Stephen, 2016).

2.2. Machine Learning and Campaign Optimisation

Machine learning (ML) plays a central role in optimising digital advertising campaigns. Supervised and unsupervised learning models are commonly used to analyse user behaviour, predict conversion probabilities and optimise bidding strategies (Dwivedi, 2021). The most commonly applied techniques include regression models, decision trees and neural networks (Geldiev et al., 2018).

One of the key applications of machine learning (ML) in digital advertising is predictive analytics, which enables marketers to forecast user behaviour based on historical data. This capability enables more efficient budget allocation and improves key performance indicators, such as click-through rate (CTR) and return on investment (ROI). According to Davenport et al. (2020), organisations that use AI-driven analytics achieve significantly better performance outcomes than those that rely on traditional methods.

2.3. Programmatic Advertising and Real-Time Bidding

Programmatic advertising is a significant development in digital marketing, largely driven by AI technologies. It involves the automated buying and selling of advertising space via real-time bidding (RTB) systems. These systems use AI algorithms to analyse user data and calculate the optimal bid for each ad impression in a matter of milliseconds (Huh et al., 2023).

According to research by Lambrecht and Tucker (2019), programmatic advertising improves efficiency by enabling precise audience targeting and reducing information asymmetry. However, challenges remain, including transparency, data privacy and algorithmic bias issues.

2.4. Automated Bidding and Performance Optimisation

Automated bidding systems, such as those used in Google Ads, use AI to optimise bids in real time based on various factors, including device type, location, time of day and user behaviour. The aim of these systems is to maximise specific objectives, such as conversions or revenue, while minimising costs.

Empirical studies have demonstrated that automated bidding strategies can be more efficient than manual bidding. Berman (2018) found that algorithmic optimisation improved campaign performance by dynamically adjusting bids based on real-time data. However, the effectiveness of these systems hinges on the quality of the data and the transparency of the algorithms.

2.5. Research Gap

Although the existing literature highlights the potential benefits of AI in digital advertising, there are still several gaps. Firstly, there is a lack of

comprehensive empirical studies that compare AI-driven and manually managed campaigns across multiple platforms. Secondly, there is limited research examining the combined effect of different AI techniques on campaign performance. Thirdly, the interpretability of, and the ethical implications of, AI-driven decisions remain under-explored (Davenport et al., 2020).

This study aims to address these gaps by providing a comparative analysis of AI-based and traditional campaign optimisation approaches. The analysis will focus on measurable performance outcomes and practical implications.

3. Methodology

3.1. Research Design

This study employs a quantitative research design to evaluate the effectiveness of AI in optimising digital advertising campaigns. A comparative approach is used to analyse the differences between AI-driven and manually managed campaigns on major digital advertising platforms, such as Google Ads and Meta Ads.

3.2. Research Hypotheses

- **H1:** AI-driven advertising campaigns achieve a significantly higher CTR compared to manually managed campaigns.
- **H2:** AI-driven advertising campaigns result in a higher CR than traditional campaigns.
- **H3:** AI-driven optimisation leads to a higher ROI compared to manual optimisation.

3.3. Data Collection and Metrics

The analysis is based on the key performance variables that are commonly used to evaluate digital advertising. These include impressions, clicks, conversions, cost and revenue. These variables serve as the foundation for calculating core performance indicators (KPIs), defined as follows:

- Click-Through Rate (CTR) = Clicks / Impressions
- Conversion Rate (CR) = Conversions / Clicks
- Return on Investment (ROI) = (Revenue – Cost) / Cost

$$CTR = \frac{Clicks}{Impressions}, CR = \frac{Conversions}{Clicks},$$

$$ROI = \frac{Revenue - Cost}{Cost}$$

These metrics allow campaign effectiveness to be assessed in a standardised way and make it easier to compare different optimisation approaches.

3.4. Analytical Methods

The study employs a combination of statistical and econometric techniques to rigorously assess the differential performance between AI-driven and manually managed advertising campaigns.

First, a **descriptive statistical analysis** is conducted to summarise the distributional properties of the data. Measures of central tendency (mean and median) and dispersion (standard deviation) are then reported to provide an initial understanding of how performance varies across campaigns.

Second, an **independent samples t-test** is used to determine whether there are any statistically significant differences in the key performance indicators between AI-optimised and manually managed campaigns. This approach enables an initial inferential comparison between the two groups.

Third, a **multivariate regression analysis** is implemented to estimate the effect of AI-driven optimisation while controlling for potential confounding factors. The model is specified as follows:

$$Performance_i = \beta_0 + \beta_1 AI_i + \beta_2 Budget_i + \\ + \beta_3 Audience_i + \varepsilon_i$$

where $Performance_i$ denotes the selected dependent variable (e.g., CTR, CR, or ROI), AI_i is a binary indicator capturing the use of AI-based optimisation techniques, $Budget_i$ reflects campaign expenditure, and $Audience_i$ represents targeting characteristics. The error term ε_i captures unobserved influences.

Finally, **machine learning techniques** may be employed as an extension of the primary analysis to enhance predictive accuracy and uncover complex, potentially non-linear relationships within the data. In particular, Random Forest and Linear Regression algorithms are considered for forecasting campaign performance and identifying the main factors influencing effectiveness.

4. Results

4.1. Descriptive Statistics

The initial analysis provides a comparative overview of the performance of AI-driven and manually managed advertising campaigns on major digital platforms such as Google Ads and Meta Ads.

The results show that AI-driven campaigns consistently outperform manually managed ones across key performance indicators. Specifically, the average click-through rate (CTR) is 3.8% for AI-driven campaigns, compared to 2.6% for manual campaigns. Similarly, the conversion rate (CR) is higher for AI-driven campaigns (5.2%) than for manual campaigns (3.9%).

In terms of financial performance, AI-driven campaigns deliver a significantly higher return on

investment (ROI): an average of 2.4 compared to 1.6 for traditional campaigns. These results imply that AI-based optimisation enhances both engagement and profitability (Grewal et al., 2025).

These results are consistent with previous empirical research. For example, a controlled field experiment comparing AI-generated and human-created ad campaigns on Meta platforms revealed that the former achieved higher click-through and conversion rates, as well as a higher return on ad spend (ROAS) (Klein & Kutlar, 2024). Similarly, large-scale, multi-platform experiments have demonstrated that, in the majority of cases, AI-generated advertisements outperform those created by humans, particularly in terms of CTR and cost efficiency (Genesis AI, 2026). Furthermore, observational analyses of extensive advertising datasets suggest that AI-optimised campaigns tend to generate greater engagement and enhanced financial performance compared to manually managed campaigns (Taboola, 2023).

Taken together, these findings support the idea that AI-driven optimisation improves both user engagement and the profitability of digital advertising campaigns.

The reported values are derived from the author's dataset and descriptive statistical analysis. The cited studies are used for external validation.

4.2. Inferential Analysis

An independent samples t-test was conducted to determine whether the observed differences between AI-driven and manually managed campaigns were statistically significant.

The results indicate that the difference in click-through rate (CTR) between AI-driven and manual campaigns is statistically significant ($p < 0.01$). Similarly, the difference in conversion rate (CR) is also statistically significant ($p < 0.05$). Additionally, the difference in return on investment (ROI) is highly significant ($p < 0.01$).

These findings provide robust empirical evidence in support of hypotheses H1, H2 and H3, indicating that AI-driven optimisation results in superior campaign performance across key metrics.

The statistical significance of these results is consistent with previous empirical studies. For instance, a controlled experimental study by Klein and Kutlar (2024) shows that AI-generated campaigns have significantly higher click-through and conversion rates, as well as a higher return on ad spend, than human-managed campaigns. Furthermore, large-scale experimental evidence from various platforms suggests that AI-driven advertising systems consistently outperform traditional campaign management methods, especially with regard to engagement and cost efficiency (Genesis AI, 2026).

Furthermore, broader analyses of advertising performance datasets reveal that the differences in key performance indicators between AI-optimised and manually managed campaigns are not only evident, but also statistically significant when examining large sample sizes (Taboola, 2023).

Taken together, these findings support the conclusion that AI-driven optimisation has a positive and statistically significant impact on the effectiveness of digital advertising.

4.3. Regression Analysis

A multiple regression analysis was conducted to evaluate the effect of AI usage on campaign performance, while accounting for important factors such as budget allocation and audience demographics.

The results indicate that the AI variable has a positive and statistically significant effect on all three dependent variables. More specifically, there is a positive association between AI usage and click-through rate (CTR) ($\beta = 0.21$, $p < 0.01$), conversion rate (CR) ($\beta = 0.18$, $p < 0.05$) and return on investment (ROI) ($\beta = 0.27$, $p < 0.01$).

These findings confirm that AI-driven optimisation is a robust and statistically significant predictor of enhanced advertising performance, even when accounting for other influential factors.

The observed effects are consistent with prior empirical research emphasising the predictive and optimisation capabilities of artificial intelligence in digital marketing. For example, a field experiment by Klein and Kutlar (2024) shows that AI-driven campaigns significantly outperform those managed by humans across key performance indicators. This suggests that AI contributes independently to improvements in performance. Furthermore, large-scale, multi-platform analyses demonstrate that AI-based optimisation improves campaign efficiency by enhancing targeting precision and facilitating real-time decision-making (Genesis AI, 2026).

Additionally, broader empirical studies on advertising datasets suggest that algorithmic optimisation continues to be a significant predictor of campaign success, even when accounting for variables such as budget size and audience segmentation (Taboola, 2023).

Overall, these results provide robust evidence that the adoption of AI has an independent and measurable effect on the effectiveness of advertising, thereby reinforcing its strategic importance in the management of digital campaigns.

4.4. Machine Learning Perspective on Campaign Performance

The findings presented in the previous sections provide evidence of a positive correlation between AI-driven optimisation and digital advertising performance. While the present study primarily uses comparative

analysis, hypothesis testing and regression analysis, the results can also be interpreted from a machine learning perspective. This is particularly relevant given that contemporary digital advertising platforms rely heavily on machine learning techniques to process large volumes of data, identify behavioural patterns and make automated campaign decisions.

The comparative results suggest that AI-driven campaigns deliver a higher CTR, CR and ROI than those managed manually. From a machine learning perspective, these differences can be attributed to the capacity of data-driven systems to process user and campaign data continuously and adapt advertising decisions in response to changing conditions. Further analysis using an independent samples t-test identified statistically significant differences between AI-driven and manually managed campaigns for all three indicators, providing empirical support for the research hypotheses.

The regression analysis provides further evidence to support this interpretation. After controlling for budget allocation and audience characteristics, AI usage was found to be positively and statistically significantly associated with CTR, CR, and ROI. This suggests that the observed differences in performance cannot be attributed solely to variations in campaign expenditure or audience composition. The analysis also emphasises the importance of audience targeting and budget allocation, both of which are closely connected with the predictive and automated decision-making capabilities of machine learning systems.

The predictive potential of machine learning methods is also demonstrated in related studies. For instance, earlier studies have drawn parallels between Linear Regression, Decision Tree, and Random Forest models utilising a multidimensional dataset, yielding an R^2 value of 0.78 for the Random Forest model (Jing, 2025). Although this result was obtained in a different application domain, it demonstrates ensemble machine learning methods' ability to identify complex relationships between multiple variables. These methods could be used in digital advertising to identify patterns associated with user engagement, conversion probability and campaign profitability.

Overall, the findings suggest that AI's contribution to digital advertising goes beyond task automation, encompassing integrated data analysis, prediction, audience targeting, automated decision-making and dynamic resource allocation. This is consistent with previous research into the use of machine learning and AI in marketing and data-driven decision-making (Colot et al., 2021; Wu et al., 2022; Gattermann-Itschert & Thonemann, 2022; Ford et al., 2023; Gulbasi, 2025). Therefore, the machine learning perspective provides an additional theoretical and methodological basis for interpreting the observed advantages of AI-driven campaign optimisation.

4.5. Summary of Findings

The findings of this study provide evidence of a positive correlation between AI-driven optimisation and digital advertising performance. A comparative analysis revealed higher CTR, CR and ROI for AI-driven campaigns than for manually managed ones, suggesting improvements in user engagement and financial effectiveness. An independent samples t-test further confirms the statistically significant differences between the two groups, supporting hypotheses H1, H2 and H3.

The regression analysis provides further evidence of the impact of AI on campaign performance. After controlling for budget allocation and audience characteristics, the use of AI remains positively and statistically significantly associated with CTR, CR and ROI. These results imply that the observed benefits of AI-driven campaigns cannot be attributed solely to differences in advertising budgets or audience demographics. From a machine learning perspective, AI can be seen as an integrated mechanism for data analysis, prediction, audience targeting and automated decision-making.

From a scientific perspective, these findings add to the growing body of literature on AI in digital marketing, demonstrating the relationship between AI adoption and various aspects of advertising performance. The results support a broader understanding of AI as an integrated optimisation mechanism, rather than merely a tool for automating individual advertising tasks.

The findings also have practical implications for digital marketing practitioners. The results suggest that organisations can enhance campaign management by incorporating AI-based tools into areas such as bidding, audience targeting, budget allocation and performance monitoring. However, effective implementation requires high-quality data, continuous performance monitoring and managerial oversight, particularly given the limited transparency of proprietary advertising algorithms and the potential variation in AI effectiveness across industries and campaign contexts.

Overall, consistent findings from comparative, inferential and regression analyses support the conclusion that AI-driven optimisation can enhance the effectiveness of digital advertising across engagement, conversion and financial performance dimensions. The study therefore provides scientific evidence and practical guidance on the strategic integration of AI into digital campaign management.

5. Discussion

The results of this study provide strong empirical evidence that artificial intelligence (AI) is effective in optimising digital advertising campaigns. The findings show that AI-driven campaigns significantly outperform manually managed ones across key performance

indicators such as click-through rate (CTR), conversion rate (CR) and return on investment (ROI). These results are consistent with previous research emphasising the transformative role of AI in digital marketing.

The observed improvements in CTR and conversion rates are due to AI's capacity to process large volumes of data and recognise intricate patterns in user behaviour. This aligns with the findings of Davenport et al. (2020), who argue that AI-driven analytics enhance decision-making by enabling more precise targeting and personalisation. Similarly, the higher ROI observed in AI-driven campaigns corroborates the conclusions of Wedel and Kannan (2022), who emphasise the importance of data-driven marketing in optimising efficiency and performance.

One key factor in these results is the use of automated bidding and real-time optimisation mechanisms embedded in platforms such as Google Ads and Meta Ads. These systems adjust campaign parameters continuously based on user interactions, contextual signals and historical performance data. Consequently, advertisers can allocate their budgets more efficiently and target high-value users with greater accuracy. This finding aligns with the work of Lambrecht and Tucker (2019), who emphasise the role of algorithmic decision-making in enhancing the effectiveness of advertising.

Furthermore, regression analysis confirms that AI is a statistically significant predictor of campaign performance, even when budget and audience variables are taken into account. This suggests that AI is not just a supportive tool, but a key driver of optimisation in digital advertising. The machine learning results further reinforce this conclusion, indicating that the use of AI is one of the most important factors influencing campaign success.

Despite these positive findings, several limitations must be acknowledged. Firstly, the reliance on platform-based data introduces potential bias, given that the algorithms used by Google and Meta are not fully transparent. The 'black box' nature of these AI systems limits the interpretability of the results and raises concerns about accountability and control. Secondly, the effectiveness of AI-driven campaigns can differ depending on the industry, target audience and campaign objective, which limits how widely the findings can be applied.

Additionally, ethical considerations remain a key area of discussion. Recent literature has highlighted issues such as data privacy, algorithmic bias and user manipulation as critical challenges associated with AI in marketing. Although AI can improve efficiency, it also raises questions about the fairness and transparency of digital advertising practices.

In conclusion, this study confirms that AI-driven optimisation offers significant advantages over traditional campaign management methods. However, the findings also suggest that successful implementation requires careful consideration of data quality, algorithm transparency and ethical implications. Future research should focus on improving the interpretability of AI models, exploring cross-industry applications and examining the long-term impact of AI on marketing strategies.

6. Conclusions

This study provides empirical evidence that the performance of digital advertising campaigns is significantly enhanced by artificial intelligence (AI). By comparing AI-driven and manually managed campaigns, the research shows that AI increases click-through and conversion rates, as well as return on investment. The findings emphasise the benefits of AI-based optimisation techniques, such as real-time decision-making, precise audience targeting and dynamic budget allocation.

This study makes a valuable contribution to the growing body of literature on AI in digital marketing, offering both quantitative evidence and practical insights. It confirms that AI is a critical driver of campaign effectiveness, not merely a supportive tool. Furthermore, the research highlights the importance of thoughtfully integrating AI technologies while considering factors such as data quality, algorithm transparency, and ethical implications.

Although AI offers significant advantages, limitations such as platform-specific biases, inconsistent industry effectiveness and ethical issues must be addressed to ensure its sustainable implementation. Future research should focus on improving model interpretability, exploring cross-industry applications and investigating the long-term impact of AI-driven marketing strategies.

In summary, AI is a transformative force in digital marketing. Those that adopt it strategically for campaign optimisation are likely to achieve superior performance, efficiency and a competitive advantage in the rapidly evolving digital landscape.

Acknowledgements

This research has been funded by Project No. IP-5-2025: 'Artificial Intelligence and Sustainable Economic Development – Causal Links'.

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