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MODEL OF AN INFORMATION SYSTEM FOR ANALYSIS AND EVALUATION OF ADVERTISING IN SOCIAL NETWORKS

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This study examines different models for evaluating advertising effectiveness on social media, focusing specifically on the factors that drive successful campaigns on Facebook. Our analysis revealed shortcomings in three prevalent models frequently used by marketing and SMM professionals when developing ad materials. We determined that the quality of online advertising assessment critically depends on both the volume and the quality of the metrics gathered for analysis. Therefore, the central aim of this research was to create an improved model that overcomes the limitations of existing tools by systematically updating and refreshing data pulled from social media platforms. The paper details the unique features of this new model in comparison to similar programs and provides a thorough analysis of how its components interact, both internally and with external systems. During the model's development, we identified the key tasks required to build the accompanying application and specified the technologies involved. We outline the model's core operational principles, which are organized into four main blocks, each handling the processing and analysis of advertising effectiveness metrics. Additionally, we assessed how the proposed model addresses a significant challenge – keeping data from social networks continuously updated – and proposed methods to resolve this. The potential of the developed software to enhance the evaluation of digital advertising strategies was also analyzed, considering its importance across different business sectors and its value for marketers who rely on precise data insights. The application was tested using an active SMM agency's Facebook account, and its performance in gathering metrics was compared against alternative programs. Future enhancements could include more in-depth analysis of the collected data and expanded features for visualizing the findings.

Keywords: information system model; performance metrics; marketing in social networks; advertising analysis.

Problem statement

Assessing advertising performance on social media has become vital for contemporary marketing strategies. As technology advances and social networks become increasingly pervasive, the need for accurate and effective tools to evaluate advertising campaigns on these platforms grows more urgent. However, despite considerable research, a gap persists in this field. Current understanding lacks a comprehensive model that adequately captures the complex dynamics involved in social media ad assessment. The significance of this research stems directly from the absence of a single, reliable framework capable of providing a holistic evaluation of advertising effectiveness in this environment. The central challenge lies in the lack of a standardized structure that can effectively synthesize the intricate interplay of variables influencing ad success. Further investigation is crucial to address this knowledge gap by constructing a model that not only identifies but also quantifies advertising impact and success within the fluid landscape of evolving social networks.

Analysis of recent research and publications

Recent research and publications highlight the significant popularity of advertising on social networks, owing to their massive user base and potential as highly effective marketing channels for businesses. However, success is not automatic for all social media advertising campaigns. Key performance indicators determine the effectiveness of online advertising, making it essential for marketers to utilize software that can properly assess the numerous influencing factors.

Several studies provide valuable context for this field. For instance, the work by Gordon et al. (2019), "Advertising Effectiveness on F acebook: A Comparison of Measurement Methods," offers a detailed analysis of evaluating ads on F acebook. It demonstrates a strong understanding of the mechanisms and indicators driving campaign success on this specific platform, contributing significantly to the development of advertising evaluation models by examining the interplay between advertising strategies, audience response, and effectiveness metrics.

Earlier foundational work, such as "Social Media Marketing" by Kaplan & Haenlein (2011), explored the integration of social media into marketing strategies, emphasizing its importance and advertising potential. Key themes in their work included the overall impact of social media on marketing practices, considerations for advertising effectiveness, and the analysis of related trends.

Synthesizing findings like these underscores' critical needs for current evaluation models: they must incorporate continuous and timely data updates to work with the most relevant information. Furthermore, it highlights the necessity of designing model interfaces that can remain functional despite changes in the data structure provided by social networks.

Building on these studies, several challenges requiring solutions become apparent. These include inconsistencies in the metrics used for evaluation, determining the appropriate volume of data needed for meaningful analysis, and the persistent difficulty of ensuring models are both timely updated and consistently relevant in a rapidly changing digital landscape.

Formulation of article objectives

The primary objective of this work is to develop an information technology model for the effective evaluation of advertising on social networks, with a particular focus on Facebook. To achieve this, the following research tasks have been defined:

1. Analyze existing models for assessing advertising effectiveness on social networks.
2. Investigate information technology models and the types of data they utilize.
3. Identify limitations of current models and propose ways to enhance their accuracy and adaptability.
4. Develop a structured model for evaluating advertising campaigns on Facebook, ensuring real-time data processing and adaptability to changing data structures.
5. Compare the proposed model with existing approaches by analyzing assessment results based on collected data.

This work aims to bridge the identified research gap by introducing a comprehensive and adaptive model that accounts for the evolving nature of social media advertising. The proposed model will be designed to enhance analysis data accuracy, ensure continuous updates, and provide marketing professionals with reliable tools for campaign evaluation.

Main Results

To understand the current landscape of social media advertising evaluation, this research examined three models frequently employed by Social Media Marketing (SMM) agencies: Livedune (Manzyuk, 2022), CMS Magazine (O'g'li, 2023), and Socnetv (Kumar, 2018). Note that CMS refers to Content Management System.

First, Livedune functions as an analytical tool for assessing advertising effectiveness. It utilizes machine learning to analyze user behavior data from social networks, aiming to identify the most impactful advertisements. The Livedune model encompasses data collection and analysis, the identification of

performance metrics, the application of machine learning algorithms for predicting ad effectiveness, and the automation of certain decision-making processes. However, like any such model, its effectiveness hinges on the quality of the input data and the chosen metrics. Therefore, robust data collection and analysis processes are vital for generating accurate predictions. Livedune also presents several drawbacks: it may have limited integration capabilities with diverse social media platforms, potentially complicating multi-platform campaign analysis. Furthermore, users face significant costs, and data updates can be slow, often providing slightly outdated information unsuitable for real-time analytics.

The second model, from "CMS Magazine," evaluates advertising using several core metrics, including:

- Number of views (impressions).
- Click-through rate (CTR).
- Conversions (desired user actions).
- Cost per conversion.

These are supplemented by audience metrics like engagement rates and new subscriber counts. CMS Magazine employs machine learning algorithms to pinpoint effective ad materials and offer recommendations for campaign improvement. Compared to Livedune, the CMS Magazine model relies on simpler metrics and omits user emotion analysis, yet it still offers valuable information for campaign evaluation. Its weaknesses include potentially limited support for various social platforms beyond a standard set and a lack of advanced campaign management features (like targeted audience creation or budget adjustments). Additionally, if the tool isn't actively updated, it may fail to account for new trends, algorithm changes, or emerging analytical methods, reducing its competitiveness.

The third model, Socnetv, operates as an analytical tool focused on social network content analysis rather than direct ad evaluation (Kumar, 2018). It ranks content popularity based on likes, comments, and views, primarily studying platforms like Facebook, Instagram, and Twitter. While different in focus from Livedune, both utilize analytical methods to assess activity effectiveness. Socnetv's shortcomings include infrequent updates, which diminish its relevance as social platforms evolve. This lack of updates limits its functionality and support for new features. It also lacks comprehensive real-time monitoring capabilities, making it difficult to quickly identify and respond to negative reactions to advertisements.

Ultimately, the suitability of each model depends on specific business requirements, as each has distinct advantages and disadvantages. Several improvements could enhance these existing models:

- Incorporating alternative data sources (e.g., user demographics, location).
- Increasing the volume of data used for analysis to improve prediction quality.
- Implementing a mechanism for automatic background data updates.
- Ensuring timely updates and adjustments to the data schema to align with social media policy changes.

Addressing the limitations of existing tools, this work proposes an information technology model named GuessYes, designed for more effective analysis and evaluation of advertising in social networks, particularly Facebook. This model integrates several key elements. It measures ad effectiveness using a range of indicators, including views, clicks, likes, comments, and different types of reach (organic, paid, viral). It leverages data analysis and IT to collect and process campaign data, identifying which audience segments respond best, which ad formats are most effective, and which themes resonate most strongly. Crucially, GuessYes enables the calculation of Return On Investment (ROI) by analyzing advertising expenditure against revenue (Alalwan et al., 2017), helping companies assess campaign profitability and refine their strategies. A significant advantage is the background data updating process, ensuring analytics are based on the most current information available.

The GuessYes model operates in four main stages:

1. Data Collection: Gathering campaign data, including target audience demographics, ad creative details, and placement information.
2. Data Analysis: Processing the collected information using a data analyzer (software designed for large datasets) to identify key performance indicators (KPIs) like CTR and conversion metrics (Geissinger et al., 2023).

3. Effectiveness Evaluation: Utilizing the analyzed KPIs to assess campaign performance, informing decisions about necessary adjustments.
4. Effectiveness Enhancement: Applying insights from the evaluation to improve future social media advertising campaigns.

Finally, the model calculates targeting metrics to identify audience groups most receptive to specific ads, aiding in the planning of future campaigns and helping businesses achieve their marketing objectives more efficiently.

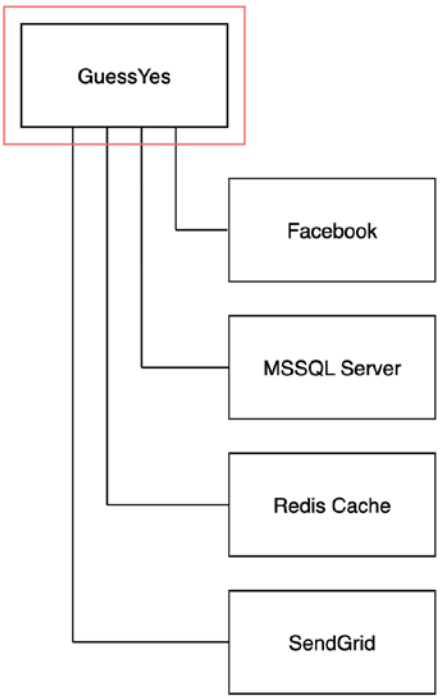

Fig. 1. Relationship model between the GuessYes and third-party applications.

The application of this information technology model can help companies significantly improve their advertising campaign efficiency and potentially increase revenue. By providing deeper insights, GuessYes allows businesses to identify more effective advertising methods and optimize their ad spend. Figure 1 illustrates the interactions between the core GuessYes system and the external systems it relies upon:

- Facebook (Hosain & Ahshanul, 2023): Serves as the primary source for statistical data. It provides crucial user interaction metrics, campaign analysis data, and audience communication effectiveness indicators. Integrating Facebook allows GuessYes to perform accurate targeting, analyze consumer behavior, refine engagement strategies, and enhance overall campaign effectiveness.
- GuessYes (GuessYes, n.d.): Functions as the central processing core. It manages all information flow within the model and presents data and functions to the user via its interface. It handles data integration, processing, control, and user interaction.
- SendGrid (Durumeric et al., 2015): An integrated email delivery system used within GuessYes for automated, reliable communication (e.g., notifications) with users and clients.
- Microsoft SQL Server (R.J.P.K. Rajakaruna et al., 2023): Acts as the main data repository, providing reliable storage for large volumes of diverse information (text, numbers, images, etc.). Its use ensures data stability, consistency, and protection, which are vital for the model's operation.
- Redis Cache (Aivalis, 2022): A caching tool responsible for efficient data processing management. It temporarily stores frequently accessed data, reducing access times and improving the overall performance of the GuessYes model.

Each third-party application plays an integral role: Facebook provides data, GuessYes processes it, SQL Server and Redis Cache store data, and SendGrid handles email communication.

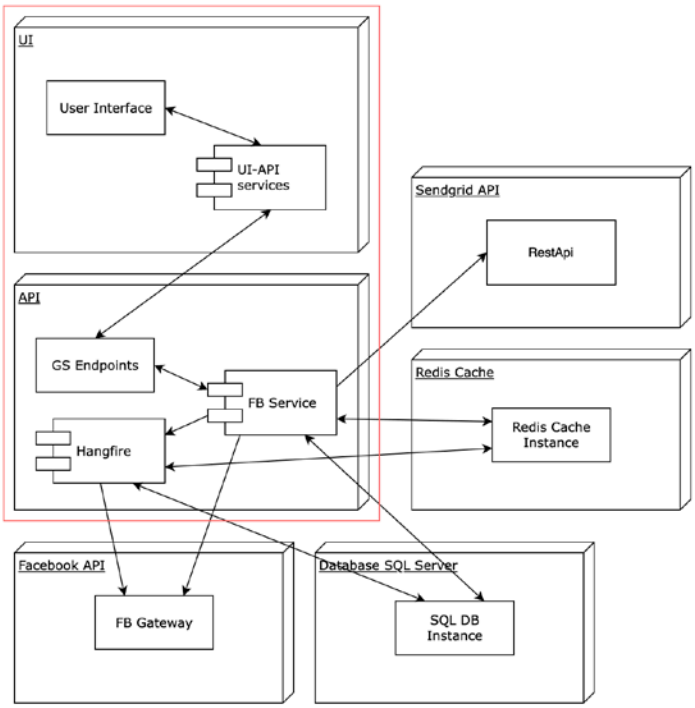

Fig. 2. Model of interaction among components of the GuessYes model and connections with applied applications.

Figure 2 provides a view of the information system's internal model. The primary components include the User Interface (UI), the Application Programming Interface (API), the SendGrid API, the Facebook API, the SQL Server Database, and the Redis Cache. These components interact in various ways; some contain sub-services or interfaces, while others communicate directly. Their roles are:

- UI: Displays information clearly to the user.
- API: The server-side component responsible for data processing and analysis.
- Facebook API: Interface to the third-party application providing statistical data.
- Database SQL Server: The primary database for information storage.
- Redis Cache: Cache memory for faster information retrieval.
- SendGrid API: Interface to the third-party email sending service.

A key distinction of this model lies within the API submodel (indicated by the red rectangle in Fig. 1). This segment integrates the Hangfire component to facilitate background data updates. It also manages data loading and transformation for analysis. This architecture improves the model's adaptability and robustness, especially when the social network changes its data query format. From a practical standpoint, the model's efficiency for the user is measured by data loading time and operational cost, both anticipated to be lower compared to similar models.

The GuessYes model exclusively uses authentic data provided directly by the user or extracted from Facebook's servers. This ensures data integrity, building confidence in the analysis results. The analysis relies on mathematical dependencies rather than AI-driven interpretation, which supports the accuracy of the outcomes.

Furthermore, the model avoids reliance on a single data source. As shown in Figure 1, the core system utilizes statistical data from Facebook, information stored in its own memory (cache and database), and user-provided inputs. This multi-source approach enhances the quality of calculated indicators and ensures reliability even if there are temporary issues with the social network's server interface.

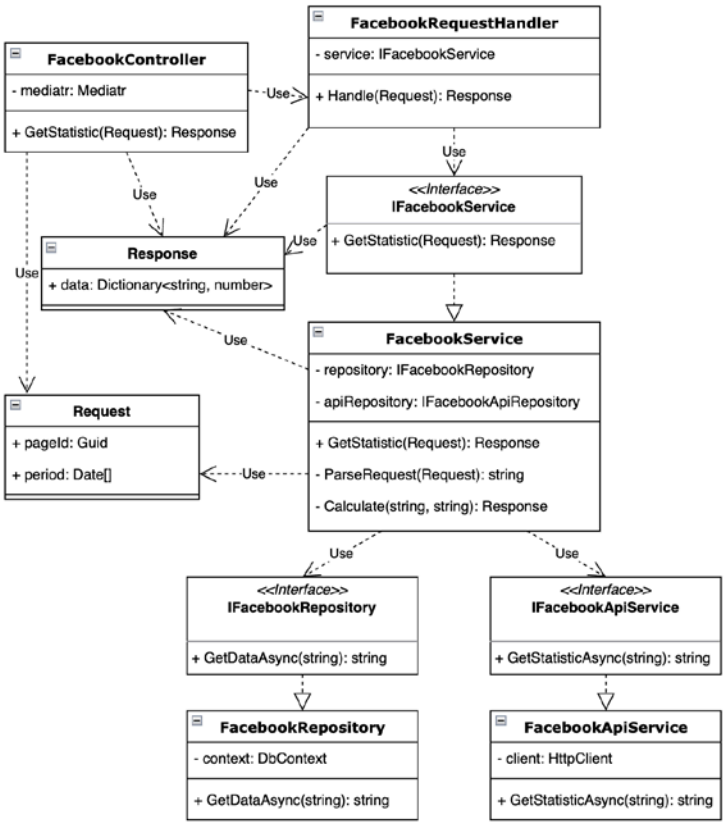

Fig. 3. The sub-modules diagram of the GuessYes model.

The high-level diagram in Figure 3 reveals a meticulously organized architecture designed for robust interaction with the Facebook platform. The FacebookController acts as a central orchestrator, invoking Mediatr events to manage control flow. Concurrently, Hangfire runs as a separate hosted service, independently handling periodic background data updates. This design leverages Mediatr for a decoupled, extensible codebase, while Hangfire ensures regular, automated data refreshes. The FacebookRequestHandler manages incoming requests, mediating between the controller and underlying services.

The core logic resides within the IFacebookService interface and its FacebookService implementation, defining essential functionalities and promoting modular design. The data access layer, represented by IFacebookRepository and FacebookRepository, utilizes both MSSQL and Redis. Hangfire operates here as well, autonomously managing scheduled updates to maintain data freshness and enhance performance.

Integration with the external Facebook API is handled by IFacebookApiService and FacebookApiService, encapsulating communication complexities. Hangfire's use here ensures periodic API calls are scheduled efficiently. The overall result is a modular, scalable, and technically sound architecture where each component has a distinct role, enhancing maintainability. The strategic use of Hangfire as an independent service provides both enhanced performance and autonomous background data management.

Regarding the model's architecture, key design patterns enhance modularity and maintainability. Dependency Injection (DI) is foundational, managing dependencies between components like FacebookService and its required repositories or services. This promotes loose coupling, flexibility, and significantly improves testability by allowing easy substitution of dependencies.

The Mediatr pattern orchestrates communication, decoupling requesters (like controllers) from handlers. Components communicate via messages without direct awareness of each other, simplifying the codebase and boosting maintainability and scalability.

The Repository pattern (IFacebookRepository, FacebookRepository) abstracts the data access layer. By centralizing interaction logic with data stores (MSSQL, Redis), it makes the data access system more maintainable, adaptable to storage changes, and standardized across the model.

Combined with the Repository pattern, the Unit of Work pattern manages transactions to ensure data consistency. The FacebookService coordinates operations across multiple repositories, ensuring they are performed atomically, which is crucial when handling multiple data operations concurrently, such as updating ad data while refreshing background information.

Discussion of Research Findings: The challenge of evaluating advertising in social networks is recognized in academic literature. For instance, Drummond et al. (2018) investigated social media's impact on new ventures and B2B relationships within the food production industry. Their findings indicated that Facebook and Twitter influence firm interactions, information exchange, collaboration, and operational coordination, suggesting social media affects resource levels in inter-company relationships and networks.

Mason et al. (2021) highlighted the complexity of measuring digital advertising's causal effects, even with detailed data. They noted that unobserved factors often complicate analysis and that while randomized controlled trials (RCTs) are ideal, most campaigns rely on observational methods. Their research found that observational methods using typical industry data often fail to accurately replicate the causal effects measured by RCTs, suggesting these common approaches may not precisely capture advertising's true impact.

Artym-Drohomyretska et al. (2018) provided a comprehensive analysis of online advertising strategies, evaluation methods, and effectiveness measurement (from economic and communication perspectives). They classified evaluation models (impression, effectiveness, hybrid) and discussed the role of Big Data and user analysis, particularly on platforms like Facebook with its wide reach and micro-targeting options.

Furthermore, Yu (2019) examined the economic aspect of advertising effectiveness through a case study of a Ukrainian IT company. The study emphasized that evaluating an ad strategy is fundamental to overall marketing success and that the choice of advertising type dictates the appropriate success measurement model. It also proposed a five-stage scheme for comprehensively assessing modern advertising campaigns.

Conclusions

In summary, the model created through this research offers a robust system for evaluating advertising within social networks, distinguished by its multi-level and modular architecture. Designed for minimal component coupling, this structure not only facilitates future functional expansion via new modules but also ensures adaptability to the evolving data structures common on social platforms. The practical implementation of this model yields several key benefits: it effectively receives and integrates data from diverse sources, enabling a more reliable assessment of advertising effectiveness, which directly informs the improvement of advertising strategies. Crucially, the model's design enhances its adaptability and reliability, especially in scenarios involving changing data request formats, while providing the capability to evaluate campaigns across potentially various social networks.

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МОДЕЛЬ ІНФОРМАЦІЙНОЇ СИСТЕМИ АНАЛІЗУ ТА ОЦІНКИ РЕКЛАМИ В СОЦІАЛЬНИХ МЕРЕЖАХ

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У цій науковій роботі досліджуються різні підходи до оцінки ефективності реклами в соціальних мережах, приділяючи особливу увагу факторам, що визначають результативність кампаній на платформі Facebook. Аналіз показав, що три популярні моделі, якими часто користуються маркетологи та SMM-фахівці для створення рекламних матеріалів, мають певні недоліки. Ми встановили, що якість оцінки онлайн-реклами значною мірою залежить від обсягу та релевантності зібраних метрик, які використовуються для подальшого аналізу. Тому ключовою метою нашого дослідження стало створення покращеної моделі. Вона покликана усунути слабкі місця існуючих підходів завдяки механізму систематичного оновлення та актуалізації даних, що

надходять із соціальних мереж. Робота детально розглядає унікальні характеристики запропонованої моделі, порівнюючи її з аналогічними програмними рішеннями, та аналізує взаємодію її компонентів – як між собою, так і з зовнішніми системами. Під час розроблення моделі визначено основні завдання для створення відповідного програмного застосунку та технології, які були в ньому реалізовані, виділено ключові аспекти функціонування моделі, що складається з чотирьох основних блоків: кожен із них забезпечує якісне опрацювання та аналіз метрик рекламної ефективності. Окремо проведено оцінювання, як запропонована модель сприяє вирішенню однієї з головних проблем – забезпечення безперервного оновлення даних із соцмереж, і запропоновано конкретні методи для цього. Також було проаналізовано потенціал розробленого програмного забезпечення для підвищення точності оцінювання рекламних стратегій на цифрових платформах, його значення для різних бізнес-секторів та актуальність для маркетологів, які потребують точного аналізу даних. Створений програмний продукт пройшов тестування на активному Facebook-акаунті SMM-агентства, а його ефективність порівнювалася з програмами-аналогами, що використовуються для збору метрик. У майбутньому можливий подальший розвиток застосунку, зокрема через поглиблений аналіз зібраних даних та розширення функціоналу для наочної візуалізації отриманих результатів.

Ключові слова: модель інформаційної системи; метрики ефективності; маркетинг у соціальних мережах; аналіз реклами.