

Optimization Of Posting Time And Personalization Of Machine Learning-Based Content To Increase The Engagement Rate Of Gen Z Audiences On Social Media Platforms

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Keyword	Abstract
engagement rate, machine learning, content personalization, Generation Z, post time optimization	Digital transformation has presented new challenges in marketing communication strategies, especially in reaching Generation Z audiences who have very dynamic content consumption characteristics. This study explores the integration of publication time optimization with content personalization using a machine learning approach to increase engagement rates on social media platforms. Through a survey of 53 Gen Z respondents who are active users of TikTok, Instagram, and YouTube, data was collected using a structured questionnaire on the Likert scale to measure eleven digital behavior variables. Descriptive statistical analysis and multiple linear regression were used to identify engagement patterns, while Random Forest and Gradient Boosting algorithms were implemented to build an optimal post-time predictive model. The findings showed that the content personalization algorithm gained a very positive reception with a score of 4.26 on a scale of 5, while posting time correlated significantly with audience engagement rates. The Random Forest model achieved 84.7% accuracy in predicting engagement patterns with an accuracy of 87.2%. The integration of the two strategies resulted in a 2.3-fold increase in interaction compared to the single approach. The research provides concrete recommendations regarding the optimal hours of content publication for each platform as well as a data-driven personalization implementation framework for user behavior that can be applied by content creators and digital marketing practitioners in designing more effective and measurable communication strategies.

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I. Introduction

The digital era has fundamentally changed the landscape of communication and social interaction, especially for Generation Z who are growing up in the midst of the development of information technology. Social media platforms are now the main space for Gen Z audiences to consume content, interact, and build their digital identities. In this context, *Engagement Rate* become a crucial metric that determines the success of a content creator and digital marketing strategy. Nevertheless, significant challenges arise when content creators have to compete in complex algorithms and dynamic audience preferences. Research shows that the time it takes to publish content has a substantial impact

on audience engagement rates, with content published at the optimal time being able to increase *Visibility* to achieve maximum performance (Hasan, 2025). This phenomenon is increasingly relevant considering the media consumption behavior of Gen Z which tends to *Scrolling* intensively at certain hours of the day.

Algorithm-based content personalization *Machine Learning* has become an innovative approach in increasing the relevance and appeal of content on social media platforms. Machine learning technology allows systems to analyze user behavior patterns, content preferences, and audience uptime in real-time, thus optimizing content distribution strategies (Schoeman, 2021). Implementation *Artificial Intelligence* in content

personalization has been proven to be able to improve *User Engagement* significantly through targeted recommendations and adjustments to the appearance of content according to individual user characteristics. Nevertheless, the integration between post time optimization and content personalization is still an area of research that requires further exploration, especially in the context of the unique characteristics of Gen Z audiences that have *Attention span* short but high expectations for the quality and relevance of the content.

Recent studies indicate that a combination of strategies *Timing Optimization* and *Content Personalization* can produce synergies that increase the effectiveness of digital communication exponentially (Hammouri et al., 2025). Generation Z, with characteristics *Digital Native* They show different media consumption patterns than previous generations, where they tend to be more responsive to personalized content and published at the right momentum. Platforms like TikTok, Instagram, and YouTube have implemented complex algorithms that take into account a variety of factors including posting time, *User behavior*, and *Content Relevance* to maximize content distribution (Zhang et al., 2025). Empirical research shows that creators who implement data-driven strategies in determining post timing are on the rise *Engagement Rate* Up to 40% compared to posts without a specific time strategy (Tewu et al., 2025). Therefore, this study seeks to develop a *Machine Learning* that integrates post time optimization and content personalization to improve *Engagement Rate* Gen Z audience on social media platforms comprehensively and measurably.

Based on the background that has been presented, there are several fundamental problems that need to be answered in this study. First, what is the behavior pattern of the Gen Z audience in interacting with social media content based on different posting times? Second, how can *machine learning* models be implemented to predict optimal posting times and personalize content that matches the characteristics of Gen Z audiences? Third, how much influence does the integration of post time optimization and content personalization have on increasing the *engagement rate* of Gen Z audiences on social media platforms? The formulation of this problem is the basis for developing technology-based

solutions that can help content creators and digital marketing practitioners in improving the effectiveness of their communication strategies.

This study aims to analyze the engagement behavior patterns of Gen Z audiences towards social media content at different posting times, develop *machine learning* models to predict optimal posting times and personalize content that suits the preferences of Gen Z audiences, and measure the effectiveness of integrating post time optimization and content personalization in increasing *engagement rates* on social media platforms. Through a quantitative approach with machine learning methods, this research is expected to produce predictive models that are accurate and can be implemented practically by content creators and digital industry players.

The theoretical benefit of this research is that it contributes to the development of digital communication science and *machine learning* technology in the context of optimizing social media content strategies, especially for the Gen Z audience segment, and digital marketers in determining optimal posting times and designing personalized content to increase *engagement rates*. In addition, the results of this research can be the basis for the development of artificial intelligence-based tools or applications that help automate content posting strategies on various social media platforms, thereby increasing the overall efficiency and effectiveness of digital communication.

II. Literature Review

The increasing dominance of social media platforms in digital marketing has shifted the determinants of consumer engagement from purely content quality toward more complex, data-driven mechanisms involving temporal optimization and algorithmic personalization. In this evolving landscape, engagement is not only influenced by what content is delivered, but also by when and how it is delivered, particularly within algorithm-driven environments that prioritize early interaction signals and user relevance (Kannan & Li, 2017; Lemon & Verhoef, 2016). This transformation is especially relevant for Generation Z, a digitally native cohort characterized by rapid content consumption, high expectations for personalization, and selective attention toward highly relevant and emotionally engaging content (Djafarova & Bowes, 2021;

Priporas et al., 2017). From a theoretical perspective, the Stimulus–Organism–Response (S-O-R) framework provides a robust foundation for understanding this phenomenon, where optimized posting time and personalized content act as external stimuli that influence users' internal cognitive and affective states, ultimately leading to engagement behaviors such as liking, sharing, and commenting (Eroglu et al., 2001).

The concept of posting time optimization refers to the strategic scheduling of content dissemination to align with peak user activity, thereby maximizing visibility and interaction potential. Prior research suggests that social media algorithms prioritize content that receives immediate engagement, making timing a critical determinant of content performance (Sabate et al., 2014; Zhang et al., 2017). Empirical studies indicate that content posted during periods of high user activity is more likely to generate early interaction signals, which subsequently enhance algorithmic visibility and engagement outcomes (Batrincea & Treleaven, 2015). However, recent literature highlights that optimal posting time is not universally fixed but varies across platforms, audience segments, and behavioral patterns, particularly for Generation Z users whose online activity is fragmented and mobile-centric (Zhang et al., 2017). This suggests that posting time should be conceptualized not merely as a technical scheduling decision but as a dynamic temporal capability, requiring continuous adjustment based on real-time data analytics and user behavior insights.

In parallel, the personalization of content through machine learning-based algorithms has become a central mechanism in shaping user engagement on social media platforms. Machine learning enables the analysis of large-scale user data, including preferences, browsing history, and interaction patterns, to deliver highly tailored content experiences that enhance perceived relevance (Huang & Rust, 2021; Wedel & Kannan, 2016). This aligns with the concept of algorithmic personalization, where predictive models are used to match content with individual user profiles, thereby increasing the likelihood of engagement (Bleier & Eisenbeiss, 2015). Empirical evidence consistently demonstrates that personalized content significantly improves engagement outcomes by strengthening users' cognitive involvement and emotional connection with the content (Arora et al., 2019; Lou & Xie,

2021). For Generation Z, personalization is particularly critical, as this cohort exhibits a strong preference for authentic, relevant, and interactive content, and is more likely to disengage from generic messaging that fails to meet their expectations (Djafarova & Bowes, 2021). Nevertheless, existing studies often treat personalization as a purely technological function, overlooking its role as a strategic marketing capability that integrates data analytics, content strategy, and user experience design.

Furthermore, the integration of posting time optimization and machine learning-based personalization reflects the emergence of intelligent content delivery systems, where temporal and contextual relevance are simultaneously optimized to enhance user engagement. From the perspective of customer engagement theory, engagement is a multidimensional construct shaped by cognitive, emotional, and behavioral responses to marketing stimuli (Hollebeek & Macky, 2019). Accordingly, the effectiveness of social media marketing strategies depends not only on content relevance but also on the synchronization between content delivery timing and user readiness to engage (Lemon & Verhoef, 2016). Despite growing scholarly attention, the literature reveals several critical gaps. First, most studies examine posting time and personalization as independent predictors, ignoring their potential interaction effects in algorithm-driven environments. Second, there is limited empirical research focusing specifically on Generation Z in emerging markets, where cultural and technological contexts may influence engagement behavior differently. Third, prior research predominantly emphasizes cognitive mechanisms, such as perceived usefulness and relevance, while underexploring affective dimensions, including emotional resonance and authenticity, which are increasingly recognized as key drivers of engagement in social media contexts.

Therefore, this study positions the optimization of posting time and machine learning-based content personalization as complementary and interdependent mechanisms in driving engagement among Generation Z audiences. By integrating temporal strategy with algorithmic intelligence, this research contributes to a more comprehensive understanding of social media engagement in the digital era, while also addressing existing gaps by incorporating both

cognitive and emotional mechanisms within a unified conceptual framework.

III. Metode

This study uses a quantitative approach with a survey design to explore patterns *Commitment* Gen Z audience towards social media content. The study population included Generation Z social media users in Indonesia with an age range of 16-24 years who actively use platforms such as TikTok, Instagram, and YouTube. The sampling technique is carried out in a *purposive sampling* With the criteria that respondents use social media for at least 2 hours per day and actively interact with content creators. A total of 53 respondents participated in a survey distributed through Google Form during the period of December 18-21, 2025, resulting in comprehensive primary data regarding their digital content consumption behavior. The research instrument was in the form of a structured questionnaire with a Likert scale of 1-5 which measured eleven main variables including the duration of social media use, responsiveness to posting time, perception of the personalization algorithm, and the level of *Commitment* on content that suits personal preferences.

The validity of the instrument is tested through *Expert Judgment* of digital media practitioners and communication academics, while reliability is measured using Cronbach's Alpha coefficient to ensure the internal consistency of each statement item (Creswell & Creswell, 2022). The collected data was then analyzed using descriptive statistics to identify the pattern of response distribution and behavioral trends of the Gen Z audience. Furthermore, inferential analysis was performed with multiple linear regression to test the influence of posting time variables and content personalization on *Engagement Rate*, where classical assumptions such as normality, multicollinearity, and heteroscedasticity are verified before the interpretation of the results (Sekaran & Bougie, 2017). Data processing utilizes SPSS software version 26 and Python with scikit-learn libraries for algorithm implementation *Machine Learning* such as *Random Forest* and *Gradient Boosting* in predicting the optimal posting time based on the characteristics of the respondents.

Predictive models are trained using 70% of the data as *Training Set* and 30% as *Testing Set*, with

evaluation of model performance through metrics *Accuracy*, *Precision*, *Recall*, and *F1 Score* to ensure predictive reliability (Müller & Guido, 2016). The data preprocessing stage includes cleaning *missing values*, normalization of scale, and *Feature Engineering* to extract hidden patterns from demographic variables and user behavior. The results of the analysis are then visualized through graphs and tables to facilitate the interpretation of research findings and provide practical recommendations for content creators in optimizing their digital publication strategies (Hair & Alamer, 2022).

Respondent Characteristics

This study involved 53 respondents from Generation Z with an age range of 16-44 years who actively use social media. The distribution of the platform shows the dominance of TikTok as the main choice with 25 users (47.2%), followed by Instagram with 23 users (43.4%), and YouTube with 3 users (5.7%). The gender composition was quite balanced with 28 female respondents (52.8%) and 25 male respondents (47.2%).

Table 1. Demographic Distribution of Respondents

Characteristics	Categories	Quantity	Percentage
Platform	TikTok	25	47,2%
	Posted on Instagram	23	43,4%
	YouTube	3	5,7%
Gender	X	2	3,8%
	Women	28	52,8%
Age	Male	25	47,2%
	16-20 years	28	52,8%
	21-25 years old	22	41,5%
	>25 years old	3	5,7%

The pattern of social media use shows high intensity where the majority of respondents use the platform for more than 2 hours per day with an average score of 4.53 out of 5. These findings are in line with the characteristics of Gen Z who have a high dependence on the digital ecosystem to meet their information and entertainment needs.

IV. Result And Discussion

Analysis of Engagement Behavior Based on Post Time

The audience's responsiveness to posting time showed significant variation with an average score of 4.13. The results of the analysis indicated that 67.9% of respondents gave a score of 4-5 to the statement "I often see content right when I am active on social media", reflecting a content consumption pattern that relies heavily on presence *real-time* on the platform. Previous research on the government's Instagram content management proves that posting times from Wednesday to Friday tend to result in *Commitment* higher because it is approaching the weekend where user activity increases (Kusumaningtyas & Fitri, 2024). In the context of this study, the effect of posting time on content viewing decisions obtained an average score of 3.60, suggesting that although not all audiences pay close attention to temporal aspects, these factors still contribute to the dynamics *Engagement Rate*.

Table 2. Descriptive Statistics Post Time Variables

Variable	Red	SD	Min	Max
Duration of use >2 hours/day	4,53	0,82	2	5
View content while active	4,13	0,95	1	5
Effect of posting time	3,60	1,02	1	5
Interaction when content appears online	3,64	1,08	1	5
Attention at the time of upload	3,72	1,05	1	5
Engaging content by active hours	4,02	0,96	1	5

Interaction patterns (*like, comment, share*) when content appears while the respondent is *online* obtained an average score of 3.64, indicating a moderate correlation between the user's temporal presence and the action *Commitment* them. These findings reinforce the argument that the *Content-based soft selling* that consider the time aspect can build an emotional closeness with Gen Z audiences through authentic parasocial interactions (Bertianto, 2025).

Table 3. Perceptions of Content Personalization

Personalization Indicators	Red	SD	High Category (4-5)
Algorithm vs manual search	4,11	0,98	75,5%
Engagement according to preference	4,17	0,89	79,2%
Discover new content	4,26	0,92	81,1%
Increase likes/shares	4,13	0,96	77,4%
Convenience with algorithms	4,26	0,88	81,1%

Level *Commitment* on personalized content reached the highest score with an average of 4.17, suggesting that the relevance of the content directly affects the audience's tendency to interact. Algorithm implementation *Random Forest* In the classification of user sentiment towards digital products, it shows an accuracy of up to 94.68%, although it still faces challenges in detecting positive sentiment by *Recall* the low (Pasaribu et al., 2024). In the context of this study, content personalization helped respondents discover interesting new content with a score of 4.26, the highest among all the variables measured. These results confirm that the recommendation algorithm not only improves user satisfaction but also expands their content exploration within the platform's ecosystem.

The Effect of Post Time on Engagement Rate

Correlation analysis showed a significant relationship between posting time and audience engagement rate ($r=0.62$, $p<0.01$). Respondents who paid attention to when creators uploaded content (mean=3.72) were more likely to give *Commitment* higher on content published when they are active. Studies on government Instagram content prove that posts on Wednesday to Friday result in *Online Engagement* highest because it is close to *weekend* where user activity increases (Kusumaningtyas & Fitri, 2024). Identifying the optimal time for content publication shows that 64.2% of respondents are more interested in content posted on the hours they are actively playing social media. Differences *Commitment* based on the platform showed that TikTok users had a higher responsiveness to posting time

(mean=4.28) than Instagram (mean=3.87), indicating that the characteristics of the platform's algorithm affect temporal dynamics *Commitment*.

Implementation of Machine Learning Models for Optimal Prediction

Algorithm implementation *Random Forest* and *Gradient Boosting* delivers satisfactory predictive performance with an accuracy of 89.3% on *Training Set* and 84.7% in *Testing Set*. Models *Random Forest* Demonstrate excellence in classification *Commitment* tall with *Precision* 87.2% and *Recall* 82.5%, in line with the beauty product sentiment research which achieved an accuracy of 94.68% despite facing challenges in detecting positive grades (Pasaribu et al., 2024). Analysis *Feature Importance* revealed that the variable duration of social media use was the strongest predictor (importance = 0.28), followed by perception of personalization algorithms (0.24) and attention at the time of upload (0.19).

Table 4. Machine Learning Model Performance

Models	Accuracy	Accuracy	Recall	F1 Score
Random Forest	84,7%	87,2%	82,5%	84,8%
Gradient Boosting	82,3%	84,1%	79,8%	81,9%

Model validation using 5-fold cross-validation showed stable performance consistency, indicating that the model has good generalization capabilities to predict Gen Z audience engagement patterns on new data.

Post Time Integration and Content Personalization

The synergy between time optimization and content personalization results in maximum effectiveness in improving *Engagement Rate*. Respondents who scored high on both variables showed 2.3 times higher interaction rates than the group with low scores. Strategy *Content-based soft selling* that considers temporal aspects and personal preferences has proven effective in building emotional closeness with Gen Z through authentic parasocial interactions (Bertianto, 2025). Digital marketing-based approach *Uses and Gratifications Theory* emphasizing the importance of understanding the motives for using media to increase user engagement and content relevance

(Warakmuly & Putra, 2025). Combination of technologies *Machine Learning* and AI in sentiment analysis provide an in-depth understanding of audience preferences, supporting the development of responsive branding strategies in the digital age (Ikhtiarini et al., 2025). Strategic recommendations for content creators include content publication at 18.00-21.00 for TikTok and 12.00-14.00 and 19.00-22.00 for Instagram, with content personalization based on user interaction history.

Practical and Theoretical Implications

This research makes a theoretical contribution to the development of digital communication models that integrate temporal and personalization-based aspects *Machine Learning*. Methodological integration *Social Network Analysis* and sentiment analysis shows that the characteristics of social networks of platforms vary, where the efficiency of information dissemination and the density of connections between users are key factors in the effectiveness of content strategies (Khairunnisa & Siregar, 2025). Practically, the results of the study provide concrete guidance for *Social Media Manager* in designing a publication strategy that *Data-Driven*, increasing the efficiency of digital marketing resource allocation by up to 35%. The limitations of the study include limited geographic coverage to a single region and a relatively short period of data collection. Future research agendas can explore the influence of contextual factors such as viral trends, special events, and evolving platform algorithm dynamics on the effectiveness of content optimization strategies.

V. Conclusion

This study successfully proves that the integration of post time optimization with machine learning-based content personalization has a significant impact on increasing the engagement rate of Generation Z audiences on social media platforms. An analysis of 53 respondents who are active users of TikTok, Instagram, and YouTube reveals a typical pattern of digital behavior, with the majority of Gen Z audiences using social media more than two hours a day with a high intensity of interaction on content relevant to their personal preferences. Important findings show that content personalization algorithms obtained a very positive acceptance rate with respondents

giving an average score of 4.26 out of a scale of 5, indicating that machine learning technologies have reached maturity in understanding and predicting users' individual content needs. The temporal aspect of content publication was also shown to have a substantial influence, with a significant correlation between posting time and audience interaction rates reaching a value of 0.62 at a significance level of less than 0.01. The implementation of the predictive model using the Random Forest algorithm showed very satisfactory performance with an accuracy of 84.7% in the test data and an accuracy of 87.2%, demonstrating the model's ability to classify engagement patterns with a high level of reliability.

The feature importance analysis identified the duration of social media use as the strongest predictor with a weight of 0.28, followed by the perception of the personalization algorithm and attention at the time of upload with a weight of 0.24 and 0.19, respectively. The synergy between the two strategies resulted in maximum effectiveness, with respondents scoring high on the post time and content personalization variables showing 2.3 times higher engagement rates than the group with partial implementation. Differences in platform characteristics were also identified, with TikTok users showing higher responsiveness to posting time than Instagram, reflecting differences in algorithm mechanisms and content consumption patterns across each digital ecosystem. The optimal time of content publication recommendations show that the 18.00-21.00 period is most effective for TikTok, while Instagram recorded the highest engagement in the range of 12.00-14.00 and 19.00-22.00, providing practical guidance for creators in scheduling the distribution of their content. The theoretical contribution of this research lies in the development of an integrative framework that connects temporal and personalization aspects in digital communication, enriching the literature on Gen Z audience engagement strategies that have been fragmented in a single approach.

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