



Unveiling Social Media Trends in Pakistan: A Yearlong Analysis of Platform Engagement and User Behavior

Hameed Anwar

The University of Agriculture, Peshawar-Pakistan

*Correspondence: Anwar_hameed1985@gmail.com

Citation | Anwar. H, "Unveiling Social Media Trends in Pakistan: A Yearlong Analysis of Platform Engagement and User Behavior", JIRSD, Vol. 3 Issue. 2 pp 85-94, Aug 2024

Received | May 28, 2024 **Revised |** July 11, 2024 **Accepted |** July 27, 2024 **Published |** Aug 14, 2024.

This research explores the evolving dynamics of social media engagement in Pakistan from November 2022 to November 2023, focusing on major platforms like Facebook, Twitter, YouTube, and Instagram, as well as niche platforms such as Pinterest, LinkedIn, Reddit, and VKontakte. Utilizing data from Statcounter Global Stats, the study provides a comprehensive analysis of engagement trends across these platforms. Key findings reveal a gradual decline in Facebook engagement, significant fluctuations in Twitter activity, a surge in YouTube usage, and varied engagement levels on Instagram. The research highlights the implications of these trends for digital marketers, businesses, and content creators, emphasizing the need for adaptive strategies that align with shifting user preferences and emerging content trends. The insights gained from this analysis offer valuable guidance for optimizing social media strategies and navigating the complex digital landscape in Pakistan.

Keywords: Social Media Engagement, Facebook, Twitter, Youtube, Digital Marketers.

Introduction:

In the context of Pakistan's rapid digitalization, this research delves into the complex dynamics of social media engagement in a nation undergoing significant digital transformation. The digital era has revolutionized global communication, interaction, and information sharing. Social media platforms have become pivotal in shaping communication patterns, cultural exchanges, and information dissemination, playing a crucial role in this ongoing transformation [1]. As one of the world's most populous countries, Pakistan has witnessed a substantial rise in internet penetration, propelling its citizens into the digital age. Social media platforms are central to this digital shift, offering a virtual space for diverse communities to converge, express themselves, and participate in global dialogues. Understanding the nuances of social media usage in Pakistan is both a scholarly pursuit and a practical necessity for businesses, marketers, and content creators navigating this dynamic landscape [2].

This research extends beyond a single examination of user engagement on mainstream platforms, adopting a holistic approach to the digital ecosystem. It considers variations in user behavior across platforms, demographic trends, and cultural dynamics. By focusing on key platforms such as Facebook, Twitter, YouTube, and Instagram, the study aims to explore the essentials of user trends and uncover the factors driving engagement fluctuations [3]. Microblogging platforms, like Twitter, offer a unique dimension characterized by real-time interactions and concise content sharing. Visual-centric platforms such as YouTube and Instagram utilize multimedia content to capture audience attention, reflecting the evolving preferences of Pakistani users. Beyond mainstream platforms, the research also examines niche networks, including Pinterest, LinkedIn, Reddit, VKontakte, and others. Understanding the

coexistence of these platforms and their varying degrees of user engagement is crucial to grasping the diversity of interests within Pakistan's digital community [4].

This exploratory journey aims to contribute both academically and practically, offering insights that inform strategic decision-making in marketing, business, and political content creation. By investigating the complexities of social media engagement in Pakistan, the research seeks to provide a comprehensive understanding of the digital landscape, enabling stakeholders to navigate the ever-evolving realm of online interactions more effectively. In this rapidly changing environment, a critical gap exists in understanding the intricate dynamics, preferences, and user behaviors across various platforms. While global studies offer valuable insights, Pakistan's unique socio-cultural context requires a dedicated investigation into how users interact with major platforms in the country. Additionally, the lack of comprehensive research on real-time engagement patterns on microblogging platforms like Twitter, the influence of multimedia content on user behavior, and the engagement dynamics of niche audiences on alternative platforms necessitates further exploration [5].

This research aims to fill these gaps by thoroughly examining social media engagement in Pakistan and providing valuable insights for businesses, marketers, and content creators looking to optimize their strategies in this dynamic digital landscape. The findings hold significant implications for various stakeholders. For digital marketers and businesses operating in Pakistan, the study offers a data-driven foundation for shaping targeted strategies that consider platform-specific trends, temporal dynamics, and niche audience preferences. The cultural insights contribute to a deeper understanding, helping marketers create culturally relevant content [6][7]. Academically, the study adds value by presenting a longitudinal analysis of social media engagement, laying the groundwork for future research exploring the interplay of cultural, societal, and technological factors. Policymakers can benefit from insights into digital behavior, guiding policies related to digital literacy and online safety. The focus on user experience metrics provides a pathway for platforms to enhance user interactions, while the predictive value enables businesses to anticipate future trends. The comparative analysis with global trends offers cross-cultural insights, fostering a global understanding of the unique characteristics of Pakistan's digital landscape. This study serves as both a practical and academic framework, contributing to the informed management of Pakistan's dynamic social media environment [8].

Literature Review:

The rapid evolution of digital technologies has profoundly impacted the way businesses operate and engage with consumers. As of January 2020, there were 4.54 billion active internet users globally, representing 59% of the world's population, and social media usage has similarly become deeply ingrained in daily life, with 2.95 billion users in 2019, a figure expected to rise to 3.43 billion by 2023. This widespread adoption of digital and social media technologies has revolutionized marketing strategies, enabling companies to achieve their objectives more cost-effectively. For example, platforms like Facebook and Twitter have become essential tools for businesses, with more than 50 million businesses registered on Facebook and 88% of companies using Twitter for marketing purposes [9]. This shift is reflected in a growing body of literature that explores the ways digital and social media marketing have become integral to business strategies, influencing consumer behavior and market dynamics.

Several studies highlight the benefits organizations can gain from incorporating social media marketing into their overall strategy. Social media platforms offer businesses the ability to connect directly with customers, enhance brand awareness, influence consumer attitudes, and gather feedback, which can be used to improve products and services. The decline of traditional communication channels and the increasing reliance on digital platforms have forced businesses to adapt their marketing strategies to retain and expand their market share

[10][11]. However, this shift also presents significant challenges, particularly in managing the increased power consumers now wield. Negative electronic word-of-mouth (eWOM), for instance, can spread rapidly and have detrimental effects on a company's reputation. Therefore, businesses must navigate this new landscape carefully, balancing the benefits of increased consumer engagement with the risks of potential backlash [12].

The literature also addresses the broader environmental changes brought about by digital technologies. The rise of social commerce and the ubiquity of mobile devices have fundamentally altered consumer behavior, with more people using digital channels to shop and make decisions. Studies have shown that the increasing number of shopping channels has created a more diffuse consumer experience, with mobile channels becoming a norm in daily life. Mobile tools, shopping apps, location-based services, and mobile wallets have all contributed to this shift, making the consumer experience more dynamic and integrated into everyday activities [13]. Researchers emphasize the importance of understanding consumer needs, perceptions, and attitudes toward various forms of digital communication, as these factors are crucial in developing effective social media marketing strategies.

Consumer behavior in digital environments is influenced by various psychological and social factors, including motivations related to belief, community participation, and psychological fulfillment. Research has shown that social media can satisfy these motivations, thereby influencing consumer attitudes toward brands and online communities. For example, consumer experiences with platforms like Instagram have been found to be shaped by the perceived usefulness, entertainment value, and credibility of the content, as well as the absence of irritation from advertisements [14]. Additionally, the emerging trend of targeted personal advertising has raised privacy concerns among consumers, highlighting the need for businesses to be mindful of privacy issues when developing their marketing strategies. Studies suggest that invasiveness, privacy control, and perceived usefulness are key factors that influence consumer behavior and attitudes toward digital marketing [15].

The literature also underscores the importance of considering demographic, cultural, and geographic factors in social media marketing. While much of the existing research focuses on consumers from developed countries, there is a growing recognition of the need to understand consumer behavior in a broader context. For instance, studies conducted in Egypt have highlighted the role of cognition, emotion, experience, and personality in shaping consumer decisions and trust toward online vendors [16]. These findings suggest that social media marketing strategies should be tailored to different consumer segments, taking into account their unique characteristics and preferences.

The role of eWOM in shaping consumer attitudes and behaviors is another significant theme in the literature. eWOM communication can have a profound impact on information adoption, purchase intention, brand loyalty, and trust. Positive eWOM can enhance a brand's reputation and foster consumer loyalty, while negative eWOM can lead to significant challenges, including damage to the brand's image and a decline in sales. Researchers have found that consumers respond positively to personalized responses from companies addressing negative social media posts, which can help preserve brand reputation and trust. The literature also highlights the role of online opinion leaders in digital marketing. Opinion leaders, such as celebrities, micro-influencers, and market mavens, play a critical role in promoting products and services, particularly on social media platforms. Effective use of opinion leaders involves careful planning, recognition, alignment, motivation, and coordination, ensuring that the right influencers are matched with the appropriate products and services.

In conclusion, the literature on digital and social media marketing reflects the transformative impact of digital technologies on consumer behavior and business strategies. While these technologies offer significant opportunities for businesses to engage with

consumers and enhance their marketing efforts, they also present new challenges, particularly in managing consumer power and privacy concerns [17]. As digital marketing continues to evolve, ongoing research will be essential in guiding businesses on how to navigate this complex and dynamic landscape, ensuring they can leverage the benefits of social media while mitigating the risks.

Methodology:

Data Collection:

The methodology for analyzing social media engagement in Pakistan from November 2022 to November 2023 began with data collection from Statcounter Global Stats. This dataset provided monthly engagement percentages across various social media platforms, including Facebook, Twitter, YouTube, Instagram, Pinterest, LinkedIn, Reddit, VKontakte, and other niche platforms.

Data Preparation:

After collection, the data was organized into a structured format, with months as the primary variable and engagement percentages for each platform as corresponding values. This structured format was then converted into a panda Data Frame, facilitating efficient manipulation and analysis.

Data Analysis:

The core of the analysis involved examining trends and patterns in user engagement across different platforms. Key aspects of the analysis included:

- **Facebook Engagement:** Identified a gradual decline in engagement, suggesting a potential shift in user preferences towards alternative platforms.
- **Twitter Engagement:** Analyzed fluctuations and peaks, correlating them with real-time events and trending topics.
- **YouTube Engagement:** Noted a significant surge, particularly in March 2023, indicating heightened interest in video content.
- **Instagram Engagement:** Examined varying levels of engagement, with a notable peak in August 2023.

Data Visualization:

Several types of graphs were created to visualize the trends and patterns:

- **Line Graphs:** Depicted engagement trends over time for major platforms such as Facebook, Twitter, YouTube, and Instagram. These graphs illustrated fluctuations and peaks, providing a clear view of how engagement changed over the observed period.
- **Stacked Bar Graph:** Represented the distribution of engagement across all platforms within each month. This graph highlighted the relative contributions of each platform to overall engagement, showing Facebook's consistent dominance, Twitter's variable engagement, and the notable increases in YouTube and Instagram engagement at specific times.

Interpretation:

The visualizations and analyses offered valuable insights into the evolving landscape of social media engagement in Pakistan. The findings included:

- A decline in Facebook engagement, suggesting a shift in user preferences.
- Fluctuations in Twitter engagement, emphasizing the importance of aligning content with real-time events.
- A surge in YouTube engagement, reflecting growing interest in video content.
- Varied engagement levels on Instagram, indicating changing user preferences for visual content.

- Insights into niche platforms like Pinterest, LinkedIn, Reddit, and VKontakte, revealing specific user bases.

This methodology provided a comprehensive understanding of social media interactions, offering actionable insights for businesses, content creators, and marketers to optimize their strategies in response to the dynamic digital landscape in Pakistan [18].

Results and Discussion:

The detailed analysis of social media engagement in Pakistan from November 2022 to November 2023 reveals significant trends and fluctuations across various platforms. This analysis not only delves into the engagement patterns observed but also integrates visual representations, offering a comprehensive view of how user preferences and interactions have evolved during the study period.

Facebook Engagement Decline:

Facebook, historically the dominant social media platform in Pakistan, has shown a gradual decline in user engagement over the year. As depicted in **Figure 1**, Facebook's engagement started at 85.97% in November 2022 and steadily decreased to 83.05% by November 2023. This decline, while not steep, is significant given Facebook's traditionally strong user base [19]. The gradual reduction in engagement could indicate a shift in user behavior, where users might be exploring other platforms or becoming less active on Facebook.

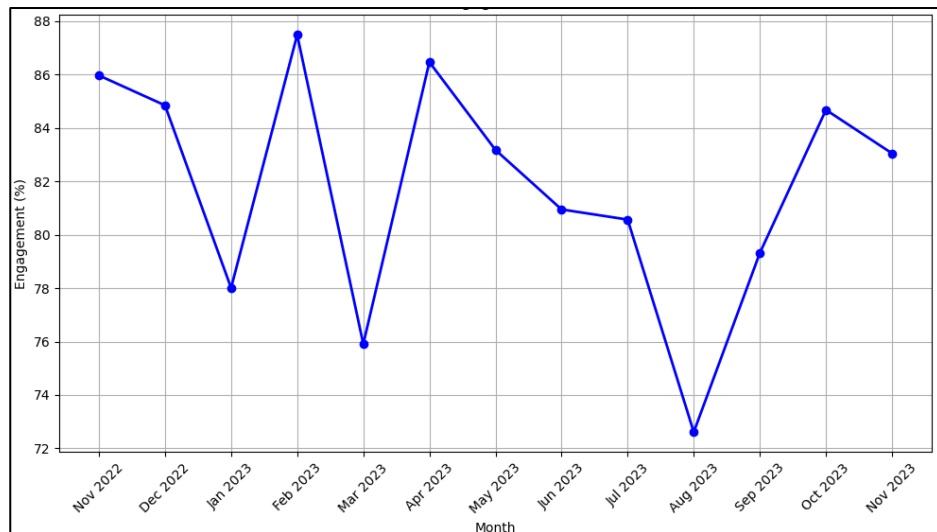


Figure 1: Facebook engagement over time.

Figure 1 illustrates this downward trend clearly, with a consistent decline month over month. The slight recovery in some months, such as a brief increase in April 2023, does not offset the overall downward trajectory. This trend could be attributed to various factors, including changes in user demographics, the emergence of alternative platforms, or perhaps changes in Facebook's content algorithms that might not align with the preferences of Pakistani users.

Twitter's Fluctuating Engagement Patterns:

Twitter, known for its real-time interactions and brief content sharing, exhibited highly variable engagement throughout the year, as seen in **Figure 2**. The platform's engagement ranged from a low of 7.69% in March 2023 to a peak of 17.88% in January 2023. These fluctuations are indicative of Twitter's sensitivity to current events and trending topics. The spikes in engagement likely correspond to significant national or global events that resonated with the Pakistani audience [20].

Figure 2 shows these fluctuations vividly, with sharp rises and falls throughout the year. The peak in January 2023, followed by a sharp drop in March, underscores how quickly

user engagement on Twitter can change based on external factors. This pattern suggests that Twitter's effectiveness as a platform in Pakistan is closely tied to its ability to serve as a hub for timely and relevant discussions.

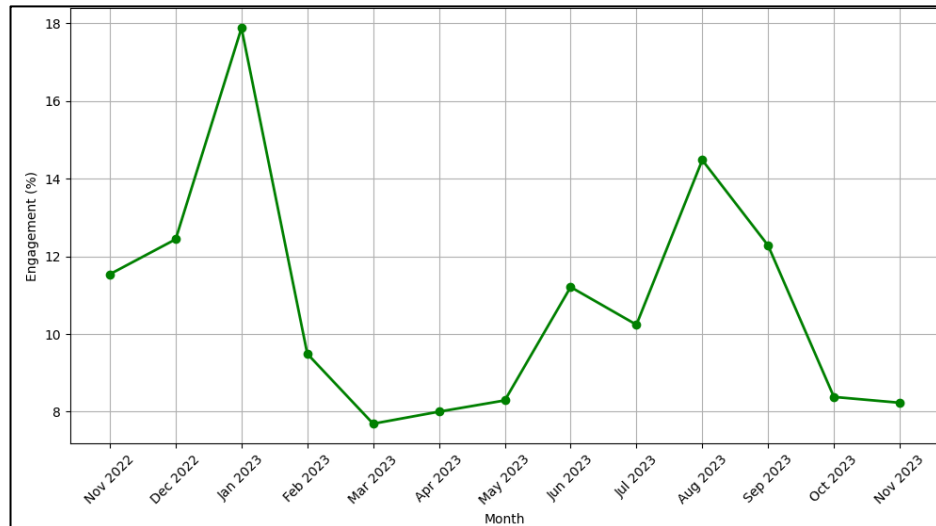


Figure 2: Twitter engagement fluctuations

Surge in YouTube Engagement:

YouTube, as a platform focused on video content, saw a significant surge in engagement, particularly in March 2023. As shown in **Figure 3**, engagement rose sharply to 13.69% during this period. This increase highlights the growing importance of video content among Pakistani users. The reasons behind this surge could include the release of popular content, an increase in internet accessibility, or a rise in the consumption of video content due to specific events or trends during that time.

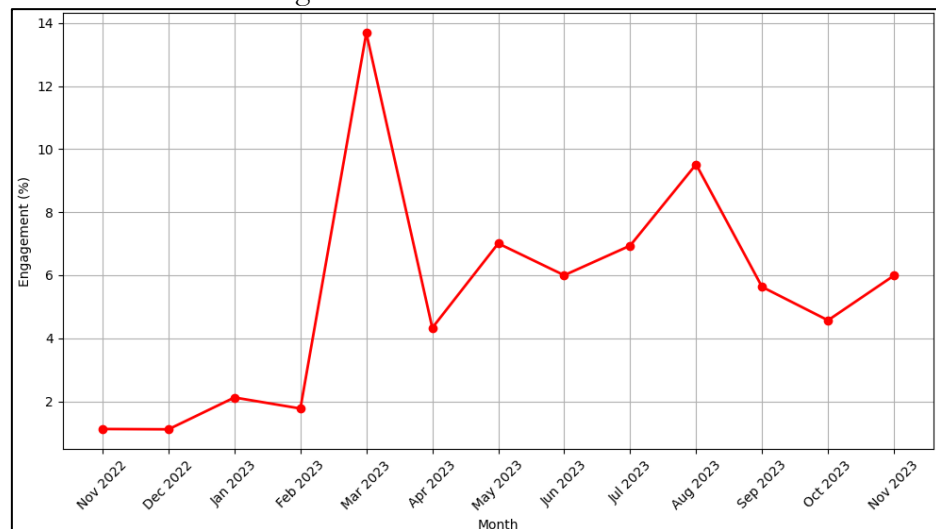


Figure 3: YouTube Engagement surge

Figure 3 captures this surge, with the engagement line sharply increasing in March 2023. This pattern suggests that users are increasingly turning to YouTube for entertainment, information, and education. For content creators and marketers, this trend underscores the importance of investing in video content that aligns with the interests of Pakistani audiences.

Instagram's Visual-Centric Engagement:

Instagram, a platform built around visual content, displayed varied engagement levels throughout the study period, with a notable peak in August 2023, as illustrated in **Figure 4**. The engagement rose to 2.29%, the highest recorded during the year, suggesting that visual content had a significant impact on users during this time. The reason for this peak could be

linked to specific trends or events that emphasized the importance of visually appealing content.

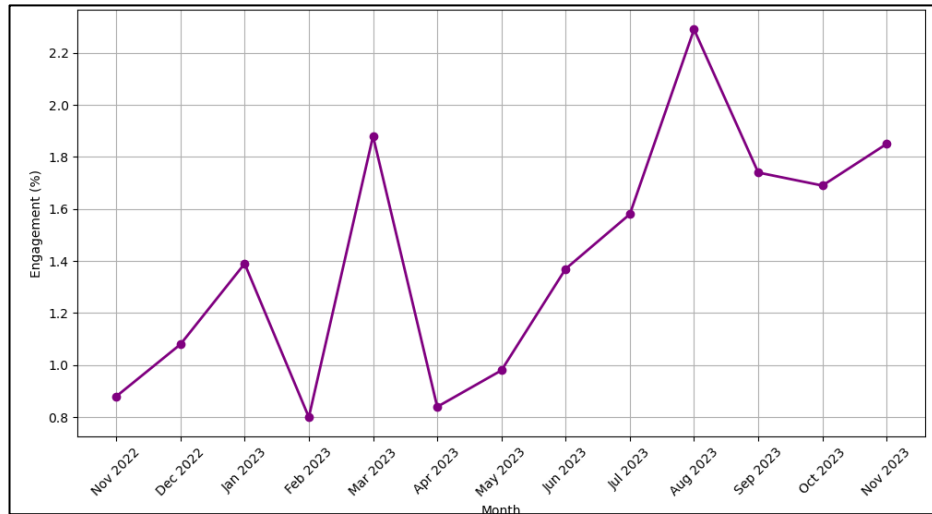


Figure 4: Instagram engagement over time.

Figure 4 demonstrates the fluctuations in Instagram engagement, with the peak in August being particularly pronounced. This trend suggests that users are drawn to visual content, especially during periods when certain trends or events make such content more relevant. For marketers, this means that timing and content relevance are critical when leveraging Instagram for brand engagement.

Engagement on Niche Platforms:

The analysis also revealed consistent but lower engagement on niche platforms such as Pinterest, LinkedIn, Reddit, and VKontakte. As shown in **Figure 5**, these platforms maintained relatively steady engagement throughout the year, though at much lower levels compared to mainstream platforms like Facebook and Twitter.

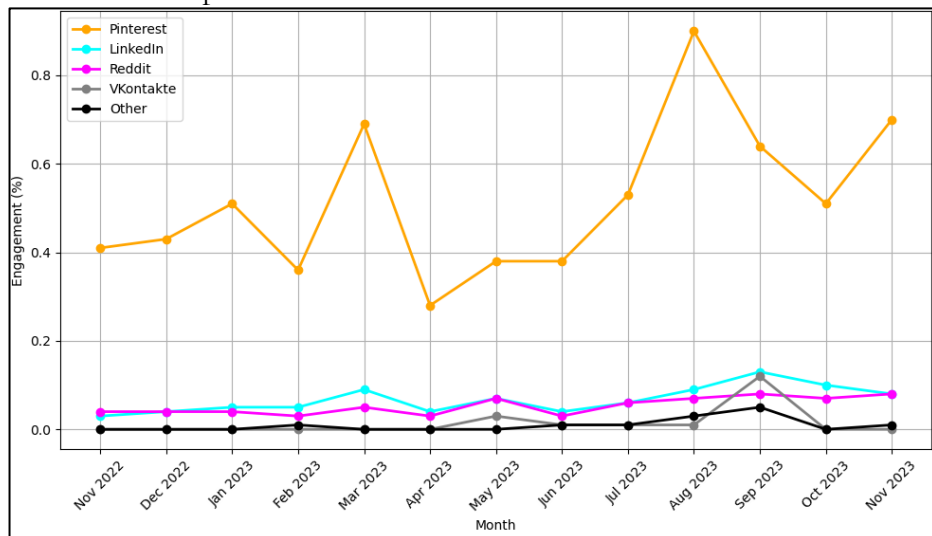


Figure 5: Engagement on niche Platforms over time.

Figure 5 highlights the engagement levels of these niche platforms, which, despite being lower, are significant within their specific user bases. The relatively stable engagement suggests that these platforms serve particular interests and communities, making them important for targeted marketing efforts.

Comparative Analysis and Overall Trends:

The stacked bar graph in **Figure 6** provides a comprehensive view of the monthly distribution of user interactions across all platforms. Each bar represents a month, with

distinct color-coded segments indicating the contribution of each platform to the overall social media landscape in Pakistan. The foundational blue layer representing Facebook's engagement serves as the baseline, while the green, red, purple, and orange layers indicate the contributions of Twitter, YouTube, Instagram, and other niche platforms, respectively.

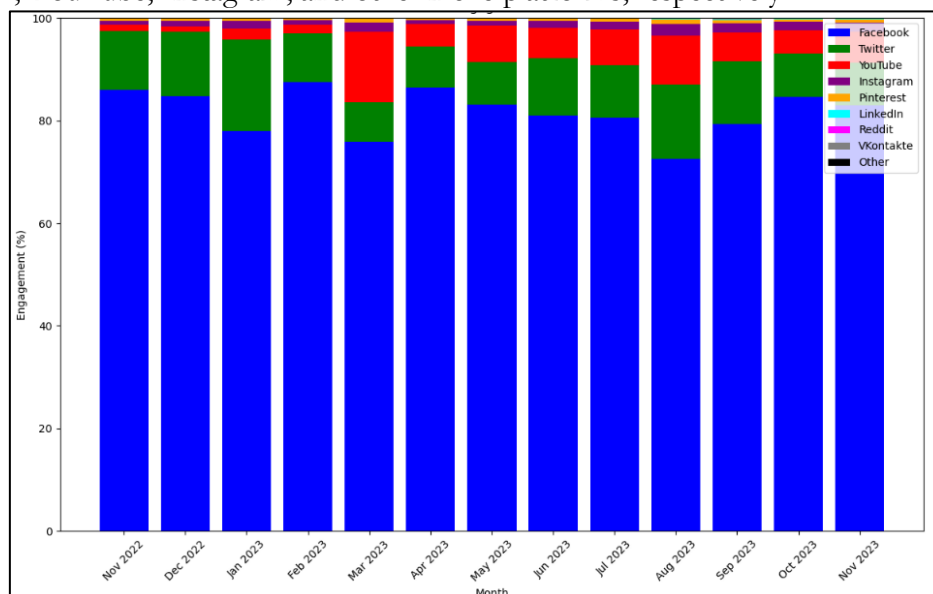


Figure 6: Social media engagement distribution

Figure 6 enables a comparative analysis of the engagement levels across platforms, allowing us to observe peaks and troughs over time. The graph clearly shows Facebook's dominance, albeit with a declining trend, and the significant contributions of YouTube and Twitter during certain periods. This visual representation is crucial for understanding how different platforms interact within the broader social media ecosystem in Pakistan.

Discussion:

The findings from this analysis offer a nuanced understanding of social media engagement in Pakistan, highlighting key trends and user behaviors across various platforms. The gradual decline in Facebook engagement could indicate a shifting digital landscape, where users are exploring alternative platforms or becoming more selective in their online activities. This trend challenges marketers and businesses to adapt their strategies to stay relevant in a changing environment.

Twitter's fluctuating engagement underscores the importance of timing and content relevance, especially in a platform driven by real-time interactions. The peaks in engagement reflect the platform's role as a hub for timely discussions, suggesting that businesses need to be agile in their content strategies to capitalize on trending topics. The surge in YouTube engagement during March 2023 highlights the growing importance of video content. This trend suggests that users are increasingly turning to video platforms for information, entertainment, and education. Content creators who can tap into this demand will likely find success in reaching their audiences.

Instagram's peak engagement in August 2023 reinforces the platform's visual-centric nature, with users drawn to content that is both visually appealing and timely. For marketers, this means that creating high-quality visual content that resonates with current trends is key to driving engagement on Instagram. Lastly, the steady engagement on niche platforms such as Pinterest, LinkedIn, and Reddit suggest that while these platforms may not have the broad reach of Facebook or Twitter, they still play a critical role in the digital ecosystem. For businesses targeting specific demographics or interests, these platforms offer valuable opportunities for engagement. Overall, this analysis provides actionable insights for

stakeholders looking to navigate Pakistan's diverse and dynamic social media landscape. By understanding the unique trends and behaviors across different platforms, businesses and content creators can develop more effective strategies that resonate with their target audiences.

Conclusion:

The detailed examination of social media engagement in Pakistan has unveiled significant trends and shifts in user behavior over the past year. The gradual decline in Facebook engagement suggests a transformation in user preferences, potentially driven by the emergence of alternative platforms and changes in content consumption habits. Twitter's variable engagement patterns underscore the importance of real-time content relevance, reflecting the platform's role as a conduit for current events and trending topics. The notable surge in YouTube engagement highlights the growing popularity of video content, indicating a shift towards more immersive and dynamic forms of media. Instagram's peak engagement period further emphasizes the impact of visual content and timely trends on user interaction. Additionally, the steady but lower engagement on niche platforms indicates their value for targeted marketing efforts, despite their smaller user bases.

Overall, the findings of this research provide actionable insights for stakeholders seeking to enhance their social media strategies in Pakistan. Businesses and content creators can leverage these insights to craft more effective and responsive marketing campaigns that align with evolving user preferences and platform dynamics. By understanding the nuanced engagement patterns across different social media platforms, stakeholders can better navigate the complexities of the digital landscape and optimize their approaches to meet the needs of diverse audiences.

References:

- [1] J. Wang, A. Aribarg, and Y. F. Atchadé, "Modeling choice interdependence in a social network," *Mark. Sci.*, vol. 32, no. 6, pp. 977–997, 2013, doi: 10.1287/MKSC.2013.0811.
- [2] H. S. Nair, P. Manchanda, and T. Bhatia, "Asymmetric social interactions in physician prescription behavior: The role of opinion leaders," *J. Mark. Res.*, vol. 47, no. 5, pp. 883–895, 2010, doi: 10.1509/JMKR.47.5.883.
- [3] B. Longo, "Using social media for collective knowledge-making: Technical communication between the global north and south," *Tech. Commun. Q.*, vol. 23, no. 1, pp. 22–34, Jan. 2014, doi: 10.1080/10572252.2014.850846.
- [4] D. Kaufer, A. Gunawardena, A. Tan, and A. Cheek, "Bringing social media to the writing classroom: Classroom salon," *J. Bus. Tech. Commun.*, vol. 25, no. 3, pp. 299–321, Jul. 2011, doi: 10.1177/1050651911400703.
- [5] K. M. Y. Law, S. Geng, and T. Li, "Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence," *Comput. Educ.*, vol. 136, pp. 1–12, Jul. 2019, doi: 10.1016/J.COMPEDU.2019.02.021.
- [6] A. C. Kimme Hea, "Social media in technical communication," *Tech. Commun. Q.*, vol. 23, no. 1, pp. 1–5, Jan. 2014, doi: 10.1080/10572252.2014.850841.
- [7] W. van Zoonen, J. W. M. Verhoeven, and R. Vliegenthart, "Understanding the consequences of public social media use for work," *Eur. Manag. J.*, vol. 35, no. 5, pp. 595–605, Oct. 2017, doi: 10.1016/J.EMJ.2017.07.006.
- [8] E. C. Hedberg and S. Ayers, "The power of a paired t-test with a covariate," *Soc. Sci. Res.*, vol. 50, pp. 277–291, Mar. 2015, doi: 10.1016/J.SSRESEARCH.2014.12.004.
- [9] S. Atallah, S. L. Hotle, and S. Mumbower, "The evolution of low-cost Carrier operational strategies pre- and post-recession," *J. Air Transp. Manag.*, vol. 73, pp. 87–94, Oct. 2018, doi: 10.1016/J.JAIRTRAMAN.2018.08.011.
- [10] C. K. M. Lee, K. K. H. Ng, H. K. Chan, K. L. Choy, W. C. Tai, and L. S. Choi, "A

- multi-group analysis of social media engagement and loyalty constructs between full-service and low-cost carriers in Hong Kong,” *J. Air Transp. Manag.*, vol. 73, pp. 46–57, Oct. 2018, doi: 10.1016/J.JAIRTRAMAN.2018.08.009.
- [11] S. A. Haslam, C. McMahon, T. Cruwys, C. Haslam, J. Jetten, and N. K. Steffens, “Social cure, what social cure? The propensity to underestimate the importance of social factors for health,” *Soc. Sci. Med.*, vol. 198, pp. 14–21, Feb. 2018, doi: 10.1016/J.SOCSCIMED.2017.12.020.
- [12] J. Abbas et al., “The moderating role of social support for marital adjustment, depression, anxiety, and stress: Evidence from Pakistani working and nonworking women,” *J. Affect. Disord.*, vol. 244, pp. 231–238, Feb. 2019, doi: 10.1016/J.JAD.2018.07.071.
- [13] L. Székely and Á. Nagy, “Online youth work and eYouth - A guide to the world of the digital natives,” *Child. Youth Serv. Rev.*, vol. 33, no. 11, pp. 2186–2197, Nov. 2011, doi: 10.1016/J.CHILDYOUTH.2011.07.002.
- [14] N. Vangeepuram, J. Carmona, G. Arniella, C. R. Horowitz, and D. Burnet, “Use of Focus Groups to Inform a Youth Diabetes Prevention Model,” *J. Nutr. Educ. Behav.*, vol. 47, no. 6, pp. 532–539.e1, Nov. 2015, doi: 10.1016/J.JNEB.2015.08.006.
- [15] D. M. Warren and K. R. Bloch, “Framing same-sex marriage: Media constructions of California’s Proposition 8,” *Soc. Sci. J.*, vol. 51, no. 4, pp. 503–513, Dec. 2014, doi: 10.1016/J.SOSCIJ.2014.06.011.
- [16] K. Kim, J. Kim, and L. N. Reid, “Experiencing motivational conflict on social media in a crisis situation: The case of the Chick-fil-A same-sex marriage controversy,” *Comput. Human Behav.*, vol. 71, pp. 32–41, Jun. 2017, doi: 10.1016/J.CHB.2017.01.035.
- [17] C. Lee, J. Shin, and A. Hong, “Does social media use really make people politically polarized? Direct and indirect effects of social media use on political polarization in South Korea,” *Telemat. Informatics*, vol. 35, no. 1, pp. 245–254, Apr. 2018, doi: 10.1016/J.TELE.2017.11.005.
- [18] S. Sinprakob and N. Songkram, “A Proposed Model of Problem-based Learning on Social Media in Cooperation with Searching Technique to Enhance Critical Thinking of Undergraduate Students,” *Procedia - Soc. Behav. Sci.*, vol. 174, pp. 2027–2030, Feb. 2015, doi: 10.1016/J.SBSPRO.2015.01.871.
- [19] S. A. DeWaelche, “Critical thinking, questioning and student engagement in Korean university English courses,” *Linguist. Educ.*, vol. 32, pp. 131–147, Dec. 2015, doi: 10.1016/J.LINGED.2015.10.003.
- [20] P. Charoensukmongkol and P. Sasatanun, “Social media use for CRM and business performance satisfaction: The moderating roles of social skills and social media sales intensity,” *Asia Pacific Manag. Rev.*, vol. 22, no. 1, pp. 25–34, Mar. 2017, doi: 10.1016/J.APMRV.2016.10.005.