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A Critical Review on Quality of Experience for Videos and User Engagement on Social Media Platforms

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ABSTRACT
Videos have been used to attract consumers and this has become an important marketing tool on social media platforms today. To meet users' expectations, content providers and marketers need to understand the factors that influence video Quality of Experience (QoE) and efficiently managing resources to optimize video and content quality. Research on users' perceptions of video QoE has attracted increasing global attention in recent years. [1], [2]. This paper critically reviews past research works on factors influencing user' perceptions of video QoE and the relevant observed variables on social media. Through a systematic literature review, this paper contributes to social media adoption by investigating video QoE in the context of social media advertising, the relationship between video QoE and user engagement. The analysis of related works is able to highlight the gaps that have yet to be addressed.

KEYWORDS: ***QoE, QoS, video quality, social media, user engagement***

1 INTRODUCTION

Social media is websites and applications that enable users to create and share content or to participate in social media platforms. It has become an integral part of today's life. Social media interaction continues affecting users' opinions on products and services. As such, social media marketing becomes the most preferred marketing channel for companies to reach their targeted users, for product promotion and brand awareness. Videos on social media platforms such as Facebook and YouTube remains an essential tool for attracting users in social media marketing today [3] [4] [5].

According to HubSpot Marketing Statistics 2023 [5], video is the number one form of media used in content strategy, overtaking infographics. The growing importance of video has driven a growing interest in understanding the video QoE (Quality of Experience) metrics to characterize the performance/popularity of social media platforms. According to Zhu's study [6], social media can be a powerful research tool for QoE evaluation but research on users' perceptions of video QoE is still in its infancy [2] , [6], [7]. Therefore, this paper aims to study the key influence factors impacting users' perceptions of video QoE on social media and how likely QoE factors impact user engagement. These insights can help content providers create better content and social posts for their active audience with the right video content at the right time on the right social media platforms.

The rest of the paper is structured as follows. Section 2 focuses on research methodology. Section 3 centers on the current landscape of video on social media platforms, differentiating between Quality of Service (QoS) and Quality of Experience (QoE), and proceeds to explore the influential factors affecting video QoE. This section also explains the significance of video QoE in relation to user engagement on social media. Finally, Section 4 discusses unaddressed gaps, potential contributions, and concludes the paper

2 RESEARCH METHODOLOGY

This paper analyses past years of related works on social media research activity that focused on the impact of QoE in different business domains and other related factors. The author used keywords "video QoE" together with "social media" to identify relevant studies. User engagement refers

to the quality of user experience that emphasizes the positive aspects of interacting with an online application [8]. User engagement can serve as a reliable indicator of consequence of QoE because QoE strongly correlate with user engagement [9]. Therefore, user engagement is part of the research chain. This chain will be applied to research publication databases such as ACM Digital Library, IEEE Xplore Digital Library, Research Gate, and Google Scholar. Also, this study will be restricted to journals written in English language only. All the articles collected will be screened and inspected in this paper to assure that each study is relevant to the aim of the study.

3 LITERATURE REVIEW

In this section, the findings of an extensive literature search have been summarized to fulfil the aim of this paper.

3.1 CURRENT LANDSCAPE OF VIDEO ON SOCIAL MEDIA PLATFORMS

Social media was first used as a platform to keep friends and family in contact. Social media is always changing due to constant technological (e.g., platforms constantly update and add new features and services) and usage (e.g., user finding new uses for social media) innovations. The early days of social media platforms such as Friendster (launched in 2002 and closed in 2015), Facebook (launched in 2004) and Twitter (launched in 2006) allows users to post text and share messages with their friends and family. Reddit (launched in 2005), a discussion forum, allows users to have asynchronous online conversations around specific topics of interest. Nowadays, these platforms allowed posting of pictures, videos, and then live videos streaming. Different platforms dedicated themselves to focus on these specific forms of media. For example, Pinterest (launched in 2010) for pictures, Instagram (launched in 2010), Snapchat (launched in 2011) and TikTok (launched in 2017) for short videos.

Instagram, Facebook, YouTube and TikTok have long dominated social media playing field as the most popular platforms used by marketers to upload their video post [5]. According to Dr. James McQuivey of Forrester Research, a single minute of video content is equivalent to 1.8 million words. Users can learn better when they can both hear and see the information, so videos often translate better to the user's way of thinking. According to Wyzowl video marketing statistic 2023, 91% of marketing professionals use video as marketing tools and 96% of video marketers say video has directly helped increase sales. 71% of marketer created social media videos in 2022. 95% marketers say video marketing has help companies increase brand awareness and achieve positive return on investment (ROI) [3]. Sally Sargood, Animoto's Chief Video Officer, pointed out that in post pandemic era, companies have realized the value of using videos for connectivity aids in engaging their employees and consumers and most common types of videos made by companies were training videos [4]. Short-form videos, lasting one minute or ranging between two and five minutes, will continue grown because Gen Z and Millennial consumers prefer to learn new products and services through short and punchy videos [5], Therefore, companies are advised to transform their education or promotional product content into video formats to increase brand awareness.

3.2 QUALITY OF EXPERIENCE FOR VIDEO

3.2.1. QoS vs QoE

In the 1990s, user satisfaction with multimedia applications and services was mainly related to the concept of Quality of Service (QoS). The term QoS was first defined by the International Telecommunication Union (ITU) as the "*totality of characteristics of the telecommunication service that affects its ability to satisfy stated and implied needs of the user of the service*". In fact, technology-centric concept of QoS is mainly oriented to quantifying the performance of the network and the media involved.

QoS metrics such as video resolution, video content detail, video/audio synchronization, framerate, packet loss rate, packet delay rate purely used to indicate audio-video quality level from the system functioning point of view, these metrics poorly correlated with actual user satisfaction. QoS does not consider the interaction between technology and the user [1].

For these reasons, user-centric concepts of QoE start to emerge in recent years. The Qualinet white paper [10] defined QoE as "*the degree of delight or annoyance of the user's experience with an application or service. It results from the fulfilment of user expectations with respect to the utility and/or enjoyment of the application or service in light of the user's context, personality,*

and current state". The term QoE, sometimes known as quality of user experience.

The International Telecommunication Union (ITU) defined QoE as '*The general acceptability of an application or service, as subjectively perceived by the end user.'* QoE focuses on examining the point of view of the end user and how he perceives the value or quality of the service [1], [6], [11]. Table 1 presents a comparison between QoS and QoE.

Table 1: QoS vs QoE

	QoS	QoE
Origins	QoS was defined by the ITU in 1994.	QoE was defined by the QUALINET in 2013 and this definition has been adopted by ITU in 2016.
Definition	Technology-centric concept. Focus on the performance of applications and networks.	User-centric concepts. Focus on user's perception of quality on applications or service, not network performance.
Performance Measurement	How well does a service perform? Measured through application/service KPI (performance, responsiveness, and availability)	How well does the service quality meet user expectations? Measured through user factors, i.e., enjoyment, feelings, satisfaction, and perceived visual quality.
Performance measurement of video quality	Can the video be delivered to the end user flawlessly without any issues? Measured through video delivery quality.	Can viewers enjoy a consistent and high-quality experience without interruptions? Measured through users' viewing experience.

Video quality is the degree of excellence of audio-visual content that meets the user's expectations. Video provides a more personalized and engaging experience through visual and audio. Wistia (2020) pointed out that user engegement can be used to measure quality. Video QoE perceived by the user as the level of satisfaction that the user experienced the video content [12]. It is a measure of viewer's perceived improvement and degradation of the audio and video and viewer's satisfaction with the video experience.

Moldovan and Metzger (2017) claimed that managing QoE based on traffic analysis will become more difficult in the future since the encryption of Internet traffic progresses [9]. The growing demand for privacy has led video streaming service providers (i.e., Over-The-Top providers) to adopt end-to-end encryption to increase user privacy. For example, YouTube mobile transmissions are mostly encrypted, and it force-redirects most of its users to an HTTPs encrypted connection to their portal [13], [14], [15]. The changes in network architecture (protocols or techniques) and the diversity of system architecture among different service providers necessitate researchers to reengineer and retrain video QoE prediction models. QoE is a topic that researchers should study. QoE and QoS are highly interconnected to ensure the reliability of Quality Assessment (QA) that promises to provide QoS and improve the user QoE of videos on social media platforms.

3.2.2. Video QoE and Related Factors

Laiche *et al*. (2020) claimed that meeting user expectations requires understanding the factors that influence QoE and efficiently managing resources to optimize video quality. The video QoE on social media platform is not only influenced by the properties of the platform/system itself (system factors) but also by the post-context in which the experience is consumed (context factors), and by the current state of the user (user factors) [6], [1], [16], [17].

QoE is affected by user factors, context factors, and system factors. These three categories often overlap and together have a mutual impact on QoE. The system (technological) factors cover the technical aspects of an application or service. The system factors are composed of content related (e.g., color, texture, resolution, 2D/3D), media related (e.g., synchronization, sampling rate), network related (e.g., delay, bandwidth) and device related (e.g., privacy, security, personalization) properties. System factors can influence QoE in video delivery services by altering the perceptual quality of the video content. For example, degradation of video quality due to compression will decrease the user satisfaction level [18]. The context factors are related to the environment in which the video experience is consumed by the user. Context factors include temporal (e.g., time of day, usage frequency, duration), physical (e.g., noise, mobility, location), economic (e.g., cost, brand, payment model), and social (e.g., content popularity, service consumption) context. The user (human) factors refer to individual characteristics of who is viewing experience and expectations from video. The user factors compose of low-level sensorial processes (e.g.,

Table 2: Summary and examples of factors influencing video QoE

Categories		Examples/ typical QoE IFs
System IFs (Higher control-objective factor)	Content-related	Video Content type (e.g., news, movies, promotion, etc.), genres (e.g., comedy, education, spots, etc.), age of content, content reliability, spatial-temporal requirements, color depth, texture, 2D/3D/360-degree, etc.
	Media-related	Encoding, video resolution, sampling rate, frame rate, media synchronization, videos, audio bandwidth, etc.
	Network-related	Network transmission parameters (e.g., delay/latency, bandwidth, jitter, packet loss rate, error rate, throughput, average bit rate, buffering times), data cost, etc.
	Device-related	System specifications, user equipment specification (display size, display resolution, CPU, memory, device type, battery lifetime, user interface), provider specification & capability, server reliability and availability, security, privacy, easy to use and maintenance, etc.
Context IFs (Medium control-objective factor)	Physical	Location (home, office, outdoor), space, environment characteristics, seating position (viewing distance and viewing height), motion, noise/disturbances (incoming phone calls or SMS message alerts), lighting condition, velocity, etc.
	Temporal	Playing time, duration, usage frequency, time of day, etc.
	Economic	Brand, cost, subscription type, payment model, desired price, budget, etc.
	Social	Content popularity (view counts), users' preferences (like, dislikes, comments), service consumption (alone, group), etc.
	Task	Audio focus, video focus, interactivity, etc.
	Usage (Tech & Info)	Goal (task, enjoyment), attention (foreground, backgrounds), etc.
Human IFs (Lower control-subjective factor)	High-level / cognitive quality processing	Understanding (social-economic background, e.g., employment, education, income), interpretation (expectation, needs and goals, motivation, user engagement (view duration), evaluation (previous experience, knowledge, and skills), user interaction with the video player (e.g., number and duration of pauses), etc.
	Low-level / sensorial quality processing	Physical (User's visual and auditory acuity, age, gender), emotional (pressure, enjoyment, mood), mental states (attention level, worldview, values), color blindness, etc.

Table 3: Objective QoE assessment vs subjective QoE assessment

	Objective QoE Assessment	Subjective QoE Assessment
Definition	To predict/estimate quality through feature extraction and regression via automatic data processing of the content information without involve human judgement directly.	Subjective ratings are based on feedback of a user who has experienced digitized content through the device. User feedback on video quality, video streaming, and network services. To measure the video quality perceived by the Human Visual System (HVS).
Data collection Tools/ methodologies	Crowdsourcing frameworks are used to automatically capture QoS technical data, or cognitive systems, and human physiological tests. QoS/QoE measuring model is based on machine learning. E.g Support Vector Machines, Random Forest, Gradient Boosted Trees and Neural Networks, etc.	Interviews, questionnaire and complaint boxes, Crowdsourcing. Standardized methodologies to quantify the annoyance of visible artifacts and/or the perceived overall quality of a video. E.g. ITU-T P.910 Subjective video quality assessment methods for multimedia application.
Video quality assessment (VQA) Models/ methods	Full reference (FR), Reduced Reference (RR) No Reference (NR)/blind PSNR (picture), PESQ (voice), VQM (video), etc.	Absolute Category Rating (ACR), Degraded Category Rating (DCR/DSIS), Double-stimulus continuous quality scale (DSCQS), Single-stimulus continuous quality evaluation (SSCQE), Multimodal Interactive Continuous Scoring of Quality (MICSQ), etc.
Test score/ QoE Metrics	Predict the quality score (MOS) based on Interest rate (watch time and view count), Popularity (viewing/ view count), Engagement (watching/ play time, commenting, and sharing), prob. of return, abandonment rate, etc.	MOS/Differential Mean Opinion Score (DMOS) scores based on enjoyment, perceived visual quality, user satisfaction, user's level of information assimilation (IA), endurability (willing to repeat and share), boredom, OneClick, etc.
Advantages	- Generally cheaper and faster	- Most reliable way to determine quality, including expectations and feelings of the users. - More appropriate to reflect the influence of context and user factors on QoE.
Disadvantages	- Limitations in considering user and context factors to QoE. - Accuracy depends on whether the models are realistic enough to determine perceived quality. - Not easy to design an accurate prediction model because perceptual features are obtained based on different prior knowledge depending on the types of display and content.	- Expensive, time-consuming, and limited assessors. - Preparation of the test, the execution, and the analysis of the results are very tedious. - Users may experience fatigue while spending a lot of time in the evaluation process of massive contents

gender, age, personality, and mood) and high-level cognitive processing levels (e.g., preferences, expectation, education, and life stage) [1], [11], [19].

User perception is how user sensory experiences the object/world and make sense of it in user's brain. Perception is a largely cognitive and psychological process. The brain has to guess what a person sees based on previous experiences. QoE is decided by cognitive and psychological determinants such as feelings, habits, requirements, and expectations. Video QoE is perceived by the user as the level of satisfaction that the user experienced with the video content. Comprehending video quality and QoE from the user's perspective has become a key element in optimizing the user experience and their quality in video content, as well as helping to perceive the impression created in the user's mind. Mirkovic *et al*. (2014) claimed that lack of interest in the content could cause the user to abandon the video immediately [20].

System factors cannot adequately estimate user satisfaction [18]. Social context and user factors play major roles in determining video QoE. Laiche *et al*. (2020) stated that despite the impact of social media on the user and context factors remain largely unexplored in academia. This is because most existing QoE studies have primarily focused on system factors, and concentrating solely on these factors is not sufficient to accurately indicate perceived quality [17]. Authors identify system-related, user behavior-related and social context-related are three main categories of QoE influence factors to reflect users' perceived quality and selecting relevant QoE influencing factors is the first steps towards an accurate QoE prediction model [1].

3.2.3. QoE measurement approaches

QoE measurement approaches can be divided into three categories: objective, subjective and hybrid (combine both). Subjective assessment that involves human subjects are considered the most reliable way of quality estimation. Objective assessment uses analytical/statistical models to predict the quality. Although the accuracy of the objective methods being lesser than the subjective ones, they are preferred in many situations as they are automatic, cheaper, and faster to be carried out than the subjective assessment. Hybrid assessments are based on machine learning tools, and they are using subjective test scores as input to train a QoE model [21]. Table 3 presents a comparison between objective and subjective QoE assessment.

A lot of research use video quality assessment (VQA) methods to automatically measure the perceptual video quality in close agreement with the human visual judgment [22], [23], [24].

3.3 VIDEO QOE ON USER ENGAGEMENT IN SOCIAL MEDIA

Information overload is a 21st-century problem [25]. Hence, user attention has become a critical economic resource for decision-making. In 1971, Herb Simon (who would win the Nobel prize in economics in 1978) offered the insight that "a wealth of information creates a poverty of attention." Simon argued that overabundance of information flow can be governed by suitable artificial intelligence agents sure to be invented in the future. Dobrian *et al*. (2013) present a measurement study of the impact of video quality on user engagement [26]. They refer to Herbert Simon's articulation of attention economics, stating that the overabundance of video content increases the responsibility of content providers to maximize their ability to attract user attention. Thus, it becomes critical to systematically understand the interplay between video quality and user engagement. User engagement can be quantified in terms of total playtime and the number of videos viewed [17], [26], [27].

According to Wyzowl video marketing statistic 2023, more than 60% of video marketers agreed number of video views and level of audience engagement (likes, shares, comments) are metrics to measure ROI on their video content [3]. Pertaining to Media Richness Theory on work conducted by Wang and McCarthy (2020) found that posts with videos had a positive relationship with user engagement because video enhanced entertaining story and informative content. Videos post with high vividness able to obtain more engagement compare with text and image post [28]

Popularity and user engagement are two major aspects on video from social context [1]. Moldovan and Metzger (2017) had conducted research to measured correlation between user engagement and video QoE based on the duration of a user watching a specific video [29], [9], [17]. Their results show that there is a strong correlation between QoE and user engagement (watching, commenting, and sharing).

For online videos, the most studied attributed is the popularity dynamics, defined as number of

times they are viewed [7]. Wu (2019) divided online video behaviors into two classes: popularity (viewing) and engagement (watching, commenting, and sharing). The ability to predict the number of views of a given video can adjust the marketing efforts of the social media marketers that publish an advertisement in social media [30].

Stoddard's (2015) study suggests that popularity often indicates higher content quality and recommends users to submit YouTube videos more frequently due to the positive correlation between views and reposts, which helps popularize videos [31]. Social media platforms incorporate a rich-get-richer element in their design, where posts with more likes or retweets become more visible. However, according to HubSpot Global Social Marketing Trends, re-sharing the same content across platforms, known as cross-posting, may not be as effective in 2023 [32].

Watch time is one of the common social context factors to predict video QoE. Video quality is related to the audience's decision to continue watching a particular video (*avg_time_watched*) [30]. Zhu *et al*., (2020) stated that recently the high online video as well as the user behavior data (viewing time, return probability, etc.) make the data-driven video QoE assessment a new trend [22]. Unlike video assessment quality scores, viewing time, number of views and return probability become the video QoE measurements.

According to Laiche et al (2020) study, the higher the user engagement level (view count and longer watch time), the higher the video QoE. The higher the popularity level (no. of likes and comments) are, the higher the QoE MOS [17], [1]. The Mean Opinion Score (MOS) that is standardized in ITU-T is the most widely used indicator of Perceived Media Quality. Users will quickly abandon watching a video if the quality is not sufficient. Akamai (2020) claimed that video delivery performance directly impacts a viewer's perception and engagement with the brand, which directly impacts the video service provider's desired business outcome. Therefore, it is important for video content providers to improve UGC video quality for better user engagement [4].

4 GAPS IDENTIFIED AND POTENTIAL CONTRIBUTIONS

There are limitations in this research that leave room for further research. These research studies only cover QoE influence factors for videos on social media platforms, while it does not find out which is the best user acceptable video quality that will score higher engagement rate for different social media platforms.

Besides the need for powerful video assessment tools to predict and assess video quality, further research can focus on aspects such as texture, and facial features, particularly within the context of object recognition in video posts. Additionally, exploring the influence of celebrity endorsements, content creators or influencers in predicting user engagement on social media platforms remains in its infancy. These research areas merit more comprehensive exploration in future studies, taking into account the impacts of emerging technologies such as 360-degree video, 5G networks, virtual reality, and others on video QoE.

This paper makes the theoretical contribution by identifying the key influence factors of video QoE on social media and highlighting positive correlation between video QoE and user engagement. This study will serve as a foundation for further studies for those interested in finding out more about video QoE and user engagement in social media.

5 CONCLUSION

This paper aims to explore the key factors influencing video QoE on social media. Investigating video QoE is not a simple task, as it is affected by user, context, and system factors. The social context and user factors play a crucial role in anticipating users' QoE expectations. The findings from relevant studies indicate a positive correlation between video quality and user engagement. It can be concluded that Video QoE is a critical measure for ensuring quality services and user engagement in social media marketing, even with the emergence of fast-evolving new technologies. Gaining insights into video QoE for each social media platform empowers marketers to create effective marketing and advertising campaigns for their target audience interested in their brand.

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