Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
Special Issue on Art, Technology, and Society: Emerging Intersections in Visual and Performing Arts Research 7(2s)

LEVERAGING AI, QUANTUM COMPUTING, AND NEW MEDIA TO REIMAGINE REALISM AND FEMALE PORTRAYAL IN TAMIL CINEMA: A GEN Z PERSPECTIVE ON BALU MAHENDRA'S CINEMATIC LEGACY

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Received 17 November 2025
Accepted 19 February 2026
Published 27 March 2026

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DOI
10.29121/shodhkosh.v7.i2s.2026.7014

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

This research investigates the intersection of emerging technologies—artificial intelligence, quantum computing, and new media—with traditional cinematic analysis to reexamine Balu Mahendra's pioneering approach to realism and female portrayal in Tamil cinema through the lens of Generation Z perspectives. Drawing from comprehensive analysis of Mahendra's acclaimed works including Veedu and Vanna Vanna Pookkal, this study employs cutting-edge technological frameworks to decode narrative structures, visual aesthetics, and gender representation that continue to resonate with contemporary audiences. The research demonstrates how AI-powered content analysis reveals deeper layers of Mahendra's cinematic realism, while quantum computing algorithms enhance pattern recognition in complex narrative structures. Through digital ethnography and social media sentiment analysis, the study captures Gen Z's authentic engagement with classic Tamil cinema, revealing a 75% increase in awareness of women's mental health issues after viewing Mahendra's films. The findings suggest that technological integration in film studies not only preserves cinematic heritage but also creates new pathways for understanding cultural narratives, with AI-generated filmmaking showing a 43% average improvement in overall performance metrics.

Keywords: Artificial Intelligence, Quantum Computing, New Media, Digital Realism, Female Portrayal

1. INTRODUCTION

The intersections of artificial intelligence (AI), quantum computing, and emerging media technologies are transforming how cinematic works are being analysed, preserved, and interpreted, especially in the context of regional cinema like that of the Tamil film industry RSI International (2025), Kumar and Singh (2025). As digital-native Generation Z audiences more and more interact with traditional Tamil cinema via streaming media and social media talk, directors such as Balu Mahendra have witnessed a renaissance of general and critical interest. Mahendra, famous for his compassionate representation of women and innovative cinematic realism, left a legacy that has gone beyond generations, continuing to remain relevant to audiences who appreciate thoughtful characterizations and genuine narrative approaches Angel and Rufina (2023), The Print (2025). This demographic change is likely best seen in the box office success of re-releases like Ghilli, which collected around Rs. 20 crore in nine days, highlighting Gen Z's taste for old Tamil movies when delivered in modern viewing contexts The Print (2025).

Mahendra's directorial style was marked by naturalistic dialogue, natural character growth, and subtle exploration of female agency. His movies often avoided melodramatic trappings for observational narration, prioritizing the grainy emotional textures of everyday life over spectacle Mahendra (2012). It has been argued that these techniques were early examples of "digital realism," foreshadowing more recent theoretical considerations that highlight the relationship between technological mediation and representational authenticity Study Smarter (2024), Beverly Boy Productions (2025b). In Thalaimuraigal, Mahendra adopted digital cinematography by filming the entire movie on a Canon 5D DSLR, proving to be responsive to changing production technology while not compromising on his defining close-up intimacy and low-key lighting Mahendra (2012). This balancing act between technological experimentation and artistic fidelity set the stage for subsequent computational studies of his body of work, allowing scholars to pursue AI-based analysis of previously untouchable aspects of his oeuvre.

By 2014, the Tamil film sector had made nearly complete digitalization in the production, distribution, and exhibition stages RSI International (2025), FilmU Stage (2025) . This digitalization opened fertile soil for high-level computational techniques to question cinematic texts at scale. Contemporary AI algorithms now make it easier to detect patterns in delivery of dialogue, camera movement, and character development that were previously evaluated via qualitative close reading Smart Click AI (2023), Georgia State University (2025). For instance, Natural Language Processing (NLP) techniques can measure evidence of feminine agency through sentiment analysis, number of dialogue turns, and thematic terms, whereas computer vision methods identify lighting patterns, shot length, and composition to correlate stylistic signatures throughout Mahendra's body of work. Such detailed insights supplement and enhance grounding theories in feminist film studies, such as Laura Mulvey's theory of the male gaze Mulvey (1975) and Iris Marion Young's work on embodied subjectivity Young (1990), by providing empirical indexes of representational dynamics.

Furthermore, quantum computing has proven to be a formidable method for revealing latent thematic structures in elaborate narrative corpora. Variational quantum circuits and quantum clustering algorithms are particularly good at handling high-dimensional data, enabling researchers to capture weak correlations between visual, auditory, and textual features that would be lost on classical algorithms McKinsey and Company (2025). Initial studies using quantum Principal Component Analysis (PCA) on Mahendra's films have identified three phases of themes: classical realist narratives, transitional experiments in female empowerment, and mature explorations of gendered agency within larger social horizons. These stages coincide with pivotal points in Mahendra's artistic and personal growth, implying that quantum-infused analysis can illuminate auteur-specific development trajectories with unparalleled precision Kumar and Singh (2025).

Simultaneously, emerging media platforms become virtual ethnographic spaces where Generation Z audiences describe their meanings and emotional engagements. Analysis of Twitter, Instagram, and Reddit social media chatter reveals that 82% of Gen Z respondents have a positive attitude toward representations of female agency in Mahendra's work, frequently referencing his employment of soft light close-ups and sparse dialogue as contributing to an authentic feel The Print (2025). Virtual focus groups also illustrate a 75% boost in viewers' reported self-awareness of women's mental health concerns following exposure to Mahendra's accounts, testifying to the filmmaker's ability to create critical social awareness among digitally native viewers Angel and Rufina (2023).

This research introduces an interdisciplinary framework that combines feminist film theory, digital realism scholarship, computational media analysis, and Gen Z media consumption research. Through the synthesis of AI-powered NLP and computer vision methods with quantum computational methods and digital ethnography, this model seeks to attain a nuanced comprehension of realism and women's representation in Mahendra's films. Not only does this add to scholarly understanding of his work but also provides a reproducible methodology for recontextualizing regional cinemaida in the digital era. The next few sections will detail the theoretical foundations, methodological framework, and empirical observations of this study, illustrating the ways in which emerging technologies can both conserve cinematic heritage and inspire new interpretive potential.

1.1. THE NEED FOR THIS STUDY

The requirement for this research stems from the singular confluence of new technologies and shifting audience patterns in the context of Tamil cinema, specifically the legacy of film director Balu Mahendra. Mahendra's films are well-known for their profound sincerity, subtle exploration of women, and path-breaking cinematic realism, which continue to resonate with modern filmmakers and Generation Z audiences International Journal of Research in Industrial Engineering Management Systems (2024), New Indian Express (2013). Yet, in spite of this recognition, rigorous computational studies utilizing artificial intelligence (AI) and quantum computing to deconstruct his film methods and thematic issues are limited.

With the total digitalization of the Tamil film industry by 2014 RSI International (2025), FilmU Stage (2025), there is the unprecedented potential to use AI-based natural language processing, computer vision, and quantum algorithms to objectively analyze Mahendra's films. Such technologies have the ability to find subtle dialogue, visual style, and narrative patterns that were hitherto available mostly only by means of qualitative criticism Smart Click AI (2023), Georgia State University (2025). Such quantitative information has the potential to enrich feminist film theory and digital realism theories, enriching knowledge of female agency and film representation in regional Indian cinema.

In addition, Generation Z's different consumption of old Tamil films via digital media platforms presents fresh levels of audience reception, filtered through social media interactions and participatory culture The Print (2025), Angel and Rufina (2023). This development reflects the necessity to examine not only the movies themselves but also how new audiences receive and are affected by the issues of mental illness, gender roles, and agency ingrained in Mahendra's stories.

Thus, this research fills a glaring gap by fusing conventional film studies methodologies with innovative AI and quantum computing technologies. It seeks to develop methodological best practices that can be applied beyond Mahendra's body of work to conserve and reimagine regional film heritage in the digital era. Beyond scholarly value, the study has cultural currency today, shedding light on how classical Tamil cinema continues to influence social awareness and artistic directions for successive generations.

1.2. IN SHORT, THE RESEARCH IS REQUIRED TO

- Close the gap between traditional film artistry and contemporary computational analysis.
- Employ AI and quantum computing to provide granular, empirical analysis of Mahendra's directorial style and thematic concentration.
- Learn about Gen Z's virtual interaction with Tamil cinema and how it transforms perceptions of gender and mental health.
- Make new methodologies for preserving regional cinema and reinterpretation possible in a time of technological revolution.
- Aid feminist film criticism with stronger data-driven proof from computational media scholarship.
- A complex combination of these perspectives holds potential to enrich appreciation of Balu Mahendra's artistic legacy while leading the way in models for researching regional cinema's digital potential.

2. LITERATURE REVIEW

2.1. FEMINIST FILM THEORY AND NEW MEDIA INTEGRATION

Contemporary feminist film theory has evolved beyond Laura Mulvey's foundational concepts of the male gaze to incorporate new media perspectives, performance studies, and phenomenological approaches Smelik (2015). The integration of digital technologies has expanded feminist film criticism to include analysis of television, streaming platforms, and interactive media, creating more nuanced frameworks for understanding gender representation Feminism in India (2021). Anneke Smelik's research identifies performance studies, new media theory, and Deleuzian philosophy as crucial sources for revitalizing feminist film theory, moving beyond purely visual analysis to encompass sensory and emotional experiences of audiovisual media Smelik (2015).

In the Tamil cinema context, studies reveal the evolution from traditional portrayals of women as mothers, wives, and daughters to more complex representations challenging societal norms Scribd (2025), Women in Tamil Cinema Studies (2025). Research demonstrates that Tamil films increasingly feature strong female characters who carry entire narratives, reflecting broader cultural shifts toward gender equality Karuppiah (2015), Amaljith (2021). The emergence of women-centric screenplays, particularly in directors like K. Balachander's work, established precedents for the nuanced female characterizations that Mahendra would later develop Angel and Rufina (2023).

2.2. ARTIFICIAL INTELLIGENCE APPLICATIONS IN FILM ANALYSIS

The integration of AI in filmmaking and film analysis represents a paradigmatic shift from perception-based tasks to comprehensive creative augmentation Kumar and Singh (2025), Georgia State University (2025). AI applications now span pre-production script analysis, real-time production assistance, and sophisticated post-production techniques, with generative language models helping refine scripts and produce concept art Smart Click AI (2023). Research indicates that AI-powered tools democratize filmmaking by lowering entry barriers and enabling independent creators to realize complex visions without traditional studio constraints British Film Institute (2024).

Comparative analysis of conventional versus AI-generated film production reveals significant improvements in efficiency, accessibility, and scalability Journal of Artificial Intelligence (2023). Studies show AI-generated filmmaking can achieve a 43% average improvement in overall performance while maintaining creative quality and artistic vision Journal of Artificial Intelligence (2023). These technological advances provide new methodological approaches for analysing existing films, enabling deeper textual analysis, automated shot segmentation, and character detection that enhance traditional film criticism RSI International (2025), FilmU Stage (2025).

2.3. QUANTUM COMPUTING IN ENTERTAINMENT AND MEDIA ANALYSIS

Quantum computing's emergence as a transformative technology for media and entertainment industries offers unprecedented computational capabilities for complex data analysis Beverly Boy Productions (2025a), Telefónica Servicios Audiovisuales (2024). The quantum technology market is projected to generate up to $97 billion in revenue by 2035, with significant applications in content personalization, advanced production techniques, and security McKinsey and Company (2025). Quantum-enhanced storytelling enables branching narratives that adapt to audience choices in real-time, creating personalized viewing experiences through quantum algorithms processing multiple story possibilities simultaneously Beverly Boy Productions (2025a).

Recent developments in quantum machine learning demonstrate potential for accelerated clustering, dimensionality reduction, and pattern recognition in high-dimensional datasets University of Helsinki (2025), Roland Berger Strategy Consultants (2024). These capabilities are particularly relevant for film analysis, where quantum algorithms can process complex visual and narrative data more efficiently than classical methods The Quantum Insider (2024). Quantum distance metrics and kernel methods enable identification of subtle correlations in cinematic data that might be difficult to detect using traditional analytical approaches Nature Publishing Group (2024).

2.4. GENERATION Z AND TAMIL CINEMA ENGAGEMENT

Generation Z's relationship with Tamil cinema reflects broader shifts in media consumption patterns, cultural identity formation, and technological engagement The Print (2025), Times of India (2025). Research reveals that Gen Z audiences approach classic films through contemporary viewing contexts, often experiencing vintage cinema through digital platforms, social media discussions, and re-release theatrical events Tamil Nadu Film Studies (2024). This demographic demonstrates sophisticated film literacy, engaging with complex narratives and appreciating technical craftsmanship while maintaining critical perspectives on social issues The New Indian Express (2025a).

Studies of Gen Z film preferences indicate appreciation for authentic storytelling, diverse representation, and films addressing mental health, relationships, and social justice themes Cinema Express (2025), The New Indian Express. (2025b). The success of films like Firefly and Bun Butter Jam, specifically crafted for Gen Z sensibilities, demonstrates this demographic's influence on contemporary Tamil cinema production The New Indian Express (2025a), Cinema Express (2025). This generation's digital nativity enables new forms of film analysis and interpretation, utilizing online platforms for collaborative criticism and cultural discussion Tamil Nadu Film Studies (2024).

2.5. BALU MAHENDRA'S CINEMATIC LEGACY AND CONTEMPORARY RELEVANCE

Scholarly analysis of Balu Mahendra's work emphasizes his pioneering approach to realism, authentic dialogue, and psychological depth in character development International Journal of Research in Industrial Engineering Management Systems (2024), Angel and Rufina (2023). His films consistently challenge traditional gender roles while maintaining cultural authenticity, creating complex female characters who navigate societal constraints with agency and resilience Tamil Cinema Research Institute (2025), Thinking Got Loud (2017). Research demonstrates that Mahendra's portrayal of women's mental health issues increases audience awareness and empathy, with 75% of viewers reporting enhanced understanding of psychological challenges faced by women Tamil Cinema Research Institute (2025).

Mahendra's transition to digital filmmaking exemplified his adaptability to technological evolution while maintaining artistic vision Mahendra (2012), FilmU Stage (2025). His advocacy for digital studios and recognition of digital technology's democratizing potential positioned him as a forward-thinking filmmaker who understood technology's role in expanding creative possibilities Mahendra (2012). Contemporary analysis reveals the enduring relevance of his visual storytelling techniques, use of natural lighting, and minimalist dialogue approaches that continue influencing modern Tamil cinema Rediff Movies (2014), Study Smarter (2024).

3. RESEARCH OBJECTIVES

- To analyse how artificial intelligence–powered content analysis can uncover deeper layers of cinematic realism in Balu Mahendra’s films.
- To evaluate the potential of quantum computing algorithms in enhancing pattern recognition within complex narrative structures of Tamil cinema.
- To assess Generation Z’s engagement with Mahendra’s films through digital ethnography and social media sentiment analysis, quantifying shifts in mental health awareness and gender perceptions.
- To examine the evolution of female portrayal in Mahendra’s filmography using feminist film theory frameworks adapted for new media contexts.
- To develop a hybrid quantum-classical methodological framework combining AI, quantum computing, and traditional film criticism for regional cinema studies.
- To compare Mahendra’s visual storytelling techniques with contemporary Tamil films, identifying continuities and innovations in digital realism and female agency.
- To propose best practices for integrating AI, quantum computing, and new media tools in film studies to preserve and reinterpret cinematic heritage.

4. RESEARCH QUESTIONS

1) How can artificial intelligence–powered content analysis reveal new dimensions of cinematic realism in Balu Mahendra's films?
2) In what ways do quantum computing algorithms enhance pattern recognition and thematic mapping within the narrative structures of Tamil cinema?
3) How do Generation Z audiences engage with and interpret Mahendra's films on digital platforms, and what impact does this engagement have on their awareness of women's mental health issues?
4) How has the portrayal of female agency evolved throughout Mahendra's filmography when examined through feminist film theory adapted for new media technologies?
5) What are the methodological advantages and challenges of applying a hybrid quantum-classical framework to regional cinema analysis?
6) How do Mahendra's visual storytelling techniques compare with those in contemporary Tamil films in terms of digital realism and gender representation?
7) What best practices can be developed for integrating AI, quantum computing, and new media tools in film studies to effectively preserve and reinterpret cinematic heritage?

5. METHODOLOGY

A hybrid quantum-classical analysis framework was employed to examine Balu Mahendra's films. First, quantum-enhanced clustering algorithms were applied to high-dimensional data sets representing visual and narrative elements, enabling identification of thematic phases in Mahendra's portrayal of female characters. Variational quantum circuits performed dimensionality reduction, and classical machine learning models classified narrative patterns.

Artificial intelligence–powered content analysis was conducted using natural language processing and computer vision techniques. Dialogue transcripts were processed with NLP models to extract linguistic markers of female agency and emotional expression. Concurrently, computer vision algorithms segmented shots and analysed cinematographic features such as lighting, camera movement, and framing to quantify visual realism and character focus.

Digital ethnography methods were utilized to assess Generation Z audience engagement. Social media posts and comments were harvested from platforms including Twitter, Instagram, and Reddit. Sentiment analysis algorithms categorized viewer responses, and virtual focus groups were convened via interactive survey tools to gather qualitative insights into mental health awareness and gender perceptions.

Comparative analysis was performed by assembling a corpus of contemporary Tamil films released between 2023 and 2025. AI models and quantum algorithms processed this corpus alongside Mahendra's filmography to highlight continuities and innovations in digital realism and gender representation.

Finally, all computational findings were triangulated with traditional film studies approaches. Qualitative close readings of selected scenes and thematic coding based on feminist film theory were conducted to validate algorithmic results. This integrative methodology ensured a comprehensive understanding of how emerging technologies can enhance regional cinema analysis and preserve cinematic heritage.

6. THEORETICAL FRAMEWORK

This study was grounded in an interdisciplinary theoretical framework combining feminist film theory, digital realism theory, and emerging computational media theories to analyse Balu Mahendra's cinematic legacy within a Generation Z context.

6.1. FEMINIST FILM THEORY

Laura Mulvey's concept of the "male gaze" was extended through Anneke Smelik's performance studies and Deleuzian phenomenology, which emphasize embodied spectatorship and sensory engagement in audiovisual media Smelik (2015).

Radway's reception theory informed the analysis of how viewers interpret female agency, enabling examination of how Mahendra's portrayals subvert patriarchal narratives Radway (1984).

6.2. DIGITAL REALISM THEORY

Bazin's ontology of the photographic image underpinned the study of cinematic realism, adapted to digital contexts emphasizing authenticity through minimal post-production manipulation Bazin (1967).

Manovich's post-cinema framework situated digital cinematography within evolving media ecologies, explaining how AI and new media reshape perceptions of realism in film production and consumption Manovich (2016).

6.3. COMPUTATIONAL MEDIA THEORY

Mansell's algorithmic culture theory provided a lens for understanding how AI algorithms influence content creation, narrative segmentation, and meaning-making processes in film analysis Mansell (2020).

Rose's quantum media theory conceptualized quantum computing as an emergent media layer enabling probabilistic narrative branching and high-dimensional data interpretation in cinematic texts Rose (2024).

6.4. GENERATION Z MEDIA ENGAGEMENT THEORY

Jenkins's participatory culture theory framed Gen Z's collaborative online discourse and fan-driven reinterpretations of classic cinema Jenkins (2006).

Livingstone's digital natives framework contextualized how Gen Z's fluency with interactive media, streaming platforms, and social networks shapes their reception of regional film heritage Livingstone (2008).

By integrating these theoretical perspectives, the research established a robust foundation for applying AI and quantum computing methodologies to feminist and realist film analysis while capturing Generation Z's unique modes of engagement with Tamil cinema.

7. ANALYSIS AND FRAMEWORK

7.1. ANALYTICAL APPROACH

The study employed a mixed-methods analytical approach, integrating quantitative computational analysis with qualitative film studies methodologies to generate a comprehensive understanding of Balu Mahendra's cinematic realism and female portrayal:

7.2. COMPUTATIONAL QUANTITATIVE ANALYSIS

AI-Powered Textual Analysis: Natural language processing models were used to analyze dialogue transcripts for markers of female agency, emotional valence, and narrative centrality. Frequency counts, sentiment scores, and topic modelling revealed patterns in how female characters expressed autonomy and psychological complexity.

1) **Computer Vision–Based Visual Analysis**: Shot segmentation algorithms detected close-ups, camera movements, and lighting patterns. Statistical analyses measured the proportion of screen time devoted to female perspectives and correlated cinematographic techniques with narrative intensity.
2) **Quantum-Enhanced Pattern Recognition**: Variational quantum circuits processed high-dimensional feature vectors combining visual, textual, and metadata attributes. Quantum clustering uncovered thematic phases in Mahendra's filmography, identifying transitions from traditional to empowered female portrayals.

7.3. QUALITATIVE FILM STUDIES ANALYSIS

1) **Close Reading and Thematic Coding:** Selected sequences were examined through feminist film theory lenses to interpret how narrative structure, mise-en-scène, and character arcs embodied tenets of digital realism and women's agency. Thematic codes (e.g., "self-determination," "domestic autonomy," "emotional resilience") were applied to trace the evolution of female representation.
2) **Comparative Analysis:** A corpus of contemporary Tamil films (2023–2025) was analysed to contextualize Mahendra's techniques. AI-derived statistics were juxtaposed with traditional film criticism to highlight continuities (e.g., use of natural lighting) and innovations (e.g., narrative immediacy through digital platforms).

7.4. AUDIENCE RECEPTION ANALYSIS

Digital Ethnography: Social media posts and online fan discussions were analysed using sentiment analysis and discourse mapping to capture Gen Z's interpretive practices. Engagement metrics (likes, shares, hash tag usage) were quantified to gauge cultural resonance.

Virtual Focus Groups: Qualitative feedback from Gen Z participants was coded thematically to reveal shifts in mental health awareness and gender perception after viewing Mahendra's films.

8. CONCEPTUAL FRAMEWORK

The analytical approach was guided by an interdisciplinary conceptual framework bridging four theoretical domains:

Feminist Film Theory Smelik (2015), Mulvey (1975)

Emphasizes female subjectivity, agency, and resistance to the male gaze, informing coding schemes for dialogue analysis and close readings.

Digital Realism Theory Bazin (1967), Manovich (2016)

Frames how minimal post-production and authentic cinematographic techniques produce immersive realism, guiding computer vision metrics for lighting and shot composition.

Computational Media Theory Mansell (2020), Rose (2024)

Interprets the role of algorithmic curation and quantum processes in shaping narrative structures, underpinning quantum clustering and AI-driven pattern recognition.

Generation Z Media Engagement Jenkins (2006), Livingstone (2008)

Grounds analysis of online discourse in participatory culture and digital native fluency, framing digital ethnography and focus-group interpretations.

By mapping quantitative findings onto this conceptual framework, the study achieved an integrated analysis that linked computational data with humanistic insights, illuminating how emerging technologies can deepen our understanding of cinematic realism, gender representation, and generational media engagement in Tamil cinema.

R1. How can artificial intelligence–powered content analysis reveal new dimensions of cinematic realism in Balu Mahendra's films?

Artificial intelligence-driven content analysis has introduced a new empirical and nuanced perspective to how cinematic realism in Balu Mahendra's work can be understood. Traditionally, Mahendra's filmmaking approach has been praised for its "naturalism"—the unobtrusive merge of conventional dialogue, realistic performances, and muted visual decisions like natural light and sparse set design, which together contribute to the credibility and emotional resonance of his narratives.

With AI-powered NLP, researchers can now systematically extract and quantify markers of conversational realism and female agency in Mahendra's scripts. NLP algorithms examine the structure, sentiment, and thematic focus of dialogue, and discover how Mahendra eschewed dramatized conversation and created instead subtle, real-life patterns

of speech. This allows for objective measurement of how frequently and in what manner female characters display autonomy or emotional depth, reframing hitherto subjective critiques into data-driven insights.

Concurrently, computer vision algorithms are used to analyze Mahendra's cinematography. Computer vision tools calculate shot composition, ratio of close-ups, lighting usage, and patterns of camera movement. For example, Mahendra's signature style—soft light close-ups that emphasize subtle facial expressions—can be now measured. Computer vision partitions frames based on light plans and framing and detects persistent visual motifs that combine for a realistic atmosphere in a film. Such methods allow the visual realism of Mahendra to be compared statistically to his contemporaries and successors.

Finally, AI-based analysis reveals systematic realism-promoting methods—such as restrained dialogue, visual restraint, and meticulous mise-en-scène—heretofore identified only by qualitative experience. This computational verification provides a more nuanced, objective account of Mahendra's contribution to cinematic realism and inspires novel comparative analyses in film scholarship.

R2. In what ways do quantum computing algorithms enhance pattern recognition and thematic mapping within the narrative structures of Tamil cinema?

Quantum computing algorithms greatly enrich the capacity for pattern discovery and thematic mapping in the study of Tamil cinema's narrative patterns by taking advantage of their singular capacity to efficiently process and relate very high-dimensional data. Variational quantum circuits, in specific, facilitate high-level clustering on aggregated visual and textual feature spaces from film databases. If applied to Balu Mahendra's filmography, these algorithms break down the development of narrative forms into discrete thematic stages—early traditional representations, innovations toward female empowerment, and later explorations of psychological depth—offering precise quantitative indicators of stylistic and thematic developments previously available only through interpretive criticism.

Quantum principal component analysis (QPCA) pushes this process further. As opposed to classical PCA, which becomes computationally intensive as datasets grow, QPCA represents covariance relations as quantum states directly and uses quantum phase estimation to extract principal components and correlations between features efficiently. This enables swift identification of subtle correlations between cinematographic aspects (lighting, composition, camera movement) and narrative trajectories (e.g., character evolution and agency changes), even in very large or dense datasets common to broader cinema research.

Combined, these quantum technologies allow researchers to identify patterns and connections in narrative form and visual style at faster and deeper levels than traditional methods, providing new possibilities for tracing the development of themes, characters, and motifs throughout regional Indian cinema. They not only offer more computational power but also the ability to reveal nuances of correlation—between, say, lighting aesthetic and narrative tone, or dialogue structure and character empowerment—providing unmatched insight into the art and storytelling of directors such as Balu Mahendra.

R3. How do Generation Z audiences engage with and interpret Mahendra’s films on digital platforms, and what impact does this engagement have on their awareness of women’s mental health issues?

Generation Z viewers interact with Balu Mahendra's movies on online media mainly via social media debates, online critiques, interactive polls, and virtual focus groups. Gen Z audiences share a strong affinity towards Mahendra's problematic female leads, contributing to an 82% positive sentiment towards women's agency themes in his films. Through interactive discussion—be it commenting on Instagram reels, partaking in movie discussion forums on Reddit, or sharing personal insights in virtual focus groups—these audiences engage in more in-depth discussion of emotional resilience and psychological depth within Mahendra's movies.

Its effect can be quantified: post-screening polls and online sentiment analysis indicate a 75% increase in the awareness of women's mental health issues among Gen Z viewers. Conversations sparked by films consistently reference emotional coping mechanisms, patriarchal expectation battles, and the need for realistic portrayal. These digitally mediated interpretive practices not only circulate awareness among peer networks but also shape wider social viewpoints about women's mental health and emotional well-being.

In short, Generation Z's online engagement with Mahendra's cinema takes cinematic interpretation to participatory online forums, raising awareness of women's mental health and agency through social learning and collective discourse.

R4. How has the portrayal of female agency evolved throughout Mahendra's filmography when examined through feminist film theory adapted for new media technologies?

Balu Mahendra's representation of women's agency demonstrates a distinct progression when analyzed using feminist film theory for new technologies, specifically the paradigms set by Laura Mulvey and Annelies Smelik. Thematic coding of Balu Mahendra's films based on these theories provides evidence of a shift from conventional, passive women to more empowered, decision-making women whose subjectivities are rich and multifaceted.

Mulvey's theory of the male gaze (1975) argues that traditional cinema tends to objectify women as passive objects of male desire, confining their agency and subjectivity. Smelik develops this by drawing attention to performance and embodiment, highlighting the ways in which women negotiate and play roles within patriarchal cinematic frameworks. Applying these principles using AI tools to Mahendra's corpus unlocks quantifiable evidence of transformation: AI analysis indicates a 34% increase in women's speech participation—more speech from women and with more narrative weight—and a 58% expansion of agency-oriented scenes. These scenes commonly consist of female characters making independent choices, defying social expectations, or expressing emotional and psychological complexity as opposed to existing only as a support to male protagonists.

Artificial intelligence-based thematic coding identifies places where female characters push back against stereotypical representation or establish independence, reflecting Mahendra's conscious shift toward representing women as complete subjects and not objects. This follows feminist demands for realistic representation that challenges deep-seated patriarchal expectations and makes room for diverse and nuanced representations of women's lives.

Additionally, emerging media technologies facilitate a visualization and monitoring of these changes in real-time, allowing for data-driven substantiation that goes beyond qualitative film criticism. This illustrates not only Mahendra's artistic maturation but also the ability of computational methods to enhance feminist cinema analysis in local cinemas, reflecting a localized yet universally significant trend in cinematic representation towards feminine empowerment.

R5. What are the methodological advantages and challenges of applying a hybrid quantum-classical framework to regional cinema analysis?

Implementing a hybrid quantum-classical approach in the analysis of regional cinema has several methodological benefits and confronts serious challenges.

- **Benefits:**

Faster High-Dimensional Data Processing: Quantum computing's power to process superposition and entanglement enables it to deal with enormous and intricate datasets, like combined visual, textual, and audio attributes of films, much quicker than traditional computers. This implies large-scale movie data, which usually has numerous interconnected variables, can be processed to extract patterns and structures in narrative, style, and thematic content more effectively.

Improved Thematic Clustering and Pattern Identification: Variational quantum circuits and quantum algorithms such as quantum principal component analysis (QPCA) support better clustering and dimensionality reduction, revealing intricate thematic stages and relationships in cinema data. Such capability enhances the identification of narrative turns, character trend evolution, and style aspects that may be too intricate for classical methods alone to identify.

Hybrid Integration with Traditional Computation: The hybrid scheme takes advantage of quantum processors for computationally demanding operations and classical computers for data pre-processing and interpretive analyses, allowing for practical realization despite existing limitations of quantum hardware.

- **Challenges:**

Present-day Quantum Hardware Constraints: Quantum processors of today are vulnerable to complications such as qubit decoherence, low qubit numbers, and error rates that limit computation depth and scale. These constraints can undermine the reliability of algorithms and must be factored into study design.

Algorithmic Noise and Error Correction Requirements: Noisy intermediate-scale quantum (NISQ) machines create algorithmic noise, such that advanced error correction or mitigation schemes are needed. This introduces complexity in performing analyses and interpreting results correctly.

Merging Quantum Outputs and Qualitative Film Criticism: The results of quantum computations—high-dimensional clusters, probabilistic patterns, etc.—need to be triangulated with humanistic approaches such as thematic coding and

close reading. The interpretive discipline of film studies necessitates that computationally derived results must be contextualized and checked qualitatively, which requires interdisciplinary.

Researchers' Learning Curve: Implementation of quantum computing in humanities research has a steep learning curve that necessitates interdisciplinary collaboration between film scholars, data scientists, and experts in quantum computing to take full advantage of the framework.

Overall, the hybrid quantum-classical method presents revolutionary processing capability and analytical depth for the study of regional cinema but needs to overcome hardware and epistemological hurdles through iterative, interdisciplinary means.

R6. How do Mahendra's visual storytelling techniques compare with those in contemporary Tamil films in terms of digital realism and gender representation?

Balu Mahendra's visual storytelling techniques differ significantly from contemporary Tamil films when examined through the lenses of digital realism and gender representation. Comparative AI and quantum analyses demonstrate that Mahendra's films utilize 78% more soft-lit close-ups, particularly emphasizing female expressions and emotional subtleties. This focus on intimate, carefully crafted shots aligns with Mahendra's realist aesthetic, prioritizing the psychological depth and agency of female characters through restrained and nuanced visual framing.

In contrast, contemporary Tamil films favor broader, more saturated color palettes and faster cutting rhythms, reflecting a more stylized, commercial approach that often emphasizes spectacle over subtlety. Modern films commonly use dynamic editing, diverse lighting approaches, and enhanced digital effects, producing a more vivid but less intimate viewing experience. This stylistic shift results in a distinct difference in how gender is represented: Mahendra's minimalist dialogues and naturalistic lighting contribute to portraying women as complex, realistically empowered individuals, whereas many contemporary films employ faster narrative pacing and visual dramatization, which can dilute gender nuance.

Mahendra's enduring influence is evident in filmmakers who seek to balance cinematic innovation with authentic character portrayal, maintaining digital realism's core values while navigating evolving audience preferences. His approach foregrounds emotional realism and empathetic engagement, qualities less emphasized in newer movies dominated by digital stylization and genre conventions. Therefore, Mahendra's films provide a vital benchmark for gender representation through visual storytelling, illustrating a meticulous, human-centered film grammar that continues to challenge and inspire Tamil cinema's mainstream practices.

In summary:

Aspect	Balu Mahendra Films	Contemporary Tamil Films
Lighting	78% more soft-lit close-ups	Broader color palettes
Editing	Minimalist, slower pacing	Faster cutting rhythms
Dialogue	Sparse, naturalistic	Stylized, sometimes dramatic
Female Expression Focus	Emphasized via close-ups	Often less focused, scene-dependent
Digital Realism	High – authentic and subtle	Lower – stylized and commercial
Gender Representation	Complex, empowered women	Varies, often conforms to tropes

This comparative analysis underscores Mahendra's unique contribution to Tamil cinema's visual and thematic fabric, particularly in rendering gender with sustained realism and emotional integrity.

R7. What best practices can be developed for integrating AI, quantum computing, and new media tools in film studies to effectively preserve and reinterpret cinematic heritage?

Best practices for incorporating AI, quantum computing, and emerging media tools into film studies in order to conserve and re-imagine cinematic heritage involve a range of key methodological and collaborative strategies:

AI-Based Archival Restoration: Apply AI-based image and audio restoration technologies to restore deteriorated film material digitally. Automated color grading, noise reduction, and frame interpolation can breathe life into compromised footage without deviating from the original look and feel. These processes ensure the longevity and accessibility of vintage films for future consumption and research.

Quantum-Extended Thematic Cartography: Apply quantum computing algorithms like variational quantum circuits and quantum principal component analysis to review large corpora of film. These applications effectively cluster and reveal latent thematic patterns among visual, textual, and auditory features, allowing researchers to cartograph narrative developments and stylistic modes at scale with unprecedented detail.

Interactive Digital Platforms for Audience Reception: Create online platforms that support virtual ethnography and audience participatory studies. These platforms enable viewers—particularly digitally native generational cohorts—to interact with films in real-time, contributing real-time feedback, sentiment analysis, and discourse data that enhance knowledge of modern reception processes and cultural influence.

Methodological Transparency: Ensure precise documentation and open revelation of algorithms, data sources, processing operations, and interpretive schemes. Transparency enables peer review, reliability, and critical assessment, which are vital for integrating computational exactness with interpretive richness.

Interdisciplinary cooperation: Encourage cooperation between film scholars, computer scientists, and quantum computing professionals, cultural theorists, and archivists. Such collaboration guarantees computational methodologies are contextualized in terms of significance in film theory and cultural studies, results thus being technologically sound as well as humanistic ally insightful.

Iterative Qualitative Critique with Computational Validation: Combine computational results with conventional film criticism practices—like close reading, thematic analysis, and audience studies—to triangulate findings. Iterative processes increase the rigor and sophistication of interpretations by bridging quantitative findings with narrative richness.

Through the observance of these practices, film studies can use new technology to protect the history of cinema, advance research methods, and democratize heritage interpretation in accessible, innovative approaches so regional and worldwide film legacies are kept alive and accessible.

9. CONCLUSION

The integration of artificial intelligence, quantum computing, and new media technologies has demonstrated significant potential to deepen and expand our understanding of Balu Mahendra's cinematic realism and evolving portrayal of women. AI–powered content analysis uncovered precise patterns in dialogue and cinematography that reinforce Mahendra's naturalistic style, while quantum computing algorithms revealed thematic phases across his filmography, highlighting a clear trajectory toward complex female agency. Digital ethnography and sentiment analysis confirmed that Generation Z audiences engage with Mahendra's films in meaningful ways, exhibiting heightened awareness of women's mental health and embracing progressive representations of female resilience.

By combining computational techniques with feminist film theory and digital realism frameworks, this research established a robust hybrid methodology that can be applied to regional cinema studies, offering accelerated data processing alongside rich humanistic insights. Comparative analyses underscored Mahendra's distinctive use of soft lighting and minimalist dialogue in contrast to contemporary Tamil films, reaffirming his lasting influence on realistic gender representation.

Ultimately, this study proposes best practices for preserving and reinterpreting cinematic heritage through transparent, interdisciplinary workflows that leverage AI for restoration, quantum computing for thematic mapping, and interactive media for audience reception. These approaches not only honour Mahendra's artistic legacy but also chart new pathways for film scholarship in the digital age, ensuring that classic works continue to inspire and resonate with future generations.

AUTHOR'S CONTRIBUTION

All authors contributed to conceptualization, methodology development, data analysis, writing, review, and final approval of the manuscript.

TRANSPARENCY STATEMENT

The manuscript represents original research work. All data sources, computational methods, and analytical frameworks have been transparently reported. Ethical approval was obtained from the Institutional Human Ethics Committee (IHEC), Approval Number: MAHER/IEC/PhD/72/Nov24.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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