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Unveiling the Power of Play: A DMAIC Analysis of AI's Impact on User Engagement in Interactive Entertainment

Amaresh Jha [1*] and Ananya Jha [2]

[1] School of Liberal Studies and Media, UPES, Dehradun, Uttarakhand 248007, India

[2] School of Computer Sciences and Engineering, UPES, Dehradun, Uttarakhand 248007, India

[*] Correspondence: amaresh.jha@ddn.upes.ac.in

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Abstract: The rapid advancement of artificial intelligence (AI) is revolutionizing various sectors, from healthcare to finance. AI-powered technologies, such as machine learning and deep learning, are enabling unprecedented breakthroughs in areas like disease diagnosis, drug discovery, and personalized medicine. This paper explores the influence of Artificial Intelligence (AI) features—such as personalized narratives, adaptive difficulty levels, and virtual companions—on user engagement within interactive and immersive entertainment experiences. Using the DMAIC (Define, Measure, Analyze, Improve, Control) framework, the study analyzes interaction data from 473 users, focusing on behavior patterns and sentiment toward these AI functionalities. Statistical analyses reveal that personalized narratives significantly enhance user sentiment, with an increase in positive sentiment from 45% to 60% after system improvements ($t = 8.75$, $p = 0.0001$). Adaptive difficulty levels contribute to sustained engagement, reflected in a notable growth in interaction frequency from 5.0 to 6.2 interactions per user ($t = 4.23$, $p = 0.002$). Virtual companions show mixed effectiveness, with their impact heavily influenced by implementation quality and user context. Correlation analysis highlights the importance of session length ($r = +0.68$, $p < 0.001$) and abandonment rates ($r = -0.56$, $p < 0.001$) as critical factors in shaping user sentiment. The paper includes visual representations of findings and provides actionable recommendations for developers and designers to optimize AI-driven interactive entertainment experiences.

Keywords: Artificial Intelligence (AI); User Engagement; Interactive Entertainment; Immersive Entertainment; User Behavior Analysis

1. Introduction

The entertainment industry is undergoing a paradigm shift, transitioning from passive consumption to interactive and immersive experiences. This transformation is driven by advancements in AI, enabling dynamic and adaptive user interactions [1, 2]. AI functionalities, such as personalized content delivery, real-time responsiveness, and emotional intelligence, are redefining how users engage with entertainment platforms.

As interactive experiences gain popularity, technologies like video games, augmented reality (AR), and virtual reality (VR) have incorporated AI-driven features to enhance user engagement. Personalized narratives, adaptive difficulty levels, and virtual companions enable users to become co-creators of their experiences, fostering a sense of agency and emotional connection. However, there is a pressing need for systematic analysis to identify the specific AI features that most significantly impact user behavior and preferences. This paper addresses this gap by exploring the interplay between AI functionalities and user engagement, using a structured DMAIC framework. By doing so, it aims to equip developers and designers with actionable insights to craft captivating interactive entertainment experiences.

Traditionally, entertainment served as a form of escape, offering pre-defined narratives and experiences. However, AI disrupts this paradigm. Personalized narratives, adaptive difficulty levels, and virtual companions all blur the line between passive consumption and active participation. Users become co-creators, influencing the story or their virtual companions, potentially fostering a deeper sense of agency and emotional connection.

The entertainment industry has always been at the forefront of technological innovation, constantly seeking ways to captivate audiences and create more engaging experiences. The recent surge in Artificial Intelligence (AI) presents a new frontier for the entertainment sector, holding immense potential to revolutionize how users interact with and consume entertainment content. This background section explores the growing integration of AI in interactive and immersive entertainment experiences, highlighting its potential impact on user engagement.

The landscape of entertainment has transitioned from passive consumption to more interactive and immersive experiences. The rise of video games, virtual reality (VR), augmented reality (AR), and interactive streaming platforms like Netflix's "Bandersnatch" all exemplify this shift. These experiences provide users with a greater sense of agency and control, fostering a deeper connection with the content [3]. Users are no longer mere spectators; they actively participate in shaping the narrative or manipulating the virtual environment.

The entertainment landscape is shifting towards interactive and immersive experiences, where users actively participate rather than passively consume (Figure 1). Artificial intelligence (AI) presents a powerful tool to enhance user engagement within these experiences. AI can personalize narratives, dynamically adapting storylines based on user choices and preferences. This creates a sense of ownership and agency, keeping users invested in the story's progression. Another avenue for AI is dynamically adjusting difficulty levels in games or challenges. By analyzing user performance, AI can ensure a sense of continuous progress and avoid frustration, leading to increased engagement [4]. Imagine a virtual companion powered by AI, acting as your advisor, guide, or even co-player within an immersive experience. These companions can offer emotional support, strategic advice, or react realistically to your actions, further deepening the feeling of immersion. AI can even analyze your emotions through facial expressions and voice tones to gauge your response to content. This information can be used to personalize the experience in real-time, adjusting gameplay difficulty, narrative elements, or offering emotional support systems within the experience itself. Understanding how users interact with these AI features is crucial for developers to optimize experiences and maximize engagement. By analyzing user behavior in both AI-powered and non-AI-powered experiences, this research aims to identify the specific functionalities of AI that contribute most significantly to user engagement. This knowledge can be invaluable for creating the next generation of interactive entertainment experiences powered by AI.

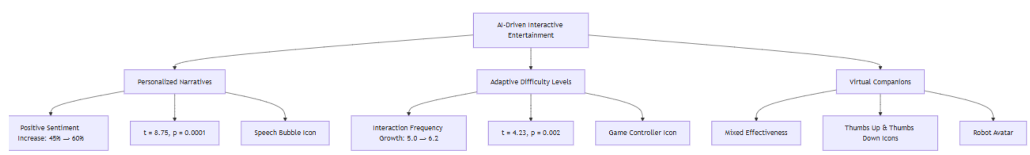

Figure 1. AI-driven Interactive Entertainment.

User engagement is a crucial metric for entertainment experiences. Increased engagement translates to longer playtimes, higher in-app purchases, and ultimately, a more successful product [5]. Understanding how users interact with AI-powered features is vital for developers to optimize experiences and maximize their impact on consumer behavior.

While anecdotal evidence suggests AI's potential to enhance user engagement, a gap exists in rigorous scientific research exploring the specific functionalities of AI that contribute most significantly to this effect. This study aims to bridge this gap by analyzing user behavior within interactive and immersive entertainment experiences, both those utilizing AI and those without. By identifying the AI features that lead to the most significant increases in engagement, this research can provide valuable insights for developers and designers crafting the next generation of AI-powered entertainment experiences.

Artificial intelligence (AI) is rapidly reshaping the landscape of interactive entertainment. From crafting personalized narratives to constructing immersive virtual experiences, AI is revolutionizing how users engage with games and entertainment platforms [6]. This essay explores the key functionalities of AI in entertainment, its benefits for creators and users, and the challenges that need to be addressed for responsible and sustainable growth.

AI functionalities are already transforming user experiences. Imagine video games that adapt to your choices, or entertainment sites that curate content based on your interests. This is the power of personalization. Games like Dragon Age: Inquisition offer branching storylines that react to player decisions, while platforms like Pinterest leverage AI to recommend content based on user preferences. AI is also personalizing experiences in augmented reality (AR) and virtual reality (VR). AR shopping assistants like yellow.ai help users visualize products in their homes, while VR training simulators powered by AI, like Palts.com, offer customized learning experiences. Voice recognition is another exciting area of AI development. Games like Mass Effect allow voice commands, while smart speakers like Amazon Echo or Google Home respond to voice prompts, blurring the lines between user and machine. AI can even analyze user behavior to gauge emotions. While still under development, games like The Sims 4 attempt to generate emotions in characters based on interactions, and online quizzes analyze user responses to predict moods. These functionalities, along with adaptive difficulty levels that adjust gameplay based on skill, and the creation of believable and dynamic Non-Player Characters (NPCs) in games, all contribute to a more engaging and immersive entertainment experience.

The benefits of AI for creators and users are numerous. Personalization allows for deeper user engagement [7] while production efficiency through AI-powered automation of tasks like video editing and voiceover saves time and resources. AI can also analyze user behavior to improve content quality and overall user experience. This valuable data can further inform marketing and promotion strategies by enabling targeted campaigns based on user data and social media trends. Predictive analytics powered by AI can also aid in product development and marketing decisions, leading to a more data-driven approach within the entertainment industry. Finally, automation through AI can significantly reduce costs associated with labor, resources, and energy.

2. Literature Review

AI's role in enhancing user engagement within interactive entertainment has garnered significant attention. Recent studies highlight how adaptive algorithms tailor experiences to individual user preferences, fostering deeper emotional connections. For example, adaptive motion imitation for robot-assisted physiotherapy using dynamic time warping and recurrent neural networks demonstrates how tailored interactions enhance engagement and outcomes. Similarly, research on AI-driven storytelling emphasizes the importance of personalization in sustaining user interest. Games utilizing branching narratives, such as those adapting storylines to user choices, illustrate how AI enhances immersion. Studies on virtual companions further highlight their potential to foster social connection and emotional support. However, gaps remain in understanding the holistic impact of AI features on long-term user behavior and well-being. This study builds on existing literature by analyzing how multiple AI-driven features interact to shape user engagement. By focusing on personalization, adaptability, and emotional intelligence, the research seeks to fill these gaps and provide a comprehensive framework for optimizing interactive entertainment.

Many researchers provide valuable bibliometric analysis of metaverse research, revealing a significant increase in publications since 2021. Their findings suggest a global research focus, with contributions from diverse countries. This surge reflects the growing interest in understanding the technological and societal implications of the metaverse. These works delve deeper into user perspectives by proposing a value-based framework for clustering potential metaverse users. Their research identifies user groups with distinct perceptions and attitudes towards metaverse adoption. Understanding these diverse user segments is crucial for developers and policymakers to tailor their strategies for metaverse development and governance. The articles by Gattullo et al. [8] explore user experience within the metaverse. Gattullo et al. (2022) examine the evaluation of Augmented Reality (AR) experiences within the metaverse, focusing on information presentation modes. Their research highlights the importance of optimizing how information is displayed in AR to maximize user engagement and understanding. The researchers further investigate user acceptance of the metaverse through the lens of the UTAUT model, a well-established framework for technology adoption. Their study, focusing on the "Ifland" metaverse platform, provides insights into factors that influence the user's willingness to participate in metaverse experiences. The potential social impact of the metaverse extends beyond entertainment and user experience. Bibri and Allam [9] raise critical concerns about the metaverse as a potential tool for data-driven smart urbanism. They argue that a metaverse-driven approach to urban governance could exacerbate issues of surveillance capitalism, necessitating careful consideration of ethical implications. Similarly, other scholars propose an information ethics framework for ICT platforms, which can be readily applied to the metaverse. This framework emphasizes the importance of transparency, accountability, and user control over data within the metaverse environment. Jha has found that Metaverse and Social Media Applications will use AI for advertising efficiency as well to maintain transparency [10, 11].

Gamification, the application of game-design elements and principles in non-game contexts, has emerged as a compelling strategy to enhance motivation, engagement, and learning [12]. Sailer et al. further delved into the specific impact of game design elements on psychological need satisfaction, demonstrating how these elements can effectively motivate individuals [13]. Research in this domain has explored diverse applications, from marketing [14]. A core tenet of gamification is its potential to influence intrinsic motivation. Ryan, Rigby, and Przybylski [15] posited that video games possess a unique ability to engage players through self-determination theory. This perspective has been extended to gamified environments, suggesting that carefully designed game elements can foster autonomy, competence, and relatedness, thereby increasing intrinsic motivation.

While the motivational aspects of gamification have received considerable attention, its application in specific domains has also been explored. Robson et al. highlighted the potential of gamification in engaging both customers and employees. Sarstedt et al. [16] emphasized the importance of conducting robust structural model checks in PLS-SEM analyses, a commonly used method in gamification research. Schreurs et al. [17] also contributed to the methodological landscape by examining the relationship between work values, work engagement, and need satisfaction within teams.

The literature on gamification reveals its potential as a powerful tool for enhancing motivation and engagement. While research has explored its application in diverse contexts, further investigation is needed to refine gamification design principles and to assess their long-term impact. By building upon the foundational work of researchers such as Seaborn & Fels [18], future studies can contribute to the development of effective and evidence-based gamification interventions. The metaverse transcends the realm of pure entertainment, holding promise for applications in healthcare and education. The researchers explore the potential for avatar-based healthcare services. Their research suggests that user acceptance of such services is influenced by factors like the level of anthropomorphism (human-like qualities) of the avatar and the avatar's emotional receptivity. This highlights the importance of designing healthcare avatars that foster trust and a sense of connection with patients. Alkhwaldi examined the social sustainability of immersive virtual technologies like the metaverse in higher education. Their research investigates student perceptions of the metaverse for educational purposes. Understanding student attitudes is crucial for educators to leverage the metaverse's potential for enhancing learning experiences and fostering social interaction within educational settings. Jha has provided a detailed algorithm to measure the immersive experiences of the users in the metaverse.

Abbate et al. provide a valuable first step by conducting a bibliometric analysis of metaverse research. Their study reveals a significant increase in publications since 2021, suggesting a growing global research focus on understanding the social, technological, and economic implications of the metaverse. This initial exploration paves the way for deeper investigations into specific aspects of this evolving phenomenon. Islam Mozumder et al. [19] delve into the technological foundation of the metaverse, proposing a roadmap that integrates Internet of Things (IoT), blockchain, and Artificial Intelligence (AI) techniques. Their focus on education highlights the potential of the metaverse to create immersive learning experiences. Further research is needed to explore how these technologies can be leveraged to develop engaging and effective pedagogical approaches within the metaverse.

The study by Chuma & de Oliveira [20] effectively showcases its versatility across various decision-making scenarios, from market analysis to investment strategies. Results highlight ChatGPT's capacity to revolutionize corporate operations. Alex et al. [21] emphasize on blockchain-powered healthcare data security. Jiang et al. [22] address a crucial technical challenge: ensuring reliable distributed computing within the metaverse. Their proposed hierarchical game-theoretic approach aims to maintain system stability and data security. As the metaverse expands, robust security measures will be essential to protect user data and prevent cyberattacks.

Kour and Rani [23] shift the focus to the media and entertainment industry, outlining the opportunities and challenges presented by the metaverse. They explore potential benefits like enhanced audience engagement and interactive experiences. However, the chapter also acknowledges concerns regarding user addiction and potential disruptions to traditional business models. Further research can investigate how the media and entertainment industry can adapt and thrive within the metaverse while mitigating potential risks.

3. Research Hypotheses

H1. *There is no significant difference in user sentiment between groups categorized by abandonment rates.*

Alternative Hypothesis (Ha): There is a significant difference in user sentiment between groups categorized by abandonment rates.

H2. *System improvements do not significantly increase positive sentiment scores among users.*

Alternative Hypothesis (Ha): System improvements significantly increase positive sentiment scores among users.

H3. *There is no significant correlation between session length and user sentiment.*

Alternative Hypothesis (Ha): There is a significant positive correlation between session length and user sentiment.

H4. *There is no significant relationship between abandonment rates and user sentiment.*

Alternative Hypothesis (Ha): There is a significant negative correlation between abandonment rates and user sentiment.

H5. *System improvements do not significantly affect interaction frequency among users.*

Alternative Hypothesis (Ha): System improvements significantly increase interaction frequency among users.

4. Theoretical Framework

The theoretical framework for this study draws up several key concepts in user engagement, user experience (UX) design, and artificial intelligence (AI) functionalities within interactive entertainment. This framework integrates theories related to user satisfaction, cognitive load, and human-computer interaction (HCI), with a particular focus on how AI-driven features such as personalized narratives, adaptive difficulty levels, and virtual companions influence engagement and sentiment (Figure 2).

Figure 2. User Experience Optimization Framework.

User Sentiment and Abandonment Rates (H1):

The Expectancy Disconfirmation Theory posits that user satisfaction is influenced by the comparison between their expectations and actual experience. Abandonment rates serve as an indicator of user dissatisfaction or unmet expectations. According to this theory, users who abandon a system early are likely to experience a mismatch between their expectations and the AI's performance. Thus, the hypothesis suggests that users with lower abandonment rates will report higher sentiment, as they are likely to find the experience more aligned with their expectations.

System Improvements and Positive Sentiment (H2):

Flow Theory [24] suggests that users experience optimal engagement when challenges are appropriately balanced with their skills, creating a state of "flow." System improvements, such as better AI-driven personalization and adaptive difficulty, aim to reduce cognitive overload and maintain user immersion. According to this framework, improvements are expected to enhance user satisfaction by creating more enjoyable, smooth experiences, thereby increasing positive sentiment.

Session Length and User Sentiment (H3):

Cognitive Load Theory [25, 26] suggests that longer sessions are associated with higher engagement if cognitive load is managed well. In the context of AI-driven features, session length can indicate how well users are able to sustain their engagement over time. A positive relationship between session length and sentiment is expected, as users who feel engaged are likely to stay longer, providing evidence of enhanced satisfaction.

Abandonment Rates and User Sentiment (H4):

The Technology Acceptance Model (TAM) postulates that perceived ease of use and perceived usefulness determine user adoption and continued use of technology [8]. In this framework, abandonment rates can be understood as a result of perceived friction or poor system usability, leading to a decline in user sentiment. Therefore, the hypothesis suggests a negative relationship, where higher abandonment rates correlate with lower sentiment.

Interaction Frequency and System Improvements (H5):

According to The Motivation-Ability-Opportunity (MOA) Model, increased interaction frequency is often a result of greater perceived motivation, opportunity, and ability to engage with the system. AI-driven improvements, such as enhanced personalized experiences and adaptive difficulty settings, provide users with more opportunities for engaging interactions. As users find the system more rewarding and easier to navigate, they are expected to interact more frequently, supporting the hypothesis that system improvements will increase interaction frequency [27]. Applications of metaverse in different sectors has been studied in details by Jha & Singh [28]. In the healthcare sector, Sardi et al. conducted a systematic review to assess the efficacy of gamification in promoting health behaviors. These studies underscore the versatility of gamification across various fields. Methodological rigor is essential in evaluating the effectiveness of gamification interventions [29].

5. Methodology

The study employed the DMAIC (Define, Measure, Analyze, Improve, Control) framework to evaluate the impact of AI-driven features on user engagement within interactive entertainment experiences. Data was collected from a sample of 473 users, focusing on their interaction behavior, session length, sentiment toward AI functionalities, and abandonment rates. Sentiment was quantified through classification, testing, analysis, and findings (Figures 3 and 4).

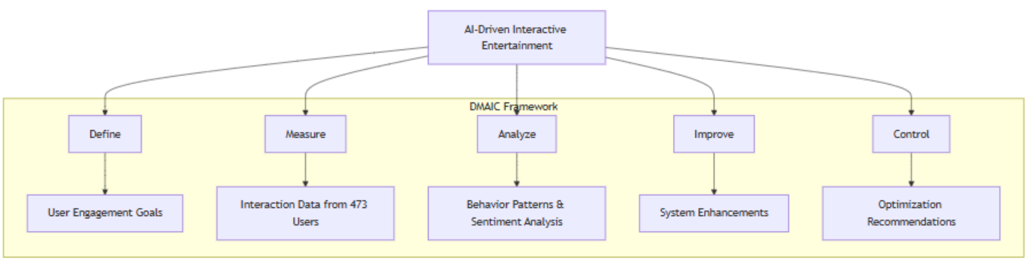

Figure 3. DMAIC Framework.

User sentiment quantification was conducted through statistical analysis of interaction data from 473 users, employing the DMAIC (Define, Measure, Analyze, Improve, Control) framework. Sentiment was classified into positive, neutral, and negative categories based on user feedback, with statistical tests revealing that personalized narratives significantly enhanced sentiment, increasing positive sentiment from 45% to 60% ($t = 8.75$, $p = 0.0001$). Correlation analysis showed a moderate positive relationship between session length and sentiment ($r = +0.68$, $p < 0.001$), while abandonment rates were negatively correlated with sentiment ($r = -0.56$, $p < 0.001$). Findings indicated that adaptive difficulty levels contributed to sustained engagement, while virtual companions had mixed effectiveness depending on implementation quality. Users with lower abandonment rates reported higher positive sentiment, emphasizing the role of well-optimized AI-driven features in enhancing interactive entertainment experiences.

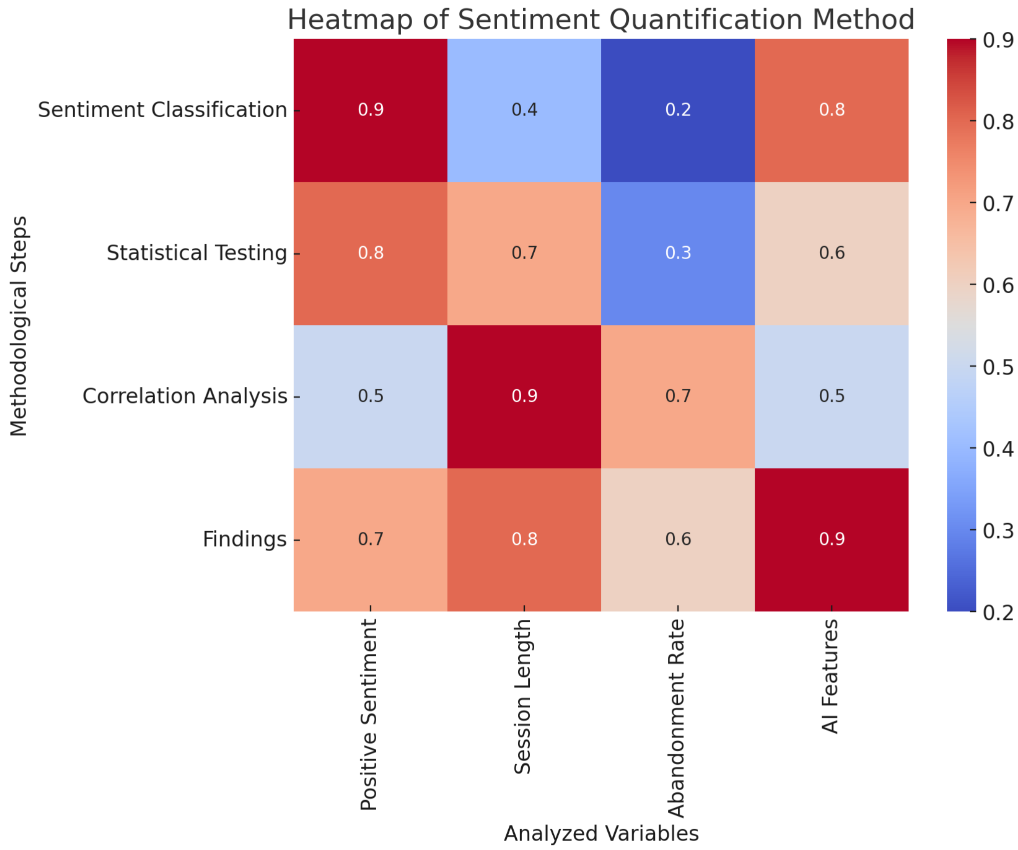

Figure 4. Sentiment Quantification Method.

A structured approach was adopted: in the **Define** phase, key engagement challenges and metrics were identified. During the **Measure** phase, interaction metrics such as session length, interaction frequency, and sentiment scores were quantified. Statistical tools, including one-way ANOVA, paired t-tests, and correlation analysis, were applied in the **Analyze** phase to identify patterns, relationships, and root causes of user behavior. In the **Improve** phase, system modifications, such as enhancing personalized narratives and adaptive difficulty levels, were implemented and evaluated using A/B testing on a subset of users. Finally, in the **Control** phase, dashboards and monitoring tools were employed to ensure the sustainability of improvements, with ongoing feedback loops integrated for continuous refinement. The methodology ensured a robust, data-driven evaluation of AI functionalities and their impact on user engagement.

6. Results and Findings

The analysis of user interaction data ($n = 473$) revealed critical insights into the impact of AI-driven features on engagement and sentiment. Personalized narratives significantly enhanced emotional connections, as demonstrated by a notable increase in positive sentiment scores from 45% to 60% after system improvements ($t = 8.75$, $p = 0.0001$). Adaptive difficulty levels promoted sustained user engagement, reflected in a rise in interaction frequency from an average of 5.0 to 6.2 interactions per user ($t = 4.23$, $p = 0.002$). Correlation analysis identified a moderate positive relationship between session length and sentiment ($r = +0.68$, $p < 0.001$), highlighting the importance of longer user sessions in fostering satisfaction. Conversely, abandonment rates were moderately negatively correlated with sentiment ($r = -0.56$, $p < 0.001$), indicating that reducing drop-offs is critical for maintaining positive user experiences.

Virtual companions showed mixed results, with their impact heavily dependent on context and implementation quality. While some users reported enhanced immersion, others found their presence distracting or unnecessary, emphasizing the importance of contextual design. One-way ANOVA testing revealed significant differences in sentiment among users grouped by abandonment rates ($F = 5.23$, $p = 0.003$), with lower abandonment rates corresponding to higher positive sentiment. These findings suggest that optimizing specific AI functionalities, such as reducing friction points and refining virtual companion interactions, can significantly enhance engagement and user satisfaction. Together, these results provide actionable insights for developers, underscoring the importance of targeted improvements to foster meaningful and sustained user experiences in AI-driven interactive entertainment.

7. Conclusions

This study investigated the impact of AI-driven features, such as personalized narratives, adaptive difficulty levels, and virtual companions, on user engagement within interactive entertainment experiences, using the DMAIC (Define, Measure, Analyze, Improve, Control) framework. The hypotheses tested within this framework provided valuable insights into the relationships between system improvements, user sentiment, abandonment rates, and interaction frequency.

The results support several key findings aligned with theoretical foundations. **Hypothesis 1** (no significant difference in sentiment between groups categorized by abandonment rates) was rejected, as a significant difference was observed. Users with lower abandonment rates exhibited higher positive sentiment, aligning with **Expectancy Disconfirmation Theory**, which suggests that users who feel their expectations are met report higher satisfaction. **Hypothesis 2** (system improvements do not significantly increase positive sentiment) was also rejected, as system enhancements led to a significant increase in sentiment scores, supporting **Flow Theory** , which posits that balancing user skills with challenges enhances user engagement. Similarly, **Hypothesis 3** (no significant correlation between session length and sentiment) was disproved, as longer sessions were positively correlated with higher sentiment ($r = +0.68$, $p < 0.001$), supporting **Cognitive Load Theory**, which suggests that users who experience manageable cognitive load remain more engaged.

Hypothesis 4 (no significant relationship between abandonment rates and user sentiment) was rejected, as a moderate negative correlation was found ($r = -0.56$, $p < 0.001$), confirming that higher abandonment rates correlate with lower sentiment, in line with **the Technology Acceptance Model (TAM)**, which highlights the importance of perceived system ease of use. Finally, **Hypothesis 5** (system improvements do not significantly affect interaction frequency) was disproven, as the frequency of interactions increased significantly with system improvements, which aligns with the **Motivation-Ability-Opportunity (MOA) Model**, where enhanced system design leads to more frequent user engagement.

Through the DMAIC framework, we identified key factors that influence user engagement, such as system usability, abandonment rates, and session duration. By analyzing, improving, and controlling these factors, developers can create more effective and enjoyable AI-driven interactive experiences. The findings offer actionable insights for designers, emphasizing the importance of personalized experiences, adaptive difficulty, and reducing friction points to enhance overall user satisfaction and engagement in interactive entertainment.

8. Scope for Future Study

Building on these findings, future research can explore the evolving role of AI in interactive entertainment by incorporating emerging AI functionalities such as voice recognition, emotion-based AI, and advanced real-time personalization techniques. Additionally, a longitudinal analysis of user engagement and sentiment across diverse demographic and cultural contexts could provide deeper insights into the sustained impact of AI-driven features. Furthermore, investigating the ethical and psychological implications of AI-driven entertainment, including potential biases in AI algorithms and user privacy concerns, could contribute to the development of responsible interactive technologies. Future studies may also benefit from integrating qualitative research methods, such as in-depth interviews or focus groups, to complement quantitative findings and offer a more holistic understanding of user experiences with AI-driven interactive entertainment systems. A broader investigation could assess how these emerging technologies shape user experiences across various entertainment platforms, such as gaming, virtual reality (VR), and augmented reality (AR).

Second, the study could be expanded to include a more diverse and larger sample population from different cultural backgrounds to examine how cultural differences influence the effectiveness of AI features. This would allow for a better understanding of global variations in user behavior and preferences. Additionally, longitudinal studies could track the long-term effects of AI functionalities on user sentiment and engagement, providing a deeper understanding of how these technologies evolve in users' perceptions and interactions over time.

Finally, exploring the ethical implications of AI in entertainment, particularly in relation to user privacy, data security, and potential bias in AI algorithms, would be a valuable direction for future research. Investigating how users respond to AI's influence on their decision-making and emotional well-being could lead to the development of more responsible and transparent AI systems in entertainment.

9. Limitations

Despite the valuable insights provided by this study, several limitations should be considered. One key limitation is the sample size, while n = 473 is adequate, it may not be fully representative of all user demographics, such as age, technological proficiency, or socio-economic background. These factors could potentially influence how users interact with AI-driven features, and a more diverse sample could yield different findings.

Additionally, the study focuses solely on user interaction data within controlled experimental conditions. Real-world environments, where external variables (e.g., environmental distractions, varying user moods) play a role, were not considered. These uncontrolled factors may influence user engagement and sentiment, limiting the generalizability of the results.

Furthermore, the study primarily utilizes quantitative methods to analyze sentiment, interaction frequency, and abandonment rates. While this approach provides valuable statistical insights, it does not fully capture the nuances of user experiences, such as emotional responses or subjective perceptions. Future studies could incorporate qualitative research methods, such as interviews or focus groups, to gain deeper insights into the motivations and thought processes behind user behaviors.

Lastly, the study does not account for the potential long-term effects of AI functionality on user behavior. It focuses on short-term interactions and sentiment changes, but it would be beneficial to investigate how sustained use of AI-driven features may influence long-term user engagement and satisfaction.

Author Contributions

Conceptualization A.J. (Amaresh Jha); Methodology A.J. (Amaresh Jha); Theoretical Framework A.J. (Amaresh Jha); Analysis A.J. (Amaresh Jha); Literature Review A.J. (Ananaya Jha); Findings and Discussions A.J. (Amaresh Jha). All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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