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An Enhanced Artificial Intelligence Generated Virtual Influencer Framework: Examining the Effects of Emotional Display on User Engagement based on Convolutional Neural Networks (CNNs)

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Article Details

Key words: Influencer marketing, Artificial intelligence, celebrity endorsements, perceived quality, virtual social presence.

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ABSTRACT

Influencer marketing has rapidly emerged as a dominant force in the contemporary digital landscape, with a growing number of social media influencers and brands increasingly embracing digital endorsements. The integration of artificial intelligence (AI), and application of Convolutional Neural Networks in Virtual Reality, Augmented Reality, Mixed Reality, and Extended Reality technologies into influencer marketing introduces transformative potential, offering sophisticated mechanisms for optimizing digital strategies. AI is set to revolutionize the industry by facilitating more efficient management of influencer and celebrity campaigns across social platforms. The advent of virtual influencers has further piqued consumer interest, significantly influencing the perceived quality of products they endorse. This quantitative study, employing a convenience sampling method within a non-probability framework, collected data via structured questionnaires. The findings reveal a robust positive relationship between AI and influencer marketing with signification improvement. The independent variables of celebrity endorsements, perceived quality, and virtual social presence exhibited significant positive correlations with influencer marketing, with AI serving as a critical mediating factor. Data was analyzed using SPSS, underscoring the strategic value of AI for enhancing influencer efficacy and highlighting the burgeoning trend of AI-driven virtual influencers.

INTRODUCTION

The rise of virtual influencers (VIs), hyper-realistic digital personas powered by artificial intelligence (AI), has transformed the marketing landscape in recent years. The emergence of virtual influencers (VIs) has not only reshaped how brands connect with consumers but also revolutionized the way marketing strategies are conceived and executed in the digital age. Virtual influencers, these hyper-realistic digital personas brought to life through artificial intelligence (AI), 3D modeling, and computer-generated imagery (CGI), provide an entirely new approach for brands looking to engage audiences with precision and creativity [1, 2]. Unlike traditional human influencers, who rely on their physical presence, charisma, and relatability, VIs offer brands complete control over every aspect of their personas, enabling seamless alignment with a brand's messaging and identity. One of the most significant advantages of virtual influencers is their ability to transcend the limitations of human influencers [3, 4]. For example, VIs do not require travel, rest, or negotiation of human limitations like illness or burnout. This allows brands to deploy campaigns at any time, with virtual influencers operating around the clock. Furthermore, virtual influencers can be utilized in multiple campaigns simultaneously, catering to various geographic locations and demographics without logistical constraints. Their constant availability ensures that brands can maintain a consistent presence online, driving engagement continuously and efficiently [5, 6]. AI plays a critical role in the creation, development, and management of virtual influencers. By harnessing AI technologies such as machine learning, natural language processing, and data analytics, VIs can be tailored with precision to reflect a brand's identity and resonate with its target audience. AI enables the generation of vast amounts of data about consumer behavior, preferences, and trends, which allows virtual influencers to interact with consumers in a personalized manner. This capability for personalization makes VIs more than just digital faces for campaigns. They can deliver targeted messaging, content, and even recommendations based on real-time data collected from their audience, resulting in higher engagement rates and more effective marketing efforts [7, 8]. Additionally, the potential of VIs lies in their flexibility and ability to evolve. Brands can adjust the appearance, behavior, and communication style of virtual influencers at will, ensuring that they remain relevant and up-to-date with the latest consumer preferences and trends [9, 10]. Unlike human influencers, whose personal lives and

public perceptions can affect their partnerships with brands, VIs offer a risk-free alternative. Brands have full creative control over VIs, ensuring that their image is consistent with the brand's values and messaging [11].

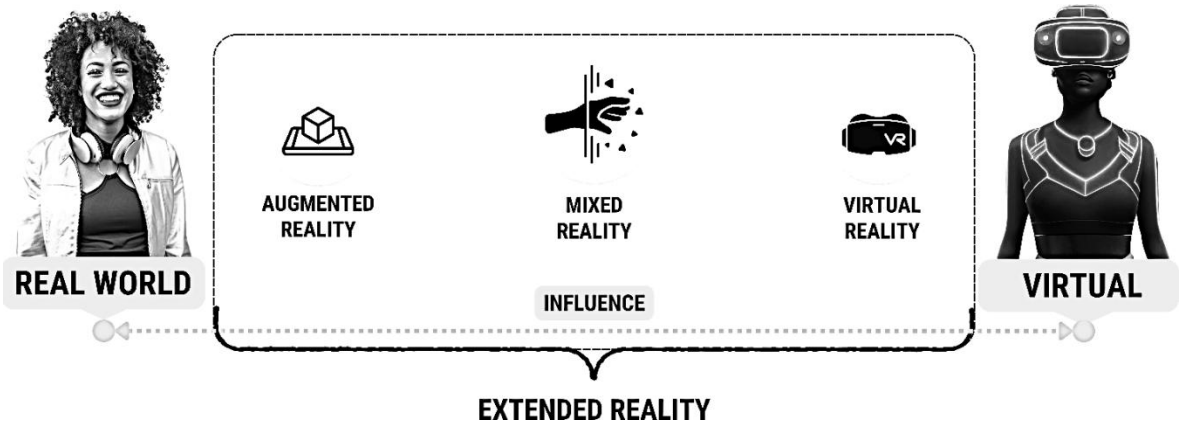

FIGURE 1: VIRTUAL INFLUENCERS BASED ON EXTENDED REALITY [12]

This level of control can be especially beneficial for brands looking to navigate sensitive topics or align with specific cultural or ethical standards without the unpredictability of human influencers. The consistency and predictability offered by VIs are invaluable in today's dynamic marketing environment. For example, virtual influencers have become prominent examples of how VIs can build loyal followings, engage with consumers, and influence purchasing decisions [13, 14].

$$\rho_c = \frac{2a_{12}}{(\mu_1 - \mu_2)^2 + \sigma_1^2 + \sigma_2^2} \qquad \text{Eq (1)}$$

Jacquard Measures of the Similarity Coefficient measure the similarity among the predicted tumor boundaries and the reference outlines. Where Y is the reference outline and X is the expected tumor boundary.

$$\text{BDE} = \frac{1}{|\text{Y}|} * \sum (\text{D}(\text{x}, \text{Y})) \qquad \text{Eq (2)}$$

The success of such influencers demonstrates that consumers are willing to engage with digital personas as long as they provide value, authenticity, and entertainment [15, 16]. Convolutional Neural Networks (CNNs) are a subset of Machine Learning (ML) within the Deep Learning (DL) model family, commonly used in image and video analysis. They excel in detection, recognition, reconstruction, and object tracking, making them valuable for virtual reality (VR),

augmented reality (AR), mixed reality (MR), and extended reality (XR) applications.

ANALYSING EMOTION OF VIRTUAL INFLUENCERS ON USER ENGAGEMENT

As virtual influencers continue to evolve, they are likely to become an integral part of the marketing ecosystem, blending the worlds of AI and creativity to offer brands new avenues for connection and engagement [17, 18]. Convolutional Neural Networks (CNNs) are part of Deep Learning networks and, being also models used in image and video analysis. The use of virtual influencers in marketing represents a significant shift in how brands think about consumer engagement and brand representation. By leveraging AI and other advanced technologies, virtual influencers provide unparalleled flexibility, consistency, and personalization [19, 20]. As AI continues to advance, virtual influencers will likely play an increasingly important role in shaping future marketing strategies [21, 22]. With their ability to engage audiences on a deeply personal level, maintain a constant online presence, and adapt to changing trends, virtual influencers offer brands an innovative tool for navigating the ever-evolving digital landscape. The conceptual framework above shows the three independent variables perceived quality, celebrity endorsements, and social presence. These independent variables are directed toward the mediator of Artificial Intelligence and the dependent variable Influencer Marketing [23, 24]. The shift from traditional advertising to digital platforms has paved the way for more innovative strategies aimed at enhancing user experience and customer satisfaction [25]. One such innovation is the rise of virtual influencers, powered by artificial intelligence (AI), which have begun to redefine the marketing landscape. As AI technologies continue to evolve, AI-driven virtual influencers will likely emerge as autonomous entities in both natural and digital marketplaces. This study focuses on the following areas of inquiry [26].

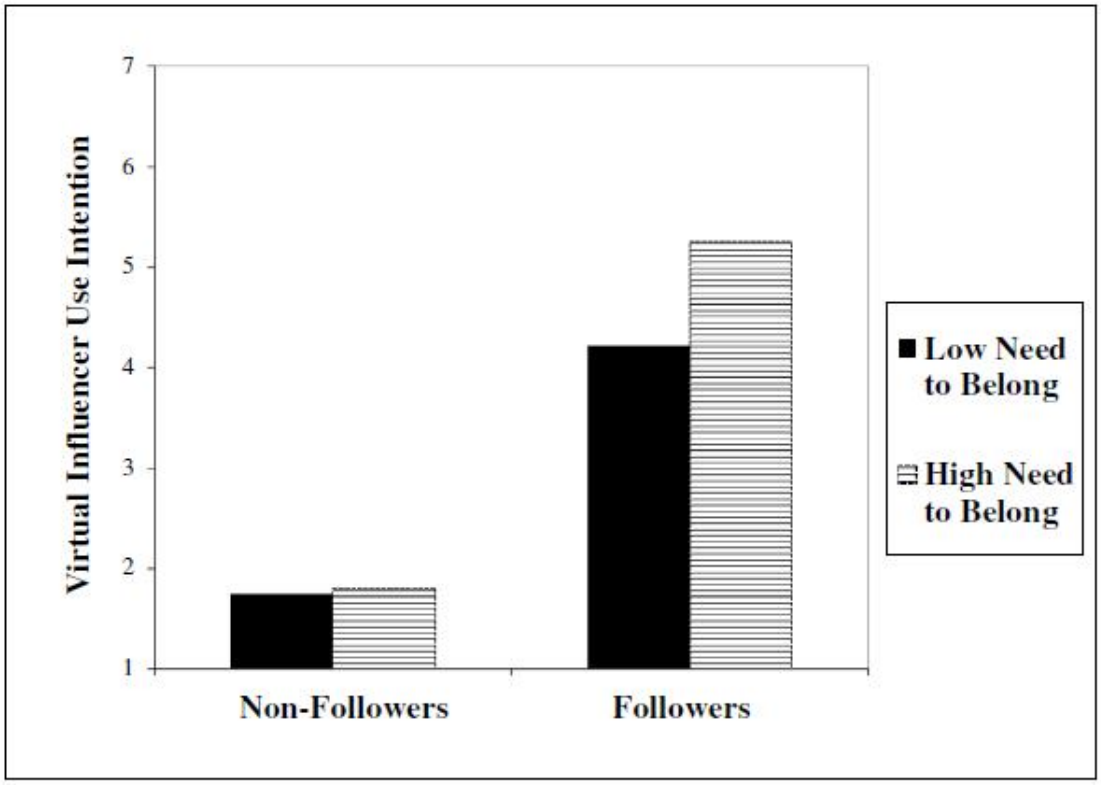

FIGURE 2: VIRTUAL INFLUENCERS ENGAGEMENT ACCORDING TO THE NEED [27]

AUTOMATING VIRTUAL INFLUENCER CREATION AND INTEGRATION

The technical process begins with client specifications and feature extraction using NLP-based models. Brand descriptions regarding facial features and clothing characteristics are collected and interpreted through models like BERT (Bidirectional Encoder Representations from Transformers) and GPT (Generative Pre-trained Transformer) [28]. BERT transforms unstructured client descriptions into actionable data by ensuring a context-aware understanding of complex instructions, while GPT generates initial prompts for virtual model creation by converting the brand's descriptions into relevant keywords and tags. This step is essential for converting client specifications into structured data to guide the virtual model creation process. Next, in the virtual model generation phase, the Juggernaut model, a variant of Stable Diffusion optimized for high-resolution, photorealistic facial feature generation, is used. LoRAs (Low-Rank Adaptations) allow for dynamic fine-tuning of the Juggernaut model,

enabling rapid adjustments based on client feedback. This ensures the virtual model accurately reflects (R) client specifications while consuming minimal resources calculated using Eq (3) [29, 30].

$$R^2 = 1 - \frac{\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2}{\sum_{i=1}^{n} (Y_1 - \bar{Y})^2} \quad \text{Eq (3)}$$

For the photoshoot and clothing integration, real clothing is captured in high-resolution brand-specific images, which are then integrated into the virtual model. The CycleGAN (Cycle-Consistent Generative Adversarial Networks) model adapts these real clothing images to match the virtual model's proportions, while ESRGAN (Enhanced Super-Resolution GAN) enhances the resolution and fine detail of the final output to ensure the clothing appears realistic [31]. The refinement and final output are completed using ComfyUI integration, where models like OpenPose and GarNet play pivotal roles. OpenPose provides body pose estimation to ensure that the clothing fits naturally on the virtual model, while GarNet simulates fabric behavior, adding realism to the clothing's interaction with the virtual body. LoRAs continue to be used for iterative refinement based on client feedback, further enhancing the virtual model's accuracy and realism [32, 33]. The process is designed to maintain brand alignment and deliver high-quality visual outputs. The models employed throughout the process offer distinct advantages: BERT ensures accurate interpretation of client specifications, Juggernaut provides high-resolution, photorealistic virtual models, and LoRAs enable flexible fine-tuning with minimal resource use. CycleGAN ensures seamless adaptation of real-world textures, while ESRGAN maintains high image resolution crucial for branding. OpenPose ensures accurate clothing fit, and GarNet adds lifelike cloth behavior, making the final result highly realistic and brand-aligned [34].

LITERATURE REVIEW

The rise of artificial intelligence (AI) has significantly transformed various aspects of marketing, particularly in the management of virtual influencers. Virtual influencers digitally created personas powered by AI, are gaining traction as a novel marketing tool that engages consumers across social media platforms without the complexities associated with human influencers. AI enables brands to control virtual influencers' narratives, appearance, and behavior, allowing for consistent brand alignment and optimal audience targeting [35, 36].

These AI-driven influencers can interact with consumers through personalized content, providing a hyper-tailored and data-driven approach to brand promotion [37].

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(Y_i - \widehat{Y}_i\right)^2} \qquad \text{Eq (4)}$$

Current literature highlights the growing popularity of virtual influencers due to their ability to generate high levels of engagement and authenticity, despite their artificial nature Additionally, AI-driven algorithms enhance their capabilities by analyzing audience preferences and adjusting influencer behavior in real-time to align with consumer trends [38, 39]. This allows for more precise targeting and a deeper understanding of consumer behavior, which contributes to increased marketing effectiveness [40]. However, ethical considerations around transparency, trust, and authenticity in AI-powered virtual influencers remain areas of concern. Consumers may struggle to differentiate between real and virtual influencers, leading to potential issues of trust and brand integrity [41, 42]. Nonetheless, as AI technology advances, the literature suggests that virtual influencers will become increasingly sophisticated, providing marketers with powerful tools to reach diverse audiences with precision and creativity [43].

ROLE OF AI IN VIRTUAL INFLUENCER CREATION

AI technologies, particularly machine learning and natural language processing (NLP), have revolutionized the creation and animation of virtual influencers. Highlight that AI-driven algorithms are pivotal in generating highly realistic avatars. These technologies enable the creation of virtual influencers with lifelike appearances and behaviors, enhancing their engagement potential. Machine learning models, trained on extensive data sets, create avatars that exhibit complex behaviors and responses, making interactions with users more natural and engaging. Convolutional Neural Networks (CNNs) are distinguished by their specialised architecture. Designed specifically for handling visual data, Convolutional Neural Networks (CNNs) are composed of three main types of layers: convolutional layers, pooling layers, and fully-connected layers. NLP systems further facilitate sophisticated dialogue systems, allowing virtual influencers to communicate with users in a contextually relevant and personalized manner. This capability not only enhances user engagement (TDI) but also enables virtual influencers to respond dynamically to user interactions, adapting their content and behavior

based on real-time feedback.

$$\text{TDI} = \sqrt{(\Delta C)^2 + (\Delta \sigma)^2} \qquad \text{Eq (4)}$$

Additionally, advanced computer vision techniques, including Generative Adversarial Networks (GANs), are employed to produce high-resolution images and videos that closely mimic human expressions and emotions [44, 45]. Convolutional Neural Networks (CNNs) use in XR technologies, considering interaction. One of the concepts used is the Brain-Computer Interface (BCI), a system that allows direct communication and control between the human brain and electronic devices by the translation of neural signals into commands that can be interpreted by a computer. These advancements contribute to the realism of virtual influencers, making them more relatable and effective in their marketing roles. AI's ability to analyze social media trends and user preferences also ensures the continuous evolution of virtual influencers, keeping them relevant in a rapidly changing digital landscape [46, 47].

MANAGEMENT OF VIRTUAL INFLUENCERS

Effective management of virtual influencers relies heavily on AI applications across various domains, including content creation, behavior modeling, and audience analysis. Emphasize that AI tools are instrumental in automating content generation and optimizing interactions based on audience feedback. AI-driven analytics track user engagement metrics, such as likes, comments, and shares, to refine the virtual influencer's content strategy and personality. For instance, sentiment analysis algorithms gauge the emotional tone of user interactions, enabling virtual influencers to adjust their communication style accordingly [48, 49]. Behavior modeling is another critical aspect, where AI systems simulate and predict the behaviors of virtual avatars. Machine learning algorithms analyze historical data to forecast how a virtual influencer might respond to various scenarios, allowing for proactive adjustments in their interactions and content. This predictive capability ensures that virtual influencers maintain a consistent and engaging presence across platforms. Audience analysis also benefits from AI's ability to process and interpret large volumes of data, segmenting audiences based on demographics, interests, and engagement patterns. This level of personalization enhances the effectiveness of virtual influencer campaigns, as content is tailored to resonate with specific user groups [50]. The integration of AI in virtual influencer management is denoted by (JSC) and presents several challenges, particularly concerning ethical considerations. Argues that the use

of AI-generated personas raises significant ethical issues, such as transparency, authenticity, and the potential for manipulative marketing practices [51].

$$JSC = \frac{|X \cap Y|}{|X \cup Y|} \quad \text{Eq (5)}$$

The lack of transparency about the virtual nature of influencers can mislead consumers into believing they are interacting with real individuals, potentially undermining trust in marketing practices. Ensuring that virtual influencers are identified as AI creations and disclosing their commercial affiliations are essential steps in addressing these concerns. Moreover, the potential for AI-generated personas to manipulate consumer behavior poses ethical challenges. Virtual influencers can be programmed to influence user emotions and decisions in ways that may not be entirely transparent [52]. Suggests that establishing ethical guidelines and regulatory frameworks is crucial to maintaining trust and credibility in AI-driven influencer marketing. This includes setting standards for transparency and ensuring that virtual influencers do not exploit vulnerable audiences. Despite these challenges, AI integration offers substantial opportunities. AI technologies enable the creation of highly personalized and engaging content, enhancing marketing campaign effectiveness. AI's real-time adaptability to user preferences allows for more dynamic and responsive marketing strategies [53]. The table highlights the reach, engagement, and earnings of three prominent virtual influencers.

RESEARCH METHODOLOGY

To explore the effect of the emotional expression of virtual influencers on user engagement presented by images, this research employed a combination of data mining, image clustering, and emotion analysis as the primary methods. Convolutional Neural Networks (CNNs) can be applied to Customer Relationship Management (CRM) processes to enhance tasks like customer segmentation, predicting customer behavior, and improving personalized marketing campaigns. Convolutional Neural Networks (CNNs) excel at identifying patterns in unstructured data like images or text, making them valuable for analyzing customer data and building predictive models.

PROPOSED FRAMEWORK FOR FUNDAMENTALS OF CUSTOMER RELATIONSHIP MANAGEMENT (CRM) BASED ON CNN

CRM refers to the strategic management of relationships between a business and its customers,

focusing on maintaining long-term and profitable connections. The cost of acquiring new customers is considerably higher than that of retaining existing ones, which has made CRM increasingly vital for businesses. Leveraging AI within CRM systems enables businesses to predict customer behavior, such as which individuals are most likely to engage with specific marketing activities, making campaigns more efficient. This enhances both co-creation and co-production between companies and their customers. AI transforms vast amounts of customer data into actionable insights, improving customer service by making interactions more intelligent and personalized through tools like conversational agents. These agents simulate human-like intelligence, facilitating smoother interactions with customers and enhancing overall effectiveness in managing customer relationships. To fully realize the potential of AI in CRM, two key factors must be considered: the characteristics of service encounters and the behavioral features of customers. Service encounters, such as customer profiling and CRM initiatives, are fundamental contexts where AI adds value.

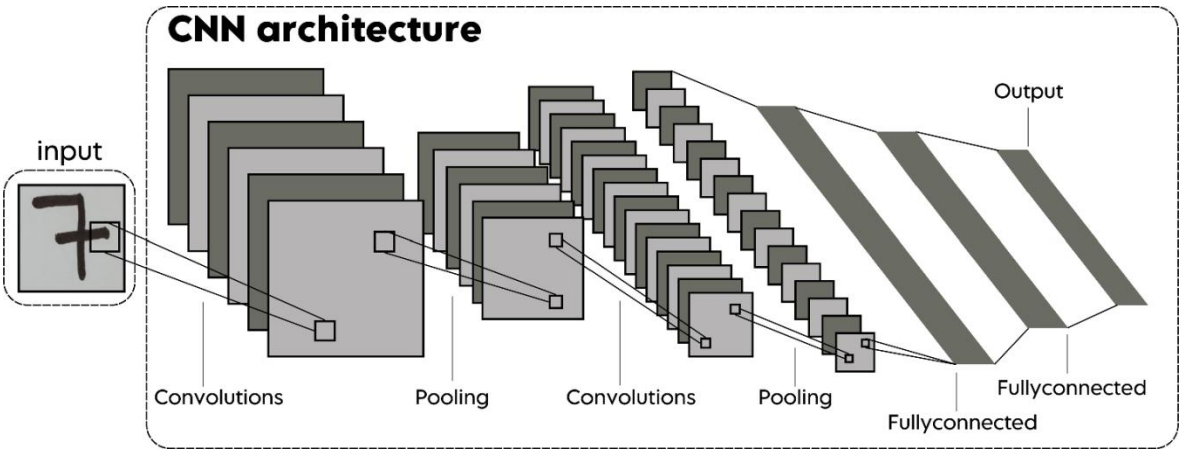

FIGURE 3: VIRTUAL INFLUENCERS FRAMEWORK BASED ON CNN AND CRM PROCESS

AI-driven systems can enhance the customer experience at various touch points, from the initial interaction to post-purchase follow-up, optimizing customer engagement at each stage of the sales funnel. Additionally, regular updates of customer data are essential to keep up with shifting behaviors and preferences. For example, during the COVID-19 pandemic, AI-driven credit card fraud detection systems struggled to keep up with the rapid shifts in consumer behavior. Patterns in purchasing habits changed drastically, creating discrepancies between

predicted behaviors and actual outcomes. AI systems must therefore be adaptive and flexible, continuously learning from new data and experiences to remain relevant and effective. The application of behavioral theories in marketing focuses on predicting and understanding consumer behavior to develop more effective products and services. As modern consumers become more informed and demanding, AI technologies can assist businesses in navigating these challenges by analyzing user-generated data from digital footprints and other online sources. AI's ability to recognize patterns in consumer behavior allows marketers to refine their strategies, making them more effective in reducing customer churn and improving loyalty. AI devices and systems must offer both practical and hedonic value to engage users and drive repeated interactions. However, there is also a growing concern surrounding the "psychology of automation," where over-reliance on AI systems might lead users to become overconfident in the technology's capabilities. While AI has proven useful in automating decision-making processes, human judgment remains critical, especially when it comes to ethical considerations and strategic choices. AI should be seen as a responsible, problem-solving tool that complements human decision-making rather than replaces it. For AI-powered marketing tools to be effective, they must align with consumer perceptions and be integrated into an organization's broader strategic framework. Understanding customer psychology and behaviors remains a crucial factor in ensuring that AI is used effectively and ethically in marketing strategies. Customer Churn Prediction: A common equation in customer churn prediction is based on probability and machine learning models. The Knowledge-Based View (KBV) asserts that knowledge, both explicit and tacit, is a critical resource in organizations.

Explicit knowledge, which can be easily shared through formalized language, and tacit knowledge, which is often harder to articulate and is learned through experience, are both valuable assets. AI-powered knowledge management systems (KMS) have emerged as a fundamental part of the KBV framework, providing organizations with the ability to process, share, and apply knowledge to solve complex problems. While AI excels at managing explicit knowledge, the integration of tacit knowledge—such as insights gained through personal experience—remains challenging. AI systems may struggle to capture and codify the subtle, nuanced knowledge that often forms the basis of human expertise. Nonetheless, AI applications have successfully acquired customer knowledge and used it to enhance marketing campaigns by

automating customer journeys and delivering personalized content at scale. Predictive models driven by AI can help businesses identify high-quality leads by analyzing customers' propensity to purchase, thereby improving marketing efficiency. Technologies such as semantic computing and natural language processing (NLP) allow AI to infer conceptual and emotional information from natural language, enhancing customer segmentation and targeting strategies. In this way, AI plays a crucial role in producing, codifying, and applying knowledge, ultimately enabling a more comprehensive understanding of customer behaviors and needs across various platforms.

FINDINGS

After obtaining the emotional states of the virtual influencer presented in pictures, the analysis moved on to the evaluation of user engagement using stepwise multiple regression analysis. The engagement rate was calculated based on the total number of likes and comments of a post and dividing it by the number of followers.

NETWORK THEORY AND AI AWARENESS (AIA) IN MARKETING

Network theory is increasingly significant in marketing, particularly in explaining social phenomena and interactions between individuals within a system. A network is composed of actors (nodes) connected through various relationships. The position of a node within a network determines its access to opportunities and constraints, which influence outcomes. Centrality, or the importance of a node in a network, has emerged as a critical measure in identifying key influencers. In marketing, centrality is often used to gauge a person's influence within a network, helping businesses target key individuals who can amplify messages and drive engagement. Central actors in networks are vital for spreading information, and metrics such as social media engagement are frequently used to measure an individual's influence in viral marketing campaigns. A prominent example is Google's PageRank algorithm, which assigns value to web pages based on their connections within a network. Similar techniques have been used in marketing to identify influential nodes that can maximize message spread. AI-driven algorithms and systems can further enhance network analysis by detecting patterns of influence and optimizing marketing strategies accordingly.

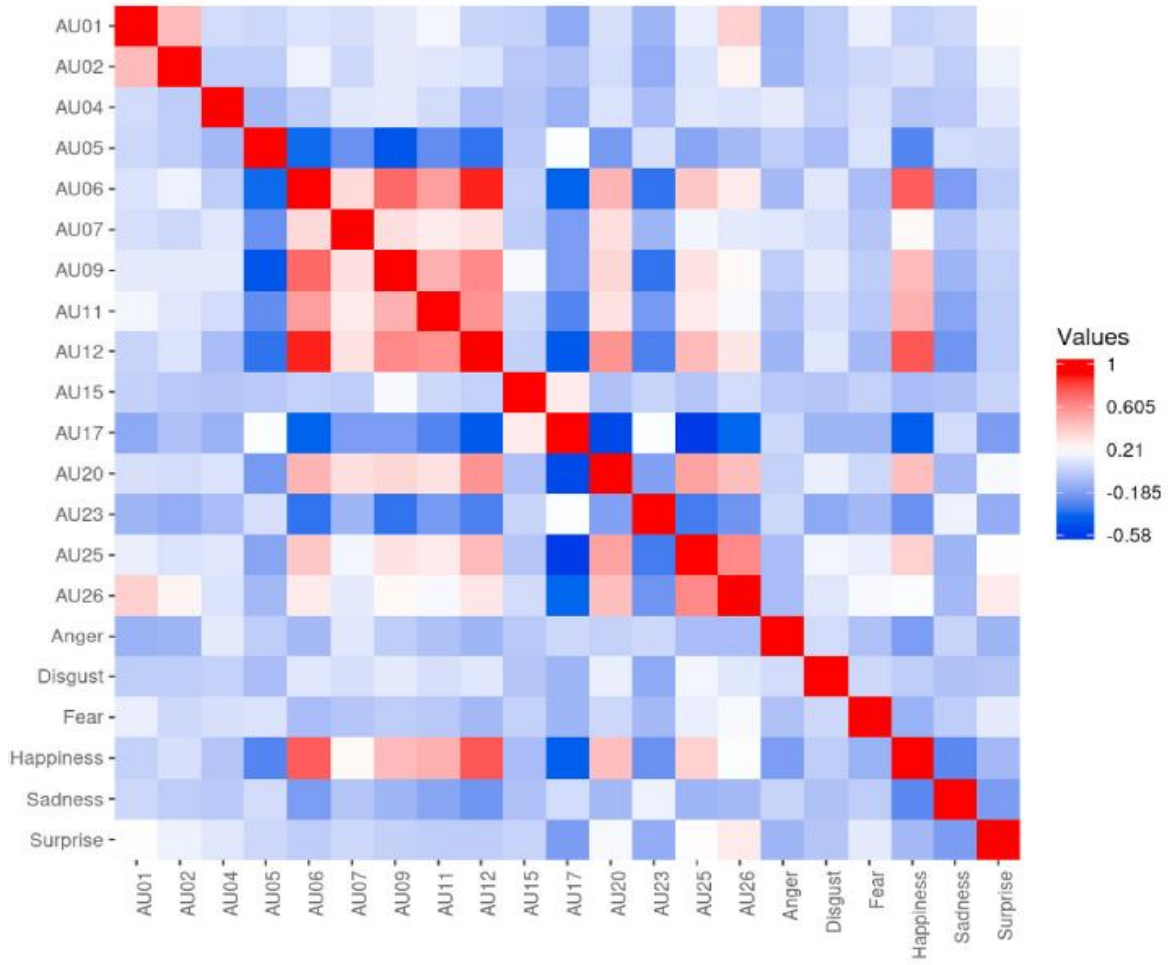

FIGURE 4: CORRELATION BETWEEN AUS AND EMOTIONS

TABLE 1: COMPARATIVE ANALYSIS OF NUMEROUS STANDARDS BASED ON VIRTUAL INFLUENCER THREATS TO HUMAN IDENTITIES USING KBV

Variable	Mean (M)		Standard deviation (SD)	TH1	TH2
Virtual influencers' threat to human	Follower	3.198	2.581	3.581	3.916
	Non-Follower	2.118	3.1	3.198	1.5
	Follower	3.4	2.581	1.41	1.1
	Non-Follower	3.198	3.5	3.198	1.51

identities	Follower	1.41	5.1	2.1	3.1
	Non-Follower	1.51	1.21	3.1	2.51

In recent years, competitive influence maximization has emerged as a fascinating area of research. This concept revolves around identifying the minimum number of influential nodes necessary to maximize a message's reach across a network. AI algorithms play a crucial role in detecting these patterns, allowing businesses to tailor their marketing strategies to maximize their impact in a competitive environment. The increasing application of AI in network theory underscores its significance in modern marketing practices. Artificial intelligence (AI) has significantly transformed marketing through advancements in information technology, with virtual influencers emerging as a revolutionary application. Previously, marketing systems lacked the intelligence needed to personalize and scale efficiently, but the 21st century has seen AI take over as a major driver of innovation. AI's ability to manage vast data sets, automate tasks, and enhance user experience has brought about a new era of virtual influencers. These digital personas rely on AI to maintain a social media presence, engage with audiences, and optimize marketing strategies, representing the future of influencer marketing.

Table 2: Comparative Analysis of Numerous Standards Based on AI Awareness Using Network Marketing

Variable	Mean (M)		Standard deviation (SD)	TH1	TH2
	Follower	2.41	5.1	3.581	3.916
	Non-Follower	1.118	3.1	3.198	5.5
AI awareness (AIA)	Follower	5.4	2.581	1.41	5.1
	Non-Follower	4.198	1.41	4.1	1.51
	Follower	6.1	5.1	3.1	3.1
	Non-Follower	7.2	1.21	2.1	1.51

The below section highlights key themes that showcase AI's role in managing virtual influencers for marketing: marketing channels, marketing strategies, performance, segmentation, targeting, and positioning (STP). These themes offer insights into how AI improves efficiency and results in marketing, particularly when virtual influencers are used. Alongside these opportunities, challenges such as ethics and data protection also arise due to the increasing influence of AI in marketing.

MARKETING CHANNELS AND STRATEGY

Marketing channels have always been the link between brands and consumers. With the rise of AI, virtual influencers have become essential in these channels, interacting with users through platforms like Instagram, TikTok, and YouTube. AI-powered virtual influencers engage followers by simulating human-like behavior, making them an integral part of the marketing ecosystem. Machine learning algorithms enable these virtual personas to understand and interact with audiences based on demographic and psychographic insight. AI-driven virtual influencers can manage real-time interactions at scale, enhancing customer engagement more efficiently than human influencers. For instance, brands like Lil Miquela demonstrate how virtual influencers can continuously interact with audiences without fatigue, offering brands a new tool for consistent digital engagement. During the COVID-19 pandemic, virtual influencers played a pivotal role in bridging the gap between brands and customers, enhancing marketing channel efficiencies when physical engagement was not possible. AI also enhances marketing channels by using advanced language processing and image recognition technologies to create personalized content. This allows marketers to develop more accurate customer profiles, leading to data-driven decisions that enhance consumer experiences.

AI's ability to automate the creation and management of virtual influencers has transformed marketing strategies. It enables brands to scale their operations while maintaining a high level of personalization, which is key in today's competitive environment. Machine learning and deep learning technologies allow marketers to automate repetitive tasks and deliver personalized marketing content based on customer preference. Virtual influencers provide brands with scalable solutions that don't rely on human influencers. These AI-powered influencers are customizable, embodying specific brand attributes while ensuring a consistent brand message across platforms.

TABLE 3: COMPARATIVE ANALYSIS OF NUMEROUS STANDARD BASED ON USING VIRTUAL INFLUENCERS' PERSONALIZATION BENEFITS

Variable	Mean (M)		Standard deviation (SD)	TH1	TH2
Virtual influencers' personalization benefits	Follower	7.11	5.1	3.581	1.916
	Non- Follower	3.8	3.198	2.581	4.581
	Follower	4.1	2.118	3.1	7.198
	Non- Follower	4.128	3.4	2.581	6.41
	Follower	5.7	5.1	3.1	8.1
	Non- Follower	1.2	1.21	2.1	2.51

Additionally, they can handle complex tasks such as personalized recommendations, further enhancing customer experience. For example, luxury brands like Balmain have leveraged AI-powered virtual influencers to target niche markets with precision. However, ethical concerns, particularly around data privacy and consumer trust, must be addressed. AI technologies, including facial recognition and deepfakes, raise questions about transparency and authenticity. Brands need to adhere to regulations like GDPR to ensure consumer trust and maintain ethical standards in AI-driven marketing strategies. Customer Personalization Score Model We can use a mathematical model to represent how personalized marketing driven by AI increases customer satisfaction or engagement. The Personalization Score (PS) can be derived as a function of AI-driven data analysis, which factors in customer preferences, behavior, and interactions.

PERFORMANCE

AI-powered virtual influencers outperform traditional influencers in several key areas, particularly regarding continuous interaction and data-driven decision-making. AI systems managing virtual influencers can analyze vast amounts of data, including consumer behavior and purchasing patterns, to enhance marketing outcomes. By using predictive models, AI enables marketers to improve engagement, conversion rates, and return on investment (ROI). AI can also track key performance indicators (KPIs) such as customer lifetime value (CLV) and customer satisfaction with greater precision than traditional methods. In addition, AI

techniques like Support Vector Machines (SVM) and Neural Networks assist in sales forecasting, allowing brands to predict market trends and adapt marketing strategies more effectively. AI's ability to conduct A/B testing on campaigns and content also helps optimize performance, allowing marketers to target specific customer segments with greater accuracy and efficiency.

TABLE 4: COMPARATIVE ANALYSIS OF NUMEROUS STANDARDS BASED ON AI AWARENESS USING PERFORMANCE

Variable	Mean (M)		Standard deviation (SD)	TH1	TH2
Intention to use virtual influencers	Follower	6.33	2.41	5.1	7.11
	Non-Follower	4.222	1.118	3.1	3.8
	Follower	6.111	5.4	2.581	4.1
	Non-Follower	2.428	4.198	1.41	4.128
	Follower	1.22	6.1	5.1	8.1
	Non-Follower	6.55	4.21	4.3	2.51

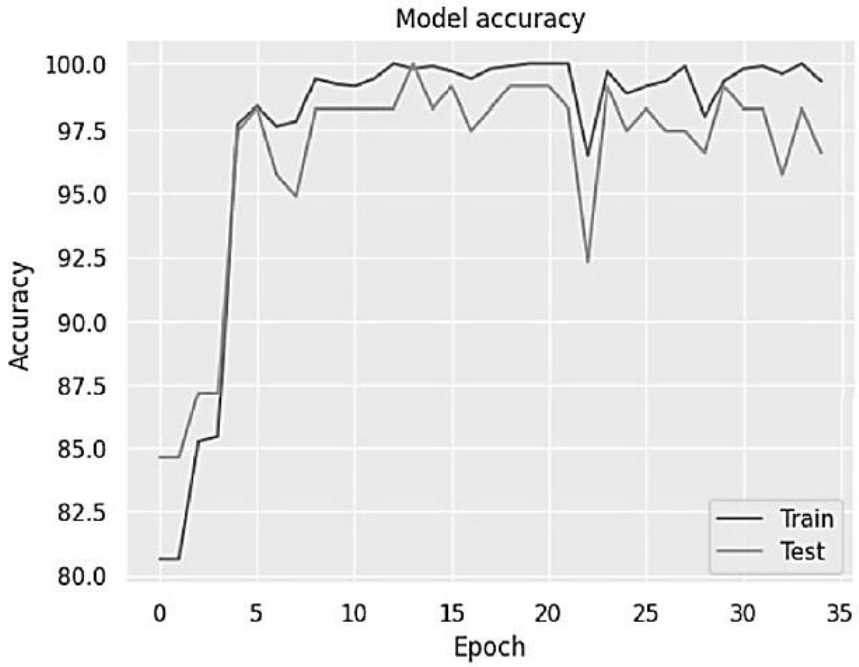

FIGURE 5: SEGMENTATION ACCURACY CURVE FOR TRAIN AND TEST FOR FOLLOWER AND NON-FOLLOWER

This precision leads to enhanced marketing effectiveness and improved profitability. AI-powered virtual influencers are transforming the marketing landscape by outperforming traditional influencers in several areas, particularly through continuous interaction and data-driven decision-making. The global virtual influencer market size, valued at USD 4.58 billion in 2023, is projected to grow at a CAGR of 38.9% and reach USD 45.82 billion by 2030. This growth highlights the increasing reliance on AI systems to manage virtual influencers efficiently.

TABLE 5: COMPARATIVE ANALYSIS OF VARIOUS THEMES FOR VIRTUAL INFLUENCERS

Variable	Mean (M)		Standard deviation (SD)	TH1	TH2
	Follower	3.198	2.581	3.581	3.916
	Non-Follower	2.118	3.1	3.198	1.5

Virtual influencers' threat to human identities	Follower	3.4	2.581	1.41	1.1
	Non-Follower	3.198	3.5	3.198	1.51
	Follower	1.41	5.1	2.1	3.1
	Non-Follower	1.51	1.21	3.1	2.51
	Follower	2.41	5.1	3.581	3.916
	Non-Follower	1.118	3.1	3.198	5.5
AI awareness (AIA)	Follower	5.4	2.581	1.41	5.1
	Non-Follower	4.198	1.41	4.1	1.51
	Follower	6.1	5.1	3.1	3.1
	Non-Follower	7.2	1.21	2.1	1.51
	Follower	6.33	2.41	5.1	7.11
	Non-Follower	4.222	1.118	3.1	3.8
Intention to use virtual influencers	Follower	6.111	5.4	2.581	4.1
	Non-Follower	2.428	4.198	1.41	4.128
	Follower	1.22	6.1	5.1	8.1
	Non-Follower	6.55	4.21	4.3	2.51
	Follower	7.11	5.1	3.581	1.916
	Non-Follower	3.8	3.198	2.581	4.581
Virtual influencers' personalization	Follower	4.1	2.118	3.1	7.198
	Non-Follower	4.128	3.4	2.581	6.41

benefits	Follower	5.7	5.1	3.1	8.1
	Non-Follower	1.2	1.21	2.1	2.51

AI enhances marketing outcomes by analyzing vast amounts of data, including consumer behavior, purchasing patterns, and real-time interactions. With a more precise approach to key performance indicators (KPIs) such as customer lifetime value (CLV) and customer satisfaction, AI provides marketers with a deeper understanding of their target audience.

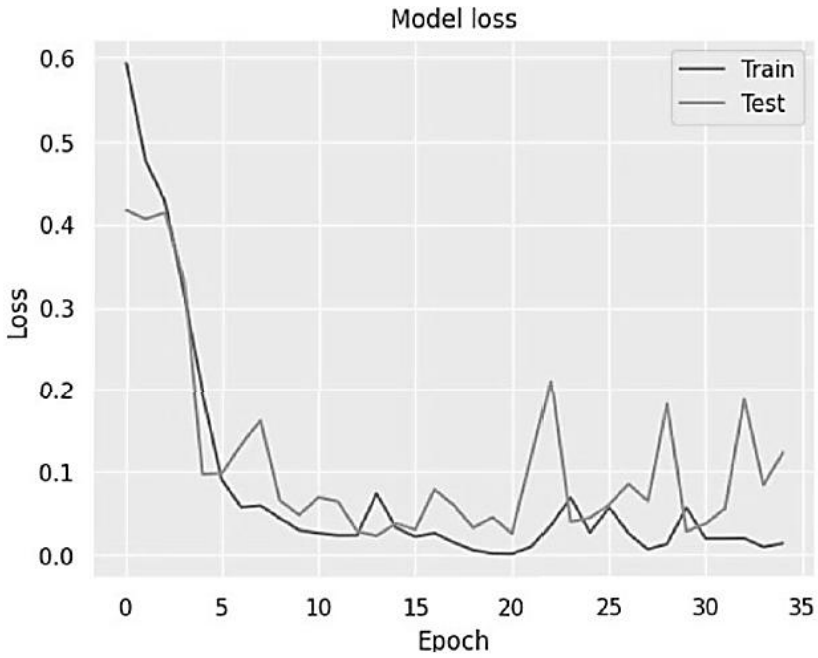

FIGURE 6: SEGMENTATION LOSS CURVE FOR TRAIN AND TEST FOR FOLLOWER AND NON-FOLLOWER

AI's ability to conduct A/B testing and utilize predictive models also plays a crucial role in improving engagement, conversion rates, and return on investment (ROI), making it an indispensable tool for brands looking to optimize performance. In addition to analyzing past data, AI techniques like Support Vector Machines (SVM) and Convolutional Neural Networks are instrumental in sales forecasting, helping brands adapt to market trends more effectively. By leveraging quantitative data on market growth and trends, brands can tailor marketing strategies for different regions such as North America, Europe, Asia Pacific, and Latin America,

ensuring that campaigns resonate with diverse consumer bases. Moreover, AI allows marketers to profile their audience and create highly tailored strategies. It enables precise segmentation, ensuring that campaigns target specific regions (such as the U.S., China, Germany, etc.) and engage with various consumer segments. Brands like Epic Games, Inc., Pinscreen Inc., and Soul Machines are already reaping the benefits of AI-driven virtual influencers, gaining a competitive edge in the global market. The flexibility provided by AI in marketing management also extends to customization, with free report adjustments allowing brands to focus on country-specific or regional insights. As AI continues to evolve, the potential for brands to drive more personalized, effective marketing campaigns will only grow, contributing to greater profitability and long-term success.

CONCLUSION AND RECOMMENDATIONS

This research has presented the Emerging trends in AI for virtual influencers indicating a growing focus on enhancing emotional intelligence and adaptive behavior. Discuss advancements in AI technologies that enable virtual influencers to exhibit more nuanced emotional responses and adapt their behavior based on user interactions. These developments aim to create virtual influencers capable of engaging with users on a deeper emotional level, making interactions more meaningful and impactful. Future research is likely to explore the integration of AI with augmented reality (AR) and virtual reality (VR) technologies. Combining AI with AR and VR can create immersive experiences that enhance user engagement with virtual influencers. For example, virtual influencers could interact with users in virtual environments, providing a more interactive and engaging experience. This integration has the potential to transform virtual influencer marketing by offering novel ways to connect with audiences. Additionally, advancements in AI may lead to more sophisticated models that better mimic human nuances and adapt to evolving marketing environments. Researchers are expected to focus on creating AI systems that handle complex social interactions and provide more personalized user experiences, shaping the future of virtual influencer marketing.

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