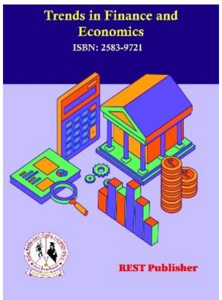
Trends in Finance and Economics
Vol: 2(4), December 2024
REST Publisher; ISSN: 2583-9721 (Online)
Website: https://restpublisher.com/journals/tfe/
DOI: https://doi.org/10.46632/tfe/2/4/8



Evaluation of Social interaction in virtual environments by using the method of MOORA

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Abstract. *Virtual environments have become integral spaces for social interaction, blurring the lines between the physical and digital realms. This paper delves into the multifaceted aspects of social interaction in virtual environments, examining the current landscape and proposing innovative approaches to enhance and deepen these experiences. The study begins by surveying the existing literature on social interaction within virtual environments, highlighting key theories and frameworks that underpin the understanding of virtual social dynamics. Building upon this foundation, the paper explores the psychological and sociological aspects of human behavior in virtual spaces, considering factors such as presence, identity, and the impact of social cues. As virtual workspaces become more prevalent, understanding social dynamics in these environments becomes crucial. Research can help design effective virtual collaboration tools and platforms, optimizing communication and productivity for remote teams. Virtual environments are increasingly being used for therapeutic and healthcare purposes. Studying social interactions within these environments can aid in developing virtual interventions for mental health, phobia treatment, and rehabilitation, among other applications. Versatile with unique alternatives a new method for optimization is proposed MOORA. This method is objective denotes the matrix of responses of the alternatives, however, proposing better policies, which rates are used. Well established. Multi-objective another method for optimization is used for comparison, reference point method. Then, various competitions this proved to be the best choice among the methods. From the result Social VR Platforms is in 1st rank whereas Online Multiplayer Games is in last rank.*

Keywords: *Virtual self, Virtual environments, Virtual relationships, Social interactions, Symbolic interaction. Activity theory.*

1. INTRODUCTION

Exploring social interactions via immersive virtual environments offers realism, controlled experiments, and ethical advantages. Yet, challenges include ecological validity concerns, technical limitations, potential sample biases, and cyber security issues. Future progress hinges on enhancing realism, fostering interdisciplinary collaboration, understanding long-term effects, and establishing ethical guidelines for responsible research in virtual settings [1] Social interaction and social development in virtual environments represent a burgeoning area of study, exploring how individuals interact, communicate, and develop relationships within computer-generated spaces. Participants navigate digital platforms, engaging in activities mirroring real-world scenarios, fostering the development of social skills and relationships. Researchers investigate the impact of virtual interactions on cognitive and emotional development, social identity formation, and the potential parallels or disparities with face-to-face interactions. Understanding these dynamics is crucial for harnessing the positive aspects of virtual environments while addressing challenges and optimizing social development outcomes [2] Active worlds, a virtual reality platform, combines geography and social interaction, creating immersive digital spaces. Users navigate dynamic landscapes and engage socially through avatars. This synthesis of geography and interaction allows for collaborative exploration, creativity, and communication. The platform's spatial design influences user experiences, shaping social dynamics within this virtual realm and highlighting the interconnectedness of geography and social interaction in virtual reality [3] "Virtual selves, real relationships" delves into the interplay between self-identity and social interactions in virtual environments. Users create digital personas, influencing their real-world relationships. Exploring the context and role of these interactions sheds light on how the emergence of the virtual self-impacts social dynamics, identity formation, and the blurring boundaries between online and offline relationships [4] Transformed social interaction in collaborative virtual environments involves separating representation from behavior and form. This concept focuses on the ability to redefine how users are presented and how they interact within virtual spaces. By decoupling representation, individuals can engage in collaborative activities without being constrained by the limitations of physical reality. This approach opens possibilities for creative expression, diverse interaction styles, and innovative forms of communication, fostering a dynamic and adaptive environment for social engagement in the virtual realm [5] The use of applied virtual environments, documented in a PDF, aims to facilitate the learning of social interaction skills for individuals with Asperger's Syndrome. These environments offer a controlled, customizable setting where users can practice and refine social skills, providing a tailored and supportive approach to address the specific challenges associated with Asperger's. The PDF likely delves into the efficacy and methodologies of employing virtual environments as a tool for skill development in this context [6] Multimodal Adaptive Social Interaction in Virtual Environment (MASI-VR) is designed to enhance social skills in children with Autism Spectrum Disorders (ASD). This approach utilizes various sensory modalities within a virtual environment, offering personalized and adaptive interactions to cater to the unique needs of individuals with ASD. MASI-VR aims to provide a supportive and customizable platform for improving social communication and behavioral outcomes in children on the autism spectrum [7] Designing learning environments that enhance social interactions in virtual training spaces involves identifying essential variables. These include user interface design, communication tools, collaborative features, and feedback mechanisms. By optimizing these variables, virtual training spaces can foster effective learning through meaningful social interactions, simulating real-world scenarios and promoting engagement and knowledge retention [8] Embodied interaction in social virtual environments refers to the integration of physical body movements and gestures as a means of communication within digital spaces. This concept acknowledges the significance of the user's body in shaping social interactions within the virtual realm. By employing technologies like motion sensors or virtual reality systems, users can express themselves through body language, enhancing the richness and authenticity of their interactions. This approach aims to bridge the gap between face-to-face communication and digital experiences, creating a more immersive and natural environment for social engagement where users' physical actions play a central role in shaping their virtual presence and interactions [9] This longitudinal study investigates various factors, including task performance, head movements, subjective reports, and simulator sickness, to understand the dynamics of transformed social interaction in collaborative virtual environments. By tracking these metrics over time, researchers aim to unveil patterns and correlations that shed light on the evolving nature of user experiences and interactions within immersive digital spaces [10] Talk and embodiment in collaborative virtual environments examines how communication and physical presence intersect in digital spaces. It delves into how users express themselves verbally and through body language within virtual collaborations, influencing the dynamics of interaction. Understanding these aspects is crucial for creating immersive, effective, and natural-feeling collaborative experiences in virtual environments [11] Virtual-reality-based social interaction training for children with high-functioning autism represent an innovative therapeutic approach. Leveraging virtual reality technology, this training provides a simulated environment where children can engage in realistic social scenarios. Tailored to the unique challenges faced by those with high-functioning autism, the program allows for targeted practice of social skills in a controlled and supportive setting. Virtual interactions help bridge gaps in understanding and communication, offering a safe space for learning and experimentation. This immersive training methodology holds promise in improving real-world social interactions for children with high-functioning autism, contributing to their overall social development and integration [12] Social inhibition in immersive virtual environments explores the phenomenon where individuals may experience reluctance or constraint in their social interactions within digital spaces. Despite the perceived anonymity and separation from the physical world, some users may exhibit inhibited behavior due to factors such as self-consciousness or fear of judgment. This phenomenon poses interesting questions about the psychological impact of immersive technologies on social behavior and raises considerations for designing virtual environments that encourage open communication and reduce inhibitions. Understanding social inhibition in immersive virtual environments is essential for optimizing user experiences and fostering genuine and uninhibited interactions in digital spaces [13] The evaluation of gaze tracking technology for social interaction in virtual environments scrutinizes the effectiveness and potential applications of gaze tracking in the digital realm. Gaze tracking enables the monitoring of users' eye movements, providing valuable insights into attention, engagement, and communication patterns within virtual spaces. This evaluation likely delves into the accuracy, usability, and implications of gaze tracking technology, shedding light on its role in enhancing social interactions in virtual environments. The findings are likely to contribute to the refinement and advancement of technologies aimed at creating more immersive and socially responsive virtual experiences [14]

2. MATERIALS AND METHODS

Alternative parameters: Virtual Reality (VR) Chatrooms, Social VR Platforms, Online Multiplayer Games, Virtual Conferences and Events, Augmented Reality (AR) Social Apps
Evaluation parameters: User Satisfaction, Social Interaction Quality, System Resource Usage, Learning Curve.

Virtual Reality (VR) Chartrooms: virtual reality chatrooms refer to online spaces where users can interact with each other in a virtual environment using VR technology. In these chatrooms, participants are represented by avatars, which are digital representations of themselves. Users can communicate through text, voice, or even gestures, depending on the capabilities of the VR platform. These virtual reality chatrooms aim to provide a more immersive and lifelike social experience compared to traditional text-based or video chat platforms. Participants feel a sense of presence in the virtual space, as if they are physically sharing the same environment. This technology has the potential to revolutionize online communication by making it more immersive and engaging.

Social VR Platforms: Social VR platforms refer to virtual reality environments specifically created to facilitate social interactions. These platforms enable users to engage with each other in a shared digital space, using VR headsets and avatars to create a more immersive and interactive experience. Users can communicate, collaborate, and socialize in a variety of virtual environments designed for different purposes.

Online Multiplayer Games: Online multiplayer games are video games that allow multiple players to participate and interact with each other over the internet. These games connect players from different locations, enabling them to compete or collaborate in real-time virtual environments. Players can engage in various activities, such as team-based competitions, cooperative missions, or player-versus-player battles, enhancing the social aspect of gaming by fostering interaction and competition among a community of online players.

Virtual Conferences and Events: Virtual conferences and events refer to gatherings or meetings that take place in a digital or online space rather than a physical location. Utilizing web-based platforms, participants can attend and engage in these events remotely using their computers or other internet-enabled devices. Virtual conferences often feature keynote speakers, presentations, panel discussions, and networking opportunities. They provide a flexible and accessible way for individuals from different geographical locations to come together, share knowledge, collaborate, and connect without the need for physical travel. Virtual conferences have become increasingly popular, especially in situations where in-person gatherings are challenging or restricted.

Augmented Reality (AR) Social Apps: Augmented Reality (AR) social apps are applications that combine augmented reality technology with social networking features. These apps use the camera on a mobile device to overlay digital elements onto the real-world environment, enhancing the user's perception of their surroundings. In the context of social apps, AR is leveraged to enable users to share and interact with digital content in a more immersive and contextual way. This can include features like AR filters, stickers, or interactive elements that users can incorporate into their photos and videos, fostering a more engaging and visually enriched social media experience. AR social apps often aim to blend the virtual and physical worlds, allowing users to express themselves creatively and connect with others in novel ways.

User Satisfaction: User satisfaction refers to the level of contentment or fulfillment that users experience when interacting with a product, service, or system. It is a subjective measure that reflects how well the provided features, functionality, and overall experience meet or exceed the expectations and needs of the user. Factors contributing to user satisfaction may include usability, performance, design, customer support, and the extent to which the product or service fulfills its intended purpose. High user satisfaction is often indicative of a positive user experience and can lead to increased loyalty, positive word-of-mouth recommendations, and continued usage of the product or service. Conversely, low user satisfaction may result in dissatisfaction, decreased usage, and negative feedback, influencing the success and reputation of the offering. User satisfaction is a crucial metric in assessing the success of products and services across various industries.

Social Interaction Quality: Social interaction quality refers to the overall positive or negative experience individuals have when engaging with others in social settings. It encompasses various factors that contribute to the perceived value and satisfaction derived from social interactions. Key elements influencing social interaction quality include effective communication, mutual respect, empathy, emotional support, and the overall enjoyment of the interaction. Positive social interaction quality often leads to strengthened relationships, increased trust, and a sense of connection. In contrast, poor social interaction quality may result from factors such as miscommunication, conflict, or a lack of understanding, leading to negative emotions and potentially strained relationships. Evaluating and enhancing social interaction quality is crucial in various contexts, including personal relationships, workplace dynamics, and community interactions, as it contributes to overall well-being and positive social outcomes**.**

System Resource Usage: System resource usage refers to the extent to which a computer or software application utilizes and consumes hardware resources such as CPU (Central Processing Unit), memory (RAM), storage, network bandwidth, and other processing capabilities. Monitoring system resource usage is essential for assessing the performance, efficiency, and stability of a computer system or software application. High system resource usage may indicate that the system is under stress or that a particular application is demanding more resources than available. This can lead to performance degradation, slowdowns, and even system crashes. Conversely, low resource usage may suggest that the system is operating within its capacity, leaving room for additional tasks or applications. System administrators and developers often monitor resource usage to optimize performance, identify bottlenecks, and ensure that the system can handle the workload efficiently. Resource management is a critical aspect of maintaining a stable and responsive computing environment, especially in multi-tasking or multi-user scenarios.

Learning Curve: The learning curve refers to the graphical representation of how a person or group of people progresses in learning a new skill or acquiring knowledge over time. It illustrates the relationship between the amount of time spent on a particular task or activity and the individual's performance or competency. The learning curve concept is based on the idea that as individuals engage in a new task or activity, their performance tends to improve with experience and practice. Initially, the curve is steep, indicating a rapid rate of learning and improvement. As time goes on, the rate of improvement may slow down, and the curve may level off, suggesting that the individual has reached a plateau of competence. Understanding the learning curve is essential in various fields, including education, training, and business. It helps educators and trainers design effective learning programs, estimate the time and resources needed for skill acquisition, and set realistic expectations for learners. Additionally, businesses may use the learning curve to assess the efficiency of production processes and identify opportunities for optimization and improvement.

MOORA Method: MOORA (Multi-Objective Rational Analysis) has been successfully implemented, with its dimensionless numbers serving as its second key attribute. These dimensionless numbers form the basis for further analysis. The study concludes by examining the disparities in well-being across the ten counties of Lithuania in relation to its overarching goals. Notably, the affluent regions sharply contrast with some of the most impoverished areas. A critical concern is the migration of labor from other districts to Vilnius, reflecting economic disparities. The approach rejects autonomous redistribution and advocates for strategic commercialization and industrialization in specific locations [15]. Concrete multi-objective optimization is crucial for enhancing systems while considering constraints and conflicting attributes. There are critical decision points in product design and multi-goal optimization, particularly in scenarios involving commercial interactions with conflicting interests. These decisions include increasing revenue and reducing product expenses, enhancing performance while minimizing automotive fuel consumption, and managing weight while addressing associated challenges [16]. Moora introduces a novel MCTM technique developed to address shortcomings in traditional procedures. The feasibility of this new approach is assumed based on its potential benefits. The literature on Multi-Criteria Decision Making (MCDM) indicates that MOORA, while requiring processing time, proves effective in resolving complex issues. Furthermore, the consistent nature of MOORA suggests that it demands minimal setup and offers a reliable solution [17]. The institution employs a decision-making tool named MOORA to address various situations. This tool is particularly useful in quickly identifying scholarship candidates through a machine selection technique, aiming to enhance educational achievement, especially for underprivileged children [18]. MOORA, a green multi-criteria selection method, handles high heterogeneity and diverse components for comprehensive analysis. It effectively resolves complex decision-making challenges, despite occasionally yielding grades with conflicting results. The technique considers both positive and negative standards, striving to select the optimal option [19]. MOORA is a multi-objective optimization approach, widely used for navigating and improving processes. It encourages experimentation with new ideas and is considered a valuable and versatile strategy [20]. The method's ability to recall all attributes and their weights enhances the accuracy of alternative evaluations. Its simplicity makes it easy to understand and implement, applicable to decision problems of any size and nature. Combining features leads to more precise targeting and streamlines the decision-making process [21]. The acronym MOORA stands for Multiple Objective or Multiple Criteria Optimization Based on Ratio Analysis. It is an optimization mechanism that simultaneously considers two or more conflicting attributes. This approach finds applications in diverse decision-making scenarios within the complex supply chain environment, such as selecting warehouse locations, suppliers, products, and method designs [22]. In failure prioritization using MOORA, each identified failure is assigned excellent priorities, minimizing significant shortcomings of the conventional Risk Priority Number (RPN) score and selection process. By incorporating range concept utilization, the method provides reliability and delivers logical outcomes to decision-makers. Comparative analysis with traditional approaches demonstrates that disasters are thoroughly prioritized and identified through this technique [23]. The Moora Analysis is revisited with a focus on recent expert research, emphasizing the utilization of the MOORA and MOOSRA approaches based on the latest available statistics. In the context of the initial selection method, these approaches are preferred. The MOORA and MOOSRA methods are applied for decision-making, contributing to diversity and innovation in a production setting. This method proves highly reliable, particularly in economic welfare assessments, where the ratio expresses a preference for the numerator over the denominator. From an ideological perspective, the MOORA and MOOSRA techniques align with other established performance evaluation methods. Both the ratio device and the benchmark MOORA approach with components are employed, considering the type and significance of goals and options in the simulation of port planning. Various stakeholders, including local, state, and federal governments, as well as collaborating organizations, play crucial roles in this process. While consumer sovereignty is indirectly linked to the industrial process, authorities are acknowledged as valid representatives of customers. In the context of decision-making for a CNC machine tool in a collaborative environment, MOORA is employed to address subjective, unreliable, and conflicting value issues. This approach navigates the complexities of decision-making by integrating a variety of fuzzily articulated language variables. The discussion on MULTI-MOORA Ranking orders across regions is presented on this page, summarizing the outcomes through a comparative analysis.

3. RESULTS AND DISCUSSION

TABLE 1. Social interaction in virtual environments

	User Satisfaction	Social Interaction Quality	System Resource Usage	Learning Curve
Virtual Reality (VR) Chartrooms	0.85	0.75	5.20	8.10
Social VR Platforms	0.92	0.80	4.80	7.50
Online Multiplayer Games	0.88	0.78	5.50	8.30
Virtual Conferences and Events	0.78	0.70	4.30	7.80
Augmented Reality (AR) Social Apps	0.95	0.85	6.00	8.50

Table 1 shows compare above values User Satisfaction: AR Social Apps have the highest user satisfaction (0.95), indicating that users find these applications very satisfying. Social VR Platforms also have high user satisfaction (0.92). VR Chat rooms and Online Multiplayer Games have slightly lower user satisfaction, but still reasonably high (0.85 and 0.88 .Virtual Conferences and Events have the lowest user satisfaction among the listed categories (0.78). Social Interaction Quality: AR Social Apps have the highest social interaction quality (0.85). Social VR Platforms and Online Multiplayer Games also have high social interaction quality (0.80 and 0.78,VR Chartrooms and Virtual Conferences and Events have lower social interaction quality (0.75 and 0.70, System Resource Usage: AR Social Apps have the highest system resource usage (6.00), suggesting that they may demand more from the system. VR Chat rooms, Social VR Platforms, Online Multiplayer Games, and Virtual Conferences and Events follow in decreasing order of system resource usage (5.20, 4.80, 5.50, and 4.30. Learning Curve: AR Social Apps have the highest learning curve (8.50), indicating that they might be more challenging for users to learn. Online Multiplayer Games and Virtual Conferences and Events have the next highest learning curves (8.30 and 7.80. VR Chat rooms and Social VR Platforms have lower learning curves (8.10 and 7.50).

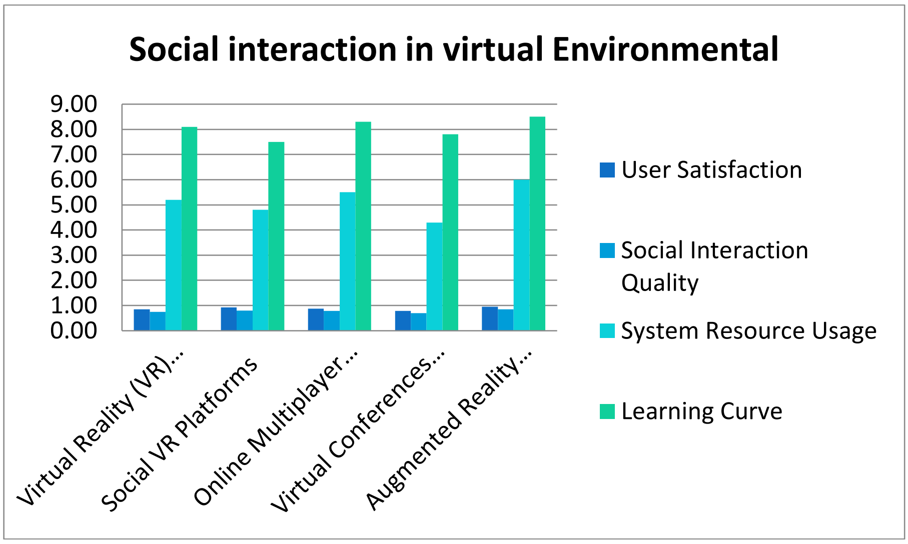

FIGURE 1. Social interaction in virtual environments

Figure1 illustrates the graphical representation of Social interaction in virtual environments

TABLE 2. Divide & Sum

0.7225	0.5625	27.0400	65.6100
0.8464	0.6400	23.0400	56.2500
0.7744	0.6084	30.2500	68.8900
0.6084	0.4900	18.4900	60.8400
0.9025	0.7225	36.0000	72.2500
3.8542	**3.0234**	**134.8200**	**323.8400**

Table 2 shows the Divide & Sum matrix formula used this table.

TABLE 3. Normalized Data

User Satisfaction	Social Interaction Quality	System Resource Usage	Learning Curve
0.4330	0.4313	0.4478	0.4501
0.4686	0.4601	0.4134	0.4168
0.4482	0.4486	0.4737	0.4612
0.3973	0.4026	0.3703	0.4334
0.4839	0.4888	0.5167	0.4723

$$X_{n1} = \frac{X1}{\sqrt{(X1)^2 + (X2)^2 + (X3)^2 \ldots}} \ldots \ldots \ldots \ldots \ldots (1)$$

Table 3 shows the various Normalized Data, Alternative: Virtual Reality (VR) Chartrooms , Social VR Platforms, Online Multiplayer Games, Virtual Conferences and Events, Augmented Reality (AR) Social Apps Evaluation preference User Satisfaction, Social Interaction Quality, System Resource Usage, Learning Curve. Normalized value is obtained by using the formula.

TABLE 4. Weight

Weight			
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25

Table 3 shows weight. Each factor is assigned a weight of 0.25, and the total sum of weights is 1.0 (since there are 4 factors, each with a weight of 0.25).

TABLE 5. Weighted normalized decision matrix

Weighted normalized decision matrix			
0.1082	0.1078	0.1120	0.1125
0.1172	0.1150	0.1033	0.1042
0.1121	0.1121	0.1184	0.1153
0.0993	0.1006	0.0926	0.1084
0.1210	0.1222	0.1292	0.1181

$$X_{wnormal1} = X_{n1} \times w_1 \ldots \ldots \ldots \ldots \ (2)$$

Table 3 shows the various Normalized Data, Alternative: Virtual Reality (VR) Chart rooms , Social VR Platforms, Online Multiplayer Games, Virtual Conferences and Events, Augmented Reality (AR) Social Apps Evaluation preference User Satisfaction, Social Interaction Quality, System Resource Usage, Learning Curve. Normalized value is obtained by using the formula (2).

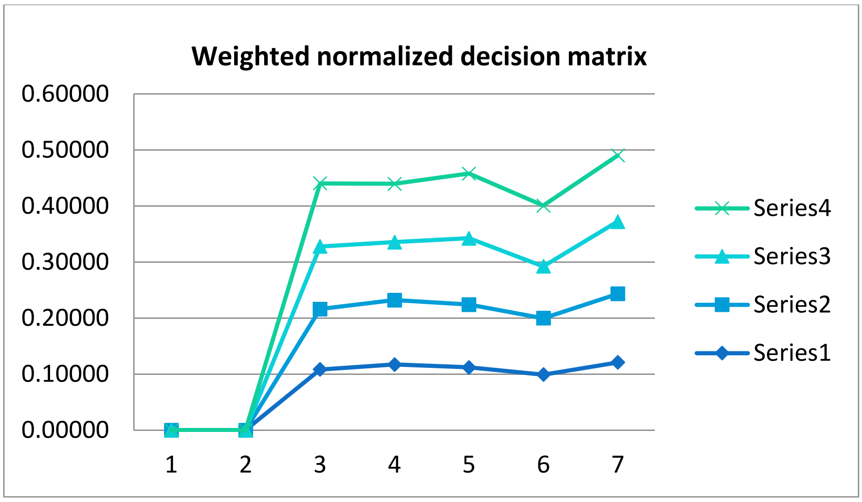

FIGURE 2. Weighted normalized decision matrix

Figure1 illustrates the graphical representation of Social Weighted normalized decision matrix

TABLE 6. Assessment value& Rank

	Assessment value	**Rank**
Virtual Reality (VR) Chat rooms	-0.0084	4
Social VR Platforms	0.0246	1
Online Multiplayer Games	-0.0095	5
Virtual Conferences and Events	-0.0010	2
Augmented Reality (AR) Social Apps	-0.0041	3

$$\text{Assesment value} = \sum X_{wn1} + X_{wn2} - X_{wn3} \qquad (3).$$

Table 6 shows the Assessment value& Rank used. The Assessment value for Virtual Reality (VR) Chat rooms -0.0084, Social VR Platforms 0.0246, Online Multiplayer Games -0.0095, Virtual Conferences and Events -0.0010, Augmented Reality (AR) Social Apps -0.0041., the final rank of this paper, Augmented Reality (AR) Social Apps is in 3rd rank, Virtual Conferences and Events is in 2nd rank, Virtual Reality (VR) Chat rooms is in 4th rank, Online Multiplayer Games is in 5th rank, and the Social VR Platforms is in 1st rank. The final result is done by using the Moora method.

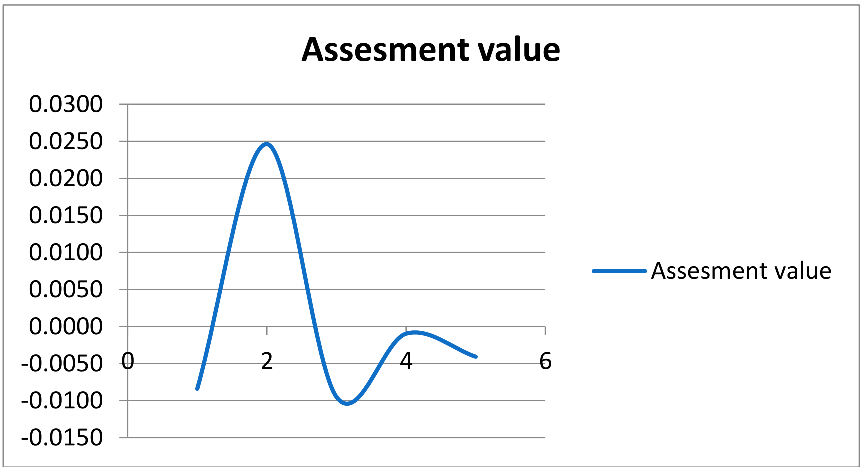

Table 6 shows the Assessment value. The Assessment value for Virtual Reality (VR) Chat rooms -0.0084, Social VR Platforms 0.0246, Online Multiplayer Games -0.0095, Virtual Conferences and Events -0.0010, Augmented Reality (AR) Social Apps -0.0041.

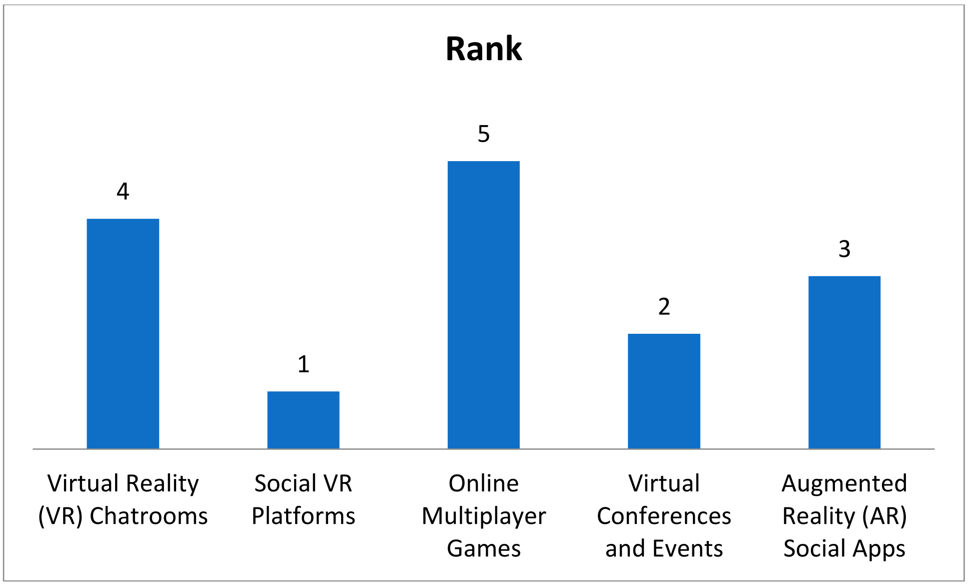

FIGURE 4. Rank

The final result of this paper, Augmented Reality (AR) Social Apps is in 3rd rank, Virtual Conferences and Events is in 2nd rank, Virtual Reality (VR) Chat rooms is in 4th rank, Online Multiplayer Games is in 5th rank, and the Social VR Platforms is in 1st rank. The final result is done by using the Moora method.

4. CONCLUSION

Social interaction in virtual environments represents a dynamic and evolving landscape with profound implications for human connection and collaboration. As technology continues to advance, these environments provide an immersive platform for individuals to engage, communicate, and build relationships in novel ways. The diverse range of virtual spaces, from social media platforms to virtual reality simulations, offers users an unprecedented level of interactivity. While virtual interactions cannot fully replace face-to-face communication, they offer unique advantages, fostering global connections, transcending physical barriers, and accommodating diverse preferences. The challenges of virtual interactions, such as the potential for misinformation and the need for digital etiquette, underscore the importance of thoughtful design and responsible use. As society navigates this digital frontier, it becomes imperative to strike a balance between the benefits and pitfalls of virtual socialization, ensuring that technology enhances rather than diminishes the richness of human connection.

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