**Statistical Study on Increasing Usage of AR/VR in Real World**

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**Abstract**

Augmented and Virtual Reality have emerged as powerful technologies to learn skills, revolutionizing the way people learn skills related to various fields, enhancing the immersive aspect of activities and applications in all fields thus making a real impact on the user-experience. This study provides a statistical and analytical view using available data about their increasing usage and implementations, the positive impact of various implementations & applications and increasing popularity of commercial AR/VR products globally. This research intends to help in analyzing the current state of AR/VR technology globally as well as forecast on the increasing usage of AR/VR through a projection of its increasing revenue.

Keywords: Augmented Reality, Virtual Reality, Statistical, Analytical, Increasing usage, Positive impact, Global popularity, Commercial products, Projection

**1. Introduction**

Augmented Reality (AR) and Virtual Reality (VR) are two great technologies that have evolved the way people interact with the digital world. Augmented Reality involves using technology to create an “Augmented” version of reality by superimposing digital information over the real world, while Virtual Reality can use technology to create a simulated environment that creates “Virtual Reality” that you can move around in and experience as if you were really there **[1]**. Both technologies use special equipment such as headset or glasses to bring these experiences to life.

**Augmented Reality (AR)**

Augmented reality (AR) involves overlaying visual, auditory, or other sensory information onto the real world to enhance one’s experience, enhancing various activities such as gaming, product visualization, marketing, architecture, and education. Utilizing human senses like sight, sound, and touch, AR combines computer-generated data with reality via hardware and software. Its versatility extends to metaverse implementations and corporate applications, contributing to the growing trend of immersive computer experiences **[2]**.

**Virtual Reality (VR)**

Virtual reality (VR), the use of computer modelling and simulation that enables a person to interact with an artificial three-dimensional (3-D) visual or other sensory environments. VR applications immerse the user in a computer-generated environment that simulates reality through the use of interactive devices, which send and receive information and are worn as goggles, headsets, gloves, or body suits **[3]**. The goal of VR technology is to create environments indistinguishable from reality, offering users an immersive experience. VR has been instrumental in providing realistic simulations for training purposes, such as flight simulation for military training, and enhancing experiential learning across various domains.

**Education and skill training**

AR/VR systems have revolutionized training by offering realistic simulations for various real-life activities, promoting cost-effective and safer training methods. AR/VR technology enriches the learning process by placing individuals in diverse scenarios, enhancing experiential learning across domains like healthcare and emergency preparedness **[4]**. These technologies have been instrumental in providing simulated surgical training and emergency scenario training. Police departments in countries like the Netherlands and the UK employ AR/VR for training to prepare for emergency scenarios.

**Increasing Usage and Adoption**

The adoption of AR/VR technology is rapidly increasing, with global shipments of AR/VR headsets projected to reach 43.5 million by 2025 **[5]**. [The global extended reality (XR) market, which includes AR, VR, and mixed reality (MR), is expected to rise to over $100 billion U.S. dollars by 2026](https://www.statista.com/outlook/amo/ar-vr/india) **[6]**. The AR & VR market in India is projected to reach a revenue of ₹US$759.9m in 2024 and is expected to have approximately 742.3m users by 2028 **[6]**. Various sectors, including education, healthcare, retail, and real estate, are increasingly employing AR/VR technologies to enhance customer experiences and provide innovative solutions.

**Industry Adoption**

AR/VR technologies are widely adopted across industries, from gaming and consumer goods to education and healthcare. Popular applications and software include OSSOVR, PokemonGo for gaming, Tilt Brush for painting, Enscape for architectural design, Toyota’s TeenDrive 365 and Hyundai Virtual Guide. These technologies are transforming businesses by providing immersive and interactive experiences for customers, driving industry growth and innovation.

This Research paper will further explore and discuss such innovations, their degree of benefit and effectiveness, as well as further and upcoming implementations. This study will mainly employ existing literature, case studies and empirical research to elucidate the role of AR/VR technology in shaping the future of skill acquisition and lifelong learning.

**2. Examples, Implementations and Related Work**

|  |  |  |  |
| --- | --- | --- | --- |
| Reference | Subject | Method | Findings |
| Abdullah M. Al-Ansi **[7]** | AR and VR development in Education | Analyzing | Adoption of AR and VR in education recent years |
| Dr A Udaya Shankar **[8]** | Impact of AR and VR in Education | Literature Review | Improvement in teaching and learning experience |
| Patrice Labedan **[9]** | VR in pilot training | Case Study | Cardiac activities during training |
| Zain Hussain **[10]** | Use of AR and VR for improving knowledge and skills in medical students | Randomized Trials and Pre-test, Post-test | Effectiveness of AR/VR devices for teaching medical students |
| Min-Chai Hsieh **[11]** | AR for primary marine wildlife education | ADDIE model with Pre and Post test | Using augmented reality to enhance learning experience of children for marine wildlife education |
| İbrahim Yaşar Kazu **[12]** | Engagement of AR and VR in higher studies | Data Analysis | VR's adaptability and potential for personalized learning experiences contributing to more efficient and effective learning |
| Jing Zhang **[13]** | Trends in the Use of Augmented Reality, Virtual Reality, and Mixed Reality in Surgical Research | Global Bibliometric and Visualized Analysis | [use of augmented reality (AR), virtual reality (VR), and mixed reality (MR) in surgical research](https://link.springer.com/article/10.1007/s12262-021-03243-w) increased globally |

Table 1: References for related works

**Al Ansi (2023)** analysed AR/VR in education, noticing a dramatic research increase in the preceding decade. Highlighted exponential adoption during COVID-19 and how it enhances e-learning interactions **[7]**. Similarly, **Dr Shankar (2023)** conducted a literary review showing how strong the impact of AR/VR is on education by utilising descriptive methods and questionnaires **[8]**. **Patrice (2021)** Performed a Case study on use of VR in pilot training, comparing real life and simulation data to propose improvements **[9]**. **Hussain (2021)** used randomized trials to studying the effectiveness of AR/VR in improving knowledge and skill gain for medical students **[10]**. **Hsieh (2017)** applied ADDIE model to study the effect of AR in marine wildlife education, finding improvement in learning experiences for children **[11]**. **Kazu (2023)** performed data analysis on the engagement of AR and VR in higher studies. The findings showed that VR’s adaptability and potential for personalized learning experiences contribute to more efficient and effective learning **[12]**. Lastly, **Zhang (2022)** conducted a global analysis on AR/VR/MR trends in surgical research, which indicated rise in its usage globally with USA leading in contributions, also suggesting continued growth **[13]**.

The amalgamation of such studies shows not only the different areas in which implementations of AR/VR technology being developed but also that AR/VR is helpful and would be growing in usage in the future. Thus comes our hypotheses,

H1: The usage and implementation of AR/VR in various fields is still increasing.

H2: Developing implementations will have a majorly positive impact on the AR/VR technology field.

H3: Common use commercial implementations of AR/VR are becoming increasingly popular.

**3. Information Study**

**Hypothesis 1:**

|  |  |
| --- | --- |
| **Education** | VR in education valued at USD 28.85B in 2024, projected to reach USD 67.02B by 2029. 1 in 5 adults in US experience AR and VR. **[14][15]** |
| **Healthcare** | AR/VR experienced in healthcare valued at USD 658.2M in 2020, expected to grow to USD 8.5B by 2028 with a CAGR of 18.8% from 2023 to 2030. **[16]** |
| **Gaming** | virtual reality (VR) in gaming market size was valued at USD 7.92 billion in 2021 and is projected to reach USD 53.44 billion in 2028, at a CAGR of 31.4% during 2021-2028 **[17]** |
| **Automobiles** | the global virtual reality in automotive market size was valued at USD 759.3 million in 2019 and is projected to reach USD 14,727.9 million by 2027, exhibiting a CAGR of 45.1% during the forecast period **[18]** |
| **Engineering** | The engineering and construction sectors’ VR and AR market is projected to reach USD 4.76 billion by 2025. **[19]** |
| **Military** | The spending on VR is approximately $6.4 billion in the US, $5.1 billion in the Asia Pacific region, and $3 billion in Europe, Middle East, and Africa combined. **[20]** |
| **Manufacturing** | The global augmented reality & virtual reality in manufacturing market size was valued at USD 8.01 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 28.3% from 2023 to 2030. **[21]** |
| **Entertainment** | VR/AR usage rates: social media(47%), followed by videogames (40%), live streaming (32%), film and entertainment (31%), advertising (28%), and music (28%). **[22]** |

Table 2: Various stats regarding AR/VR in different fields

Graph 1: Top 5 countries in terms of AR/VR penetration

Graph 2: Top 5 countries in terms of AR/VR revenue

Graph 3: Market Size of AR/VR

The various graphs present the increase in usage, market size and revenue of different distributions, they represent the fact that the usage and implementation for AR/VR in various fields globally is increasing throughout the years thereby suggesting that H1 is true.

**Hypothesis 2:**

AR and VR technologies are continuously reshaping multiple sectors, like education, healthcare, gaming, automotive, engineering, military, manufacturing and entertainment. Throughout all fields it can be said that immersiveness is the common attraction, as the AR/VR technologies allow the simulation of various things with good accuracy, allowing people to gain experience without experiencing those situations in reality. In learning and training part of the various fields especially education, AR/VR also allows catering to different learning styles.

|  |  |
| --- | --- |
| Fields | Use/ Benefits |
| Healthcare | Training, diagnostics, surgery, and fitness. Foster a deeper understanding of complex concepts, ignite student curiosity, and promote collaborative learning. |
| Gaming | Immersive Interaction, smell, touch, physics, movements. |
| Automotive | Design, production, sales and marketing |
| Engineering | Architecture, Engineering and Construction. Enhance comprehension of intricate processes |
| Military | Equipment training, flight training, weapons training etc. Revolutionize the way armed forces personnel access information, plan mission strategy, and conduct critical operations. |
| Manufacturing | Modernize and streamline processes, eliminate costly errors and reduce downtime |
| Entertainment | Enhance product visualization and the customer experience. |

Table 3: Benefits and uses of AR/VR in various fields

Spatial computing is a technology that allows the seamless integration of devices into the physical

Spatial computing is a technological advancement that facilitates the seamless integration of devices into the physical environment, resulting in a more natural and intuitive digital world user experience **[29]**. This technology enables accurate mapping and overlay of virtual content onto the user's environment, boosting intuitiveness and opening up possibilities for improved productivity, visualization, gaming, and education, GPS etc.

Immersive commerce is an extension of e-commerce that focuses on improving customer experience by using augmented reality, virtual reality and immersive technology to create virtual smart stores from existing brick and mortar locations **[30]**. Immersive Commerce Platforms leverage AR/VR to revolutionize online shopping by offering realistic product previews, virtual try-ons, and interactive visualizations, enhancing the shopping experience and increasing customer engagement and conversion rates.

Emotion recognition is the process of identifying human emotion **[31]**. Emotion recognition in VR utilizes biometric sensors and machine learning algorithms to analyze users' expressions and gestures, enhancing emotional engagement and personalization in virtual experiences. This technology dynamically adjusts content based on users' emotional states, improving communication, therapy, and training applications. To date, the most work has been conducted on automating the recognition of facial expressions from video, spoken expressions from audio, written expressions from text, and physiology as measured by wearables **[31]**.

Haptic feedback technologies simulate tactile sensations in AR/VR environments, allowing users to feel and interact with virtual objects realistically, enhancing simulations, gaming experiences, and medical applications. Haptic technology facilitates investigation of how the human sense of touch works by allowing the creation of controlled haptic virtual objects **[32]**.

Six degrees of freedom (6DOF), or sometimes six degrees of movement, refers to the six mechanical degrees of freedom of movement of a rigid body in three-dimensional space **[33]**. Six Degrees of Freedom Tracking enables users to move freely in physical space while accurately tracking their movements in six dimensions, enhancing immersion, comfort, and reducing motion sickness in VR experiences.

The previously mentioned applications/implementations of AR/VR and many more such implementation indicate the positive impact that such implementations will have in development of AR/VR as well as information science and even commerce. Thereby proving H2 to be right.

**Hypothesis 3:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Apple Arkit [37] [40]** | **Google ARcore [38][39]** | **Meta quest [34][42]** | **HTC Vive [35]** | **Sony Playstation VR [36][43]** |
| **Launched date** | 5 June 2017 | 1 March 2018 | 21 May 2019 | 5 April 2016 | 13 October 2016 |
| **Developed by** | Apple Inc. | Google | Meta platforms | HTC corporation | Sony Group |
| **Based on** | AR(augmented reality) | AR(augmented reality) | VR ( Virtual Reality) | VR ( Virtual Reality) | VR( Virtual Reality) |
| **Features** | * Device motion tracking * World tracking * Scene understanding * display conveniences | * Motion tracking. * Environmental understanding. * Depth understanding. * Light estimation. * User interaction. * Oriented points. * Anchors and trackable. * Augmented Images. | * Boundary, Pass-through and Spatial Anchors * Voice commands and voice dictation * Display settings * Accessibility features | * Eye tracking * Motion Tracking * Audio Strap * Wireless Adapter * Facial Tracker | * 5.7 inch OLED panel * 1080p resolution * Social Video screen enabled * 3D audio effect * 360 degree head movement |
| **Usage Area** | IOS Mobile Applications like IKEA place, MeasureKIt, jigshaw, kings of pool etc. | Android applications like Measureapp, INKHUNTER, Mole Catch AR, Beer Pong etc. | Gaming, Entertainment, Fitness and Wellness, Travel, Design and playing virtually with friends | Gaming, Education and business sector | Entertainment and gaming |
| **Market Revenue** | 50.37 billion | No data available | 1.9 billion **[42]** | 3 million | 25.96 billion**[43]** |
| **No. of Units Sold** | Not applicable | Not applicable | 2.03 million | 1.4 million | 50 million**[43]** |

Table 4: Growing and famous Commercial AR/VR Products

The above tabulated data well indicates how AR/VR is being used in day-to-day life and how its reach and sales is increasing thereby signifying the increasing popularity of AR/VR commercial products worldwide, proving H3 to be true.

**4. Discussion on Recent Trend**

**Apple Vison Pro: Current AR/VR trend**

Apple Inc. developed the mixed-reality headset known as Apple Vision Pro. At Apple's Worldwide Developers Conference on June 5, 2023, it was revealed, and on January 19, 2024, pre-orders went live. On February 2, 2024, it was made available for purchase in the United States. Apple describes the Apple Vision Pro as a "spatial computer" that combines digital and physical media. Physical inputs can be used to communicate with the system, including eye tracking, motion gestures, and speech recognition.

The gadget has Apple's M2 chip, two OLED panels with a combined pixel count of 23 million, 12 cameras, five sensors, six microphones, and Siri. In order to minimise lag, Apple's new R1 chip operates in parallel with the M2 chip in the headset. The 256GB storage variants are priced at $3,499; the 512GB version is priced at $3,699, and the 1TB edition is priced at $3,899.

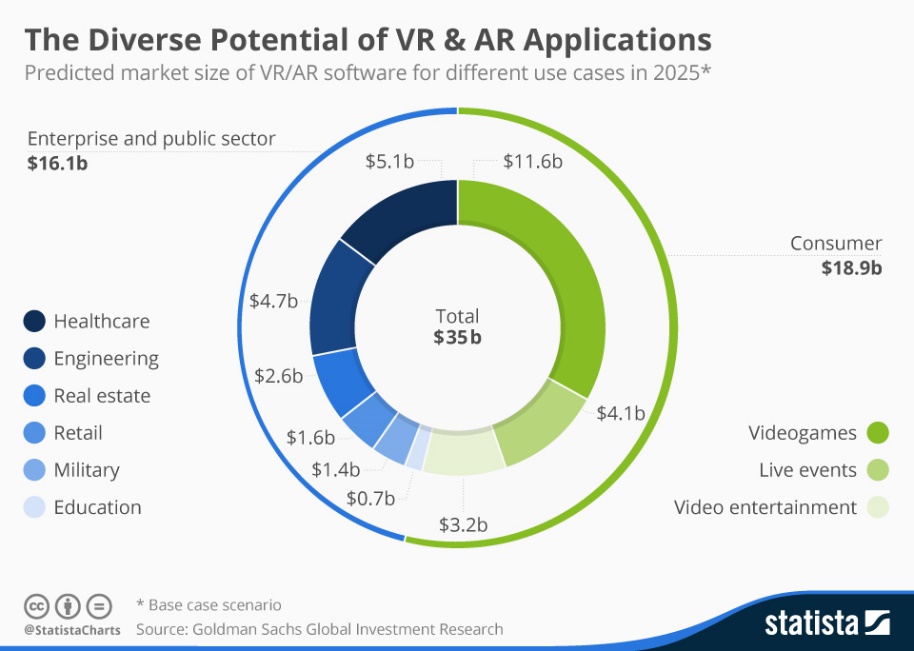
Apple's Vision Pro headset is more popular than expected, even with its higher price tag and shorter battery life. The company originally predicted sales of 150,000 to 200,000 units, but the actual numbers have risen past 200,000 units, according to seasoned Apple analyst Ming-Chi Kuo. Additionally, he disclosed that the return percentages dropped to 1%.

The Vision Pro may evolve into a platform that leads to new inventions and markets in the future rather than merely an AR/VR headset. The Vision Pro will probably completely reimagine virtual reality experiences in a variety of industries, including education, design, healthcare, and entertainment, as spatial computing continues to advance. Additionally, in the near future, we will see Vision Pro as an engaging and dynamic learning platform.

**5. Conclusion**

The Usage and implementation of AR/VR is projected to keep increasing with the same boom as more implementations are added so will sales and market size of AR/VR will increase. This increase in implementations will bring positive impacts to user, companies, the field AR/VR. With the increasing performance from implementations, more convenient and well implemented devices will come to the commercial AR/VR products market, it’s a given these products will do well in said market. It is noted, that all three hypotheses converge and affect each other with various points of connection.

**6. Future Scope:**



Graph 4: Forecast

The graph titled “The Diverse Potential of VR & AR Applications” provides predictions for the market size of Virtual Reality (VR) and Augmented Reality (AR) software across different sectors in 2025. According to Goldman Sachs, who predict the industry reaching a value of $80 billion a year ($35 billion software and $45 billion hardware) by 2025, the potential of AR/VR tech is extremely diverse. The total predicted software market size is $35 billion, divided into the Enterprise and Public Sector ($16.1 billion) and the Consumer sector ($18.9 billion). The Enterprise and Public Sector is further broken down into Healthcare ($5.1 billion), Engineering ($4.7 billion), Real Estate ($2.6 billion), Retail ($1.6 billion), Military ($1.4 billion), and Education ($0.7 billion).

In the Consumer sector, the market is segmented into Videogames ($11.6 billion), Live Events ($4 billion), and Video Entertainment ($3 billion). The graph highlights the diverse potential of VR and AR applications, with healthcare and video games predicted to have the largest shares in their respective sectors. These predictions, sourced from Goldman Sachs Global Investment Research, represent a base case scenario, indicating that actual outcomes could be higher or lower depending on various factors.

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