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Bridging the gap with 5G: A look at how next-generation technology is transforming telemedicine in India

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A B S T R A C T

This analysis delves into the evolving telemedicine landscape in India. It dissects the service models employed by both government and private healthcare providers, highlighting their distinct approaches in delivering telemedicine services. The study unveils how government initiatives strive to bridge geographical gaps and widen accessibility, while private players leverage technology for a more patient-centric experience. Furthermore, the research investigates patient perceptions of the impact of 5G technology on telemedicine services. It evaluates aspects crucial for effective consultations, such as connected devices, connection stability, video quality, speed of data transfer, and overall user satisfaction. This analysis reviews patient experiences with 5G and its potential advancements in transforming telemedicine delivery. The exploration then extends to the potential advantages and growth prospects for telemedicine service providers in India's healthcare sector. The analysis highlights key benefits like increased geographical reach, improved cost-effectiveness for both patients and providers and enhanced scalability to cater to a wider population. Additionally, it explores the possibilities of deeper technological integration within healthcare systems, market expansion into underserved regions, and the role of supportive regulations in fostering innovation. By examining potential investment opportunities and strategic partnerships, the research offers valuable insights for stakeholders interested in capitalizing on the burgeoning telemedicine market in India. This comprehensive examination provides critical insights into the current state and future prospects of telemedicine in India. It sheds light on the evolving landscape, the impact of technological advancements, and the potential for this innovative approach to revolutionize healthcare delivery across the nation.

1. Introduction

The rapid proliferation of various information and communication technologies is inducing swift transformations across industries, ushering in a dynamic landscape brimming with novel opportunities. Digital transformation is profoundly influencing every sector, including healthcare, fundamentally altering operational paradigms and catalyzing innovation (Georgiou, Georgiou, & Satava, 2021). The advent of 5G technology is revolutionizing the communication sphere by outstripping conventional applications with its speed, reduced latency, and augmented capacity. Scientists are exploring its potential applications in their respective domains, with practical scenarios being developed for integration into the healthcare sector (PricewaterhouseCoopers, 2021). The COVID-19 pandemic has accelerated the adoption of connected medical devices, particularly for remote patient monitoring and telemedicine. This enables individuals to manage their health effectively from home by receiving online diagnoses and tracking their activities, thereby reducing reliance on in-person visits to healthcare facilities (Deloitte, 2021). The World Health Organization (WHO) defines telemedicine as the practice wherein healthcare professionals utilize information and communication technologies to deliver healthcare services to patients through remote clinical care, information transfer, and disease prevention and injury prevention. It encompasses research,

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evaluation, and continuous education for healthcare providers, all aimed at enhancing public health (World Health Organization, 2010). Undoubtedly, telemedicine primarily targets reducing health disparities among diverse socio-economic strata and ensuring equitable access to medical resources, particularly for those in need. The overarching goal of this technological solution is not only to streamline processes but also to render them swift, cost-effective, and highly accurate. Enhancing healthcare accessibility represents another stride in telemedicine's journey, proving beneficial not only for remote and underserved regions but also for individuals with severe mobility impairments (Parameswara & Olickal, 2023).

It is imperative for stakeholders across the healthcare spectrum to comprehend the communication requisites associated with health applications driven by 5G technology. Establishing such understanding necessitates collaboration among contributors, providers, service providers, and regulators. Guided by this awareness, the selection of an appropriate wireless technology capable of fulfilling these objectives and supporting the performance requirements of healthcare applications becomes more streamlined and apparent. However, 5G's support for low latency and high-speed transmission of vast data quantities facilitates advancements such as remote robotic surgery and in-ambulance treatment. Thus, the effective planning, implementation, and evaluation of such systems hinge on robust technical foundations rooted in an understanding of the communication prerequisites to sustain desired functionalities. The quantum leap in technical features offered by 5G compared to 4G underscores its potential, as it can accommodate significantly more connections and achieve speeds approximately 100 times faster than 4G. Ultra-low latency further enhances these advantages by minimizing the time taken for network requests to traverse.

The term "telemedicine", sometimes referred to as "telehealth", denotes the provision of healthcare remotely via electronic means of communication and information and communication technologies (ICTs). This obviates the need for patients to be physically present for various healthcare services provided by their medical practitioners or other healthcare providers (Rajkumar et al., 2023). The Indian government has accorded considerable importance to telemedicine initiatives, exemplified by the formulation of telemedicine practice guidelines and the e-Sanjeevani initiative. Moreover, the establishment of 23 tele-mental health centers overseen by the National Institute of Mental Health and Neurosciences underscores a significant commitment to advancing tele-mental healthcare. Collectively, these initiatives epitomize pioneering endeavors reshaping the healthcare landscape across India (Suhas et al., 2022).

2. Objective

To assess a patient's perception of 5G technology's impact on the overall quality, experience and price of telemedicine services.

3. Literature Review

3.1 History of Telemedicine in India

In 2001, the Indian Space Research Organization (ISRO) introduced telemedicine to India through the Telemedicine Pilot Project. Subsequently, in 2005, the Ministry of Health and Family Welfare (MoHFW) collaborated with the Health Ministry to form the National Telemedicine Taskforce. This paved the way for various national initiatives such as the National Rural Telemedicine Network, the Integrated Disease Surveillance Project (IDSP), the National Cancer Network (ONCONET), the Digital Medical Library Network, and the National Medical College Network. These initiatives primarily aim to enhance healthcare accessibility and education through digital means across the country. (Chellaiyan, Nirupama, & Taneja, 2019). India had not widely used telemedicine before the COVID-19 pandemic, and its early experiments had not always been effective. Furthermore, before the rules were released on March 25, 2020, telemedicine was not illegal. In India, several court rulings hindered the use of telemedicine. Following a top court in Maharashtra, one of the biggest states in India upheld negligent behavior charges for an incident involving a telephone consultation that resulted in the patient's death, the public questioned the value of telemedicine (Agarwal, 2018). Because there was no clear policy or regulation in place and a criminal negligence verdict, the future of telemedicine in India was therefore uncertain until COVID-19 brought the issue to light. The ability of telemedicine to transfer medical data over large distances is a benefit. In a published study during the first decade of the twentieth century, the first known usage of telemedicine was the transmission of electrocardiograms over telephone lines. (Chellaiyan, Nirupama, & Taneja, 2019). The conveyance of information concerning health-related occurrences, such as outbreaks and epidemics, using ancient hieroglyphics and scrolls may be the earliest known example of telemedicine (Hurst, 2016).

Nearly fifty years ago, telemedicine was written off as a costly, unreliable, and complicated technology. Thanks to the fast advancements in the information technology and telecommunications sectors, telemedicine is today a reliable, workable method. Telemedicine has proven successful for practitioners and medical specialties across a wide range of specializations (Sood et al., 2007). The first telemedicine service in the country was introduced by Apollo Hospital in the village of Aragonda in the Chittoor District of Andhra Pradesh. It was linked to the Apollo Hospital in Chennai through telemedicine. The mammography services provided by Sri Ganga Ram Hospital in Delhi, the cancer services provided by Regional Cancer

Center in Trivandrum, and the surgical procedures performed at Sanjay Gandhi Postgraduate Institute of Medical Sciences in Lucknow are a few noteworthy examples of how well telemedicine services are used in India. (Agarwal et al., 2020)

3.2 Telemedicine Growth

In India, telemedicine usage has been rising recently, particularly in the wake of COVID-19. Over the years 2020–25, the Indian telemedicine industry is projected to expand at a CAGR (compound annual growth rate) of 31%, reaching US$5.5 billion. (Ernst & Young, 2020) The need for virtual treatment, which includes telepathology, teleconsultation, teleradiology, and e-pharmacy, is rising as a result of the epidemic. Experts in the healthcare sector predict that firms using machine learning and other cutting-edge technology to diagnose more common diseases in India will continue to garner attention. The prolonged funding freeze, which has impacted health tech alongside other industries, is the drawback. A 2023 Tracxn study states that funding for health tech decreased by 55% in 2022 to a total of $1.4 billion, down from $3.2 billion in 2021. (Deloitte, n.d.) Using telemedicine networks, several prestigious institutions, including AIIMS Delhi, Christian Medical College (CMC), Vellore, PGIMER, Chandigarh, SGPGIMS, Lucknow, and others, are exchanging professional information and engaging in various other educational activities. (Mahapatra & Mishra, 2007) Telemedicine is now a crucial component of standard medical practice in India. In his Republic Day speech, former President Dr. Kalam additionally utilized the term "telemedicine" five times. This is undoubtedly a major driving force in India's quest to grow into a developed country. (Telemedicine in India, 2006)

3.3 Applications of Telemedicine

3.3.1 Tele Education

Utilizing communication technology enables distance learning, which is known for its high interactivity and flexibility. An engaging virtual education platform can provide practical guidance and up-to-date information on the latest developments in precise and effective therapeutic techniques, making learning more adaptable and engaging. (Patil et al., 2002).

3.3.2 Online Consultation

Telehealthcare serves various functions such as preventive care, health promotion, and remote medical assistance. It encompasses activities like consultations and follow-ups. In India, telemedicine has played a crucial role in meeting healthcare needs during large gatherings like the Maha Kumbha melas. For example, the Uttar Pradesh government employs mobile telemedicine vans equipped with videoconferencing technology. These vans facilitate consultations between local doctors and specialists from different hospitals, including highly specialized ones, thereby enhancing access to medical expertise during such occasions. (Agarwal et al., 2020).

3.3.3 Emergency Preparedness

When it comes to human-induced catastrophes like war and rioting as well as natural disasters like earthquakes, tsunamis, and tornadoes, online medical care has the potential to be of great assistance. Since most terrestrial communication connections either malfunction or break during disasters, a transportable and portable telemedicine system with connectivity via satellite and specialized telemedicine applications is suited for disaster relief (Sandhu et al., 2021).

3.3.4 Telemedicine in the Home

By leveraging telemedicine technology, individuals who are elderly or underprivileged and unable to leave their homes due to chronic illnesses can receive care in the comfort of their own homes. This eliminates the need for patients to travel long distances for check-ups, as home healthcare providers can monitor them centrally. Remote patient monitoring offers a faster and more cost-effective alternative to traditional methods of care. (Patil et al., 2002).

3.5 Benefits of Telemedicine

The bulk of the included research emphasized the advantages of telemedicine and predicted its continued use in the nation's healthcare system during the global outbreak (Agarwal et al., 2020; Sandhu. An et al., 2021). Five sub-themes were identified as the primary drivers behind the continued use of teleconsultation: improving patient-provider satisfaction, accessibility, and cost-effectiveness, providing new and follow-up treatment, providing immediate medical advice, and reducing the gap in healthcare between urban and rural areas.

3.5.1 Patient-provider Satisfaction

The studies included in the research demonstrated high levels of satisfaction among both healthcare providers and patients regarding telehealth services. According to Sandhu et al. (2021) and Sahu (2020), 82% of patients who underwent teleconsultations expressed satisfaction with their experience, with 58.1% indicating a willingness to utilize such services again in the future. Rajkumar et al. (Das et al., 2020) found that since physical palpation and thorough examinations are no longer essential for diagnosing and treating dermatological issues, over half of the participants anticipated incorporating teleconsultations into their routine dermatology care. Moreover, the research revealed that both clinicians and patients would recommend telemedicine to others.

3.5.2 Easy accessibility and affordability

Patients can obtain high-quality medical care right at their door with the use of teleconsultations. According to research, people who preferred to keep using telemedicine services discontinued personal consultations while the pandemic was ongoing to reduce their risk of exposure and save time and money on hospital stays. It lessened the inconvenience that patients experienced as a result of costly, lengthy travel. Healthcare providers noted in another study that e-consults provided simple access to specialist care and that it was a valuable supplement to routine consultations (Agarwal et al., 2020).

3.5.3 Both initial and ongoing care

Benefits from teleconsultations have been discovered across the nation, including easier monitoring (Sandhu et al., 2021), which helps to relieve hospital overcrowding (Agarwal, N et al., 2020). According to a teledermatology study, virtual care was offered for both new and follow-up clients during the pandemic, whereas earlier teleconsultations were mostly focused on follow-up care. For both new and follow-up patients, telehealth-based healthcare services were successfully provided. Most patients sought guidance on prescription changes and associated consequences during follow-up conversations, and teleconsultations with new patients comprised of disease sign screening, documentation, and, if necessary, video conferences.

3.5.4 Immediate medical guidance

Parents of epileptic children primarily used telephone consultations to get medical advice. The questions they had concerned antiepileptic medication use and modification, commercial brands, regular check-ups, and possible negative effects of COVID-19 on children with epilepsy (World Health Organization, 2018). Research found that 74.3% of patients receiving routine follow-up care need guidance for changing their medication dosage or continuing their course of treatment (Agarwal et al., 2020). In a different study, patients were most frequently advised to take their medications, followed by questions about appointments and scheduling surgical procedures (Sahu et al., 2020). In a similar vein, Nair et al. were able to successfully contact patients who had undergone epilepsy surgery and offer guidance for medication tapering (Nair et al., 2021). Conversely, Adhikari et al. found that the most frequently given medical advice to patients was modifications in drug dosage or composition or the prescription of a new medication (Adhikari et al., 2021).

Bridging the gap between urban and rural healthcare Lockdown has made it more difficult for patients to be transported to difficult-to-reach places (World Health Organization, 2018). According to the findings of a dermatological survey, around 82% of participants worked in an urban environment, and 50% owned a private clinic (Bhargava & Sarkar, 2020).
Additionally, patients in remote locations may be able to obtain teleconsultations (Das et al., 2020). Patients from rural areas benefit greatly from virtual consultations as they can receive therapy and consultation without having to travel large distances, which saves money and effort (Bhargava & Sarkar, 2020). The majority of the nation's rural and semi-urban areas have access to telecommunications infrastructure and the Internet. Teleconsultation is therefore becoming more crucial in addressing those with limited access to treatment (Nair et al., 2021).

3.5.5 Internet-based Telemedicine Communication

A teleconsultation platform and an online medical information system are two examples of internet-based communication in telehealth that have been previously given in (Wang & Gu, 2009). Through the internet, the network was utilized to link medical professionals, equipment, and data across multiple locations. However, it was observed that the system's limited bandwidth connectivity was restricting the huge amount of medical data transmission. A prototype web-based telemedicine system was created by the authors (Celik et al., 2010). It uses a web browser interface to create a data channel and audio-visual link between the caregiver and the client's house. Other diagnostic functions, including the usage of an ECG, blood pressure, respiration, temperature of the body, and stethoscope, could also be provided by the established data channel.

A wireless IP network with communication via voice as its primary function was examined by (Zhao et al., 2001). The web-based system translates analog speech signals through digital data, adds an IP address, compresses and divides the information into packets, and then permits dissemination across a wireless IP network. TCP/IP addresses make it simple to link standard PCs and other devices to the system because it is internet-based. For telemedicine applications, the system offers multimedia communication capabilities including data, voice, video, and imaging. Medical picture transmission has been demonstrated to cause nodal delay when using the internet, even though 3G and 4G connections can facilitate video conferencing in telemedicine (Saravanan & Sudhakar, 2017). The authors created a parabolic dish antenna that facilitates quick internet-based telemedicine communication to lessen this impact. 5G will hasten the expansion of the Internet of Medical

Things and bring about a significant shift in mobility. With 5G's software-defined networks and network slices, evolutionary algorithms could produce one-of-a-kind apps for various network tiers. The literature study states that low latency, flexibility, ubiquitous mobility, reliability, and fog computing are made possible by 5G and are essential for very large-scale Web of Things applications (Kumari et al., 2019).

3.6 5G in Telemedicine

3.6.1 Comparison with 4G

Presently, mobile data transfer relies primarily on 4G/LTE or Wi-Fi technologies. 4G/LTE boasts minimal signal delay of around 20 ms, optimized mainly for internet activities like browsing and video streaming. However, this delay falls short for real-time sensor data integration. Wi-Fi, while an option, faces interference risks due to its use of unsecured radio bands (Sauter, 2018). Comparatively, the forthcoming 5G telecommunication standard outshines existing 4G/LTE standards in various aspects. It offers a significant increase in data transmission speed, up to 10GB/s, along with impressively low latency of less than 1 ms and a capacity increase of up to 1000 times. This ensures a quality of service almost akin to real-world data response times of zero. Millimeter wave technology, integral to 5G networks, facilitates rapid data transfer rates, reaching several gigabits per second. However, deploying a 5G ultra-dense cellular network necessitates numerous small cells with restricted coverage areas (Andrews et al., 2014). To enhance spectrum efficiency and throughput, massive multi-input, multi-output technology is being developed, allowing simultaneous transmission of multiple data beams in both uplink and downlink applications. Additionally, 5G consumes up to 10 times less energy compared to its predecessor, 4G/LTE (Andrews et al., 2014). Over the next decade, it's predicted that 5G network traffic will surge by 1000-fold, while infrastructure energy consumption will halve from current levels. This reduction is crucial for lowering the overall cost of ownership and mitigating environmental impacts (Andrews et al., 2014). These advancements meet the demands of emerging digital applications such as the Internet of Things (IoT), autonomous driving, machine-to-machine (M2M) connections in industrial settings, and various medical applications that were previously impractical due to technical constraints (Zhang et al., 2018). Particularly, medical systems adhere to the Ultrareliable Low-Latency Communication protocol, mandating sub-millisecond latency and a response rate of less than one packet loss in 105 packets to ensure patient safety.

3.7 Benefits of 5G Enabled Telemedicine

3.7.1 Imaging in Medicine and 5G

As the number of accumulated photos grows, manual segmentation becomes labor-intensive, making analysis and diagnosis challenging. Abd Elaziz et al. (2021) suggest that traditional methods may not suffice for handling large volumes of image data. To address this, Multiplanar Reconstruction (MPR) is employed for automatic sectioning of medical images (SMI), allowing acquisition from any viewing angle. Various technologies, including region-based methods, clustering techniques, deep learning, machine learning, and threshold algorithms, are utilized in this process (Zhang et al., 2017). However, the transmission of hundreds of megabytes of SMI data over networks, particularly via the Internet, poses challenges. Each MPR contact requires rebuilding the raw data, increasing the risk of data breaches and creating bottlenecks. This underscores the potential benefits of 5G communication, combined with System Designed Networks (SDN) and “network slicing”, to enhance Intranet and Internet security and capacity in a more adaptable, efficient, and cost-effective manner.

Conversely, less complex imaging modalities like ultrasound or dermatological image transfer can effectively transmit high-quality images using inexpensive transmission technologies or accessible apps. This also applies to otolaryngologic exams, especially with remote video-otoscopy images, which recent reviews suggest can provide sufficient diagnostic information in most cases and result in high user satisfaction.

3.7.2 Telesurgery in Clinical Practice

The aim of telesurgery, or remote surgery, is to overcome geographical barriers in providing advanced healthcare, even for complex medical procedures and surgeries. By leveraging telemedicine, remote diagnostics, and remote surgery, highly skilled medical expertise can be decentralized from large hospitals to improve the efficiency of healthcare services and yield significant cost savings. Telesurgery represents the most challenging aspect of remote healthcare services, allowing surgeons to control aspects of a procedure from a central location. Successfully validating this application implies validation for a broader range of less demanding remote healthcare applications (Bethea et al., 2004).

3.7.3 Pre-operative Preparation

When the surgeon first sees the patient in the pre-anesthesia area, they need to have access to all the medical records, including both medical data and photos, so they can review everything. If it's a complicated procedure, a lot of surgeons will not only review a complete 3-D reconstruction of imaging studies (MRI, CT, and so on), but they might even used simulation to practice the procedure beforehand. All of this requires real-time access to enormous amounts of imaging data.

3.7.4 Government and Private Telemedicine Service Providers

Many governmental and private sector entities in India have started to work in the telemedicine space; a few of these are included below: a C-DAC, Pune, Mohali, Thiruvananthapuram; Indian Institute of Technology, Kharagpur; SGPGI, Lucknow; Apollo Telemedicine is a Network Foundation, Hyderabad; Online Telemedicine Research Institute, Ahmedabad; Televital India, Bangalore; Vepro India, Chennai; Prognosis Medical Systems Pvt. Ltd., Bangalore; diagnosis Technologies, Ahmedabad; Karishma Software Ltd., New Delhi; Neurosynaptic Communications Pvt Ltd., Karnataka; Amrita Institute of Medical Sciences (AIMS), Kochi, Kerala; Larsen & Turbo, Mumbai; West Bengal Electronics Industry Development Corporation Ltd., Kolkata; and Space Hospitals Ltd., Chennai. The Sir Ganga Ram Hospital (SGRH) in New Delhi is one of them. Amrita Asia Heart Foundation (AHF); Narayana Hrudayalaya, Bangalore; Escorts Heart Hospital, Fortis; and so on (Federation of Indian Chambers of Commerce & Industry, 2020).

In India, numerous telemedicine services are offered by both public and private organizations. The following is a list of the few services: eSanjeevani: Available in two versions: “eSanjeevani OPD – Stay Home OPD”, a telemedicine system for patients, and "eSanjeevani AB-HWC”, a platform for doctor-to-doctor telemedicine. The Ministry of Health and Family Welfare, Government of India, introduced Thanksgiving 2019 with eSanjeevani AB-HWC. This doctor-to-doctor hub-and-spoke model is being implemented by Health and Wellness Centres (HWCs) across the nation (Ministry of Health & Family Welfare, Government of India 2020). “eSanjeevani AB-HWC” enables virtual connections between the doctor at the spoke (HWC) and the doctor/specialist at the hub (hospital/tertiary healthcare facility) via video conferencing. Among the primary features of “eSanjeevani ABHWC” are the Comprehensive Electronic Medical Record (EMR), video conferencing, teleconsultation, and MIS-based application (Ministry of Electronics & Information Technology, Government of India 2021). Since November 2019, states and UTs have constructed about 102,000 spokes and about 1200 hubs, and more than 5,200,000 consultations have been conducted.

The Ayushman Bharat Scheme of the Indian government has implemented a telemedicine system called eSanjeevani OPD, which connects doctors and patients. Created in Mohali, India, by the Center for Development of Advanced Computing. This is the first online OPD service of its sort provided to citizens by a national government. Its goal is to give patients online medical advice from doctors in the comfort of their own homes. This program has proven to be highly helpful during the COVID-19 pandemic 35 states and Union territories in the country have access to eSanjeevani OPD (ANI 2021). Since its introduction in April 2020, the eSanjeevani OPD platform has completed over 85,000,000 consultations overall. Over 1100 specialty OPDs have been established on eSanjeevani OPD, and eSanjeevani services are offered 24/7/365 in several States. eSanjeevani: The doctor-to-doctor portal offers a great deal of potential to raise the standard of healthcare at the local level. The World Health Association defines this as consultations for healthcare management between healthcare providers, which falls under the fourth tier of telemedicine. (World Health Organization, 2018). To manage their patients effectively, physicians employed in outlying peripheral hospitals might use this gateway to consult with super experts or specialists from specialized medical centers in affluent urban areas. The doctors can receive auxiliary support from a committed group of skilled paramedics equipped with a minimal array of technological devices, all without significantly interfering with their daily tasks. Over 60 million patients have been served by eSanjeevani to date. The eSanjeevani network comprises over 102,000 others Health & Wellness Centers, 12,000 Hubs, 1120 online OPDs, and over 207,000 providers who have been onboarded.

4. Proposed Conceptual Model

Based on a review of existing research literature, we have developed a model to understand user adoption of 5G enabled telemedicine services. As shown in Fig 1. the conceptual model will be further investigated through empirical studies to test the proposed hypotheses.

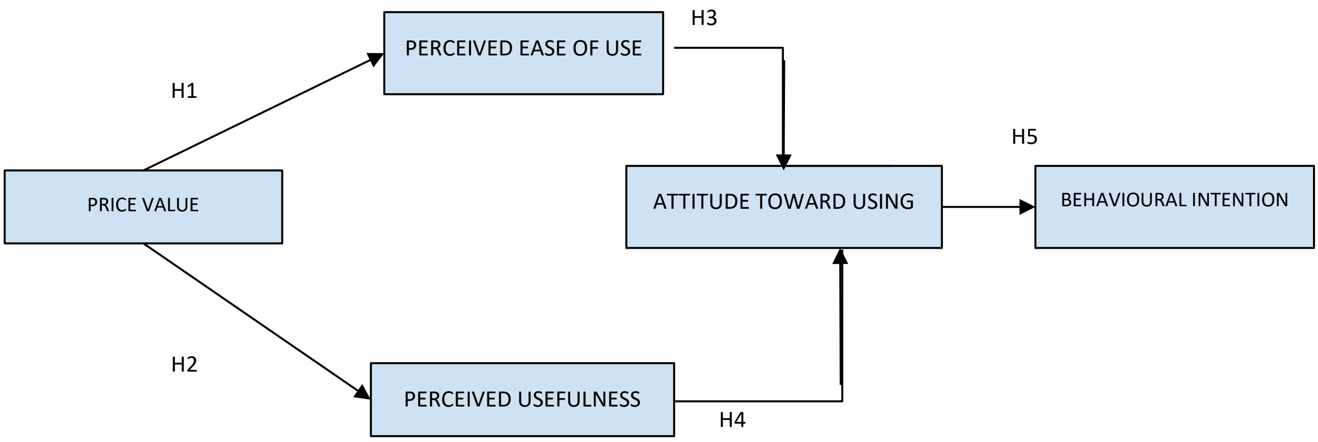

Fig. 1. Proposed Conceptual Model of 5G-enabled Telemedicine Adoption

4.1 Hypothesis

H_1: *Price Value has a positive impact on Perceived Ease of Use.*

H_2: *Price Value has a positive impact on Perceived Usefulness.*

H_3: *Perceived Ease of Use positively affects attitudes toward 5 G-enabled telemedicine services.*

H_4: *Perceived usefulness positively affects attitude toward using 5G-enabled telemedicine services.*

H_5: *Attitude toward using positively affects the intention to use 5G-enabled telemedicine services.*

5. Research Methodology

5.1 Questionnaire Design

The uptake of telemedicine services offered by 5G is being examined in this survey. The survey investigates four important characteristics that impact user acceptance: perceived utility, perceived ease of use, attitude, and behavioral intention. It does this by drawing on the Technology Acceptance Model (TAM) framework. We will also look at price-value perception as an external element influencing user decisions in addition to these fundamental TAM characteristics. A range of question styles will be used in the survey in order to collect both quantitative and qualitative data. User impressions of the price-value and TAM dimensions will be gauged through Likert scale questions. Open-ended inquiries will probe more deeply into consumer expectations, worries, and experiences with telemedicine powered by 5G. By including these components, the study hopes to offer insightful information about users' opinions about telemedicine powered by 5G. Healthcare professionals, legislators, and tech developers may use this data to better understand user demands, remove acceptance hurdles, and ultimately encourage the seamless incorporation of 5G technology into telemedicine's future.

6 Statistical Analysis

6.1 Tools Used

The tools used for the analysis of this study were MS Excel and PLS SEM

6.2 SEM analysis (Structural Equation Modeling)

SEM is a statistical technique used to analyze relationships between multiple variables, often to test a hypothesized model. Together, they created a model based on the TAM theory that outlined the connections between price-value, attitude, behavioral intention, perceived usefulness, and ease of use. The SEM test is then used to evaluate how well the model fits the data, providing information about the viability of the relationships that were postulated.

Table 1
Reliability and Validity Scores of Constructs

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Attitude	0.872	0.888	0.914	0.728
Behavioral Intention	0.906	0.927	0.938	0.793
Perceived Ease of Usefulness	0.893	0.892	0.935	0.827
Perceived Use	0.901	0.914	0.93	0.77
Price Value	0.815	0.826	0.878	0.644

As given in Table 1, All constructs have Cronbach's alpha values above 0.8, which is generally considered good. This suggests that the items within each construct are highly correlated, indicating strong internal consistency. For example, in the case of Behavioral Intention with a value of 0.906, it implies that the items related to behavioral intention are reliably measuring the same underlying concept. Again, all constructs exhibit high composite reliability values, generally above 0.8. This further confirms the reliability of the measurement model, indicating that the items within each construct consistently measure the intended construct. For example, in the case of Perceived Ease of Usefulness, both rho_a and rho_c values are above 0.89, indicating strong internal consistency. AVE values range from 0.644 to 0.827. While all values are above the threshold of 0.5, suggesting satisfactory convergent validity, there is some variability across constructs. Constructs with higher AVE values, such as Perceived Ease of Usefulness, indicate that a larger proportion of the variance is due to the construct itself rather than measurement error.

Structural Model

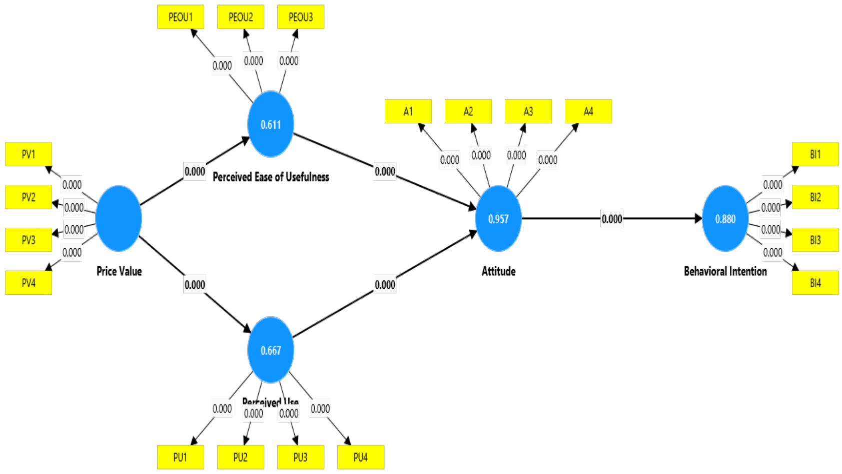

Fig. 2. Structural Model as per PLS SEM Analysis

The R-square (R^2) and adjusted R-square (R^2 adjusted) values provide crucial insights into the effectiveness of predictive models for different constructs (See Fig. 2). The results indicate that the models for predicting Attitude and Behavioral Intention are highly robust, with the predictors explaining approximately 95.7% and 88.0% of the variance in these constructs, respectively. These high R-square values suggest that the included predictors comprehensively capture the underlying factors influencing Attitude and Behavioral Intention, demonstrating a strong ability to predict these outcomes. Conversely, the models for Perceived Ease of Usefulness and Perceived Use, while still effective, explain a slightly lower proportion of variance at around 61.1% and 66.7%, respectively. This suggests that there may be additional factors beyond those included in the models that contribute to Perceived Ease of Usefulness and Perceived Use. Nevertheless, the adjusted R-square values, which account for model complexity and sample size, remain relatively high across all constructs, indicating the robustness of the models. Overall, these findings underscore the predictive power of the models and provide valuable insights into the extent to which the included predictors explain the variability in the dependent variables.

Table 2
Hypothesis Testing Results

	Path coefficients	2.5%	97.5%	f-square
Attitude → Behavioral Intention	0.938	0.921	0.972	7.324
Perceived Ease of Usefulness → Attitude	0.470	0.821	0.922	0.379
Perceived Use → Attitude	0.517	0.393	0.746	0.460
Price Value → Perceived Ease of Usefulness	0.782	0.481	0.791	1.573
Price Value → Perceived Use	0.817	16.000	10.000	2.000

The results in Table 2, indicate strong relationships between the variables in the model. Starting with the path coefficient between Attitude and Behavioral Intention, it is notably high at 0.938, with confidence intervals between 0.921 and 0.972. This suggests that attitude significantly influences behavioral intention, with a substantial effect size indicated by the f-square value of 7.324. Moving on to the relationships between perceived ease of usefulness and attitude, as well as perceived use and attitude, both paths show significant associations, with coefficients of 0.470 and 0.517 respectively. However, it's important to note wider confidence intervals for these paths, indicating a slightly greater uncertainty in the estimates. Regarding the influence of Price Value on perceived ease of usefulness and perceived use, the coefficients are substantial at 0.782 and 0.817 respectively, indicating a strong positive relationship. However, the confidence interval for the path from Price Value to perceived use is exceptionally wide, ranging from 16.000 to 10.000, suggesting potential instability or uncertainty in this particular relationship. Overall, the results suggest robust support for the hypothesized relationships in the model, particularly the strong influence of attitude on behavioral intention, and the significant impact of price value on perceived ease of usefulness and perceived use, although further investigation may be warranted regarding the path from Price Value to perceived use due to the wide confidence interval.

8. Limitation And Future Scope

The survey examining the uptake of telemedicine services powered by 5G relies on the Technology Acceptance Model (TAM) framework to investigate user acceptance through perceived utility, ease of use, attitude, and behavioral intention, while also considering price-value perception as an external factor. Limitations of the study include potential sample bias, reliance on self-reported data, assumptions regarding technology literacy, and temporal relevance. To address these limitations and expand future scope, researchers could explore geographical variations in adoption, internet penetration's impact, cross-cultural influences, longitudinal trends, advanced qualitative analysis of open-ended responses, and integration challenges with existing healthcare systems. By doing so, the study aims to provide comprehensive insights for stakeholders, including healthcare professionals, legislators, and tech developers, to better understand user demands, remove acceptance barriers, and facilitate the seamless incorporation of 5G technology into telemedicine on a global scale.

9. Conclusion

In conclusion, this study has provided valuable insights into the adoption of 5G-enabled telemedicine services through the development and testing of a conceptual model. By drawing on the Technology Acceptance Model (TAM) framework and considering price-value perception as an external factor, the research has explored the key determinants influencing user acceptance. The findings from the structural equation modeling (SEM) analysis highlight the significant impact of attitude on behavioral intention, indicating that users' overall perception and attitude towards 5G-enabled telemedicine services strongly influence their intention to use them. Additionally, the study reveals the crucial role of perceived ease of usefulness and perceived use in shaping users' attitudes, underscoring the importance of these factors in driving acceptance. Moreover, the results demonstrate a strong positive relationship between price-value perception and perceived ease of usefulness, as well as perceived use, further emphasizing the influence of pricing considerations on users' perceptions and attitudes towards 5G-enabled telemedicine services. Despite these valuable insights, the study acknowledges certain limitations, including potential sample bias and reliance on self-reported data. To address these limitations and expand future scope, researchers are encouraged to explore geographical variations in adoption, cross-cultural influences, and longitudinal trends, among other factors. Overall, this research contributes to a better understanding of user adoption of 5G-enabled telemedicine services and provides actionable insights for stakeholders, including healthcare professionals, legislators, and tech developers. By addressing acceptance barriers and leveraging the findings of this study, stakeholders can facilitate the seamless incorporation of 5G technology into telemedicine on a global scale, ultimately enhancing healthcare accessibility and delivery.

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