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Exploring the Impact of Telehealth Integration on Patient Outcomes and Nursing Practice in Post-Acute Care Settings using the TOPSIS Method

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Abstract: *Telemedicine within private healthcare settings contributes to professional development and enhances the overall patient experience. Patients no longer endure lengthy queues or the need for numerous doctor visits. Electronic patient records replace the reliance on paper files, resulting in enhanced accessibility and efficiency while diminishing overall wait times. Telemedicine facilitates direct communication between patients and healthcare experts, including physicians and other professionals, through methods like video consultations, phone calls, or online messaging platforms. Especially remote healthcare to maintain, this maintenance the mode of delivery is very favourable or underserved areas. It also ensures convenient access for those facing geographical barriers, promoting digital transformation, operational streamlining, and cost reduction within healthcare services. Automation in tasks like appointment scheduling and billing administration lightens the workload of professionals, allowing them to focus more on patient care. Telemedicine, facilitated by information and communication technology (ICT), enables controlled human interaction while remaining a valuable tool during crises like the COVID-19 pandemic. It extends healthcare delivery to patients' homes and serves as a critical tool for managing infections. Amid the current COVID-19 crisis, telemedicine stands as an unparalleled system for healthcare delivery, even though it presents challenges. The use of telemedicine and virtual software platforms has surged due to the rapid adoption of ICT during the pandemic, and these tools have found applications in various medical facilities. Although they are more commonly employed in smaller settings, their usage continues to grow. In the context of epidemics like COVID-19, telemedicine and virtual software platforms can help monitor patients closely, reduce the spread of the virus, and alleviate social isolation. These methods are now widely accepted and endorsed by governments, especially in light of stay-at-home measures, making them crucial for providing health services through telehealth. No Telehealth Integration, Video Calls for Consultation, Remote Monitoring and Video Consultation, Remote Monitoring, Video Consultation, and AI-Based Triage, Combination of In-person and Telehealth Services and Mobile Application-Based Telehealth Services. Patient Satisfaction Score, Readmission Rate (%), Nurse Workload (Hours/Patient) and Cost of Care (USD). the Ranking ofExploring the Impact of Telehealth Integration in No Telehealth Integration is got the first rank whereas is the Remote Monitoring, Video Consultation, and AI-Based Triage is having the Lowest rank.*

Keywords: *MCDM, No Telehealth Integration, Video Calls for Consultation, Remote Monitoring and Video Consultation, Remote Monitoring, Video Consultation, and AI-Based Triage.*

1. INTRODUCTION

The evolution of telehealth in healthcare delivery has been a transformative journey, revolutionizing the way healthcare services are provided and accessed. This section provides an overview of key milestones and developments that have shaped the field of telehealth. Telehealth traces its roots back to the early 20th century when the concept of telemedicine was first introduced. The idea was to use telecommunication technologies to for healthcare providers and between patients reduces the gap between especially distant or in lesser areas [1].In the mid-20th century, telephone consultations emerged as one of the earliest forms of telehealth. Patients could seek advice from healthcare professionals over the phone, enabling faster access to medical guidance. The advent of video conferencing technology in the latter half of the 20th century marked a significant milestone in

telehealth. It allowed for visual interactions between healthcare providers and patients, simulating face-to-face consultations.

With the development of wearable and portable medical devices, telehealth expanded its scope to include remote monitoring of vital signs, chronic conditions, and other health metrics [2]. This allowed for continuous tracking of patient health status.The integration of electronic health records into telehealth platforms revolutionized the accessibility and sharing of patient information. This facilitated seamless Involved in patient careto various health care providers Communication between the proliferation of smartphones and mobile applications led to the emergence of mHealth. Patients could now access healthcare information, schedule appointments, and even conduct video consultations through their mobile devices [3]. Telehealth found particularly significant applications in specialized fields like radiology, mental health, and dermatology. Teleradiology, for instance, enabled remote interpretation of medical imaging, expanding access to expert opinions. Governments and healthcare regulatory bodies recognized the potential of telehealth in improving healthcare access and outcomes. They introduced policies and regulations to support and govern telehealth practices. The covid-19 pandemic for widespread adoption of telehealth acted as a catalyst [4]. Lockdowns and social distancing measures necessitated remote healthcare solutions, leading to a surge in telehealth utilization. The integration of AI-driven tools in telemedicine platforms enhanced diagnostic accuracy, personalized treatment plans, and automated patient monitoring, further revolutionizing telehealth. Telehealth has also expanded internationally, allowing for consultations and collaborations between healthcare professionals across different countries, breaking down geographical barriers [5].Post-intensive careSettings laterIntensive care settings refer to healthcare facilities or services that provide specialized care for individuals after they have been discharged from an acute care hospital but still require ongoing medical attention and rehabilitation. These settings are crucial for patients who have undergone surgery, experienced a serious illness, or suffered an injury, and need a level of care that falls between acute hospital care and full recovery at home [6]. Here are some key types of Post-acute care settings: Skilled nursing Facilities (SNFs)Skilled nursing facilities short term medical Provide service and rehabilitation services for individuals recovering from surgery, injury, or acute illness. They offer round-the-clock nursing care, physical therapy, occupational therapy, and other rehabilitative services. Inpatient Rehabilitation Facilities (IRFs) IRFs specialize in intensive, multidisciplinary rehabilitation for patients Stroke, spinal cord injuries, traumatic Brain injuries and others recovery from acute conditions [7]. They provide comprehensive care, including Body, career and Speech therapy. Long term Intensive treatment Hospitals (LTACHs)LTACHs offer extended care for patients with complex medical needs who require ongoing hospital-level care but no longer need acute care services. These facilities specialize in treating critically ill or medically complex individuals. Impact of Tele health Integration on Patient Outcomes The integration of tele health into healthcare delivery has brought about significant impacts on patient outcomes across various dimensions [8]. This section delves into the specific ways in which telehealth has influenced and improved patient outcomes Telehealth eliminates geographical barriers, allowing patients to access healthcare services remotely. This is particularly crucial for individuals in rural or underserved areas, as well as those with mobility limitations. Improved access leads to earlier interventions and timely management of health issues, ultimately resulting in better outcomes. Through telehealth, patients can receive timely consultations and advice without the need for scheduling and waiting for in-person appointments [9]. This expedites the diagnostic process and ensures that necessary treatments or interventions are initiated promptly. Improved Chronic Disease Management Telehealth facilitates continuous monitoring of patients with chronic conditions. Remote monitoring devices and wearable technology allow healthcare providers to track vital signs, medication adherence, and other relevant metrics. This proactive approach enables early detection of potential complications and enables timely adjustments to treatment plans.Telehealth has revolutionized the field of nursing by leveraging technology to deliver healthcare services remotely [10]. This transformation has had a profound impact on nursing practice in several key ways: Increased Access to Care Telehealth has expanded healthcare access, especially for those in remote or underserved areas. Nurses can now provide consultations, monitor patients, and offer education through video conferencing, phone calls, and other virtual platforms. Improved Patient Engagement: Through telehealth, nurses can engage with patients in their own environments. This can lead to more open and honest discussions, increased patient comfort, and potentially better adherence to treatment plans [11]. Chronic Disease Management: Telehealth enables continuous monitoring of patients with chronic conditions. Nurses can track vital signs, review symptoms, and provide timely interventions, reducing the need for frequent in-person visits and hospitalizations. While telehealth offers numerous benefits, its integration into healthcare systems and nursing practice is not without challenges and barriers. Here are some of the key issues: Technological Barriers Access to Technology:
Not all patients have access to reliable internet connections or devices like smartphones or computers, which are essential for participating in telehealth consultations [12]. Digital Literacy: Some patients, particularly older adults or those in underserved communities, may have limited experience or comfort with using technology, making it difficult to engage in telehealth. Regulatory and Legal Challenges Licensing and Credentialing:

Nurses providing telehealth services may need to be licensed in the state where the patient is located, which can be a complex and time-consuming process. Reimbursement and Payment Policies: Policies governing reimbursement for telehealth services vary by location and payer. Navigating these reimbursement systems can be challenging for both healthcare providers and patients [13].Two studies on telehealth in Michigan (Whitton and Adams, 2003) emphasized the importance of evaluating network structures in determining program success. They identified various organizational factors, including commitment to telehealth leadership, logistical support, project autonomy, and self-sufficiency, as key contributors to program success. Conversely, challenges related to finance, technology, and human resources were identified as potential barriers to success in other telehealth programs [14]. In Quebec, Fortin et al. (2003) evaluated different telehealth initiatives and highlighted the significance of aligning network requirements with the demands of both the central and distant healthcare facilities for successful implementation. They also emphasized the need for organizational transformation and supportive frameworks at management levels for effective telehealth adoption. Chikote and colleagues (1999) assessed a telehealth network and found that factors related to participating organizations, such as competent management and well-equipped centers, played a crucial role in the success of the program. Additionally, they noted that the geographical distance between reference and request centers was a factor influencing telehealth utilization [15]. However, it is important to note that while these studies provide valuable insights, their applicability to individual contexts may vary, and generalizing their findings can be challenging due to the diversity of healthcare organizations and their unique characteristics. The shifting global demographics, marked by an increasingly elderly population, pose a dual set of challenges. These challenges primarily revolve around the prevalence of persistent health conditions, which are not only on the rise but also becoming more widespread [16]. The capacity to effectively manage and cater to the growing number of individuals with these conditions is dwindling. Recognizing this situation brings to light a potential issue that requires attention. The remedy for addressing this matter lies in the effective management of long-term health conditions through self-monitoring and self-management practices, which have garnered significant international interest. This interest is particularly focused on supporting self-monitoring through the utilization of information technologies (IT). In this context, telehealth care proves to be exceptionally valuable [17].

2. MATERIALS AND METHOD

Traditional Care without Telehealth Integration*:* Standard in-person healthcare services without the incorporation of telehealth technology.

Consultations via Video Calls*:* Utilizing video calls to conduct remote consultations between healthcare providers and patients.

Remote Monitoring Coupled with Video Consultation*:* Implementing remote monitoring technology to track patient data, alongside video consultations for more comprehensive care.

Remote Monitoring, Video Consultation, and AI-Enhanced Triage*:* Incorporating a trifecta of remote monitoring, video consultations, and artificial intelligence-driven triage systems for a holistic approach to healthcare.

Blended Approach of In-person and Telehealth Services*:* Combining both in-person and telehealth services to cater to a diverse range of patient needs.

Telehealth Services via Mobile Application*:* Delivering healthcare services through a dedicated mobile application, providing convenient access for patients.

Patient Satisfaction Score: This measures the level of contentment or approval expressed by patients regarding the care and services they receive. It reflects how well healthcare providers meet the expectations and needs of their patients.

Readmission Rate (%): This indicates the percentage of patients who return to the hospital within a specified period (often within 30 days) after an initial admission for the same or related condition. High readmission rates may suggest a need for improvement in post-discharge care.

Nurse Workload (Hours/Patient): This quantifies the amount of time nurses spend providing care to individual patients. It's an important metric for assessing staffing levels and ensuring that nurses have adequate time to attend to each patient's needs.

Cost of Care (USD): This represents the total expenses incurred in providing healthcare services to a patient. It encompasses various elements, including diagnostics, treatment, medications, and other associated costs.

Method: The TOPSIS ranking method involves assessing and comparing items based on a weighted average to enhance clarity. One prevalent strategy entail addressing and minimizing uncertainties, while assigning equal weight to each response. Timely handling of the matter is crucial in this process, which is employed in TOPSIS.

Subsequently, a comprehensive approach is adopted, as indicated by reference [18].The TOPSIS procedure employs an advanced yet straightforward ranking system. This state-of-the-art technique aims to select alternatives with solutions, although they may be considerably less than perfect. It strives to identify a superior response that offers advantages by expanding the scale and reducing costs. Conversely, it elevates the price scale for less desirable options. This process effectively leverages records and also diminishes the TOPSIS attribute associated with favorable criteria, as outlined in reference [19].The TOPSIS approach utilizes two fuzzy functions, one for membership and the other for a census sheet. This forms the foundation for applying FMCDM to attributes. The discussion encompasses motivations, existing challenges, and constraints associated with its implementation and adoption in FMCDM. Additionally, it aims to enhance usability and offers suggestions for researchers, as detailed in reference [20].In contrast, TOPSIS stands out from heuristics due to its distinctive characteristics. It incorporates a range of parameters and allows for value adjustments, leading to multiple response values within the TOPSIS algorithm's development, as indicated in reference. The TOPSIS method evaluates five distinct measurements with varying sizes of randomness. It applies these assessments to problems through a numerical example. The consistency ratio, along with factors like odds ratio of alternatives and mean Spearman correlation, contributes to determining the priority with coefficients for detailed ranking orders[21]. Our study involves a comparative analysis. Ultimately, we rely on Spearman correlation of alternatives rather than an average of coefficients, along with the number of numbers and properties as distance measures, to comprehend influence and order. Regression is then employed through a compromise programming system known as "Close to Ideal," which was formulated to strike a balance between "Majority" and "Opposition," ultimately resulting in a "Personal Minimize Maximum" approach [22].

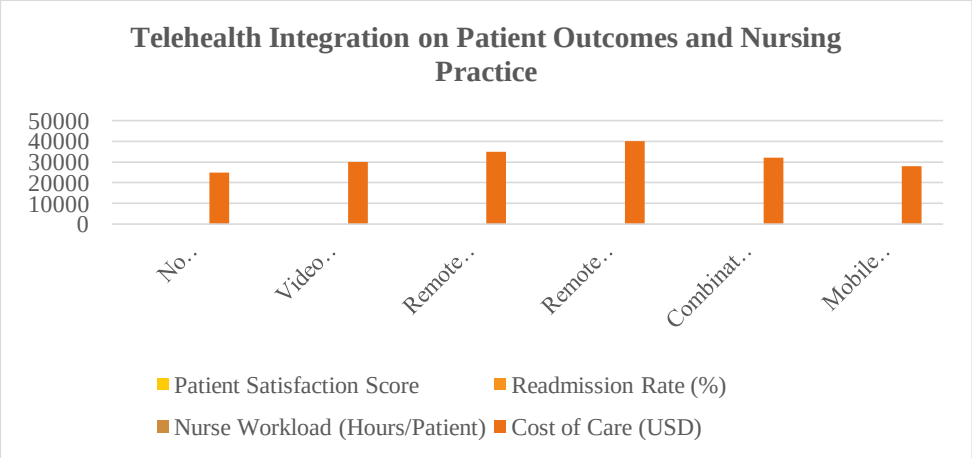
This approach, termed "Group Application," offers the optimal solution. The TOPSIS method is distinguished for its short-range and negative-optimal characteristics, which are crucial in determining a solution that addresses distances without significant considerations, as outlined in reference. TOPSIS unity for choice (optimal solution sequence by technique) the technique will be given to denote TOPSIS, Selected opportunity So much to discover the criterion is technique [23]. TOPSIS serves as a viable approach for resolving such challenges. It entails the calculation of both the Positive Ideal Solution (PIS), representing the shortest distance, and the Negative Ideal Solution (NIS), indicative of the longest distance, thereby allowing for a comprehensive evaluation. Subsequently, a "satisfaction level" is ascertained for each criterion, determined through the max-min operator. This process culminates in the resolution of contradictions, ultimately yielding a solution characterized by conformity and satisfaction, as elucidated in reference [24].TOPSIS, as an optimal solution method (e.g., for regulatory efficacy), proves to be valuable. It facilitates the examination, comparison, and assessment of various alternatives. Consequently, it is a practical tool for task-oriented group decision-making within diverse settings. A comprehensive and effective selection procedure is elaborated upon in a subsequent section [25].TOPSIS has been conducted using a comprehensive approach. Initially, extensive statistical analysis and theoretical assessments serve as the foundation. These evaluations are pivotal in decision-making or appraisals concerning attribute configurations and the assessment of the impact of environmental weights (EW). The examination is conducted on both a specific and reciprocal level for decision-making or assessments in terms of outcomes. Similarly, the influence of environmental weights (EW) on TOPSIS is scrutinized. The choice between E-TOPSIS or utilizing EW in the evaluation is instrumental in regulating activities, as outlined in reference [26].

3. RESULT AND DISCUSSION

TABLE 1. Exploring the Impact of Telehealth Integration on Patient Outcomes and Nursing Practice in Post-Acute Care Settings

Scenario	Patient Satisfaction Score	Readmission Rate (%)	Nurse Workload (Hours/Patient)	Cost of Care (USD)
No Telehealth Integration	7.5	12.3	4.2	25,000
Video Calls for Consultation	8.2	9.8	3.8	30,000
Remote Monitoring and Video Consultation	8.7	8.1	3.5	35,000
Remote Monitoring, Video Consultation, and AI-Based Triage	9	7.5	3.2	40,000
Combination of In-person and Telehealth Services	8.5	10.5	3.9	32,000
Mobile Application-Based Telehealth Services	8.3	10.2	4	28,000

Table 1 Shows Exploring the Impact of Telehealth Integration on Patient Outcomes and Nursing Practice in Post-Acute Care Settings in Evaluation Parameters is Patient Satisfaction Score, Readmission Rate (%), Nurse Workload (Hours/Patient) and Cost of Care (USD) and Alternative is No Telehealth Integration, Video Calls for Consultation, Remote Monitoring and Video Consultation, Remote Monitoring, Video Consultation, and AI-Based Triage, Combination of In-person and Telehealth Services and Mobile Application-Based Telehealth ServicesFrom the figure 1 and table 1 it is seen that Remote Monitoring, Video Consultation, and AI-Based Triage (9)is showing the Highest Value Patient Satisfaction Score and No Telehealth Integration (7.5)is showing the lowest value. No Telehealth Integration (12.3) is showing the Highest Value Readmission Rate (%) and Remote Monitoring, Video Consultation, and AI-Based Triage (7.5) is showing the lowest valueNo Telehealth Integration (4.2)is showing the Highest ValueNurse Workload (Hours/Patient) and Remote Monitoring, Video Consultation, and AI-Based Triage (3.2) is showing the lowest value. Remote Monitoring, Video Consultation, and AI-Based Triage ($40,000) is showing the Highest Value Cost of Care (USD) and No Telehealth Integration ($25,000) is showing the lowest value.



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

TABLE 2. Normalized Data

Patient Satisfaction Score	Readmission Rate (%)	Nurse Workload (Hours/Patient)	Cost of Care (USD)
0.3654	0.5092	0.4535	0.3186
0.3995	0.4057	0.4103	0.3823
0.4239	0.3353	0.3779	0.4460
0.4385	0.3105	0.3455	0.5097
0.4141	0.4347	0.4211	0.4078
0.4044	0.4223	0.4319	0.3568

Table 2 shows the various Normalized Data for Patient Satisfaction Score, Readmission Rate (%), Nurse Workload (Hours/Patient) and Cost of Care (USD).Normalized value is obtained by using the formula (1).Table 3 shows Weightages used for the analysis. We taken same weights for all the parameters for the analysis.

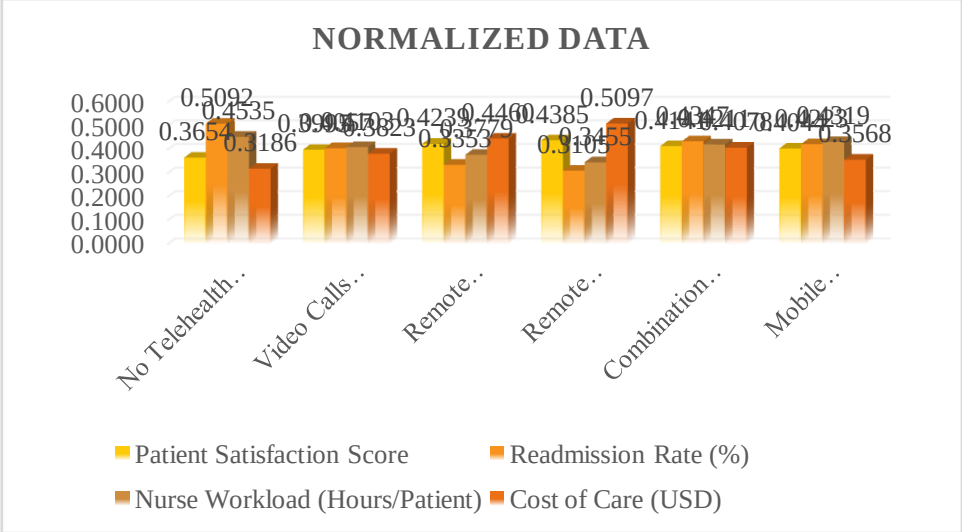

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TABLE 3. Weightages

Weightages			
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
0.25	0.25	0.25	0.25

$$\boldsymbol{X_{wnormal1}} = X_{n1} \times w_1 \qquad (2).$$

TABLE 4. Weighted Normalized Decision Matrix

No Telehealth Integration	0.0913	0.1273	0.1134	0.0796
Video Calls for Consultation	0.0999	0.1014	0.1026	0.0956
Remote Monitoring and Video Consultation	0.1060	0.0838	0.0945	0.1115
Remote Monitoring, Video Consultation, and AI-Based Triage	0.1096	0.0776	0.0864	0.1274
Combination of In-person and Telehealth Services	0.1035	0.1087	0.1053	0.1019
Mobile Application-Based Telehealth Services	0.1011	0.1056	0.1080	0.0892

Table 4 shows Weighted Normalized Decision Matrixin Patient Satisfaction Score, Readmission Rate (%), Nurse Workload (Hours/Patient) and Cost of Care (USD). To figure out the weighted normalized decision matrix, we used the formula (2).

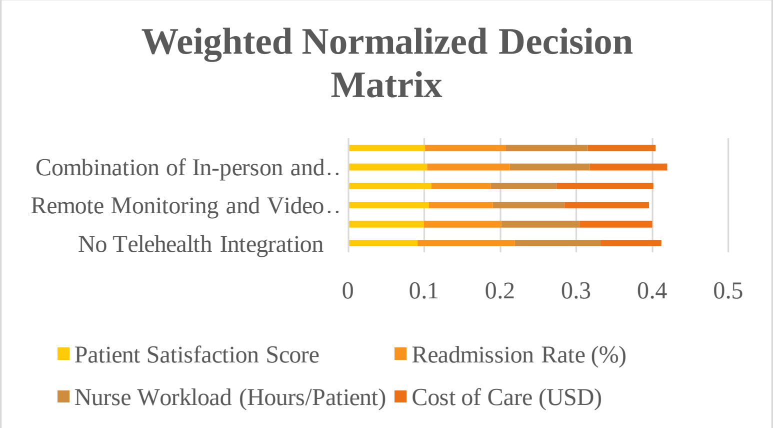

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Figure 3shows weighted normalized decision matrix for Table 4 shows Weighted Normalized Decision Matrix in Patient Satisfaction Score, Readmission Rate (%), Nurse Workload (Hours/Patient) and Cost of Care (USD). To figure out the weighted normalized decision matrix, we used the formula (2).To figure out the weighted normalized decision matrix, we used the formula (2).

TABLE 5. Positive and Negative Matrix

Positive Matrix				Negative matrix			
0.1096	0.1273	0.0864	0.0796	0.0913	0.0776	0.1134	0.1274
0.1096	0.1273	0.0864	0.0796	0.0913	0.0776	0.1134	0.1274
0.1096	0.1273	0.0864	0.0796	0.0913	0.0776	0.1134	0.1274
0.1096	0.1273	0.0864	0.0796	0.0913	0.0776	0.1134	0.1274
0.1096	0.1273	0.0864	0.0796	0.0913	0.0776	0.1134	0.1274
0.1096	0.1273	0.0864	0.0796	0.0913	0.0776	0.1134	0.1274

Table 5 shows Positive and Negative Matrix for No Telehealth Integration, Video Calls for Consultation, Remote Monitoring and Video Consultation, Remote Monitoring, Video Consultation, and AI-Based Triage, Combination of In-person and Telehealth Services and Mobile Application-Based Telehealth Services. In variousPositive Matrix in Maximum value 00.1096,0.1273, Minimum value 0.0864, 0.0796is taken and for Negative matrix the Minimum value 0.0913, 0.0776and Maximum value0.1134, 0.1274is taken.

TABLE 6. Final Result of Exploring the Impact of Telehealth Integration

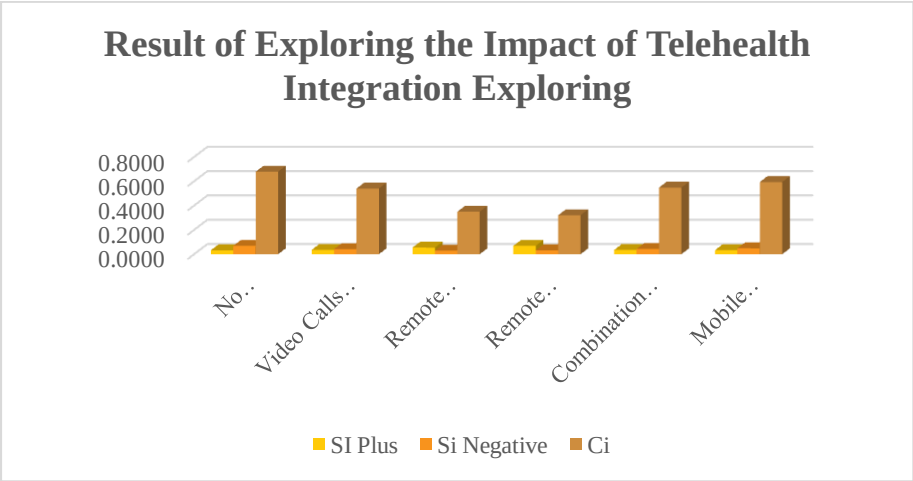
	SI Plus	Si Negative	Ci	Rank
No Telehealth Integration	0.0326	0.0689	0.6790	1
Video Calls for Consultation	0.0358	0.0421	0.5404	4
Remote Monitoring and Video Consultation	0.0546	0.0294	0.3497	5
Remote Monitoring, Video Consultation, and AI-Based Triage	0.0689	0.0326	0.3210	6
Combination of In-person and Telehealth Services	0.0352	0.0427	0.5485	3
Mobile Application-Based Telehealth Services	0.0332	0.0486	0.5943	2

Table 6 shows the final result of TOPSIS for Exploring the Impact of Telehealth Integration. Figure 3 shows the TOPSIS Analysis Result of Exploring the Impact of Telehealth Integration. In Table 6,Si positive is calculated using the formula (3). From figure 3, In Si positive, Remote Monitoring, Video Consultation, and AI-Based Triage is having is Higher Value andNo Telehealth Integration is having Lower value. Si Negative is calculated using the formula (4). In Si Negative, No Telehealth Integration is having is Higher Value Remote Monitoring and Video Consultation is having Lower value. Ciis calculated using the formula (5). In Ci, No Telehealth Integration is having is Higher Value and Remote Monitoring, Video Consultation, and AI-Based Triage is having Lower value.

$$X_{si+1} = \sqrt{((X_{wn1} - X_{p1})^2 + (Y_{wn1} - Y_{p1})^2 + (Z_{wn1} - Z_{p1})^2)} \quad (3)$$

$$X_{si-1} = \sqrt{((X_{wn1} - X_{n1})^2 + (Y_{wn1} - Y_{n1})^2 + (Z_{wn1} - Z_{n1})^2)} \quad (4)$$

$$X_{ci1} = \frac{X_{si-1}}{(X_{si+1}) + (X_{s(i-1)})} (5)$$



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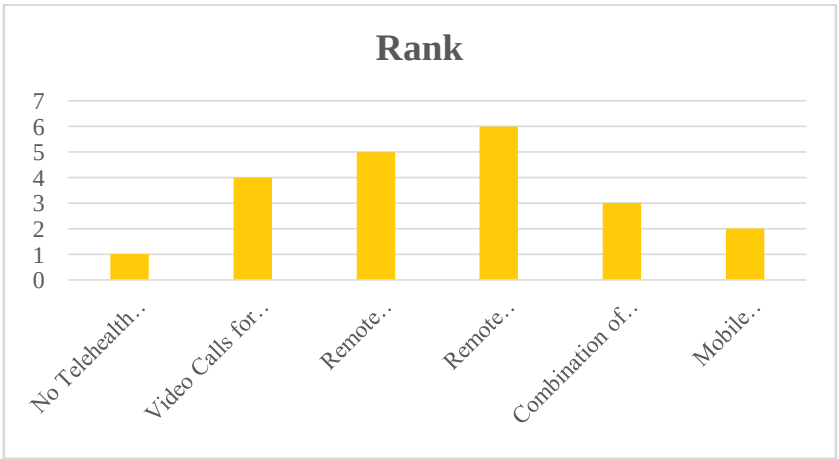

FIGURE 5. Rank

Figure 5 Shows the Ranking of Exploring the Impact of Telehealth Integration in No Telehealth Integration is got the first rank whereas is the Remote Monitoring, Video Consultation, and AI-Based Triage is having the Lowest rank.

CONCLUSION

Telemedicine within private healthcare settings contributes to professional development and enhances the overall patient experience. Patients no longer endure lengthy queues or the need for numerous doctor visits. Electronic patient records replace the reliance on paper files, resulting in enhanced accessibility and efficiency while diminishing overall wait times. Telemedicine facilitates direct communication between patients and healthcare experts, including physicians and other professionals, through methods like video consultations, phone calls, or online messaging platforms. Especially remote healthcare to maintain, this maintenance the mode of delivery is very favourable or underserved areas. It also ensures convenient access for those facing geographical barriers, promoting digital transformation, operational streamlining, and cost reduction within healthcare services. Automation in tasks like appointment scheduling and billing administration lightens the workload of professionals, allowing them to focus more on patient care. Telemedicine, facilitated by information and communication technology (ICT), enables controlled human interaction while remaining a valuable tool during crises like the COVID-19 pandemic. It extends healthcare delivery to patients' homes and serves as a critical tool for managing infections. Amid the current COVID-19 crisis, telemedicine stands as an unparalleled system for healthcare delivery, even though it presents challenges. The evolution of telehealth in healthcare delivery has been a transformative journey, revolutionizing the way healthcare services are provided and accessed. This section provides an overview of key milestones and developments that have shaped the field of telehealth. Telehealth traces its roots back to the early 20th century when the concept of telemedicine was first introduced. The idea was to use telecommunication technologies to for healthcare providers and between patients reduces the gap between especially distant or in lesser areas. In the mid-20th century, telephone consultations emerged as one of the earliest forms of telehealth. Patients could seek advice from healthcare professionals over the phone, enabling faster access to medical guidance. The advent of video conferencing technology in the latter half of the 20th century marked a significant milestone in telehealth. It allowed for visual interactions between healthcare providers and patients, simulating face-to-face consultations. With the development of wearable and portable medical devices, telehealth expanded its scope to include remote monitoring of vital signs, chronic conditions, and other health metrics. the Ranking of Exploring the Impact of Telehealth Integration in No Telehealth Integration is got the first rank whereas is the Remote Monitoring, Video Consultation, and AI-Based Triage is having the Lowest rank.

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