Proceedings of Bhavisya Entrepreneur 2025: National Symposium on Entrepreneurship Innovation
ISBN: **978-93-343-9865-6**

NSEI/2025/04

Smart Village Adoption in Healthcare: Bridging Gaps Through Technology and Innovation- A Review

Aniket Saha[1], Disha Das[2], Antara Sen[3], Deepasri Das[4], Indrakshi Ghosh[5], Dr. Shantanu Datta[6]

[1-5] Department of Electronics and Communication Engineering, GNIT, Kolkata
[6] Mechanical Engineering (ASHU Department) GNIT, Kolkata

*aniketsaaha73@gmail.com

***Abstract*-**The concept behind the 'Smart Village' is that technology is a major force behind development since it improves rural residents' access to education, electricity, agriculture, healthcare, entrepreneurship, local business prospects, and internet connectivity. One of the most crucial is healthcare, as access to care is often difficult for those living in rural areas. Modern technologies like telemedicine, solar energy, artificial intelligence (AI), and the Internet of Things (IoT) can improve the efficiency, accessibility, and affordability of healthcare delivery in rural areas. By exploring innovations such as health kiosks, the integration of renewable energy, mobile apps, artificial intelligence-based diagnostics, preventive health policies, and mental health coverage under smart village uptake, this article explores how smart healthcare solutions can help close gaps in rural healthcare delivery.

Keywords: Smart Village, healthcare, health kiosks, artificial intelligence, mental health.

I. INTRODUCTION

The idea of "smart villages" seeks to enhance rural communities' quality of life by utilizing cutting-edge ideas and digital technologies [1]. An important part of this change is healthcare, which is essential for development. Rural healthcare delivery is frequently hampered by a lack of awareness, a lack of qualified experts, and restricted access to medical facilities. Technologies like telemedicine, mobile health apps, remote diagnostics, and data-driven decision-making can close these gaps through the implementation of smart villages [2]. This study investigates how improving the accessibility, affordability, and effectiveness of medical services in rural communities can be achieved by incorporating smart healthcare solutions into the smart village framework [3]. By analyzing the settings, purposes, and clinical settings where health kiosks are used; whether or not usability testing of health kiosks is being published, and if so, how; and what the factors that encourage and hinder kiosk implementation are, we hope to determine the current and future roles of health kiosks[4]. Height and weight are measured automatically by the kiosk, and information is given regarding body composition, including muscle mass, BMI, and percentage of body fat[5]. The users can quickly check their pulse rate and oxygen saturation first, and then their blood pressure is monitored with a completely automated arm cuff, with the results emerging in 20 seconds. For cardiac health evaluation, the kiosk performs a 6 or 12 lead ECG scan, which is important in delivering information regarding

ISBN: **978-93-343-9865-6**

cardiac function[6]. The digital stethoscope translates acoustic sounds into electric signals to more effectively examine heart and lung sounds[7]. Also included are clinically accepted self-administered tests for depression and anxiety for mental health screening. Added to this, solar energy significantly lowers electricity costs by ensuring hospitals have continuous power for crucial care during outages. This frees up funds for better patient services and care while enabling vital equipment to operate dependably. Again these days, through the use of AI models, remote diagnostics, illness outbreak prediction, and treatment plan personalization, rural healthcare gaps are filled. In underprivileged, isolated communities, this enhances access to critical medical knowledge and leads to better health outcomes.

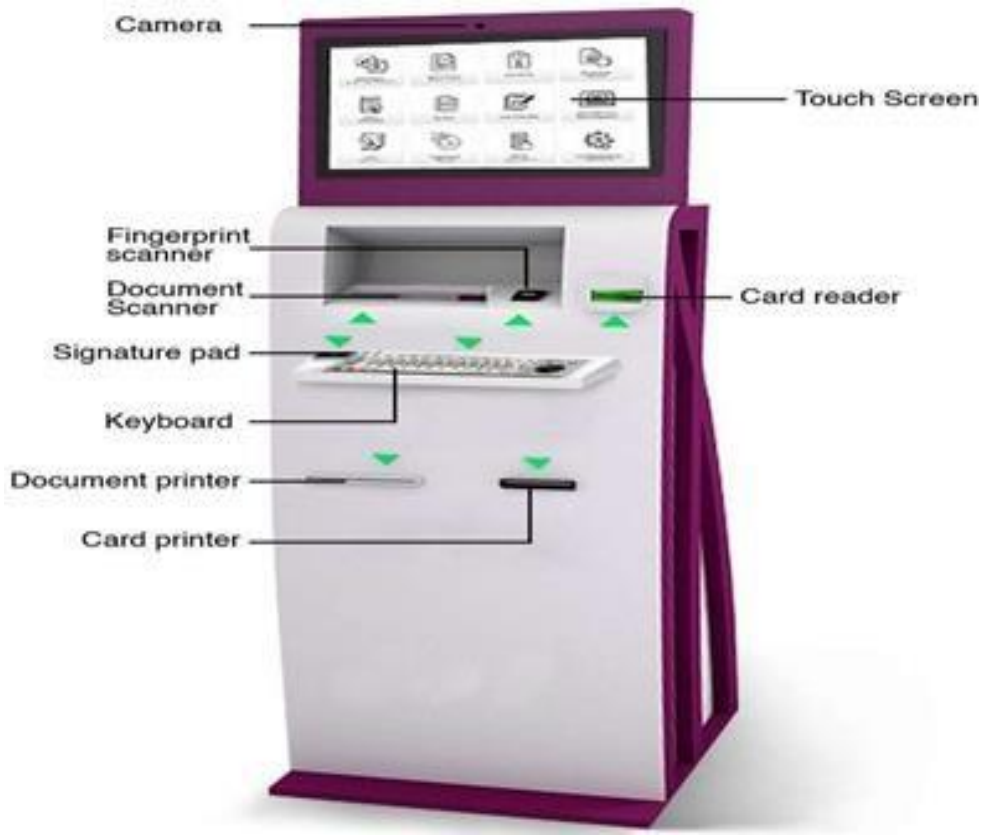


Fig1. A Smart Health Kiosk System [8]

II. LITERATURE REVIEW

Jacobsen et al., 2023 describe that the creation and application of smart technologies have promised for enhancing healthcare, mobility, and governance, among other facets of rural living [9]. Intelligent health kiosks possess integrated sensors that assist in monitoring the patient's vital signs such as blood pressure, heart rate, body temperature, blood oxygen saturation, weight, and BMI. In addition to displaying the patient's vital signs, health kiosk possesses state-of-the-art diagnostic equipment such as body composition analysis, blood glucose, and cholesterol test. The health kiosk is touch screen and easy to use with instructions on how to use a kiosk on a step-by-step basis making it accessible to almost everyone and individuals with lower health literacy. Users can create, store, and share their health records to be used in the future with certain smart health kiosks. This gives a physician access to the patient's medical history. Mobile apps and websites can access users' health data because it is stored in the cloud [10]. The consumer is able to get knowledge about his or her health condition at any time without going for an appointment using the smart health kiosk. They save the user from taking repeated trips to healthcare professionals, clinics, doctors, or

ISBN: **978-93-343-9865-6**

hospitals. Patients are able to maintain a record of their health information over a long time, and these smart health kiosk records and stores the results.

Shahsavari et al.,2024 stated that solar energy, as a clean and renewable resource, offers a promising solution to address the energy needs of rural healthcare facilities [11]. Solar energy is harnessed through photovoltaic (PV) panels, which convert sunlight into electricity, and solar thermal systems, which trap and store solar heat for purposes such as water heating and space heating [12]. Solar panels are mounted on roofs or nearby open spaces to absorb sunlight and transform it into direct current (DC) electricity via the photovoltaic effect. This electricity is stored in batteries with the help of an inverter, converting DC to alternating current (AC) for medical devices, lights, refrigeration, water pumping equipment, and communication devices. Guaranteed power supply for life-saving medical equipment, vaccine refrigeration, diagnosis, and emergency services, especially maternal services and round-the-clock services. Foley et al.,1995 stated that solar systems are free-standing, minimizing diesel generator usage and risks of fuel supply during adverse weather or outreach issues [13]. Reliable power enhances staff retention, service quality, and patient outcomes, as well as avoids vaccine spoilage and equipment damage due to voltage fluctuations.

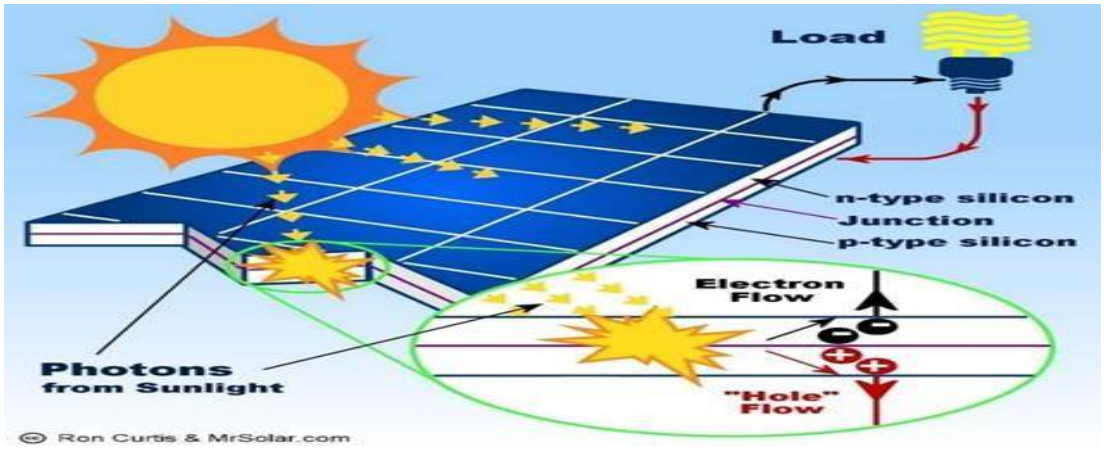


Fig 2. Illustration of solar panel operation (photons, electrons, holes, load) [14]

Effective administration of patient records and referrals and gathering and reporting of health statistics is significantly enhanced when computerized services, software, and solutions are made possible by electricity access. Solar powered solutions can also be used to power the staff quarters, supplementing the healthcare center related interventions - which facilitates the recruitment and retention of qualified health workers and decreasing employees' absenteeism in health facilities.

Now considering smart mental health care, which is the application of innovative technologies like artificial intelligence, mobile apps, wearable technology, telemedicine, and electronic medical records to improve the delivery, monitoring, and personalization of mental health services for individuals and populations.

Smart mental care couples digital systems and devices with mainstream mental health treatment to facilitate dynamic access to information, tailored interventions, monitoring at a distance and enhanced treatment adherence. These are exemplified by AI chatbots for therapy, mood-tracking phone apps, wearable monitors in real time and telemedicine platforms for online consultations [15]. Mobile Apps offer psychoeducation, symptom monitoring, guided exercises, and direct contact with mental health professionals.AI and Machine Learning assist in diagnosis through the examination of behavioral and physiological information; facilitate predictive care in illness such as depression or psychosis. Wearables and IoT Devices track sleep, activity, and vital signs to assist with early intervention and continued care [16]. Reduces access obstacles by enabling remote therapy and consultations, especially in underprivileged or rural communities. By reducing logistical and geographic obstacles, these actions help reach underserved or distant groups. Digital interoperability and computerized record keeping speed up screening, referral, and follow-up processes. Analyzes individual

ISBN: **978-93-343-9865-6**

behavioral data to provide tailored interventions that improve efficacy and user engagement while enabling scalable, less expensive delivery than in-person care.

Example programs include the SMART Mental Health Project in India achieved significant service use increases and better outcomes in rural communities through the use of digital tools, electronic referrals, and community health worker integration [17]. Smart mental care is quickly revolutionizing mental health prevention, diagnosis, and treatment but must be carefully designed and regulated to provide equitable, secure, and effective care for everyone.

AI-driven diagnostic tools, according to Kothinti, R.R., 2024, are advanced medical technologies that analyze medical data and assist in illness identification by utilizing artificial intelligence techniques including machine learning, deep learning, and natural language processing [18]. Improving patient outcomes, reducing healthcare costs, and increasing survival rates all depend on early disease identification. Early diagnosis improves treatment outcomes for the majority of life-threatening conditions, including cancer, heart disease, and neurological diseases. Machine learning (ML) and deep learning (DL) form the backbone of AI-based diagnostic devices, facilitating automatic pattern detection and predictive analytics in healthcare[19]. ML algorithms process structured and unstructured health information, detecting correlations that aid in disease diagnosis. Artificial neural networks are used in deep learning, a subfield of machine learning, to understand and analyze complex data with extreme precision, such as genetic codes and medical imaging. For example, Convolutional Neural Networks (CNNs) are widely used in radiology to detect anomalies, fractures, and malignancies in medical imaging, greatly increasing the accuracy of diagnosis. Computer systems can read and interpret unstructured material found in clinical notes, research articles, and electronic health records (EHRs) thanks to Natural Language Processing (NLP). NLP allows automated extraction of patient-related data, enabling doctors to make well-informed decisions based on previous medical histories, symptoms, and response to treatments. By converting vast amounts of textual data into structured, usable insights, NLP improves diagnostic accuracy, reduces administrative burdens, and enhances clinical decision support systems (CDSS). Medical imaging diagnostics heavily relies on computer vision, an area of artificial intelligence that focuses on picture interpretation. AI-driven predictive analytics utilizes these datasets to assess disease risks, forecast potential outbreaks, and recommend personalized treatment plans.

I. DISCUSSION

- By supplying clean, reliable, and affordable electricity—a necessity for efficiently and safely delivering medical services in off-grid or isolated communities—solar energy makes rural healthcare possible.
- For most women and children, adequate, continuous lighting during pregnancy and delivery, along with tools like an ultrasound or a fetal heart rate monitor, can be life-saving.
- Maternal and child health care requirements like baby warmers, delivery suction machines, phototherapy, lighting and fans are the ones that can be solar-powered
- ICT is an important facilitator of broader "telemedicine" initiatives, which have proven to be highly effective in enabling activities such as distant health worker consultations and continuous training and education.
- Cancer detection is likely one of the most exciting applications of AI in medicine, where earlier detection improves survival outcomes.
- Through the identification of minute anomalies in breast tissue that human radiologists might overlook, artificially intelligent mammography analysis enhances the early detection of breast cancer. AI-powered screening expedites the detection process and improves diagnosis accuracy.
- By accurately identifying nodules and other lesions, AI algorithms trained on CT images and chest X-rays help detect lung cancer early. Similarly, AI-powered dermatology apps use deep learning on skin lesions to distinguish between benign and malignant conditions such as melanoma[20].
- AI is transforming cardiovascular disease (CVD) diagnosis and risk forecasting by analyzing medical imaging, electrocardiograms (ECG), and patient data[21]
- AI in Neurological Disorders such as Early Detection of Alzheimer's and Parkinson's Disease AI tools analyze speech patterns, motor functions, and cognitive examinations to detect early signs of Alzheimer's and Parkinson's. Machine learning algorithms can track the evolution of the disease, allowing for medication interventions that can stop cognitive loss.
- AI enhances early detection and aids in the development of focused therapeutics by identifying biomarkers for illnesses like Alzheimer's [22].

ISBN: **978-93-343-9865-6**

- AI uses predictive modeling and quick diagnostic tests to improve the identification, monitoring, and control of infectious illnesses.

II. CONCLUSION

The smart village concept shows how technology may be a unifying force in rural care by eliminating the long-standing barriers of accessibility, affordability, and quality. By incorporating innovations like telemedicine, solar-powered facilities, health kiosks, and AI-based diagnostics, rural communities can access scalable and sustainable healthcare solutions. In addition to promoting early disease identification and preventative care, these technologies enhance regional healthcare capabilities and lessen dependency on metropolitan areas. Furthermore, digital connection and renewable energy support the reliability of medical infrastructure, while AI-driven technologies improve diagnostic accuracy and evidence-based decision-making. Together, these programs improve rural communities, encourage diversity, and close the healthcare gap between urban and rural areas.

REFERENCES:

[1] Lucan, J., Pokmajević, M. and Kunčič, U., 2024. Impact of technology on the quality of life of elderly people in smart villages: Literature review. IFAC-Papers OnLine, 58(3), pp.262-267.
[2] Perez, K, Wisniewski, D., Ari, A., Lee, K, Lieneck, C, & Ramamonjiarivelo, Z. (2025, February). Investigation into application of Al and telemedicine in rural communities: a systematic literature review. In Healthcare (Vol. 13. No. 3. p.324). MDPI.
[3] Renukappa, S., Suresh, S., Abdalla, W., Shetty, N., Yabbati, N., & Hiremath, R. (2024). Evaluation of smart village strategies and challenges. Smart and Sustainable Built Environment, 13(6), 1386-1407.
[4]Jakobsen , K., Mikalsen, M. and Lilleng, G., 2023. A literature review of smart technology domains for research on smart rural communities. Technology in society, 75, p.102397.
[5] Borga, M., West, J., Bell, J.D., Harvey, N.C., Romu, T., Heymsfield, S.B. and Dahlqvist Leinhard, O., 2018. Advanced body composition assessment: from body mass index to body composition profiling. Journal of Investigative Medicine, 66(5), pp.1-9.
[6] Sigit, R., Arief, Z. and Bachtiar, M.M., 2015. Development of Healthcare Kiosk for Checking Heart Health. EMITTER International Journal of Engineering Technology, 3(2), pp.99-114.
[7] Leng, S., Tan, R.S., Chai, K.T.C., Wang, C., Ghista, D., & Zhong, L. (2015). The electronic stethoscope. Biomedical engineering online,14(1),66.
[8] Lyu, Y., Vincent, C. J., Chen, Y., Shi, Y., Tang, Y., Wang, W., ... & Ding, J. (2015). Designing and optimizing a healthcare kiosk for the community. Applied ergonomics, 47, 157-169.
[9] Jawhar, S. (2024). Smart City Development in Bodø: Is it possible to Harmonize Urban and Rural Needs? (Master's thesis, Nord universitet).
[10] Lo'ai, A. T., Mehmood, R., Benkhlifa, E., & Song, H. (2016). Mobile cloud computing model and big data analysis for healthcare applications. IEEE Access, 4, 6171-6180.
[11] Izuka, U., Ojo, G. G., Ayodeji, S. A., Ndiwe, T. C., & Ehiaguina, V. E. (2023). Powering rural healthcare with sustainable energy: a global review of solar solutions. Engineering Science & Technology Journal, 4(4), P-No.
[12] Ewim, D. R., Olatubosun, S. A., & Abolarin, S. M. Energy Alternatives and Efficiency Options for Sustainable Development in Nigeria. In Localized Energy Transition in the 4th Industrial Revolution (pp. 225-245). CRC Press.
[13] Foley, G. (1995). Photovoltaic applications in rural areas of the developing world (Vol. 304). World Bank Publications.
[14] Maghraby, Y. R., Ibrahim, A. H., Tayel, A., Azzazy, H. M. E. S., & Shoeib, T. (2025). Towards sustainability via recycling solar photovoltaic Panels, A review. Solar Energy, 285, 113085.
[15] Anser, M. K., Nabi, A. A., Ahmad, I., Abro, M. M. Q., & Zaman, K. (2025). Advancing Mental Health Care: A Comprehensive Review of Digital Tools and Technologies for Enhancing Diagnosis, Treatment, and Science.
[16] Dias, D., & Paulo Silva Cunha, J. (2018). Wearable health devices—vital sign monitoring, systems

ISBN: **978-93-343-9865-6**

and technologies. Sensors, 18(8), 2414.
[17] Maulik, P. K., Kallakuri, S., Devarapalli, S., Vadlamani, V. K., Jha, V., & Patel, A. (2017). Increasing use of mental health services in remote areas using mobile technology: a pre–post evaluation of the SMART Mental Health project in rural India. Journal of global health, 7(1), 010408.
[18] Kothinti, R. R. (2024). Deep learning in healthcare: Transforming disease diagnosis, personalized treatment, and clinical decision-making through AI-driven innovations. World Journal of Advanced Research and Reviews, 24(2), 2841-2856.
[19] Rahman, A., Debnath, T., Kundu, D., Khan, M. S. I., Aishi, A. A., Sazzad, S., ... & Band, S. S. (2024). Machine learning and deep learning-based approach in smart healthcare: Recent advances, applications, challenges and opportunities. AIMS Public Health, 11(1), 58.
[20] Mahboub, B., Tadepalli, M., Raj, T., Santhanakrishnan, R., Hachim, M. Y., Bastaki, U., ...