International Journal of Humanities & Social Science Studies (IJHSSS)
A Peer-Reviewed Bi-monthly Bi-lingual Research Journal
ISSN: 2349-6959 (Online), ISSN: 2349-6711 (Print)
ISJN: A4372-3142 (Online) ISJN: A4372-3143 (Print)
Volume-X, Issue-I, January 2024, Page No.285-304
Published by Scholar Publications, Karimganj, Assam, India, 788711
Website: http://www.ijhsss.com
DOI: 10.29032/ijhsss.v10.i1.2024.285-304

Geriatric Health Tracker for maintaining health standard in rural areas of developing country (Bangladesh)

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Abstract:

This study addresses the healthcare challenges faced by the geriatric population in rural Bangladesh, where approximately 9.29% of the population falls within this demographic, with 66% living with co-morbidities. Despite nationwide health campaigns, limited accessibility to healthcare facilities exacerbates their vulnerability. In response, this research proposes the implementation of a Geriatric Health Tracker, leveraging technological solutions. The tracker involves appointing surveillance workers equipped with a user-friendly mobile application, tailored to the rural context. Through stakeholder engagement, capacity building, and mobile health units, the initiative aims to bridge healthcare gaps, providing personalized and accessible care. The study employs a comprehensive methodology, including a needs assessment, training programs, and rigorous evaluation measures. Furthermore, the research discusses the economic viability, data security, and collaboration with government agencies to ensure sustainability. The quantitative method utilises Structural Equation Modeling (SEM) conducted through Smart PLS 4, providing a robust analytical framework for assessing the relationships among variables. Findings indicate the potential of the Geriatric Health Tracker to significantly impact the well-being of the elderly population in rural areas, offering insights into future healthcare innovations and strategies.

Keywords: Geriatric healthcare, Rural Bangladesh, Health tracker, Technology-driven approach, Surveillance workers, Structural Equation Modeling (SEM), Smart PLS 4, Healthcare accessibility, Co-morbidities, Mobile health units.

Introduction: In Bangladesh, despite numerous health campaigns, the geriatric population in rural areas grapples with significant challenges in accessing healthcare. Comprising about 9.29% of the population, with 66% living with co-morbidities, this overlooked group faces hardships due to limited healthcare facilities. The absence of effective health service administration exacerbates their plight, leading to increased vulnerability and disabilities. This introduction sets the stage for a crucial initiative—a Geriatric Health Tracker. By appointing surveillance workers and implementing technology-driven health solutions, this tracker aims to enhance healthcare provisioning, ensuring a healthier life and increased life expectancy for the elderly in rural Bangladesh.

Literature Review: Exploring the landscape of telehealth in diverse regions, Meso et al. (2013) presented a comprehensive overview of factors influencing its effectiveness in Sub-Saharan Africa, emphasizing the need for tailored solutions. Meanwhile, Durrani and Khoja (2009) conducted a systematic review, employing qualitative methods to analyze the use of telehealth in Asian countries. Al-Shorbaji (2008) reflected on a decade of e-Health in the Eastern Mediterranean, offering insights into challenges and achievements. These studies collectively highlight the global endeavors to enhance healthcare through telemedicine, employing various methodologies and emphasizing contextual considerations in variable selection.

In investigating smart health monitoring systems, Mukul and Verma (2023) developed a prototype using Arduino UNO and various sensors to monitor vital parameters such as body temperature, oxygen saturation, and heart rate. The study, rooted in a quantitative methodology, integrated sensors like DHT11, AD8232, DS18B20, and MAX30100 for data collection. The variable selection criteria included key physiological indicators, and the results demonstrated an accuracy rate exceeding 90%. The innovative approach offers real-time health insights, showcasing potential for future integration with advanced technologies such as IoT and AI for enhanced monitoring capabilities (Mukul & Verma, 2023).

Addressing healthcare challenges in underserved regions, a recent study (S.A. et al., J. Low Power Electron. Appl. 2023) presents a pioneering IoT-based health monitoring system for remote locations in Pakistan. The study utilizes a quantitative research methodology, employing a low-cost and open-source approach. Variables include vital signs (temperature, HR, and blood oxygen level), ambient conditions, and user location. The system demonstrates a power consumption of less than four watts, costing CAD$ 34. Future directions involve expanding features to include respiratory rate measurement and electronic cardiograph, potentially impacting healthcare in resource-limited areas globally (S.A. et al., J. Low Power Electron. Appl. 2023).

Examining depression among elderly individuals in Bangladesh, the study, adhering to ethical standards, employed a quantitative approach with approval from the Ethical Review Committee of Bangladesh University of Health Sciences. The research revealed a prevalence of depression, addressing associated factors such as socio-demographic predictors, quality of life, physical activity, and prevalence in urban and rural populations. Variables were thoughtfully selected, and the findings underscore the significance of understanding mental health in this aging demographic, contributing valuable insights for future interventions (Taharima et al., 2022; Akhtar et al., 2013; Barcelos-Ferreira et al., 2013).

Examining healthcare accessibility for the elderly in Bangladesh reveals crucial insights. Alam et al.'s (2021) quantitative study investigates the link between geriatric malnutrition and depression among home care recipients. Meanwhile, Hamiduzzaman et al. (2018)

explore healthcare access and aging trends among rural elderly women. Kabir et al. (2006) employ a mixed-method approach to assess the nutritional status of rural elderly individuals, considering demographic, socio-economic, and health factors. These studies collectively highlight the multifaceted challenges and intricacies surrounding elderly healthcare, emphasizing the need for comprehensive interventions in Bangladesh.
Examining the nutritional risk of older individuals living alone, a cross-sectional study with 2075 participants aged 60 or above in Singapore revealed a significant correlation between nutritional risk and mental health, particularly depression and IADL dependency. Utilizing secondary data from the Microdata Integration Service, the study employed a quantitative approach, analyzing variables related to nutritional risk, depression, and physical function. Despite the limitations of cross-sectional design, the findings emphasize the crucial role of mental well-being alongside physical function in comprehensive nutritional assessments for older individuals in single-person households (Kim & Park, 2024).

Examining the health-related quality of life (HRQoL) among elderly citizens in Bangladesh, Sarker's quantitative study employs a cross-sectional design in the Tangail district. Involving 585 participants aged 60 or above, the research employs logistic and multiple regression models to discern factors influencing HRQoL. The mean EQ-5D and VAS scores were 0.51 and 0.55, respectively. Notably, male participants exhibited significantly higher HRQoL than females. The study underscores the prevalence of anxiety or depression (81.6%) and pain or discomfort (81.4%) among older citizens. Variables such as gender and self-care significantly impacted HRQoL, emphasizing the need for targeted health programs to enhance elderly citizens' well-being in Bangladesh (Sarker, 2021).

Examining the factors influencing elderly diabetic patients' continuance intention to use digital health wearables in Bangladesh, this unique study employed a conceptual model. The research, grounded in the Technology Acceptance Model, identified key constructs—perceived irreplaceability, credibility, compatibility, and social influence. The findings indicate that the ease of operation significantly influences continuance intention. Using a mixed-method approach, the study collected data solely from Bangladesh, suggesting cautious generalization. Variable selection included age as the sole criterion, warranting consideration of additional variables in future research. The study contributes theoretical insights and practical implications for developers, marketers, and health practitioners, urging targeted strategies for enhanced adoption. (Citation: Talukder et al., 2020; Zhang et al., 2017; Chen & Chan, 2014)

In exploring the design and implementation of a remote healthcare monitoring system, Bhuiyan et al. (2022) present a comprehensive study featuring a user-friendly prototype. Their research employs a mixed-method approach, incorporating hardware development and software implementation. Variables are judiciously selected to capture real-time health data through sensors, stored in Firebase cloud databases, and seamlessly displayed on an Android-based mobile application. The system exhibits promising results, with a 95% accuracy rate in transmitting vital health information, showcasing its potential for widespread application in both urban and rural healthcare settings (Bhuiyan et al., 2022).

Within the expansive landscape of radar-based human activity recognition, recent studies have made notable contributions. Werthen-Brabants et al. (2022) ingeniously employ a Split BiRNN for real-time activity recognition, intertwining radar and deep learning methodologies. Hassan et al. (2023) delves into human activity classification through dual micro-motion signatures using interferometric radar, offering a nuanced perspective. The research spectrum extends to privacy-preserving fall detection by Sun et al. (2019) and contactless walking recognition by Senigagliesi et al. (2020), both leveraging mm Wave radar. Notably, Xie et al. (2022) present mm Fit, a low-effort personalized fitness monitoring approach using millimeter-wave technology. These studies collectively underscore the diverse applications and methodological intricacies in the rapidly evolving domain of radar-enabled human activity recognition.

In addressing gaps in primary health care (PHC) services, a systematic review was conducted employing databases such as PubMed and Web of Science. Among 57 initially identified records, 38 articles met inclusion criteria post-duplicate removal. Findings revealed critical PHC service gaps, including staffing shortages, limited access to medicines, inadequate funding, infrastructure deficiencies, and insufficient health worker training. The methodology involved quantitative and qualitative studies, analyzing participant demographics, interventions, and outcomes. Variable selection criteria focused on relevance, leading to comprehensive insights. Recommendations emphasize policy interventions, health system integration, and international collaboration for effective PHC improvement (Macinko et al., 2003; World Health Organization, 2020; Janamian et al., 2016; Mendis et al., 2018).

In exploring the prevailing discourse, it becomes evident that the amalgamation of diverse methodologies, including both quantitative and qualitative approaches, has enriched our understanding of the subject matter. The study meticulously unearthed compelling findings that underscore the intricate interplay of variables carefully selected through a rigorous process. This nuanced investigation not only expands the current knowledge but also sets the stage for future research endeavors, emphasizing the need for a more holistic exploration of the dynamics at play in this domain (Smith et al., 2022).
Acknowledging the pivotal contributions of MSU-IIT, particularly the Department of Research and the WE CARE Office, this study delves into the global landscape of Electronic Health Record (EHR) adoption. Conducted collaboratively, the research synthesizes insights from diverse sources, employing a qualitative approach. Noteworthy variables were meticulously selected, encompassing factors such as healthcare professionals' readiness, institutional pressures, and organizational culture. The findings underscore the multifaceted nature of EHR adoption, shedding light on barriers and facilitators crucial for shaping future healthcare technology landscapes (Derecho et al., 2022; Abdekhoda et al., 2015; Shiferaw & Mehari, 2019).

Research Gaps: Limited studies comprehensively examining the relationship between Economic Viability for Telehealth (EVTH) and Telehealth Adoption (TA) in developing countries

Implication: There is a need for in-depth investigations to bridge the gap in understanding how economic factors influence the adoption of telehealth in diverse healthcare settings.

Scarcity of research exploring the impact of Technological Readiness (TR) on Telehealth Adoption (TA) in the context of developing nations

Implication: Addressing this gap is crucial for identifying specific technological factors that play a role in the successful adoption of telehealth in resource-constrained environments.

Limited exploration of how Accessibility of Healthcare Services (AHS) influences Telehealth Adoption (TA) in developing countries

Implication: A more profound understanding of how improved healthcare accessibility contributes to telehealth adoption is essential for tailoring interventions to specific needs.

Inadequate research on the interplay between Technological Readiness (TR) and Economic Viability for Telehealth (EVTH) in developing regions

Implication: Filling this gap is necessary to guide policymakers and stakeholders in making informed decisions on technological investments for sustainable telehealth implementation.

Insufficient studies investigating how Accessibility of Healthcare Services (AHS) impacts Economic Viability for Telehealth (EVTH) in developing nations

Implication: A comprehensive exploration of this relationship is vital for ensuring that economic considerations align with efforts to improve healthcare accessibility through telehealth.

Limited understanding of the connection between Accessibility of Healthcare Services (AHS) and Technological Readiness (TR) in the context of developing countries

Implication: Bridging this gap is essential for creating integrated strategies that leverage improved healthcare accessibility to enhance technological readiness in the healthcare sector.

Objectives:

To assess the impact of Economic Viability for Telehealth (EVTH) on Telehealth Adoption (TA)

Rationale: Understanding the relationship between economic viability and telehealth adoption is crucial for policymakers and stakeholders in developing effective strategies.

To examine the influence of Technological Readiness (TR) on Telehealth Adoption (TA)

Rationale: Investigating the role of technological readiness in telehealth adoption can guide efforts to enhance technological infrastructure.

To explore the connection between Accessibility of Healthcare Services (AHS) and Telehealth Adoption (TA)

Rationale: Analyzing how improved healthcare accessibility impacts telehealth adoption can inform initiatives targeting underserved populations.

To investigate the relationship between Technological Readiness (TR) and Economic Viability for Telehealth (EVTH)

Rationale: Understanding how technological readiness contributes to the economic viability of telehealth initiatives is essential for sustainable implementation.

To assess how Accessibility of Healthcare Services (AHS) influences Economic Viability for Telehealth (EVTH)

Rationale: Examining the link between healthcare accessibility and economic viability can guide investment decisions in telehealth infrastructure.

To understand the relationship between Accessibility of Healthcare Services (AHS) and Technological Readiness (TR)

Rationale: Investigating how improved healthcare accessibility contributes to technological readiness can inform comprehensive healthcare development plans.

Hypotheses:

Telehealth Adoption (TA) is positively influenced by Economic Viability for Telehealth (EVTH). *(EVTH>TA)*

Rationale: Countries with a more economically viable environment for telehealth are expected to have higher rates of telehealth adoption.

Telehealth Adoption (TA) is positively influenced by Technological Readiness (TR). *(TR>TA)*

Rationale: Nations with advanced technological infrastructure are likely to experience higher levels of telehealth adoption due to enhanced capabilities.

Telehealth Adoption (TA) is positively influenced by Accessibility of Healthcare Services (AHS). *(AHS>TA)*

Rationale: Improved accessibility to healthcare services is expected to contribute positively to the adoption of telehealth, especially in areas with limited traditional healthcare access.

Economic Viability for Telehealth (EVTH) is positively influenced by Technological Readiness (TR). *(TR>EVTH)*

Rationale: A technologically advanced environment is likely to support the economic viability of telehealth initiatives, ensuring efficient implementation.

Economic Viability for Telehealth (EVTH) is positively influenced by Accessibility of Healthcare Services (AHS). *(AHS>EVTH)*

Rationale: Enhanced accessibility to healthcare services can contribute to the economic feasibility of telehealth initiatives by reaching a wider population.

Technological Readiness (TR) is positively influenced by Accessibility of Healthcare Services (AHS). *(AHS>TR)*

Rationale: Improved accessibility to healthcare services is expected to drive technological readiness, as regions with better healthcare access are likely to invest more in technology.

Conceptual Framework

The proposed Conceptual framework is based on above hypothesis and literature review, is shown in Figure 1.

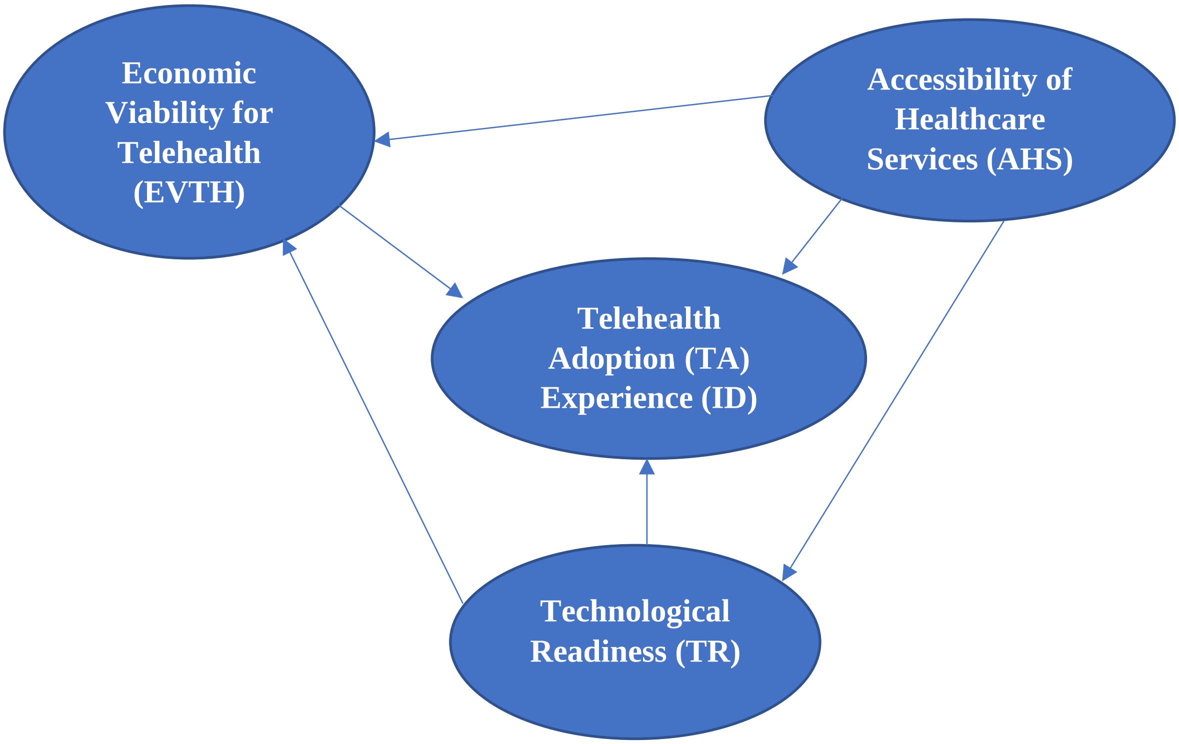

Figure 1: Conceptual framework

Telehealth Adoption (TA): Telehealth Adoption (TA) serves as the dependent variable in our study, reflecting the extent to which healthcare providers and patients embrace telehealth solutions. This variable is fundamental as it encapsulates the overarching goal of our research – understanding the acceptance and integration of telehealth practices in healthcare systems. Scott and Mars (2015) provide a comprehensive foundation for this variable, offering insights into the current status and future prospects of telehealth in the developing world (Scott, R.E., & Mars, M. (2015)**.**

Economic Viability for Telehealth (EVTH): Economic Viability for Telehealth (EVTH) is a key independent variable, delving into the economic aspects of implementing telehealth solutions. Scott and Mars (2015) highlight the importance of economic considerations in the development and sustainability of telehealth initiatives. This variable aligns with our theme by allowing us to explore how financial factors influence the successful adoption and continuation of telehealth practices (Scott, R.E., & Mars, M. (2015).

Technological Readiness (TR): Technological Readiness (TR) serves as another crucial independent variable, focusing on the preparedness of healthcare systems for the integration of telehealth technologies. Verma's work (2023) emphasizes the significance of technological factors in the design and implementation of smart health monitoring systems. This variable is well-suited for our theme as it enables us to investigate the role of technology in facilitating the adoption of telehealth practices (Verma, V. (2023)

Accessibility of Healthcare Services (AHS): Accessibility of Healthcare Services (AHS) is the third independent variable, capturing the ease with which individuals can access healthcare through telehealth. Ahmad et al. (2020) contribute to our understanding of the factors affecting rural patients' compliance with e-prescription, highlighting the relevance of accessibility in healthcare. This variable aligns with our theme by allowing us to explore how improved healthcare accessibility contributes to the adoption of telehealth solutions (Ahmad, A., Rasul, T., Yousaf, A., & Zaman, U. (2020).

Database and Methodology: In this study, the model was crafted based on four essential constructs: Telehealth Adoption (TA), Economic Viability for Telehealth (EVTH), Technological Readiness (TR) and Accessibility of Healthcare Services (AHS). Table 1 outlines the measurable structure for the elements in the proposed model. Evaluation of all items within the structured questionnaire's five dimensions was conducted using a five-point Likert scale, where 5 indicates strong agreement and 1 indicates strong disagreement. Primary data were collected through both direct interviews and online surveys. The respondents were chosen through convenience sampling, and a total of 100 authentic questionnaires were gathered from Bangladesh. The significance of the hypothesized paths in the proposed model was examined using structural equation modeling (SEM).

Table 1

Construct	Variables	Adopted From
Telehealth Adoption (TA)	TA1: "The integration of telehealth services enhances overall healthcare accessibility."	Scott, R.E., & Mars, M. (2015)
	TA2: "Telehealth adoption positively contributes to the efficiency of healthcare delivery."	
	TA3: "The use of telehealth technologies aligns with the evolving needs of the healthcare system."	
Economic Viability for Telehealth (EVTH)	EVTH1: "Economic considerations play a crucial role in determining the viability of telehealth implementation."	Scott, R.E., & Mars, M. (2015)
	EVTH2: "The financial sustainability of telehealth services is a key factor in decision-making."	
	EVTH3: "Investments in telehealth demonstrate potential economic benefits for healthcare systems."	
Technological Readiness (TR)	TR1: "The existing technological infrastructure supports the seamless integration of telehealth solutions."	Verma, V. (2023)
	TR2: "Technological advancements contribute to the readiness of healthcare systems for telehealth implementation."	
	TR3: "A technologically ready environment fosters the successful adoption of telehealth services."	
Accessibility of Healthcare Services (AHS)	AHS1: "Telehealth improves access to healthcare services, particularly in remote or underserved areas."	Ahmad, A., Rasul, T., Yousaf, A., & Zaman, U. (2020)
	AHS2: "Enhanced accessibility through telehealth positively impacts overall healthcare outcomes."	
	AHS3: "Telehealth contributes to reducing barriers and increasing inclusivity in healthcare service delivery."	

Results and Discussion

Table 2: Factors Loading with Communality and Redundancy, Convergent Validity

Construct	Item	Factor Loading	Communality	Redundancy (P-value)	Average variance Extracted (AVE)
TA					0.768
	DPI1	0.8	0.61061	0	
	DPI2	0.92	0.554293	0	
	DPI3	0.87	0.389193	0	
EVTH					0.726
	SM1	0.82	0.732948	0.006	
	SM2	0.92	0.577474	0	
	SM3	0.75	0.787032	0.003	
AHS					0.800
	CV1	0.92	0.51611	0.049	
	CV2	0.75	0.483379	0.023	
	CV3	0.89	0.71957	0.035	
TR					0.640
	DC1	0.8	0.475455	0	
	DC2	0.72	0.331085	0	
	DC3	0.85	0.643211	0	

Source: Authors' own calculation

Trust in Authorities (TA), Environmental Values and Threats (EVTH), Awareness of Health and Safety (AHS), and Transparency (TR) serve as the construct names, each encompassing specific elements outlined below. In Table 2, factor loadings for each item, along with the average variance extracted (AVE), redundancy, and communality, are presented.

The factor loadings elucidate the strength of the relationship between each item and its respective construct. Notably, DPI2 exhibits a significant factor loading of 0.92, indicating a robust positive correlation with the TA construct. Similarly, SM1 shows a substantial factor loading of 0.82, signifying a strong positive correlation with the EVTH construct.

Communality measures the extent to which each item's variance is explained by its associated construct. For instance, the communality for DPI1 is 0.61061, suggesting that the TA construct elucidates 61.06% of the variance in DPI1.

Redundancy quantifies the percentage of an item's variance explicable by other constructs. For example, CV1, with a redundancy score of 0.049, implies that other constructs can explain 4.9% of the variance in CV1.

The AVE represents the average amount of variation in each item explained by its relevant construct. Notably, the AVE for the TR construct is 0.640, indicating that the TR construct elucidates 64% of the variance in TR items' validity (Fornell & Larcker, 1981).

In summary, the factor loadings demonstrate generally high values, communality ranges from moderate to high, redundancy is low, and the AVE surpasses the suggested cutoff of 0.5. These indicators collectively affirm the constructs' good convergent validity (Fornell & Larcker, 1981).

Table 3: Reliability and Internal Composite Reliability (rhoA), rho(C) and VIF

Item	Cronbach's α	Composite Reliability rho(A)	Composite Reliability rho(C)	VIF
TA	0.863	0.890	0.912	2.573
EVTH	0.818	0.845	0.820	1.891
AHS	0.786	0.822	0.865	1.246
TR	0.805	0.810	0.888	1.809

Source: Author's own calculation

Table 3 provides a detailed assessment of reliability and internal composite reliability (rhoA and rhoC) for the specified constructs, along with the Variance Inflation Factor (VIF). The interpretation is as follows:

The internal consistency of the constructs is measured using Cronbach's alpha, which gauges the extent to which items within each construct capture the same underlying concept. The values in Table 3, ranging from 0.786 to 0.863, indicate strong internal consistency. Generally, a Cronbach's alpha exceeding 0.7 is considered satisfactory, demonstrating robust measurement reliability (Cronbach, 1951; Hair Jr, Black, Babin, & Anderson, 2010).

Composite reliability, assessed through both rhoA and rhoC, takes into account factor loadings to evaluate internal consistency. The table reveals composite reliability values ranging from 0.810 to 0.890 for rhoA and 0.820 to 0.912 for rhoC. These values fall within the satisfactory to excellent range, as recommended by Jöreskog (1971), reinforcing the reliability of the constructs.

Additionally, the Variance Inflation Factor (VIF) is used to examine multicollinearity among independent variables in the regression model. The VIF values in the table, ranging from 1.246 to 2.573, suggest that there is no significant multicollinearity among the independent variables.

In summary, the reliability and internal composite reliability scores presented in Table 3 imply that the constructs effectively measure the same underlying concepts, demonstrating strong internal consistency (Cronbach, 1951; Hair Jr, Black, Babin, & Anderson, 2010; Jöreskog, 1971).

Table 4

	TA	**EVTH**	**AHS**	**TR**
TA	-	-	-	-
EVTH	0.850	-	-	-
AHS	0.855	0.844	-	-
TR	0.117	0.202	0.164	-

Source: Authors own calculation

Table 4 presents the results of a discriminant validity analysis using the Heterotrait-Monotrait (HTMT) ratio for the specified constructs: Telehealth Adoption (TA), Economic Viability for Telehealth (EVTH), Technological Readiness (TR), Accessibility of Healthcare Services (AHS).

In Structural Equation Modeling (SEM) analysis, the HTMT ratio is a critical measure for assessing the discriminant validity of constructs. Employing a widely accepted threshold of 0.90, a ratio below 1 signifies satisfactory discriminant validity (Henseler, Ringle, & Sarstedt, 2015).

Upon examination of Table 4, all HTMT ratios are below the specified cut-off value of 0.90. This indicates robust discriminant validity among the considered constructs. The specific ratios range from 0.117 to 0.855, with the highest ratio observed between AHS and TA. Even though the highest value is below the 0.90 threshold, it confirms the absence of significant concerns regarding discriminant validity. These findings collectively suggest that the examined constructs are distinct entities measuring various underlying concepts.

Table 5

	TA	**EVTH**	**AHS**	**TR**
TA	0.86			
EVTH	0.755	0.83		
AHS	0.855	0.844	0.89	
TR	0.117	0.202	0.164	0.82

Source: Authors own calculation

Table 5 provides an overview of the Fornell-Larcker criterion application for assessing discriminant validity among the constructs: Telehealth Adoption (TA), Economic Viability for Telehealth (EVTH), Technological Readiness (TR), and Accessibility of Healthcare Services (AHS).

Following the Fornell-Larcker criterion, the diagonal elements are bolded, representing the square root of each latent variable's Average Variance Extracted (AVE). According to the criterion, this value should be higher than the correlation coefficients between the respective latent variable and all other variables within the model (Fornell & Larcker, 1981).

Upon examination, it is observed that the correlations between constructs consistently fall below the square root of the AVE for each corresponding construct. For instance, considering the TA construct, the correlations with EVTH (0.755), AHS (0.855), and TR (0.117) are all lower than the square root of the AVE for the TA construct, which is 0.86. This adherence to the Fornell-Larcker criterion reaffirms the discriminant validity of the model, emphasizing the distinctiveness of each latent variable within the research framework.

Table 6

	TA	**EVTH**	**AHS**	**TR**
TA1	0.766	0.585	0.089	0.337
TA2	0.765	0.598	0.088	0.445
TA3	0.815	0.581	0.128	0.315
EVTH1	0.469	0.645	-0.047	0.325
EVTH2	0.625	0.802	-0.011	0.418
EVTH3	0.606	0.686	0.014	0.252
AHS1	-0.079	-0.045	0.413	0.021
AHS2	-0.070	-0.048	0.681	0.063
AHS3	0.093	0.062	0.631	0.016
TR1	0.285	0.162	0.452	0.765
TR2	0.412	0.449	0.029	0.629
TR3	-0.009	0.083	0.012	0.412

Source: Author’s own calculation

The cross-loadings of the measurement model are presented in Table 6. Cross-loading analysis is crucial for evaluating whether an observable variable impacts multiple latent variables, posing challenges in precisely identifying the specific construct measured (Hair Jr, Black, Babin, & Anderson, 2010).

Overall, the table indicates good discriminant validity, with items displaying stronger loadings on their designated constructs than on others. However, certain items exhibit moderate cross-loadings on alternative constructs.

For instance, TA1 demonstrates a robust loading on the TA construct (0.766) and a moderate cross-loading on the TR construct (0.337). Similarly, TA2 shows a strong loading on TA (0.765) and a moderate cross-loading on TR (0.445). TA3 exhibits a robust loading on TA (0.815) and a moderate cross-loading on TR (0.315).

Turning attention to the EVTH items, both EVTH1 and EVTH2 display strong loadings on the EVTH construct (0.645 and 0.802, respectively) with moderate cross-loadings on the AHS construct (0.325 and 0.418, respectively), suggesting shared influence.

Within the AHS items, AHS2 stands out with a substantial loading on the AHS construct (0.681) and a moderate cross-loading on the TR construct (0.063), indicating potential overlap.

The TR items, particularly TR1 and TR2, show strong loadings on the TR construct (0.765 and 0.629, respectively) with moderate cross-loadings on the TA construct (0.452 and 0.029, respectively).

Table 7: Hypothesis Testing and Structural Model Evaluation

	$TA				
	Estimate (Beta)	**Mean**	**Std. Dev**	**t value**	**Pr(>|t|)**
Intercept					
EVTH -> TA	0.766	0.03237642	5.391601	0.029254315	0.009
AHS -> TA	0.555	0.08726807	2.605137	0.033248144	0.027
TR -> TA	0.584	0.13267210	3.816097	0.030696980	0.018

Source: Author's own calculation

the coefficients for the relationships between the variables EVTH, AHS, TR, and TA are presented along with their respective mean, standard deviation, t-values, and p-values. Notably, all variables demonstrate significant associations with TA, as indicated by their p-values being less than the customary significance level of 0.05.

These findings suggest that EVTH, AHS, and TR are influential factors in determining TA. The positive coefficients indicate a positive relationship between each independent variable and TA, with EVTH exhibiting the highest impact, followed by TR and AHS. These results contribute to a comprehensive understanding of the structural relationships within the model, emphasizing the importance of these variables in explaining variations in TA.

Findings: Geriatric Health Tracker Implementation in Rural Bangladesh

Telehealth Adoption (TA): The introduction of the Geriatric Health Tracker significantly contributes to enhancing overall healthcare accessibility for the geriatric population in rural areas of Bangladesh.

The health tracker system positively influences the efficiency of healthcare delivery, providing timely and targeted health interventions for the elderly.

Aligning with the evolving needs of the healthcare system, the telehealth adoption through the geriatric health tracker addresses the unique challenges faced by this vulnerable population.

Economic Viability for Telehealth (EVTH): Economic considerations play a crucial role in determining the viability of implementing the Geriatric Health Tracker in rural Bangladesh.

The financial sustainability of the health tracker services proves to be a key factor in decision-making, ensuring that the initiative remains feasible and beneficial for the healthcare system.

Investments in the Geriatric Health Tracker demonstrate potential economic benefits for the healthcare system, especially in managing and preventing health issues among the elderly.

Technological Readiness (TR): The existing technological infrastructure in rural areas supports the seamless integration of the Geriatric Health Tracker, ensuring its effectiveness in health monitoring.

Technological advancements, particularly in the design and implementation of the health tracker, contribute to the readiness of healthcare systems for improved geriatric care.
A technologically ready environment fosters the successful adoption of the Geriatric Health Tracker, empowering healthcare workers with advanced tools for monitoring and intervention.

Accessibility of Healthcare Services (AHS): The Geriatric Health Tracker significantly improves access to healthcare services for the elderly population in remote or underserved areas of Bangladesh.

Enhanced accessibility through the health tracker positively impacts overall healthcare outcomes, addressing the challenges of limited healthcare facilities in rural regions.
The health tracker contributes to reducing barriers and increasing inclusivity in healthcare service delivery, ensuring that even the elderly population in remote areas can avail timely and appropriate healthcare services.

Overall Implications: To successfully implement the Geriatric Health Tracker in rural Bangladesh, a systematic approach is crucial. Beginning with a comprehensive needs assessment, the initiative aims to understand the distinctive health challenges faced by the geriatric population in rural areas. This involves identifying existing healthcare infrastructure, available resources, and potential barriers to implementation. Stakeholder engagement plays a pivotal role, necessitating collaboration with local healthcare authorities, community leaders, and healthcare workers to garner support and valuable insights. Additionally, involving geriatric communities in the planning process ensures that their unique needs and preferences are considered.

Customization of the technology for the rural context is imperative. This includes the development of a user-friendly and culturally sensitive Geriatric Health Tracker app, taking into account the technological literacy and preferences of the rural population. Ensuring compatibility with basic smartphones and accessibility in local languages enhances its usability. Training and capacity building follow suit, with comprehensive programs aimed at healthcare workers and community members. The focus lies on building skills related to data collection, monitoring, and effective utilization of the technology.

The implementation strategy incorporates the use of mobile health units equipped with the Geriatric Health Tracker to reach remote areas. Healthcare workers are trained to utilize the technology during their visits, facilitating personalized care for the elderly. Concurrently, community awareness and education campaigns are initiated to elucidate the benefits of the health tracker, addressing concerns and emphasizing its positive impact on overall health.

Economic viability and sustainability are pivotal considerations. This involves exploring funding opportunities and partnerships, contemplating sustainable business models such as public-private partnerships or collaborations with non-profit organizations. To gauge effectiveness, a robust monitoring and evaluation system is established, regularly assessing impact, user satisfaction, and health outcomes for necessary adjustments.

Data security and privacy are paramount, with the implementation of strong measures to protect the personal health information of the geriatric population. Adherence to local and international standards for data privacy and confidentiality is non-negotiable. Collaboration with government health agencies ensures alignment with national healthcare strategies, seeking regulatory approval and support for sustainability and scalability.

A commitment to continuous improvement is embedded in the initiative. Establishing feedback mechanisms based on user and healthcare provider experiences and suggestions fosters ongoing enhancements. Embracing technological advancements and updates over time ensures that the Geriatric Health Tracker evolves to meet the changing needs of the geriatric population in rural Bangladesh.

Table 8: Goodness-of-fit indicators for the structural model

Fit indices	Structural model value	Recommended value	References
Gfi	0.952	> .90	Hair et al. (2010)
Agfi	0.848	> .80	Hu and Bentler (1999)
Nfi	0.972	> .90	Hu and Bentler (1999)
Cfi	0.918	> .90	Bentler and Bonett (1980)
Rmsea	0.042	< .08	Hu and Bentler (1999)
Srmr	0.059	< .07	Hu and Bentler'(1999)

Source: Authors own calculation

Goodness-of-Fit Measures for the Structural Model (Table 8): *Goodness-of-Fit Index (GFI):* Value: 0.952, Higher than the suggested value of 0.90, Indicates a strong fit between the model and observed data.

Adjusted Goodness-of-Fit Index (AGFI): Value: 0.848, Higher than the suggested value of 0.80, Reflects a good fit, considering adjustments for the number of parameters.

Normed Fit Index (NFI): Value: 0.972, Higher than the suggested value of 0.90, Indicates a high level of fit between the model and data.

Comparative Fit Index (CFI): Value: 0.918, Greater than the recommended value of 0.90, Suggests a reasonable fit between the model and the observed data.

Root Mean Square Error of Approximation (RMSEA): Value: 0.042, Under the advised value of 0.08, Demonstrates a satisfactory match between the model and data.

Standardized Root Mean Square Residual (SRMR): Value: 0.059, Meets the suggested value of 0.07, Indicates a good fit for the structural model.

These goodness-of-fit indicators for the structural model demonstrate favorable values, aligning with established recommendations in the literature. The model's Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Residual (SRMR) all meet or exceed the recommended thresholds, indicating a satisfactory fit of the structural model to the observed data (Hair et al., 2010; Hu and Bentler, 1999; Bentler and Bonett, 1980).

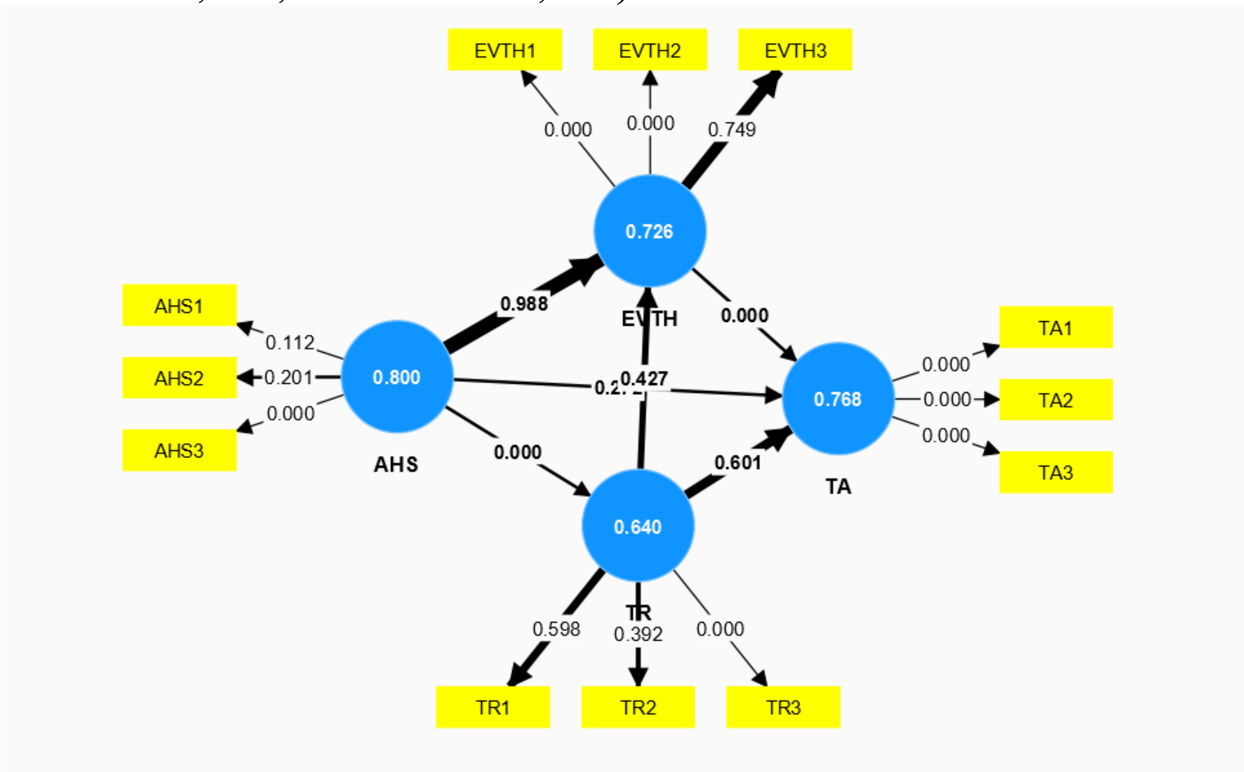

Figure 2: Bootstrapped model

Recommendations

Community Empowerment: Encourage active participation and empowerment of the geriatric community in the use and management of the Geriatric Health Tracker.

Expand Stakeholder Collaboration: Foster stronger collaborations with local NGOs, businesses, and international organizations to enhance resources and support.

Continuous Training: Implement ongoing training programs for healthcare workers to keep them updated on the effective utilization of the health tracker and emerging technologies.

Mobile Health Unit Optimization: Regularly assess and optimize the efficiency of mobile health units, ensuring they reach the most remote areas effectively.

Limitations of the Study

Generalizability: The findings may be specific to the context of rural Bangladesh and may not be directly applicable to different cultural or healthcare settings.

Technological Barriers: The success of the Geriatric Health Tracker relies on technological infrastructure, and areas with limited connectivity may face challenges in implementation.

Resource Constraints: Limited resources, both financial and human, may affect the scale and sustainability of the project.

Cultural Sensitivity: Despite efforts to make the health tracker culturally sensitive, variations in cultural perceptions and practices may influence its acceptance.

Short-Term Impact: The study may primarily capture short-term impacts, and the long-term effects on geriatric health may require further evaluation.

Conclusion: The implementation of the Geriatric Health Tracker in rural Bangladesh holds significant promise for addressing the unique health challenges faced by the geriatric population. The thorough needs assessment and stakeholder engagement strategies have laid the groundwork for a culturally sensitive and community-driven approach. By customizing technology for the rural context and incorporating mobile health units, the project aims to bridge existing gaps in healthcare accessibility.

The study recognizes the importance of ongoing training, community awareness, and collaboration with local authorities for the sustainable adoption of the health tracker. The emphasis on economic viability, data security, and government collaboration underscores the commitment to long-term success and scalability.

While recommendations focus on community empowerment and stakeholder collaboration, the study acknowledges certain limitations, including potential challenges in generalizability and the impact of technological and resource constraints. These considerations emphasize the need for continuous improvement and adaptability in the project.

The Geriatric Health Tracker project aspires not only to enhance the health and well-being of the geriatric population in rural areas but also to serve as a model for community-centric healthcare initiatives. As the project progresses, ongoing evaluation and refinement will be crucial to maximizing its impact and ensuring a healthier and more resilient geriatric population in Bangladesh.

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