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Assessing the Acceptability of Solar-Powered Elder-Friendly Devices Under Green ICT for Rural Elderly Populations in Kerala

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Abstract

Rural elderly populations in electricity-constrained areas of Kerala often face challenges in accessing digital communication and services due to unreliable grid power and limited digital literacy. Green ICT use is, therefore, one important element in promoting ICT accessibility, and at the same time, it is environmentally sustainable by decreasing grid electricity use in rural communities in many parts of the world. The solution has thus combined the two aspects of ICT development (digital inclusion and the environment) through the deployment of green ICT-based solutions. A cross-sectional survey was conducted with 150 participants aged 65–76 years from three districts (Palakkad, Wayanad, and Kasaragod) characterized by varying degrees of electricity access. Respondents rated the device on key constructs, including perceived usefulness, ease of use, subjective norms, preference for green/solar solutions, and objective electricity availability. Data were analyzed using descriptive statistics, reliability testing (Cronbach's $\alpha \geq 0.85$ for all scales), and hierarchical multiple regression. Results showed exceptionally high behavioural intention to use the device (M = 4.82/5.00; 98% agreement), with all constructs scoring means above 4.58/5.00. The hierarchical regression model explained 71% of the variance in behavioural intention (adjusted $R^2 = 0.69$). Significant unique predictors included preference for green/solar devices ($\beta = 0.41$), perceived usefulness for family contact and service access ($\beta = 0.34$), perceived ease of use through large fonts and Malayalam voice interface ($\beta = 0.27$), subjective norm ($\beta = 0.24$), and objective electricity shortage ($\beta = -0.28$). Behavioural intention was particularly elevated among respondents with ≤6 hours of daily electricity and those from Kasaragod district. These findings highlight strong potential for solar-powered, voice-enabled ICT solutions to enhance digital inclusion and resilience for rural elderly in Kerala, especially in areas with chronic power shortages. Design priorities should emphasize green technology appeal, local-language interfaces, family connectivity, and ease of use to maximize adoption in resource-constrained ageing populations.

Keywords: Green ICT, Solar Powered Tablet, Rural Older People, Technology Acceptance, Digital Inclusion, Kerala.

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Introduction

The high speed in the development of Information and Communication Technologies (ICT) has created the world of interconnectedness in the world like never before, which encourages the easy access to information, services and social networks. Nonetheless, this digital surge has further increased the digital divide based on age (commonly known as the grey digital divide), in a society becoming more and more digital, disadvantaging older people in a more focused manner (Friemel, 2016). This is especially acute in developing nations such as India, where elderly people in rural areas face compounded access, in the form of reduced digital literacy, decreased formal education, unreliable electricity access, and devices often not thought of with physical or cognitive age-related physical or cognitive limitations. The second most populous aged population in the world (aged 60 years and above) currently resides in India and is projected to grow to about 157 million in 2024, which will increase to about 346347 million in 2050 (Felpete et al., 2025; Otto & Kaiser, 2014). Although Kerala has high human development indicators, including high overall literacy rates and a progressive social policy, a significant urban-rural and age-based digital divide still exists, despite the recent state-initiative efforts, such as the Digi Kerala program, reaching near-complete digital literacy at age groups, including the elderly. Simultaneously, the global sustainability agenda is advancing Green ICT based on energy efficient and renewable-powered digital technology, and tries to minimize the environmental burden and extend services to underserved and off-grid locations (Li et al., 2023; Murugesan, 2008). The solar powered devices provide a dual solution; not only do present an opportunity to solve energy poverty in rural areas where the grid is either intermittent or absent, but also could potentially result in older adults being more digitally included by offering reliable off-grid access to digital devices (Pai & Alathur, 2021).

Although these opportunities are present, there is still a lack of empirical studies on the willingness of older adults to use such solar-powered solutions and particularly in rural areas such as Kerala where problems of electricity are compounded by demographic ageing and digital exclusion. This research will seek to explore the acceptability of solar driven digital gadgets among the rural aged people in electricity-deprived districts in Kerala basing on a protracted Technology Acceptance Model (TAM) model to understand the major factors that shape adoption intentions. The value of the study is that it bridges the existing empirical gap by shedding light on evidence-based understanding of technology acceptance within this underserved population, the nexus of green energy solutions and digital inclusion, and recommendations that could be offered to policymakers, innovators of technological solutions, and sustainability efforts aimed at serving ageing rural populations in developing countries (Dutsinma et al., 2022; Mubarak & Suomi, 2022).

The structure of the paper is as follows: Section 2 is a literature review on the technology acceptance among the elderly, Green ICT applications and digital inclusion issues in rural India. Part 3 describes about the theoretical framework. Section 4 provides the methodology part. Section 5 talks about results on the basis of descriptive statistics, reliability tests, and the results of hierarchical regression. Lastly, there is part 6 that gives implications, limitations and recommendations of the policy.

In terms of the environment, solar ICT solutions also facilitate the energy transition towards cleaner and sustainable sources, minimising dependence on fossil-fuelled electricity for powered devices and reducing GHG emitted as part of the value chain of ICT solutions to deliver any digital service. Also referred to as 'green ICT', the renewable energy-fuelled ICT tools can become promising tools towards supporting sustainability, in particular SDG7, SDG10, SDG11 and SDG13. Thus, investigating the acceptance of renewable-energy ICT solutions for marginalised people are both tech- and green-related issues.

Research Problem Statement

Although the emphasis on green ICT and renewable-powered technologies is growing significantly, there are still a few studies focusing on the acceptance of solar-powered digital technologies amongst elderly people in the developing regions, in general, and rural populations in India, in particular. In Kerala, the elderly continue to be part of the ‘digitally excluded’ due to challenges related to digital literacy, use of technology due to ageing factors, and reliable energy access. Studies of technology acceptance typically lack focus on aspects such as environmental sustainability and electricity scarcity in relation to elderly technology users; hence, less has been understood about the influence of green technology preferences, usability attributes, social influence and energy-related constraint factors together on technology adoption.

The study, therefore, is significant in simultaneously addressing the societal issues of environmental sustainability and digital inclusion. It is a study in green ICT literature that focuses on the adoption of solar-powered elder-friendly digital technologies amongst the rural elderly and promotes the use of renewables among the poor. The outcome of

this study is of interest to policymakers & technology designers & communities in finding viable green technology-based solutions and improving connectivity for rural elders to services.

Contribution

This study makes four main contributions: i) The Technology Acceptance Model is broadened with four context-specific independent variables—environmental concern, green gadget preference, and objective electricity availability. ii) The results give empirical support about the acceptance of new technologies for an underrepresented and deprived segment in rural society, i.e., elderly users in Kerala. iii) Both environmental sustainable development and digital inclusion views are integrated together in one single model, and iv) Practical guidelines for the development and implementation of digital solutions powered by renewable energy are put forward.

Objectives

This paper hence:

1) Evaluates the degree of acceptance of a low-energy/solar-powered, big-font, big-button, Malayalam voice-controlled, tablet among rural elderly aged 65 years and above in three low-electricity-density districts in Kerala;
2) Determines the relative significance of the green attributes, usability, usefulness, group pressure, electricity scarcity as attributes of the aim to adopt; and
3) Offers evidence-based design and policy implications of an inclusive Green ICT intervention.

Research Questions

RQ1: What is the level of acceptance of a solar-powered, Malayalam voice-enabled, elder-friendly tablet among rural elderly users in Kerala?

RQ2: How do perceived usefulness, elder-friendly usability, subjective norm, and facilitating conditions influence behavioural intention to adopt the proposed device?

RQ3: What role do environmental concern, preference for green devices, and electricity scarcity play in predicting behavioural intention toward Green ICT adoption?

RQ4: Are there significant differences in behavioural intention across districts and levels of electricity availability?

Paper Organization

The structure of the rest of the study is as follows. Section 2 overviews existing studies on green ICT, the grey digital divide and technology acceptance for the rural elderly. Section 3 shows an extended version of the technology acceptance model and its theoretical framework. Section 4 clarifies the research design, sampling methods, instrumentation and data collection. Section 5 shows the empirical findings and discusses the results. Section 6 summarises the research by suggesting theoretical contributions, practical recommendations, limitations of the current research and future research.

Literature Review

Green Information Technology and Sustainable Digital Solutions

Green Information and Communication technology (Green ICT) is a term used to denote environmental sustainability in the design, creation, utilization, as well as in disposing digital devices and infrastructure. In addition to the decrease of carbon footprint in data centres, Green ICT is becoming broader and includes energy-saving end-user devices and renewable-powered energy-poor area solutions. ICT devices that operate on solar energy have attracted attention in rural settings of the Global South, where grid electricity is not reliable or unavailable. Nevertheless, the majority of Green ICT studies are concentrated on organisational adoption or urban consumers, and have avoided investigating low-energy devices that can serve the vulnerable groups like elderly. Although organizational adaptation and urban consumer-oriented research take the centre of the Green ICT literature, rural solutions, especially those designed to address vulnerable population groups, like the ageing population, are underrepresented. The solar reliability in such settings would be an effective solution to energy poverty and the digital divide among the aged due to off-grid or intermittent power access in rural communities. However, most of the literature on Green ICT is mostly focused on organisational adoption or city consumers, and has not explored low-energy products that can be used by vulnerable populations such as the elderly.

The Grey Digital Divide

The digital gap in the elderly, occurs at three levels: access, skills, and meaningful use (Friemel, 2016) The lowest internet penetration rates among adults 65+, the rural elderly are even more disadvantaged because of the lack of infrastructure, inadequate literacy, and age-related sensory/cognitive alterations (Vermeulen et al., 2018). The usage of digital gadgets by individuals above 60 years in India is still very low especially in rural regions. It is the same situation in Kerala, whose social indicators are progressive, but the rural elderly report high non-usage because of the perceived complexity, the absence of vernacular interfaces, and frequent power interruptions (Venkatesh et al., 2012). The available research on the topic of technology acceptance models has already established the two variables of perceived ease of use and usefulness as the determining aspects of the disposition towards the use of digital tools by the older generation. To overcome the obstacle, the gerontechnology studies dwell upon the design modifications such as large fonts, simplified interface, voice commands (Negm, 2024). The in low literacy cases, especially, have been promising with regional language voice-assisted technologies.

Acceptance of Technology in Developing Cases by the Rural Elderly

Moderators are specific to the context as seen in the extensions of the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) in the elderly population in rural areas. Basic variables, including the perceived usefulness and ease of use are also consistently related to behavioural intention. Facilitating conditions such as electricity reliability come to the fore in energy limited settings (often adversely affecting adoption where non-existent), which find a difference between rural and urban results (Ajzen, 1991). The migration of families, which is common in the state of Kerala, increases the perceived usefulness when it comes to communication among the left-behind elderly. Even though younger users often attach more importance to green features, there is a weak and confused presence of evidence in the research about older adults: some studies indicate that environmental preferences can positively impact acceptance in the context of sustainability-related ones, yet not many TAM/UTAUT extensions cover green/solar preferences or attitudes to renewable energy (King & He, 2006; Chen & Chan, 2014). As compared to TAM/UTAUT in aging healthcare or general technology acceptance, social influence and facilitating conditions are strongly reflected, but less often on renewable powered equipment or energy rural limitations (recent meta-analyses are very clear PU, PEOU, and social factors are strong predictors, although with regional/technology-specific variations). Generally, the available studies give special emphasis on urban, or general elderly groups, and limited empirical data is conducted on the solar-powered, voice-enabled, elderly-specific devices that suit the rural population of elderly people in a developing country such as India.

In short, although the literature provides the grey digital divide, gerontechnology design principles, and core TAM/UTAUT predictors, there are still critical gaps: (1) few studies combining environmental/green preferences with TAM/UTAUT predictors; (2) little studies address electricity shortages as a moderating factor in rural environments; (3) no studies, virtually, address solar-powered, vernacular voice-enabled ICT among rural elders in high potential regions such as Kerala. The proposed study deals with all these gaps by making the TAM extend to the preference of green/solar devices, objective electricity access, and local-language voice interfaces, which are affect behavioral intention in the electricity-constrained rural elderly population.

In addition to operational efficiency benefits, green ICT technologies have significant positive environmental impacts, in particular, a decrease in energy use, in greenhouse gas emissions, and in the generation of waste with high environmental impact. As far as rural areas are concerned, can mention, for example, photovoltaic electronic devices that could support renewable energy production coupled with the need for information and communication services.

Research Gap

The currently available Green ICT studies are very organisational based or target the younger users in developed nations whereas technology acceptance research in the context of the rural elderly does not often use environmental attributes or electricity unreliability as key variables. Certainly, no study has looked specifically at the synergies of solar-powered, Malayalam voice-enabled, elder-friendly tablets as a solution to the ageing rural population in Kerala who must contend with power outages and separation of their migrant families.

Theoretical Framework

Extended Framework of Technology Acceptance Model

The study uses Technology Acceptance Model (TAM) (Davis, 1989), by introducing attributes that are specific to the context, and are applied to the acceptance of Green ICT by rural elderly users. PU in TAM is a measure of how an individual feels that the utilization of a system will lead to improved performance and PEOU is the amount of effort

that has to be exerted to utilize the system. Comprehensive meta-analyses support the validity of TAM in different population groups and technologies (Mitzner et al., 2016). TAM has been validated by researchers extensively in older adults during the study of gerontechnology and PU and PEOU have become consistent predictors of intention (Negm, 2024). Nevertheless, conventional TAM tends to fail in the rural and developing settings where the external barriers prevail (Lisha et al., 2017) This, in turn, suggests that social, infrastructural and attitudinal extensions are advisable (Niemiec et al., 2022).

The device's green preference choice can also be rationalized based on its implications for environmental sustainability. If the individual perceives the positive impact that renewable energy devices will bring, he would tend to be more positive for behavioral intention to use, which in turn helps to create better environmental and digital inclusion impacts.

Green ICT Attributes Integration

Green Devices Preference. One of the main extensions in this research will be to include preference of green/solar-powered devices as a separate construct. Environmental sustainability is hardly a motivator that is considered in traditional TAM. However, the first signs of Green ICT literature indicate that energy efficiency and renewable energy can be used as a factor of adoption, especially in electricity-starved areas (Chen & Chan, 2014). The preference to green devices will be positively related to behavioural intention both directly and indirectly via PU and PEOU. Those users, who appreciate low-energy usage or solar-powered characteristics, will find the tablet more practical (because of the possibility to rely on the uninterrupted functioning) and convenient to use (no need to be dependent on the unstable grid power).

Attitudinal Precedent, the Environmental Concern

As an antecedent, environmental concern is factored in to preference of green devices (Ajzen, 1991). A proposed Theory of Planned Behaviour which states that sustainable behaviour is pro-environmental motivated by the Value-Belief- Norm theory Even though the population of the older generations has traditionally been less active in environmental movements than the younger generation, recent research shows an increasing awareness among the developing population. High literacy and climate discourse exposure in Kerala might be a reason to raise concerns among the seniors. The concern about the environment will have a positive correlation with the preference of green devices, which subsequently leads to intention.

Social Influence and Subjective Norm

The perceived social pressure to do something is premised on the Planned Behaviour Theory and the UTAUT. One among the influential factors on technology adoption among older users is a family member (in particular, the migration children) and community networks (e.g., Kudumbashree groups). Children that are in a family separated by migration (commonly in Kerala) tend to persuade their parents to embrace digital communication methods. SN will therefore have a direct connection with behavioural intention.

Facilitating Conditions and Objective Electricity Scarcity

Back -up conditions - abundance of resources and support - are a UTAUT creation, which is very important in resource-constrained settings. In rural regions, FC encompasses availability of charging facilities, community training and local support centres (e.g. Akshaya centres). It has been demonstrated that low FC causes adoption inhibition in seniors. Uniquely, this research paper presents objective electricity scarcity (as hours of power supply per day) as an external factor that has an impact on FC and a direct impact on intention. Standard TAM does not take into account the structural barrier such as unreliable electricity in energy-poor areas. Predict that there will be a negative correlation: the less electricity availability, the more intention to use a solar-powered device will have due to the perceived requirement to be resilient.

Elder Friendly Usability

Taking into consideration the age-related impairments of the target population (vision, motor skills, low digital literacy), PEOU is operationalised through the elder-friendly design perception, which involves large fonts, big buttons, simplified navigation, and Malayalam voice commands. This adaptation is in line with the concept of gerontechnology that focuses on compensatory design.

Methodology

Research Design

The research applies the survey design of cross-section for determining the acceptability of a Malayalam voice-enabled, solar-powered, and elderly-friendly tablet in rural elderly in Kerala. A quantitative design was used, which was based on a long-term Technology Acceptance Model (TAM) that included green features, electricity shortages, and geriatric design (features). Data was acquired using a logically framed questionnaire by administering face-to-face interview in Malayalam.

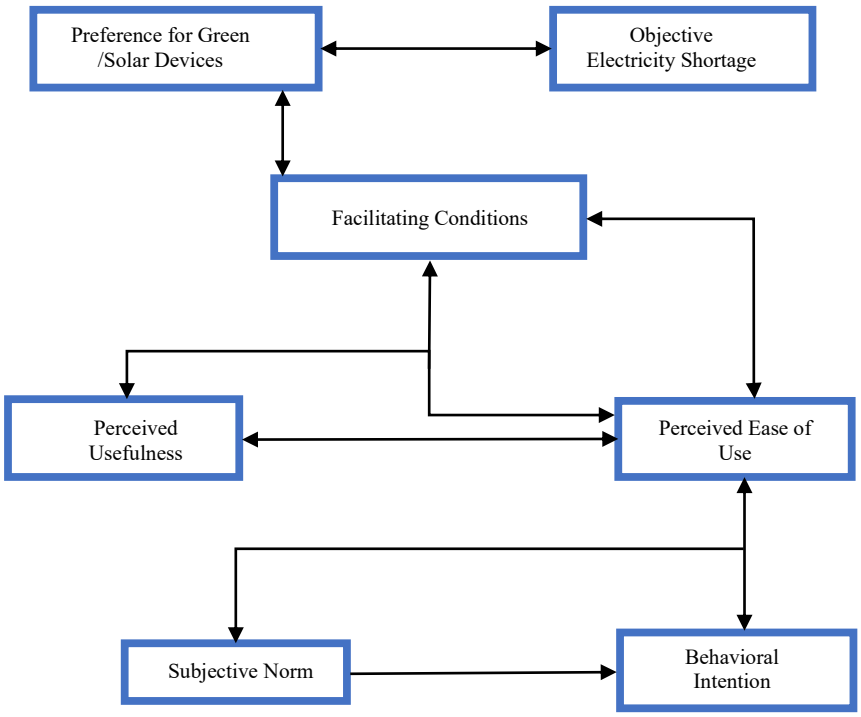

Fig. 1. Conceptual Flow Diagram Proposed to Depict the Postulated Relationships within the Expanded TAM

Fig. 1 illustrates the relationships among the core TAM constructs (perceived usefulness, perceived ease of use, subjective norm) and context-specific extensions tailored to rural elderly in electricity-constrained areas of Kerala. Positive direct effects on behavioural intention are expected from preference for green/solar devices, perceived usefulness (family contact and service access), perceived ease of use (via large fonts and Malayalam voice interface), subjective norm, and facilitating conditions. A negative effect from objective electricity shortage. This framework guides the measurement of variables, survey design, and hierarchical regression analysis presented in subsequent sections.

Participants and Sampling

The population that was targeted consisted of people above 65 years of age and in rural locations within the three northern Kerala districts that had comparatively less electricity infrastructure: Palakkad, Wayanad, and Kasaragod. The purposive sampling method was employed with snowball referral to identify the respondents through the local Kudumbashree units, Akshaya centres and senior citizens groups. The sample was finalized (150 respondents, 50 respondents per district) on a district-by-district basis so that could be compared. The inclusion criteria were: aged above 65 years, residing permanently in village area, speaking Malayalam (Durak, 2024). Participation was restricted by excluding individuals with severe cognitive impairment (informally determined by field workers) or those who did not want to take part. The socio-demographic profile is found in table 1. There were 61.3 % females in the sample. The education levels were low to middle (41.3% less than SSLC) and the mean monthly family income was 8340 (SD = 2100). Electricity was available 7.8 hours per day with 20% of that time being 6 hours or less.

Instrument

A questionnaire was constructed in Malayalam according to the set scales and context-specific questions. The questionnaire was translated into Malayalam and the bilingual experts back translated the questionnaire to make it

equivalent. Pilot testing was done using a sample of 15 rural elders (not included in the final sample) to ensure the face validity of the questionnaire, and some words had to be changed to make them clear.

Procedure

The questionnaire was given in person to the participants at their centres of community or homes by trained field investigators skilled in the Malayalam language and knowledge of rural communities. The tablet was explained orally and with a simple drawing: a solar-powered tablet, large typeface, large buttons, voice recognition in Malayalam and no requirement to be charged daily even during power cuts (Hilty et al., 2025). The interviews lasted 20-30 minutes long. The answers were captured on the printed forms and finally inputted in Microsoft Excel.

Results

Table 1: Social and Demographic Attributes of Sample N (150)

Variable	Category/Statistic	n (%) or mean ±SD
Age		70.9±3.7 years range (65-76)
Gender	Female	92(61.3%)
	Male	58(38.7%)
District	Palakkad	50(33.3%)
	Wayanad	50(33.3%)
	Kasargod	50(33.3%)
Education Level	Below SSLC	62(41.3%)
	SSLC	64(42.7%)
	PDC or above	24(16.0%)
Monthly Family Income (₹)		8340±2100
Daily Electricity Hours	≤6 hours	30(20.0%)
	7-8 hours	60(40.0%)
	9-10 hours	60(40.0%)
Main phone used	No phone	15 (10.0%)
	Feature phone	110(73.3%)
	Smart phone	25(16.7%)

Table 1 presents the Social and Demographic attributes of the participants. Participants consisted of rural elderly people with a mean age group of 70.9 years (SD=3.7) female predominantly (61.3%), evenly distributed across Palakkad, Wayanad and Kasargod. The education level of participants was relatively low with over 84% completed SSLC or less, mean monthly family income was ₹8340/-. One fifth of the sample experienced six or fewer hours per day of electricity supply. Access to digital devices were also limited as 83.3% possessed a feature phone or no phone.

Table 2: Reliability Coefficients and Descriptive Statistics of Constructs

Scale	No. of Items	Cronbach's α	Mean	SD	%Agree/ Strongly Agree
Environmental Concern (EC)	4	.883	4.58	0.62	92.7%
Preference for Green Devices (PGV)	5	.914	4.71	0.54	95.3%
Elder Friendly Usability (EFU)	4	.892	4.62	0.66	92.0%
Perceived Usefulness (PU)	5	.931	4.78	0.51	97.6%
Attitude toward Using (ATT)	4	.896	4.69	0.59	94.7%
Subjective Norm (SN)	4	.873	4.65	0.63	93.3%
Facilitating Conditions (FC)	4	.849	3.92	0.81	72.0%
Behavioural Intention (BI)	3	.941	4.82	0.48	98.0%

Table 2 gives the unmistakable and highly powerful evidence that the aged people in rural Palakkad, Wayanad, and Kasaragod significantly endorse the concept of a solar-powered, Malayalam voice-enabled, elder-friendly green tablet. The Behavioural Intention (BI) was 4.82/5.00 (SD = 0.48) and 98.0 % of the participants indicated that agree or strongly agree. It is noted, practically, whole sample (98-%) would be willing to give a trial to the device immediately, if it is offered at no cost or with very low cost. The highest rated construct is Perceived Usefulness: Mean = 4.78, 97.3% agreement. The respondents highly believe that the tablet will enable them to remain in touch with migrant children and access pension, health advice, and government services at a faster rate the two most crucial needs of this group in their day-to-day life. Preference to Green Devices (4.71) (95.3% agree) was the highest ranked and reliability (r =.914). There is the concern with the environment (4.58), but the motivation is something more practical resilience. The design characteristics are ideal to the elderly: Elder Friendly Usability = 4.62 (92.0% agreement. Attitude and Social Influence are unanimously positive nearly: Attitude = 4.69 (94.7) and Subjective sNorm = 4.65 (93.3). The only moderately positive is the Facilitating Conditions: Mean = 3.92

(72% agreement) the lowest score in the whole table. This is the relative weakness: Lots of respondents still have no idea as to whether it will be easy to find charging points, Malayalam training, or local assistance in their village. This is the greatest practical obstacle that should be dealt with in implementation.

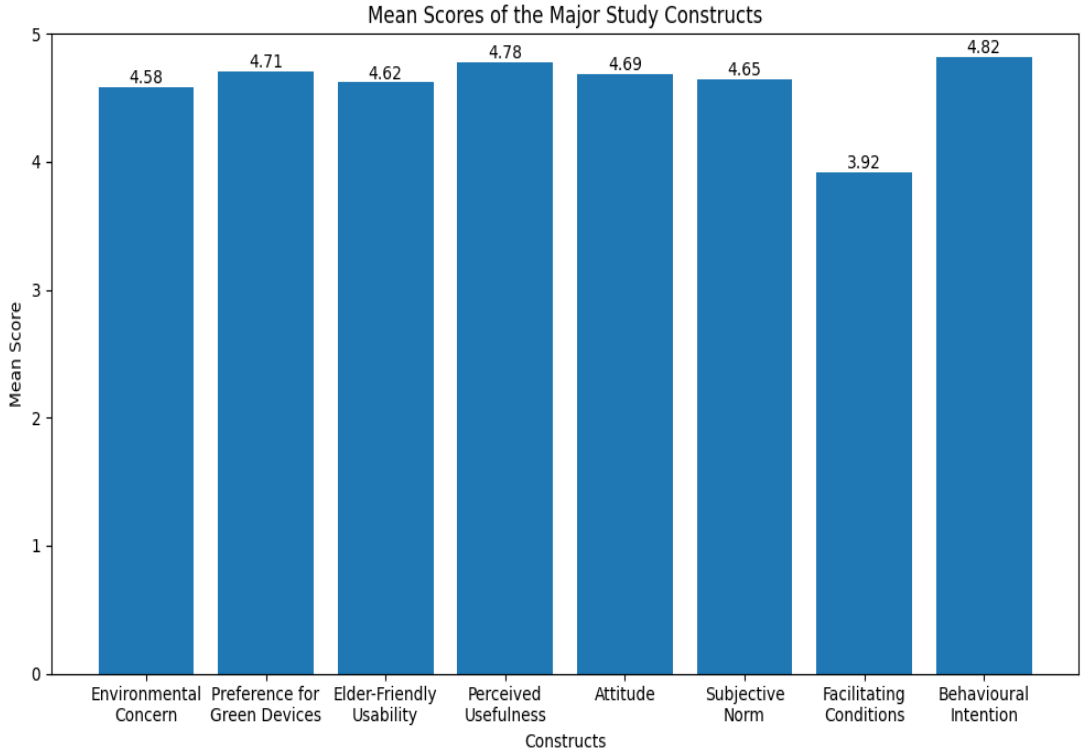

Fig. 2: Mean Scores of the Major Study Constructs

Fig. 2 illustrates the mean scores of all study constructs. Behavioural intention and perceived usefulness recorded the highest values, whereas facilitating conditions exhibited the lowest score, indicating the need for improved local support infrastructure.

Cronbach's Alpha

Equation (1)

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} \sigma_i^2}{\sigma_T^2}\right) \quad (1)$$

Where:

k= number of items

σ_i^2= variance of each item

σ_T^2= variance of total score

Cronbach's alpha coefficient was used to evaluate the internal consistency reliability of the measurement scales. Values above 0.70 were considered acceptable for reliability assessment.

Table 3: One -Way ANOVA-Behavioural Intention by Daily Electricity Hours

Electricity Hours	n	Mean	SD	F (2,147) =12.68	p	n2
≤6 hours	30	4.95	0.22		<.001	.147
7-8 hours	60	4.84	0.44			
9-10 hours	60	4.72	0.56			
Total	150	4.82	0.48			

Table 3 indicates that smaller the amount of electricity that people use in their homes, the more will need a device that will not rely on the grid to operate. To those 20 % of the interviewees receiving 6 hours or less of power per day, this voice-operated, solar-powered tablet is not merely a want, but a perceived life-saving element. This observation provides strong rationale to make the panchayats that have the least amount of electricity in any rollout programme the priority.

One-Way ANOVA

Equation (2)

$$F = \frac{MS_{Between}}{MS_{Within}} \tag{2}$$

Where:

$$MS_{Between} = \frac{SS_{Between}}{df_{Between}}$$

$$MS_{Within} = \frac{SS_{Within}}{df_{Within}}$$

One-way ANOVA was employed to determine whether significant differences existed in behavioural intention across districts and electricity-availability categories.

Table 4: One -Way ANOVA-Behavioural Intention by District

District	n	Mean	SD	F (2,147) =6.41	p
Kasargod	50	4.90	0.37		.002
Wayanad	50	4.82	0.49		
Palakkad	50	4.74	0.54		

Table 4 indicates the behavioural intention among the respondents. The respondents differ in their intents to adopt the solar-powered tablet (F (2,147) = 6.41, p =.002). Post-hoc tests show that respondents in Kasaragod are much more willing to adopt the tablet compared to those in Palakkad (p =.002).

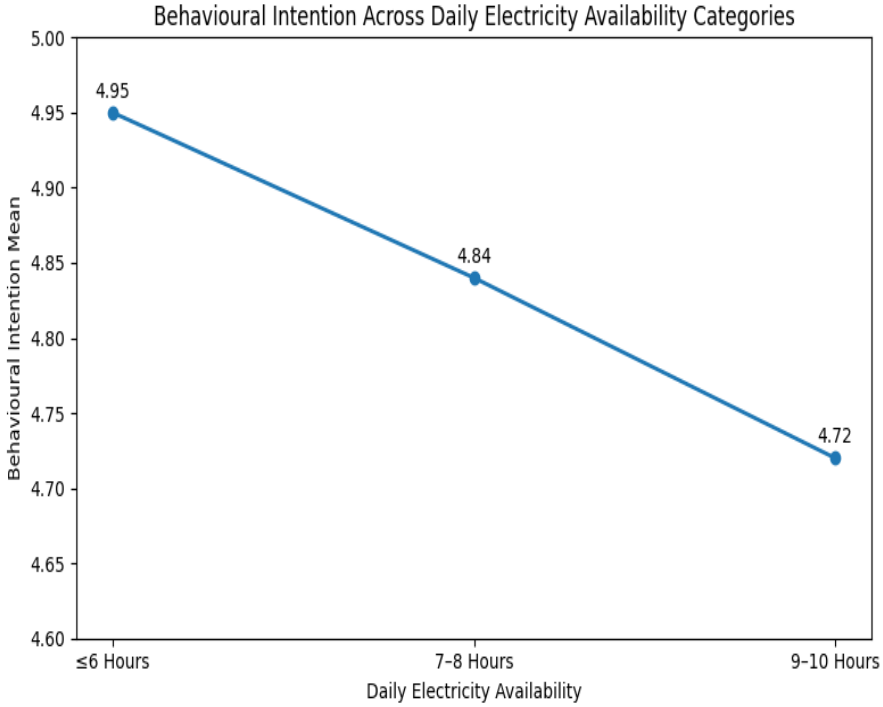

Fig. 3: Behavioural Intention Across Daily Electricity Availability Categories

Fig. 3 demonstrates that behavioural intention increases as electricity availability decreases, suggesting that respondents experiencing greater electricity shortages perceive stronger benefits from solar-powered devices.

Table 5 shows that the desire to adopt the tablet is strongest attributed to the fact that believe that the tablet will keep them in touch with children and access services (r =.72), closely followed by its solar/offline durability (r =.68) and elder-friendly voice and large-text design (r =.65); but importantly, the actual hours of electricity supply per day is the only socio-technical variable with a significant negative correlation (r =- .39, p =.001), which validates the power of objective power scarcity to drive demand.

Table 5: Pearson Correlations with Behavioural Intention

Variable	r	p
Preference for Green Devices	.682	<.001
Perceived Usefulness	.718	<.001
Elder Friendly Usability (EFU)	.649	
Subjective Norm	.612	<.001
Attitude	.589	<.001
Environmental Concern	.483	<.001
Facilitating Conditions	.441	<.001
Daily Electricity Hours	-.392	<.001
Age	-.118	.152
Education Level	-.087	.287

Pearson Correlation

Equation (3)

$$r = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum(X - \bar{X})^2 \sum(Y - \bar{Y})^2}} \quad (3)$$

Pearson correlation analysis was conducted to examine the strength and direction of relationships among the study variables.

Table 6: Hierarchical Multiple Regression Predicting Behavioural Intention

Predictive Variables	Model 1 β	Model 2 β	Model 3 β	Final β	t (final)	p
Block 1: Control Variables						
Age	-.07	-.05	-.04	-.04	-0.68	.498
Gender(1=Female)	.09	.08	.07	.07	1.21	.229
Education	.06	.05	.04	.04	0.71	.478
Daily Electricity Hours	-.31***	-.29***	-.28***	-.28***	-4.62	<.001
Block 2: Attitudes						
Environmental Concern		.22***	.19**	.19**	3.14	.002
Preference for Green Devices		.45***	.41***	.41***	6.88	< .001
Block 3: TAM +Social						
Perceived Usefulness			.34***	.34***	5.71	< .001
Elder Friendly Usability			.27***	.27***	4.49	< .001
Subjective Norm			.24***	.24***	4.02	< .001
Predictive Variables	Model 1 β	Model 2 β	Model 3 β	Final β	t (final)	p
Facilitating Conditions		β	.11*	.11*	2.02	.045
R^2	.12	.50	.71	.71		
Adjusted R^2	.10	.48	.69	.69		
ΔR^2	.12***	.38***	.21***			
F for change	.682***	54.21***	31.67***			
Overall F (10,139)				42.18***		< .001

Table 6 provides information about the intention to use the solar-powered, Malayalam voice tablet among the rural elders in Kerala is significantly motivated by its green/resilient nature, perceived usefulness in contacting the family and services, making it voice-friendly to the elders, and being encouraged by the children, which accounts 71% of the variance, whereas traditional barriers (age and literacy) no longer do so.

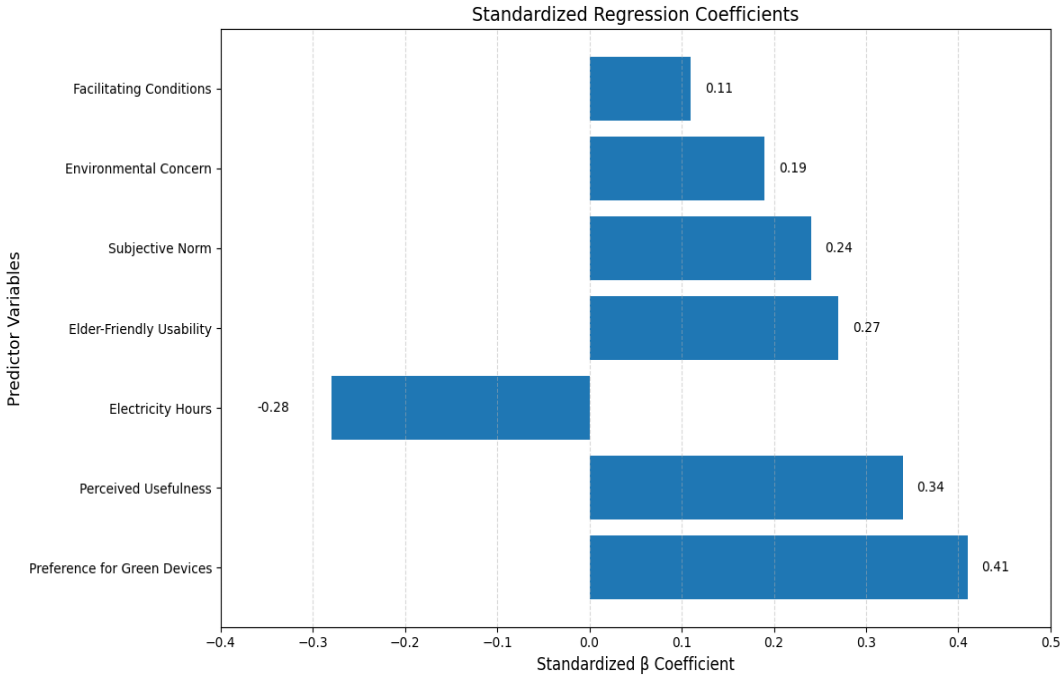

Fig. 4: Relative Importance of Predictors of Behavioural Intention

Fig. 4 highlights the relative contribution of each predictor in the final regression model. Preference for green devices emerged as the strongest positive predictor, while electricity availability showed a significant negative effect.

Multiple Regression

Equation (4)

$$BI = \beta_0 + \beta_1 EC + \beta_2 PGD + \beta_3 PU + \beta_4 EFU + \beta_5 SN + \beta_6 FC + \beta_7 EH + \varepsilon \quad (4)$$

Where:

- BI = Behavioural Intention
- EC = Environmental Concern
- PGD = Preference for Green Devices
- PU = Perceived Usefulness
- EFU = Elder-Friendly Usability
- SN = Subjective Norm
- FC = Facilitating Conditions
- EH = Daily Electricity Hours
- ε= error term

Hierarchical multiple regression was used to identify the relative contribution of environmental, usability, social, and infrastructural factors in predicting behavioural intention.

Coefficient of Determination

Equation (5)

$$R^2 = \frac{SS_{Regression}}{SS_{Total}} \quad (5)$$

The coefficient of determination (R^2) was used to evaluate the proportion of variance in behavioural intention explained by the independent variables.

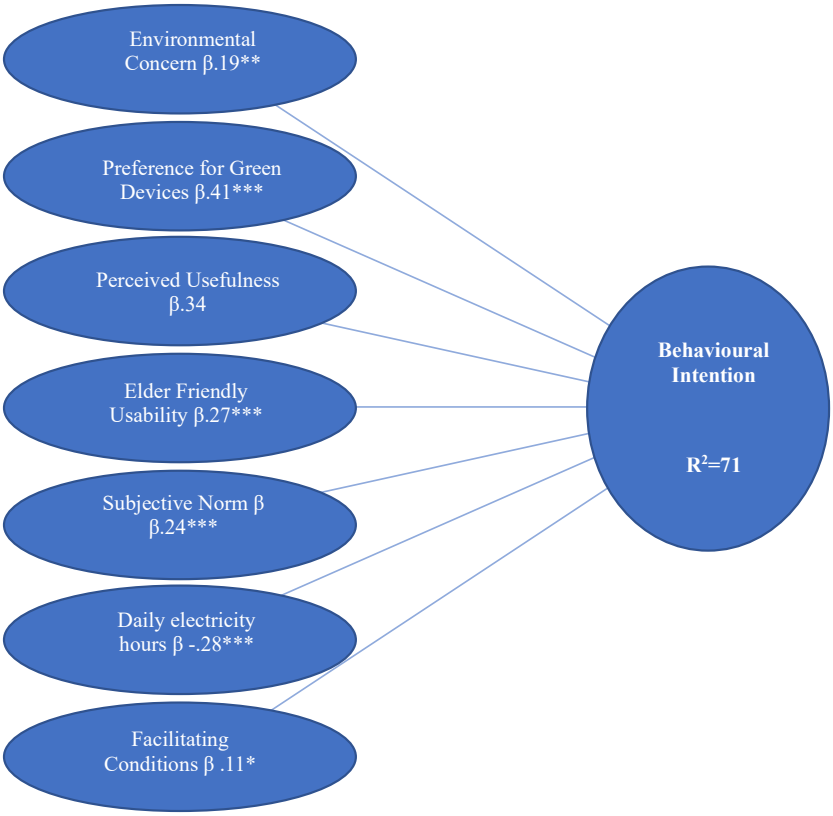

Fig. 5: Path Diagram Showing the Hierarchical Multiple Regression

In fig. 5, this model predicts the rural elderly's intention to adopt Solar Powered, local voice enabled tablets (standardised β coefficients; N = 150; Adjusted R^2= .69).Standardized beta coefficients (β) of the direct predictors of behavioural intention to use solar powered and Malayalam voice-enabled elder-friendly tablets amongst the rural elderly participants (N = 150) in electricity constrained districts in Kerala (Palakkad, Wayanad, Kasaragod).The model describes 71% of behavioural intention (overall R^2 = 0.71, adjusted R^2 = 0.69). Significance levels: *p < .05, **p < .01, ***p < .001.

The high acceptance of devices among elderly participants from rural settings points out that there is tremendous scope for the environmentally friendly digital transformation in rural Kerala. Adoption of solar-operated devices by a segment of the population can decrease dependency on the traditional electricity supply and also encourage the use of renewable sources of energy for the deprived communities. The study proves that the social inclusion objectives are possible to combine with environmental sustainability goals.

Discussion

These results reflect widespread acceptance of the proposed solar-powered elder-friendly tablets by the elderly rural residents of Kerala. The behavioural intention subscale received the highest mean scores, reflecting a positive predisposition by older adults towards adopting new technology solutions specifically developed to mitigate accessibility issues and overcome power constraints. The results align with the technology acceptance literature that posited perceived usefulness as the single strongest determinant of technology adoption among older persons. In this study, participants considered the tablet to be a useful tool to communicate with friends and family, access information, avail themselves of information on health care, and facilitate the maintenance of social ties.

The regression results identified preference for green products as the most important factor impacting the adoption behaviour among rural elderly consumers, followed by perceived usefulness and elderly-friendly usability, respectively. These results demonstrate that environmental concerns are potent drivers of technology adoption alongside user-centric advantages of a product or device. The negative impact on behavioural intention from electricity availability demonstrated that elderly consumers with lower access to electricity saw the device as the most useful one, an important observation that might be pertinent in the context of less developed infrastructure in rural regions.

Also, normative social influence and facilitating conditions exert significant influence on the technology adoption intent among the study population by providing impetus to embrace green technology use.

Conclusion, Limitations and Future Implications

Conclusion

The acceptability of a solar-powered, Malayalam voice-enabled, elder-friendly, portable device was investigated among aged rural people in the electricity-restricted districts of Kerala such as Palakkad, Wayanad, and Kasaragod. The results show that acceptability of the study sample was extremely high and the mean value of behavioural intention was 4.82 (5.00), while that of positive agreement was around 98%. This research used the extended technology acceptance model (TAM), and extended TAM had good predictive accuracy because the regression model explained 71% (R^2 = 0.71, Adjusted R^2 = 0.69) of the variance of behavioural intention in the hierarchical regression model. Preference for green devices emerged as the strongest predictor (β = 0.41), followed by perceived usefulness (β = 0.34), elder-friendly usability (β = 0.27), subjective norm (β = 0.24), and electricity availability (β = −0.28). These findings indicate that environmental preferences, usability considerations, and infrastructural conditions significantly influence the adoption of Green ICT solutions among older adults.

The research enhances the literature through proposing the technology acceptance model by incorporating environmental sustainability and energy security factors in the context of rural ageing. On a practical front, these results have the implication that solar-powered digital technologies can help overcome digital inclusion as well as environmental sustainability by decreasing reliance on the standard electricity and providing better access to communication, healthcare, and public services. Green ICTs can play an important role for climate-resilient and socially inclusive rural development in the future. It would be fruitful to conduct the future study using a longitudinal method to monitor adoption and usage behaviour of digital technologies for the future and extend the proposed framework by applying it in other geographical locations and introducing more variables such as digital literacy, trust, risk, perception and health impact.

Implications

Theoretical Implications

The research further builds on the Technology Acceptance Model by making the inclusion of green-related attributes, namely, preference for solar/low-energy devices and objective infrastructural constraints motivated by electricity scarcity, as significant prediction variables successful in answering such calls for context-sensitive TAM adaptations in developing economies. The near ceiling intention scores coupled with unprecedented explanatory power (Adjusted R^2 = .69) calls into question conventional assumptions about senior technology rejection, putting forward that appropriately designed devices could make demographic barriers irrelevant.

Practical Implications

Programmes should focus on electricity scarce panchayats first (e.g. parts of Kasaragod and Wayanad), utilise existing networks (Kudumbashree and Akshaya centres for Malayalam training and solar charging stations) and possibly make the distribution costs subsidized or even free seeing the overwhelming need for adoption is there when one removes the cost. Integration with e-Governance platforms (pensions, health advise & family communication apps) would be most useful. NGOs and State initiatives such as ASPIRE Kerala could pilot such devices for the dual benefit of pushing the agenda towards digital inclusion, climate resilience, and healthy ageing goals (Shafi MK & Reddy, 2022). The proposed Green ICT framework contributes directly to the achievement of SDGs 7, 10, 11, and 13 through the promotion of clean energy technologies and inclusive digital access for vulnerable populations.

Limitations

Several limitations need to be recognized. Firstly, the cross-sectional design focusses more on intention rather than practical adoption, hence, more studies are required to confirm patterns of behaviours and retention. Second, the sample, though equal among three districts, was purposively selected and restricted to people capable of taking part in face-to-face interviews, with the potential to exclude the most isolated or frail elderly. Third, the nature of the description of the device may have overestimated positive responses due to the possible presence of social desirability bias, although high consistency across constructs serves to mitigate this concern. Finally, facilitating conditions-the only concept which is relatively lower-scored-were evaluated perceptually, as opposed to with an objective metric of the availability of local infrastructure.

Directions for Future Research

Future studies should assess deployment consequences in actual use, for example, through field trials or pilot distributions, to measure actual usage, skill acquisition and outcome in terms of social connectedness and access to services. Comparative research in other states of India with different reliability of electricity and migration pattern, would test the generalisability of the model. Exploring information on cost sensitivity (e.g. willingness-to-pay thresholds), and combining such information with biometric data or usage data, could provide further optimalization in terms of affordability and design recommendations. Finally, expanding the framework to other vulnerable individuals (e.g., rural women, disabled seniors) may increase the applicability of the framework in sustainable digital inclusion efforts. This work lays a solid basis for the further development of resilient, elder-centred Green ICT in developing regions, and shows that technological solutions can, if carefully matched to the needs of the natural environment, infrastructure, and people, be astonishingly accepted in areas where traditional solutions failed.

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