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Seniors in the Digital Age: Perceptions, Adaptation and Inclusion

Sunita Narang
ORCID: 0000-0002-4224-5159
Acharya Narendra Dev College, University of Delhi, Delhi, India

Shalu Mahajan
ORCID: 0009-0004-0591-5995
Acharya Narendra Dev College, University of Delhi, Delhi, India

Preeti Marwaha
ORCID: 0009-0000-7425-4749
Acharya Narendra Dev College, University of Delhi, Delhi, India

Sharanjit Kaur
ORCID: 0000-0002-4224-5159
Acharya Narendra Dev College, University of Delhi, Delhi, India

Gunjan Rani
ORCID: 0009-0001-6425-7441
Acharya Narendra Dev College, University of Delhi, Delhi, India

ABSTRACT

Digital technology has transformed society over the past two decades. Despite numerous advantages, it is still posing challenges for seniors. While some older adults have embraced these changes, others struggle with digital literacy. Bridging this gap is essential to ensure that seniors can fully participate in the rapid digital transformation. This research explores the perceptions of 359 seniors towards digital transformation and evaluates their adaptation levels. Employing an integrated statistical and machine learning framework, the study reveals that seniors widely recognize the use of digital technology across education, entertainment, healthcare, e-commerce, and communication. Their primary online activities include entertainment, payments, and social networking. Seniors emphasize on the provision for basic computer skill training and secure online environment for the improved digital experience. However, the willingness to adapt with digital transformation varies within seniors. Results indicate a statistically significant difference ($p<.05$) in willingness to enhance technical knowledge across demographic variables viz., age, marital status, area of residence, education level and work profile. Senior citizens are divided into four segments viz., Functional Adopters, Social Adopters, Reluctant Adopters, and Tech-Savvy Pioneers by using K-means clustering algorithm considering their digital adoption. It is recommended to make tailored policies for inclusion of Indian senior citizens in the digital mainstream as per their segment. Literacy programs, infrastructure and community support may play a critical role for the same.

Keywords: Digital Inclusion, Digital Divide, Digital Adoption, Senior Citizen, Digital Access, Challenges.

INTRODUCTION

Digital technology offers many benefits and conveniences, but its rapid advancement has led to a digital divide, adversely affecting seniors. Researchers are trying to capture different factors contributing to digital divide, and the difficulties faced by older adults in adapting to this changing scenario. Quan-Haase et al. [1] and Choi et al. [2] identified persistent gaps influenced by socioeconomic status, education, and location, noting that the divide now includes not just access but also skills, usage, and outcomes. Lee and Kim [3] observed that while the COVID-19 pandemic spurred digital adoption among older adults, it also deepened some divides. Gonzalez-O˜nate et al. [4] found that perceived usefulness was the most important factor in technology adoption for seniors, followed by ease of use and social influence, suggesting seniors prefer technologies that offer clear and practical benefits. As digital tools become essential for communication, information access, and other daily activities, ensuring the digital inclusion of seniors has become increasingly important. This study investigates digital proficiency of seniors by examining five key factors viz. Perception, Access, Challenges, Usage, and Adaptability, through survey data. Understanding these factors is vital for bridging the digital gap and promoting greater inclusion of older adults in the digital world. Digital inclusion aims to ensure that everyone regardless of their age, socioeconomic status, or location has access to digital technologies and the skills to use them. While studies by Fern´andez-Ard`evol and Rosales [5], Olphert and Damodaran [6] and Singh et al. [7] show progress in digital access for seniors, they also highlight ongoing inequalities and stress the need for comprehensive strategies that extend beyond merely providing access to devices. Digital proficiency helps seniors stay independent and connected by enabling social interaction, information access for healthcare and entertainment. Although senior digital adoption is growing, significant disparities remain based on education, location, gender, and other factors. Research highlights the need to address multiple aspects of digital inclusion, from access and skills to psychological and social support. Schmidt and Torres [8], and Katey and Chivers [9] show that seniors living alone value technology for independence but face challenges without in-home support. Martinez-Alcal´a et al. [10] found a growing positive attitude towards technology among older adults. Wang and Chen [11] identified four attitudinal groups cutting across demographics, namely enthusiastic adopters, pragmatic users, reluctant participants, and resistant non-users, indicating the need for personalized digital inclusion strategies. Seniors face unique challenges in adopting digital technologies, including physical issues like impaired vision and dexterity, cognitive difficulties such as working memory limits, and psychological barriers like fear and lack of confidence. Socio-economic factors also affect their access and adaptability. Studies show that age-related physical changes impact touchscreen use [12], cognitive barriers affect navigation [13], and anxiety limits technology use [14]. Additionally, older adults (65 to 74 years) use smartphones similar to middle-aged adults, while those over 75 years use them reluctantly [15]. Few recent studies also highlight the growing adaptation of seniors to digital technologies. Horton et al. [16] found a rise in online banking use, though security concerns persist. Kim et al. [17] finds increased telehealth adoption during the pandemic, with continuous use relying on good interface design and support. Cruz-Jentoft and Rodrigues [18]

showed seniors can reach digital proficiency similar to younger adults with proper instructions, but with more practice at the same time. Pacheco and Chen [19] found that peer-based learning is more effective for teaching digital skills to seniors than self-directed or instructor-led methods. Hassan and Thompson [20] explored inter-generational support, revealing it can both help or limit digital learning of seniors. It is also shown that demographic factors too impact digital engagement of seniors. Varanasi and Lim [21] found education level predicts digital proficiency more strongly than age, income, or location. Morales and Santos [22] highlighted ongoing gender gaps in digital use among seniors in Latin America. Research also shows that digital engagement improves the well-being of seniors by reducing depression, boosting social connection, and increasing autonomy [23, 24]. Nakamura et al. [25] found that using digital services like telehealth, grocery delivery, and smart home systems helps seniors live independently at home about 2.7 years longer than those who do not use these technologies. Garcia and Ramirez [26] found that 37% of seniors have experienced increased stress and digital fatigue from pressure to adopt digital services during and after the COVID-19 pandemic. Thus, they emphasized that the non-digital options may also be available for essential services. Williamson and Chen [27] analysed digital inclusion policies in 18 countries. It was suggested that the recipe for a successful program design for seniors should be a combination of infrastructure investment, skills training, ongoing support, and their active involvement. Patel et al. [28] found that India's DISHA program effectively taught basic digital skills to over 250,000 seniors but faced low retention without ongoing support. Bouwman and Lewis [29] highlighted that digital-first government services pose barriers for about 22% of seniors and gave recommendations for hybrid models that keep non-digital access options. Based on this, the broad objectives of the proposed study are as follows:

(a) Assess the extent of digital technologies adoption among seniors and identify factors influencing it.
(b) Examine the primary purpose and duration of digital service usage by seniors.
(c) Explore willingness of seniors to adopt digital technologies and improve technical skills across different demographic groups. (d) Predict adoption willingness of seniors and categorize them into actionable segments for targeted support.

After the introduction outlining the study's objectives and rationale, the paper is organized into five sections. Section 2 describes the sample; data collection and the techniques used for data analysis. Section 3 presents the results along with their analysis. Section 4 provides the discussion followed by key conclusions in section 5. It also discusses the broader implications of the findings.

METHODOLOGY

This section outlines the research methodology used to examine the adoption of digital technologies by seniors. Primary data is collected from June, 2024 to October, 2024 from 359 participants aged 50 and older. These participants are comfortable with internet usage, familiar with digital devices and perceive the associated benefits and challenges of the digital world. The study uses stratified purposive sampling technique to survey seniors across India, from urban, semi-urban and rural areas, ensuring a rich, balanced and representative sample. The data set is processed in multiple stages to obtain insights. A 5-point Likert scale-based

questionnaire has been developed based on previous studies and is used for data collection from senior citizens (11). The questionnaire consists of 19 closed-ended questions which are based on a five-point Likert scale. It covers five aspects of digital adaptation among senior citizens, namely perception (P). Access (A), Challenge (C), Usage (U) and adoption (D) of digitalization. The questionnaire also has twelve multiple response questions dealing with digital adoption patterns, specific service engagement, challenges, and areas of improvement. The steps for revealing the influential factors on the senior's adaptation of digital technologies are elucidated below.

Data Preprocessing

To ensure data accuracy and consistency, column names are standardized, formatting issues, spelling errors are corrected, and missing values are imputed using appropriate statistical methods. Personally, Identifiable Information (PII) is removed for privacy. Likert-scale responses are converted to ordinal scales, and date fields are properly formatted.

Feature Engineering is used to transform raw data into meaningful numeric variables. Label encoding is applied to ordinal variables, while one-hot encoding is applied for converting categorical variables (e.g. Gender: Male/Female → Gender Male, Gender Female) [30]. New features are created, including Diversity Score (count of digital services used) and Confidence Score (average Likert-scale rating for confidence in digital tools).

Descriptive Analysis is used to identify key patterns using frequency distributions for categorical variables like age, gender, and residence. Graphical visualizations are used to present the data clearly and transparently.

Diagnostic Analysis explores relationships between variables. Cross-tabulation examines demographic and attitudinal relationships, while Chi-square tests assess associations between categorical variables such as gender and privacy measures. Correlation analysis is used to evaluate numerical relationships, such as Confidence Score versus Diversity Score. ANOVA and t-tests are conducted to test differences in digital adoption willingness across demographic groups.

Supervised and unsupervised machine learning techniques are applied for predictive modeling and segmentation. We have used linear regression (see Eq. 1) to predict willingness to adopt digital practices based on four explanatory variables viz. Perception (P), Access (A), Challenge (C), Usage (U) and Adoption (D) of digitalization.

$$D = \beta_0 + \beta_1 P + \beta_2 A + \beta_3 U + \epsilon \ldots\ldots [1]$$

K-Means clustering, an unsupervised learning method, is applied to segment participants in four groups (k=4) based on five key variables: Confidence Score, Total Service Usage, Social Application (App) Usage, Privacy Measures Score, and Adoption Difficulty Score. These features are derived from survey responses and Likert-scale items to capture multiple dimensions of digital engagement. The Confidence Score measures participants' self-assessed comfort and

competence with digital technologies, distinguishing clusters by perceived digital self-efficacy. Total Service Usage quantifies the number of digital services regularly used, enabling differentiation between higher and lower adopters based on usage breadth. Social App Usage captures engagement with social communication platforms, helping identify clusters with varying degrees of digital social connectivity. Privacy Measures Score assesses the extent to which participants adopted digital security practices, distinguishing users by their awareness and implementation of privacy measures. Adoption Difficulty Score reflects the challenges and barriers faced during digital technology use, differentiating users by their ease or struggle in adoption. Together, these metrics provide a senior user with their digital behaviors, confidence, security practices, social engagement, and adoption challenges.

Output Segments includes:

1. Tech-Savvy Pioneers: High confidence, Broad Service Adoption.
2. Functional Adopters: Moderate confidence, Essential Service Adoption.
3. Social Users: Low Digital confidence, Social/Communication apps adoption.
4. Reluctant Adopters: Low confidence, Low adoption, significant Barriers.

This structured approach ensures effective insight extraction using statistical and machine learning techniques. The following sections discuss the results in detail.

RESULTS

This section investigates the extent of digital technology adoption among seniors and the underlying factors influencing this process. Demographic analysis, followed by regression modeling, identifies significant predictors of adoption. Subsequently, clustering analysis classifies seniors into four distinct groups, ranging from proficient users to reluctant adopters, offering actionable insights for designing targeted digital inclusion strategies.

Demographic Analysis

The demographic analysis outlines characteristics of respondents across variables such as age, gender, marital status, residence, education, and work profile. It includes a summary table presenting frequencies and percentages. This analysis helps contextualize findings and ensures the relevance of the sample to the objectives of the study on digital technology adoption among seniors.

The survey primarily includes respondents aged 50–60, with fewer participants in the 60–70 and 70–80 age brackets. Gender distribution is nearly balanced, with a slight male majority. Most participants are married, followed by widowed individuals; unmarried and divorced respondents are less represented. Urban residents make up the largest group, though rural and semi-urban dwellers are also included. As per educational qualifications, most respondents have completed school, while fewer hold graduate or post-graduate degrees, and very few have diplomas or undergraduate qualifications. In terms of work profile, others (retirees) form the largest group, followed by homemakers, professionals, and small business owners, while unskilled workers and clerical staff represent the smallest segments.

Digital Adoption Patterns

This section shows the distribution of major digitalisation areas, primary purpose of digital service usage and the length of digital services usage. It is to be noted that multiple responses were allowed for the first two categories shown in Figure 1 and Figure 2a. Figure 1 shows the main areas of digitalization where respondents suggested that education leads with adoption 68%, while entertainment, healthcare, e-commerce, communication, and government services all show adoption between 49-53%. It highlights growing opportunities for learning, access to medical services, and staying connected, showing overall integration into the digital world. Digital technology adoption is relatively low (34%) among seniors in the context of social activism. This limits their civic participation, leading to under representation in advocacy efforts.

Table 1: Demographic Profiling of the Respondents

Demographic Variable	Categories	Count	Percentage
Age	50-60 years	217	60.45%
	60-70 years	100	27.86%
	70-80 years	42	11.70%
Gender	Female	167	46.52%
	Male	192	53.48%
Marital Status	Married	283	78.83%
	Widow/Widower	50	13.93%
	Unmarried	15	4.18%
	Divorced	11	3.06%
Area of Residence	Urban	182	50.70%
	Rural	104	28.97%
	Semi-urban	73	20.33%
Educational Level	Schooling only	134	37.33%
	Diploma	14	3.9%
	Under-Graduate	10	2.79%
	Graduate	100	27.86%
	Post-Graduate and above	101	28.13%
Work Profile	Managers/Professionals	70	19.50%
	Small Business Owners	69	19.22%
	Unskilled Workers	16	4.46%
	Clerical Staff	15	4.18%
	Home makers	87	24.23%
	Others	102	28.41%

Figure 2 shows the commonly used digital services among respondents. Entertainment leads (60%), closely followed by online payments and social networks, each with around 55% usage. Banking and online shopping show moderate adoption rates (46-4 47%), while travel booking (35%) and medical services (31%) are less frequently used. Figure 3 concludes that approximately 46% of the respondents have been using digital services for more than four years, suggesting strong and sustained participation. In general, digital adoption has been

prominent in areas such as education, entertainment, healthcare, e-commerce, communication, government and employment among seniors.

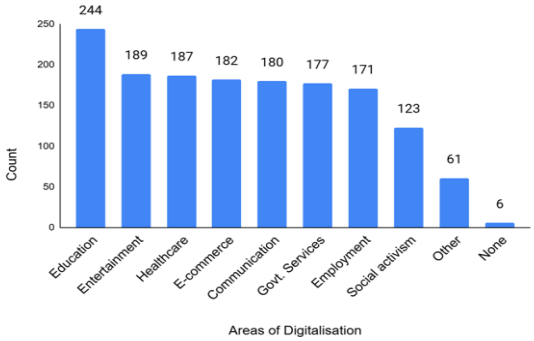

Figure 1: Major areas of Digitalisation as selected by respondents (multiple responses)

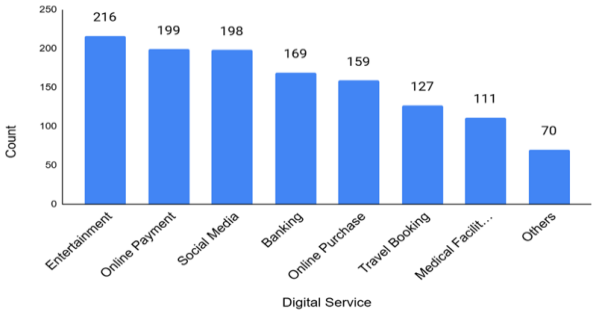

Figure 2: Types of Digital services (multiple responses)

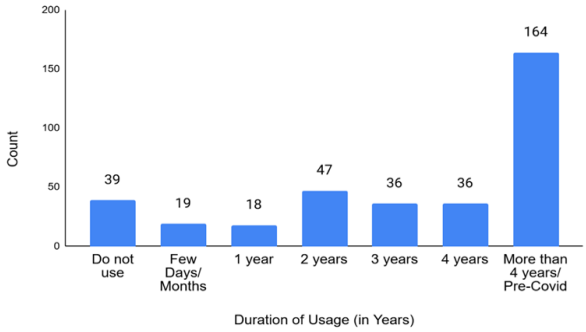

Figure 3: Duration of Average Usage of Digital Services

Service Specific Digital Engagement

This section explores engagement of seniors with various digital services, including government and financial platforms. It also examines the use of payment, entertainment, communication, and medical services applications. Figure 4 presents the distribution of the government services used among respondents. The Digilocker, which is used to store IDs and documents, is preferred by 169 respondents, constituting 47.08% of the total responses. It is followed by MyGov, Ayushman Bharat, DigiYatra, E-Sign, Meri Pehchan, Umang App, Jeevan Praman. Figure 5 highlights the various levels of involvement with various financial services among the respondents. Banking services emerged as the most widely used financial service, with over 55% of respondents engaging in them. Insurance, tax-related services, and fixed deposits followed, each used by around 20–25% of participants. Mutual funds and stock markets had moderate usage (17.27% and 15.60 %, respectively), while bonds and advisory services saw limited adoption. In conclusion, seniors tend to prefer simpler digital financial tools such as banking, while more complex options such as bonds and advisory services have a lower adoption, indicating a cautious approach to advanced financial products.

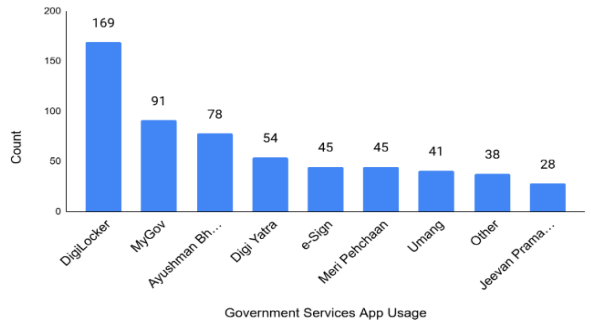

Figure 4: Government Services Usage

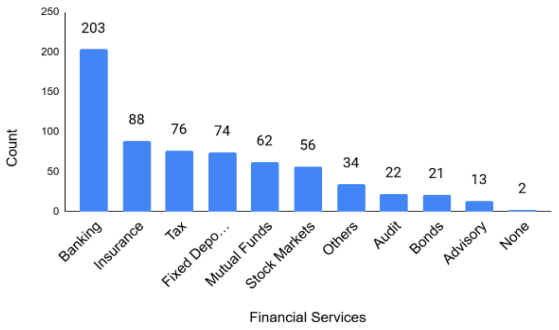

Figure 5: Financial Services Usage

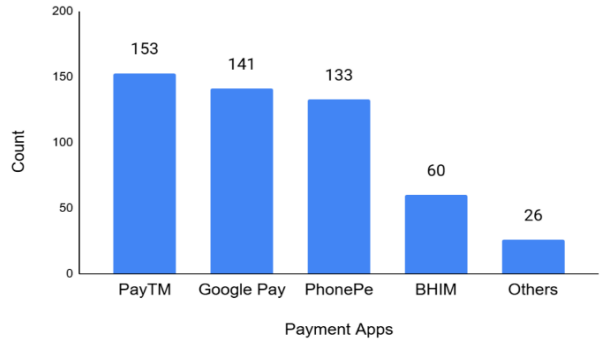

Figure 6: Payment App Usage

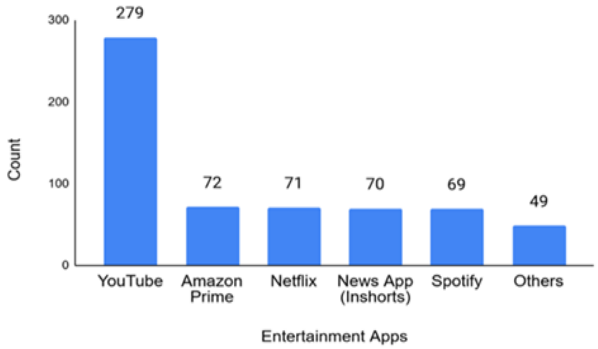

Figure 7: Entertainment App Usage

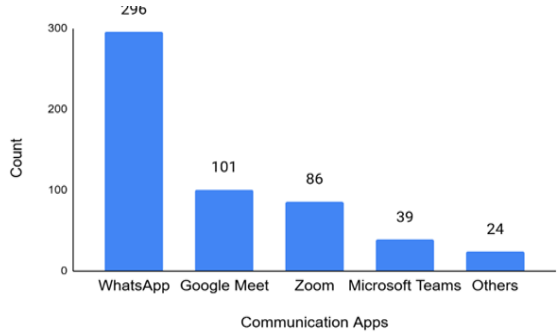

Figure 8: Communication App Usage

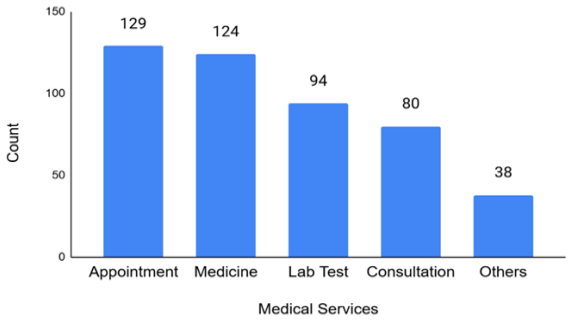

Figure 9: Medical Services App Usage

Thereafter, we observe a usage of apps belonging to four different categories viz. payments, entertainment, communication and medical facilities. Figure 6 shows the distribution of digital payment app usage among respondents. Paytm is the most popular, with 42.62% usage, followed by Google Pay at 39.28%. PhonePe at 37% making it a strong contender in the digital payment space. Figure 7 shows YouTube dominates app usage with 77%, followed by Amazon Prime, Netflix, News Apps, and Spotify at 19% each. Figure 8 shows that WhatsApp is the main communication app, used by 82. 45% of the respondents. It helps seniors stay connected, share information, feel secure, access entertainment, and maintain emotional wellbeing through simple, accessible communication app. Google Meet follows with 28%, and Zoom is used by 24%. It is interesting to find in Figure 9 that over 35% of the seniors are using medical service

apps for booking appointments and ordering medicine. Lab test bookings (26%) and doctor consultations are also popular. In summary, versatile apps for payment and medical facilities are being used by seniors. However, one or two apps are mostly adopted in the field of entertainment and communication.

Challenges and Areas of Improvement

This section presents the distribution of key privacy measures followed by users of digital apps, along with improvement in app usage. Figure 10 outlines the privacy measures taken by respondents when using digital apps. The most common measure was not sharing personal information online, chosen by 54.04% of respondents. Using strong, unique passwords followed at 46.80%, while avoiding suspicious websites and links was adopted by 37.33%. Two-factor authentication was used by 33.70%, and reliable antivirus software was selected by 22.56%.

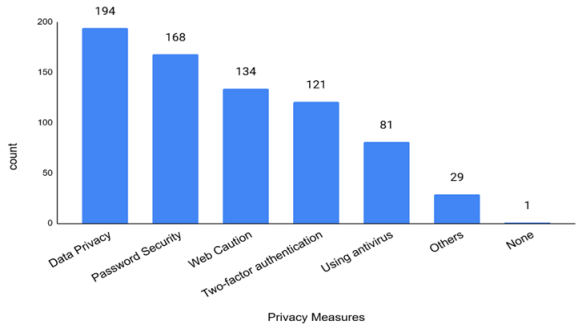

Figure 10: Privacy Measures

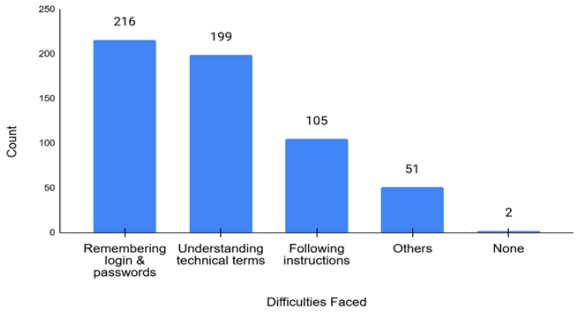

Figure 11: Difficult to Use

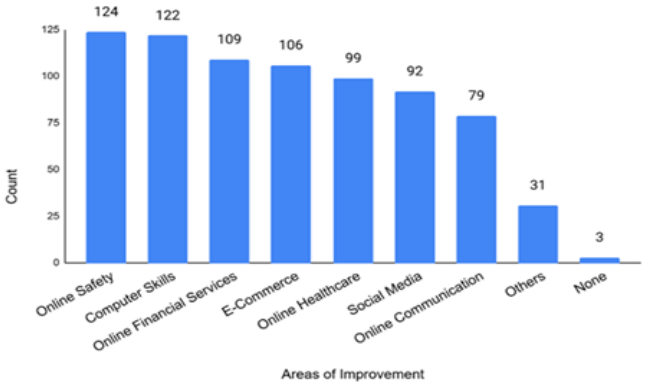

Figure 12: Distribution of Areas of Improvement for Digital Apps as selected by respondents (multiple responses)

Statistics in Figure 11 identifies key difficulties in using digital apps, with the most common being Remembering login and passwords (37.33%) and understanding technical terms (33.70%). Other challenges include Following Instructions and various other issues. Figure 12 highlights areas of improvement for digital apps based on the feedback of the respondents. Key areas include improving online safety (124 respondents), basic computer skills (109 respondents), online financial services (109 respondents), and e-commerce (106 respondents).

Other areas of improvement include online healthcare (99 respondents), social media (92 respondents), and online communication (79 respondents). The data emphasizes the importance of enhancing security, usability, and user engagement across various categories of digital apps.

Behavioral and Attitudinal Analysis

This section presents the behavioral and attitudinal analysis of the respondents, which is recorded using a 5-point Likert scale ranging from statements of strong agreement to statements of strongly disagreement.

Table 2: Distribution of Behavioural and Attitudinal responses given on Likert scale-based statements by the respondents

Statements around Digital adoption	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I am aware of digitalization.	59 (16%)	155 (43%)	96 (27%)	31 (9%)	18 (5%)
I am in favour of digitalization in India.	71 (20%)	180 (50%)	75 (21%)	19 (5%)	14 (4%)
I feel an enhanced sense of independence with digitalization.	52 (17%)	150 (49%)	106 (34%)	0 (0%)	0 (0%)
I believe that digitalization can empower people.	82 (23%)	181 (50%)	59 (16%)	23 (6%)	14 (4%)
I am able to use mobile/computer/tablet to access internet.	71 (20%)	163 (45%)	66 (18%)	40 (11%)	19 (5%)
I easily find relevant information/digital service online.	56 (16%)	147 (41%)	93 (26%)	40 (11%)	23 (6%)
I am afraid of using new technology.	22 (6%)	99 (28%)	125 (35%)	75 (21%)	38 (11%)
I often lack interest in using new technology.	33 (9%)	95 (26%)	111 (31%)	90 (25%)	30 (8%)
I experience vision problems and/or arthritis limiting the usage of digital devices.	36 (10%)	129 (36%)	97 (27%)	68 (19%)	29 (8%)
I often feel overwhelmed while learning how to use digital services.	28 (8%)	141 (39%)	122 (34%)	42 (12%)	26 (7%)
I do not consider digital transactions safe.	42 (12%)	90 (25%)	109 (30%)	87 (24%)	31 (9%)
I can easily perform basic functions on mobile and/or Computer.	55 (15%)	161 (45%)	77 (21%)	42 (12%)	24 (7%)
I explore many entertainment options online.	58 (20%)	156 (53%)	81 (27%)	0 (0%)	0 (0%)
I often use social media to connect with family and friends.	67 (19%)	167 (47%)	58 (16%)	44 (12%)	23 (6%)
I confidently use digital services.	50 (14%)	119 (33%)	105 (29%)	60 (17%)	25 (7%)
I regularly get support from family members or friends to use digital services.	69 (19%)	182 (51%)	78 (22%)	23 (6%)	7 (2%)

I frequently use internet in the day for various purposes.	64 (18%)	162 (45%)	83 (23%)	32 (9%)	18 (5%)
I believe digitalization has increased comforts across many aspects of our lives.	66 (18%)	179 (50%)	87 (24%)	20 (6%)	7 (2%)
I am willing to enhance my technical knowledge by attending training workshops.	50 (14%)	114 (32%)	117 (33%)	59 (16%)	19 (5%)

Table 2 shows the behavioural and attitudinal analysis of the respondents. Seniors largely express positive attitudes towards digitalization. Most of them are aware (59%) and supportive of its growth in India (70%). A significant majority (66%) feel that digitalization enhances their independence, and 73% of seniors believe it empowers people. These insights suggest strong foundational acceptance. Most seniors demonstrate functional digital skills, with 65% able to access the internet via mobile, computer, or tablet. Similarly, 57% find it easy to locate relevant digital services or information. These figures reflect a growing accessibility of digital devices among seniors. However, they face multiple barriers to digital adoption, including fear (34%), lack of interest (35%), physical limitations like vision or arthritis (46%) and feeling overwhelmed by learning new technologies (47%). Additionally, 37% express concerns about the safety of digital transactions, underscoring the need for trust-building and user-friendly solutions. Digital usage among seniors is widespread: 60% perform basic functions on mobile or computer, 73% access various entertainment options online, and 66% use social media to stay connected. However, only 47% confidently use digital services, indicating regular usage. Seniors are actively adapting to digital life: 70% regularly receive support from family or friends, aiding their transition. Daily internet use (63%) and belief in digital comforts (68%) reflect growing acceptance. Moreover, 46% show readiness to enhance skills through training, indicating a positive outlook toward further digital adaptation.

Willingness to Adapt to Digitalisation

This section examines willingness of seniors to adapt to digitalization through predictive modeling, identifying key influencing factors. Bivariate analysis is conducted to investigate differences in willingness of seniors to adapt to digitalization.

Predictors of "Willingness to Adopt Digitalisation"

This section discusses various significant contributors to the willingness to adapt technical knowledge and general digital adaption by conducting regression analysis on the four predictors Perception (P). Access (A), Challenge (C) and Usage (U) of digitalization. In Table 3, the model indicates an R-squared of approximately 0.474 and an adjusted R-squared of about 0.468. It indicates that all four explanatory variables explain 47.4 percent of the variation in adopting tech knowledge. The estimated coefficients of all explanatory variables as shown in Table 4, has a positive impact on the digital adaptation, Comfort in using apps (β =0.373, p = 0.000) is the strongest positive predictor of seniors' willingness to adapt to digital technology, followed by perception (β = 0.146) and access to devices (β = 0.091). Perceived challenges (β = 0.005, p = 0.892) have no significant impact on adaptation. The non-significant impact of challenges may stem from the relatively younger age group (50–60), who are more digitally exposed, resilient, and familiar with technology.

Table 3: Regression Model Summary

Model	R	R^2	Adjusted R Square	SError	F-stats	Significance
1	0.688	0.474	0.468	0.51088	79.711	0.000

*Predictors: U, C, P, A ; Dependent Variable: Adaptation, R: Correlation coefficient, S Error: Standard Error of Estimates, β: regression Coefficient, F-stats: F-statistics

Table 4: OLS Regression Results, B: Unstandardized regression coefficient, SError: Standard Error of Estimates, β: regression Coefficient, t-stats: t-statistics

Model	B	SError	β	t-stats	Significance
(Constant)	1.454	0.202	–	7.213	0.000
Perception of respondents	0.146	0.045	0.172	3.259	0.001**
Access to digital devices	0.091	0.042	0.129	2.181	0.030*
Challenge	0.005	0.039	0.005	0.136	0.892
Comfort in using apps	0.373	0.043	0.474	8.719	0.000**

*-significant at 5%, **-significant at 1% (two-tailed)

Varying behaviour of "Willingness to adopt digitalisation" across demographics

This section presents the results of comparing Willingness to adopt digitalisation and in improving technical knowledge across various demographic variables to study their impact through Anova and t-test. Table 5 shows the test statistic results along with their p-values. For Age of the Respondents (with more than two groups), an ANOVA test was conducted. The result indicates an F-statistic of approximately 0.75 and a p-value of about 0.001, suggesting statistically significant difference across age brackets. For Gender (a two-group variable: Female and Male), an independent sample t-test was performed. The t-statistic is about 0.727 and the p-value is approximately 0.395, which is above the common significance level (α = 0.05). This suggests that the observed gender difference is not statistically significant. For Marital Status (with multiple groups), an ANOVA test found an F-statistic of about 4.150 with Seniors in the Digital Age a p-value of roughly 0.007 indicating significant difference. For Area of Residence (with multiple groups), the ANOVA test revealed an F-statistic of about 8.134 and a p-value of approximately 0.000. Since the p value is below 0.05, this suggests that there is a statistically significant difference in willingness to enhance technical knowledge across the areas of residence. For Education Level and Work profile also, ANOVA test was conducted and highly significant difference were found between different groups.

User Segmentation for Digital Adoption

Table 6 presents the results of a K-Means cluster analysis that grouped respondents into four segments based on five features: average confidence across 19 Likert-scale items along with their digital service usage, social app activity, privacy measures adopted, and difficulties encountered. The analysis highlights distinct user profiles, revealing varying levels of digital engagement, confidence, and challenges. The clustering analysis identified four distinct user groups based on digital behaviour:

- Functional Adopters: Confident and moderately active users who engage with essential digital services in a practical, need-based manner, adopting some privacy measures without over complicating its usage.

- Social Users: Users with modest confidence and low overall digital engagement, mainly using essential or social features with minimal privacy precautions.
- Reluctant Adopters: Slightly less confident than Social Users, but they experience the highest difficulties, indicating significant barriers to digital adoption despite limited usage.
- Tech-Savvy Pioneers: The most confident and digitally active group, engaging broadly with digital services and social apps while also adopting strong privacy measures. They are enthusiastic and proactive despite facing some challenges.

Table 5: Distribution of Behavioural and Attitudinal responses given on likert scale

Statements around Digital adoption	Test	Statistic	p-value
Age	ANOVA	0.7467	0.001*
Gender	t-test	0.7270	0.395
Marital Status	ANOVA	4.150	0.007*
Area of Residence	ANOVA	8.134	0.000*
Education Level	ANOVA	7.686	0.000*
Work Profile	ANOVA	4.985	0.000*

Table 6: Results of K-Means clustering for user segmentation

Cluster	Total users in the group	Average Likert Score	Total Service Usage Score	Social Usage Score	Privacy Measures Score	Adoption Difficulty Score
Cluster 1 – Functional Adopters	110	4.00	12.53	4.31	2.89	1.34
Cluster 2 – Social Users	112	3.68	5.37	2.10	1.04	0.84
Cluster 3 – Reluctant Adopters	100	3.81	5.69	2.03	1.30	2.65
Cluster 4 – Tech Savvy Pioneers	37	4.40	23.24	7.51	4.41	1.78

The Confidence Score, based on a Likert scale, measures users' self-assessed comfort with digital technologies. Scores range from 3.68 (Social Users) to 4.40 (Tech-Savvy Pioneers). Higher scores indicate greater digital self-efficacy, helping distinguish user clusters by their perceived confidence in navigating and using digital tools independently. Total Service Usage values range roughly from 5 to 23 across clusters, a reasonable threshold is set around 10 services used. The low-engagement groups, Social Users (5.37) and Reluctant Adopters (5.69), demonstrate lower adoption rates, while the higher engagement groups, Functional Adopters (12.53) and Tech-Savvy Pioneers (23.24), show significantly higher adoption rates. Setting a threshold around 10 digital services effectively distinguishes adopters, who exhibit higher adoption rates, from non-adopters with lower rates. Social App Usage, a key clustering variable, reflects participants' engagement with communication platforms. Scores ranged from 2.03 (Reluctant Adopters) to 7.51 (Tech-Savvy Pioneers), highlighting varied social connectivity. Higher scores indicate active digital socialization, helping differentiate highly engaged users

from those with minimal use of social networking applications. Privacy Measures Score indicates how actively users adopt digital security practices. Scores range from 1.04 (Social Users) to 4.41 (Tech-Savvy Pioneers), reflecting varying awareness and behavior. Higher scores suggest proactive privacy management, while lower scores indicate minimal engagement with digital safety, helping distinguish user clusters by their security-consciousness. Adoption Difficulty Score reflects the extent of challenges users face in using digital technologies. Scores range from 0.84 (Social Users) to 2.65 (Reluctant Adopters), highlighting varying levels of digital barriers. Higher scores indicate greater difficulty, helping distinguish user clusters by their ease or struggle in adopting digital tools.

DISCUSSION

This research provides valuable insights into the digital inclusion of seniors, highlighting key factors that influence their digital proficiency. Seniors have been adopting digital technologies for over four years, primarily using them for entertainment, online payments, and social media. The main areas of digital engagement include education, entertainment, healthcare, e-commerce, and communication. Online entertainment offers seniors an accessible way to stay mentally engrossed, reduce loneliness, and enjoy leisure time. It includes streaming movies, listening to music, playing games, or watching devotional or cultural content. These activities boost mood, improve cognitive function, and provide a sense of connection with familiar interests or communities, especially for those with limited mobility or living alone. The main use of healthcare app is to book appointments and order medicines. Seniors commonly use government apps like DigiLocker and MyGov, along with financial services apps for banking and insurance, and payment apps such as PayTM and GPay as their top digital tools. Seniors practice online privacy by avoiding data sharing and using strong passwords. However, they face challenges remembering passwords and understanding technical jargon in apps.

In this analysis, usability emerges as the most influential predictor, followed by Perception and Accessibility. The Challenge variable does not show a significant impact on the digital adaptation among seniors. There is a significant impact of the area of residence on the willingness of seniors to improve technical knowledge, with statistical evidence ($p < 0.05$) indicating geographic variation in the interest in digital learning. Senior users can be categorized into four groups: Functional Adopters, Social Adopters, Reluctant Adopters, and Tech-Savvy Pioneers, allowing the creation of tailored digital engagement strategies for each group.

CONCLUSION

This study provides a comprehensive examination of digital inclusion among older adults, identifying significant determinants of their digital proficiency and offering insights into strategies for improving their engagement with technology. The findings of the study offer actionable guidance for policymakers, educators, and technology developers to foster inclusive digital environments for seniors. To bridge the digital divide among India's senior citizens, policies should focus on tailored digital literacy programs, accessible infrastructure, and supportive community initiatives. Few organizations in India have conducted workshops to enable seniors to use smartphones, access online services, and stay connected socially.

Ensuring affordable internet access and user-friendly devices is crucial. Collaborations with local communities can provide personalized training, enhancing seniors' confidence and independence in the digital realm. These efforts not only empower the elderly but also promote their active participation in tech-driven society. Future research should prioritize tailored interventions for vulnerable seniors at risk of digital exclusion, and include longitudinal studies to assess the long-term effects of digital engagement on their quality of life.

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Author Contribution
Dr. Sunita Narang: Conceptualization, Methodology, Software, validation, formal Analysis, Investigation, Data curation, Writing original draft, Review and Editing, Project administration.
Dr. Shalu Mahajan: Conceptualization, Methodology, software, validation, formal Analysis, Data curation, Writing original draft, Review and Editing.
Dr. Preeti Marwaha: Software, validation, formal Analysis, Writing original draft, Review and Editing, Visualization.
Dr. Sharanjit Kaur: Conceptualization, Validation, Review and Editing, Supervision
Ms. Gunjan Rani: Software, Investigation, Data curation, Review and Editing, Visualization.

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The authors confirm that the data set supporting the findings of this study are available and will be shared by the corresponding author upon reasonable request.

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