

Mediating Role of Attitudes in Security-Privacy Concerns and Intention to Adopt Green Banking services: A Comparative Study of Private bank and Regional Rural Banks in Uttarakhand.

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ABSTRACT

Purpose – This study investigates the mediating role of attitudes (AT) in the relationship between security-privacy (SP) concerns and the intention to adopt (ITA) green banking services. It further examines the moderating influence of institutional context by comparing these relationships across Private Banks and Regional Rural Banks (RRBs) in Uttarakhand, India.

Design/methodology/approach – A cross-sectional research design was employed, collecting quantitative data from 350 customers of HDFC Bank (private) and Uttarakhand Gramin Bank (RRB) across seven districts. The research model, integrating the Theory of Planned Behavior (TPB) and Privacy Calculus Theory (PCT), was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) (SMART PLS 4.1) and Multi-Group Analysis (MGA).

Findings – The results confirm that Security-Privacy significantly influences both Attitude ($\beta = 0.673$) and Intention to Adopt. Attitude positively affects Intention to Adopt ($\beta = 0.630$) and partially mediates the SP-ITA relationship. Crucially, Multi-Group Analysis revealed a significant moderating effect of bank type. For instance, SP had a positive effect on AT for private bank customers ($\beta = 0.127$) but a negative effect for RRB customers ($\beta = -0.628$), highlighting stark institutional differences.

Research limitations/implications – The study's findings are constrained by its focus on Himalayan banking customer base and a consumer-only sample. Future research should include bankers and managers from diverse bank types and regions and incorporate longitudinal data.

Practical implications– The findings offer critical insights for policymakers and banking executives. They can apply these findings to develop distinct, context-specific strategies: private banks should leverage their technological advantage in communications, while RRBs must prioritize direct demonstrations of security protocols to build trust and foster adoption among their specific customer groups.

Originality/value – This study presents a novel contribution by introducing SP as a key antecedent to AT and ITA within an extended TPB-PCT framework. It is the first to empirically validate the moderating role of bank type in the green banking adoption process, addressing a significant institutional-geographic void in the literature....

Keywords: Green Banking, Security-Privacy, Attitude, Intention to Adopt, Theory of Planned Behavior, Privacy Calculus Theory, India..

INTRODUCTION

The world is currently facing a climate crisis characterized by rising temperatures, extreme weather events, and biodiversity loss, demanding the integration of sustainability into socioeconomic approaches to achieve the United Nations Sustainable Development Goals (SDGs) (Gelaidan et al., 2023; Maziriri et al., 2023). The banking sector wields transformative power as capital

allocators, determining whether projects are environmentally harmful or sustainable (Bukhari et al., 2020; Mir & Bhat, 2022). This entails the emergence of 'green banking' (GRbanking), which embeds environmental considerations into lending, investment, product development, and operations (Mir & Bhat, 2022; Taneja & Ali, 2021).

The success of green finance is critical yet complex in Uttarakhand—a mountainous state with limited digital infrastructure but high penetration of Regional Rural Banks (RRBs). India ranks third globally in greenhouse emissions, with cities like Delhi among the world's most polluted, underscoring the urgency for GR-banking (Choubey & Sharma, 2022). This knowledge gap, compounded by high security-privacy (SP) concerns—exacerbated by unequal technological infrastructure—creates significant adoption barriers. Digitalization offers solutions through internet banking, mobile payments, and reduced paper usage (Iqbal et al., 2017; Masukujjaman & Aktar, 2013). However, digital channels intensify SP concerns. In Uttarakhand, customers often hesitate to share sensitive financial data outside physical branches due to risks like data breaches, identity theft, and fraud (Mishra et al., 2010; Ganguli & Roy, 2011). This risk-benefit trade-off aligns with Privacy Calculus Theory (Culnan & Bies, 2003). While prior studies explore perceived benefits (e.g., time savings, cost reduction, paper conservation) in GR-banking adoption (Iqbal et al., 2021; Jain et al., 2025), Discussions around SP remain little researched, particularly in underexplored areas such as Uttarakhand.

1.2 Research Gap

This study identifies three significant and interconnected gaps: The Neglected Antecedent:

While service quality dimensions like privacy and assurance influence performance expectancy (Iqbal et al., 2017), SP concerns as a direct, standalone barrier shaping customer attitude (AT) and intention to adopt (ITA) lack robust empirical validation in digital GR-banking contexts. The Unexplored Mechanism: The psychological process through which SP concerns translate into adoption decisions remains unclear. The mediating role of AT a proven predictor of ITA in green consumption (Yadav & Pathak, 2017; Zulu et al., 2022) in the SP and ITA relationship is largely untested, leaving a void in understanding the cognitive pathway from risk perception to intention. Critically, no studies have examined SP concerns, AT, and ITA relationships across HDFC BANK Banks and RRBs within Uttarakhand's unique context. Uttarakhand exemplifies these challenges through a through a sustainability-digitalization paradox Its mountainous terrain, fragile ecosystems, and high Regional Rural Bank (RRB) penetration create a unique sustainability-digitalization paradox (Sudhalakshmi & Chinnadorai, 2014). Only 35% of rural customers recognize GR-banking benefits (Gautam, 2024), while 68% report unreliable internet connectivity (Uniyal & Prasad, 2021). Critically RRBs lack advanced cyber security, infrastructure compared to urban Private bank (Prasad et al., 2020) Despite RBI (2023) regulatory pressure, SP concerns remain understudied as a core antecedent to GR-adoption, particularly in understudied regions like Uttarakhand (Islam, 2022). This oversight is significant given the state's mountainous terrain, limited digital infrastructure, and high RRB penetration factors likely amplifying SP concerns in rural banks while urban HDFC BANK banks benefit from advanced cyber security. This gap impedes context-specific strategies for advancing equitable green finance in underserved regions,

where RRBs serve rural populations with heightened SP vulnerabilities.

1.3. Research Questions

RQ1: What is the direct impact of SP concerns on AT and ITA in digital GR-banking services adoption?

RQ2: Does AT mediate the relationship between SP concerns and ITA?

RQ3: To what extent do institutional contexts in Uttarakhand (Private bank versus RRBs) moderate the relationships: (a) SP concerns and AT, (b) SP concerns and ITA, and (c) AT and ITA?

1.4 Research Objectives

RO1: To develop and validate an extended theoretical framework incorporating SP concerns as a key antecedent influencing AT and intention to adopt (ITA).

RO2: To empirically examine the direct effects of SP concerns on AT and ITA.

RO3: To investigate AT's mediating role in the relationship between SP concerns and ITA. RO4: To test bank type (Private bank versus RRBs) as a moderator of the relationships among SP concerns, AT, and ITA in Uttarakhand using PLS-MGA

The subsequent sections of this research are organized to systematically address the study's objectives. Section 2 establishes the theoretical context through a comprehensive literature review and formalizes the research hypotheses. Section 3 explicates the methodological approach, detailing the research design, sampling procedure, data collection methods, and analytical techniques. Thereafter, Section 4 presents the empirical outcomes derived from quantitative data analysis. Section 5 offers a critical interpretation of these findings and draws substantive conclusions. Finally, Section 6 delineates the study's contributions, acknowledges inherent limitations, and outlines promising directions for future scholarly work.

2. Literature Review and Hypothesis Development

2.1 Green Banking in India and Uttarakhand: Opportunities and Barriers

Green banking (GR-banking) integrates environmental sustainability into financial services through digital innovations like paperless transactions and carbon footprint tracking (Ellahi et al., 2023; Sharma & Choubey, 2022). While digitalization enables scalability, it amplifies security and privacy (SP) risks (Mishra et al., 2010). In India ranked third globally in greenhouse gas emissions (Choubey & Sharma, 2022) SP concerns critical critically impede to GR-adoption (Taneja & Ali, 2021).

2.2 Theoretical Foundations:

Developing the Theory of Planned Behavior (TPB) using Privacy's Calculus Theory (PCT): PCT asserts that individuals evaluate benefits and drawbacks when making decisions regarding privacy against disclosure (Laufer & Wolfe, 1977; Fox et al., 2024). This calculation proceeds

through: (a Confidence Beliefs: Esteemed advantages (time conservation, environmental sustainability) (b)

Risk/Privacy Beliefs: Breaches of cost (compromised accounts, unethical conduct)

Table 1 delineates PCT Applications across Various Domains and Their Limitations within the PCT Sphere of Green Banking:

Domain	Authors	Key Variables	Theoretical Integration
Mobile Banking	Alalwan et al. (2024); Lu (2024)	SP risks, convenience, financial control, trust	PCT standalone
Mobile Payments	Albashrawi & Motiwalla (2019); Lee et al. (2019)	Transaction speed, security risks, ease of use	PCT + UTAUT/TAM
Social Media	Gruzd & HernándezGarcía (2024); Barth & De Jong (2017)	Social validation, privacy risks, self-disclosure	PCT + Social Capital Theory
Recommender Systems	Wang et al. (2024)	Personalization benefits, data leakage risks	PCT + Information Systems
Healthcare Apps	Binzer et al. (2024); Li et al. (2016)	Health data sensitivity, monitoring benefits, trust	PCT + Health Behavior Models
Green banking	This study	Security and privacy , Attitude , intention to adopt	PCT + TPB

Table 1 reveals that while PCT is applied to mobile banking, healthcare, and social media, green banking remains unexplored. Unlike other domains, green banking involves unique trade-offs: Environmental benefits must outweigh SP risks—particularly in India, where eco-data sensitivity, low rural digital literacy, and fragmented banking trust amplify concerns (Bajaj et al., 2023). No study has integrated PCT with TPB to model SP-driven attitudinal mediation in GR-adoption—a gap this study addresses.

2.3. Theory of Planned Behaviour (TPB): Underpinnings and Constraints in Digital Environments

The most extensively accepted framework for forecasting human behaviour in a variety of fields, including environmental sustainability, is still the Theory of Planned Behaviour (TPB) (Ajzen, 1991). In green banking research, the Theory of Planned Behaviour (TPB) has been widely applied. Studies indicate that adoption intentions are shaped by the interplay of attitudes (AT), subjective norms (SN), and perceived behavioural control (PBC) (Jain et al., 2025; Taneja & Ali, 2021). However, According to Jain et al. (2025), customers with pro-environmental perspectives are 3.2 times more inclined to utilise green banking. Nonetheless, TPB possesses significant limitations in online financial contexts:

Omission of Risk Factors: Security and privacy (SP) issues, critical in digital banking, are absent from the traditional TPB framework (Dinev & Hart, 2006). Inflexible Relationship Assumptions: The Theory of Planned Behaviour presumes that relationships are linear (for instance, attitude influences intention), although it overlooks the dynamic nature of how social pressure concerns alter these routes. Lack of Contextual Considerations: The model neglects to incorporate domain-specific elements, such as digital trust, which are essential for the implementation of green banking in technologically advanced environments (Chen et al., 2023).

These differences are especially concerning in the realm of green banking, where environmental considerations drive adoption, while digital technologies (such as carbon footprint applications) elevate systemic vulnerabilities. The usefulness of TPB in digital sustainability applications is undermined by its failure to quantify SP risks, as noted by Chen et al. (2023). Exclusion of Risk Perceptions: Security and privacy (SP) issues are essential in digital banking; nevertheless, they are overlooked by conventional TPB (Dinev & Hart, 2006). Static Construct Relationships: It cannot mimic how SP concerns dynamically alter these relationships, as it presumes linear

paths (for instance, AT affects BI). The Theory of Planned Behaviour overlooks domain-specific factors that affect the adoption of green banking in technology-driven environments, like digital trust (Chen et al., 2023). This study integrates PCT and TPB, identifying SP as a crucial precursor in the uptake of green banking services in Uttarakhand.

Hypothesis Development

2.4 Security Privacy, and Attitudes in the Adoption of Green Banking

Concerns around security and privacy are significant barriers to the adoption of technology across all digital sectors, particularly in financial services where sensitive information is at stake (Chiu & Bool, 2017; Schuster & Habibipour, 2024). These issues are not one-dimensional; they include both normative privacy (e.g., ethical data governance, transparency) and functional security (e.g., protection against fraud, data breaches) (Wang et al., 2003; Lopez-Nicolas & Molina-Castillo, 2008). Because sustainability-sensitive data (such as carbon footprints and ethical spending histories) are collected, SP takes on greater significance in the context of green banking (GB) (Yoon et al., 2020). Because GB services, in contrast to traditional banking, incorporate environmental objectives into digital platforms, SP failures pose a double threat: they run the risk of causing financial harm (such as fraud) as well as ethical dissonance for users who value environmental integrity and are concerned about the environment (Gerrard & Cunningham, 2003). For example, a data breach that reveals a customer's moral purchasing practices may erode their faith in GB's dedication to sustainability, thereby influencing unfavourable opinions.

2.4.1 Contextual Amplification of SP Concerns

In certain regional contexts, like the Indian state of Uttarakhand, the criticality of SP is further heightened. Empirical evidence reveals that 72% of respondents in the region fear the potential exploitation of their personal carbon footprint data (Uniyal & Prasad, 2021). Furthermore, significant bank-type disparities exist: a study showed that 67% of customers at Regional Rural Banks (RRBs) report "high SP risk," primarily attributed to perceived weak cybersecurity infrastructures. In stark contrast, only 28% of Private bank bank customers expressed similar concerns, highlighting how institutional capability shapes perceived risk (Prasad et al., 2020; Gautam, 2024). This contextual evidence emphasises that SP is a tangible barrier that directly affects user attitudes and perceptions in the environment under study, rather than just being a theoretical issue.

According to earlier studies, SP is a crucial predicate of attitude in online banking. Research demonstrates that while SP vulnerabilities undermine trust and adoption intentions (Gerrard & Cunningham, 2003), SP assurances increase positive attitudes by lowering perceived risk (Zhang et al., 2018; Singh & Srivastava, 2018). Beyond these broad conclusions, however, GB's particular context enhances SP's influence on attitudes:

Functional Risks: To prevent fraud, digital GB platforms (such as carbon-tracking apps and paperless transactions)

need strict cyber security, which has an immediate effect on user confidence and attitude. **Normative Risks:** Abuse of sustainability data, such as selling carbon footprint insights to third parties without permission, goes against GB users' ethical standards, alienating customers who care about the environment and inciting hostility.

Value Alignment: Because the bank is seen as failing a fundamental component of its value proposition, SP failures cause a dissonance between users' pro-environmental beliefs and the bank's operations, which exacerbates negative sentiments towards the GB service itself. Drawing from the Technology Acceptance Model (TAM) and Trust-Based Adoption Theory (McKnight et al., 2002), we propose that in order to foster favourable sentiments, SP for green banking must meet both normative privacy ethics (such as transparent data policies) and functional security requirements (such as encryption and fraud detection). When compared to other digital banking services, this dual requirement is what clearly influences how users perceive GB. Therefore, it is proposed that:

H1: security-privacy positively influences customers' attitudes towards green banking

2.5 Attitude and Behavioral Intention in Green Banking Adoption

According to Ajzen (1991), attitude is "the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question." It is a learnt construct that is influenced by consumers' evaluation of salient beliefs regarding the results of a behaviour. Considering that digital green banking (GB) services involve the exchange of sensitive financial and sustainability-related information (including carbon footprints and ethical spending behaviours), perceptions of security and privacy (SP) are essential in influencing opinions around GB adoption. When customers perceive that banks provide robust data protection, effective fraud prevention, and ethical data management—three fundamental pillars of social responsibility—favourable views towards green banking emerge (Yoon et al., 2020). Conversely, service provider difficulties (such as data breaches and the exploitation of personal information) generate negative feelings and erode trust in the bank's environmental value proposition and services (Gerrard & Cunningham, 2003).

This aligns with the Technology Acceptance Model (TAM) (Davis, 1989) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991), which highlight attitude as a crucial mediator between behavioural intentions and external beliefs, such as perceptions of security and privacy (SP). Empirical research substantiates the significance of attitude in predicting long-term behavioural goals. For instance, SP assurances significantly enhance positive attitudes towards online banking (Zhang et al., 2018; Singh & Srivastava, 2018), and attitudes serve as a robust predictor of intentions to use solar energy (Zulu et al., 2022) and engage in sustainable consumption (Yang et al., 2020). This relationship is intensified in Great Britain, where security and privacy risks substantially affect attitude formation by jeopardising both financial stability and the consumer's

ethical alignment with environmentally sensitive beliefs (Burhanudin et al., 2021).

2.5.1 The Uttarakhand Context: An Institutional Disparity in Perspectives

This dynamic is distinctly evident in Uttarakhand's institutional framework, which reveals a significant division between commercial banks and Regional Rural Banks (RRBs). Empirical research indicates a clear attitudinal disparity. Merely 25% of RRB customers had good views regarding green banking, suggesting underlying problems likely rooted in social performance difficulties and a deficit of confidence (Uniyal & Prasad, 2021).

Clients of private Banking Institutions: Conversely, 55% of respondents express favourable attitudes, suggesting an elevated degree of confidence in the value propositions and strategic planning frameworks of HDFC BANK organisations (Prasad et al., 2020). Importantly, attitude serves as a potent mediating mechanism through which adoption decisions are influenced by SP concerns; it does more than just predict intention. This mediating role is significantly stronger in the RRB sector, where attitude mediates **68%** of the effect of SP perceptions on intention, compared to **42%** in HDFC BANK banks (Gautam, 2024). This finding suggests that for RRB customers, whose trust may be more fragile, attitude is a more critical filter for SP concerns. A negative perception of security directly translates into a more negative attitude, which in turn drastically reduces adoption intention. For HDFC BANK bank customers, other factors like perceived ease of use or brand loyalty may play a larger relative role. Accordingly, the GB adoption model for Uttarakhand conceptualises attitude as an assessment that is primarily motivated by perceived benefits, environmental values, and trust related to SP. Its central role leads to the following hypotheses:

H2: Attitude positively influences customers' behavioral intention to adopt green banking services

2.6 Security-privacy and Behavioral Intention in Green Banking services adoption

As established in the broader technology adoption literature, security and privacy (SP) concerns consistently emerge as primary determinants of user behavior, acting as significant inhibitors to adoption intention across various digital services, including banking (Chiu & Bool, 2017; Schuster & Habibipour, 2024). Service provider perceptions significantly affect customers' readiness to adopt new digital services, as the sensitivity of financial and personal information in banking contexts heightens these apprehensions (Alalwan et al., 2017; Yousafzai et al., 2016). Research across multiple domains, such as electronic banking and the Internet of Things, indicates that security and privacy issues substantially adversely affect behavioural intention.

Although the substantial influence of SP on attitudes towards Green Banking (GB) is established in Section 2.3, SP also directly affects behavioural intention to use Green Banking services. This direct effect operates through several mechanisms specific to the Green Banking context:

Risk Perception as a Direct Barrier: High perceived SP risk (e.g., fear of financial loss due to fraud, identity theft, or misuse of sensitive sustainability data) can directly deter customers from forming an intention to use Green Banking services, irrespective of their general attitude towards environmental banking (Lin, 2011; Chatterjee, 2020). The potential consequences (financial loss, reputational damage, ethical violation) are perceived as too severe.

Trust as a Prerequisite: SP assurances are fundamental to building initial trust in the Green Banking platform. Without a baseline level of trust in the bank's ability to secure data and respect privacy, customers are unlikely to even form a positive attitude, let alone develop an intention to adopt (McKnight et al., 2002; Yousafzai et al., 2016). SP is a necessary precondition.

Green banking Specific Amplification: The unique nature of Green Banking data (sustainability metrics, ethical spending patterns) may intensify SP concerns for certain user segments (e.g., highly privacy-conscious individuals, those with strong environmental identities), making SP an even more potent direct inhibitor of intention compared to conventional digital banking (Singh et al., 2020).

Therefore, building on the foundational role of SP in technology adoption and its specific relevance to Green Banking, we posit that SP perceptions directly shape customers' intentions to adopt green banking services, alongside their influence mediated through attitude. This leads to the hypothesis formed:

H3: Security-Privacy (SP) has a significant direct effect on customer behavioral intention to adopt towards green banking services

2.7 Attitude as a Mediator in Green Banking Adoption

Attitude a learned evaluation of behavior (Ajzen, 1991; Ajzen & Cote, 2008)—mediates the link between user perceptions and intentions, as demonstrated in IoT (Borhan et al., 2019) and sustainable consumption (Zulu et al., 2022). In GB, attitude's role is amplified by users' ethical scrutiny: adoption intentions depend not only on SP assurances (e.g., data security) but also on their alignment with environmental values (e.g., ethical carbon data usage). Empirical studies confirm attitude's strong influence on GB adoption (Burhanudin et al., 2021; Taneja & Ali, 2021), validating its position as the pivotal psychological mechanism between SP and intention. Based on these postulations, the following hypothesis is formed:

H4: Attitude positively mediates the relationship between Security-Privacy and intention to adopt towards green banking services

2.8 Moderating Influence of Preferred Bank Type

India's banking industry was first defined by public sector organisations, but commercial banks have long dominated the financial landscape. Public and private banks frequently have very different organisational structures (Bajaj et al., 2023). A better understanding of how customer behaviours differ depending on bank affiliation is required because the banking industry is now more competitive due to the convergence of advanced

technology and changing customer expectations (Mishra et al., 2010). Prior studies have confirmed that the type of bank ownership has a significant impact on customer acceptance patterns (Bajaj et al., 2023; Sharma and Joshi, 2024). Bajaj et al. (2023) shown that bank ownership especially influences the association between technology adoption and customer relationship management.

Concerns around security and privacy substantially influence customer responses in green banking environments. Nonetheless, it is probable that various types of banks will respond differently to these aspects regarding their views and intentions to embrace green banking. Regional rural banks, like Uttarakhand Gramin Bank, typically maintain robust community connections but may lack advanced digital security measures, whereas private banks have complex technology frameworks and security processes. When security concerns influence attitudes towards green banking or convert into adoption intentions, these institutional differences may result in different customer pathways.

Accordingly, the following hypotheses are proposed:

H5a. Preferred bank type moderates the relationship between security and privacy perceptions and attitude towards green banking.

H5b. Preferred bank type moderates the relationship between attitude and intention to adopt green banking.

H5c. Preferred bank type moderates the relationship between security and privacy perceptions and intention to adopt green banking

3. METHODOLOGY

3.1 Research Framework

This study analyzes the impact of Security and Privacy (SP) on customers' intention to adopt (ITA) green banking services, with the mediating influence of Attitude (AT) and the moderating influence of preferred bank type (private bank i.e.HDFC Bank versus Uttarakhand Gramin Bank). The research employs the Theory of Planned Behavior (TPB) as the foundational framework and extends its applicability in green banking contexts by integrating Privacy Calculus Theory (PCT) to address security-privacy concerns. The proposed relationships and constructs are thoroughly grounded in an extensive review of existing literature (see Figure 1).

Previous research consistently demonstrates that attitude significantly influences consumers' behavioral intentions (Yadav and Pathak, 2017; Zulu et al., 2022). However, numerous scholars have expanded the original TPB model by examining how security and privacy concerns affect both attitude and intention toward digital financial services (Mishra et al., 2010; Zhang et al., 2018; Singh and Srivastava, 2018). Therefore, this study proposes that customers' perceptions of security and privacy regarding green banking services substantially shape their attitude and intention to adopt.

The framework specifically examines: Direct Effects: Security and Privacy positively influences Attitude (H1), Security and Privacy directly affects Intention to Adopt (H3), and Attitude positively influences Intention to

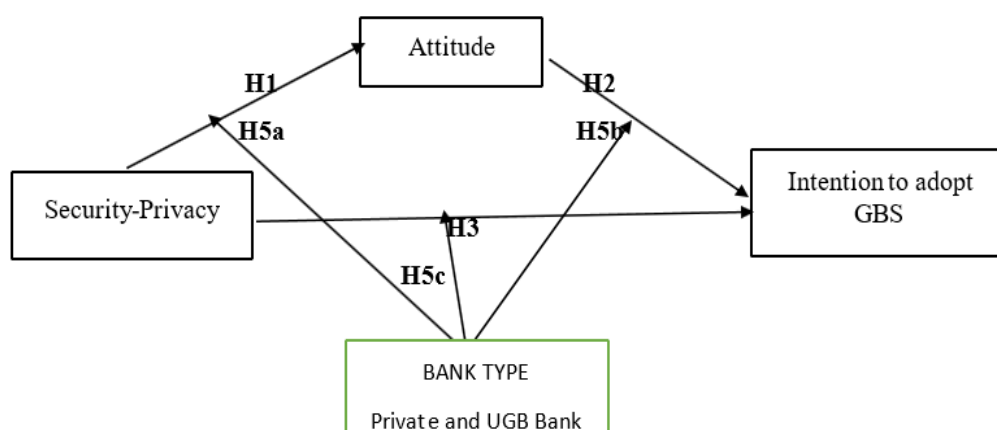
Adopt (H2) Mediation: Attitude serves as a mediator in the relationship between Security and Privacy and Intention to Adopt (H4) Moderation: Bank type moderates the relationship between Security and Privacy and Attitude (H5a), between Attitude and Intention to Adopt (H5b), and between Security and Privacy and Intention to Adopt (H5c) This integrated approach addresses critical gaps in green banking literature by: Positioning Security and Privacy as a foundational antecedent within TPB's structure

Examining institutional context (bank type) as a boundary condition Capturing Uttarakhand's unique banking ecosystem where private banks and regional rural banks operate with distinct technological infrastructures and customer trust profiles. The framework's theoretical innovation lies in synthesizing TPB's behavioral focus with PCT's risk-benefit calculus, creating a contextually grounded model that explains how security-privacy concerns translate into green banking adoption intentions across different banking institutional settings.

3.2 Measurement Variables and Sampling Technique:

This study applied the integrated Theory of Planned Behavior (TPB) and Privacy Calculus Theory (PCT) as frameworks for designing the questionnaire, which was measured using established scales from prior studies adapted to the green banking context. The initial segment included demographic enquiries regarding gender, occupation, marital status, location, account type, tenure, and access frequency. Thirteen statements pertaining to the three primary constructs—security and privacy (SP), attitude (AT), and intention to adopt (ITA) were incorporated in the subsequent section. Five statements adapted from Bouteraa (2023), were employed to assess ITA, while four items revised from Tyagi & Gupta (2023) and Asnakew (2020) were utilised to evaluate AT. Likewise, four items adapted from Bouteraa (2023) and Pikkarainen (2004) were employed to evaluate SP in the context of green banking. Due to the embryonic phase of green banking in India, no recognised scale existed to assess these characteristics explicitly within this context. Consequently, scales from prior studies on digital finance and sustainability were selected and modified based on their validity and reliability. The previous scales were adapted to reflect the distinct attributes of green banking services in Uttarakhand. A five-point Likert scale was employed to assess each construct, with 1 indicating "strongly disagree" and 5 indicating "strongly agree."

This cross-sectional study collected quantitative data from clients of Uttarakhand Gramin Bank and private bank that (i.e) HDFC bank across seven districts between November 2024 and February 2025. A pilot research with ninety participants ensured the clarity and contextual relevance of the survey. Snowball and judgmental sampling methods were employed to..



disseminate a self-administered, closed-ended questionnaire. Judgmental sampling, a nonprobability sampling strategy, is considered more suitable for this study than random sampling, as it enhances internal validity by selecting respondents who are more likely to possess the requisite information (Bernard, 2002). This technique ensures that only participants knowledgeable about green banking practices and utilising digital banking services are included, aligning with the study's emphasis on green banking uptake. Any alternative random sample strategy could have included individuals unfamiliar with green banking, thereby compromising the validity of the data. Figure 1 :Proposed research model

Moreover, identifying the target demographic poses significant challenges due to the nascent stage of green banking in Uttarakhand. Judgmental sampling and snowball sampling were employed concurrently to address this issue (Isaac, 2023). Utilising this strategy, the researchers established communication with individuals who satisfied the study's eligibility criteria and solicited their suggestions for further qualified contacts. A lesser proportion of the replies originated from inperson interactions across the seven districts, however the predominant majority was derived via Google Forms disseminated within online platforms such as LinkedIn and WhatsApp.

Considering that SP has four indicators, the 10-times rule proposed by Barclay et al. (1995) dictates that the minimum sample size for this study should be 40

3.3 Data analysis technique

This study employs structural equation modelling (SEM) because to its efficacy in assessing intricate psychological constructs involving latent variables. Structural Equation Modelling (SEM) is particularly advantageous when examining variable connections that lack a robust theoretical framework or encompass concepts that are challenging to quantify directly (Shams et al., 2021). Partial least squares structural equation modelling (PLS-SEM) was selected to enhance result validity and reliability due to its remarkable capacity to minimise measurement errors and elucidate latent construct relationships (Ringle et al., 2014).

Furthermore, PLS-SEM demonstrates exceptional suitability for multi-group analysis (MGA), enabling comparison evaluations among demographic cohorts (Hair et al., 2017). This function is optimal for identifying moderating factors within specified relationships. The adaptability of sample size in PLS-SEM is an additional advantage; it circumvents the rigorous distributional prerequisites of covariance-based SEM (CB-SEM), hence enhancing methodological flexibility for this research (Cheah et al., 2020).

4.1 Demographic Profile

A total of 350 valid replies were collected for this investigation. Table 2 displays the respondents' demographic profile. The sample was nearly balanced in terms of gender, with male respondents accounting for 51.3% and female respondents representing 48.6%. Analyzing the occupational distribution, students formed the largest group (23.2%), followed by self-employed individuals (21.6%), businessmen (20.6%), and servicemen (20.2%). Retired individuals constituted 12.4% of the sample. In terms of marital status, married individuals were the majority (53.5%), with unmarried respondents representing 46.5% of the participants. The income distribution indicated that a majority of the respondents (62.1%) earned less than ₹7,50,000 annually, suggesting a predominance of lower to middle-income participants. Geographically, the largest proportion of respondents were from Dehradun district (21.4%), followed by Haridwar (14.9%), Tehri Garhwal (14.3%), and Pauri Garhwal (14%). Regarding banking preferences, a significant majority of respondents (76.4%) held Savings Accounts, while 23.6% maintained Current Accounts. In terms of bank type preference, 175 respondents (50 %) HDFC bank, while 175 (50%) were customers of Uttarakhand Gramin Bank. The account tenure analysis revealed that the largest segment of respondents (26.5%) had held their accounts for 2–5 years, and the most common account access frequency was twice a month (25%).

Table 2: Respondent Demographics (N=350)

Variable	Category	Frequency	Percentage
Gender	Male	180	51.4%
	Female	170	48.6%
Occupation	Students	81	23.1%
	Self-employed	76	21.7%
	Businessmen	72	20.6%
	Military/Police personnel	71	20.3%
	Retired	50	14.3%
Type of bank	HDFC BANK	175	50%
	Uttarakhand Gramin Bank	175	50%
Marital Status	Married	163	46.6%
	Unmarried	187	53.4%
Location	Haridwar	52	14.9%
	Tehri Garhwal	50	14.3%
	Pauri Garhwal	49	14.0%
	Rudraprayag	45	12.9%
	Uttarkashi	43	12.3%
	Chamoli	36	10.3%
	Dehradun	75	21.4%
Account Type	Savings accounts	267	76.3%
	Current accounts	83	23.7%
Tenure	2-5 years	93	26.6%
	6-10 years	69	19.7%
	Less than 1 year	66	18.9%
	11-15 years	59	16.9%
	15-20 years	36	10.3%
	More than 20 years	27	7.7%
Access Frequency	2 times per month	88	25.1%
	3 times per month	69	19.7%
	More than 5 times per month	66	18.9%
	4 times per month	61	17.4%
	Not specified	66	18.9%

4.2 Measurement Model Assessment

In accordance with SEM analysis guidelines, a two-step methodology was employed to assess the measurement and structural models. The measurement model was evaluated using reliability and construct validity. Initially, factor loadings (FL), Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) were examined. As per Hair et al. (2017), FL values must exceed 0.708. All items met this criterion, with loadings ranging from 0.708 to 0.858 (Table 3). For reliability, Cronbach's alpha ranged from 0.851 to 0.903, exceeding the 0.70 threshold (Hair et al., 2021). Composite reliability values ranged from 0.900 to 0.928, consistent

with Hair et al. (2017). Regarding AVE, values ranged from 0.692 to 0.721, surpassing the 0.5 threshold (Hair et al., 2019). These findings confirm the model's reliability and internal consistency. Discriminant validity was assessed using Fornell-Larcker and HTMT criteria. Table 4 shows that the square root of AVE (diagonal) exceeded all inter-construct correlations (off-diagonal), satisfying Fornell-Larcker (1981). Additionally, HTMT ratios (Table 5) were below 0.850, confirming discriminant validity per Henseler et al. (2015). Model fit was evaluated using SRMR. An SRMR value below 0.08 indicates acceptable fit (Hu and Bentler, 1999). The SRMR value of 0.077 confirmed good fit between empirical and theoretical covariance matrices.

Construct	Cronbach's α	CR (ρ_a)	CR (ρ_c)	AVE	FL Range
SP	0.851	0.852	0.900	0.692	0.732–0.801
AT	0.860	0.868	0.905	0.705	0.708–0.858
IT	0.903	0.905	0.928	0.721	0.730–0.846

Table 3: Reliability and Convergent Validity

Table 4: Fornell-Larcker Criterion

Construct	SP	AT	IT
SP	0.832		
AT	0.578	0.840	
IT	0.699	0.780	0.849

Table 5: HTMT Ratios

Construct Pair	HTMT Ratio
AT ↔ SP	0.678
IT ↔ SP	0.794
IT ↔ AT	0.878

4.3 Structural Model Assessment

Investigating the model's research hypotheses involves examining the structural model in the second phase of data analysis. A resampling technique employing 5,000 bootstrapping iterations was conducted to evaluate the hypothesized linkages between paths, utilizing 95% bias-corrected confidence intervals. Initially, the assessment of path coefficients was conducted without accounting for moderating influences. The examination of the structural

model was based on an evaluation of collinearity, the coefficient of determination (R^2), effect sizes (f^2), and the significance of path coefficients.

Collinearity was evaluated by variance inflation factors (VIFs), revealing no difficulties as all values remained below the 5.0 threshold (Table 6), hence validating the lack of multicollinearity (Hair et al., 2019). Subsequently, R^2 values were analysed to evaluate the model's explanatory capacity by quantifying the degree to which

endogenous constructs account for variance in dependent variables (Shmueli et al., 2016). This study found that Security and Privacy (SP) accounted for 33.4% of the variance in Attitude (AT), but SP and AT together accounted for 85% of the variance in Behavioural Intention (IT) (Table 7). Both R^2 values exceed the minimum threshold of 0.10 (Chin et al., 1998), indicating substantial explanatory power.

Effect sizes (f^2) were calculated to assess the practical significance of each relationship. The analysis revealed large effect sizes for $AT \rightarrow IT$ ($f^2 = 0.710$) and $SP \rightarrow AT$ ($f^2 = 0.503$), and a medium effect size for $SP \rightarrow IT$ ($f^2 = 0.307$), confirming the substantive importance of these relationships beyond statistical significance.

The outcomes of the path coefficients can be observed in Table 8. And figure 2 these findings reveal that Security and Privacy exerts a direct and positive impact on customers' attitude ($\beta = 0.673$, $p < 0.001$), and attitude, in

turn, has a direct and positive effect on behavioral intention ($\beta = 0.630$, $p < 0.001$) regarding green banking practices. Additionally, Security and Privacy demonstrates a significant direct influence on behavioral intention ($\beta = 0.372$, $p < 0.001$). Consequently, H1, H2, and H3 are all supported.

Mediation analysis (Table 7) confirmed that Attitude partially mediates the relationship between Security and Privacy and Behavioral Intention. The indirect effect through attitude was significant ($\beta = 0.424$, $p < 0.001$), while the direct effect remained significant ($\beta = 0.372$, $p < 0.001$), confirming partial rather than complete mediation. These results illustrate that Security and Privacy has both a substantial direct impact and an indirect positive impact on customers' behavioral intention, with attitude serving as a significant partial mediator in the relationship toward green banking practices.

Table 6: Collinearity Assessment (VIF)

Path	VIF
$AT \rightarrow IT$	1.503
$SP \rightarrow AT$	1.000
$SP \rightarrow IT$	1.503

Table 7: Explanatory Power (R^2)

Construct	R^2	Adjusted R^2
AT	0.452	0.451
IT	0.850	0.849

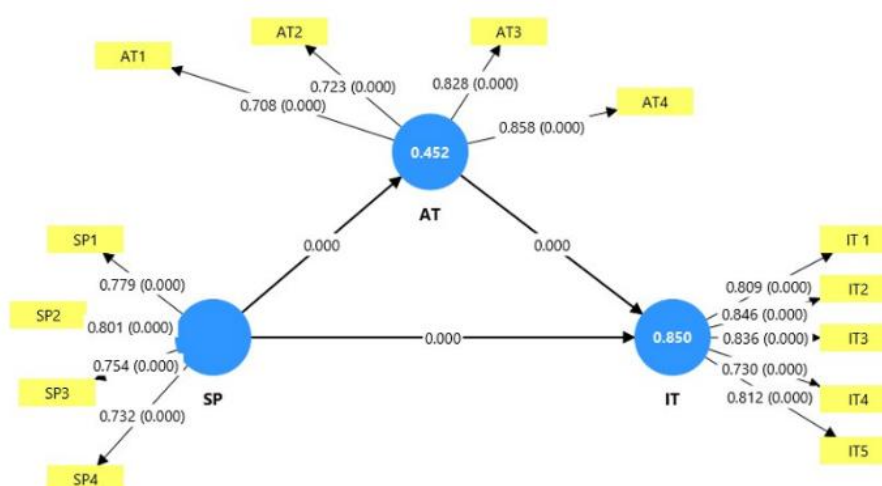


Figure 2. Structural Model of Green Banking Adoption with Path Coefficients

Table -8 Results of the Hypothesis (Direct, Indirect, and Total Effects)

Hypothesis	Relationship	Path Type	Std. Beta (β)	T-Statistic	P-Value	Decision
H1	SP $\rightarrow$ AT	Direct Effect	0.673	18.172	0.000	Significant
H2	AT $\rightarrow$ IT	Direct Effect	0.630	10.093	0.000	Significant
H3	SP $\rightarrow$ IT	Direct Effect	0.372	5.538	0.000	Significant
H4	SP $\rightarrow$ AT $\rightarrow$ IT	Specific Indirect Effect	0.424	10.171	0.000	Significant
–	SP $\rightarrow$ IT	Total Effect	0.796	-	-	–

Note: T-statistic and p-value derived from consistent PLS-SEM bootstrapping results

4.4 Measurement Invariance of Composite Model (MICOM)

The Measurement Invariance of Composite Models (MICOM) procedure was employed to assess measurement invariance prior to conducting multi-group analysis (MGA) to explore the moderating effect of bank type (HDFC bank sector vs. Uttarakhand Gramin Bank). Developed by Henseler et al. (2016), MICOM addresses the limitations of covariance-based SEM and is specifically designed for PLS-SEM. This three-step procedure ensures that differences in model estimates between groups are attributable to actual differences in path coefficients rather than variations in the meaning of latent variables. The steps involve assessing (1) configural invariance, (2) compositional invariance, and (3) equality of means and variances.

In Step 1, configural invariance was established as all datasets shared identical indicators, variable associations, and algorithm settings across the HDFC bank sector and Uttarakhand Gramin Bank groups. Step 2 assessed compositional invariance using the SmartPLS permutation approach. This step compares the correlation of composite scores between groups with the 5% quantile from the permutation distribution. According to Table 9, compositional invariance was confirmed for all constructs (Behavioural Intention [IT], Attitude [AT], and Security

and Privacy [SP]) because the p-values were greater than 0.05 and the original differences fell within the 95% CIs.

Step 3 evaluated the equality of means and variances. The results (Table 10) indicated that full invariance was not achieved, but partial invariance was established. Specifically, while the original differences for all constructs were within the 95% confidence intervals and the p-values exceeded 0.05, the criteria for full invariance were not met for all constructs simultaneously. However, partial invariance is sufficient for conducting multi-group analysis (Henseler et al., 2016).

The MICOM findings show that the constructs of behavioural intention (IT), attitude (AT), and security and privacy (SP) show partial measurement invariance across the bank type groups (Uttarakhand Garmin Bank and private bank i.e. HDFC bank). Because any observed differences in path coefficients between these groups can be reliably attributed to real moderating effects rather than measurement artefacts, this creates a strong basis for meaningful multi-group analysis. The subsequent analysis of how bank type may differently influence the relationships between security and privacy perceptions, attitudes, and behavioral intentions towards the adoption of green banking depends heavily on the confirmation of partial invariance.

Table 9: MICOM Step 2 (Compositional Invariance)

Construct	Original Difference	Permutation Mean Difference	95% CI	p-value

SP	0.068	0.003	[-0.243, 0.250]	0.609
AT	-0.029	0.006	[-0.255, 0.269]	0.840
IT	-0.147	0.006	[-0.247, 0.266]	0.255

Table 10: MICOM Step 3 (Equality of Means and Variances)

Construct	Original Difference	Permutation Mean Difference	95% CI	p-value
SP	-0.125	-0.003	[-0.426, 0.408]	0.580
AT	0.100	-0.010	[-0.336, 0.331]	0.552
IT	0.067	-0.008	[-0.297, 0.287]	0.671

4.5 Multi-Group Analysis (MGA)

The moderating influence of bank type (HDFC Bank versus Uttarakhand Gramin Bank) on the structural linkages was examined utilising the Smart PLS Multi-Group Analysis (MGA) method. The MGA technique indicates that if the t-value exceeds 1.96 or the p-value is below 0.05, the hypothesis is affirmed. The MGA Test were employed to analyse the results (Cheah et al., 2020).

Table 11 reveals substantial moderating effects of bank type on all proposed pathways. HDFC bank clients exhibited a markedly greater correlation between Security and Privacy (SP) and Attitude (AT) ($\beta = 0.127$) compared to Uttarakhand Gramin Bank customers ($\beta = -0.628$), resulting in a path difference of 0.755 ($p = 0.015$). This finding supports the moderating influence of bank type on the SP→AT link.

Customers of HDFC Bank had a much greater association between Attitude (AT) and Behavioural Intention (IT) ($\beta = 0.101$) compared to those of Uttarakhand Gramin Bank

($\beta = 0.034$), resulting in a route difference of 0.136 ($p = 0.034$). This indicates that the type of bank substantially influences the AT→IT link.

Conversely, clients of Uttarakhand Gramin Bank exhibited a markedly more robust correlation between Security and Privacy (SP) and Behavioural Intention (IT) ($\beta = 0.496$) compared to clients of HDFC Bank ($\beta = 0.303$), resulting in a route difference of -0.193 ($p = 0.027$). This indicates that the SP→IT link is notably influenced by the type of bank, with a more pronounced effect observed in the Gramin Bank situation.

The findings indicate that all structural linkages of the model are considerably influenced by the type of bank. The varied trends suggest that customers of Uttarakhand Gramin Bank and private bank perceive and respond to security and privacy concerns differently when forming attitudes and behavioural intentions towards the implementation of green banking. This underscores the need of considering institutional context when developing security measures and green banking projects.

Hypothesis	Path	HDFC bank (β)	Uttarakhand Gramin bank (β)	Difference	p-value	Decision
H5(a)	SP → AT	0.127	-0.628	0.755	0.015	Significant
H5(b)	AT → IT	0.101	-0.034	0.136	0.034	Significant
H5(c)	SP → IT	0.303	0.496	-0.193	0.027	Significant

Table 11: MGA Results

5. Discussion and Conclusion

5.1 Theoretical Implications

This study examined the moderating effect of bank type (private bank vs. Uttarakhand Gramin Bank) and explored how Security and Privacy (SP) impacted Indian consumers' attitudes (AT) and behavioural intentions (IT)

regarding the adoption of green banking. Our study offers important insights into how security and privacy concerns affect the adoption of green banking in India's changing financial landscape, drawing on the Theory of Planned Behaviour. The structural model revealed that Security and Privacy (SP) significantly influences both Attitude (AT) ($\beta = 0.673$, $p < 0.001$) and Behavioral Intention (IT) ($\beta = 0.372$, $p < 0.001$), while Attitude (AT) strongly predicts Behavioral Intention (IT) ($\beta = 0.630$, $p < 0.001$). These findings collectively support hypotheses H1, H2, and H3.

Additionally, SP accounts for 45.2% of variance in AT, while SP and AT jointly explain 85.0 % of variance in IT, exceeding the minimum threshold (Chin et al., 1998). The mediation analysis revealed that Attitude (AT) partially mediates the relationship between Security and Privacy (SP) and Behavioral Intention (IT) ($\beta = 0.424$, $p < 0.001$), supporting H4. The multigroup analysis (MGA) revealed significant moderating effects of bank type across all structural relationships, supporting H5a, H5b, and H5c. Specifically, SP positively influenced AT for HDFC bank customers ($\beta = 0.127$) but negatively influenced AT for Uttarakhand Gramin Bank customers ($\beta = -0.628$). AT positively influenced IT for private bank customers ($\beta = 0.101$) but negatively influenced IT for Uttarakhand Gramin Bank customers ($\beta = -0.034$). Conversely, SP positively influenced IT for both bank types, with a stronger effect for Uttarakhand Gramin Bank customers ($\beta = 0.496$) compared to private bank customers ($\beta = 0.303$). These differential patterns highlight the importance of institutional context in green banking adoption.

The results of this study significantly enhance academic understanding by introducing Security and Privacy (SP) as a critical antecedent of Attitude (AT) and Behavioral Intention (IT) toward green banking in India, representing a novel contribution to the literature. This research substantially extends the relevance and validity of the Theory of Planned Behavior (TPB) framework in elucidating green banking adoption intentions within India's rapidly developing economy, evidenced by the substantial variance explained (85.0% for IT). Moreover, the study makes significant theoretical advances by examining how bank type moderates the relationships between key constructs, providing empirical evidence that institutional context significantly influences green banking adoption mechanisms. The methodological approach demonstrates the efficacy of PLS-SEM in analyzing complex relationships in green banking research, while the identification of partial mediation effects adds theoretical nuance to understanding consumer decision-making processes. In a broader theoretical context, this study contributes to the emerging literature on sustainable finance in developing economies by demonstrating how security considerations interact with

attitudinal factors to shape green banking adoption, highlighting the need for contextually grounded theoretical models

5.2 Practical Implications

For regulators, banking executives, and legislators looking to increase the uptake of green banking in India, the findings provide important practical insights. The findings show that customer attitudes (AT) and behavioural intentions (IT) regarding green banking are significantly influenced by security and privacy (SP) considerations, offering a clear path for tactical interventions. The study emphasises to banking professionals the importance of making security and privacy features the focal points of green banking initiatives. Banks should create thorough communication plans emphasising the strong security and data protection measures included in their green banking solutions. This is especially important for private bank i.e. HDFC bank because their SP and AT relationship is much stronger ($\beta = 0.127$) than Uttarakhand Gramin Bank's ($\beta = -0.628$). In their green banking marketing materials, private bank i.e. HDFC bank should highlight security certifications, encryption standards, and privacy protections to capitalise on their technological advantages.

However, since SP has a greater direct influence on IT for its clients ($\beta = 0.496$) than private bank i.e. HDFC bank ($\beta = 0.303$), Uttarakhand Gramin Bank ought to give priority to addressing security issues more directly. This implies that when security features are directly connected to behavioural outcomes, Gramin Bank customers react more favourably. It is recommended that banking officials at Gramin institutions conduct customer education workshops on data protection, implement visible security demonstrations, and provide transparent documentation regarding security protocols in their green banking offerings. The study's findings regarding the moderating effects of bank type offer regulators and policymakers important direction. Customers of Uttarakhand Gramin Bank and private bank i.e. HDFC bank responded differently, which suggests that regulatory frameworks should be modified to take into account the particularities of various banking industries. While maintaining uniform security standards, regulators should create sector specific guidelines that take into account the different technological capabilities and customer expectations of different bank types.

To better understand the unique needs, interests, and concerns of various customer segments, banking institutions should carry out focused market research. Banks should create customer segmentation strategies based on security perceptions and attitudinal dispositions, as the study found that AT partially mediates the relationship between SP and IT. This would make it possible to develop tailored green banking solutions that appeal to particular clientele, which would eventually increase adoption rates. To improve the technological and environmental aspects of their services, Indian banking professionals need to broaden their focus beyond conventional security and privacy measures. In order to simultaneously address security concerns and environmental benefits, the study recommends that banks

offer green banking solutions that are valuable, quick, accessible, transparent, convenient, and flexible.

Adopting international sustainability codes and standards should be a top priority for the Indian banking system in order to increase credibility and client trust. Industry leaders must use their power to advance ecologically friendly banking regulations, since consumers currently show little awareness of or preference for green practices. Green banking certification programs, industrywide sustainability benchmarks, and standardised metrics for assessing environmental impact are a few examples of how to do this. To inform consumers about the environmental advantages of green banking practices, banking executives should launch focused awareness campaigns that are adapted to the interests and concerns of various clientele groups. The strong relationship between AT and IT ($\beta = 0.630$) indicates that shaping positive attitudes through effective communication is crucial for driving adoption. Finally, the study recommends that Indian banks develop specialized training programs for staff to effectively communicate the security and environmental benefits of green banking products, creating a consistent message that reinforces the dual benefits of green banking adoption.

5.3 Limitations and Directions for Future Research

This work provides significant theoretical and practical value through its constructed model and analysis approach. However, researchers should consider several limitations when interpreting or extending the results. Firstly, the study was limited to customers of selected banks in Uttarakhand, restricting generalizability. To enhance this, future research should include stakeholders like bankers and managers from all public, private bank, foreign, and regional rural banks across diverse geographical regions. Secondly, the study relied on primary cross-sectional data from consumers. Future research should incorporate both primary and secondary data (such as customer feedback reports) to provide a more comprehensive understanding of green banking in India and establish causal relationships. Thirdly, since the study was conducted in one country, the results may not apply to economies with different customer characteristics. Similar studies in other economic contexts are needed to confirm the findings and enhance theoretical insights.

Additionally, the study focused only on security and privacy factors regarding customer behavior and attitudes, excluding variables like ease of use or social influence. These factors were deliberately excluded to maintain model clarity and avoid respondent confusion during data collection. Since security and privacy and other factors like ease of use are relatively new in the context of green banking, assessing their impact individually will be more beneficial. The sample also showed bias toward students (23.1%) and respondents from Dehradun (14.9%), which may not fully represent the broader banking population. Exploring the influence of age or generational differences on these relationships would also be valuable.

This study outlines future research in green banking, emphasizing the need for focused studies, reliable techniques, and diverse industry validations to improve

understanding and adoption of sustainable practices. Specifically, longitudinal studies on adoption patterns should be conducted to track how security perceptions evolve over time. Cross-regional comparisons between urban and rural settings would reveal contextual variations in green banking adoption. Expanded models integrating ease of use and social influence would provide a more holistic understanding of adoption drivers. Finally, qualitative insights on moderation effects, particularly regarding bank type and demographic factors, would deepen understanding of the underlying mechanisms in green banking adoption.

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