Sustainable Banking through Mobile Technology
A Study on User Preferences and Engagement with Green Banking Services Among Users in Visakhapatnam

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ARTICLE INFO	ABSTRACT
	This study examines the role of mobile technology in promoting sustainable banking practices, focusing on user preferences and engagement with green banking services among 200 respondents in Visakhapatnam. The research employs a structured questionnaire to assess three key dimensions: awareness and adoption of green banking, factors influencing user preferences, and the impact of mobile technology on eco-conscious financial practices. Descriptive and inferential statistical analyses, including mean, standard deviation, ANOVA and correlation, reveal that while users appreciate the environmental benefits and convenience of mobile green banking, gaps persist in awareness and accessibility. The study highlights the importance of user-friendly interfaces, security, rewards, and personalized features in enhancing engagement. Findings suggest that mobile technology significantly facilitates the adoption of green banking, reducing the reliance on traditional methods. Recommendations are provided for banks to align their strategies with user preferences, leveraging technology to foster a sustainable and customer-centric banking ecosystem. **Key Words:** Green Banking, Banking, Awareness, User Preference.

Introduction

Banks have always played a pivotal role in shaping the economic, social, and financial landscapes of nations. As indispensable intermediaries, they facilitate the allocation of capital, ensure liquidity, and promote financial inclusion. Beyond their conventional roles, modern banks are evolving to address the demands of a rapidly transforming global economy. This evolution is characterized not only by the adoption of advanced technologies but also by their growing commitment to sustainability. As global concerns about climate change, environmental degradation, and resource depletion intensify, the banking sector has embraced innovative approaches like green banking to align its operations with environmental goals (Kaur, 2021).

Functions of Banks
The primary functions of banks in India remain largely consistent across various types; however, the specific customer segments and the focus areas of each sector may vary. Below is an overview of the major functions performed by banks in India:
Acceptance of Deposits: Banks serve as safe custodians of public funds, offering deposit facilities such as savings accounts, current accounts, fixed deposits, and recurring deposits.
Demand Withdrawal Facility: Customers are provided the convenience of withdrawing their funds on demand through mechanisms such as ATMs, checks, and online transfers.
Credit and Lending Services: Banks play a critical role in providing loans to individuals, businesses, and industries. These include personal loans, home loans, education loans, and credit for industrial or agricultural purposes.
Fund Transfers: Facilitating seamless transfer of funds, banks provide services such as NEFT, RTGS, UPI, and IMPS to support both domestic and international transactions.

Issuance of Bank Drafts and Instruments: Banks issue financial instruments like demand drafts, pay orders, and bankers' checks to facilitate secure monetary transactions.

Safe Deposit Locker Services: To ensure the safekeeping of valuables, banks provide locker facilities to their customers.

Foreign Exchange Management: Banks authorized for foreign exchange transactions help customers with currency exchange, remittances, and trade-related foreign exchange services.

Utility Services and Support: Beyond traditional banking, banks offer value-added services such as bill payment platforms, investment advisory services, insurance products, and mutual fund distribution.

This comprehensive suite of functions underscores the multifaceted role of banks in meeting the diverse financial needs of individuals, businesses, and the economy at large.

Types of Banks and Their Roles

Banks can be classified into various types based on their functions, ownership, and target customer base. Among these, *commercial banks* are the most prevalent, providing a broad range of services, including deposit mobilization, credit extension, and financial advisory. These institutions cater to individuals, small businesses, and corporations, forming the backbone of economic activity. Central banks, such as the *Reserve Bank of India (RBI)*, oversee monetary policy, regulate credit supply, and maintain financial stability. They play a critical role in ensuring macroeconomic equilibrium and preventing systemic risks (Mishra & Mohanty, 2020).

Cooperative banks, another significant category, primarily serve underserved and rural communities. By pooling resources and operating on a cooperative principle, these banks empower small borrowers, farmers, and artisans, contributing to equitable economic growth. Similarly, *development banks* focus on long-term investments in infrastructure, industrial projects, and public utilities, driving national development objectives. A recent innovation in the banking sector is the emergence of digital-only banks, which operate exclusively online, offering enhanced convenience, reduced costs, and eco-friendly services (Nayak, 2022).

India's banking system is well-structured, with various types of banks serving distinct purposes to meet the financial needs of the population. Below is a detailed explanation of the major types of banks in India, along with examples and references.

Central Bank: The central bank is the apex financial institution that regulates and oversees the monetary and financial system of the country. In India, the Reserve Bank of India (RBI) performs this role. Its functions include controlling inflation, managing currency issuance, regulating banking operations, and ensuring financial stability. The RBI also acts as the lender of last resort for commercial banks and the government (Mishra & Mohanty, 2020).

Examples: Reserve Bank of India (RBI) (India's central bank), Federal Reserve (USA).

Cooperative Banks: These banks are financial institutions owned and operated by their members. These banks primarily serve rural areas by providing affordable credit to farmers, small traders, and artisans. They operate on a principle of mutual assistance and are governed by the Cooperative Societies Act. Cooperative banks are categorized into urban and rural cooperative banks, depending on their operational area (Kaur, 2021).

Examples: Andhra Pradesh State Cooperative Bank (APCOB), Saraswat Cooperative Bank.

Commercial Banks: Commercial banks are the most common type of banks, providing a wide range of financial services such as deposits, loans, and fund transfers. These banks can be classified further into public sector banks, private sector banks, and foreign banks based on ownership. Commercial banks cater to individuals, businesses, and corporations to meet their financial requirements (Sarma & Rao, 2019).

Examples: State Bank of India (public sector), HDFC Bank (private sector).

Regional Rural Banks (RRBs): RRBs were established to promote financial inclusion and economic development in rural areas. They primarily provide credit to small-scale farmers, rural artisans, and agricultural labourers. RRBs operate under the supervision of the RBI and NABARD (National Bank for Agriculture and Rural Development) (Sharma & Singh, 2020).

Examples: Andhra Pradesh Grameena Vikas Bank, Baroda Uttar Pradesh Gramin Bank.

Local Area Banks (LABs): Local Area Banks are small financial institutions that operate within a limited geographical area. These banks aim to mobilize rural savings and provide credit to the local population, including small enterprises and farmers. They play a crucial role in strengthening the local economy (Nayak, 2022).

Examples: Coastal Local Area Bank, Capital Local Area Bank.

Specialised Banks: Specialized banks focus on providing financial services for specific industries or economic activities. They include export-import banks, development banks, and banks for housing finance. These institutions help drive growth in targeted sectors by offering customized financial solutions (Kumar & Reddy, 2021).

Examples: Export-Import Bank of India (EXIM Bank), National Housing Bank (NHB).

Small Finance Banks (SFBs): Small finance banks cater to underserved segments such as micro-enterprises, small businesses, and low-income groups. They are designed to promote financial inclusion by providing banking services to unbanked populations. These banks accept deposits and offer loans similar to commercial banks but focus on priority sectors (Sarma & Rao, 2019).

Examples: Ujjivan Small Finance Bank, AU Small Finance Bank.

Payments Banks: Payments banks are a new category of banks in India, introduced to enhance financial inclusion. They are designed to provide basic banking services such as savings accounts, remittances, and mobile payments. However, they are not allowed to issue loans or credit cards. Payments banks leverage technology to offer cost-effective services to their customers (Sharma & Singh, 2020).
Examples: Paytm Payments Bank, Airtel Payments Bank.

The Indian Banking System

India's banking system, a cornerstone of its financial infrastructure, has evolved over decades to accommodate the diverse needs of its growing economy. It is primarily divided into three categories: Scheduled Commercial Banks (SCBs), Cooperative Banks, and Regional Rural Banks (RRBs). SCBs, which include public sector banks, private sector banks, and foreign banks, dominate the banking landscape by providing a wide array of services, from retail and corporate banking to wealth management. Public sector banks, in particular, account for a significant share of banking activity and serve as instruments of socio-economic development (Sarma & Rao, 2019).

Cooperative banks cater to rural and semi-urban areas, supporting agricultural and small-scale industries. Regional Rural Banks (RRBs) play a complementary role by extending credit to farmers and small enterprises in remote areas. This multi-tiered structure ensures that financial services penetrate every corner of the country. Moreover, India's banking industry has embraced digitalization, with initiatives like the Unified Payments Interface (UPI), Real-Time Gross Settlement (RTGS), and mobile banking apps transforming how banking services are delivered (Sharma & Singh, 2020).

Green Banking: A Paradigm Shift

Key initiatives under green banking include promoting paperless banking through digital platforms, financing renewable energy projects, and adopting energy-efficient technologies in branch operations. Additionally, banks are increasingly introducing green financial products, such as green bonds, to fund projects with positive environmental impacts. These efforts underscore the sector's commitment to balancing profitability with responsibility (Kaur, 2021).

Green banking is a broad term that encompasses practices and strategies designed to ensure sustainability in the economic, environmental, and social dimensions of banking. It involves integrating eco-friendly principles into banking operations, products, services, and infrastructure to reduce the environmental footprint while promoting sustainable development. By adopting green banking practices, financial institutions can make their processes, IT systems, and physical infrastructure more efficient and effective, with minimal or no adverse impact on the environment (Sharma & Singh, 2020).

Considering the inherent environmental impact of banking operations and infrastructure, a structured approach to green banking can be implemented at two key levels: greening processes, products, services, and strategies; and greening infrastructure. These levels provide a comprehensive framework for banks to operate in an environmentally responsible manner while contributing to broader sustainability goals.

Greening Strategies

This dimension focuses on embedding environmental sustainability into the core operations and offerings of banks. By aligning business practices with green principles, banks can significantly reduce their carbon footprint and promote eco-consciousness among stakeholders. The following are some strategies for greening banking processes and products:

Eco-Friendly Operations: Implementing paperless banking through digital solutions such as online transactions, e-statements, and mobile banking apps can reduce paper consumption and waste. Transitioning to digital workflows also improves operational efficiency (Kaur, 2021).

Green Products and Services: Banks can introduce environmentally friendly financial products, such as green loans for renewable energy projects, green bonds, and eco-savings accounts. These products incentivize clients to adopt sustainable practices (Mishra & Mohanty, 2020).

Sustainable Business Strategies: Integrating environmental, social, and governance (ESG) criteria into decision-making processes enables banks to assess the long-term impact of their operations and investments. This includes offering financial support only to projects that meet specific sustainability standards (Nayak, 2022).

Customer Education: Encouraging customers to adopt green banking practices by raising awareness about digital banking services and the benefits of reducing their environmental footprint. This can be achieved through campaigns and educational programs (Kumar & Reddy, 2021).

Greening Infrastructure

This aspect emphasizes the need for banks to modernize their IT and physical infrastructure to make it environmentally sustainable. Greening infrastructure not only helps in reducing energy consumption but also sets a precedent for other industries to follow. The following are key initiatives:

Sustainable IT Infrastructure: Transitioning to energy-efficient IT systems, including data centers and server management, is essential. Cloud computing and virtualization technologies can optimize energy use while maintaining operational efficiency (Sharma & Singh, 2020).

Eco-Friendly Buildings: Constructing or retrofitting bank buildings with sustainable materials and technologies such as solar panels, rainwater harvesting systems, and energy-efficient lighting can significantly reduce the carbon footprint. Green building certifications, such as LEED, can guide this process (Sarma & Rao, 2019).

Renewable Energy Integration: Banks can invest in renewable energy sources to generate electricity for their own consumption. This reduces dependency on conventional energy sources and demonstrates a commitment to sustainability.

Waste Management: Implementing waste reduction and recycling programs within bank premises ensures better resource utilization and reduces environmental degradation.

By adopting these practices, banks can transform themselves into institutions that not only drive economic growth but also contribute positively to environmental sustainability. Green banking practices represent a proactive approach to addressing global environmental challenges while fostering a culture of sustainability within the financial sector (Sharma & Singh, 2020).

Green Processes

To achieve the status of a truly "green bank," every functional unit and activity within a bank must be designed to align with environmentally friendly practices that enhance sustainability. A wide array of opportunities exists for banks to green their operations. Key areas of focus include the following:

Supply Chain Management: Adopting sustainable supply chain practices enables banks to minimize their environmental footprint.

Inventory and Freight Optimization: Implementing techniques to minimize inventory and reduce wasted freight can significantly lower carbon emissions (Nayak, 2022).

Carbon-Footprint-Oriented Network Design: Designing supply chain networks with a focus on reducing carbon emissions is essential for sustainable banking operations (Mishra & Mohanty, 2020).

Enterprise Resource Management (ERM: Effective resource management is critical to reducing waste and optimizing operations.

Paperless Transactions: Facilitating digital workflows eliminates paper-based processes, contributing to environmental conservation (Sharma & Singh, 2020).

Intelligent Device Management: Using advanced techniques to optimize workforce management and device efficiency ensures minimal energy consumption (Kaur, 2021).

Customer Relationship Management (CRM): Customer interactions can be transformed into sustainable processes by leveraging technology.

Electronic Communications: Wherever possible, banks should use electronic methods to interact with customers, reducing the need for paper-based correspondences (Kumar & Reddy, 2021).

Sustainable Engagement: Integrating eco-friendly approaches in CRM fosters stronger customer relationships and aligns with their values of sustainability (Sarma & Rao, 2019).

Sourcing and Procurement: Sustainable sourcing is an essential part of green banking.

Vendor Selection: Banks should prioritize vendors with high sustainability ratings for their products, services, and operational practices (Sharma & Singh, 2020).

Product Life Cycle Management (PLM): Eco-conscious product design and management reduce resource usage and environmental impact.

Sustainable Product Design: Banking products and services should be designed to consume fewer resources and reduce their carbon footprint (Nayak, 2022).

End-of-Life Management: Implementing systems that ensure minimal environmental impact when products reach the end of their lifecycle is crucial for sustainability (Kaur, 2021).

Green Products and Services

Consumer demand for sustainable financial choices has driven banks to develop innovative green products and services. Below are some key options that banks can offer to customers:

Digital and Telephone Banking: Facilitating online and telephone banking services allows customers to conduct most of their transactions anytime, anywhere, significantly reducing the reliance on physical branches and paper-based processes (Mishra & Mohanty, 2020).

Automated Payment Systems: Automatic Payments: Automated bill payment systems eliminate the need for paper checks, envelopes, and postage, reducing waste and resource consumption (Sharma & Singh, 2020).

Paperless Statements and Communication: Electronic Statements: Sending statements, product information, and annual reports digitally minimizes paper usage and contributes to environmental sustainability (Sarma & Rao, 2019).

Green Investment Options: Sustainable Mutual Funds: Banks can offer mutual funds that focus on investing in environmentally conscious companies, encouraging sustainable business practices (Kaur, 2021).

Green Loans: Offering specialized credit lines to homeowners for energy-efficient upgrades, such as solar panels or smart appliances, promotes sustainable living (Sharma & Singh, 2020).

Co-Branded Green Credit Cards: Partnering with environmental charities to offer co-branded credit cards enables customers to contribute to green causes with every purchase. These cards promote environmental awareness while aligning with customer preferences for sustainable choices (Nayak, 2022).

Other Green Banking Activities

Green banking encompasses a variety of initiatives that go beyond basic operations and services, aiming to integrate environmental consciousness into financial systems and create sustainable value. Here are several innovative activities that banks can adopt to promote green banking:

Innovative Financial Solutions: Banks can formulate new financial solutions or redesign existing ones to incorporate environmental perspectives. These may include offering sustainability-linked loans, green bonds, or products tied to environmental performance indicators. Such measures encourage corporates and individuals to adopt sustainable practices (Kaur, 2021).

Concessionary Loans for Eco-Friendly Projects

Eco-Conscious Lending: Providing loans at preferential rates to businesses or individuals undertaking environment-friendly projects is a significant green initiative. Examples include projects using renewable energy sources such as solar and wind power or manufacturers of fuel-efficient vehicles (Mishra & Mohanty, 2020).

Support for SMEs: Banks can support small and medium enterprises engaged in producing green technologies, thereby promoting eco-friendly entrepreneurship.

Green Investment Funds

Green Funds for Customers: Banks can introduce funds specifically designed for environment-friendly projects. These funds allow customers to invest in sustainable initiatives, ranging from renewable energy installations to conservation projects (Nayak, 2022).

Socially Responsible Investment Opportunities: Offering portfolios that focus on ethical and environmentally sustainable investments fosters a culture of responsibility among investors.

Participation in Carbon Credit Business: Banks can play a pivotal role in the carbon credit business, supporting global efforts to combat climate change.

Facilitating Clean Development Mechanisms (CDM): Providing comprehensive services related to carbon credit transactions, such as advisory services and financing for clean energy projects, positions banks as critical players in sustainability (Sharma & Singh, 2020).

Support for Environmental and Community Projects: Banks can align with global and local environmental initiatives through active participation and funding.

Community Cleanups: Supporting projects like waste management drives and pollution control measures at the community level.

National Initiatives: Collaborating on large-scale programs addressing climate change, water conservation, biodiversity protection, and air quality improvement reflects a commitment to long-term sustainability (Kumar & Reddy, 2021).

Strategic Approach to Green Goals

To effectively implement green banking initiatives, banks need to adopt a structured approach by:

Setting Green Goals: Banks must establish short-term and long-term sustainability objectives. These goals could include specific targets such as reducing energy consumption by a certain percentage or achieving carbon neutrality within a defined timeframe.

Developing Green Strategies: A robust strategy encompassing eco-friendly policies, technological adoption, and partnerships with green organizations can guide the greening process.

Phased Execution of Activities: Banks should execute their green initiatives systematically, ensuring they address both immediate environmental concerns and long-term sustainability challenges.

These measures enable banks to transform their operations, aligning profitability with environmental responsibility, and creating a sustainable future for the financial sector.

The Role of Technology in Banking Transformation

Technology has revolutionized the banking sector, making services faster, more accessible, and more efficient. Mobile banking, internet banking, and digital wallets are prime examples of how technology has streamlined banking operations while enhancing customer convenience. In the context of green banking, technology acts as a catalyst for promoting sustainability. Mobile banking apps enable paperless transactions, reducing the need for physical resources such as paper and fuel. Furthermore, advanced analytics and artificial intelligence (AI) are being leveraged to optimize operations, identify sustainable investment opportunities, and enhance customer engagement (Nayak, 2022).

The advent of blockchain technology and fintech innovations has further transformed the banking landscape. Blockchain ensures secure, transparent, and tamper-proof transactions, while fintech solutions provide personalized and eco-friendly banking experiences. For instance, several banks now offer carbon footprint tracking tools integrated into their mobile apps, allowing customers to assess and reduce their environmental impact (Sharma & Singh, 2020).

Green Banking in India: Progress and Challenges

India has made notable strides in adopting green banking practices. Leading banks have launched initiatives to promote environmental sustainability, such as installing solar-powered ATMs, transitioning to energy-

efficient data centers, and financing clean energy projects. The RBI's guidelines on green banking have further encouraged financial institutions to integrate sustainability into their operations (Gupta & Bansal, 2020).

However, challenges persist. Limited awareness among customers, high implementation costs, and technological gaps in rural areas hinder the widespread adoption of green banking. Moreover, balancing environmental goals with profitability remains a concern for many banks. Despite these challenges, the growing emphasis on corporate social responsibility (CSR) and regulatory support provides a conducive environment for the growth of green banking in India (Mishra & Mohanty, 2020).

Review of Literature

Smith and Kumar (2018) underscored the importance of integrating digital technologies into banking operations to foster green banking practices. They argued that mobile-based platforms are instrumental in reducing the environmental footprint of banks by streamlining operations, minimizing paper usage, and enhancing efficiency. Their research highlighted global case studies where banks successfully implemented eco-friendly banking models, thereby aligning their operations with sustainability goals. The authors also pointed out the potential challenges in implementing such systems, particularly in developing nations, where infrastructure and consumer readiness might pose barriers.

Gupta (2019) provided an in-depth analysis of the levels of awareness and adoption of green banking services among urban youth. The study revealed that although the younger population shows an increasing awareness of the environmental benefits of mobile banking, factors such as ease of use, perceived safety, and accessibility significantly influence their decision to adopt these technologies. Gupta emphasized that banks need to invest in user-friendly, secure, and engaging mobile applications to cater to this demographic. The findings also suggested that government and institutional awareness campaigns play a vital role in promoting these technologies.

Choudhary and Reddy (2020) examined the transformative role of mobile technology in promoting environmentally sustainable banking practices, particularly in developing countries. Their research highlighted that mobile banking apps act as catalysts for reducing paper consumption, energy usage, and carbon footprints. The study also explored the broader implications of green banking on environmental conservation, including its role in achieving global sustainability goals. Choudhary and Reddy concluded that mobile technology offers a unique opportunity for banks to align their business objectives with environmental priorities, thereby creating a win-win scenario for both consumers and the planet.

Sharma and Patel (2021) conducted a comprehensive study on customer preferences for green banking technologies, with a specific focus on youth engagement. They found that the younger generation is particularly drawn to digital banking platforms due to their convenience, personalization, and alignment with their environmental values. The study identified a strong correlation between technological innovation and user satisfaction in green banking, emphasizing the need for banks to continuously innovate their digital platforms to retain and attract environmentally conscious users. Sharma and Patel also discussed the significance of social media campaigns in spreading awareness and driving adoption among tech-savvy youth.

Mishra and Verma (2021) explored the dual impact of mobile banking technologies on reducing operational costs and improving sustainability in banking. Their research demonstrated that digital banking initiatives, such as e-statements, online fund transfers, and virtual customer support, significantly reduce resource consumption and waste generation. The authors also highlighted the economic benefits for banks, which include reduced overhead costs and improved efficiency. Mishra and Verma concluded that mobile-based banking solutions serve as a practical and effective approach for achieving financial and environmental sustainability.

Rao and Srinivasan (2022) presented a detailed review of green banking practices in India, focusing on the challenges and opportunities associated with adopting sustainable technologies. Their study revealed that while Indian banks are making strides in green banking, they face obstacles such as high initial costs, lack of consumer awareness, and regulatory hurdles. The authors stressed the importance of collaboration between banks, policymakers, and technology providers to overcome these barriers. Rao and Srinivasan also highlighted successful examples of green banking initiatives in India, such as green loans and carbon credit financing, which demonstrate the potential for scalability and impact.

Das and Nair (2023) investigated the influence of mobile-based banking services on customer satisfaction and environmental sustainability. Their findings indicated that consumers are more likely to adopt green banking services when they perceive these services as secure, reliable, and environmentally beneficial. The study also explored the psychological aspects of consumer behaviour, noting that individuals who value sustainability are more inclined to engage with green banking technologies. Das and Nair emphasized that banks need to focus on trust-building measures, such as robust security protocols and transparent communication, to enhance user adoption and satisfaction.

Objectives of the Study

1) To study the concept of Green Banking.

2) To examine the awareness and adoption of mobile-based green banking services among youth in Visakhapatnam.
3) To analyse user preferences and factors influencing engagement with sustainable banking technologies.
4) To evaluate the impact of mobile technology on promoting environmentally friendly banking practices among young users.

Hypotheses of the Study

H_{o1}:	Awareness and adoption of mobile-based green banking services are significantly high among users in Visakhapatnam.
H_{o2}:	User preferences significantly influence engagement with mobile-based green banking services.

Research Methodology

This study employs an exploratory and descriptive research design to investigate the adoption and engagement of mobile-based green banking services. The design integrates both qualitative insights and quantitative data analysis to provide a comprehensive understanding of user awareness, preferences, and the impact of mobile technology on sustainable banking practices. The quantitative data collected forms the basis for measuring key variables and testing hypotheses, making this approach robust and data-driven.

Area of Study
The research is conducted in Visakhapatnam, a key urban centre in Andhra Pradesh and its proposed capital. The city is a hub for financial activities and technological innovations, providing a suitable environment to assess the adoption and effectiveness of mobile-based green banking services. The focus on Visakhapatnam allows the study to capture insights from a region experiencing rapid digital transformation and growing environmental consciousness.

Sampling Technique
The study uses a convenience sampling technique to select respondents from banking service users in Visakhapatnam. This non-probability sampling method enables the collection of data from participants who are easily accessible and willing to respond, ensuring a diverse representation of users. The sample size for the study is 200 respondents, carefully chosen to provide sufficient data for meaningful statistical analysis.

Data Collection
The study employs both primary and secondary data to gather comprehensive information.
Primary Data: Primary data was collected through a structured questionnaire designed to address three key areas:
➢ Awareness and adoption of mobile-based green banking services.
➢ User preferences and factors influencing engagement with sustainable banking technologies.
➢ The impact of mobile technology on promoting environmentally friendly banking practices.
The questionnaire was distributed to respondents via email and WhatsApp using Google Forms, targeting active users of banking services in Visakhapatnam.
Secondary Data: Secondary data was sourced from relevant academic journals, research papers, books, and reports on green banking and mobile banking technologies to provide contextual and theoretical support for the study.

Data Analysis Techniques
The collected data was analysed using a combination of descriptive and inferential statistical techniques:
Descriptive Statistics: Tools like mean, standard deviation, and percentages were used to summarize and present the data, offering insights into patterns of awareness, preferences, and adoption.
Inferential Statistics: To test hypotheses and compare differences among groups, ANOVA (Analysis of Variance) and correlation was employed. This helped assess the significance of variations in the awareness and engagement levels of different respondent groups, SPSS 27 has been used to analyse the data.
This methodology ensures a systematic approach to exploring and understanding the dynamics of green banking adoption and its relationship with mobile technology in Visakhapatnam.

Reliability Test
The table below presents the reliability and descriptive statistics for the variables analyzed in this study: Awareness, User Preference, and Impact of Mobile Technology. These variables, crucial for evaluating mobile-based green banking services, were assessed using a structured questionnaire. The table includes the number of items per variable, mean scores, range, and Cronbach's alpha values, ensuring a robust understanding of the data's reliability and central tendencies.

Table 1: Reliability Test

Variables	Items	Mean	Range	Cronbach's Coefficient
Awareness	7	3.319	1-5	0.950
User Preference	7	3.320	1-5	0.955
Impact of Mobile Technology	7	3.279	1-5	0.958
Overall Reliability	21	3.306	1-5	0.978

Source: Field Study

The table provides a comprehensive analysis of the study's key variables. The **Awareness** variable, consisting of 7 items, has a mean score of 3.319, indicating a moderately high level of awareness among respondents regarding green banking practices. The reliability for this variable, as measured by Cronbach's alpha, is exceptionally high at 0.950, signifying internal consistency in responses.

For the **User Preference** variable, also measured with 7 items, the mean score is slightly higher at 3.320, reflecting favourable user preferences towards mobile-based green banking services. The Cronbach's coefficient for this variable stand at 0.955, indicating excellent reliability and consistency.

The **Impact of Mobile Technology** variable, with a mean score of 3.279 across 7 items, shows a similar trend, emphasizing the positive influence of mobile technology on sustainable banking practices. The reliability measure for this variable is 0.958, which again confirms the robustness of the collected data.

When considering all 21 items collectively for overall reliability, the mean score is 3.306, indicating a generally favourable perception of mobile-based green banking services among respondents. The overall Cronbach's alpha value is 0.978, suggesting outstanding internal consistency across the entire dataset.

This detailed analysis underscores the reliability and validity of the measures used in the study, supporting the dependability of the findings derived from the data.

Demographic Profile of the Respondents

Table 2 presents the demographic profile of the users who participated in the study. This detailed breakdown provides insights into various demographic characteristics, including gender, age, employment status, educational qualification, family income, family size, and marital status. Understanding these attributes helps contextualize the study's findings and ensures a comprehensive analysis of user preferences and engagement with mobile-based green banking services.

Table 2: *Demographic Profile of the Users*

Demographic Variable		*N*	*Percentage*
Gender			
	Male	90	45
	Female	110	55
Age			
	18-25	146	73
	25-35	42	21
	35-45	12	6
Employment Status			
	Self Employed	19	9.5
	Government Employee	6	3
	Private Employee	18	9
	Student	157	78.5
Educational Qualification			
	12th Class/Diploma	16	8
	Graduate	40	20
	Post Graduate	135	67.5
	PhD	9	4.5
Family income			
	Less than 2 Lakhs	163	81.5
	2-3 Lakhs	13	6.5
	3-5 Lakhs	6	3
	5-10 Lakhs	12	6
	Greater than 10 Lakhs	6	3
Family Size			
	Joint Family	45	22.5
	Individual Family	155	77.5
Marital Status			
	Married	40	20
	Unmarried	160	80

Source: Field Study

The table reveals the demographic diversity of respondents. In terms of gender distribution, females constitute a slight majority at 55%, while males account for 45% of the sample. Age-wise, the majority of respondents (73%) belong to the 18–25 age group, reflecting the prominence of youth engagement in green banking. The 25–35 and 35–45 age groups represent 21% and 6% of the sample, respectively.

When analysing employment status, a significant proportion (78.5%) of respondents are students, followed by self-employed individuals (9.5%), private employees (9%), and government employees (3%). This indicates a predominance of younger, potentially tech-savvy users in the study.

Educational qualifications show that most respondents are highly educated, with 67.5% holding postgraduate degrees. Graduates make up 20%, while 12th class or diploma holders and PhD holders represent 8% and 4.5%, respectively.

In terms of family income, a large majority (81.5%) earn less than ₹2 lakhs annually, suggesting that most respondents come from lower-income backgrounds. The remaining income groups are relatively evenly distributed, with 6.5% earning ₹2–3 lakhs, 6% earning ₹5–10 lakhs, and only 3% earning ₹3–5 lakhs or more than ₹10 lakhs.

Family size data reveals that individual families constitute a significant majority (77.5%), compared to 22.5% who belong to joint families. Additionally, marital status indicates that the majority (80%) of respondents are unmarried, further emphasizing the youthful demographic of the study population.

This detailed demographic profile provides a comprehensive understanding of the study participants, enabling more nuanced interpretations of the data and its implications for green banking services.

Views of the Respondents

Table 3 presents the views of respondents on three critical dimensions related to green banking: awareness and adoption of green banking, user preferences and factors influencing engagement, and the impact of mobile technology on sustainable banking practices. The table outlines the distribution of responses across a Likert scale ranging from "Strongly Disagree" (SDA) to "Strongly Agree" (SA), highlighting the perceptions and attitudes of participants toward mobile-based green banking services.

Table 3: *Views of the Respondents*

Variables		SDA	DA	N	A	SA
Awareness and Adoption	I am aware of the concept of green banking.	21 (10.5)	16 (8.0)	77 (38.5)	67 (33.5)	19 (9.5)
	I understand the environmental benefits of using mobile-based green banking services.	10 (5)	38 (19)	58 (29)	56 (28)	38 (19)
	Mobile apps offered by banks provide adequate features for green banking.	20 (10)	29 (14.5)	69 (34.5)	65 (32.5)	17 (8.5)
	I have adopted mobile banking services for environmental sustainability.	20 (10)	19 (9.5)	68 (34)	47 (23.5)	46 (23)
	Mobile green banking reduces the use of physical resources (e.g., paper, fuel).	12 (6)	33 (16.5)	71 (35.5)	46 (23)	38 (19)
	Mobile green banking contributes to reducing the carbon footprint.	20 (10)	18 (9)	59 (29.5)	63 (31.5)	40 (20)
	Green banking services are easily accessible through mobile platforms.	18 (9.0)	19 (9.5)	76 (38)	54 (27)	33 (16.5)
User Preferences and Factors Influencing	I prefer mobile apps that offer eco-friendly banking services.	18 (9)	10 (5)	74 (37)	79 (39.5)	19 (9.5)
	User-friendly interfaces in mobile apps influence my engagement with green banking.	20 (10)	18 (9)	61 (30.5)	69 (34.5)	32 (16)
	The convenience of mobile green banking services motivates me to use them.	15 (7.5)	30 (15)	65 (32.5)	67 (33.5)	23 (11.5)
	Green banking services meet my financial transaction needs efficiently.	19 (9.5)	20 (10)	63 (31.5)	65 (32.5)	33 (16.5)
	The rewards or incentives for using green banking services increase my engagement.	16 (8)	33 (16.5)	60 (30)	59 (29.5)	32 (16)
	I feel confident in the security of green banking technologies.	16 (8)	19 (9.5)	70 (35)	72 (36)	23 (11.5)
	Personalized features in mobile green banking apps enhance my engagement.	16 (8)	26 (13)	68 (34)	71 (35.5)	19 (9.5)
Impact of Mobile Technology	Mobile technology has made it easier to adopt sustainable banking practices.	19 (9.5)	30 (15)	66 (33)	57 (28)	28 (14)
	Green banking apps encourage me to make eco-conscious financial decisions.	16 (8)	23 (11.5)	74 (37)	48 (24)	39 (19.5)
	The integration of mobile technology promotes environmental sustainability.	19 (9.5)	29 (14.5)	68 (34)	67 (33.5)	17 (8.5)
	Using mobile apps for green banking has reduced my dependence on traditional banking methods.	19 (9.5)	26 (13)	70 (35)	38 (19)	47 (23.5)
	Mobile technology has increased awareness about green banking among youth.	16 (8)	32 (16)	63 (31.5)	55 (27.5)	34 (17)

		19 (9.5)	17 (8.5)	80 (40)	51 (25.5)	33 (16.5)
	Mobile green banking has positively influenced my perception of banks' environmental responsibility.	19 (9.5)	17 (8.5)	80 (40)	51 (25.5)	33 (16.5)
	Green banking apps provide adequate tools to track my environmental impact through financial activities.	15 (7.5)	30 (15)	70 (35)	58 (29)	27 (13.5)

Source: Field Study

The data in Table 3 reveals diverse perspectives on green banking services among respondents. Regarding awareness and adoption, 33.5% of respondents agree that they are aware of green banking concepts, while 29% recognize the environmental benefits of mobile green banking. Notably, 34.5% of respondents find mobile banking apps feature-rich, enhancing their adoption of sustainable banking. A significant portion, 35.5%, agrees that mobile green banking minimizes physical resource usage.

Under user preferences and factors influencing engagement, 39.5% of respondents express a strong preference for eco-friendly banking apps, while 34.5% indicate that user-friendly interfaces play a crucial role in engagement. Security is a key factor, with 36% agreeing that they trust green banking technologies. Additionally, 35.5% of respondents value personalized features in mobile apps.

For the impact of mobile technology, 33% agree that it facilitates the adoption of sustainable practices, while 40% strongly agree that green banking apps positively influence perceptions of banks' environmental responsibility. Similarly, 35% of respondents find mobile apps helpful in tracking their environmental impact, further emphasizing their role in promoting sustainability.

These findings highlight the growing awareness, preference, and influence of mobile technology in fostering engagement with green banking initiatives, underscoring its transformative potential in sustainable banking practices.

Significance of Awareness and Adoption of Green Banking

Table 4 presents the results of the ANOVA analysis conducted to assess the significance of various items related to awareness and adoption of green banking. Each item (A_1 through A_7) represents a different aspect of respondent perceptions, with the F-values and associated significance levels indicating the statistical relevance of these items. The data helps determine whether there are significant differences among groups regarding their awareness and adoption of mobile-based green banking services.

Table 4: *Significance of Awareness and Adaption*

		Sum of Squares	df	Mean Square	F	Sig.
A_1	Between Groups	1.582	1	1.582	1.360	.245
	Within Groups	230.373	198	1.163		
	Total	231.955	199			
A_2	Between Groups	2.765	1	2.765	2.140	.145
	Within Groups	255.855	198	1.292		
	Total	258.620	199			
A_3	Between Groups	7.682	1	7.682	6.618	.011
	Within Groups	229.818	198	1.161		
	Total	237.500	199			
A_4	Between Groups	1.293	1	1.293	.863	.354
	Within Groups	296.707	198	1.499		
	Total	298.000	199			
A_5	Between Groups	7.880	1	7.880	6.241	.013
	Within Groups	249.995	198	1.263		
	Total	257.875	199			
A_6	Between Groups	5.668	1	5.668	4.019	.046
	Within Groups	279.207	198	1.410		
	Total	284.875	199			
A_7	Between Groups	.456	1	.456	.353	.553
	Within Groups	255.419	198	1.290		
	Total	255.875	199			

Source: Field Study

The ANOVA results in Table 4 highlight the significance of various survey items related to awareness and adoption of mobile-based green banking services. For **A_3** (the item related to mobile app features and green banking adoption), the F-value is 6.618, with a significance level of .011, indicating a statistically significant difference among the groups. Similarly, **A_5** (regarding mobile green banking reducing physical resource usage) shows an F-value of 6.241 and a significance level of .013, confirming its statistical significance. **A_6** (the impact of mobile technology on environmental sustainability) also presents a significant F-value of 4.019 and a p-value of .046, signifying a meaningful difference among responses. However, items **A_1**, **A_2**,

A_4, and **A_7** did not exhibit statistical significance, with p-values above the common threshold of .05, suggesting that no significant differences were found for these items.

These findings indicate that while certain aspects of awareness and adoption of green banking (such as features of mobile apps and their environmental impact) are significant in influencing respondents, others may not hold the same importance, requiring further analysis to understand potential variations in perception.

The Null hypothesis has been accepted that there are no significant differences between the gender

Influence of User Preference in Green Banking

Table 5 highlights the correlations among various dimensions of user preferences (UP_1 through UP_7) in adopting green banking services. The table employs Pearson Correlation (PC) coefficients to measure the strength and direction of relationships, with significance levels tested using a two-tailed (2T) approach. The values of N represent the sample size for each correlation pair. This analysis helps understand how different aspects of user preferences are interlinked in influencing the adoption of green banking practices.

Table 5: *Influence of User Preference in Green Banking*

		UP_1	UP_2	UP_3	UP_4	UP_5	UP_6	UP_7
UP_1	PC	1	.704**	.790**	.783**	.796**	.735**	.711**
	S 2T		.000	.000	.000	.000	.000	.000
	N	200	200	200	200	200	200	200
UP_2	PC	.704**	1	.691**	.831**	.746**	.882**	.752**
	S 2T	.000		.000	.000	.000	.000	.000
	N	200	200	200	200	200	200	200
UP_3	PC	.790**	.691**	1	.714**	.757**	.672**	.708**
	S 2T	.000	.000		.000	.000	.000	.000
	N	200	200	200	200	200	200	200
UP_4	PC	.783**	.831**	.714**	1	.783**	.857**	.747**
	S 2T	.000	.000	.000		.000	.000	.000
	N	200	200	200	200	200	200	200
UP_5	PC	.796**	.746**	.757**	.783**	1	.688**	.737**
	S 2T	.000	.000	.000	.000		.000	.000
	N	200	200	200	200	200	200	200
UP_6	PC	.735**	.882**	.672**	.857**	.688**	1	.767**
	S 2T	.000	.000	.000	.000	.000		.000
	N	200	200	200	200	200	200	200
UP_7	PC	.711**	.752**	.708**	.747**	.737**	.767**	1
	S 2T	.000	.000	.000	.000	.000	.000	
	N	200	200	200	200	200	200	200
**. Correlation is significant at the 0.01 level (2-tailed).								

Source: Field Study

Table 5 illustrates the strong interrelationships between user preferences variables (UP_1 through UP_7) in the context of green banking adoption. The Pearson Correlation (PC) coefficients range between .672 and .882, indicating substantial positive correlations among the variables. All correlations are significant at the 0.01 level, as denoted by the S 2T values of .000.

The highest correlation is observed between UP_2 (user-friendly interfaces in mobile apps) and UP_6 (confidence in the security of green banking technologies), with a PC value of .882. This underscores the critical link between secure and user-friendly platforms in fostering engagement.

Significant correlations such as between UP_1 (preference for eco-friendly banking apps) and UP_3 (convenience of services) with PC values of .704 and .790, respectively, reveal the interconnected nature of user preferences for green banking features.

Other notable correlations include UP_4 (efficiency in meeting transaction needs) with UP_5 (rewards and incentives), having a PC value of .783, and UP_7 (personalized features) with UP_6, with a PC value of .767.

These results emphasize the multifaceted dependencies between different aspects of user preferences, suggesting that banks should focus on holistic strategies incorporating user-friendly designs, personalization, rewards, and security to promote green banking adoption.

The null hypothesis has been accepted that User preferences positively influence engagement with mobile-based green banking services.

Suggestions to the Bankers

Based on the insights derived from the study, which highlight the levels of awareness, user preferences, and the impact of mobile technology on green banking adoption, the following suggestions are proposed. These

recommendations aim to address the identified gaps, enhance customer engagement, and promote environmentally sustainable banking practices through innovative and user-centric approaches.

Prioritize User-Friendly Digital Platforms: Banks should develop and enhance mobile applications with intuitive interfaces and seamless navigation to ensure customers can easily access and utilize green banking services. A simplified yet feature-rich user experience fosters customer engagement and satisfaction.

Strengthen Security Measures: Implement advanced security protocols, such as multi-factor authentication and end-to-end encryption, to instil confidence in users about the safety of their financial transactions. Highlighting these security features can help mitigate apprehensions about digital vulnerabilities.

Incentivize Green Banking Practices: Introduce rewards, discounts, or loyalty programs for customers who adopt environmentally sustainable banking methods. For example, offering reduced fees for paperless statements or preferential rates for eco-friendly loans can motivate user participation.

Promote Awareness Campaigns: Conduct targeted awareness initiatives that educate customers on the environmental benefits of green banking. Use digital and traditional media to communicate how mobile banking services contribute to sustainability and reduce carbon footprints.

Integrate Personalized Features: Leverage data analytics to offer tailored services that align with individual customer preferences, such as customized notifications, budget tracking, or carbon footprint calculators. Personalization enhances user engagement and positions green banking as a valuable lifestyle choice.

Collaborate with Sustainability Partners: Forge partnerships with environmental organizations to co-develop programs that promote green banking. Highlight these collaborations through campaigns, showcasing the bank's commitment to environmental stewardship and encouraging customers to align with these values.

By implementing these strategies, banks can not only drive the adoption of green banking services but also position themselves as leaders in sustainable financial practices.

Conclusion

The study comprehensively explored the awareness, user preferences, and the impact of mobile technology on the adoption of green banking services among users in Visakhapatnam. The findings reveal a moderate level of awareness regarding the environmental benefits of green banking, highlighting the need for targeted educational initiatives to bridge this gap. While respondents expressed a preference for user-friendly and secure mobile applications, the study also underscored the influence of convenience, rewards, and personalized features in driving engagement with green banking services.

The study further established that mobile technology has significantly facilitated the adoption of sustainable banking practices, reducing reliance on traditional methods and encouraging eco-conscious financial decisions. Despite this progress, areas such as accessibility, advanced features, and integration of green tools remain avenues for improvement. Statistical analyses, including descriptive and inferential techniques, validated the correlation between user preferences and the effectiveness of green banking initiatives, emphasizing the importance of aligning technology with customer expectations.

Overall, the study concludes that while green banking is gaining traction, a more holistic approach is required to maximize its environmental and operational benefits. Banks should invest in innovative solutions, promote awareness, and ensure the seamless integration of sustainability into their services. By addressing the identified gaps and leveraging technology, banks can not only meet customer needs but also contribute to broader environmental goals. This research provides a foundational framework for policymakers and banking institutions to refine their strategies and foster a sustainable banking ecosystem.

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