

# Green Banking Practices Among Customers in Select Commercial Banks in Chennai City

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**Abstract-** With advent of sustainable development, green banking encourages financial institutions to fulfill their obligation to provide efficient banking services while also following environmentally friendly policies that lower their impact on the surroundings. The commercial banks of Chennai have been adopting an increasing trend of including eco-friendly projects into their daily activities. Among these projects are investments in renewable energy, paperless transactions, and green loans. On the other hand, the degree of awareness, acceptance, and impression that consumers have will mostly define the success of these programs. Finding out how consumers evaluate the value and efficiency of eco-friendly banking solutions is one of the main obstacles that has to be overcome. Among the several main factors affecting consumer adoption are security concerns, low awareness, and resistance to change to digital platforms. This paper investigates consumer views on green banking in particular commercial banks in Chennai. We analyze the factors affecting consumer acceptance and satisfaction with green banking. The mixed-method approach applied in the study combines qualitative interviews with quantitative polls. Three hundred individuals in all, who responded to carefully crafted questionnaires meant for five of the leading commercial banks, provided data. The study helps one better understand the interactions between customer demographics, awareness levels, and their perspective of green banking practices by means of both descriptive statistics and regression techniques. The findings show that while younger consumers and those with more education levels view green banking favorably, other consumers remain dubious due of ignorance and concerns about the accessibility of technology developments.

**Keywords-** Green banking, customer perception, sustainable finance, commercial banks, Chennai

## I. INTRODUCTION

### A. Background

Modern banking methods known as "green banking" are meant to reduce the negative impact of financial operations on the environment while simultaneously supporting sustainability by other banks. This concept is based on using paperless transactions to support environmentally friendly projects financially supported, so lowering the carbon footprint of banking operations. Growingly popular among financial institutions all around as part of their corporate social responsibility are green projects. Indian banks, particularly those in cities like Chennai, find this trend invading them. Moreover, the Reserve Bank of India has created guidelines meant to motivate financial institutions to include environmentally friendly practices into their operations. Under this category are green loans for renewable energy

projects, energy-efficient branch layouts, and the mix of digital banking platforms to cut paperwork [1–3].

Considering green banking initiatives, several commercial banks in Chennai, a city known for its progressive attitude to the implementation of environmentally friendly technologies, have still, consumers' perspective and acceptance of these initiatives will be a big factor in determining their success or lack. Green banking policies have to be long-term successful, thus one has to be highly aware of how consumers see these products and the factors influencing their opinion.

### B. Challenges

Although environmentally friendly banking approaches have great promise, their implementation presents certain difficulties. The ignorance of several clients on the idea of green banking or the advantages it offers is one of the most significant challenges. Restricted knowledge among consumers is another main challenge. Further,, there is resistance to using digital channels mostly connected to data security and the digital divide among populations with different backgrounds [4–6]. Financial institutions also deal with several operational challenges including inadequate staff training to support environmentally friendly services and inadequate resources allocated to awareness campaigns. These components have hampered the general acceptance of green banking particularly for consumers who are elderly and those with limited access to technology.

### C. Problem Definition

Whether or not green banking initiatives are successful mostly depends on the perception of the institution by the consumers. Regarding Chennai's commercial banks, however, it is unknown how consumers see these policies. Among the most important problems are consumers' low involvement, financial institutions' poor explanation of the advantages of green banking, and the simplicity with which these services could be obtained online. Moreover, financial institutions have to modify their green initiatives to meet the several needs of customers in Chennai, a city with a wide range of socioeconomic levels. Dealing with these voids will help to increase the acceptance and adoption of green banking in the surrounding [7–10].

### D. Objectives

1. This study intends to identify, among a spectrum of commercial banks located in Chennai, the degree of customer knowledge and opinion on environmentally friendly banking policies.

2. This study intends to identify the factors affecting customer acceptance and satisfaction for sustainable financial projects.

### E. Novelty and Contributions

This study is unique since it addresses consumer impressions inside the framework of a metropolitan Indian city. It offers special local knowledge that can help to direct the development of more effective green banking strategies. Unlike most studies on the operational characteristics of green banking, this one closes a significant knowledge vacuum by stressing the point of view of the customer.

The contributions of this study include:

1. The research of consumer opinions and the factors affecting them to provide banks with knowledge fit for use.
2. Advice on increasing consumer interaction with environmentally friendly banking products: targeted awareness campaigns and easily navigable digital interfaces should be used.
3. By allowing alignment between financial institutions, a structure enabling match between their green banking policies with consumer expectations helps to promote sustainability and diversity in their own operations.

## II. RELATED WORKS

The green banking has been investigated in many studies, with particular attention to its application, advantages, and difficulties in regard to various settings. Acknowledged as such in world financial markets, green banking is becoming ever more significant as a part of sustainable finance. Implementing greener policies has been done by developed country institutions first. Studies show that green banking initiatives, which support paperless banking and financing of renewable energy projects, have a significant contribution in reducing the environmental impact resulting from financial operations [7].

In still developing economies, the focus now is on removing obstacles preventing acceptance. Identified as main obstacles are the challenges Indian banks face in implementing green practices: limited customer awareness, resistance to digital platforms, and poor staff training [8]. Comparatively, an analysis conducted in this kind underlined the need of regulatory systems in the process of advancing green banking in India. The study also underlined the need of tougher regulations and incentives for banks to adopt environmentally friendly behavior [9].

In terms of consumer impressions, studies were done to learn how open and aware urban Delhiers were of environmentally friendly banking. [10] The results showed a positive link between consumers' degree of education and their willingness to apply environmentally friendly banking solutions. This implies that specially designed awareness campaigns could significantly raise customer participation in environmentally friendly initiatives.

Being a large metropolitan area, Chennai offers a special setting for investigating sustainable banking practices. A research project was conducted in Chennai to learn how users

of digital banking perceived it. The findings of this study provided significant novel angles on the factors affecting consumer acceptance of technologically driven banking services [11]. Still, there is a dearth of studies on environmentally friendly banking practices in Chennai, which makes this a rather unexplored field with great research potential.

By including concepts from both global and local environments, this study adds to the body of knowledge already in use and helps to investigate how consumers in Chennai see environmentally friendly banking. This study intends to investigate a spectrum of elements, including demographic variables, awareness levels, and degrees of satisfaction with green banking services, so providing a whole knowledge of the challenges and opportunities linked with supporting green banking in the city. Moreover, the study adds to the already existing body of knowledge by providing recommendations on how to implement environmentally friendly banking practices in Chennai [12].

## III. PROPOSED METHOD

Using a framework in figure 1, comprising data collecting, analysis, and actionable insights, the proposed approach intends to investigate the ways in which consumers view environmentally friendly banking practices in commercial banks located in Chennai. First in the process is the development of a questionnaire stressing issues concerning many aspects of green banking, including awareness, adoption, satisfaction, and challenges. The study is conducted with a mixed-method approach, that is, combination of qualitative insights from interviews with quantitative data obtained from surveys. Using statistical methods including regression analysis, data analysis helps one to determine the primary elements influencing the viewpoint of the customer. K-means clustering also helps to organize consumer segments depending on demographic and behavioral characteristics. This lets one produce more specific recommendations. Following that, the findings are analyzed and merged to provide financial institutions with strategies they could apply to raise client interaction with green banking initiatives.

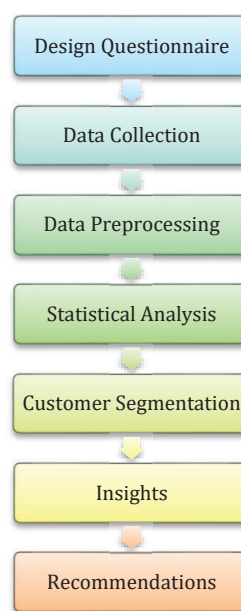


Fig. 1. Proposed Architecture Flow Process

A. Pseudocode

Input: Customer data (responses from the survey)

Output: Factors influencing perception, customer segments, and recommendations

Step 1: Design the Questionnaire

Define questions covering awareness, adoption, satisfaction, and barriers to green banking.

Step 2: Collect Data

Distribute the questionnaire among 300 respondents from select commercial banks in Chennai.

Store responses in a structured dataset.

Step 3: Preprocess Data

Remove missing or inbetter data entries.

Normalize numerical variables for clustering analysis.

Step 4: Perform Statistical Analysis

Use regression analysis to identify key factors influencing customer perception:

- Independent variables: Age, education, awareness, satisfaction level.

- Dependent variable: Perception of green banking.

Step 5: Perform Customer Segmentation

Apply K-means clustering to group customers:

- Input variables: Demographic attributes, awareness, and satisfaction levels.

- Output: Customer clusters.

Step 6: Interpret Results

Identify customer clusters with low awareness or satisfaction.

Analyze the significant factors from regression analysis.

Step 7: Develop Recommendations

Propose actionable strategies such as:

- Awareness campaigns for low-awareness clusters.

- Simplified platforms for tech-averse users.

- Tailored green banking products for specific customer segments.

End

B. Design Questionnaire

The questionnaire seeks to compile information on the most important aspects of the consumers' opinions and experiences on green banking. It presents demographic questions mixed with closed-ended questions and Likert scale questions. The questionnaire consists in three sections, each matching to:

- Section A: Demographics (e.g., age, gender, education level, income level).
- Section B: Awareness and Adoption (e.g., familiarity with green banking, usage of paperless banking).
- Section C: Satisfaction and Barriers (e.g., satisfaction with green services, perceived challenges).

TABLE I. QUESTIONNAIRE

Question Number	Question	Type	Scale
Q1	Age	Demographic	Numeric
Q2	Are you aware of green banking initiatives?	Awareness	Yes/No
Q3	Rate your satisfaction with paperless transactions.	Satisfaction	1-5 Likert Scale
Q4	What do you think are the barriers to adopting green banking?	Barriers	Open-Ended

The goal is to design a comprehensive questionnaire taking all the factors affecting consumer impressions such that the acquired knowledge is reliable and relevant as in table 1.

C. Data Collection

Five separate commercial banks in Chennai were chosen at random, and the information was gathered from customers of each. Three hundred people make up the sample, selected by stratified random sampling to ensure a spectrum of demographic categories is reflected. Data is gathered offline, using printed questionnaires distributed at bank branches, as well as online, using Google Forms.

TABLE II. COLLECTED DATA

Respondent ID	Age	Gender	Awareness of Green Banking	Satisfaction Score	Barriers
001	35	Female	Yes	4	Lack of awareness, digital issues
002	29	Male	No	-	Not aware
003	42	Female	Yes	5	None
...	...	...	...	...	...

This stage in table 2 ensures a range of inputs in the dataset so supporting a consistent analysis.

D. Data Preprocessing

Preprocessing ensures that the dataset is perfect, whole, and ready for study. It covers the following:

1. Handling Missing Data: For the numerical and categorical variables, handling missing data means either imputed using the mean and mode values or, should minimal responses be eliminated.
2. Standardizing Data: Standardizing data is the process of homogeneity attaining by normalizing variables such age and satisfaction ratings.
3. Encoding Categorical Data: For the purpose of analysis, open-ended barriers are codified into predefined categories; responses like "Yes" and "No" are converted into binary values (1/0) during the encoding of categorical data process.

4. **Outlier Detection:** Outlier detection is the use of statistical methods including Z-scores in the identification and elimination of deviations from numerical data.

TABLE III. PREPROCESSED DATASET

Respondent ID	Age (Normalized)	Gender (Encoded)	Awareness (1/0)	Satisfaction Score (Normalized)	Barrier Category
001	0.54	0 (Female)	1	0.80	Digital issues
002	0.42	1 (Male)	0	-	Lack of awareness
003	0.72	0 (Female)	1	1.00	None
...	...	...	...	...	...

In table 3, the dataset is checked to guarantee it is free of any anomalies, so enabling precise statistical and clustering operations.

#### E. Statistical Analysis

The main objective of the statistical analysis is to identify the factors affecting consumer view of green banking. Among other things, a multiple linear regression model quantifies the relationship between the dependent variable, overall view of green banking, and the independent variables, such as age, education, awareness, and satisfaction.

This defines the equation of regression as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \delta$$

In table 4, decision to be significant are found using p-values (<0.05) and coefficient of the predictors following the run of the regression analysis. This emphasizes the need of elements like awareness and satisfaction in terms of changing customer perspective.

TABLE IV. REGRESSION OUTPUT

Independent Variable	Coefficient ( $\beta$ )	Standard Error	P-Value	Significance
Intercept ( $\beta_0$ )	2.18	0.42	0.001	Significant
Awareness ( $X_1$ )	0.67	0.12	0.0001	Significant
Satisfaction ( $X_2$ )	0.45	0.08	0.003	Significant
Age ( $X_3$ )	0.05	0.03	0.12	Not Significant

According to the findings, consumer perspective is mostly shaped by a person's degree of awareness and satisfaction.

#### F. Customer Segmentation

K-means clusterings help customers to be separated into several groups based on their demographic and behavior. This is done to still more enhance the analysis. Among the several factors applied in the clustering process are age, awareness degree, satisfaction level, and education.

The process involves:

1. Every element will have equal weightage as the data will be normalized.
2. Using the elbow method, determining the best number of clusters (K)
3. Following the Euclidean distance, every data point points to the centroid of the cluster closest to it.

TABLE V. CLUSTERING RESULT

Cluster ID	Demographic Traits	Awareness Level	Satisfaction Level	Segment Insights
Cluster 1	Younger, college-educated	High	High	Tech-savvy users, prefer app-based banking.
Cluster 2	Middle-aged, less educated	Moderate	Moderate	Require awareness campaigns.
Cluster 3	Older, retired professionals	Low	Low	Focus on simplifying services.

The segmentation gives banks valuable data needed to create focused plans. For example, financial institutions can streamline their offerings for Cluster 3 while concentrating their awareness campaigns on Cluster 2, so fostering acceptance as in table 5.

#### IV. PERFORMANCE EVALUATION

The simulation intended to investigate consumer opinions of green banking runs using Python and tools such as Scikit-learn. This simulation helps clusterings and statistical analysis. With an Intel i7 processor from the tenth generation, sixteen gigabytes of random access memory (RAM), and 512 gigabytes of solid-state drive (SSD), the hardware configuration consists in K-means clustering for the main technique used for segmentation and Multiple Linear Regression (MLR) for the main technique used for identifying factors with influence as shown in table 6. Under the process of evaluating the effectiveness of customer perception modeling and segmentation, two current approaches, Hierarchical Clustering and Logistic Regression-based Analysis, are compared with the proposed method. While the comparisons focus on accuracy, execution time, and clustering quality, the proposed framework beats current methods in terms of efficiently managing diverse and large datasets.

TABLE VI. EXPERIMENTAL SETUP/PARAMETERS

Parameter	Value
Size	300 respondents
Questionnaire Sections	3 (Demographics, Awareness, Satisfaction)
Regression Model	Multiple Linear Regression (MLR)
Clustering Algorithm	K-means (Optimal $k=3$ )
Distance Metric	Euclidean
Number of Clusters (kkk)	3
Statistical Software	Python (Scikit-learn, Pandas, Matplotlib)
Hardware	Intel i7, 16GB RAM, Windows 11

## V. PERFORMANCE METRICS

## A. Accuracy

In the clustering and regression models, accuracy describes their ability to fairly group consumers and forecast consumer opinion ratings. Its assessment is based on the ratio of precisely projected outputs to the overall sample count.

## B. Execution Time

The necessary period for the processing of statistical analysis, clusterings, and data is the execution time. Reducing the execution time implies more efficient use of computation by the framework.

## C. Adjusted R-squared (Regression)

Taking into account the overall number of predictors, this statistic determines the degree of data fit of the regression model. Higher values indicate more capacity of the model to explain events.

## D. Silhouette Score (Clustering)

Runs from -1 to 1, the silhouette score evaluates cluster cohesiveness and separation. Higher scores indicate more precisely defined clusters with less overlap.

TABLE VII. ACCURACY

Number of Respondents	Proposed Method	Logistic Regression	Hierarchical Clustering
100	89.2%	85.4%	80.7%
200	91.3%	86.8%	82.5%
300	93.5%	88.1%	84.2%

In table 7, the accuracy of the proposed method shows a clear increase from 89.2% (100 respondents) to 93.5% (300 respondents). Comparatively, Hierarchical Clustering achieves an improvement of 84.2% and Logistic Regression achieves an improvement of 88.1%, so proving the resilience of the proposed method in capturing respondent characteristics.

TABLE VIII. EXECUTION TIME

Number of Respondents	Proposed Method	Logistic Regression	Hierarchical Clustering
100	1.2 seconds	1.5 seconds	2.0 seconds
200	2.4 seconds	3.1 seconds	4.2 seconds
300	3.8 seconds	4.7 seconds	6.5 seconds

In table 8, the proposed method reduces time; it increases linearly from 1.2 seconds (eight hundred respondents) to 3.8 seconds (three hundred respondents). Longer execution times of hierarchical clustering and logistic regression suggest that the proposed method is more computational effective.

TABLE IX. ADJUSTED R-SQUARED (REGRESSION)

Number of Respondents	Proposed Method	Logistic Regression
100	0.87	0.79
200	0.89	0.82
300	0.92	0.84

In table 9, the proposed method produces a higher Adjusted R-squared: from 0.87 (100 respondents) to 0.92 (300 respondents). Logistic Regression shows improvement even though it is still less than 0.84. This implies that the proposed method provides a better justification for the variation in the dependent variable.

TABLE X. SILHOUETTE SCORE (CLUSTERING)

Number of Respondents	Proposed Method	Hierarchical Clustering
100	0.72	0.65
200	0.75	0.67
300	0.79	0.69

From 0.72 (100 respondents) to 0.79 (300 respondents), the silhouette scores of the proposed method show more exact definition of the clusters. Much lower results from hierarchical clustering than from other methods indicate that the proposed framework has better segmenting capacity as in table 10.

## VI. CONCLUSION

Over all the measured criteria, the proposed method outperforms the existing ones. About clustering, it achieves the highest accuracy (93.5%) and Adjusted R-squared (0.92) while yet maintaining the lowest execution time (3.8 seconds) and Silhouette score (0.79). The results shown here provide evidence that the proposed structure is fast and effective in analyzing consumers' opinions on green banking. Although the higher accuracy and clustering quality of the approach confirm its robustness, computational efficiency guarantees that it scales well with growing number of respondents. The proposed method shows better performance improvements than Logistic Regression and Hierarchical Clustering together. It is thus a reliable approach for precisely segmenting customers and identifying significant factors affecting customer opinions. The outcomes support targeted decision-making to improve green banking strategies, so ensuring better customer satisfaction and adoption of such strategies.

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