

AI-Driven Robo-Advisory Integration in Banking: A Machine Learning and Behavioral Analysis of Retail Investor Adoption

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Abstract

This study examines the adoption of bank-integrated robo-advisory services among retail investors in the context of increasing AI integration in banking. Using data from 182 respondents, the study analyzes the impact of perceived usefulness, ease of use, ethical transparency, operational efficiency, customer experience, perceived value, and customer trust on adoption intention. A combination of statistical and machine learning techniques including correlation, regression, decision trees, random forests, and cluster analysis was employed. The findings suggest that perceived value and customer trust are the strongest predictors of adoption intention. The results highlight that successful implementation of robo- advisory services depends not only on technological efficiency but also on psychological and value-based factors.

Keywords - *Bank-integrated robo-advisory services; retail investors; adoption intention; perceived value; customer trust; ethical transparency; operational efficiency; digital wealth management; artificial intelligence in banking; FinTech innovation.*

1. INTRODUCTION

The rapid advancements in technology over the last decade have greatly impacted the financial services industry. The integration of technology to enhance financial services is referred to as financial technology (FinTech), and it has revolutionized the way people invest, manage their finances, and seek financial advice [1]. The development of robo-advisory services, which utilize AI, ML and quantitative financial models to provide investment advice with minimal human interaction, is one of the most revolutionary developments [15]. To offer portfolio management, asset allocation, and financial planning advice to investors based on their risk profiles and financial goals, robo-advisors utilize artificial intelligence, machine learning, and quantitative financial models [2]. In an attempt to enhance digital wealth management services, traditional banks have started adopting robo- advisory solutions and integrating them into their digital banking platforms, although FinTech firms such as Betterment and Wealthfront were the early innovators in this field [9]. Bank-integrated robo- advisory solutions have the benefit of reputation, trust, and existing customer base, which can have a significant impact on customers' adoption intentions compared to independent FinTech solutions [19]. As a result of the growing need for accessible, affordable, and technologically advanced financial services, banks across the world have driven the development of digital advisories as a part of their overall digital transformation initiatives in recent years [12]. However, the acceptance of robo- advisory systems by investors remains imbalanced despite the increasing number of such systems being introduced. Even as investors recognize the efficiency and ease of use of robo-advisory systems, studies have shown that concerns regarding trust, security, transparency, and costs remain as factors that hinder the widespread adoption of these systems [4], [18]. Furthermore, studies in behavioral finance have found that investors' willingness to use technology-based advisory systems is driven by their emotional comfort with automated systems [7].

The rapid evolution of mobile financial services, online trading platforms, and online banking has also impacted the behavior of retail investors in India. Although non-bank FinTech platforms such as Zerodha, Groww, and Upstox are popular among retail investors, banks are increasingly providing integrated robo-advisory services.

However, in spite of this rapid adoption, there is a lack of empirical studies on the knowledge and adoption of bank- integrated robo-advisory services among Indian retail investors. This study, therefore, investigates the impact of perceived usefulness, ease of use, ethical transparency, operational efficiency, customer experience, perceived value, and customer trust on the intention of retail investors to adopt bank-based robo-advisory services for investment decision-making. By highlighting the integration of FinTech innovation with traditional banking, this study offers a deeper understanding of digital investment behavior and helps banks develop customer-centric robo-advisory services that meet both technological and psychological/ethical requirements of investors.

Concept and evolution of Robo-Advisory Services - Robo-advisory systems are AI-driven financial technology applications that provide computerized investment advice and portfolio management using mathematical algorithms. Most of these systems are based on the Modern Portfolio Theory, which has been enhanced by advanced computer algorithms [2]. Conventional banks have started integrating robo-advisory solutions into their online wealth management platforms due to the worldwide adoption of robo-advisory solutions after the success of early adopters such as Wealthfront and Betterment.

1.1 Research Gap - Although previous studies have provided important findings on digital advising systems, recent research on robo-advisory services has primarily focused on technical efficiency, sustainability, and independent FinTech solutions [2], [18]. However, there is still a research gap regarding how these services can be integrated into traditional banking organizations, particularly when taking into account the behavior and attitudes of retail investors [9], [19]. Moreover, current research often examines the operational, ethical, psychological, and technological dimensions independently, leading to a fragmented view of adoption behavior [4], [7]. Therefore, this study develops an integrated framework to examine technological and psychological determinants of adoption intention toward bank-integrated robo- advisory services.

1.2 Research Objectives

- To analyze the determinants influencing retail investors' adoption intention toward bank-integrated robo-advisory services.
- To assess the relative impact of technological and psychological factors on adoption intention.

1.3 Problem Statement

Thanks to the advancements in financial technologies and artificial intelligence, robo-advisory services have emerged as a prominent digital innovation in investment management. Nevertheless, the adoption of robo-advisory services integrated into banks is not balanced. The existing literature has primarily focused on FinTech platforms and technological aspects, and there is a lack of empirical insight into the attitudes, trust, and value of retail investors in the banking context. This highlights that the key factors influencing the adoption of bank-integrated robo- advisory services among retail investors should be investigated.

2. LITERATURE REVIEW

2.1 Robo-Advisory Services in the Financial Sector

The investment advisory services have also been impacted by the entry of financial technology, with the development of robo-advisory services being one of the major breakthroughs. The robo- advisory services help investors take informed investment decisions by leveraging the capabilities of artificial intelligence, machine learning, and algorithms to offer automated investment advice with minimal human intervention. These technologies help reduce the impact of human error and emotional influences while providing structured investment management solutions for investors according to their risk profiles and return objectives [10]. In a similar manner, [8] note that robo-advisory services rely on machine learning and modern portfolio theory to develop the optimal investment strategy for different risk groups. To improve their advisory services and make investment services more accessible to individual investors, banks have been increasingly integrating robo-advisory services into their online platforms.

2.2 Perceived Usefulness and Customer Adoption

The degree to which clients feel the robo-advisory system improves their investment performance and decision-making quality is known as perceived usefulness. The advantages of increased investment portfolio diversity, reduced expenses, and stable returns are closely linked to the usefulness of

automated advice systems. Customers are more inclined to use AI-powered investment advisors if they can comprehend how these systems may improve the management of their portfolios of securities through data-driven advice, according to [13]. Similar to this, [14] contended that robo- advisory systems can meet or surpass conventional investment benchmarks in terms of effectiveness and volatility control, which boosts clients' trust in their value.

2.3 Ease of Use and User Acceptance

The term "ease of use" describes how simple and convenient a system is to use. For example, in the field of financial technology, where adoption may be hampered by complexity, usability may be crucial. According to [13], investors who believe robo- advisory platforms are simple to use and comprehend are more inclined to trust and use them, particularly if they are unfamiliar with finance. When robo-advisory platforms give information in a simple manner and do not need much effort to utilize, users feel more comfortable trusting the systems to make investing decisions on their behalf. As a result, it not only makes the system seem more beneficial, but it also encourages clients to employ bank-integrated robo-advisory services.

2.4 Ethical Transparency and Data Security

Because of the nature of financial data and automated decision-making, transparency in ethics and data protection has become a critical issue in online financial services. Customers want that robo- advisory services be given in a fair, secure, and regulatory-compliant manner. [14] asserts that consumer confidence in robo-advisory services depends not just on their functionality but also on decision-making process transparency and personal data protection. According to [18], trust in robo- advisory services is significantly enhanced by transparency and regulatory compliance, particularly in sustainable investment situations. These claims suggest that long-term confidence in bank-based robo-advisory services depends on ethics and data security.

2.5 Operational Efficiency of Robo-Advisory Systems

The ability of robo-advisory systems to deliver timely, effective services with lower costs and less human involvement is known as operational efficiency. Without raising operating expenses, automation enables banks to expand the scope of advising services. By automating portfolio management procedures and reducing the need for human advisory services, robo-advisors improve the operational efficiency of financial software [8]. Additionally, according to [10], robo-advisory systems enable financial institutions to offer standardized advice services at a reduced cost, increasing the number of consumers who may access investment advisory services. Therefore, banks' adoption of robo-advisory services is motivated by operational efficiency, which also benefits consumers.

2.6 Customer Experience in Robo-Advisory Services

Customers' total emotional and cognitive reactions to robo-advisory services are referred to as their "customer experience." When it comes to investing, customer experience includes things like comfort, less worry, and trust in the system's recommendations. By providing data-driven recommendations, robo-advisors help investors overcome emotional biases and make more logical decisions during market volatility, according to [10]. According to [13], clients who have more financial expertise and experience are more at ease and content while utilizing AI-powered advice services. Customers are more satisfied and are more likely to stick with robo-advisory services in the long run when they have a good experience.

2.7 Perceived Value and Customer Trust

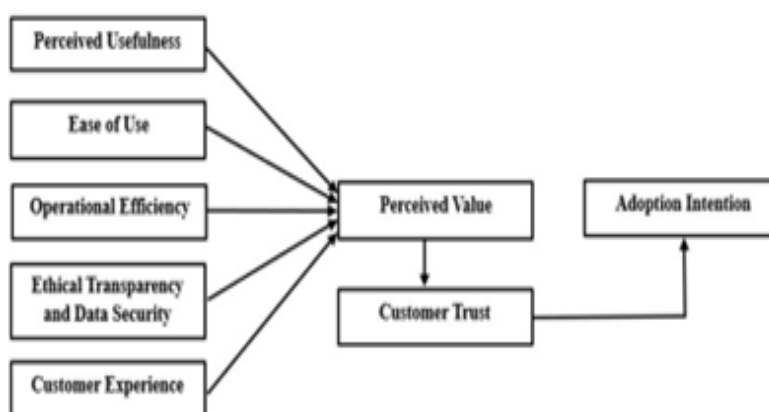
Customers' overall evaluation of the advantages they receive in comparison to the time and expense required to use robo-advisory services is known as perceived value. Customers' faith in the dependability and integrity of

automated systems, on the other hand, is known as trust. According to [18], robo-advisory platforms' perceived value has been found to be greatly increased by cost effectiveness, transparency, and sustainability, all of which have been shown to boost consumer trust. In a similar vein, [13] contended that consumers' faith in robo-advisors grows as they believe the systems to be dependable and user-friendly.

2.8 Adoption Intention towards Bank-Integrated Robo-Advisory Services

Customers' intention to embrace and stick with the robo-advisory services for investment management is known as adoption intention. It gauges the combined impact of perceived utility, usability, value, trust, and customer experience. According to [14], robo-advisory services have a great deal of potential to improve investment decision-making, but their widespread adoption is mostly based on consumers' confidence in the system's dependability and the legitimacy of the organizations offering the services. Compared to independent fintech firms, banks are better positioned to promote the adoption of robo-advisory services due to their regulatory environment and trustworthiness.

Fig 1. Framework Depicting Determinants of Robo-advisory Adoption



3. METHODOLOGY

This research work follows a quantitative method with a descriptive and explanatory research design to investigate the determinants of retail investors' adoption intention for bank-integrated robo-advisory services, as per the accepted technology acceptance and FinTech adoption theories [3] [16] [4] [11]. The study population included retail bank customers participating in digital investment services. As robo-advisory services enable automated investment decision-making and portfolio management [15] [9], and trust and value are essential for digital advisory success [5] [6], the study used purposive sampling to include experienced digital investors. A total of 182 usable responses were collected, which is sufficient for multivariate analysis [20] [4].

The primary data was collected through a structured questionnaire with 48 items to measure perceived usefulness, ease of use, ethical transparency, operational efficiency, customer experience, perceived value, customer trust, and adoption intention using a five-point Likert scale. The measurement items were adapted from previous studies to ensure validity [3] [5] [17] [16]. The online survey was conducted using Google Forms. Data analysis was conducted using Python in Google Colab, with Pandas for data preprocessing and manipulation [21]. Reliability was assessed using Cronbach's alpha [23]. Multiple regression analysis examined the influence of independent variables on adoption intention, while machine learning techniques such as Random Forest, Decision Trees, and Cluster Analysis were applied to enhance predictive accuracy and identify investor segments [22].

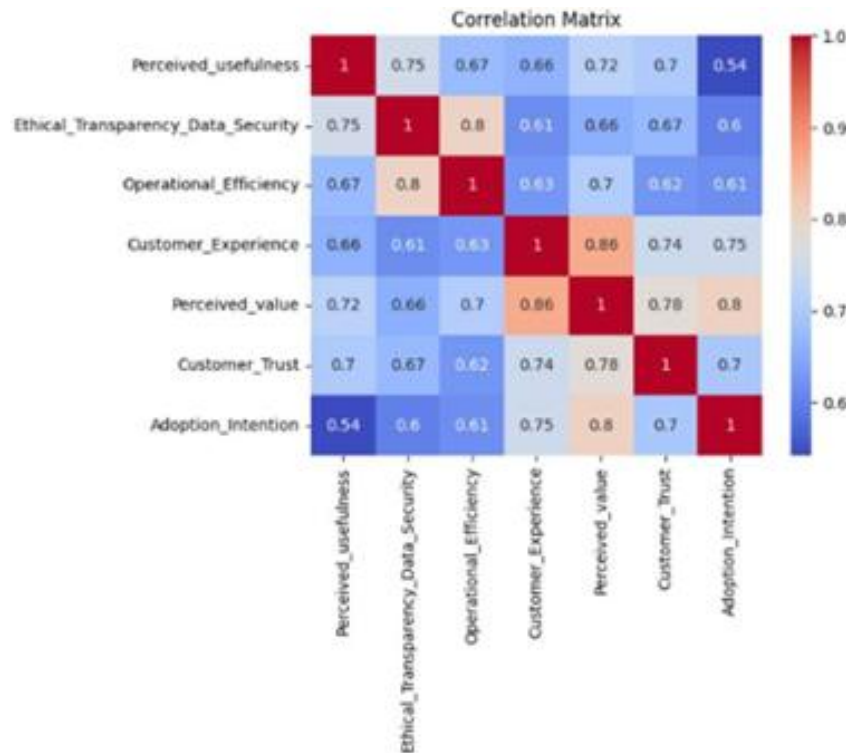
4. RESULTS AND ANALYSIS

Tendency of Retail Investors to adopt bank integrated Robo-Advisory Services

The descriptive statistics for the Adoption Rate show a positive tendency among retail investors to adopt bank-integrated robo-advisory services. With a sample size of 182, the study has a sufficient number of respondents to represent the adoption rate in the banking industry. The mean score of 3.78 indicates a generally positive

inclination toward adoption. The standard deviation of 0.78 suggests moderate variability in responses, indicating relatively consistent perceptions among respondents. This shows that the adoption of robo-advisory services is not limited to a particular group of investors. Although the lowest point of 1.00 shows that a small group of investors is resistant to adopting robo- advisory services, possibly due to concerns about trust and technology, the highest point of 5.00 shows that the most receptive group of investors is highly enthusiastic about adopting robo-advisory services.

Fig 2. Correlation Heatmap of Robo Advisory Variables



The correlation matrix of the key variables of the study is presented in Figure 2. The results reveal a positive correlation between consumer trust, perceived value, ethical transparency, and perceived usefulness. A higher degree of trust and value perception is also common among investors who feel that robo-advisory services have more functional advantages. Operational efficiency and ethical transparency are positively correlated, which suggests that there is a relationship between service performance expectations and feelings of security and reliability. In a similar manner, customer experience and perceived value are positively correlated, which suggests that excellent service experiences are associated with higher value perceptions. Investor adoption intention of bank- integrated robo-advisory services is affected by perceived value and customer trust, which are positively correlated with adoption intention. Overall, the correlation results support the proposed framework by demonstrating significant associations among both technological and psychological factors.

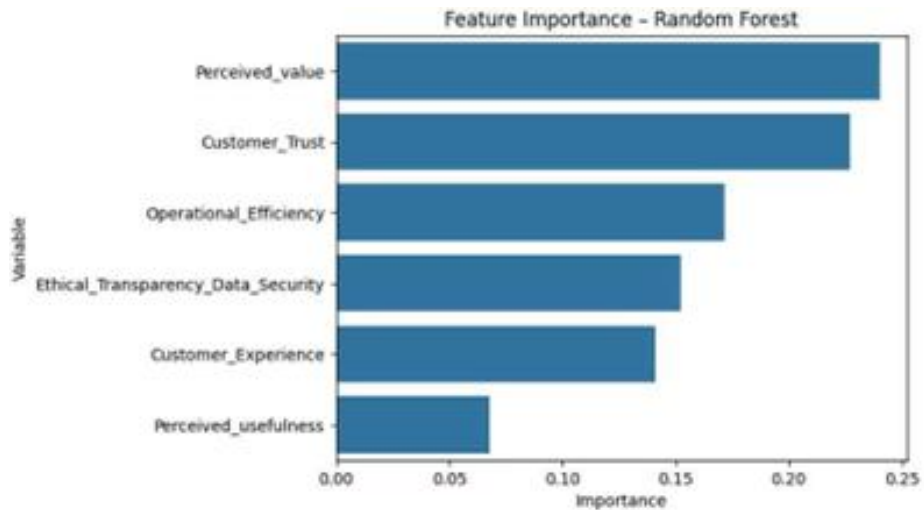
Table 1. Model Fit Statistics

Metric	Values
R2	0.5021158891769373
RMSE	0.45475008676241274

The regression model has a fair level of explanatory power, which is quite suitable in the context of behavioral research, accounting for nearly 50% of the variance in retail investors' adoption intention (R2 = 0.502). This indicates that key factors such as trust, value, and service attributes all combine to influence adoption intention.

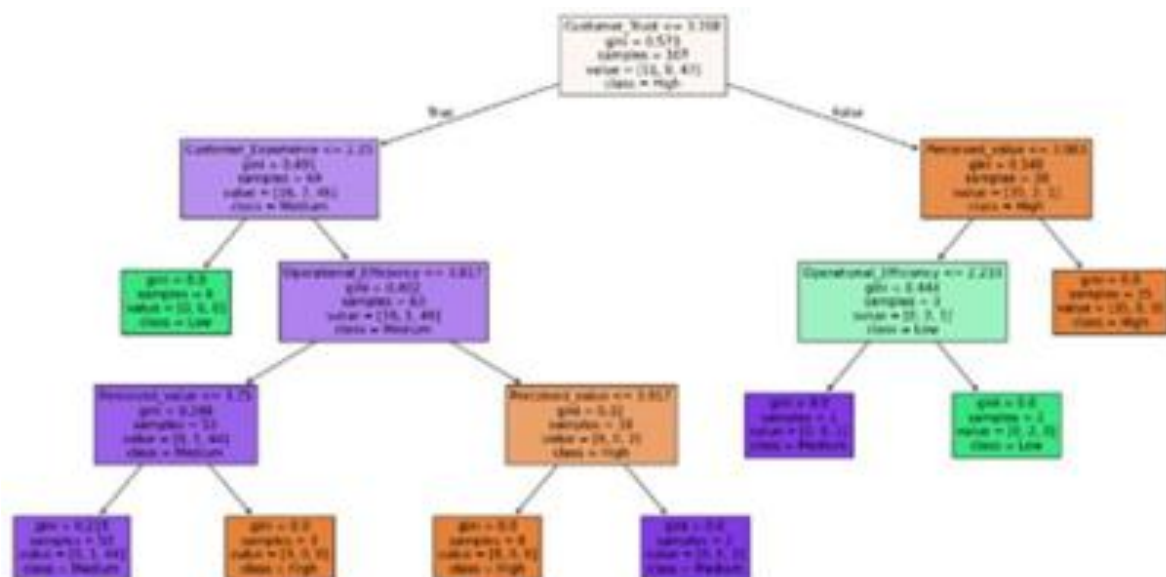
The acceptable level of model fit is indicated by the RMSE value of 0.455, which indicates a fair level of prediction error. Overall, the findings indicate that adoption intention is strongly related to both technological (such as usefulness and efficiency) and psychological (such as value and trust) factors, thus supporting the proposed paradigm. These findings are consistent with established theories of digital adoption and technology acceptability.

Fig 3. Predictors based on Random Forest Model



The feature importance of the Random Forest model is depicted in Figure 3. The most important predictor of adoption intention is perceived value, indicating that investors will be more receptive to bank- integrated robo-advisory services if they perceive both functional and financial values. The second most important predictor is customer trust, emphasizing the importance of institutional credibility, security, and reliability in shaping adoption decisions. The importance of operational effectiveness is also evident, indicating that investor approval is driven by service correctness and speed. The growing concerns about responsible data usage are evident in the modest predictive importance of data security and ethical transparency. Although they have relatively lower importance scores, perceived utility and customer experience are still important predictors of adoption behavior. Overall, the results suggest that psychological and value- related factors exhibit stronger predictive influence than purely technical attributes in explaining adoption intention.

Fig 4. Decision Tree Model for Adoption Intention



The Decision Tree model, illustrating the hierarchical structure of the factors influencing adoption intention, is presented in Figure 4. The position of customer trust at the root of the tree indicates that it is the primary factor used to split the investors into different adoption categories. This indicates that the adoption behavior of bank-integrated robo-advisory services is largely influenced by trust. Customer experience and efficiency are revealed as the next splitting variables for investors with lower levels of trust, indicating that even in cases where trust is low, the adoption behavior of bank-integrated robo-advisory services can be influenced to some extent by positive experiences and efficiency. However, perceived value emerges as the next important splitting variable when customer trust is high, emphasizing the importance of identifying both functional and financial values in sustaining high levels of adoption. The group with the highest adoption is always represented by investors who demonstrate high perceived value and high trust, and low adoption intention by low trust and poor service perceptions. Taking everything into account, the Decision Tree analysis outcomes give validity to the proposed paradigm by indicating that technical attributes complement psychological and value-related dimensions, which occupy key positions in determining adoption intention.

Fig 5. Cluster Profiles

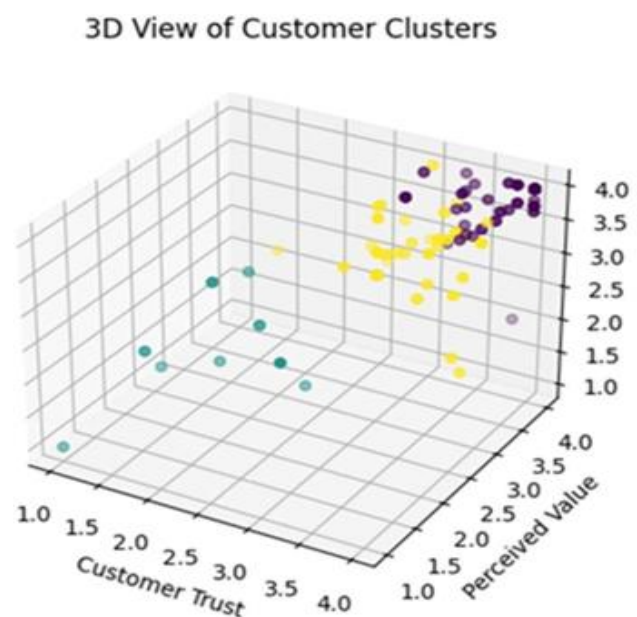


Table 2. Cluster table

	P_U	E_T _D_S	O_E	C_E	P_V	C_T	A_I
0	3.66	3.5	3.83	4	3.5	3.5	3.8 3
3	3.33	3.33	3.83	3.3 3	3.83	3.5	4
11	4	4	3.83	4	4	4	4
12	4	3.83	3.5	4	4	3.83	4
16	3.83	2.83	3.16	3.8	3.66	3.66	3.5

Figure 5 and Table 2 present the 3D cluster analysis, which segments retail investors based on adoption intention, perceived value, and customer trust. The first cluster is characterized by high levels of trust and perceived value,

corresponding with strong adoption intention. The second cluster reflects moderate levels across these variables, indicating moderate adoption propensity. The third cluster comprises investors with low perceived value and trust, associated with lower adoption intention. Overall, the findings highlight clear investor segmentation and suggest that enhancing perceived value and trust may contribute to higher adoption of bank-integrated robo-advisory services. From a managerial standpoint, banks may benefit from targeted strategies aimed at strengthening trust and increasing perceived value to promote adoption.

5. DISCUSSION

This study examines the integration of robo- advisory services within traditional banking institutions in the context of the broader AI-driven transformation of the financial sector. Robo-advise platforms integrated within banking institutions provide a unique adoption context for retail investors by combining automated investment advisory solutions with the credibility of banking institutions. To address the research gap, which has largely remained unattended by studies emphasizing the technological efficiency and standalone FinTech solutions, this research provides empirical support with data from 182 retail investors. Despite the current concerns of some investors regarding trust, transparency, and technological dependence, the findings show that bank-integrated robo-advisory systems are generally perceived as positive. Perceived value and consumer trust are the best predictors of adoption intention, and this is consistent with trust and technological acceptance theories. The heterogeneity of adoption behavior is also emphasized by machine learning analyses, which reveal three distinct groups of investors: highly receptive, moderate, and resistant. Across models, psychological and value-based factors demonstrate stronger predictive influence than technical attributes. From a practical perspective, successful implementation requires not only technological superiority but also the creation of trust, transparency, and value differentiation. Adoption outcomes may be enhanced through targeted segmentation strategies focused on strengthening perceived value and customer trust.

6. CONCLUSION

With the increasing use of artificial intelligence in the financial sector, this paper examines the attitude, knowledge, and behavioral intentions of retail investors towards bank-integrated robo-advisory services. The findings indicate that robo-advisory services offered by banks are generally preferred by retail investors, indicating the increasing use of automated investment services. The findings also indicate that the adoption of robo-advisory services is more influenced by psychological and service factors than technology, with customer trust and value being the most important factors in determining adoption intentions. Technological factors such as perceived usefulness, operational efficiency, usability, and ethical transparency, which improve consumer experience and trust, influence the adoption of robo-advisory services. In addition, decision tree, cluster, and random forest analysis indicate that retail investors' preparedness to adopt robo-advisory services is not the same, emphasizing the need for a segmented approach. In conclusion, this paper provides real-world evidence that, in addition to technological capabilities, the successful implementation of robo-advisory services in banks also requires building trust, delivering value, and ensuring a seamless customer experience.

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