Sustainable AI in Robo-Advisory Platforms: Opportunities and Challenges in the Digital Finance Era

Manish Handa [redacted]

University Canada West

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Supervisor: Dr. Sherry Abdellatif

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Abstract

Financial services are experiencing revolutions of digital technologies, and FinTech-inspired changes in the industry are challenging the traditional approaches to the management of finances through automation, artificial intelligence, and data-driven decision-making. This has lowered costs, brought the services to a greater number of people, and opened innovation to areas never previously possible under the traditional banking models. In this paradigm shift, robo-advisory platforms have become a major force of disruption since they provide affordable, scalable, and accessible investment services, unlike an ordinary advisor. Sustainability provisions, such as ESG portfolios, are also being added to such platforms as investor focus changes. However, certain major hurdles remain because of dangers on cybersecurity, trust, inconsistent regulation, and inaccurate ESG reporting, among others, making its adoption challenging.

In this study, a qualitative conceptual research design is adopted using secondary literature referenced in peer-reviewed articles, regulatory reports, and industry publications. A scoping review and a documentary analysis have been carried out to help determine what has been done so far and identify gaps in existing studies. The evidence points to three key themes, including risk (cybersecurity, legal, and privacy vulnerability), consumer protection (trust, transparency, and stakeholder requirements), and governance (fiduciary role, algorithmic responsibility, and RegTech/CSR). Comparative analysis highlights the possibilities of robo-advisory platforms in terms of democratization of access, cost reduction, and the possibility to integrate ESG-specifics, as well as discloses the weaknesses of robo-advisory platforms regarding building trust, ensuring resilience, and protection against greenwashing.

To fill these gaps, this paper suggests the Trust-Cybersecurity-Sustainability (TCS) Framework, which combines psychological (trust), technical (cybersecurity), and ethical (sustainability /ESG) aspects of the robo-advisory platform adoption. The framework focuses on the mediating effect of the investor behaviour and expounds on the previous models of adoption by introducing concepts of governance and sustainability. It has contributions to theory, adding knowledge to adoption and trust frameworks, and practice, helping to inform financial institutions, regulators, and policymakers in designing robo-advisory platforms that are sustainable, resilient, and transparent.

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1. Introduction: Background and Objectives

1.1.Background

1.1.1. Overview of the Chosen Research Area

The financial market is beginning to undergo a gigantic digitalization procedure, in which the convergence of artificial intelligence (AI) and amplified data analytics will initiate the same. The wealth management is changing due to the robo-advisory platforms, especially the computerization of investment advice and management of portfolios through websites. Robo-advisory platforms were initially meant to be an inexpensive alternative to a financial planner in the post-2008 recession era and are a technology that employs algorithmic decision-making in order to lessen the entry obstacle and democratize the financial service (Roh et al., 2023).

Robo-advisory platforms have evolved to be extremely dynamic, meaning that they are now able to integrate the variables of ESG preferences, tax optimization, and risk profiling (Abraham et al., 2019). And the shift to a global one is increasing, and AUM assets markets are expected to have reached USD 2 trillion (and above) by 2026 (Abraham et al., 2019). This innovation will reiterate their contribution to the evolution of the future of finance.

Nevertheless, despite their potential, there is some worrying news about robo-advisory platforms. According to the critics, algorithm-based counselling is impersonal, unheard, and unobserved morally (Yi et al., 2023). The absence of cybersecurity and the distrust of consumers are also considered negative factors to increase their usage. These questions are not to be talked about at a technical level but deeper research related to the theoretical and practical aspects of digital financial advice.

1.1.2. Relevance to Business/ Management Context

The case of robo-advisory platforms as disruptors and facilitators of financial services is relevant to business and management because it can be used as a springboard into the future and a means to prepare business and management to deal with financial service disruption. On one hand, they interfere with the old model of business by providing scaled as well as small-cost advisory services and, hence, competing with the traditional wealth managers. Conversely, they help businesses to match the trends in the world, like digitalization and sustainability.

It seems that the robo-advisory platform is both an opportunity and a threat to management. They present institutions with an avenue through which they can increase the number of customers, cut expenses, and augment their competitiveness. Meanwhile, they also depend on AI, which incurs management difficulties due to responsibility and regulatory and ethical considerations when making decisions. Moreover, investors are placing growing importance on financial institutions to such an extent that they incorporate ESG in their advice to investors. Robo-advisory platforms, therefore, are instrumental in aligning the investment strategies and sustainability agendas, if they can address the trust and cybersecurity issues (Nguyen et al., 2023).

1.1.3. Research Questions

This study raises the following research questions:

Research question (RQ) 1: What are the opportunities and challenges when using robo-advisory platforms compared to human financial advisors and traditional investment platforms?

Research question (RQ) 2: How do robo-advisory platforms promote sustainability goals and integrate ESG factors into their services?

1.1.4. Theoretical Background of Research Area

The research has a theoretical basis based on various sources of literature, namely behavioural finance, trust theory, cybersecurity risk frameworks, and sustainability.

Theories and Models

The use of the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) provides an understanding of robo-advisory platform adoption by the users, where trust and perceived security are the most important variables (Roh et al., 2023). In addition to this, the agency theory also indicates how investors and advisors, whether human or algorithmic, might be conflict-of-interest parties that fostered the focus on monitoring, transparency, and accountability.

Opportunities: Sustainability, SDGs, and ESG

The support of the United Nations Sustainable Development Goals (SDGs) can be achieved with the help of robo-advisory platforms, which have the potential to support the SDGs by making portfolio standards more accessible and democratic and implementing ESG standards in their portfolios. The ESG integration by a robo-advisory platform has the potential to redirect capital to sustainable companies and industries, which will support a responsible investment (Vasile & Manta, 2025). Robo-advisory platforms enable the smallest of investors to access ESG-themed portfolios on a large scale, allowing personal investors to contribute their bit to bigger sustainability changes.

Challenges: Trust and Cybersecurity Risks

Despite these opportunities, challenges still exist. Trust forms a key adoption determinant since there is a certain degree of risk and uncertainty in the nature of the financial decision process. The research has shown that clients would be cautious about relying on AI-based platforms, because they feel that they are mysterious and lack human touch (Yi et al., 2023). Furthermore, the threat posed to robo-advisory platforms is characterized by extremely high security risks, including information leakage, fraud through algorithms, and fraud (Adekoya et al., 2025).

Trust-Cybersecurity Relationship

The trust and the cybersecurity risk are mutually dependent. Publicized attacks can erode the user's trust, which can be enhanced with effective security tools. The mediating factor between risk perception and adoption intention, through which cybersecurity resilience is a state of long-term acceptance of robo-advisory platforms, is mediated by trust. This interaction typifies one of the most important theoretical perspectives of this paper through the linking of the concept of digital security and the trend of behaviour adoption.

1.2. Research Aims and Objectives

The general purpose of the research under consideration is currently to critically discuss the opportunities and challenges that the use of robo-advisory platforms is open to, paying particular attention to the issues connected to sustainability, the risks of cybersecurity dangers, and integrating ESG. The research proposal will be useful to provide a contribution to the scholarly and management debate by bridging the gap in theoretical and practical knowledge.

The targeted objectives are as under:

1. To examine the relative prospects and threats of robo-advisory platforms compared to human financial advisors and the traditional investment platform.
2. To understand how robo-advisory platforms incorporate sustainability targets in their operations, especially with ESG investment strategies.
3. To understand the current relationships between trust, cybersecurity, and the use of robo-advisory platforms.
4. To pinpoint gaps that are found in existing literature and suggest a conceptual framework for future studies.
5. To make recommendations to policymakers, practitioners, and researchers on what can be done to improve trust, resilience, and sustainability in robo-advisory platforms.

2. Literature Review

2.1. Overview

The increase of robo-advisory platform is one of the most revolutionary changes in the field of financial technologies (FinTech) during the last decade. This new breed of technology-enabled platforms built on artificial intelligence (AI), machine learning, and algorithmic decision-making has upended the wealth management sector in terms of value rather than lowering costs (Roh et al., 2023). Being a disruptive innovation, robo-advisory platforms not only undermine the purpose of typical human advisors but expand the investor-advisor relationships as well. But on the one hand, opportunities in terms of democratizing finance and sustainable investing accompany them, and on the other hand, trust and cybersecurity issues, as well as regulatory sufficiency concerns, appear (Farahani & Ghasemi, 2024; Yi et al., 2023).

The synthesis of this prior research comprises four key themes: (1) robo-advisory platform opportunities; (2) challenges, with emphasis on trust and cybersecurity; (3)

sustainability and ESG integration; and (4) adoption and risk-perception theoretical lenses. The review identifies these zones by mapping them and provides the basis on which the voids of existing information can be filled.

2.2 Opportunities for Robo-Advisory Platforms

2.2.1 Democratization of Finance

Among the most-discussed opportunities is the democratization of financial advice. Compared to human advisors, robo-advisory platforms can save users high expendable money management fees by fully automating portfolio construction, rebalancing, and tax optimization, thereby making financial advice affordable to more citizens who would otherwise not be able to afford real-world human financial advisors. It has been demonstrated that millennial and digitally native investors are especially attracted to robo-advisory platforms because they are cheap and easily accessible (Vasile & Manta, 2025).

In addition to that, robo-advisory platforms may eliminate entry barriers: they may open accounts with a minimum balance requirement or no requirement whatsoever. Early American reporting mentioned that one year-younger and less financially educated investors gravitated towards sites like Betterment and Wealthfront; later empirical research demonstrates that lower financial literacy and younger age are strong predictors of robo-advisory platforms usage (De Crescenzo, 2017; Yi et al., 2023; Piotrowski and Orzeszko, 2023; Roh et al., 2023). This will be in tandem with the broader SDG 10 of minimizing inequalities in financial literacy and access.

2.2.2 Efficiency and Objectivity

The other good aspect is efficiency. The use of algorithm-based systems is capable of handling large data streams, hence being more efficient in optimizing the allocation of assets as

opposed to human advisors. Conversely, robo-advisory platforms generate advice that possesses certain behavioural biases, such as overconfidence or herding, in which more consistent advice is given with increasing power (Nain and Rajan, 2023). This objectivity enhances the performance of the portfolio because it relies on quantitative models as opposed to subjective opinion.

2.2.3 Personalization through AI

Investment strategy personalization by user risk profile and time duration, and preferences have also been made possible by the assistance of AI by a robo-advisory platform. Machine learning models evolve all the time to the behaviour of the investor and provide more personal advice (Nguyen et al., 2023). What is more, natural language processing (NLP) interfaces enhance the experience of the users, making financial tips more interactive and user-friendly.

2.2.4 Integration with ESG and Sustainability

The most important emerging opportunity is the mission of robo-advisory platforms concerning the promotion of sustainable investing. Several works demonstrate that more investors are interested in ensuring that portfolios are aligned with ESG factors (Vasile & Manta, 2025). Robo-advisory platforms can scale up ESG integration due to the ability to provide pre-designed sustainable portfolios based on big data analytics assessment of environmental and social performance across businesses. It is associated with SDG 13 (Climate Action) and SDG 12 (Responsible Consumption and Production).

With the startups like Wealthsimple and Nutmeg already being able to show how robo-advisory platforms could be employed in a way that considers ESG products and enables them to direct investments to sustainable businesses, it is clear that they will continue to play a role going

forward. To get a comprehensive summary of the current robo-advisory platforms in Canada and how they would fit in a comparative analysis of their offerings in terms of integrating ESG, ***refer to Appendix A.***

2.2.5 Financial Inclusion, DEI, and Sustainable Development Goals (SDGs)

One of the factors that drives financial inclusion also comes with the use of Robo-advisory platforms in lessening the entry barrier that may have previously locked out small and underrepresented investors. In contrast to the conventional advisor that has a high minimum requirement, robo-advisory platforms are affordable, low-cost and accessible services that help to democratize finance (Abraham et al., 2019; Onabowale, 2025). This aligns with the principle of Diversity, Equity, and Inclusion (DEI) in financial services because this enables women, minorities and households in the lower income bracket to also get access to digital wealth management tools.

Improving inclusion is associated with the following Sustainable Development Goals (SDGs), where the contribution of robo-advisory platforms is relevant. A case in point is that SDG 10 (Reducing Inequalities) is advanced by their low prices and availability, and SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action) by sustainable investment portfolios (Faradynawati & Söderberg, 2022; Vasile & Manta, 2025). Moreover, the robo-advisory platforms support Sustainable Development Goals (SDGs) 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure) since they foster the use of digital innovations and expand the range of access to capital markets.

Such lens would not only see robo-advisory platforms as enhancing efficiency and sustainability but also as a tool advancing two key aims such as channeling inclusive growth and robo-advisory platforms become an important instrument toward supporting both financial equity and global sustainable development.

2.3 Challenges of Robo-Advisory Platforms

2.3.1 Trust Deficits

Trust becomes a repeated motif in the literature and has always been named a point preventing the adoption of robo-advisory platforms. According to Yi et al. (2023), skepticism has resulted because the users tend to view algorithmic advice as non-transparent, or a black-box. In contrast to human advisors, robo-advisory platforms are unable to express empathy or to instill confidence in the client in times of turmoil in the market. Such a lack of emotional quotient generates a lack of trust, which is especially true among older or less-tech-savvy investors.

In addition, trust is neither equal nor absolute as it is based on cultural, demographic, and experience variables. Research indicates that younger and technology-savvy clients are more willing to accept algorithmic recommendations, but older investors still want to interact with another person (Piotrowski & Orzeszko, 2023).

2.3.2 Cybersecurity Vulnerabilities

Robo-advisory platforms are vulnerable to cybersecurity threats given the digital aspect of their nature. The significant risks include data leakage, identity theft, and tampering with algorithms and algorithms thus eroding investor trust. When financial platforms lose the trust of users due to a single cyberattack, as Adekoya et al. (2025) observe, this may take years to restore. Since the issues of money are a candid subject, there are great stakes involved.

Furthermore, there are new kinds of systemic risk as a result of the AI-powered systems. The financial instability may spread rapidly because of the links between platforms (algorithmic errors or problems caused by malicious attacks). Robo-advisory platforms contrast with human advisors in that they rely fully on the integrity and security of data.

2.3.3 Regulatory and Ethical Concerns

The fast development of robo-advisory platforms is difficult to keep up with by regulators. The issue of fiduciary duty, liability when the computed solution introduces an error, or how the decision-making process of a particular AI is transparent, is not established. Other researchers suggest increased explainability of the algorithms to enable accountability (Schwarcz et al., 2025).

There are also central issues of ethics involved. Unless exercised, robo-advisory platforms will be stuck in algorithmic discrimination, where certain groups of investors are discriminated against. Absence of human judgment in decision-making also clouds ethical dilemma and can be applied in long-term judgment of finances.

2.4 Trust and Cybersecurity: An Interdependent Relationship

The security threats and cybersecurity mingle with trust. One of the greatest breaches of data is a pure assault on trust, and a solid cybersecurity existence could be a foundation of a greater level of trust. The literature indicated that trust is the mediating variable in the relationship between the perceived risk and the intention to adopt (Yi et al., 2023). In other words, investors will be willing to adopt robo-advisory platforms in case they feel that the platforms are secure and trustworthy.

A number of models include the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) that emphasize the role of perceived security in influencing behavioural intent (Roh et al., 2023). These models affirm that development of trust depends not only on the technical capability to resist but also on transparency, regulatory adherence and communication to the users.

2.5 Sustainability and ESG Integration

2.5.1 Investor Demand for ESG

One of the key trends in the last few years is the increase in demand for ESG-aligned investments. Sustainability is important to the millennials and Gen Z investors, who represent the major user segment of robo-advisory platforms. Research indicates that ESG integration is not optional anymore, but rather it is becoming a necessity for those providers in the financial sector (Faradynawati & Söderberg, 2022).

2.5.2 Robo-Advisory Platforms as Scalable ESG Enablers

Robo-advisory platforms can promote sustainable finance through the scale of multi-asset portfolios focused on ESG. By using big data and AI, they can observe sustainability reports, greenhouse gas emissions, and corporate governance of firms and construct ESG rankings. Having this capability allows an agent in the mass market to align portfolios up to sustainability objectives without extensive financial literacy (Faradynawati & Söderberg, 2022; Vasile & Manta, 2025).

2.5.3 Challenges of ESG Integration

Nonetheless, ESG integration is not problem-free. Vice scholars point out the problems of greenwashing, when labels added to ESG do not imply actual sustainability in the company

(Nguyen et al., 2023). Moreover, ESG criteria can be oversimplified by robo-advisory platforms, which do not reflect environmental and social performance complexity. It begs the question of how credible and efficient the robo-advisory platform on ESG will be.

2.6 Theoretical Lenses

2.6.1 Technology Acceptance Model (TAM) and UTAUT

The TAM model focuses on perceived usefulness and perceived ease of use as a factor that determines the adoption of technology (Roh et al., 2023). These dimensions are mediated by the trust and perceptions of security in the robo-advisory context. UTAUT also adds on to the adoption theory to include the factor of social influence and facilitating conditions (Roh et al., 2023).

2.6.2 Trust Theory

The trust theory is used as a basis through which investors avoid making risky decisions and embrace AI-powered financial services. The act of assuming vulnerability through positive expectations of the actions of another individual is referred to as trust (Afroogh et al., 2024). Applying it here, it illuminates the role of transparency, reputation and the strength of cybersecurity in adoption.

2.6.3. Stakeholder Theory

According to the stakeholder theory, financial service providers have a responsibility ahead of them to attend to both the shareholders' returns and other assurances to the wider society (Faradynawati & Söderberg, 2022). The robot-advisory platforms incorporating the ESG criteria can be considered as the practical implementation of the stakeholder theory, which aims to make the investment portfolio correspond to the ethical and sustainability requirements.

2.6.4. Sustainable Development Goals and ESG

Robo-advisory platforms have the potential to transform retail investors' understanding of ESG preferences into rules and tilts on specific themes with the sustainability goals of the United Nations (SDGs) through AI-driven screening and portfolio construction at scale. In practice, these platforms may map allocations to such goals as SDG 10 (Reduced Inequalities) via low fees, low minimums, and digital onboarding to widen access; SDG 12 (Responsible Consumption and Production) through controversy screen and resource efficiency; and SDG 13 (Climate Action) via low-carbon indices and exposure to green bonds, enabled by links to SDG 8/9 regarding innovation and infrastructure as the key to sustainable growth (Abraham, Schmukler, & Tessada, 2019). Without clear governance and disclosures, including explainable ESG logic, auditable data pipelines and safeguards against greenwashing, and credible digital-scale SDG alignment, other than a marketing label, will be elusive, on par with the evolving FinTech expectations and trust requirements of AI-enabled advice services (Hsieh, Chang, & Su-han, 2024; Afroogh et al., 2024).

2.6.5 Modern Portfolio Theory

The theory is built on the foundations of Financial Economics discipline. The theory was introduced by Harry Markowitz in 1952. It discussed the importance of investors' attention to risk-return trade-off. Theoretically, the higher the risk the higher return or vice versa. Markowitz highlighted the significant role of diversification in asset allocation to construct the "efficient frontier" across asset classes (fixed income, equity, derivatives, cryptocurrencies, real estate, etc...) as an investment strategy to reduce risk without reducing expected return. The aim is to ensure portfolio optimization and construct the assumption that investors are rational and markets are efficient (Donadelli, et al. 2025, Markowitz, H., 1952). When applying the theory to

robo-advisory platforms, it is evident that most prominent North American platforms (such as Wealthfront or Betterment) use robo-advisory platforms to conduct investor profile questionnaires and feed it into the algorithm to run automatic rebalancing based on the risk-return profile of the investor (Betterment, 2025; Wealthfront, 2025).

2.6.6. Corporate Social Responsibility (CSR) Theories and Models

Whereas Stakeholder Theory (Freeman, 1984) provides an explanation of who organizations are answerable to, the varieties of CSR theories elaborate on what the responsibilities of businesses are towards these stakeholders and how the same can be undertaken through the adoption of practices. Therefore, CSR models are supplementary to Stakeholder Theory: the former focuses on who firms should consider, whereas the latter determines how they have to meet the various expectations of different sides. This greater context of governance is applicable in robo-advisory platforms since responsibility is not limited only to the investors; other stakeholders, such as regulators, society, and the environment, are also involved.

Probably the most popular framework is the Pyramid of CSR put together by Carroll, where four aspects of responsibility are defined: economic, legal, ethical, and philanthropic (Carroll, 1991). Such categories, as mentioned by Carroll later, constitute an entirety, with the ethics being present at all levels, trade-offs being unavoidable, and applicability in the international scope evident (Carroll, 2016). When applied to robo-advisory platforms, economic responsibility is the ability to offer a low-cost and broadly available digital investment service; the legal responsibility rests on adherence to financial regulations and data-protection laws; the ethical responsibility consists of transparency, fairness, and the prevention of greenwashing; and

the philanthropic responsibility of allowing financial literacy and democratizing sustainable investing.

The Triple Bottom Line (TBL) model (Elkington, 1998) is an addition to the above Carroll model in the sense that sustainability is being embedded in strategy with the formulation of people, planet, profit. The latest research proves that the integration of TBL is not a matter of choice anymore but a source of organizational resilience and sustainable competitive advantage because when the economic viability and social equity and environmental sustainability are achieved, long-term success is attained (Sapsanguanboon, Faijaidee, & Potasin, 2025). In the robo-advisory setting, this implies a balancing between profitability and ESG portfolios that contribute to climate targets (planet) and making wealth management accessible to a broader range of people (people), in addition to monetary returns (profit).

Lastly, stakeholder engagement and stakeholder governance would mean something within the scope of CSR. Stakeholder Theory has been growing in prominence as a framework in the context of raising and resolving challenging ethical and trust-related questions in various sectors, and bibliometric data show that Stakeholder Theory is an influential theory to guide CSR-based decision-making (Azevedo Silva da Costa et al., 2025). With robo-advisory platforms, this interrelation illuminates that, in addition to satisfying adoption and trustworthiness conditions, platforms are also supposed to uphold social legitimacy by adopting responsible AI, transparent integration of ESG and multiple stakeholder accountability. This study is also based on the foundations of the AI-Ethics CSR Governance framework to address the opportunities and compliance challenges and ethical concerns of the use of AI in the banking sector (Abdellatif, 2025)

Overall, the theories of CSR and models contribute to the overall theoretical underpinning of the research because of their widening of the stakeholder-centered models of adoption towards a more comprehensive understanding of governance. The integration of the CSR Pyramid as proposed by Carroll, the TBL, as well as stakeholder-based CSR governance in this study places robo-advisory platforms in their place as socio-technical systems, the legality of which is contingent on their profitability, regulation-compliant behaviour, ethical and sustainable developmental actions.

2.7 Summary

There are two lines of thought that appear in the literature: On the one hand, the attractive prospects of robo-advisory platforms are related to the value of cost-effectiveness, democratization, individualization, and ESG integration. Conversely, they are confronted with a serious problem of trust, cybersecurity, and adequacy of regulations.

Most importantly is the nature of the interplay between trust and cybersecurity proves to be a deciding factor on adoption. Although sustainability and integration with ESG make robo-advisory platforms more attractive, some questions of transparency and greenwashing need to be solved to increase their efficiency.

This review forms the rationale of future research to fill these gaps, especially by conducting multi-method empirical research to validate the adoption patterns, measure the cybersecurity resilience, and evaluate the adoption of ESG integration in practice.

3. Methodology

3.1 Research methods

The research design is qualitative and conceptual, based on pre-existing theoretical frameworks and secondary sources, in accordance with critical-review and agenda-setting research styles in areas of rapid change (Hsieh, Chang, & Su-han, 2024; Vukovic et al., 2025). Conceptual designs are mostly suited when no empirical evidence is able to accumulate as fast as technologies are developing (Ruben & Ortiz, 2025; Rjab, Mellouli, & Corbett, 2023). We also make references to adoption constructs that were defined in empirical investigations of the use of AI-powered robo-advisory platforms (Piotrowski & Orzeszko, 2023; Nguyen et al., 2023).

The theoretical background has several points of view that make up its principles. Roh, Park, and Xiao (2023) use UTAUT to understand the aspects of adoption of robo-advisory platforms, while Yi et al. (2023) utilize it to establish the role of trust, usability, and knowledge in the establishment of the investor behaviour stage. Meanwhile, Faradynawati and Söderberg (2022) discuss the concept of sustainability preference in online investment platforms, and Schwarcz, Baker and Logue (2025) introduce the issue of governance and fiduciary duty. As it can also be seen in the paper by Abdellatif (2025), the ideas of AI ethics and corporate social responsibility (CSR) could be integrated into financial governance with the help of the conceptual framework of RegTech. Collectively, these studies serve to inform the evolution of Trust-Cybersecurity-Sustainability (TCS) as a framework that asserts adoption as an outcome of trust, cybersecurity risk, and integration of sustainability.

3.2 Data Collection Methods and Data Sources

The research is solely based on secondary sources**,** and it combines research articles published by academicians and regulatory agencies, policy reports, and industry studies.

3.2.1 Phase 1: Scoping Review of the Literature

Issues of power, trust, and control concerning AI-powered robo-advisory platforms were captured through a scoping review. There were four broad themes that came out.

- Confidence and trust in the informed decision on the investor trust that is foundation on knowledge, usability, and transparency (Yi et al., 2023; Sidat and Matchaba-hove, 2021).
- The threats of cybersecurity, vulnerabilities, and the effects of cyber attacks on investor confidence (Adekoya, Atlam, & Lallie, 2025; Hasanah et al., 2024).
- One of the opportunities of sustainable finance democratization, as well as the risk of greenwashing, has become sustainability and ESG integration (Faradynawati & Söderberg 2022; Vasile & Manta 2025).
- Regulation and governance- fragmented structures and governance problems (Baker & Dellaert, 2018; Schwarcz et al., 2025).

3.2.2 Phase 2: Documentary and Policy Analysis

The second step incorporated a documentary review of regulation structures, policy reports, and legal reviews. The articles by Baker and Dellaert (2018), Jedlicbkova (2024) and Ruben and Ortiz (2025) address the topic of fiduciary responsibility in robo-advice and focus on the ethical and governance concerns of autonomous AI systems. The article by Vučinić and Luburić (2024) provides comparative perspectives on FinTech regulation. The example provided by Abdellatif (2025) is particularly applicable to Canada and can be applied when changing AI ethics and CSR into financial governance. Notably, the Office of the Superintendent of Financial Institutions (OSFI) has newly updated its Guideline E-23 to incorporate AI and machine learning into the scope of its enterprise-wide model risk management policy framework with the final

guidance to be released in 2025, marking a significant change towards managing AI-related risks in Canadian financial institutions

This step was completed using content and critical discourse analysis to understand how the concepts of trust, cybersecurity-based risks, and sustainability are addressed in policy and governance discourse.

3.3 Analytical Strategy

To be rigorous, this study relies on conceptual integration and triangulation. ESG was mainly associated with academic literature on adoption (Roh et al., 2023). Policies and legal documents provided an outlook on fiduciary responsibility, liability, and algorithmic liability (Schwarcz et al., 2025; Shin-Ru Hsieh et al., 2024). Industry reports and investor studies provided testimony of sustainable investment behaviour (Abraham et al., 2019; Faradynawati & Söderberg, 2022).

Incorporating these views will help in building the TCS framework, which connects trust, cybersecurity resilience, and sustainability as the pillars influencing the adoption of the robo-advisory platforms.

3.4 Scope and Limitations

The present research is conceptual and exploratory. Although it lacks primary data collection, the rigor is maintained by relying on peer-reviewed sources of information, regulation analysis and industry opinion. An example is the bibliometric analysis by Fahruri et al. (2023) that allows mapping adoption research, or the power of conceptual integration as shown by Abdellatif (2025), who proved its usefulness as a policy-relevant tool.

The integration of these approaches leads to the TCS framework that is theoretically sound, policy-relevant, and practically useful to resolve the ethical and technical dilemmas of the AI-powered robo-advisory platforms subject to cybersecurity threats.

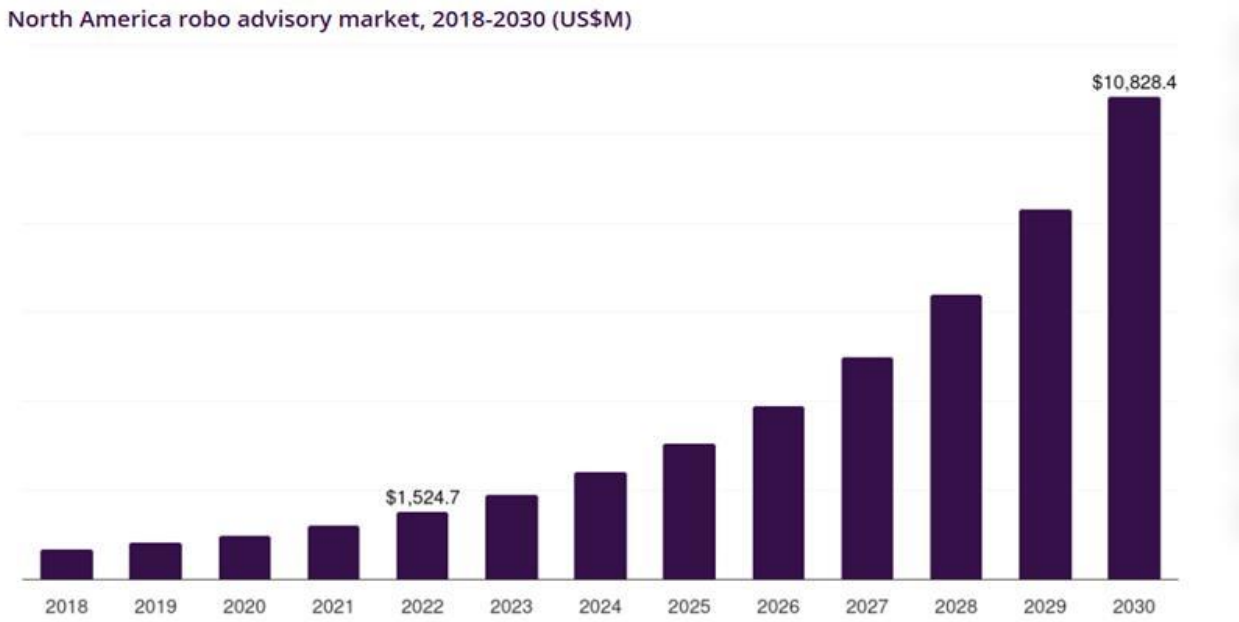
4. Results

This section will sum up the findings of the material reviewed so as to show how it answers the research questions to some level. In contrast to the literature review, which summarized previous studies, Results are grouped around converging evidence themes and how such patterns address: RQ1 (opportunities vs. challenges of robo-advisory platforms) and RQ2 (how robo-advisory platforms integrate ESG and promote sustainability). As there was no original collection of primary data, the so-called results are provided in the form of thematic findings synthesized based on existing theories, models, and sources of evidence. The findings reveal the possibility and the limitations of AI-enabled robo-advisory platforms, especially concerning adoption rate, trust, security threats following cyberattacks, consumer protection, governance, and sustainability.

According to Grand View Research (2025) North America robo advisory market highlights

- The North American robo advisory market generated a revenue of USD 1,524.7 million in 2022.
- The market is expected to grow at a CAGR of 28.2% from 2023 to 2030.

Figure 1. *Growth of North American Robo Advisory Market, from 2018 to 2030 (US$M)*



Source: North America Robo Advisory Market Size & Outlook, 2030

4.1. Using the Theoretical Lens to Structure the Synthesis

This section applies the lenses introduced in Section 2.6 to organize findings, rather than re-stating the theories. We use adoption models to group opportunities, trust/cybersecurity to explain barriers, and stakeholder/CSR/governance to distinguish credible ESG integration from performative claims. Each lens is tied explicitly to RQ1 and RQ2.

4.1.1. Adoption theories (Applied)

Rather than re-explaining TAM/UTAUT, we use them to cluster results: lower fees, ease of onboarding, and automated rebalancing map to perceived usefulness/ease (opportunities), while algorithm aversion and low financial literacy map to residual barriers.

Synthesis for RQ1: opportunities are conditional, materializing only when enablers (usability + support) offset perceived risk.

4.1.2. Trust theory (Applied)

We use the mediating variable of trust to transform platform characteristics into adoption/retention: apparent security measures and informative logicality - increased perceived reliability - increased intention to adopt and remain.

Synthesis for RQ1: trust deficits erase cost advantages after breaches/opacity, explaining why some platforms stall despite strong pricing.

4.1.3. Stakeholder and Sustainability Perspectives (Applied)

Stakeholder/CSR/TBL lenses are used to question ESG credentials in our results: where screening is clear, pipelines of data are trackable and connections to SDGs definitive, ESG seems substantive; where disclosures are limited, risk of greenwashing is higher.

Synthesis for RQ2: Robo-advisory platforms can scale ESG access, but credibility hinges on process transparency, not labels.

4.1.4. Governance and Regulation Models (Applied)

We operationalize governance as levers to transform risk as perceived into risk as managed: clarity of fiduciary duty, model-risk management, explainability/test-for-bias, and redress avenues.

Synthesis for RQ1: These levers reduce frictions to adoption that are caused by cyber/privacy and opacity. Connection to RQ2: Verifiable ESG integration is based on the same controls.

4.1.5. Integrated Approach (TCS in Use)

The TCS (Trust-Cybersecurity-Sustainability) framework integrates these lenses: robust cybersecurity enables trust; credible ESG sustains trust; governance spans all three. We use TCS

to interpret the patterns in Section 4.2 and to motivate the recommendations, directly addressing RQ1 (opportunities vs. challenges) and RQ2 (credible ESG integration).

4.2.Qualitative Data Analysis

The thematic analysis of the literature and regulatory documents revealed three themes of risks and consumer protection, governance, and additional comparative prompts on opportunities, challenges, and ESG sustainability. This study proposes a typology based on thematic analysis, including themes and subthemes derived from the critical literature review and policy analysis of academic, legal, and industry sources.

Table 1. *Thematic Analysis (Designed by author)*

1. Risks	1.1 **Cybersecurity Risks -** Data Leaks, Hacking, Identity Theft, and Platform vulnerabilities lower the trust.	Adekoya et al. (2025); Hasanah et al. (2024)
	1.2 **Legal/Regulatory Risks -** Disorganized and vague liability systems discourage adoption.	Baker & Dellaert (2018); Schwarcz et al. (2025)
	1.3 **Data Privacy Risks :** Fears of consenting to and storing their data, as well as tracking down information sensitivity abuse.	Jedličková (2024)
2. Consumer Protection	2.1 **Trust & Transparency:** Investors want someone to explain to them the	Yi et al. (2023); Piotrowski & Orzeszko (2023)

	recommendations that AI powered systems is providing.	
	2.2 **Complaints & Redress:** Limited methods of dispute resolution and accountabilities.	Abraham et al. (2019)
	2.3 **Stakeholder Needs:** Expansion in the services provided along the line of personalization, green integration and inclusion.	Nguyen et al. (2023); Faradynawati & Söderberg (2022)
3. Governance	3.1 **Fiduciary Duty:** It is uncertain that the robo-advisory platforms can uphold their fiduciary duty.	Baker & Dellaert (2018)
	3.2 **Algorithmic Accountability :** Must demand fairness, explainability and non-biasness.	Schwarcz et al. (2025); Bianchi & Brière (2021)
	3.3 **RegTech & CSR :** Harnessing RegTech and CSR to make ethical adoption.	Abdellatif (2025); Ruben & Ortiz (2025)

4.2.1. Theme 1: Risks

Cybersecurity is the risk that is rated as the highest to robo-advisory platforms. Adekoya et al. (2025) assess the multidimensional costs of cyberattacks in financial services, whereas Hasanah et al. (2024) identify the shortcomings in the risk-profiling systems that could expose

the users to mismanagement. Legal and regulatory risks exist because of the inconsistent systems, and fiduciary obligations and liability remain a controversial topic (Baker & Dellaert, 2018; Schwarcz et al., 2025). Moreover, data security issues, especially related to consent, storage, and algorithm abuse, restrict the trust of users (Jedličková, 2024).

Subtheme 1.1. Cybersecurity Risks

The risk of fraud, malicious hacks, and injections of Robo-advisory AI-based platforms is high. Cyberattacks disrupt the stability of data integrity and availability and affect financial operations negatively, and investor confidence (Adekoya et al., 2025).

Subtheme 1.2. Legal and Regulatory Risks

The limitations exist due to the lack of homogeneous regulations and unequal duty enforcement of the fiduciary role. These jurisdiction-related disparities in the appropriateness and reporting rules undermine investor trust and platform dispensation (Baker & Dellaert, 2018; Schwarcz et al., 2025).

Subtheme 1.3. Data Privacy Risks

Lack of strong consent management and transparency in data practices is a drag on adoption. In order to avoid misuse of sensitive financial information, researchers observe the necessity to retain more control over the storage, retention and non-abusive utilization of data. (Jedličková, 2024).

Synthesis/RQ link: Cyber, legal/liability, and data-privacy vulnerabilities are more of a systemic than an isolated risk. The direct response to RQ1 (challenges) is this tendency (the absence of credible security control and accountability, the advantage of cost and access is not being turned into a sustainable adoption).

4.2.2. Theme 2: Consumer Protection

The problem of consumer protection is closely related to trust and transparency. Financial participants are usually reluctant to trust black-box models with explanations (Piotrowski & Orzeszko, 2023). Redress systems and complaint systems are not developed as the clients do not know their path to seek dispute (Abraham, Schmukler, & Tessada, 2019). Moreover, stakeholders are asking more personalized services and sustainable investment opportunities, most notably millennials, who have a majority share in the robo-advisory adoption (Nguyen, Chew, Muthaiyah, Teh, & Ong, 2023; Faradynawati & Söderberg, 2022).

Subtheme 2.1. Trust and Transparency

Based on studies, the key predictors of adoption are perceived usability, trustworthiness, and knowledge. The other problem with black-box opacity is that it reduces the confidence of the investors. (Piotrowski & Orzeszko, 2023; Yi, Rom, Hassan, Samsurijan, & Ebekozien, 2023).

Subtheme 2.2. Complaints and Redress

Robo-advisory platforms in general do not follow clear lines of accountability, and complaint feedback is usually unavailable. This lack of consumer protection level decreases trust in the governance of the platforms (Abraham et al., 2019; Baker & Dellaert, 2018).

Subtheme 2.3. Stakeholder Needs

Investors are demanding more custom portfolios that are aligned to ESG interests. It is proven that the demand related to sustainable investment options is very strong among millennials (Nguyen et al., 2023; Faradynawati & Söderberg, 2022).

Synthesis/RQ link: The two most important areas of concern, as discussed in the literature, are a lack of transparency (opaque recommendations) and weak redress mechanisms. The rationale behind RQ1 was that trust and transparency are never soft, but scale.

4.2.3 Theme 3: Governance

Governance issues revolve around fiduciary responsibilities, algorithmic responsibility and instilling ethics into practice. There are still questions about whether the fiduciary standard that is applied by robo-advisory platforms is equivalent to human advisors (Baker & Dellaert, 2018). There is growing concern with the idea of algorithmic accountability, and demand for explainability and fairness of decision-making (Schwarcz et al., 2025). The principles of RegTech and CSR are emerging as the trends of making financial creations complemented by ethical principles (Abdellatif, 2025; Ruben & Ortiz, 2025). The prudential supervisor of Canada recently highlighted the efficiency of regulations, without affecting resilience, which states that it will be ready to step in as risks become apparent in the financial system environment directly pertaining to the bank-affiliated robo-advisory platforms (Office of the Superintendent of Financial Institutions [OSFI], 2025).

Subtheme 3.1. Fiduciary Duty

The automation of the platforms raises the question of their comprehensiveness with fiduciary duties like suitability, disclosure, and acting in the best interest of the client (Baker & Dellaert, 2018; Schwarcz et al., 2025).

Subtheme 3.2. Algorithmic Accountability (Explainability & Bias)

Regulators are demanding more answers to questions of explainability, fairness, and bias testing of algorithms. The identified algorithms-related problems, namely, accountability and algorithm aversion, are accessible through pathways proposed by the given XAI solutions (Schwarcz et al., 2025; Bianchi & Brière, 2021).

Subtheme 3.3. RegTech and CSR

Embedding RegTech technologies with the principle of CSR enables the systems to be extremely transparent and ethical in their governance. Compliance-automation enhances control, and CSR-oriented oversight liberation can make the innovation of robo-advisory platforms personified in adherence to social trust (Abdellatif, 2025; Ruben & Ortiz, 2025).

Synthesis/RQ link: Alignment technologies, such as embedded fiduciary principles, explainability, and testing bias, translate perceived platform risk into actual risk. This indicates the way limitations in RQ1 can be addressed.

4.2.4 Comparative Opportunities

Robo-advisory platforms are economically effective, and their fees range between 0.25% and 0.50% of AUM per year as opposed to 1.0% of AUM in the case of human advisors (Abraham et al., 2019). They open financial markets to the middle-income and younger investors by lowering the entrance fee. The personalization powered by AI allows for the portfolio to be optimized in real-time (Farahani & Ghasemi, 2024; Han & Ko, 2025). The integration of ESG enhances their value creation even more (Vasile & Manta, 2025).

4.2.5 Comparative Challenges

Barriers of adoption still exist. A lack of trust hinders the degree of trust in algorithms (Afroogh et al., 2024). The rate of vulnerability regarding cybersecurity is still high (Adekoya et al., 2025). Uncertainty is the result of regulatory disintegration (Schwarcz et al., 2025; Hsieh et al., 2024). Simplified risk-profiling is a distorted understanding of complex investor requirements (Hasanah, Sudarso, & Koesrindartoto, 2024). Lastly, robo-advisory platforms do not give the same empathy as human advisors do in turbulent markets (Tan, 2020; D’Acunto & Rossi, 2020).

4.2.6 ESG and Sustainability

The ESG inputs and portfolios are applied in Robo-advisory platforms based on the UN Sustainable Development Goals (Vasile & Manta, 2025; Faradynawati & Söderberg, 2022). They also make sure that sustainable finance is made available to everyone, including retail investors, as entry is not very difficult (Yi et al., 2023). However, it increases the chances of inconsistent reporting of ESG and greenwashing, which reduces the credibility of ESG (Ramazan & Ashraf, 2025).

Synthesis/RQ link (sets up RQ2): Robo-advisory platforms can make ESG more scale-friendly, although the quality and disclosure of the provided data are biased, transparent ESG reasons and auditing of inputs are impossible, and claims of sustainability are already falling under the greenwashing umbrella. This nuance is central to RQ2.

Critical Synthesis: It is demonstrated that robo-advisory platforms can bring access to ESG menus, but this has a varying impact. Most provide products that replicate wide indices with light exclusions that create little actual tilt in the real world. To conduct this study, ESG integration is only believed to be credible when four conditions are met: (1) the screening logic is explicable (what is screened in/out and why); (2) look-through holdings reflect material portfolio tilts versus a non-ESG benchmark (not de minimis); (3) data pipelines, and ratings sources are not only auditable and consistent but reported with measures; and (4) stewardship outcomes (votes, engagements, escalations, exits) are also reported and measured. Without them, the threat becomes the democratization of sustainable investing, not re-labelling-i.e., greenwashing, which then becomes detrimental to trust and uptake within the TCS frame.

4.2.7 Synthesis and Emerging Themes

Comprehensively, robo-advisory platforms are affordable, scalable, personalized, and environmentally conscious, yet have weaknesses regarding trust, cybersecurity risks, and regulation. Human financial advisors also maintain advantages in empathy and reassurance during a crisis, which also implies a complementary relationship. This literature mapping indicates well-researched areas of adoption and efficiency and little work on ESG and regulation, with new interest in XAI, RegTech, fraud detection, and governance of sustainable AI (Fahruri, Rusmanto, Dezie, & Warganegara, 2023; Abdellatif, 2025).

Persistent challenges in Robo-advisory Platforms

Both literature and practitioners highlighted challenges in developing trust, remedying vulnerabilities in cybersecurity, and managing fragmented regulatory landscapes. Other issues like the risk of data privacy breaches, lack of transparency in algorithms, and non-uniformity in ESG reporting, among others, only erode trust of the users and decrease adoption (Adekoya et al., 2025; Baker & Dellaert, 2018; Schwarcz et al., 2025; Jedličková, 2024).

Cross-theme synthesis: There are always conditional dependencies between the opportunities (cost, access, personalization, ESG menus) and: (i) plausible cybersecurity/oversight to maintain a trust relationship, and (ii) articulate, transparent ESG pipelines to maintain claims of sustainability. It is a place where the TCS framework can be used to structure both the RQs (opportunities vs. challenges) and RQ2 (credible ESG integration).

5. Discussion

To present a systematic review of the current state of research, this paper elicits a typology of the robo-advisory literature along 11 key dimensions, such as adoption, cost, trust, cybersecurity, governance, ESG integration and fraud detection. The typology categorizes the research outputs into three: dense (well-researched), underexplored, and fragmented/missing, all of which are noticed in Table 2. This organized mapping indicates that although much work has been done in the field of adoption, trust, cost accessibility (Roh et al., 2023; Piotrowski & Orzeszko, 2023; Abraham et al., 2019), there are still huge gaps in the field of ESG validation, cybersecurity resilience, and harmonization of global governance (Nguyen et al., 2023; Schwarcz et al., 2025). More precisely, the so-called fraud detection is fundamentally nonexistent in the robo-advisory literature, which also reflects the disordered character of the latter (Fahruri et al., 2023).

Based on this typology, published articles are categorized as dense, underexplored and missing/fragmented, and the result shows that most of the research includes the works of adoption, trust, and cost dimensions and not much is done to investigate ESG validation, cybersecurity resilience, and fraud detection studies.

Table 2. *Typology of Robo-Advisory Platforms Literature Across Research Dimensions*

Dimension	Dense (well-researched)	Underexplored	Missing/Fragmented
Adoption & Intention	Roh et al. (2023) Piotrowski & Orzeszko (2023) Nguyen et al. (2023)	Sidat & Matchaba-hove (2021)	
Cost & Accessibility	Abraham et al. (2019) Farahani & Ghasemi (2024)		
Trust & Transparency	Afroogh et al. (2024) Yi et al. (2023) Belanche et al. (2019)		
Cybersecurity	Adekoya et al. (2025)	Hasanah et al. (2024)	
Data Privacy & Ethics	Jedličková (2024)		
Governance & Regulation	Baker & Dellaert (2018) Schwarcz et al. (2025)	Shin-Ru Hsieh et al. (2024)	
Algorithmic Accountability (XAI)	Bianchi & Brière (2021)		
Risk Profiling	Hasanah et al. (2024)		
Behavioral Finance	Yi et al. (2023) Sidat & Matchaba-hove (2021)		
ESG/SDG Integration	Faradynawati & Söderberg (2022) Vasile & Manta (2025)	Ramazan & Ashraf (2025)	
Fraud Detection	Ramazan & Ashraf (2025)		Fahruri et al. (2023)

Note. Dense clusters appear in adoption, trust, and cost dimensions, while gaps remain in ESG validation, cybersecurity resilience, and global governance harmonization.

The typology developed by it not only confirms the fragmented environment of the field, but also interdependence among trust, cybersecurity and sustainability. The identified gaps serve as the parts of the component of the TCS Triad Framework that unite these three dimensions into a model of the adoption and the legitimacy of robo-advisory platforms ***(see Figure 2).***

5.1.Gap Analysis of the Existing Literature

A review of the existing literature on robo-advisory platforms implies the existence of the extant literature that is abundant in terms of magnitude but has a fractured focus. A lot of the literature has followed two apparently unrelated directions, one being the technical side of algorithms, cybersecurity and regulatory compliance, and the other being the uptake of consumers in terms of the constructs of trust, ease-of-use and perceived value. The notable aspect concerns the lack of a common framework that captures the interaction that happens among the fields to define the legitimacy and sustainability of the robo-advisory platforms. Trust, though widely recognized as the key to adoption, is hardly ever analyzed alongside the

concrete, cybersecurity practices and governance mechanisms through which it could be maintained in the long-term (Baker & Dellaert, 2018; Roh et al., 2023; Yi et al., 2023; Adekoya et al., 2025). Likewise, sustainability, in this case through the combination of ESG portfolios, is underrepresented in the retail robo-advisory market where the issues of greenwashing and authenticity have been overlooked and have an impact on sustainable investing democratization (Faradynawati & Söderberg, 2022; Vasile & Manta, 2025). Another requirement limiting the literature is methodological issues, since most of the studies rely on cross-sectional surveys and lack longitudinal or multimethod studies that could provide an insight into the way trust develops, decays, or is re-built after the occurrence of cyber incidents (Piotrowski & Orzeszko, 2023). To this is the absence of a serious approach to fiduciary duties, the separation of powers with respect to regulation, and the materialization of algorithmic responsibility, which are the pillars of investor protection and platform accountability (Schwarcz et al., 2025; Hsieh et al., 2024). Even solutions that might appear to aid in alleviating algorithm aversion, such as explainable AI (XAI), are hardly implemented in the context of robo-advisory (Bianchi & Brière, 2021; Schwarcz et al., 2025). Taken together, these gaps also point to the need to develop a more holistic, interdisciplinary framework not only highlighting trust, cybersecurity resilience, and sustainability as key enterprises, but also acknowledging them as mutually defining areas of robo-advisory platform uptake and ongoing viability. Several gaps can be identified as follows:

5.1.1 Limited Multi-Method Studies

A preliminary critical literature review revealed that a large majority of empirical studies into the area of robo-advisory platforms are based on single methods of investigating them, i.e. surveys or case studies (Piotrowski & Orzeszko, 2023; Yi et al., 2023). There are a few studies that mix quantitative (e.g. adoption rates, portfolio results) with qualitative (e.g. investor trust

stories) data. This limits the wealth of knowledge on how investors make decisions and how trust is perceived against technological reliability.

As an example, risk-profiling questionnaires are extensively used to segment customers (see Risk Profiling Questionnaires in Investment, uploaded source), but there is little evidence about whether these instruments account for nuances of behavioural finance or whether this kind of instrument is perceived as reliable in digital-only environments.

5.1.2 Limited Empirical Validation of Trust and Cybersecurity Link

Even though various authors consider trust to be the foundation of the robo-advisory platform adoption (Yi et al., 2023; Nguyen et al., 2023), they do not study the connection between trust and cybersecurity risks. Trust is usually conceptualized as a fixed entity, when in fact it is dynamic: a concept that can be greatly affected by the perception of data security, system resilience, and regulatory protection (Baker & Dellaert, 2018).

The existing literature tends to ignore the importance of cyber incidents, regardless of the connection to the loss in investments, in reducing investor confidence beyond the level justified by the incident. This gives an unfilled research gap at the nexus of cybersecurity practices, trust-building systems and the practice of adoption.

5.1.3 Insufficient Research on ESG and Sustainability Integration

Most of the research focuses on institutional sustainable finance, but not retail-oriented robo-advisory platforms, where sustainability integration is an emerging topic in robo-advisory platforms (Faradynawati & Söderberg, 2022). There is poor empirical evidence on:

- The perception of retail investors on the ESG-aligned robo-portfolios.
- Whether the potential to democratize sustainable finance that robo-advisory platforms have arises naturally or is more a matter of rebranding existing ESG products.
- How the algorithmic design can contribute to preventing greenwashing in the long term and allowing the attainment of the actual sustainability alignment.

This break prevents the creation of a multifaceted picture of the potential of robo-advisory platforms in the context of the SDGs application to individual finance settings.

5.2 Contribution of This Study to Address the Gaps

This research has solved the already identified gaps in the literature by using a multi-method approach that will help identify and use a combination of a scoping review, policy analysis, and developing a conceptual framework. Based on a systematic assembly of research results of scholarly examinations, regulatory reports, and industry surveys, the research achieved a thorough summary of the opportunities and issues of robo-advisory platforms.

This study could be able to compare the literature with typology of adoption, risks and governance sustainability based on the secondary data collected. This has demonstrated areas of interest-both models of adoption and efficiency studies, but also unserved topics such as cybersecurity risks, fiduciary duties and integration with ESG.

The research also added to the body of knowledge, in that there was an introduction to the holistical perspective of the technology adoption theories (e.g., TAM, UTAUT), trust frameworks, and the sustainability perspective as introduced within the framework of a regulatory governance. It demonstrates that a lack of trust, regulatory fracturing and risk of data

privacy intersect the element of sustainability to pose threats and opportunities in the transition to the robo-advisory platforms.

It is anticipated that these contributions of the study will add value to the literature through actual practices in the financial services industry through regulation of regulations and sustainable investments. In the instance of institutions, the findings are useful in identifying how to integrate the mechanisms of trust-building and ESG strategies in the digital finance models. The data offer greater compliance framework common grounds to regulators across jurisdictions. The implication of the study to the policymakers is on the way to democratize sustainable finance without the threat of instability. The paper will contribute to the existing body of knowledge regarding the robo-advisory platforms by providing a three-dimensional evaluation of the features in the light of the assumptions of trust, cybersecurity, and sustainability (ESG/SDGs).

5.2.1. Integration of Trust and Cybersecurity

Through examining the overlaps of distrust and cybersecurity risk, this paper demonstrates that trust is a psychological and technical phenomenon. The fact that robo-advisory platforms appear to be less affected by the misuse of information is pertinent to the adoption views and much more important than the strictly anthropocentric idea of being a human versus a robot in terms of the specific use of individual knowledge being more prone to hacking attempts.

5.2.2. ESG and SDGs as a Value-Adding Lens

The future of this study is the ability of robo-advisory platforms to democratize sustainable finance by including ESG filters at scale. Robo-advisory platforms have the potential

to operationalize SDGs at the retail level as compared to traditional advisors; hence, the paper is one of the first to systematically interconnect the algorithmic finance business model with SDGs.

Are robo-advisory platforms promoting sustainability or just changing their name? Low fees and automated onboarding make it easier for more people to get involved, but there is still a gap in impact when ESG portfolios (a) rely on unclear vendor ratings, (b) only show small carbon/governance deviations compared to the underlying benchmark, and (c) don't give much information about sustainability. In TCS terms, weak S (sustainability credibility) makes T (trust) weaker, no matter how strong cybersecurity is. The strategy is to move from "ESG as a label" to "ESG as a legitimate process," which means having clear rules, data that can be checked, and results that can be measured. This changes robo-advisory ESG from being about marketing to being about sustainability backed by good governance.

5.2.3. A Holistic Comparative Framework

In contrast to the disjointed prior works, the present paper compares robo-advisory platforms, human advisors, and traditional platforms to each other and shows that robo-advisory platforms are complements and not substitutes. This analysis is of use to both academics and practitioners.

In the process, this study contributes to a nexus between the trust theoretical model (Afroogh et al., 2024), the current trend in technology adoption (TAM/UTAUT), and sustainability (ESG/SDGs).

5.3 Proposed Framework

Using the analysis, this research proposes the Trust-Cybersecurity-Sustainability (TCS) framework of Robo-Advisory platform adoption. This framework combines a psychological, technical and ethical aspect into one.

5.3.1. Key Components of the Framework:

5.3.1.1. Trust Dimension

Borrowing the model of trust elaborated by Afroogh et al. (2024), it is possible to include foundations of ability (algorithmic competence), benevolence (alignment with client interests), and integrity (transparency in recommendations).

5.3.1.2. Cybersecurity Dimension

The cybersecurity dimension encompasses the perception of risk by the investors, the resilience of the platform, regulatory conformity, and the security of the information relating to clients. One of the biggest threats to robo-advisory platforms is associated with cybersecurity risks that include data breaches, identity thefts, manipulation of algorithms, and others, which are seen to compromise the investor confidence (Adekoya, Atlam, & Lallie, 2025). Cybersecurity and trust are mutually amplifying: the more resilient digital environment is perceived, the higher is the probability of adoption (Afroogh et al., 2024). The significance of uniformity in the fiduciary treatment, alongside the liability regimes and data security, are that the perceived credibility reduces in the cases when the jurisdictions enact inconsistent fiduciary treatment (Schwarcz et al., 2025; Jedličkova, 2024). Such profound treatment of cybersecurity, in its turn,

not only ensures security to financial operations, but it also acts as the producer of long-term trust towards AI-driven finances.

5.3.1.3. Sustainability Dimension (ESG/SDGs)

The sustainability aspect is committed to the connection between ESG portfolios and each other, and their compliance with the United Nations Sustainable Development Goals (SDGs) and the protection against greenwashing. The sustainable democratization of finance became possible due to robot-adviser systems because it is ethically affordable to scale an ESG portfolio, and it is widely accessible (Vasile and Manta, 2025; Abraham, Schmukler, and Tessada, 2019). Still, all is not that sunny in ESG integration; simplified guidelines and inefficient disclosures can create an illusion of sustainability and misdirect the whole process (Nguyen et al., 2023). According to the researchers, the main driving force behind a plausible adoption of ESG is the need to possess transparent reporting, explainable AI models, and good data governance (Faradynawati & Söderberg, 2022; Hsieh, Chang, & Su-han, 2024). By turning ESG into a rigorous process, robo-advisory platforms will be more ethical and will result in the growth of the level of trust of the investors, which will put financial innovation in the same category as sustainability issues.

5.3.1.4. Mediating Role of Investor Behaviour

The behaviour of investors is a key mediating variable in the adoption of robo-advisory platforms. The aspect of cybersecurity guarantees, integration of sustainability, and trustworthiness of the platform are those issues that differ based on risk appetite, financial literacy, and behavioural biases. Literature shows that the rate of adoption is higher among younger and more digitally literate investors than among older generations because they do not

trust the recommendations provided by algorithms and do not know them well (Yi et al., 2023; Piotrowski & Orzeszko, 2023). Preliminary data support the idea that millennial and Gen Z investors are more likely to demand ESG integration than other investors because of their value-oriented investing preferences (De Crescenzo, 2017). Therefore, trust, cybersecurity, and sustainability, as glorified by any investment behaviour are only worth as much as they lead to practical adoption by their investors.

5.3.1.5. Outcome: Adoption and Retention

Trust and cybersecurity, together with sustainability, directly influence both adoption and customer retention in robo-advisory platforms. Technical competence, ethical and felt security influence adoption and retention, which is orchestrated by providing the technical competence, ethical and felt security on a longitudinal basis (Afroogh et al., 2024). Robo-advisory platforms have opened the door to financial advice to a broader scope of people, yet maintaining this kind of clientele implies constant reminding of fairness, transparency, and resilience (Abraham, Schmukler, & Tessada, 2019). According to literature, this area of retention has been underdeveloped, and researchers discussed that human advisors still have advantages in empathy and reassurances during a crisis (Tan, 2020; D'Acunto and Rossi, 2020). Therefore, embedded trust (i.e., explainable AI, cybersecurity soundness, and ESG integrity) processes are critical towards their transition to committed engagements and client retention.

5.4. The Conceptual Framework

This study introduced a conceptual framework, the Trust-Cybersecurity-Sustainability (TCS) Framework, combining dimensions of adoption, trust, governance, and sustainability. The conceptual framework addresses a critical gap in the existing literature by realizing that trust,

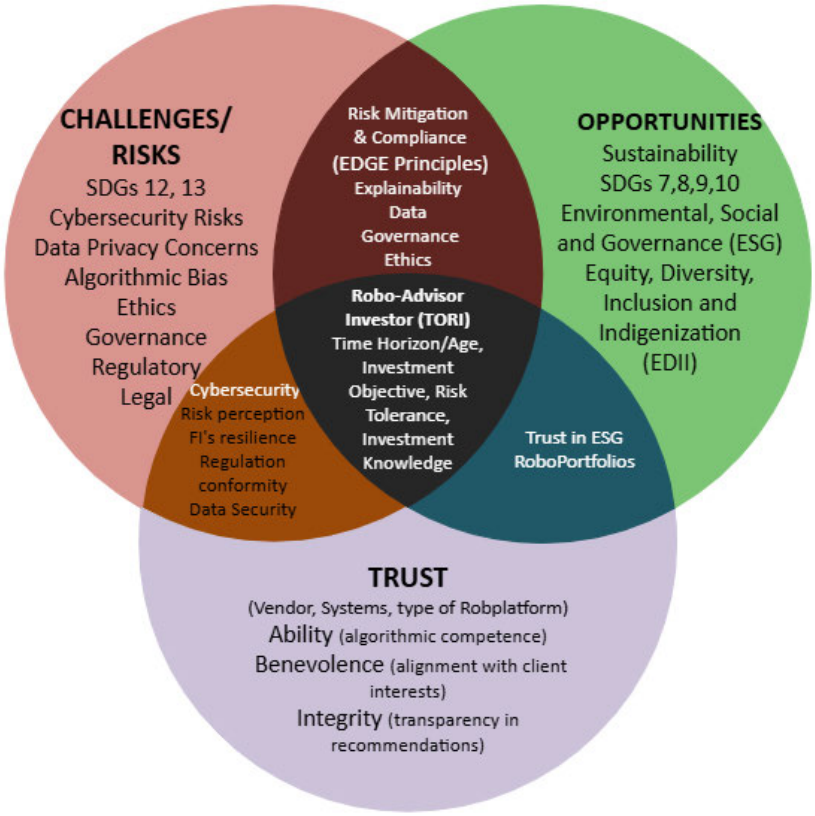
digital resilience, and sustainability integration are all mutually interdependent elements that are key to the successful operation of robo-advisory platforms, especially within the emerging digital finance landscape of Canada.

Validation was achieved through triangulation of the scoping review insights with empirical themes extracted from industry whitepapers and regulatory reports, enhancing the framework's credibility and relevance. This framework contributes to both theory and practice by offering a stakeholder-rich and complex setting.

This framework for ethical and sustainable adoption contributes to theory by expanding current adoption models to ethical and sustainability factors and to practice through a modelling framework applied by institutions, regulators, and policymakers. It is made to be stakeholder-rich, flexible, and interdisciplinary, and thus, such technological innovation becomes compatible with a fiduciary responsibility, cybersecurity precautions, and ESG responsibility.

Financial institutions and policymakers are encouraged to adopt the framework as a guiding cross-disciplinary model for robo-advisory platforms that are trustworthy, resilient and sustainability-focused. Its application is not restricted to Canada but can eventually be used all over the world to construct global standards in balancing efficiency with responsibility in digital finance.

Figure 2. *The proposed TCS Triad Framework for Robo-Advisory Platforms*



Note*. The conceptual framework presented in this study was developed by the author as part of their MBA research project, under the academic guidance and industry-informed expertise of Dr. Shahinaz H. Abdellatif, who served as the subject matter expert (SME)*

The TCS Triad Framework for Robo-Advisory Platforms

The TCS Triad Framework complements the preceding study by bringing together three interdependent dimensions, Challenges/Risks, Trust, and Sustainability Opportunities to understand how the usage of robo-advisory platforms can be adopted, legitimized, and retained over time. Research in this area is still loose and, in some ways, dichotomous, with one body of work dedicated to the technicalities of cybersecurity and compliance (Adekoya, Atlam, & Lallie, 2025; Afroogh et al., 2024) the other in terms of user endorsement as well as confidence (Yi et

al., 2023; Piotrowski & Orzeszko, 2023), with a third currently making its mark on ESG integration and sustainable finances (Faradynawati & Söderberg, 2022). However, these three views are seldom combined, and it remains unanswered how the three interrelate with each other in practice. The TCS Triad Framework fills this gap by conceptualizing robo-advisory platforms as socio-technical systems where their viability must be related to robo-advisory platforms managing risks, building trust, and the sustainability of robo-advisory platforms must be embedded in their design and governance.

The first dimension, Challenges/Risks, recognizes that threats to security extend past cybersecurity violations to data privacy threats, algorithmic bias, disproportional enforcement of the law, bad governance, and legal risks, including cross-border liability and fiduciary duty enforcement. Also, it is linked to risks connected to sustainability, such as SDGs 12 and 13 being threatened by greenwashing or by energy-intensive and water-provisioning algorithms. This problem is the so-called carbon footprint of AI, where the energy being spent and the amount of water utilized to train large models are enormous and can take away the climate goals the robo-advisory platforms are supposed to be propagating (Bolón-Canedo et al., 2024). Data breaches, identity theft, and algorithm manipulation have also been listed as some of the most necessary cautions to digital advice, shaking investor confidence in the process (Adekoya, Atlam, & Lallie, 2025). The literature helps us understand that strong cybersecurity resilience positively correlates with adoption by minimizing the perceived risk and demonstrating the reliability in digital space (Afroogh et al., 2024). Meanwhile, the disparity in the enforcement of fiduciary duty on a cross-jurisdictional level undermines trust, so there is an importance of a strong regulatory structure and enforcement authority (Schwarcz et al., 2025; Jedličková, 2024).

The second dimension, Sustainability Opportunities, demonstrates that ESG integration and the United Nations 17 Sustainable Development Goals (SDGs) can be used to gain higher legitimacy in robo-advisory platforms. It seems that robo-advisory platforms have a unique opportunity to democratize sustainable finance by scaling to offer low-cost/accessible ESG portfolios (Vasile & Manta, 2025; Abraham, Schmukler, & Tessada, 2019). The most problematic, however, is weak disclosures and simplified ESG standards that can be used as an attempt at greenwashing and kill the credibility and resulting trust in investors (Nguyen et al., 2023). According to the researchers, in order to achieve credible ESG adoption, there must be transparent reporting, explainable AI models, and strong data governance (Faradynawati & Söderberg, 2022; Hsieh, Chang, & Su-han, 2024). To expand on this, Bolón-Canedo et al. (2024) advocate the implementation of green AI, the models of machine learning and greener algorithms that will incur lower costs of computation and will still be accurate. These practices can make robo-advisory platforms consistent with SDG 13 by lessening their impact on the environment. Strict implementation of ESG is likely to empower more ethically amenable robo-advisory platforms, allowing financial innovation to play a role in meeting sustainability objectives, such as SDGs 7, 8, 9, & 10, and EDII.

The third dimension, Trust, based on Ability (competence), Benevolence (alignment with client interest), and Integrity (transparency in recommendations), and influenced by the vendor, underlying systems, and the type of robo-advisory platform, examines the competence of the platform as a factor of adoption and retention, investor interests and efficient communication. This is mediated by investor behaviour: the younger crypto-savvy generations are more easily

accessed by robo-advisory platforms, and older clients are less comfortable through their relative lack of familiarity and general lack of confidence with algorithmic systems (Yi et al., 2023; Piotrowski and Orzeszko, 2023). At the same time, millennials and Gen Z investors are particularly perturbed about the integration of ESG and are ready to invest in the assets that would allow them to contribute to your financial performance with their own values (De Crescenzo, 2017). This can leave such behavioural conditions clear, whereby trust is not in a vacuum but instead platform and investor dependent.

The operation space of the robo-advisory platform is at the intersection of these three dimensions, where validation measures, risk management, and the EDGE principles (Ethics, Data Governance, and Explainability) decrease the risk of non-compliance audit, and client-centred portfolio construction (TORI: time horizon, objectives, risk tolerance, investment knowledge) and ESG integration are developed. Adoption levels are caused by perceptions of competence, resilience, and sustainability fit, and retention is determined by the endurance of fairness, transparency, and reliability (Afroogh et al., 2024; Tan, 2020; D'Acunto and Rossi, 2020). The TCS Triad Framework, in such a manner, brings together diverse literatures into a new, interdisciplinary model, showing how the three components, trust, cybersecurity, and sustainability, not only operate independently but are mutually reinforcing pillars of robo-advisory adoption and long-term legitimacy.

6. Limitations

This study presented several limitations that must be acknowledged when interpreting and informing future research.

6.1 Absence of Primary Data Collection

This study is founded on a literature-based analysis mainly. Because the secondary sources deliver a very strong theoretical background, the absence of survey, interview or experimental data, however, results in some conclusions being more conceptual than empirical.

6.2 Generalizability Across Markets

Regulatory and cultural factors, where a robo-advisory platform is adopted, can widely differ by region (e.g., North America, Europe, Asia). The scholarship used in this paper is global and therefore it can lack accuracy with a single jurisdiction.

6.3 Technological Evolution

FinTech is a very fast-moving discipline. New trends in AI (such as explainable AI, generative models) and blockchain-based advisory may become outdated very soon and render existing frameworks obsolete. Therefore, as much as the Trust-Cybersecurity-Sustainability (TCS) framework is applicable in modern times, it may require improvements in the future.

6.4 ESG Data Reliability

There is a likelihood of greenwashing and inconsistencies in reporting the ESG data and its metrics. The reliance on the literature available in this study presupposes a certain level of data soundness, which is disputable in practice.

6.5 Behavioural Assumptions

The model is based on rational behavioural assumptions of investors in relation to trust, cybersecurity, and ESG levels. Behavioural finance studies, however, reveal that predictions tend to be subjected to biases, emotions, and heuristics, which tend to influence decisions and hence introduce uncertainty in the prediction.

7. Recommendations and Future Research

7.1 Recommendations

Following the investigation, there are a few recommendations to be offered to various stakeholders:

For Regulators

- Establish universally accepted global regulatory frameworks, especially on cybersecurity controls and environmental, social, and governance (ESG) disclosures on robo-advisory platforms.
- Implement stress-testing of algorithms like stress tests in banking so that algorithms can hold up against cyberattacks.

For Robo-Advisory Platforms

- Increase the transparency of algorithms to give customers understandable and interpretable explanations of portfolio recommendations.
- Add assurances around cybersecurity to marketing and onboarding, and present trust as a guarantee that goes beyond a service feature but is a means of mitigating risk.
- Enhance ESG products with the use of AI-based ESG screening tools that reduce greenwashing and make their portfolios consistent with the SDGs. In this respect,

emerging AI principles can be applied to develop energy-efficient machine learning models not only to reduce the cost of computation, but also to democratize access to sustainable fintech solutions (Bolón-Canedo et al., 2024).

For Investors

- Increase the financial literacy on the subject of how robo-advisory platforms operate, namely the aspects of data privacy, ESG portfolios, and risk management instrumentation.
- Induce investors to insist on multi-layered warranty signs (certifications, third-party audits, and security certifications) with the providers.

7.2 Future Research

The next research direction should be based on the study and cover its weaknesses, and continue the discussion about the robo-advisory platform adoption:

7.2.1. Empirical Validation of the TCS Framework

Conduct surveys and experiments to investigate the relationship between trust and perception of cybersecurity trust and sustainability with adoption behaviour.

7.2.2. Cross-Cultural Comparisons

Determine whether different cultures (e.g., collectivism and individualism) result in different perceptions of the credibility and ESG appeal of robo-advisory platforms.

7.2.3. Behavioural Finance and Robo-Advisory Platforms

Explore how cognitive biases (overconfidence, loss aversion) are presented to determine adoption decisions beyond rational factors of trust/cybersecurity.

7.2.4. AI Explainability and Trust

Explore how explainable AI (XAI) can be used in robo-advisory platforms to achieve higher adoption of the technology by users, and reduce regulatory risk.

7.2.5. Blockchain and Decentralized Finance (DeFi)

Consider how this could disrupt current models of robo-advisory platforms because of the potential of blockchain-based robo-advisors, which would enhance cybersecurity and transparency, along with ESG monitoring.

7.2.6. Longitudinal Studies

Monitor robo-advisory platform long-term client retention, as adopting is just the beginning - the trust has to be sustained over the years (this is another issue that is less explored).

8. **Conclusion**

This study provides a significant contribution to both theory and practice by aiming to examine the promising potential and impending dilemmas of AI-driven robo-advisory platforms critically and give specific attention to how concerns related to trust, cybersecurity risks, and integration of sustainability into the robo-advisory context will influence the current adoption processes in the digital finance age. A scoping review of academic, regulatory, and industry references identified 3 key themes: risks (Cybersecurity, legal and data privacy exposures), consumer protection (trust, transparency, redress and stakeholder requirements), and governance (fiduciary duty, algorithmic accountability and RegTech/CSR). Such thematic implications prove

that even though robo-advisory platforms make finance more approachable and more affordable and customized (in particular, the introduction of ESG-appropriate portfolios), democratizing the access to such services, the barriers, which already exist, such as the lack of well-consistency in regulations, data misappropriation, and the lack of transparency in the algorithms, limit the offerings of robo-advisory platforms, not to mention the lack of trust among the investors.

In solving these challenges, the present study suggests the Trust-Cybersecurity-Sustainability (TCS) Framework that balances all three models, namely, psychological, technical, and ethical and develops a consistent model of adoption. The framework illuminates that the role of trust on digital resiliency and performance of robo-advisory platforms is mediated by investor behaviour, and efficiencies translate into adoption and retention in cases of perceived fairness, transparency, and resilience of robo-advisory platforms. By suggesting this model, the work contributes to theory and practice by elaborating adoption/trust scholarship within the lens of sustainability and governance and by providing regulators, policymakers, and financial institutions with a framework that facilitates the development of sustainable and trust-driven, resilient, and trustworthy robo-advisory platforms.

The research also suggested that there were certain long gaps, such as limited application of empirical method, underdeveloped validation of the nexus between trust and cybersecurity and insufficient evidence of the threat of the ESG integration and greenwashing. These indicate the need for future research that combines the longitudinal information with the behavioural finance experiments, explainable AI (XAI) demonstration and cross-cultural studies to verify and refine the TCS model.

In conclusion, Robo-advisory platforms are not aimed to replace human financial advisors but rather become an inseparable addition that must be adopted by the majority. On their part, they will succeed by bridging the prevalent trust, cybersecurity resilience and sustainability integrity gaps. With the Trust-Cybersecurity-Sustainability (TCS) Framework in place, the institutions and the regulators will have a chance to make sure that they are not only efficient, but also ethical and resistant simultaneously. Finally, green financial democratization can be supported by robo-advisory platforms, since, besides uniting technological experimentation, fiduciary diligence, and international sustainability goals, it can also turn into a tool of inclusive and responsible digital finance.

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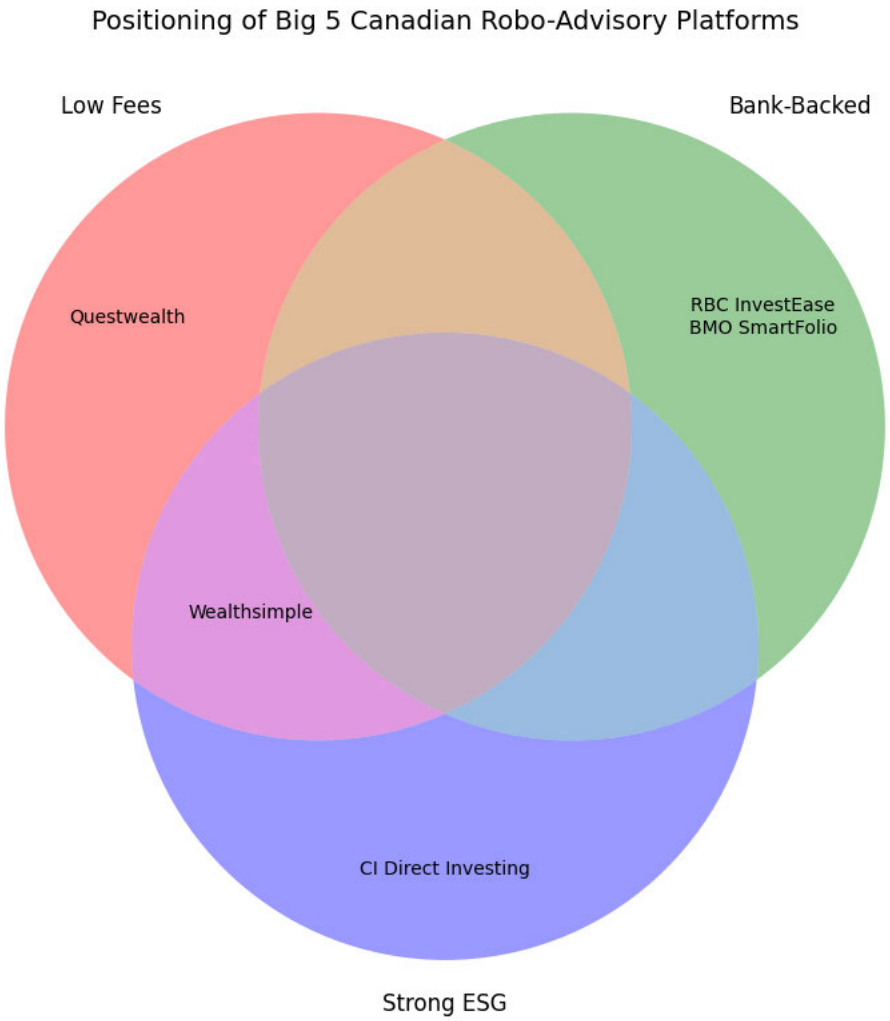
Appendix A: Robo-Advisory Platforms in Canada

The diagram below shows how the Big 5 robo-advisory platforms in Canada can be ranked based on three factors, namely Low Fees, Bank-Backed Trust and Good ESG Offerings.

Figure A1. *Placing the Big 5 Canadian Robo-Advisory Platforms along Low Fees, Bank-Backed Trust, and Good ESG criteria.*



Note. *Self-created using Python in Google Colab.*

This positioning idea assists in accentuating the comparative advantages of the major robo-advisory platforms in Canada without involving the exact figures on AUM.