KTH ROYAL INSTITUTE
OF TECHNOLOGY

Licentiate Thesis in Business Studies

Understanding Customers in AI-empowered Financial Advisory Systems and Services

An interdisciplinary study of Robo-advisors

HUI ZHU

Stockholm, Sweden 2023

Understanding Customers in AI-empowered Financial Advisory Systems and Services

An interdisciplinary study of Robo-advisors

HUI ZHU

Academic Dissertation which, with due permission of the KTH Royal Institute of Technology, is submitted for public defence for the Degree of Licentiate of Philosophy on on the 30th of May, 2023, at 10.00 a.m. in E2, Qsquars backe 2, KTH campus, Stockholm

Licentiate Thesis in Business Studies
KTH Royal Institute of Technology
Stockholm, Sweden 2023

ISBN 978-91-8040-572-0
TRITA-ABE-DLT-2323

Printed by: Universitetsservice US-AB, Sweden 2023

Abstract

AI-empowered financial advisory services, also known as robo-advisors, present both innovations and challenges as they replace human financial advisors, reshape customer service, and attract customers with different characteristics than their predecessors. Therefore, it is more important than ever for financial service providers to understand customers' perception and experience of using robo-advisors on the service front line. However, our systematic literature review indicates that research on robo-advisors is scattered across different disciplines with a narrow focus on sharing knowledge across fields. Moreover, empirical studies on robo-advisors have primarily focused on customer acceptance and intentional behaviors, often based on data collected through surveys. Also, these studies have paid less attention to the role of robo-advisor design and the context in which customers interact with fully functional robo-advisors in real-life situations. To address these gaps, this thesis aims to synthesize interdisciplinary knowledge and identify gaps in the research on robo-advisors. It also aims to explore customers' experience of using and interacting with robo-advisors and how the experience affects their perception and adoption of the service. By conducting a systematic literature review and a qualitative user study, this thesis finds that customers' perceptions of robo-advisors often do not meet their expectations. Non-transparency and incomprehensible information about the system's decision-making are significant barriers to customers' adoption of robo-advisors. This thesis contributes to a deeper understanding of customers in AI-empowered financial advisory services by using theories and approaches across different disciplines. It also provides practical implications for practitioners in the robo-advisory service industry.

Keywords: FinTech; artificial intelligence; automated information system; robo-advisors; customer service experience; financial advisory service

Sammanfattning

AI-förstärkta finansiella robotrådgivare innebär både innovationer och utmaningar eftersom de ersätter mänskliga finansiella rådgivare, omformar kundservice och lockar till sig andra typer av kunder än deras föregångare. Därför är det viktigare än någonsin för tjänsteleverantörer i det finansiella systemet att förstå kunders erfarenheter och upplevelser av robotrådgivning i servicefronten. Dock indikerar avhandlingens systematiska litteraturgenomgång att tidigare forskning om robotrådgivare är spridd över olika discipliner med begränsat fokus på att dela kunskap mellan disciplinerna. Dessutom har de empiriska studierna rörande robotrådgivare primärt fokuserat på kundacceptans och intentionsbeteenden – ofta baserat på data insamlad via enkäter. Tidigare studier har också ägnat mindre uppmärksamhet åt robotrådgivares design och den kontext där kunder interagerar med robotrådgivare i verkliga situationer. Baserat på dessa brister i tidigare studier syntetiserar avhandlingen tvärvetenskaplig kunskap och identifierar luckor i forskning om robotrådgivare. Avhandlingen utforskar också kunders erfarenhet av att använda och interagera med robotrådgivare och hur dessa erfarenheter påverkar deras upplevelser av och användande av tjänsten. Genom en systematisk litteraturgenomgång och en kvalitativ intervjubaserad användarstudie visar avhandlingens studier att kunders upplevelse av robotrådgivare inte motsvarar deras förväntningar. Bristande transparens och svårbegriplig information om systemets beslutsfattande är betydande hinder för kundernas antagande av sådana tjänster när de interagerar med robotrådgivare. Avhandlingen bidrar till en djupare förståelse för kundupplevelser av AI-förstärkta finansiella robotrådgive genom att integrera teori och metod från olika discipliner. Det ger också praktiska implikationer för finanssektorns företag med verksamhet inom robotrådgivning.

Nyckelord: FinTech; artificiell intelligens; automatiserat informationssystem; robotrådgivare; kundupplevelse; tjänsteföretag; finansiell rådgivning

Acknowledgments

A licentiate thesis is the halfway journey for me as a PhD student, and it is also a critical checkpoint to summarize and evaluate my current work. Most importantly, this thesis helps to illustrate the visionary direction for my future research. I want to thank all the people who helped during my research and writing of this thesis.

First, I would like to express my sincere gratitude to my principal supervisor, **Inga-Lill Söderberg** for her unconditional support and fundamental advice towards my overall research and individual plan for personal development. Thanks for giving me the opportunity to start my licentiate programme at one of the top universities worldwide, and granting me many opportunities to join different courses and conferences to expand my competence. I would also like to thank my vice-supervisor, **Prof. Eva-Lotta Sallnäs Pysander** for giving me much encouragement and constructive advice on every detail of my research practice, article formulation, and academic writing. These two supervisors are also role models as splendid female researchers for encouraging and guiding me during my research journey at KTH.

Second, I would like to thank **Olli Vigren** for being my co-author of Paper I and for contributing his expertise regarding the methods and theoretical building of that paper. Also, I would thank **Prof. Kent Eriksson** for being my advance reviewer and **Jakob Tholander** for agreeing to be the opponent at my licentiate defense.

Third, I want to thank my colleagues in the Division of Real Estate Business and Financial System who gave me feedback in our division research seminar such as **Andreas Fili**, **Agnieszka Zalejska Jonsson**, **Henry Muyingo**, **Lotta Snickare**, and **Anna Broback**. And thanks to the administrators in the Department of Real Estate and Construction Management, especially **Marie Larsson**, **Eva Magnusson**, **Tora Hedenvind**, and **Annette Stenberg**, for supporting my study and research. Moreover, I would give my special thanks to my previous colleagues in the Human-computer Interaction team at Uppsala University, where I worked together with **Prof. Annika Waern**, **Laia Turmo Vidal** and **Elena Márquez Segura** as a research assistant. They enlightened me by opening the door to academia and helped me lay a solid foundation for my upcoming studies and research in KTH. I also want to thank **Prof. Christina Keller** from Lund University for providing guidance on developing the concept of Paper I during my PhD course.

Moreover, I want to show my special thanks to my fellow PhD students who have inspired me and shared my sorrow and happiness, especially **Ida Faradynawati** and **Kritthana Kimuam** who are PhD students in my division, and **Petra Jääskeläinen** who is doing her PhD in the media technology group at KTH. I also want to thank **Joakim Fichtel, Jing Sun** and **Hsu-Chi Weng** for their support.

Also, I would like to thank my husband **Tianmin Lyu** for his unconditional support and love, and my cats **Roro** and **Coco**, who keep companying me beside my laptop and being cute and calm while I am writing papers and my thesis. I also want to thank my friends **Sara Lessing** for helping me translate the thesis abstract into Swedish and **Lili Liu** who always supports and believes in me.

Last, I appreciate all participants who joined my empirical study as volunteers and anonymously contributed to scientific research.

Table of Contents

List of Figures

List of Tables

List of Papers and Contributions

This thesis is based on the following two papers, which are referred to in the text by their Roman numerals.

Paper I: Zhu, H., Vigren, O., & Söderberg I. L. (XXXX). Implementing AI-empowered Financial Advisory Services: A Literature Review, Integrative Framework, and Critical Research Agenda. (*submitted for review*)

Paper I was written by me, Vigren and my main supervisor Söderberg. I was responsible for the first round of literature searching, and Vigren joined me in the paper screening process and content analysis. I was mainly responsible for writing the paper under Söderberg's guidance. Vigren contributed to the texts of method. Söderberg contributed to the theoretical basis and revision.

Paper II: Zhu, H., Sallnäs Pysander, E. L., & Söderberg, I. L. (2023). Not transparent and incomprehensible: A qualitative user study of an AI-empowered financial advisory system. *Data and Information Management.* (accepted on April 20, 2023)

Paper II was written by me, my vice-supervisor Sallnäs Pysander, and Söderberg. The protocol and interview questions were designed by me and Söderberg. The user tests and data analysis were done by me under the supervision of the two co-authors. I was mainly responsible for writing the paper. Sallnäs Pysander contributed to part of the texts of method and several rounds of revision. And Söderberg contributed to texts of related work.

List of acronyms and abbreviations

AI	Artificial Intelligence
FinTech	Financial Technology
HCAI	Human-centered AI
HCI	Human-computer Interaction
IS	Information System
FinTech	Financial Technology
UI	User Interface
RA	Robo-advice
RAs	Robo-advisors
RA service	Robo-advisory service

1 Introduction

This licentiate thesis is a compilation thesis comprising two full research articles. By adopting interdisciplinary studies, this thesis investigates: (1) customer service in artificial intelligence (AI)-empowered financial advisory systems; and (2) customers' interactions with the interfaces of this autonomous intelligent system in frontline service encounters. The primary focus is on customers' perception and their experience of using this AI-empowered service; and how service providers can adopt this customer-centered perspective in introducing and implementing frontline services of AI-empowered financial advisory services.

This section will introduce the research rationale, research purposes, and research questions of this licentiate thesis. The structure of the whole thesis will be presented at the end of this section.

1.1 Research rationale

AI-empowered technology has been implemented in various service sectors, constructing innovations and challenges for service providers' transformation in frontline customer services. In financial service sectors, this AI-empowered technology provides advisory financial services to customers directly without human interventions, replacing frontline employees who are experts in giving customers advice regarding financial management or investment. This type of service is called a robo-advisory (RA) service, and its underlying information systems, together with the interactive interfaces, are known as robo-advisors (RAs). Unlike other technology innovations in financial services (e.g., ATMs, digital wallets, and Internet banks), the AI-empowered system behind RA can interpret and learn from numerous data to adapt to the preferences of different customers, making accurate predictions of the markets, recommending customized portfolio, and rebalancing and maintaining customers' investment (Fisch et al., 2019; Jung, Dorner, Glaser, et al., 2018; Jung et al., 2019). The current RAs now have similar features and workflow (Figure 1). Customers can download them from application stores on the mobile end or visit their websites. Some interfaces of RAs are designed as conversational chatbots, with or without avatars. Given these technological advancements, RAs have been promoted by service providers to replace human financial advisors and attract those customers who are different from those targeted by conventional advisory services.

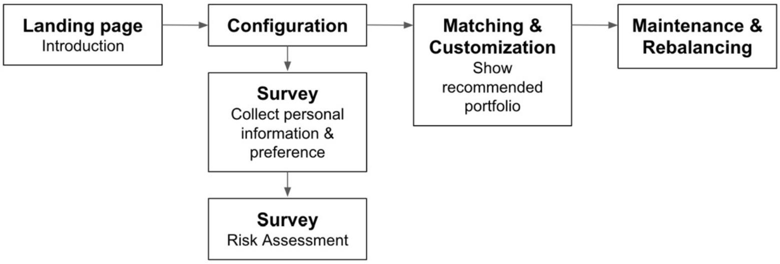

Figure 1. The workflow of a Robo-advisory system based on Nueesch et al. (2014).

RAs have proven their potential market values by attracting an increasing number of retail investors and managing their wealth. According to CNBC, RAs have managed approximately $785 billion since the first customer-facing RA launched around 2008 (Iacurci, 2022). RAs also experienced explosive market growth during the COVID-19 pandemic when customers became more open to digital and automated services (Ben-David & Sade, 2020; Gan et al., 2021; Guo & Polak, 2021; Insider Intelligence Editors, 2021). Therefore, RAs now attract attention from researchers in different disciplines and practitioners in both conventional financial industries and FinTech companies. Despite RAs' rapid growth worldwide, there are undeveloped questions revolving around customers' perception and experience of RAs in service encounters. In this thesis, the encounter is a broad term indicating customers' indirect or direct interaction with RA services.

Studies of customers in financial service sectors have historically been related to the customer-bank relationship (Morgan & Hunt, 1994). In line with this logic, conventional financial advisory service primarily relies on human experts who communicate with customers by establishing and maintaining a trustworthy customer-bank relationship to nudge customers' investment decisions (Silic & Ruf, 2018; Söderberg, 2013). However, RAs have disruptively changed this situation by replacing human experts with autonomous systems and interactive interfaces in service encounters. These intelligent interfaces have become the only intermediary customers can access to interact with service providers. Previous knowledge in financial advisory services is no longer applicable to RA services. Also, research has stagnated in the broader context of financial service sectors by focusing on customer experience in Internet banking (Chauhan et al., 2022; Klink et al., 2020; Mbama & Ezepue, 2018). Therefore, research in financial advisory services calls for interdisciplinary foci on customer-AI interaction and their experience in autonomous intelligent systems.

In the context of Information Systems (ISs) and Human-centered AI interaction (HCAI), customers' perception of autonomous intelligent systems and the design features of interactive interfaces of RA are the main foci (Ben David et al., 2021; Deng & Chau, 2021; Deo & Sontakke, 2021; Hildebrand & Bergner, 2021; Jung, Dorner, Weinhardt, et al., 2018). Most of these studies utilize anthropomorphic design and explainable AI to address trust issues and information opacity when customers interact with RAs. These studies have highlighted the "black box" issues of RA systems and sought attention to customers' perception of the RA service frontline. However, few empirical studies are based on evaluations or user tests of fully functional RA systems (e.g., a robo-advisor by a retail bank). Moreover, user tests in some literature lack consideration of customers' real-life situations (e.g., incomes, risk groups, and investment preferences). Hence, to improve the RA system design and understand customers' perception of RA service, it is necessary to conduct empirical studies based on customers' interaction with functional RAs in real-life situations.

Obtaining an in-depth understanding of customers is more significant than ever for providers to introduce and implement RA services successfully. By removing human financial advisors, customers highly depend on their comprehension of information in RAs to make financial decisions (Salo & Haapio, 2017). A majority of empirical studies regarding RA customers are based on behavioral finance (Bhatia et al., 2020; Chong et al., 2022; Deng & Chau, 2021; Shanmuganathan, 2020) and the technology acceptance model (Belanche et al., 2019; Gan et al., 2021; Hohenberger et al., 2019; Seiler & Fanenbruck, 2021). Studies anchored in behavioral finance investigate factors affecting customers' financial decision-making in purchasing financial products recommended by RAs (e.g., overconfidence, risk aversion); while researchers using the technology acceptance model treat RAs as a type of emerging technology. By conducting quantitative surveys, these studies interpret customers' perception and behavioral intention of using RAs. However, two knowledge gaps are identified from the existing research focusing on RA customers. First, these customer-related features have been scattered around in different disciplines, not being synthesized yet. Second, without being connected to service design or customer service encounters, these studies have limited contributions to service providers regarding introducing and implementing RA services in an emerging market. Therefore, service providers require a more comprehensive framework with a state-of-the-art understanding of making managerial decisions in practice.

In conclusion, the gaps identified and addressed in this thesis are: (1) the lack of customer-AI interaction logic in financial advisory services; (2) the need for more empirical data based on customers' experience in using and interacting with functional robo-advisory systems in customers' real-life situation; and (3) the interdisciplinary knowledge regarding RA needs to be integrated and synthesized for service providers to be able to implement customer services.

1.2 Research purposes and research questions

To mitigate the knowledge gaps identified in the research rationale section, this thesis aims to seek an in-depth understanding of customers' perception and interaction with AI-empowered financial advisory systems, as well as the services in these systems. This thesis also aims to provide a basis for providers to make managerial decisions when designing and implementing robo-advisory services. The sub-aims of this thesis are as follows:

Sub-aim 1: To synthesize interdisciplinary knowledge and identify gaps in existing research related to RA customers and their interaction with RA services and systems.

Sub-aim 2: To explore factors affecting customers' ability to use RAs and their perception and adoption of RAs.

Accordingly, the research questions (RQs) of this thesis are:

RQ1: What is the knowledge, supported by empirical and theoretical evidence identified in the existing literature, that can help service providers to design and implement AI-empowered financial advisory services?

RQ2: How does customers' experience interacting with robo-advisory systems affect their perception and adoption of this AI-empowered financial advisory service?

1.3 Definitions and scopes

This section explains the definitions of recurring terms and concepts in this thesis. For those concepts with many different definitions, the one that suits the context most is selected and interpreted here (Table 1).

Table 1. Definitions of important terms in this thesis.

Terms	Definitions in this thesis
Artificial intelligence (AI)	According to the Oxford Dictionary, AI addresses computers' human-like task performance competencies, e.g., learning, reasoning, self-correction, speech recognition, decision-making, etc.
AI-empowered service	Service that is partially or delegated by intelligent agents supported by AI capabilities, also known as AI-enable and AI-mediated.
Machine Learning (ML)	As a subset of AI, ML addresses the method of using data and algorithms that AI learns, adapts, and improves its performance, such as accurate predictions.
Algorithm	"An algorithm is a thing that programs implement, gets data process and other computation done" (Hill, 2016. p.35).
Transparency	Transparency is the process of making information explicitly and openly available so that users can exploit the disclosed information to make decisions. In Information Systems and design science, the challenge of information (Turilli & Floridi, 2009).
Explainability	The reasoning mechanism underlying an autonomous system and its output/decision can be explained in a way that human beings can understand, also commonly used in Explainable AI (XAI).

The robo-advisory services and systems discussed in this thesis are customer-facing, which provide services including financial planning, investment portfolios, asset management, and maintenance. Thus, other AI-empowered financial services, such as insurance and mortgage, or services for business firms are excluded from this thesis.

In Paper II, a representative RA by a retail bank is selected for user testing and evaluation. Based on this specific RA, the findings can be generalized to other RAs because popular RAs have a similar workflow (Figure 1). The distinctions between different RAs could be the financial products constituting the investment portfolio (e.g., funds and stocks) or different strategies in funds management, which are back-end services and not in the scope of our discussion.

1.4 Structure of the thesis

The following contents of this thesis start with a background section (Section 2), including theoretical underpinning and a summary of related work. Section 3, Methodology and Method, introduces the motivations and logic of method selections. This section also addresses the methods used in Paper I and Paper II, including the user study design, data collection, analysis, and ethical considerations. Section 4 builds on the empirical and theoretical findings of both Paper I and Paper II. These results are also examined and discussed in this section. Section 5 presents the contributions, including implications for practitioners and researchers in highly relevant fields. The limitations and future work of this thesis are also discussed.

2 Background

This section begins with an introduction to the supportive theories where this thesis is positioned. Due to the interdisciplinary nature of RAs, the synergy between financial advisory services and human-centered AI logic can be addressed by this thesis. This section also introduces and summarizes the state-of-art research and literature review papers revolving around RAs, however, in a brief way. This is because Paper I is a systematic review article synthesizing current studies focusing on RAs. Last, the gaps in the related work are addressed, and these gaps are supposed to be mitigated by this thesis.

2.1 Theoretical underpinnings

2.1.1 Financial advisory services

Customer service in financial service sectors has historically been about the relationships between customers and service providers (Allen & Gale, 1999; Barnes & Howlett, 1998; Morgan & Hunt, 1994; Peppard, 2000). Financial services are intangible, involve a high degree of expert knowledge, and the service quality is difficult to evaluate (Mukherjee & Nath, 2005). Financial markets and services are also difficult for laypeople (i.e.: people with little knowledge or no time to look closely at financial investment) to understand (Hilgert et al., 2003; Moore, 2003). The development of a relationship between a customer and a service provider serves to mitigate uncertainty from customers. This could earlier be a human financial advisor who takes over in assuring a relationship with the customer.

In line with this logic, human advisors play a significant role in financial advisory services by establishing and maintaining customer-bank relationships and communicating with customers in explaining complex financial products in the frontline service (Söderberg, 2013). Besides the role of human advisors, customers' decision-making is another research focus in financial advisory services. Under this research focus, studies based on behavioral finance share the notion that customers are not rational, and their financial decisions can be affected by psychological factors and bias. Therefore, financial advisory service encounters should address these issues (Bonaccio & Dalal, 2006; Chen & Koufaris, 2015; Chira et al., 2008; Cruciani, 2017). Studies focusing on customers' characteristics are predominant in this field and profoundly impact future research (Collins, 2012; Engelmann et al., 2009; Nguyen et al., 2016).

These predominant theories in conventional financial advisory services construct foundations of upcoming research in AI-empowered financial advisory service encounter in understanding customers. RA service removes human advisors, and the interactive interfaces installed on the mobile end or websites have become the only way for customers to interact with service providers. These factors revolving around financial service encounter profoundly influence RA service encounters. For example, customer features and the trustworthy relationship between customers and RAs. These factors have been synthesized and contextualized in AI-empowered advisory services in Paper I. These theories used in conventional financial advisory also help with the user test design in Paper II. However, the RA service encounter is more complex in the Human-AI interaction era. Customers' behaviors are even harder to investigate due to the involvement of algorithm-related factors in financial services, for example, customers' attitudes towards algorithms and their ability to use intelligent autonomous systems for financial investment. Based on the conclusions of this thesis, I argue that these theories should be developed by including knowledge from other disciplines and factors generated in the interactions between customers and AI-empowered technologies.

2.1.2 Human-centered AI

Researchers in human-centered AI (HCAI) share the notion that high levels of human control should have the same importance as the design and implementation of high levels of automation, addressing the essential roles of human-centered approaches, for example, user-experience design, stakeholder engagement, usability testing, iterative refinement and evaluation (Shneiderman, 2022; Stanford University, United States of America & Auernhammer, 2020). Based on human-computer interaction, HCAI deploys a human-centered perspective into an algorithm-focused view (Xu, 2019). This human-centered perspective also shapes the future of AI by considering ethics, technology delegates human intelligence, and human factors design, therefore proposing reliable, trustworthy, and satisfactory solutions for users to adopt in everyday life. HCAI aims to prevent or correct errors made by AI and provide explainability and transparency to users who question how the decisions are made by AI-empowered systems.

In financial advisory services, transparency and explainability are important because customers' involvement level is relatively higher and is long-term compared with other service encounters. Customers face the possibility of losing their wealth if selecting an underperforming RA. Moreover, because RAs remove human advisors and lower the entry bar of customers, customers who do not understand the financial terms or logic behind the investment decision made by the autonomous systems will leave, even though RAs are found to perform better than human advisors in some studies (Beltramini, 2018; D'Hondt et al., 2020). In reality, RAs are originally driven and promoted by service providers (Fisch et al., 2019), and to the best of the author's knowledge, no existing research has conducted any user studies on existing RAs. Therefore, adopting this human-centered AI approach is necessary to evaluate and refine the current RAs to generate new knowledge and insights for designing and implementing such autonomous systems in financial advisory activities. The thesis is under the implication of the theory of HCAI.

2.2 Related work

2.2.1 Financial customer service in the age of digital transformation

Financial innovation and the development of technology continuously reshape frontline customer services and service encounters. In conventional financial advisory services, potential interest conflicts exist between customers and advisors when advisors recommend financial products that can harvest more incentives for themselves rather than prioritizing customers' profits (Bolton et al., 2007; Burke et al., 2015). Thus, providing customers with transparent information in the service encounter can assist customers in understanding the logic and reasoning underlying the advice proposed by financial advisors (Smith, 1998). This can also help to establish a trustworthy relationship between customers and financial advisors. To address this issue, researchers develop digital solutions, including supportive platforms for human advisors to use in frontline customer service encounters, as well as collaborative tools installed in tablets that help human advisors share symmetry information with customers (Kilic et al., 2015; Nueesch et al., 2014, 2016; Nussbaumer et al., 2012; Nussbaumer & Matter, 2011). These studies lever up the roles of digital solutions and prove that the design of digital tools is as important as the other factors in financial advisory service encounters (e.g., the personality of advisors, the reputation of banks, and the performance of financial products). Moreover, these digital innovations also prepare the autonomous transformation of financial advisory services by proposing significant design principles in frontline service encounters, including human-centered design, fee transparency, and perceived comprehensibility, even though these digital platforms are only supportive tools for human advisors.

2.2.2 Service robot: AI-empowered customer service in the frontline

With the development of machine learning and data science, technologies empowered by AI have been used in customer services to replace frontline employees of service providers. Unlike digital tools, these AI-empowered tools can learn from customers' data, tailor service to their requirements, and predict their behaviors (Kaplan & Haenlein, 2019; Robinson et al., 2020). Customers can experience services and interact with service providers through interactive interfaces, and such autonomous interfaces are called service robots (Wirtz et al., 2018). Services robots are also referred to as customer-facing robots in some articles. Service robots have been used in different service sectors, for example, the healthcare (Holland et al., 2021; Roy et al., 2000), hotels (Choi et al., 2020; Pinillos et al., 2016), tourism industry (McCartney & McCartney, 2020), and domestic environment (Breuer et al., 2012; Forlizzi & DiSalvo, 2006). Unlike their predecessors, research in service robots addresses if this service is easy to learn and use by customers instead of solely pursuing technology advances.

According to Xu (2019), there are three waves in AI development history (Table 2). The failure of the first two waves is not only because of the unmatured technology but also due to the alienation of human satisfaction and requirement. Thus, the design and implementation of AI-empowered technology in frontline customer service should not only seek solutions for performance in functionality but also consider customers' requirements regarding social, emotional, and ethical aspects, as well as the relationship with frontline employees (Belanche et al., 2020; Breuer et al., 2012; Huang & Rust, 2018; Robinson et al., 2020). Research in service robots also touches upon the role of interface design (Shin, 2021; Zierau et al., 2020). Even though this knowledge has not been contextualized in financial advisory services, these valuable findings in service robots establish the fundamental of this thesis.

Table 2. A comparison of the three waves of AI (Xu, 2019. p. 45)

	First Wave (1950s-1970s)	Second Wave (1980s-1990s)	Third Wave (2006-)
Major advances in technologies	Early symbolism and connectionism school, production systems, knowledge inference, preliminary expert systems	Statistical model in speech recognition and machine translation, artificial neural network in pattern recognition, expert systems	Breakthroughs in applications of deep learning in speech recognition, pattern recognition, big data, high-performance computers
Human needs	Not satisfied	Not satisfied	Starting to provide useful and real problem-solving AI solutions
Focus	Technological solutions	Technological solutions	Integrated solutions: ethical design, technological enhancement, human factors design
Characteristics	Academia driven	Academia driven	Technological enhancement and application + a human-centered approach

2.2.3 Previous literature review of robo-advisors

To date, there are three review articles regarding RAs (i.e.: Hentzen et al., 2022; Lisauskiene & Darskuviene, 2021; Torno & Metzler, 2021). According to the analysis of these three articles, we find it still necessary to have a new review paper because the previous RA review has not contextualized theories of service robots into financial advisory services, or synthesized knowledge for service providers to make managerial decisions when introducing and implementing RA services. In paper I, we analyzed these three review articles and explained how our systematic review paper can extend beyond the existing review articles in the following aspects.

First, our review method conducted an interdisciplinary perspective by including papers from different research fields that are highly relevant to RAs such as financial service, Information Systems, design science, law, and regulations. The corpus of our review paper is more comprehensive and includes the fields of the other three review papers. Second, in terms of the research approaches and aims, we used a solid theoretical framework (i.e.: Belanche et al., 2020) as a basis for article searching and analysis, focusing on the findings of existing RA research, aiming to provide service providers a managerial reference. Differently, Hentzen et al.'s review paper used the TCCM (Theory, Context, Characteristics and Methodology) framework and focused on the methods and theories of RA literature, rather than the results of previous research. Lisauskiene & Darskuviene (2021) focused on the RA research related to behavioral biases in investment. And Torno & Metzler (2021) emphasized on categorizing existing knowledge into three actors in RA research to discover their relations (RA users, RA service, and RA competitions). Last, by formulating a new framework and critical agenda, our research has contributed to service providers for their successfully introducing and implementing RAs in practice, which, is not addressed by other review papers.

2.3 Summary

RAs are trending topics with growing relevance in research in multiple disciplines and frontline practitioners. It is important to conduct interdisciplinary research so that the theoretical findings can be shared across research communities revolving around the RA phenomenon, as well as practical takeaways that can advance the implementation of RA service and RA system design for practitioners in the FinTech sectors.

Positioning in the interdisciplinary theories in financial advisory services and human-centered AI, this thesis and its constituent papers strive to mitigate the previous gaps identified in related work by presenting novel knowledge regarding AI-empowered advisory services and the autonomous system underlying the services. The research objects of these two papers are essentially the same because RA information systems are a service themselves. However, the two constituent papers have different focuses, respectively. Paper I is positioned in the financial advisory service and service robot theories, and Paper II is based on the information system and human-centered AI theories.

3 Methodologies and Methods

As mentioned previously, the constituent parts of this thesis are constructed on different methods for specific article types and RQs. In each case, the authors propose a main problem to investigate and select the most appropriate approach. This section describes the motivations for method selections and reflections on how these methods can compensate for each other to answer the RQs and achieve methodological triangulation.

3.1 Motivations of method choice

This thesis originated from an unofficial meeting between our research team and representatives of a retail bank's robo-advisor product team. This discussion indicates that robo-advisor service providers primarily rely on the experiences of Internet banks and other web-based financial services when designing and implementing robo-advisors as part of their frontline services. As a result, they probably lack the perspective of customers' perception of as autonomous social agents. This led me to conduct an integrative literature review to provide service providers with a solid reference to make informed decisions when introducing this innovative service or product to customers. Ideally, the research gaps and questions identified from this review can benefit my future academic work and the research process as a whole. Based on the research gaps and questions introduced in Sections 1 and 2, I will discuss the selection of research methods for the two papers separately.

3.1.1 Literature review method

The literature review method systematically synthesizes and evaluates existing knowledge and collective evidence to address unknown components or a constructive agenda for further research (Snyder, 2019; Walsh & Downe, 2005). Compared to other less-systematic review approaches, such as meta-review and integrative review, systematic literature review fits my research objectives due to its rigorous, transparent, and reproducible process.

In addition to the fundamental review method, different approaches exist for categorizing and analyzing articles in the review corpus. According to Paul et al. (2021), a framework-based review can be more informative and impactful by providing useful information and scientific classifications. There is a trend towards more framework-based literature review papers being published in prestigious business journals. For example, some literature review articles (e.g., Mandler et al., 2021; Roy Bhattacharjee et al., 2022) deploy the Theory, Characteristics, Context, and Method (TCCM) framework (Paul & Rosado-Serrano, 2019).

Therefore, Paper I adopts Belanche et al. (2020)'s service robot implementation theoretical framework to contextualize our RQs into Belanche's main themes (Figure 2).

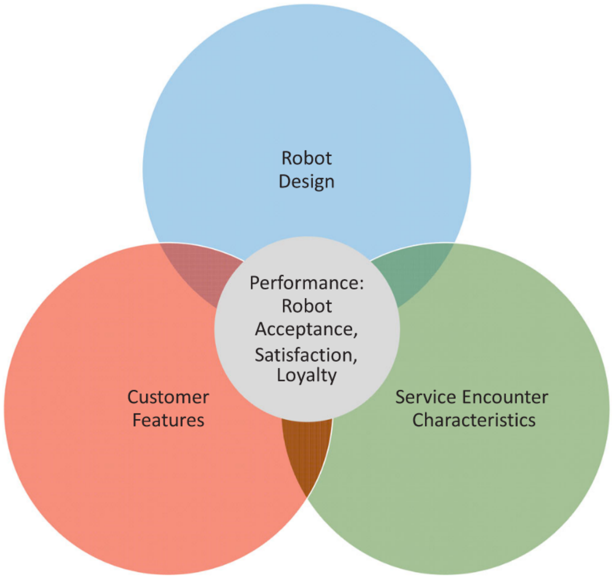

Figure 2. Belanche's framework on service robot implementation (Belanche et al., 2020)

3.1.2 User-centered approach

A user-centered approach has been used for designing or evaluating technology artifacts by involving end-users throughout the design and development process (Abras et al., 2004; Spink, 2002; Still & Crane, 2017). This approach aims to understand users' needs, desires, and social, psychological, bodily, and emotional perceptions in a situated environment by addressing the user experience. Due to its exploratory nature, user-centered approaches can also be used for specific purposes, for example, to evaluate the explainability of an existing system (Petkovic et al., 2018)

The basis of the method choices of Paper II is twofold. First, according to the identified research, empirical studies based on customers' interaction with RAs are required for an in-depth understanding of the AI-empowered financial advisory phenomenon. To our knowledge, no empirical studies exist evaluating fully functional RAs, nor are there any studies showing the result of RAs based on customers' real-life data (e.g., investment preference, incomes, and wealth). Second, human-centered AI theory justifies that user-centered approaches can also benefit human interaction with AI by enhancing transparent operations, delivering equitable outcomes, and respecting privacy (Chari et al., 2020; Ribera & Lapedriza, 2019; Shneiderman, 2022; Xu, 2019).

Paper II is inspired by user-centered approaches. We tailored the specific method as a mixed-approach user study to fit our research context in financial advisory service, given that Paper II aims to elaborate on the barriers in customer-RA interaction, not to re-design or evaluate a specific RA system. Moreover, this user study also utilized a retrospective think-aloud approach to provide participants with a secure environment when inputting their financial data (Haakana et al., 2016). These methods will be introduced in detail in the following parts.

3.2 Paper I: systematic literature review and theory-based analysis

The data collection and analysis of Paper I follow a standardized, systematic review approach (Figure 3). The overall process contains (1) a search protocol: to select Scopus as our source and to confirm two groups of keywords to cover potential articles concerning RA service implementation; (2) inclusion and exclusion criteria: to include peer-reviewed journal articles and two conference proceedings from IEEE and ACM; (3) include only articles written in English; and (4) exclude articles without the scope of RA implementation and paper with poor quality.

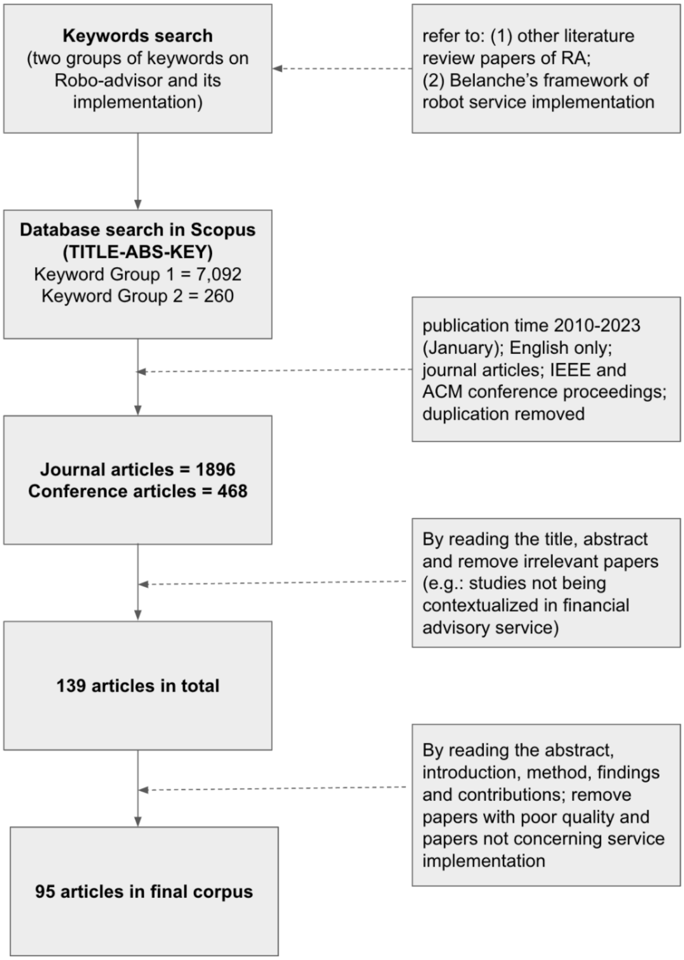

Figure 3. Article search and selection.

Finally, 95 articles are included in our corpus. In the analysis, we adopt Belanche et al. (2020)'s theoretical framework of service robot implementation. We used this framework's three main themes (i.e., robot design, customer features, and service encounter characteristics) and developed sub-themes on our own to contextualize service robot theory into AI-empowered advisory service. We analyze all articles in the corpus by categorizing their research objects and findings into three main themes. This inductive analysis involved developing most codes based on our literature reading, with some of the codes already present in Belanche et al. (2020).

3.3 Paper II: user test with retrospective videos

The user test in Paper II contains: (1) **an introduction** to inform each participant about the aims and process of this study, (2) **a pre-survey** to collect demographics, self-reported financial knowledge and experience, and frequency of using digital and AI systems, (4) **scenario setting** to stimulate participants to think about a scenario in which they would like to invest the savings, (5) **task performance** to ask participants to use the selected RA application by themselves until the final step when the final recommendation shows to them, and participants' interaction with the RA will be recorded, and a video will be exported for the next step, and (6) **a post-test retrospective interview** to ask participants to answer questions regarding their experience of using RA, in parallel with describing and explaining the behaviors by referring to the video recorded while participants are performing tasks.

We selected a RA application developed by a retail bank, one of Sweden's largest financial groups. Two participants joined the pilot test to test and refine procedures, and their data were excluded from the following analysis. Finally, 24 participants recruited by convenience sampling with stable incomes joined the formal user tests. According to the self-reported experience and knowledge of financial investment, these participants were divided into two groups: non-expert and expert customers.

This user test collected three categories of data: pre-survey data, video recordings of the task performance (AVG.=19.8 mins), an audio recording of the post-interview (AVG. = 30 mins), and retrospective descriptions are included in the post-interview. These data were brought into the analysis process (Figure 4). The main data resource for analysis is the post-test retrospective interview. The videos were used as supportive data when participants retrospectively discussed their behaviors during the task performance. And we attempted to find patterns within the different groups by referring to pre-survey data.

The interview recordings were transcribed into text and were imported into the software NVivo for further analysis. The coding was analyzed inductively by finding themes with similar meanings. Three authors coded four interviews in parallel to validate the coding items and make the coding consistent within our research group. After the discussion, the initial coding metrics (an Excel sheet with codes, sub-codes, and their definition) were confirmed, and the rest of the interviews were coded by one of the authors. This author added codes inductively if new themes emerged in the following 20 interview transcriptions. The three authors synthesized and discussed these codes and annotations based on transcriptions. In parallel with the interview transcription analysis, the video recordings were used as supportive data material when participants retrospectively discussed their behaviors and intentions when interacting with the RA.

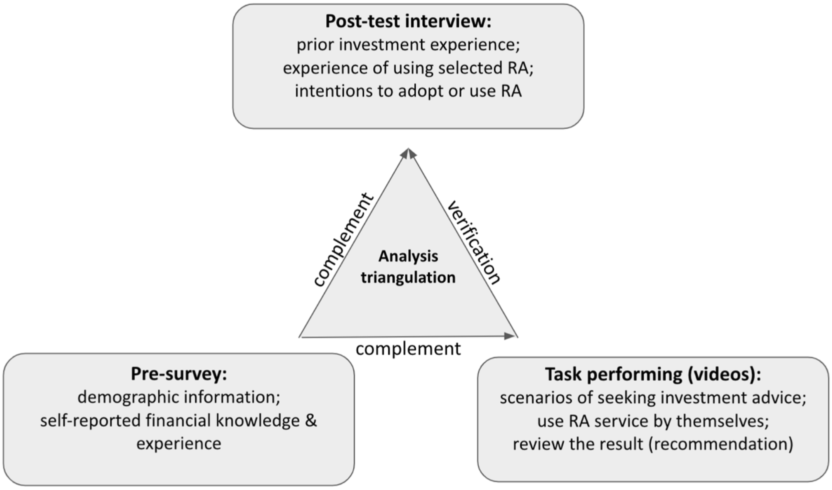

Figure 4. The triangulation of method and analysis of Paper II.

3.4 Ethical considerations

The ethical considerations of this thesis center on the data collection process in the user study of Paper II. Before the test, all participants were asked to sign a consent form regarding their information usage and privacy protection in this study. Participants were also informed to stop and quit the test whenever they wanted. We asked participants to use an unidentified test account to log into the RA system during the test. However, the final recommended portfolio was still based on their inputs. The service provider cannot identify their personal information, and we erased all these inputs manually after each test. All the video and audio recordings were anonymous and saved on a mobile hard drive preserved at KTH.

4 Summary of the Research Articles and Findings

This section briefly revisits the background and aims of the two papers and summarizes their findings accordingly and how these findings answer RQs. This section also discusses how innovations established by this thesis can stimulate new research and how practitioners in RA service can benefit from our new knowledge (Paper I).

4.1 Findings and summary of Paper I

Paper I: Zhu, H., Vigren, O., & Söderberg I. L. (XXXX).

Implementing AI-empowered Financial Advisory Services: A Literature Review, Integrative Framework, and Critical Research Agenda

The emergence and evolution of AI-empowered advisory services are based on the powerful computational capabilities of AI, which have created both innovations and challenges in frontline customer service. With financial advisors removed, customers can only rely on the use of an application and communicate with service providers through interfaces, making frontline service complex and customers' behaviors difficult to predict. Thus, understanding the phenomenon of frontline service encounters is critical for service providers who want to successfully introduce and implement customer services.

This systematic review has identified several gaps in the literature. Firstly, articles discussing RAs and RA service are scattered across different disciplines, and an interdisciplinary study is required to synthesize the knowledge. Additionally, the knowledge and theories of robot service and Human-AI interaction in service encounters have not yet been contextualized in financial advisory service factors. Lastly, existing literature shows repetitive topics and methods, highlighting the need for an agenda to stimulate new research in RA service.

The core findings of Paper I construct a conceptual framework regarding RA service implementation based on Belanche et al. (2020)'s service robot framework; and a critical research agenda discussion disputes within existing literature and stimulating future research directions. The framework answers RQ1 by synthesizing and explaining the predominant factors (i.e., themes, sub-themes, outliers) which should be considered for designing and implementing RA in frontline customer services (Figure 5). Moreover, our agenda extends RQ1 by identifying gaps for future research in RA research and RA service implementation (Figure 6).

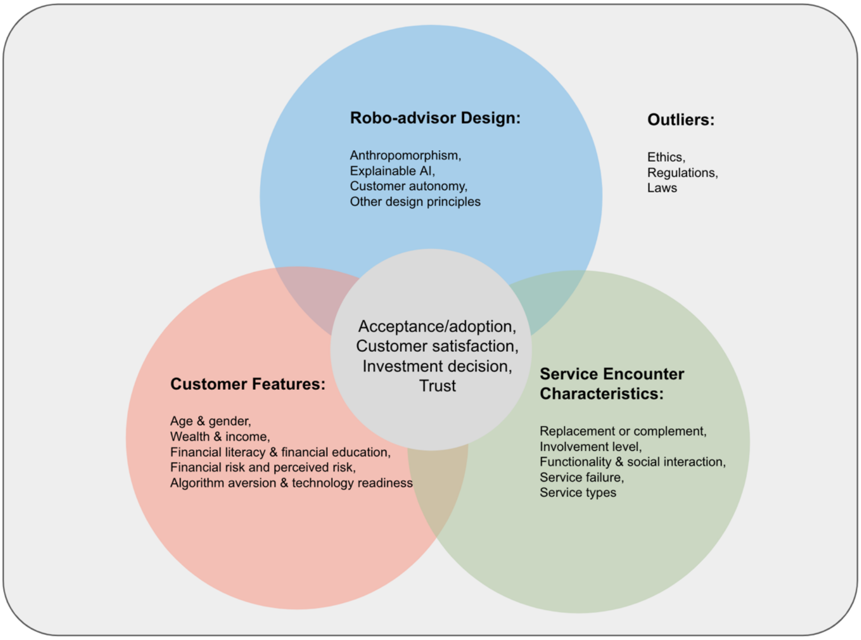

Figure 5. The framework of RA service implementation is based on Belanche et al. (2020)'s conceptual framework.

A framework for RA service implementation. Based on the thematic analysis of selected literature in our corpus, our new framework contextualizes service robot theories into AI-empowered advisory financial and explains three main themes (i.e., Robo-advisory Design, Customer Features, and Service Encounter Characteristics) and develops new sub-themes under each main themes. Paper I also explains how those sub-themes work jointly towards concepts, such as RA service acceptance, customer satisfaction, customer investment decision, and customers' trust towards RAs. Moreover, the outliers, which are not included in Belanche et al. (2020)'s framework, is also introduced in our framework as these factors are vital for service regulation and customer protection in the context of financial investment. As important findings of Paper I, our new framework synthesizes existing knowledge and articulates the concepts in existing literature regarding RA implementation. Also, it provides a reference for service providers to make managerial decisions when introducing or designing RA services for frontline customers. For example, if a FinTech company wants to develop a new RA for customers within certain age and income, they can check how different customer features in age and income can affect the design of RA interfaces; and the company can also decide the involvement level, for example, to encourage customers to start from a small amount if they are young people with relatively lower budget.

A critical research agenda to stimulate future research. Unlike research agendas in other literature review papers, Paper I focuses on potential research gaps and addresses critical discussions on provocative disputes in the existing literature. In Figure 6, the top three themes are controversial and worthy of in-depth discussion because different answers can be found in existing literature according to their specific focuses and the authors' attitudes towards RAs and RA service. The topics listed in the big block are research gaps that can assist future research work to generate new knowledge, pushing RA research forward.

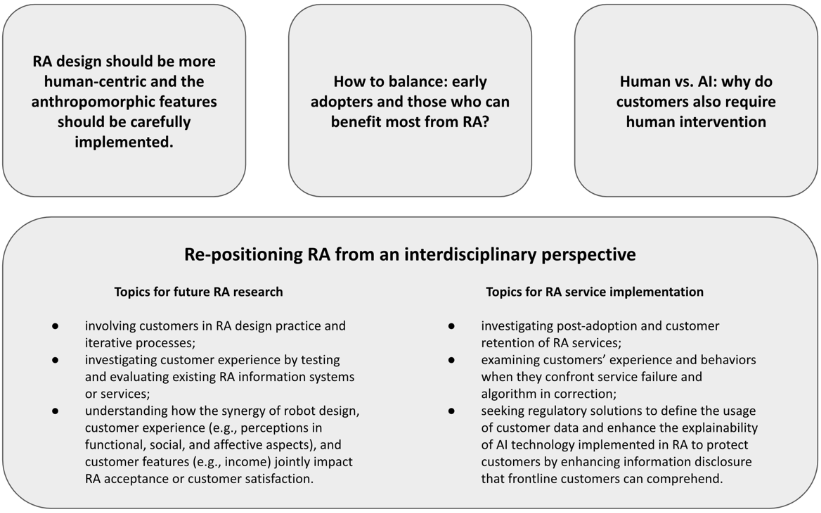

Figure 6. The critical agenda of Paper I.

4.2 Findings and summary of Paper II

Paper II: Zhu, H., Sallnäs Pysander, E. L., & Söderberg, I. L. (2023).

Not transparent and incomprehensible: A qualitative user study of an AI-empowered financial advisory system

Despite RAs' rapid growth, compared with traditional advisory services, customers' awareness and perception of RAs are still undeveloped, and their adoption is still low among customers in the financial service market. Previous research in IS treats RAs as emerging technology and focuses on influential factors to understand their behavioral intention of using RAs or adopting RAs' final recommendation (Ben David et al., 2021; Gan et al., 2021; Hildebrand & Bergner, 2021; Hohenberger et al., 2019; Lourenço et al., 2020; Seiler & Fanenbruck, 2021; Wu & Gao, 2021). However, these adoption-focused studies have limited contributions towards RA system design and lack the view of customers' perception and experience of using a functional RA in real-life situations.

Based on an essential gap identified in our literature review that user-centered tests should be conducted to understand customer-RA interaction happening in the service frontline, Paper II also aims to articulate how the experience of using a fully functional RA system can affect customers' perception and adoption of RA service.

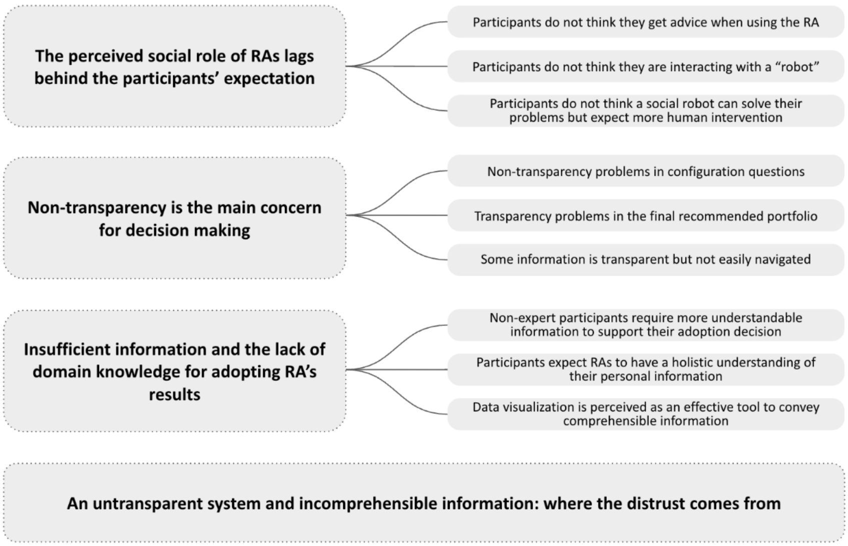

Figure 7. A summary of core findings of Paper II

As a holistic user study, Paper II answers RQ2 by identifying four predominant themes regarding customers' ability to use RA systems; and, based on such experience, customers' perception and adoption of RAs (Figure 7). These findings articulate customers' experience of using a fully functional RA system provided by a retail bank and their review of the final recommended portfolio provided by the selected RA. This advice is based on their input data, including real-life income, risk group, and investment preference.

The findings show that customers' perceptions of RAs do not meet their expectations. And during their interactions with the RA, non-transparency and incomprehensible information about the system's decision-making are significant hurdles to their adoption of RA service. Moreover, data visualization shows its potential to assist customers in interpreting and understanding the system in three aspects: visualizing financial knowledge, especially the risk assessment, interpreting the performance of the recommended portfolio, and envisioning future growth and loss (Figure 8).

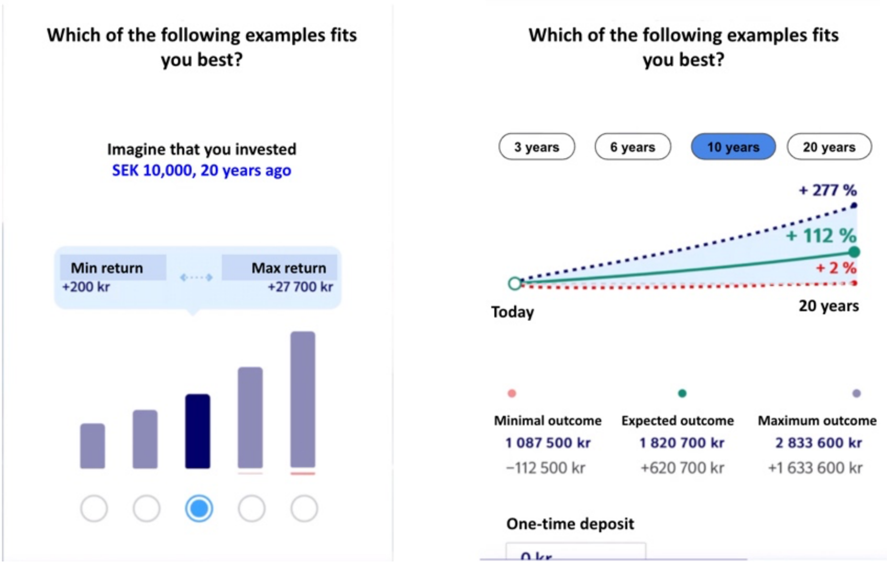

Figure 8. Left panel: The data visualization in the risk assessment phase. Right panel: the interactive diagram in the recommendation portfolio. These are not the original interfaces for translation, but the contents are the same (Paper II).

5 Conclusion and Future Research

This section presents the conclusions, contributions to the related research domains, and practical takeaways for practitioners in RA service industry. Additionally, the limitations and potential areas for future research are discussed.

5.1 Conclusions

By focusing on the customers' perspective in AI-empowered financial advisory services, this thesis comprehensively explains the factors that construct and influence RA services in the frontline. The study contextualizes three main themes in RA services: robot design, customer features, and service encounter characteristics. The sub-themes and outliers are also clearly defined and addressed through a systematic literature selection combined with a theory-based analysis process. This results in a rigorous and informative analysis and synthesis of state-of-the-art research regarding RAs. Additionally, a critical agenda is extracted from this literature review to stimulate future research regarding RAs and the implementation of RA services.

Inspired by the gaps identified in the systematic literature review, an empirical user-centered study is conducted to investigate the phenomenon of customer-RA interaction and customer experience using autonomous systems in the service frontline. The study yields four main findings. First, the perceived social roles of RAs lag behind customers' expectations. Second, the lack of transparency in the system makes it difficult for customers to decide whether to take RAs' investment advice. Third, customers require more information and financial knowledge to adopt RAs successfully. Finally, the study identified that the most significant hurdle for customers to adopt RAs is the lack of transparency and comprehensible information on RA systems.

5.2 Contributions

This thesis contributes to an in-depth understanding of customers in AI-empowered financial advisory services by integrating theoretical and methodological synergies from different disciplines. Additionally, it provides practical implications for practitioners in RA service. The thesis pushes previous research in Internet banking and conventional financial advisory services (Chauhan et al., 2022; Klink et al., 2020; Mbama & Ezepue, 2018; Silic & Ruf, 2018; Söderberg, 2013) towards AI-empowered financial service era. It also develops service robot theories by contextualizing these theories into AI-empowered financial advisory services (Belanche et al., 2020; Huang & Rust, 2018; Robinson et al., 2020). Moreover, by introducing AI-related conceptions and approaches, such as customers' experience of using RAs and their attitudes towards algorithms, the thesis enriches and elevates the roles of a RA system's perceived transparency and comprehensibility in customers' adoption of RAs' advice.

Our findings also advance previous web-based information system research addressing transparency and information symmetry in financial advisory service encounters (Kilic et al., 2015; Nueesch et al., 2014, 2016; Nussbaumer et al., 2012; Nussbaumer & Matter, 2011) by emphasizing transparency and explainability of RA systems. Lastly, the thesis compensates for other literature review articles (Hentzen et al., 2022; Lisauskiene & Darskuviene, 2021; Torno & Metzler, 2021) by focusing on RA service design and implementation.

Methodologically, this thesis adopts a user-centered approach to investigate RA service encounters in the frontline. The study tailors and mixes different approaches, including pre-survey, task-performing, and retrospective post-interview, to triangulate and compensate for each other in supporting rigorous empirical findings. The method collects customers' data based on their use of a fully functional RA and their inputs of real-life data. Compared with previous empirical studies using RA prototypes (Ben David et al., 2021; Jung, Dorner, Weinhardt, et al., 2018; Salo & Haapio, 2017) and those collecting survey data without studying user experience (Belanche et al., 2019; Gan et al., 2021), our method yields several advantages on exploring customers' experience and RA design.

In business practice, this thesis provides reliable and systematic knowledge for service providers to make managerial decisions when introducing and implementing AI-empowered technologies into financial advisory service encounters. By referring to our framework and agenda, service providers can ensure they are making informed decisions.

The thesis also switches the traditional "relationship-centered" mindset in financial advisory services (Allen & Gale, 1999; Barnes & Howlett, 1998; Morgan & Hunt, 1994; Peppard, 2000) towards a more comprehensive perspective, including deploying a "user-centered" approach to iterate current RA systems and designing RA user interfaces towards more transparency and comprehensible information. This is crucial because RA services aim to attract new generations of users with different financial behavior and experience with AI-empowered technology compared to their predecessors.

Our empirical study shows that a lack of transparency affects customers' perception of RAs, and they are not resilient or tolerant of unmet expectations. Additionally, investment is not a one-time behavior but a long-term and dynamic process, unlike other AI systems. This thesis indicates that a transparent and comprehensible system is the key premise of service encounter management for service providers in the AI-empowered financial advisory era.

5.3 Limitations and future work

In the user study of Paper II, there is a limitation in the measurement of financial literacy. We collected participants' self-reported financial knowledge and investment experience instead of conducting a standardized financial literacy test. As a result, there is a possible bias in overconfident participants or underestimating their objective financial literacy. However, based on the results of our exploratory study, future user studies can investigate in-depth how customers' financial knowledge affects their experience of using RAs.

This thesis takes the first step in exploring the barriers customers face when using RAs by using user-centered approaches to study a functional AI-empowered financial advisory service system. Our critical research agenda extracts several potential directions for future work.

The first potential direction is implementing design solutions in RA interface design by conveying transparent and comprehensible information to customers. As the interactive user interface is the only way for customers to experience RA service and communicate with service providers, future studies should focus more on developing design solutions and evaluating them by conducting user experiments.

The second potential direction revolves around the anthropomorphism of RA. With the rapid development of AI and its supporting technology, such as Generative AI (e.g., ChatGPT 4), an increasing number of service providers choose to connect their services to ChatGPT 4 to utilize its advanced competence in natural language processing and powerful learning models to communicate with customers directly. According to our findings in this thesis, most participants do not think a chatbot can solve their problems in the context of AI-empowered financial services. Therefore, future studies can investigate if Generative AI can address their concerns, conveying more trustworthiness and transparency during customer-RA interaction. Additionally, it is significant to consider the potential risks and ethical issues that financial service providers may encounter as AI technology advances continuously and rapidly.

References

Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User-centered design. *Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications*, *37*(4), 445–456.

Allen, F., & Gale, D. (1999). Innovations in financial services, relationships, and risk sharing. *Management Science*, *45*(9), 1239–1253.

Barnes, J. G., & Howlett, D. M. (1998). Predictors of equity in relationships between financial services providers and retail customers. *International Journal of Bank Marketing*, *16*(1), 15–23.

Belanche, D., Casaló, L. V., & Flavián, C. (2019). Artificial Intelligence in FinTech: Understanding robo-advisors adoption among customers. *Industrial Management & Data Systems*, *119*(7), 1411–1430. https://doi.org/10.1108/IMDS-08-2018-0368

Belanche, D., Casaló, L. V., Flavián, C., & Schepers, J. (2020). Service robot implementation: A theoretical framework and research agenda. *The Service Industries Journal*, *40*(3–4), 203–225. https://doi.org/10.1080/02642069.2019.1672666

Beltramini, E. (2018). Human vulnerability and robo-advisory: An application of Coeckelbergh's vulnerability to the machine-human interface. *Baltic Journal of Management*, *13*(2), 250–263. https://doi.org/10.1108/BJM-10-2017-0315

Ben David, D., Resheff, Y. S., & Tron, T. (2021). Explainable AI and Adoption of Financial Algorithmic Advisors: An Experimental Study. *Proceedings of the 2021 AAAI/ACM Conference on AI, Ethics, and Society*, 390–400. https://doi.org/10.1145/3461702.3462565

Ben-David, D., & Sade, O. (2020). Robo-advisor adoption, willingness to pay, and trust—Before and at the outbreak of the covid-19 pandemic. *Willingness to Pay, and Trust—Before and at the Outbreak of the COVID-19 Pandemic (July 2020)*.

Bhatia, A., Chandani, A., & Chhateja, J. (2020). Robo advisory and its potential in addressing the behavioral biases of investors—A qualitative study in Indian context. *Journal of Behavioral and Experimental Finance*, 12.

Bolton, P., Freixas, X., & Shapiro, J. (2007). Conflicts of interest, information provision, and competition in the financial services industry. *Journal of Financial Economics*, *85*(2), 297–330. https://doi.org/10.1016/j.jfineco.2005.06.004

Bonaccio, S., & Dalal, R. S. (2006). Advice taking and decision-making: An integrative literature review, and implications for the organizational sciences. *Organizational Behavior and Human Decision Processes*, *101*(2), 127–151.

Breuer, T., Giorgana Macedo, G. R., Hartanto, R., Hochgeschwender, N., Holz, D., Hegger, F., Jin, Z., Müller, C., Paulus, J., & Reckhaus, M. (2012). Johnny: An autonomous service robot for domestic environments. *Journal of Intelligent & Robotic Systems*, *66*, 245–272.

Burke, J., Hung, A. A., Clift, J., Garber, S., & Yoong, J. K. (2015). *Impacts of Conflicts of Interest in the Financial Services Industry*. 66.

Chari, S., Seneviratne, O., Gruen, D. M., Foreman, M. A., Das, A. K., & McGuinness, D. L. (2020). Explanation ontology: A model of explanations for user-centered AI. *The Semantic Web - ISWC 2020. Lecture Notes in Computer Science,* vol 12507. Springer, Cham

Chauhan, S., Akhtar, A., & Gupta, A. (2022). Customer experience in digital banking: A review and future research directions. *International Journal of Quality and Service Sciences*.

Chen, C.-W., & Koufaris, M. (2015). The impact of decision support system features on user overconfidence and risky behavior. *European Journal of Information Systems*, *24*(6), 607–623. Scopus. https://doi.org/10.1057/ejis.2014.30

Chira, I., Adams, M., & Thornton, B. (2008). *Behavioral bias within the decision making process*.

Choi, Y., Choi, M., Oh, M., & Kim, S. (2020). Service robots in hotels: Understanding the service quality perceptions of human-robot interaction. *Journal of Hospitality Marketing & Management*, *29*(6), 613–635.

Chong, L., Zhang, G., Goucher-Lambert, K., Kotovsky, K., & Cagan, J. (2022). Human confidence in artificial intelligence and in themselves: The evolution and impact of confidence on adoption of AI advice. *Computers in Human Behavior*, *127*, 107018. https://doi.org/10.1016/j.chb.2021.107018

Collins, J. M. (2012). Financial advice: A substitute for financial literacy? *Financial Services Review*, *21*(4), 307.

Cruciani, C. (2017). *Investor decision-making and the role of the financial advisor: A behavioural finance approach*. Springer.

Deng, B., & Chau, M. (2021). *Anthropomorphized financial robo-advisors and investment advice-taking behavior*. 27th Annual Americas Conference on Information Systems, AMCIS 2021. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85118625396&partnerID=40&md5=38fd0a0a65ac096324a9903636d13a2b

Deo, S., & Sontakke, N. S. (2021). Usability, User Comprehension, and Perceptions of Explanations for Complex Decision Support Systems in Finance: A Robo-Advisory Use Case. *Computer*, *54*(10), 38–48. https://doi.org/10.1109/MC.2021.3076851

D'Hondt, C., De Winne, R., Ghysels, E., & Raymond, S. (2020). Artificial Intelligence Alter Egos: Who might benefit from robo-investing? *Journal of Empirical Finance*, *59*, 278–299. https://doi.org/10.1016/j.jempfin.2020.10.002

Engelmann, J. B., Capra, C. M., Noussair, C., & Berns, G. S. (2009). Expert financial advice neurobiologically "offloads" financial decision-making under risk. *PLoS One*, *4*(3), e4957.

Fisch, J. E., Labouré, M., & Turner, J. A. (2019). The Emergence of the Robo-Advisor. In J. E. Fisch, M. Labouré, & J. A. Turner, *The Disruptive Impact of FinTech on Retirement Systems* (pp. 13–37). Oxford University Press. https://doi.org/10.1093/oso/9780198845553.003.0002

Forlizzi, J., & DiSalvo, C. (2006). Service robots in the domestic environment: A study of the roomba vacuum in the home. *Proceedings of the 1st ACM SIGCHI/SIGART Conference on Human-Robot Interaction*, 258–265.

Gan, L. Y., Khan, M. T. I., & Liew, T. W. (2021). Understanding consumer's adoption of financial robo-advisors at the outbreak of the COVID-19 crisis in Malaysia. *Financial Planning Review*, *4*(3). https://doi.org/10.1002/cfp2.1127

Guo, H., & Polak, P. (2021). *After the collision of crisis and opportunity to redefining the artificial intelligence in finance: The new intelligent finance era* (Vol. 954, p. 172). Scopus. https://doi.org/10.1007/978-3-030-72080-3_9

Hentzen, J. K., Hoffmann, A., Dolan, R., & Pala, E. (2022). Artificial intelligence in customer-facing financial services: A systematic literature review and agenda for future research. *International Journal of Bank Marketing*, *40*(6), 1299–1336. https://doi.org/10.1108/IJBM-09-2021-0417

Hildebrand, C., & Bergner, A. (2021). Conversational robo advisors as surrogates of trust: Onboarding experience, firm perception, and consumer financial decision making. *Journal of the Academy of Marketing Science*, *49*(4), 659–676. https://doi.org/10.1007/s11747-020-00753-z

Hilgert, M. A., Hogarth, J. M., & Beverly, S. G. (2003). Household financial management: The connection between knowledge and behavior. *Fed. Res. Bull.*, *89*, 309.

Hill, R. K. (2016). What an algorithm is. *Philosophy & Technology*, *29*, 35–59.

Hohenberger, C., Lee, C., & Coughlin, J. F. (2019). Acceptance of robo-advisors: Effects of financial experience, affective reactions, and self-enhancement motives. *FINANCIAL PLANNING REVIEW*, *2*(2). https://doi.org/10.1002/cfp2.1047

Holland, J., Kingston, L., McCarthy, C., Armstrong, E., O'Dwyer, P., Merz, F., & McConnell, M. (2021). Service robots in the healthcare sector. *Robotics*, *10*(1), 47.

Huang, M.-H., & Rust, R. T. (2018). Artificial Intelligence in Service. *Journal of Service Research*, *21*(2), 155–172. https://doi.org/10.1177/1094670517752459

Iacurci, G. (2022, January 16). *Robo-advisors are growing in popularity. Can they really replace a human financial advisor?* CNBC. https://www.cnbc.com/2022/01/16/robo-advisors-are-gaining-popularity-can-they-replace-a-human-advisor.html

Insider Intelligence Editors. (2021, June 30). *Young investors drove use of robo-advisors during pandemic*. Insider Intelligence. https://www.emarketer.com/content/young-investors-drove-robo-advisor-use

Jung, D., Dorner, V., Glaser, F., & Morana, S. (2018). Robo-advisory. *Business & Information Systems Engineering*, *60*(1), 81–86.

Jung, D., Dorner, V., Weinhardt, C., & Pusmaz, H. (2018). Designing a robo-advisor for risk-averse, low-budget consumers. *Electronic Markets*, *28*(3), 367–380. https://doi.org/10.1007/s12525-017-0279-9

Jung, D., Glaser, F., & Köpplin, W. (2019). Robo-Advisory: Opportunities and Risks for the Future of Financial Advisory. In V. Nissen (Ed.), *Advances in Consulting Research* (pp. 405–427). Springer International Publishing. https://doi.org/10.1007/978-3-319-95999-3_20

Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons*, *62*(1), 15–25. https://doi.org/10.1016/j.bushor.2018.08.004

Kilic, M., Heinrich, P., & Schwabe, G. (2015). Coercing into Completeness in Financial Advisory Service Encounters. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, 1324–1335. https://doi.org/10.1145/2675133.2675289

Klink, R. R., Zhang, J. Q., & Athaide, G. A. (2020). Measuring customer experience management and its impact on financial performance. *European Journal of Marketing*, *55*(3), 840–867.

Lisauskiene, N., & Darskuviene, V. (2021). Linking the Robo-advisors Phenomenon and Behavioural Biases in Investment Management: An Interdisciplinary Literature Review and Research Agenda. *Organizations and Markets in Emerging Economies*, *12*(2), 459–477. https://doi.org/10.15388/omee.2021.12.65

Lourenço, C. J. S., Dellaert, B. G. C., & Donkers, B. (2020). Whose Algorithm Says So: The Relationships between Type of Firm, Perceptions of Trust and Expertise, and the Acceptance of Financial Robo-Advice. *Journal of Interactive Marketing*, *49*(1), 107–124. https://doi.org/10.1016/j.intmar.2019.10.003

Mandler, T., Sezen, B., Chen, J., & Özsomer, A. (2021). Performance consequences of marketing standardization/adaptation: A systematic literature review and future research agenda. *Journal of Business Research*, *125*, 416–435.

Mbama, C. I., & Ezepue, P. O. (2018). Digital banking, customer experience and bank financial performance: UK customers' perceptions. *International Journal of Bank Marketing*.

McCartney, G., & McCartney, A. (2020). Rise of the machines: Towards a conceptual service-robot research framework for the hospitality and tourism industry. *International Journal of Contemporary Hospitality Management*, *32*(12), 3835–3851.

Moore, D. L. (2003). *Survey of financial literacy in Washington State: Knowledge, behavior, attitudes, and experiences*. Washington State Department of Financial Institutions.

Morgan, R. M., & Hunt, S. D. (1994). The commitment-trust theory of relationship marketing. *Journal of Marketing*, *58*(3), 20–38.

Mukherjee, A., & Nath, P. (2005). An empirical assessment of comparative approaches to service quality measurement. *Journal of Services Marketing*.

Nguyen, L., Gallery, G., & Newton, C. (2016). The influence of financial risk tolerance on investment decision-making in a financial advice context. *Australasian Accounting, Business and Finance Journal*, *10*(3), 3–22.

Nueesch, R., Puschmann, T., & Alt, R. (2014). Realizing Value From Tablet-Supported Customer Advisory: Cases From the Banking Industry. *Bled Econference*, *34*.

Nueesch, R., Zerndt, T., Alt, R., & Ferretti, R. G. (2016). Tablets penetrate the customer advisory process: A case from a swiss private bank. *BLED*.

Nussbaumer, P., & Matter, I. (2011). What You See Is What You (Can) Get? Designing for Process Transparency in Financial Advisory Encounters. In P. Campos, N. Graham, J. Jorge, N. Nunes, P. Palanque, & M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2011* (pp. 277–294). Springer Berlin Heidelberg.

Nussbaumer, P., Matter, I., Reto à Porta, G., & Schwabe, G. (2012). Designing for Cost Transparency in Investment Advisory Service Encounters. *Business & Information Systems Engineering*, *4*(6), 347–361. https://doi.org/10.1007/s12599-012-0237-1

Paul, J., Merchant, A., Dwivedi, Y. K., & Rose, G. (2021). Writing an impactful review article: What do we know and what do we need to know? *Journal of Business Research*, *133*, 337–340. https://doi.org/10.1016/j.jbusres.2021.05.005

Paul, J., & Rosado-Serrano, A. (2019). Gradual internationalization vs born-global/international new venture models: A review and research agenda. *International Marketing Review*, *36*(6), 830–858.

Peppard, J. (2000). Customer relationship management (CRM) in financial services. *European Management Journal*, *18*(3), 312–327.

Petkovic, D., Altman, R., Wong, M., & Vigil, A. (2018). *Improving the explainability of Random Forest classifier–user centered approach*. 204–215.

Pinillos, R., Marcos, S., Feliz, R., Zalama, E., & Gómez-García-Bermejo, J. (2016). Long-term assessment of a service robot in a hotel environment. *Robotics and Autonomous Systems*, *79*, 40–57.

Ribera, M., & Lapedriza, A. (2019). *Can we do better explanations? A proposal of user-centered explainable AI. 2327*, 38.

Robinson, S., Orsingher, C., Alkire, L., De Keyser, A., Giebelhausen, M., Papamichail, K. N., Shams, P., & Temerak, M. S. (2020). Frontline encounters of the AI kind: An evolved service encounter framework. *Journal of Business Research*, *116*, 366–376. https://doi.org/10.1016/j.jbusres.2019.08.038

Roy Bhattacharjee, D., Pradhan, D., & Swani, K. (2022). Brand communities: A literature review and future research agendas using TCCM approach. *International Journal of Consumer Studies*, *46*(1), 3–28.

Roy, N., Baltus, G., Fox, D., Gemperle, F., Goetz, J., Hirsch, T., Margaritis, D., Montemerlo, M., Pineau, J., & Schulte, J. (2000). Towards personal service robots for the elderly. *Workshop on Interactive Robots and Entertainment (WIRE 2000)*, *25*, 184.

Salo, M., & Haapio, H. (2017). Robo-Advisors and Investors: Enhancing Human-Robot Interaction Through Information Design. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2937821

Seiler, V., & Fanenbruck, K. M. (2021). Acceptance of digital investment solutions: The case of robo advisory in Germany. *Research in International Business and Finance*, *58*. Scopus. https://doi.org/10.1016/j.ribaf.2021.101490

Shanmuganathan, M. (2020). Behavioural finance in an era of artificial intelligence: Longitudinal case study of robo-advisors in investment decisions. *Journal of Behavioral and Experimental Finance*, *27*, 100297. https://doi.org/10.1016/j.jbef.2020.100297

Shin, D. (2021). The effects of explainability and causability on perception, trust, and acceptance: Implications for explainable AI. *International Journal of Human-Computer Studies*, *146*, 102551. https://doi.org/10.1016/j.ijhcs.2020.102551

Shneiderman, B. (2022). *Human-Centered AI* (1st ed.). Oxford University Press. https://doi.org/10.1093/oso/9780192845290.001.0001

Silic, M., & Ruf, C. (2018). The effects of the elaboration likelihood model on initial trust formation in financial advisory services. *International Journal of Bank Marketing*.

Smith, R. (1998). Beyond conflict of interest: Transparency is the key. *BMJ: British Medical Journal*, *317*(7154), 291.

Söderberg, I. L. (2013). Relationships between advisor characteristics and consumer perceptions. *International Journal of Bank Marketing*. May 8

Spink, A. (2002). A user-centered approach to evaluating human interaction with web search engines: An exploratory study. *Information Processing & Management*, *38*(3), 401–426.

Stanford University, United States of America, & Auernhammer, J. (2020, September 10). *Human-centered AI: The role of Human-centered Design Research in the development of AI*. Design Research Society Conference 2020. https://doi.org/10.21606/drs.2020.282

Still, B., & Crane, K. (2017). *Fundamentals of user-centered design: A practical approach*. CRC press.

Torno, A., & Metzler, D. R. (2021). Robo-What?, Robo-Why?, Robo-How? – A Systematic Literature Review of Robo-Advice. *PACIS*, 92

Turilli, M., & Floridi, L. (2009). The ethics of information transparency. *Ethics and Information Technology*, *11*(2), 105–112. https://doi.org/10.1007/s10676-009-9187-9

Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., & Martins, A. (2018). Brave new world: Service robots in the frontline. *Journal of Service Management*, *29*(5), 907–931. https://doi.org/10.1108/JOSM-04-2018-0119

Wu, M., & Gao, Q. (2021). Understanding the Acceptance of Robo-Advisors: Towards a Hierarchical Model Integrated Product Features and User Perceptions. In Q. Gao & J. Zhou (Eds.), *Human Aspects of IT for the Aged Population. Technology Design and Acceptance* (pp. 262–277). Springer International Publishing.

Xu, W. (2019). Toward human-centered AI: A perspective from human-computer interaction. *Interactions*, *26*(4), 42–46. https://doi.org/10.1145/3328485

Zierau, N., Hausch, M., Bruhin, O., & Söllner, M. (2020). Towards developing trust-supporting design features for AI-based chatbots in customer service. *Forty-First International Conference on Information Systems, India 2020*