

# Being Human in the Digitally Enabled Workplace: Insights From the Robo-Advice Literature

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**Abstract**—The growth in intelligent machines entering the workplace continues to challenge organizations’ digital transformation efforts. Various applications of simple to complex algorithms allow computerized systems to take on and automate an increasing number of tasks previously undertaken by human workers. Robo-advisors (RAs) in the financial sector serve as an excellent example of technological versatility and what is to come. RAs are platforms defined by a set of algorithms that offer wealth management advice online. To understand how human workers are affected by progressively intelligent machines, this article looks at the impact of RAs on human financial advisors. Through a systematic review, we present state of the art literature and examine interactions of human and digital component. Our findings illustrate possible automation scenarios for financial advisors working with RAs, the human value added, and the skills the future workforce will require. We further suggest a future research agenda. This article adds to the digital transformation literature at the intersection of workplace automation, service provision, and human-machine interaction. The aim is to provide and provoke new ideas for successful implementation and use of intelligent machines along with skilled people in a supportive work environment.

**Index Terms**—Artificial intelligence (AI), digital transformation, future workplace, human-machine interaction, reskilling, robo-advice, service automation, technology adoption.

## I. INTRODUCTION

FOR many years, we have lived alongside machines and computerized systems that are now rapidly evolving into robots and artificial intelligence (AI). At the intersection of digital transformation and innovation, researchers are increasingly concerned with these technologies as they ultimately affect organizational outcomes [1]. However, persistent challenges to implement technologies continue to impact organizations as well as their employees. This is an area of research that has attracted significant attention [2]. As reported by the World Economic

Forum (WEF) [3], technological change is fundamentally impacting the workforce. This has, and will continue, to require generations of workers to adapt and complement the work of machines, as opposed to being replaced by them. Economists Acemoglu and Restrepo [4, p. 2188] highlight the impact of robots on jobs showing that one robot per thousand workers “reduces employment-to-population ratio by 0.2 percentage points and wages by 0.42%.” And while it is often argued that technology displaces labor, more importantly, it facilitates new work activities [5], leading to what the WEF calls a “reskilling revolution.”

The implementation of robots and AI has been researched across sectors such as hospitality [6], healthcare [7], and law [8]. The COVID-19 pandemic drove the push for service offerings void of human contact [9]. And while some of these services are delivered by physical robots, others are provided by software-based virtual robots, residing behind our screens [10]. Regardless of embodied or virtual representation, Seibt et al. [11, p. 37] posit that robots “only should do what humans cannot do.” This raises the question: How much of a service should be automated by machines? Details of how collaboration between technological and human components could be best achieved remain unknown [12], however, the role and interaction of human beings in service interactions is changing as increasingly smart technologies become deeply anchored in human work environments [13] and teams [14].

Digital innovations have long disrupted the highly regulated financial sector. Financial technology (FinTech) actors have launched new products and services to cater to the needs of the digital era customer [15]. As a result, “FinTech has also challenged the role of the human advisor and how financial advisors can best utilize technology as part of the advice process” [16, p. 545]. The so-called robo-advisor (RA) is an innovation that has, not least during the COVID-19 pandemic [17], become increasingly relevant in the wealth management industry, in a move toward cheaper [18] and more intelligent advice [19]. RAs have been described as one of the most valuable FinTech innovations along with Blockchain and the Internet of Things [20]. And although the term has been applied to a range of contexts and industries, the “robo-advisor” is most often used in the financial sector [21], where it is defined as an online platform providing investment advice through algorithms to automatically build and manage client portfolios [21], [22].

The implementation of RAs causes a shift within a service profession that is deeply rooted in traditional face-to-face interactions. With the financial crisis of 2008, a job that was

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formerly carried out by highly qualified and certified financial advisors in physical branches is slowly being replaced by algorithmic software [22]. The rise of RAs is driven by a changing customer base, a tech-savvy, do-it-yourself generation seeking digital solutions [23]. To investors RAs offer two significant advantages—accessibility and affordability [24]. Anyone with access to the internet can use RAs. To banks and FinTech companies offering robo-advice, it provides an opportunity and potentially a competitive edge. The shift from human to automated financial advisors allows service provision to more customers in a shorter time frame. And although FinTech innovations, such as RAs, help to lower costs, they also contain the potential to “reduce employment and welfare” [20, p. 2098] when, e.g., the required digital skills do not exist [25].

The RA-literature has continuously increased in the past five to ten years, however, research on the impact of robo-advice on financial advisors remains fragmented. Only few literature reviews have been conducted on the subject of RAs, with the most recent ones by Torno et al. [26], Darskuviene and Lisauskiene [27], and a bibliometric one by Rico-Pérez et al. [28]. The duo, Darskuviene and Lisauskiene, analyzes the literature with an eye to the role of behavioral bias in investors. Torno et al.’s [26] research agenda provides a holistic review and suggests three focal areas of current research: users, service, and competition. For further research, Torno et al. [26] suggest some questions concerning human advisors in the realm of competition. However, RA-implementation extends beyond the question of superiority. As the authors point out, more research is needed to address hybrid RA-models and the shaping of financial practices, which this article aims to address.

Due to the rapidly evolving nature of the topic and its relevance for the ongoing debate of robots and AI impacting the workforce, a literature review on the changing advisor profession in light of robo-advice will be valuable to present the status quo and unveil avenues for further research. Synthesizing literature and generating a knowledge base has been particularly challenging with information technologies entering the landscape [29]. In order to continue research on RAs and contribute to the generation of a knowledge base, this literature review will add to our understanding of this novel technology and its impact on human financial advisors. Providing an overview of the status quo and state of the art RA technology, will help guide further debate on RAs’ impact on human advisors. This can then be positioned within the scope of the digital transformation literature. By reviewing the evidence on a particular question regarding an uncertain topic “when a general overall picture of the evidence in a topic area is needed” [30, p. 21], a systematic review can yield valuable results. To achieve that aim, the following research question (RQ) will be addressed: *What do we know about the impact of robo-advice on human financial advisors and what are future research directions we can elicit from existing research gaps in the context of digital transformation?*

The rest of the article is structured as follows. First, a brief background on the overarching concept of digitalization in the workplace and an introduction to robo-advice are provided.

Then, the research design is presented; it describes the method used to select relevant papers and conduct the review process. This is followed by the findings of the synthesis of the selected literature, which provides an overview of viewpoints and relevant factors for the coexistence and collaboration of human advisors and RAs. Retrieved from the emerging research gaps, a future research agenda is suggested in respect of the current debate on robots and AI. The article concludes with some limitations.

## II. BACKGROUND

### A. Human Workers in the Digital Workplace

Digital transformation has recently been defined as “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” [31, p. 121]. For centuries, if not millennia, the introduction of technologies has led to changes in society, the environment, and institutions. Digital transformation streams through every aspect of our lives and significantly changes the way we do things. We can use technologies to either engage in old activities or create new ones. Work environment changes related to digital transformation are now leading to a growing skills gap, highlighting that “incumbents must be aware that many employees might not keep pace with this digital high-speed train and feel left behind” and that, more importantly, it “is unclear how such a tradeoff is considered and how firms could handle related conflicts” [32, p. 258]. Changes in technology affect workers, making them either more efficient and effective, or replacing human strength, handiwork, and “slow and error-prone ‘wetware’” altogether [33, p. 5]. The former does not yet prevail due to significant organizational challenges and the need for sophisticated strategies that will enable firms to develop a sustainably dynamic workforce.

### B. Merging Technology and Human Capabilities

In the early days of introducing machines into people’s working lives, human workers were often simply replaced. Today, fears about workforce displacement still exist. Yet, economists describe technological change as central to economic growth and argue that, over time, today’s displaced workers will be able to shift to other sectors where they are needed [34]. Acemoglu and Restrepo [35, p. 1488] suggest that stability occurs when automation reduces the cost of producing labor, thus discouraging further automation while encouraging the creation of new tasks. At the same time, the tasks that remain difficult to automate are those “demanding flexibility, judgment, and common sense – skills that we understand only tacitly” [33, p. 22]. The common conviction is that human relevance will prevail in the long run. Thus, replacing human work by technology can lead to displacement, but the challenge is to create work environments that are shared by human and machine equally.

### C. Digital Transformation of the Financial Sector

One of the service sectors to confront technological innovations early on is the financial sector [36]. Until the 2008 financial crisis, the sector could pride itself on “corporate stability and safe employment” [37, p. 222]. Today, however, financial firms have to keep up with technological innovation, process disruption, and service transformation [37]. FinTech companies threaten incumbent firms if they fail to adapt to these changes [38]. Some promising technologies for the financial sector are currently represented by AI, data analysis, blockchain, and robo-advising [39], [40]. Along with these technologies however come challenges and risks that must be mitigated by keeping humans in the loop and allowing for a new division of labor [40]. Yet, the demand for digital service offerings grows and customers move away from traditional human interactions. To offer innovative and attractive services that retain expert human involvement the sector needs an “advice delivery model of the future” [41].

### D. Emergence of Robo-Advice

RAs provide investment advice to automatically build and manage client portfolios [21], [22]. In fact, however, the RA is neither a robot nor an advisor [42]. The RA is described as a robot [43], AI [44], decision aid [45], [46], [47], or platform [48]. Fueled by technology, RAs use algorithms, aided by AI and machine learning functions [49], [50], [51], [52] in some cases. To date, RAs can be divided into four generations where RA 1.0 and 2.0 automate the process of asset allocation based on simple questionnaires, the third-generation RA uses algorithms for portfolio adjustments and rebalancing while the newest model, RA 4.0, adds sophistication through self-learning AI [53]. The RA is situated in the second wave of digitalization and differs from online investment and brokerage platforms due to its abilities to undertake customer assessment and portfolio management [21]. The functionalities offered by RAs are commonly defined by the provision of investment recommendations, financial planning, and advice, along with asset or portfolio management—services that users can engage with online. Jung et al. [21] divide the process of robo-advice into the following three stages:

- 1) configuration;
- 2) matching and customizing;
- 3) maintenance

scaling down the traditional human advisory process of six stages.

Robo-advice represents a shift from a human-to-human to a human-to-computer process and holds the potential to automate the entire process [21]. Trust in human ability is turning into trust in algorithms [54]. However, researchers and practitioners believe that blending human and RA could combine the strengths and limit the weaknesses of each to serve the increasingly diverse investor clientele. Investigating this emergent research stream, we aim to provide guidance for financial firms in their transformation journey towards digitally enabled advice.

TABLE I  
NONCONTENT RELATED PAPER SELECTION: INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> <li>• “Robo-advi*”, “automated investment advi*”, “digital* investment advi*”, “digital wealth” in title, abstract, and / or keywords AND “human” in all fields / within results</li> <li>• Journal article, review paper, conference proceeding, book chapter, industry-oriented articles</li> <li>• Subject areas related to business, management, economics, sociology, psychology, social sciences (where applicable)</li> <li>• Peer-reviewed (where applicable)</li> <li>• English language</li> </ul>	<ul style="list-style-type: none"> <li>• Theses and dissertations</li> <li>• Other languages than English</li> </ul>

## III. RESEARCH DESIGN

To answer the research question, a systematic literature review was conducted [55], [56], following the principles of a structured, comprehensive, and transparent approach, visualized in Fig. 1. To begin, relevant multidisciplinary RA-literature was identified through searches of the Scopus, Web of Science, and EBSCOhost databases. Relevant papers were identified through the search term “robo-advi\*” (using truncation to include variations of the term) or related terms used in that context (e.g., automated investment advi\*). From initial readings we noticed that commonly, papers refer to retail customers that privately invest their money with a RA but differentiate financial advisors from RAs through the word “human” [54]. We therefore added the search term “human” to further narrow the list of relevant publications to identify publications that differentiate human (traditional) financial advice from automated or robo-advice.

To refine the results, further noncontent related criteria were used; see Table I. Due to the emergent nature of the topic, we extended the search scope [56] from research papers to book chapters and industry-oriented sources (e.g., *Journal of Financial Planning*, *The CPA Journal*) to include relevant views from, *inter alia*, topical experts such as certified financial advisors. Only certain subject areas were included to focus on relevant studies looking at the human side of RA-implementation and to exclude papers with, for example, a computer science focus. Due to the emerging nature of the topic, no time frame criterion was used. No subject area criterion is available on EBSCOhost. Instead, the selection was reduced by the criterion “peer-reviewed.” We did not include journal rankings as criterion to not potentially exclude relevant publications due to a low or nonexistent ranking, and the tendency of general interest journals to be ranked above specialist journals, in particular shown to be relevant for finance [55], [57]. However, we checked for potentially predatory journals and publishers [55], [58].

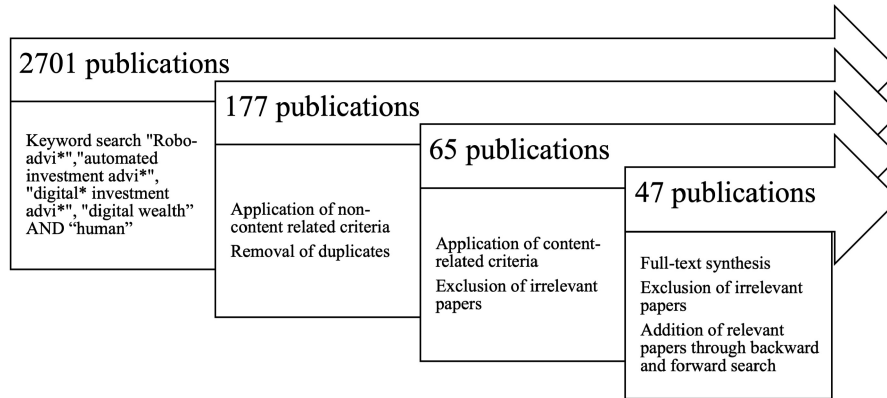


Fig. 1. Selection process.

TABLE II  
CONTENT RELATED PAPER SELECTION: INCLUSION CRITERION

Inclusion criterion
<ul style="list-style-type: none"> <li>Publications addressing the role of or impact on human advisors (e.g., performance, competition, customer preference) or business aspects related to service provision (e.g., business models)</li> </ul>

In the next step, we applied content related criteria to focus as directly on the research question as possible (see Table II), namely, address the role of or impact on human advisors. In this a priori screening of 65 abstracts, we looked at publications addressing human advisors in particular, as well as publications studying business factors of robo-advice.

In a full-text synthesis, 31 publications were excluded. Implementing triangulation among the authors to verify the relevance of selected publications confirmed 34 publications. In a forward and backward search, we screened reference and citation lists for further relevant publications, leading to the addition of 13, and a final sample of 47 publications ( $n = 47$ ).

The sample contains publications published between 2014 and 2023 consisting of 24 journal articles, 5 conference papers, 9 book chapters, and 9 papers in industry-oriented sources. The final selection is listed in Table IV in the Appendix. The selected publications were analyzed and synthesized, after which their consideration of human advisors was reviewed. Through an exploratory full-text content analysis, different viewpoints of previous studies on the role of human advisors in robo-advice were found. Notably, the abilities of humans and RAs were often mentioned to compare or differentiate between the two. Therefore, abilities were listed and examined more closely. Summing up the results from the literature review, we provide a visualization of our findings and suggest a comprehensive agenda for future research, integrated with recent works and three relevant research streams: Effects of digitally enabled work on employees, service provision along robots and AI, and effective human-machine interaction.

#### IV. FINDINGS

In the past ten years, robo-advice has been a topic of increasing interest in practice and in theory, and a promising technology for the financial sector. The very definition of RAs indicates the involvement of humans as “little to none” [59] or nonexistent [60], [61]. Yet, our findings suggest that human involvement is here to stay, at least that of advisors. To date, most literature refers to human retail investors when referring to users [62], not to human financial advisors. Within those studies examining RAs in the context of advisors, one debate keeps reappearing with inconsistent results: “Man or machine?” investigating and comparing the performance of RA and human counterpart [43], [60], [63], [64], [65], [66], [67]. Nonetheless, the history of traditional financial advisory and the evolution of technology shift the discourse to one of human-machine collaboration that the below sections will present.

##### A. Role of Human Advisors in the New Era of Advice

Several types of RAs exist today, significantly differing in maturity and service offering. For instance, RAs are defined by various stages of technological advancement, from simple questionnaire-based algorithms to artificially intelligent and conversational RAs [61], [68], [69]. To date, there is no consensus amongst researchers and professionals on the impact of RAs on human advisors. Some papers highlight the potential of the RA to replace human advisors [44], [45], [60], [61], [66], [69], [70]. In contrast, many papers emphasize the importance of human advisor involvement in the advisory process [43], [54], [63], [71], [72], [73]. As Baker and Dellaert [74, p. 730] point out: “Relationship management and other, more difficult to model aspects of the work of financial advisors are harder to automate.”

Next to technological possibilities, another key aspect for the development of robo-advice has been regulation. Giving financial “advice” is much limited by law [75] as “the consequences of poor financial advice can be severe even in an individual instance, and potentially catastrophic on a large scale” [74, p. 743]. Increasingly discussed is thus the question whether



TABLE III  
HUMAN ADVISOR ABILITIES VERSUS RA ABILITIES

Human advisor abilities	RA abilities
Relationship management (personal interaction, trustworthiness) [23], [64], [71], [72], [74], [75], [77], [79]–[83], crisis management (reassurance, support) [82], [84]–[86], expertise [54], [75], [77], coaching [74], [79], holistic [79], [87], creative [43], [87], educative [16], [75], [88]	Objective [50], [60], [66], [78], [84], [88], eliminates human error / increases accuracy [77], [81], [85], [89], data-driven [90], holistic [70], transparent [88]

RAs can fulfil the fiduciary standard or not, with ambiguous results [44], [76], [77], [78], [79]. For instance, human bias is not allowed to impact investment advice and is argued to be mitigated by human advisors, under fiduciary duty [79]. In contrast, researchers argue for the presence of bias in human advisors that can be mitigated by RAs [78]. As regulations are only slowly adapting to guide the development of RAs, the challenge for human advisors to remain relevant, working under the legal requirements for their job, grows. Which steps of the process can be automated, technologically, and legally, remains debated, though a varying degree of human involvement is to be expected [68], [70].

### B. Human Abilities, Opportunities, and Shortcomings

As part of the performance debate, researchers often look at technological and human possibilities and shortcomings. Professionals continue to ask: “[H]ow do I differentiate myself?” [64, p. 31]. We noticed some commonly noted abilities or competencies attributed to human advisors and RAs (1.0–4.0) that are listed in Table III and further described below.

Among the value that each, human advisors, and RAs, provide to customers, some abilities are shared, and others are likely to be accelerated by the combination of the two. In any case, humans still have an edge over technology in certain areas. Arguably, the fiduciary character may be fulfilled by human and RA equally [44], although objectivity, or rationality, are a key value added by RAs. Robo-advice is seen as less prone to human bias or greed [60], [66]. Contrarily, Mehrotra adds that it is the “warmth of human intervention” [72, p. 346] that best supports the fiduciary character. More so, the human touch is what most researchers and professionals regard as the true merit of human advice e.g., [67], [83]. As data from Cocca [75] shows, phone calls between customers and their (traditional) bank’s advisor still occur around six to eight times a year. Personal meetings are still held three times a year, highlighting that, still, “face-to-face meetings are of great importance” [75, p. 47].

Another vital role in the client relationship involves expertise and knowledge, and the dissemination of information. As Northey et al. [65] suggest, the source of information, whether human or automated, impacts the level of trust in the information received [65]. With the increasing authority of algorithms, trust in human experts and professionals has been reported to be

decreasing [91]. Wexler and Oberlander [91, p. 9] similarly argue that professional knowledge might move “from the front to the back room.” In spite of that, the level of expertise in human advisors is shown to significantly impact the intention to use RAs; high expertise in human advisors is generally preferred to a RA, whereas a novice human advisor cannot obtain cognitive trust, but still earns emotional trust [54]. As a result, researchers argue for maintaining the trust-based relationship between investing client and human advisor [75], [83], only with the help of machines, or, conversely, enhancing the success of RAs by adding anthropomorphic characteristics to increase trust in the machine component [54].

### C. Enabling Human–Machine Interaction

While much research is concerned with comparing RAs and human advisors, a sharp distinction between the two in future models of financial advice is neither the only nor the recommended solution. Human advisors as well as RAs provide certain benefits to customers as well as financial institutions. In particular, human interaction is a significant part of financial advice that many customers still value over a fully automated, RA-only process [23], [54], [62]. With the introduction of RAs as a tool for investment management, the requirements for human financial advisors are changing. According to Beltramini [90] we quickly become dependent on machines, ending up vulnerable. Along with existing industry solutions, researchers therefore argue for models that combine RAs and human advisors [50], [69], [71], [92]. With the potential of algorithmic tools to support and assist human work [16], a hybrid advisory model becomes feasible and even necessary as lawyers argue [86]. Even a more intelligent RA does not likely eliminate human advisors completely [81]. Researchers and practitioners therefore suggest a range of activities that will become increasingly relevant, including the education of investors [75], [93], a customization of wealth management advice or focus on specific client segments [78], [80], [94], technical skills, for instance, in the area of AI and data analytics [72], [75], [89], as well as an understanding of psychology and behavioral finance [74], [79], [84], [95].

### D. Business Models of Robo-Advice

Robo-advice is not just the application of another technology, instead it changes the business of investment management. Yet, the management of other people’s money goes back centuries, and activities related to personal investment have long been aided by technology, “the automated internet investment platform is not a new concept; it is more of an evolution” [76, p. 504] or an extension [93]. But now, the overall market share of traditional advisors will shrink [70, p. 8]; and for the remaining advisors the provision of financial advice will change, while the sector has a variety of possibilities for expansion. Customers no longer simply want a balanced portfolio, shifting the industry towards a future advice model that encompasses more areas of life [70]. The application of modern technologies challenges existing banks to remain competitive as FinTech companies

emerge [16], [93]. RAs currently on the market could either 1) come from start-up companies serving investors directly (as a technology) or could 2) be incorporated into traditional business models and be offered by banks [64]. In particular, start-ups can benefit from established banks and their trusted customer base, and, vice versa, incumbents from the technology expertise of start-ups through “white labelling,” allowing firms to incorporate pre-packaged RAs and adapting them as their own [76], [93].

Often overlooked, robo-advice involves various user groups and business models with varying impact on human advisors. As Garvía Vega points out [96, p. 3], “if the robo-advisor just performs advising services, the user could directly be the investor, while typically, in the second situation, the user will be an Investment Firm, a banking institution or an equivalent agent.” Extending on that, the user role will depend on the respective RA-model in place; a RA 4.0 using AI will only require one user, the investor, whereas less advanced RAs require the involvement of human advisors [96]. Robo-advice can thus be categorized in four models: stand-alone, segregated, integrated, and robo-for-advice [36], [96]. Segregated and integrated RAs are connected with or incorporated into a bank or banking group. Stand-alone RAs work independently for the investor. Robo-for-advice, potentially a B2B2C model, is defined specifically as a tool for human advisors that can support advisors in their work with clients [36], [88]. From a legal angle, the RA can thus benefit human advisors as “sub-adviser” or “third-party asset manager” [76]. Against the assumption that robo-advice does not require human involvement, following this logic, there are in fact RA-solutions that, inevitably, impact and involve human advisors to a varying degree.

## V. DISCUSSION

The investigation of the current literature has offered several valuable insights into the newly emerging relationship between human financial advisors and RAs. Views on the impact of RAs on human financial advisors today are strikingly divergent. The effect of digital technologies on individuals remains on the research agenda [97] but the case of robo-advice has not received much attention in the context of digital transformation and only little attention in the business and management sphere. We argue that the RA is an important subject to study at the intersection of technology and service professional as RAs have been classified as robot [43], AI [44], decision-making tool [45], or platform [48], among others. Driven by the growing digital-savvy clientele and the timely democratization of financial advice to a wider audience, the industry needs to establish new ways to make their services accessible as well as efficient. With the help of RAs, a low-cost alternative becomes available to clients, while financial advisors potentially get to free up time and boost their service offering [64].

The comparison of the automated investment platform to a robot creates the mental image of something empathetic and personified because an advisor is supposed to be exactly that. Anthropomorphism in robo-advice is being increasingly

studied from adding conversational abilities, to attaching human-like names, and assigning personality traits [46], [60], [75], [98], [99] highlighting the increasing competition between human and artificial agent. The literature reveals the increasing technological advances of RAs, raising the question of how the development of the RA will continue to develop. Under that lens, augmentation and enhancement of human capabilities will continue to evolve the debate of human–AI interaction [14] for which the RA represents a very relevant research subject.

RAs should be studied through various lenses which will add significantly to our understanding of them, improving the design and management of future work scenarios with this and other digital technologies. On the micro level, at the intersection of digital transformation and innovation management, this article studies the RA-phenomenon to explore changes in individuals’ work practices [97]. Thus far, investors have received the most attention in the RA-literature, and a consistent weakness is the lack of a differentiation of users and business models. Many papers talk about “users” as those who invest money with RAs. This will apply only to standalone models [96]. Any application of RAs in financial institutions, however, can result in changes for the work of financial advisors as, e.g., algorithms now have to be monitored, third parties (RA providers) need to be managed, and the customer base grows along with varying demands [22].

The implementation of RAs into investment management offerings involves the meaningful step of including existing and emerging professionals in the process. The majority of researchers and professionals highlight the importance of human interaction in the client relationship and the human traits that are still missing from even fourth-generation RAs. Therefore, it is not a debate of “whether or not” but a debate of “how to.” The outcome of implementing AI-driven RAs appears to be leading to sophisticated full-service automation without human interaction while also generating valuable opportunities to redirect and “supercharge the advisor’s knowledge” through synthesized data insights [51, p. 19]. By contrast, less advanced technology solutions offering generic questionnaires could “augment” the advisory process [16, p. 534], extending the advisor’s tasks to include, for example, advice that is highly tailored to individual customers [43], [100]. This concept supports Parasuraman et al. [101] in the automation context and Rühr [62, p. 3] in the RA-context, stating that “the level of automation determines the extent to which the advisory process is conducted by an algorithm instead of a human advisor.” The level of human advisor involvement will thus be determined by technology. At the same time, however, it will depend on the respective service process and customer demand as, for instance, certain customer segments may remain mostly with human advisors [79], [80]. Based on the synthesis of the literature, Fig. 2 represents a simplified summary of our findings, showing some possible dependencies in robo-advice and how various opportunities for human advisors in financial institutions emerge.

Hybrid collaboration is suggested by researchers and practitioners [43], [45], [50], [62], [69], [85] as a solution to merge

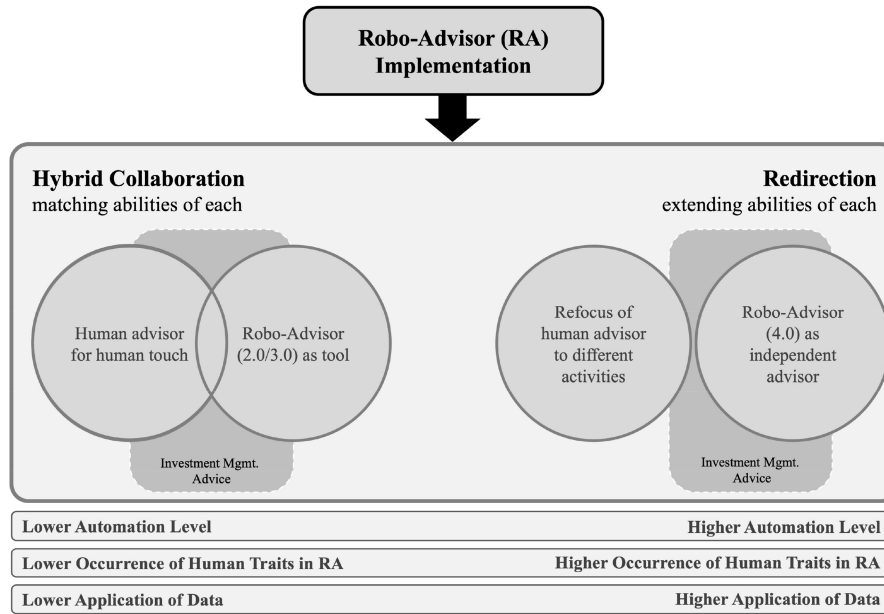


Fig. 2. Findings summary: Dependencies in robo-advisor implementation.

human and RA capabilities, as seen on the left side of Fig. 2. In that sense, parts of the process of investment advice are covered by the RA, while other aspects will be carried out and supported by humans. This requires an emphasis on human traits where possible and views the RA as a welcome tool for analytical tasks such as information processing. A less advanced RA will produce data but also make less use of it. In this scenario, the RA functions as an addition to human ability, with human advisors building on competencies such as behavioral finance, psychology, and relationship management and “other, more difficult to model aspects of the work of financial advisors [that] are harder to automate” [74, p. 730], [102]. Tedesco [103] suggests a shift from full-time investment management to one-part investment management and three-parts financial planning and guidance. This collaboration could be favorable for the less advanced models of RAs. It contains fewer human traits because those are present within human advisors.

Based on the literature, we would suggest that a more advanced, AI-driven RA would decrease the contribution of human advisors to the process of investment management advice and redirect towards other areas of expertise. As data by Becker et al. [68] shows, on average, two to three out of five asset management tasks are currently processed by algorithms, with the potential of machine learning to cover even more. Depicted on the right side of Fig. 2, the RA covers the investment advisory process almost entirely. In this scenario, the RA is more likely to have additional human traits while human advisor involvement will be significantly reduced. As researchers and professionals point out, there will be a significant need for experts in specialized services required for, e.g., taxation [75], as well as data science, computer science, or systems engineering [72], [74], [90]. Apart from investment management, financial professionals could become particularly relevant for the monitoring of algorithms [89].

It becomes apparent that with RAs of all maturity levels, the profession of financial advisors will need some adapting. Human advisors can therefore 1) strengthen client relationships and take part in the investment management process differently while being available to a broader customer base, or 2) learn new skills such as technical skills that having a RA will require. Ultimately, advisors need to exploit the benefits of RAs. The lack of being able to effectively use new technologies in the workplace may result in technostress, the stress occurring from technological solutions, running the risk of impacting advisor performance [104]. Therefore, the level of digital literacy of employees plays a significant role when it comes to technology adoption [105]. Skills and expertise to work in digitally driven workplaces but also positive valence have shown to increase the intention of employees to work with robotic technologies [13]. What is therefore highly relevant, yet mostly disregarded in theory and practice, is the management of the implementation process, ensuring the success of the RA for the sustained competitive advantage of financial institutions. While increasingly capable RAs are likely to trigger a reduced need for human advice, a financial firm’s talent is deeply anchored in the industry’s history with traits like trust and knowledge that businesses should seek to retain.

#### A. Theoretical Implications

As researchers, we have to not only use theory but must also build it to advance our understanding of new phenomena [106]. Robo-advice is a relatively new phenomenon connecting various subject areas that each use proven, reused, renewed, and even newly developed theories. Academics from various fields as well as industry professionals have over the last years

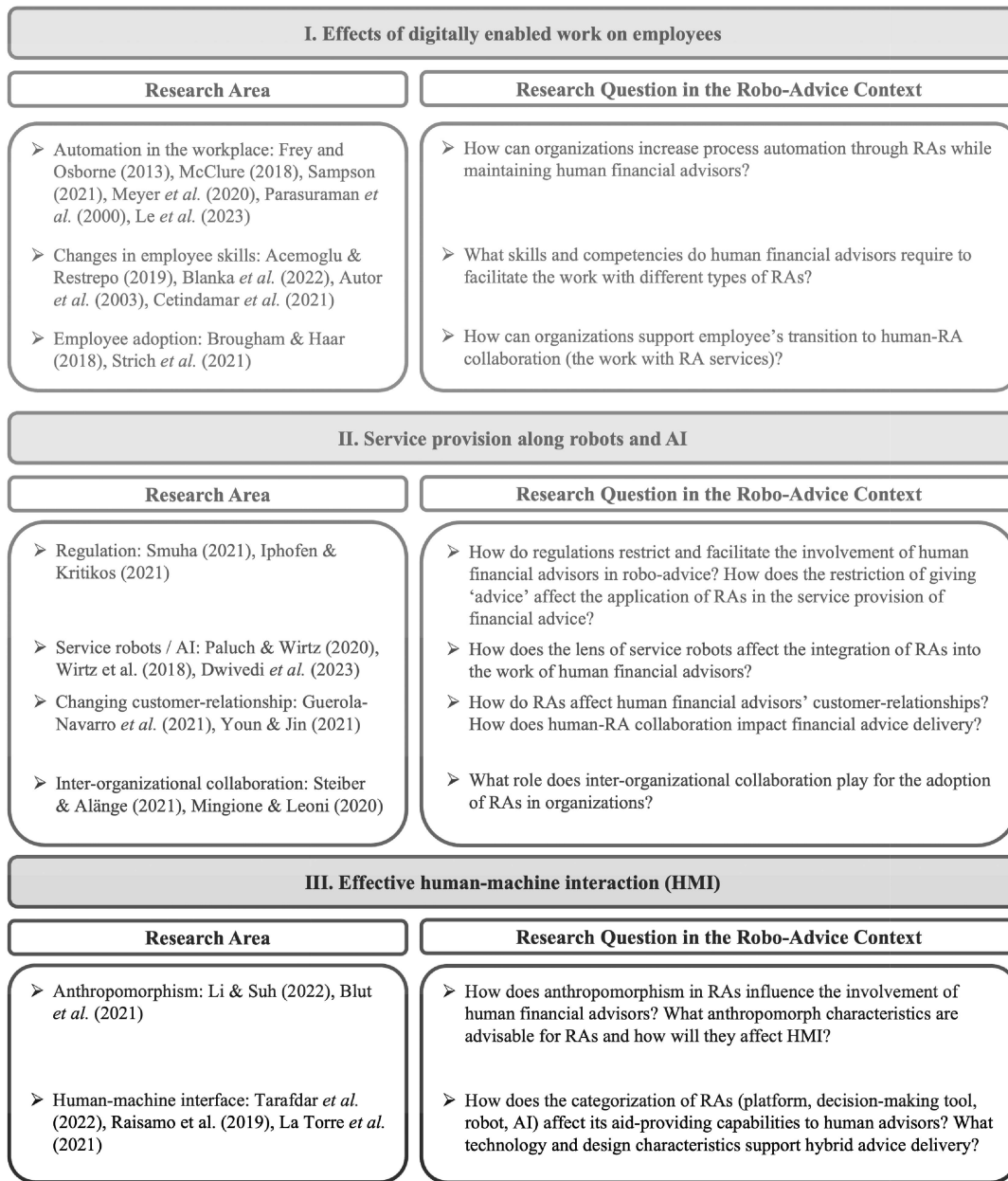


Fig. 3. Future research agenda.

contributed significantly to the emerging RA literature, although many questions raised, to date, remain unanswered.

With this literature review we have shown that talking about robo-advice does involve many variations with differing impact on participating stakeholders, including customers, advisors, financial institutions, and start-ups. Just as any other financial technology that human advisors have used before, RAs can become an integral part of financial institutions. As a consequence, the financial advisor working in the field of investment management has to acquire new skills to continue to add-value and remain a relevant human touchpoint in the equation. Future research in robo-advice should therefore continue to make significant theoretical contributions that

could be substantial for building effective human–RA interactions or, more broadly speaking, human–machine interactions in service professions. We elaborate on current research gaps and suggest a future research agenda in the following section.

### B. Practical Implications

Although primarily theoretical in outlook, this article also provides some practical implications. For practitioners, systematic reviews represent a “reliable knowledge base by accumulating knowledge from a range of studies” [107, p. 220]. We seek to inform financial institutions about the possible use case scenarios



as well as the resulting consequences for their employees. In light of the emergence of RAs, incumbents may ask: “How can digital technology and automation be leveraged by the firm to improve advice delivery from [financial advisors]?” and “How do we gain efficiencies through greater automation?” [93, p. 16] As we show, there are varying possible outcomes requiring employees to adapt to robo-advice. Successful RA-implementation calls for sophisticated and nuanced managerial guidance and a clear vision of where the advisor role is headed to ensure that human advisors do not feel overwhelmed. Financial advisors will thus need to find ways to use RAs to their advantage, while businesses will play the major role in strategically choosing and implementing the most suitable RA while providing the necessary measures for employees to adapt and reskill.

## VI. FUTURE RESEARCH AGENDA

Robo-advice signifies the continuous development of increasingly smart machines entering the workforce of service professionals. Our research adds to the current debate of combining traditional assets and capabilities (human advisors) with digital ones (RAs), a topic that remains on the research agenda of digital transformation [97]. Despite the potential benefits of robo-advice, industry today might still be far from achieving those; and the review of recent academic and industry publications has brought to light a few debates and misconceptions that may be able to explain that. Based on three key areas, Fig. 3 provides an overview of possible additional research questions and how they apply to key literature in the broader context of digital transformation.

First, previous research has shown the versatility of the RA and its applications. The level of automation will be linked to these advancements and thus significantly impact the need for human involvement [101] and change the role humans play [108]. Future research should further investigate and empirically test possible strategies following RA-implementation by using the findings of this article presented in Fig. 2. This includes an extended exploration of combining human and RA abilities as presented in Table III, in particular, how human abilities can be strengthened in light of the RA-implementation. This ties in with existing research on automation [109], [110], [111], [112], [113], changes in employee skillsets [2], [5], [105], [114], and technology adoption by employees [115], [116] as specified in Fig. 3.

The second stream involves technologically driven changes in service provision. Here, the regulatory frame will be relevant to further define future scenarios with AI [117], [118]. In addition, the different stages of the advisory process [21], [47], [68], [82] should be further investigated empirically under consideration of the need for human advisor involvement and the respective RA-models [96]. Looking at regulation and service provision may further help point out parallels to other industries using service robots and AI [119], [10], [120] to allow for a broader application of the concept. With digital services, customer relationships also beyond robo-advice are changing with shifts in knowledge dissemination, trust, education, and

literacy that should be explored [121], [122]. In the broader organizational context, we suggest putting the interplay and possible co-creation of incumbents’ long-established expertise and start-ups’ technological innovativeness [123], [124] on the RA research agenda [75].

The third research stream is based in the field of human-machine interaction that has been previously addressed in the field of robo-advice [125], [126]. RAs are increasingly receiving human traits that may increase trust in the machine component [54]. More research is needed in order to establish under which circumstances service technology should receive human traits and how this will further impact the human-to-human relationship [127], [128], [129]. Furthermore, the current debate reveals inconclusive results about the acceptance of algorithmic tools, AI, and robots. Research is needed to further explore the interface between RA and human advisor that will affect the technology’s potential to enhance or augment human abilities [14], [108], [130]. On a sublevel this will require investigations of the RA-interface, the integration with existing banking systems, and the creation of a comprehensive solution [75] that will significantly define the level of interaction possible.

To further develop our understanding of the implications of RA-technologies in service professions, working interdisciplinary across research streams will be unavoidable. This will not only provide insights into robo-advice in particular, but also add to our understanding of technology and human collaboration in digital transformation efforts in general.

## VII. CONCLUSION AND LIMITATIONS

The literature review presented in this article has explored and highlighted valuable insights that add to our understanding of combining human and technology capabilities in the workplace. However, conducting a systematic literature review inevitably comes with its limitations. Most notable is the challenge of including as many relevant papers as possible by following a systematic approach while also rigorously narrowing the selection to enable an in-depth review. A literature review represents only the status quo of the moment when it was conducted. With a rapidly evolving research stream like robo-advice, more and more papers are appearing at an impressive pace. The vast interest in the topic also means that non-scientific publications weigh in, and those must be carefully reviewed. The EBSCOhost results included more papers that had to be carefully (de)selected [55]. Furthermore, chosen keywords and criteria have the potential to miss relevant papers. Also, abstracts may not always be fully informative and are sometimes unclear in their descriptions [30]. Finally, the review process itself, from choosing specific databases to shaping the literature selection process is, inevitably, framed by the reviewers. Despite these limitations, we hope that this article adds new direction to the digital transformation literature and encourages further exploration of robo-advice in this and neighboring fields.

## APPENDIX

See Appendix Table IV

TABLE IV  
OVERVIEW OF ITEMS IN THE LITERATURE REVIEW ( $n = 47$ )

Publication	Main objective	Methodology / Type	Key findings / Conclusion
Baker and Dellaert, 2018 [74]	Identify the core components of RAs and key questions for regulators.	Law review (essay)	The core components of RAs are competence, honesty, and suitability. Regulatory key questions concern the RA algorithm, data, the choice architecture, and the IT infrastructure.
Becker et al., 2021 [68]	Examine in which process steps of automated investment advice machine learning algorithms could be applied.	Empirical analysis of machine learning algorithms	The most promising technique for robo-advice is the use of Text Mining for sentiment analyses to monitor and rebalance or perform future performance forecasting.
Beltrami, 2018 [90]	Apply the theory of Coeckelbergh to provide a rich and insightful exploration of the machine-human interface in robo-advice.	Conceptual piece with interviews with senior team members at advisory firms	The vulnerability concept opens conversations about effects of innovations and about what human beings want from these innovations. The machine-human interface can be understood in terms of the transfer of human vulnerability.
Bhatia et al., 2020 [84]	Investigate how RAs can help in mitigating behavioral biases of a retail investor.	Qualitative approach with expert interviews in India	RAs still need to mitigate investor's biases; they are not yet comprehensively self-sufficient to accurately perform risk analysis for retail investors.
Bhatia et al., 2021 [69]	Investigate the awareness, perception, and attitudes of individual investors towards RAs.	Phenomenological qualitative study, focused group discussions in India	Some investors perceive RAs as an alternative for financial advisors only for quantitative analysis. RAs act as a supplementary service rather than a substitute for financial advisors.
Brenner and Meyll, 2020 [66]	Investigate whether RAs reduce investors' demand for human financial advice.	Data from the 2015 National Financial Capability Investor Survey of US investors	Using RAs results in a 15.8 percentage point decrease in investors' likelihood to consult human financial advisors. RAs offer a valid alternative for human advice, especially for investors who fear to be victimized by investment fraud.
Chia, 2019 [60]	Investigate the trustworthiness of machines as compared to human financial advisors in acting in the best interests of clients.	Conceptual	Greater explainability can be achieved by describing the 'personality' of deep learning RAs: Greedy versus prudent, risk appetite, ethical behavior.
Chou et al., 2023 [79]	Explore the relationship between RAs and traditional banking and define the role of bank intangible assets value.	Questionnaires with investors	Bank intangible value binding affects customers' adoption of RAs. A hybrid model that contains RAs and traditional banking services can encourage the acceptance of RAs.
Cocca, 2016 [75]	Analyze how the traditional advisory model could be altered by means of virtual advisory models.	Survey with wealth management clients in Switzerland, Germany, Austria (industry-oriented)	For the majority of clients, the hybrid advisory model provided by established wealth managers holds the greatest potential as an advisory model.
Coombs and Redman, 2018 [82]	Explore the key elements of the financial adviser job role and where human interaction with the client is considered to be valuable.	Qualitative case study with financial advisors	Human involvement and RA interaction differs in different stages of the advisor process, requiring human advice in the first two stages of the process, enabling collaboration in the maintenance stage.
Cull, 2022 [16]	Provide a historical review of the development of FinTech, benefits, and challenges.	Literature review	FinTech benefits advisors and clients with efficient management, improved experience, and cost reduction. However, it challenges the role of human advisors and requires careful technology integration.
Cuzzola, 2020 [45]	Explores whether there exists an adequate regulatory framework in the current legal system for introducing AI into the structure of human-human relationships.	Law review, regulatory framework analysis	The existing legislation shows gaps in the area of automated advice. The complexity increases with pure robo-advice models.
Dewasiri et al., 2023 [87]	Determine the current application of AI and blockchain in the banking industry, to identify challenges faced by banks.	Systematic literature review	Employment, performance, security, privacy and trust, cost, ethical and regulatory challenges are the most common challenges for banks. Fusing technologies with collaborative human effort can help deal with these challenges.
Ferri, 2014 [94]	Explore how any financial advisor in America can create a low-cost online portfolio management solution and be a RA.	Column (industry-oriented)	The successful deployment of technologies like RAs relies on collaboration, governance, standardization, and harmonization of market practices.
Fisch et al., 2019 [88]	Describe and compare the characteristics of the RA industry to those of traditional human financial advisors.	Not specified	Human advisors still offer services that RAs cannot, leading to the emergence of a hybrid model, pairing RA with access to a human advisor.
Fulk et al., 2018 [80]	Compare the characteristics of consumers in their current and expected use of RA services, traditional financial planning services, or a combination of the two.	Survey of individual US consumers	Users of RA services (1) have lower income, (2) have lower net worth, (3) have received no / less inheritance, and (4) are less impulsive financially. Users of human financial planners are older and have higher levels of net worth.

TABLE IV  
(CONTINUE)

Publication	Main objective	Methodology / Type	Key findings / Conclusion
Garvía Vega, 2018 [96]	Offer a taxonomy of the Robo-Advisory industry.	Conceptual	Robo-advice involves different roles and business models. Actors include the programmer, the owner, the user, and the investor.
Gerlach and Lutz, 2021 [71]	Explores the perceived benefit and risk influence on future usage intention of Digital Financial Advice Solutions (DFAS).	Questionnaire-based online survey with investors	Few investors prefer DFAS as a substitute for traditional wealth management, while half see it as a complementary service. Almost 60% favor traditional institutions over a new entrant.
Greve and Meyer, 2021 [67]	Compare RAs with salespersons and hybrid solutions and their impact on behavioral constructs.	Experiments with German savings banks customers	Even in the presence of RAs, personal selling for complex financial products can remain relevant.
Harrison and Samaddar, 2020 [63]	Compare the performance in investment decisions between human advisor and RA.	Simulated contest of portfolio returns of human and RA, survey	Despite the inclusion of fees, historical and recent returns consistently demonstrate superior performance of the human adviser over the RA.
Hougan, 2015 [95]	Explore the RA firms Wealthfront and Vanguard and the implications of RAs for human advisors.	Column (industry-oriented)	RAs will have long-term ramifications for the industry. Advisors have to offer truly differentiated investment management or leverage the new tools.
Kitces et al., 2015 [64]	Discuss RAs and the possible future advisory model.	Roundtable discussion (industry-oriented)	Financial advisors do not yet see the value of RAs in accelerating their work. People's attitudes have to be changed and the value added by humans has to be clearly communicated.
Klass and Perelman, 2018 [89]	Discuss how RAs have disrupted investment advice delivery and the role of the fiduciary standard.	Law review, discussion	Digital advice reflects the technological evolution of traditional advisory services and fits within the existing regulatory framework, in particular within the fiduciary standard.
Levine and Mackey, 2017 [43]	Discusses the difference of human advisor and RA in the delivery of investment advice.	Column (industry-oriented)	Optimal success lies in combining the best aspects of humans with technology. Human advisors should focus on high-value-added tasks and creativity-oriented skills.
Lightbourne, 2018 [44]	Evaluate whether RAs can meet the fiduciary standard.	Law review (note)	RAs are no less likely to meet the fiduciary standard than human advisers.
Lopez et al., 2015 [93]	Explore how new digital investment services are changing the wealth management landscape.	Interviews and discussions with senior executives (industry-oriented)	New digital investment services have the potential to make advice for the mass market feasible; traditional players need to determine if and how they want to approach them.
Maume, 2019 [77]	Evaluate the interaction between client and machine from a regulatory perspective.	Law review (article)	Robo-advisory is essentially different from traditional financial advice. However, existing rules can be applied to RA but should not create a level playing field for market participants.
Mehrotra, 2019 [72]	Examine the role of AI in the space of banking and financial services in replacing humans.	Not specified	Interpersonal communication between humans remains fundamental, however, in-house training programs should deliver AI skills to existing employees.
Merkle, 2020 [23]	Explore the current and future role of RAs and human advisors in robo-advice.	Review of existing data and literature (industry-oriented)	Human advisors as money doctor are going to remain relevant. The future of delegated investment may be a hybrid model of humans and robos working together.
Metzler et al., 2022 [92]	Explain the main characteristics and features of RA business models.	Multiple case study across US-based RAs	RA business models can be distinguished by pure algorithm-based RAs and hybrid RAs with human advisors involved.
Moisand, 2014 [73]	Discuss how RAs represent a problem for the profession of financial advisors.	Column (industry-oriented)	There are substantial differences between RAs and human advisors. Human advisors provide by providing real human connection; however, RAs are much better at being marketed to the public.
Northey et al., 2022 [65]	Identify the underlying causal mechanisms that affect consumer investment decisions.	Two experiments with consumers	Consumers have more belief in advice provided by a human financial advisor (compared to a RA) when the level of involvement is high.
Riley and Schild, 2019 [83]	Examine the risks confronting the financial industry by specifically examining the role and position of small independent advisory firms.	Critical assessment of three hypothesis	The financial advising industry will experience accelerated growth through technology. Small independent advisors can only succeed and prosper by embracing reinvention.
Rühr, 2020 [62]	Investigate user preferences in the choice of a RA configuration and the role of transparency in control over a	Choice-based conjoint experiment in Germany, survey	Users prefer hybrid automation and high levels of control and transparency.

TABLE IV  
(CONTINUE)

Publication	Main objective	Methodology / Type	Key findings / Conclusion
Sabharwal and Anjum, 2018 [81]	Explore use cases of RAs using machine learning and the future potential of reinforcement learning (RL) algorithms.	Use case analysis	RAs help to deliver enhanced customer service making increasing use of available data. With the use of RL algorithms, RA could offer more advanced financial services.
Seidt et al., 2019 [76]	Discuss the comparison of RAs and human advisers, and challenges posed by robo-models for regulators.	Informal interviews with leadership and staff of RA-firms	State and federal regulators must collaborate, share information, and enhance their resources to ensure the success of new advisory models while adequately safeguarding investor interests.
Singhvi, 2021 [78]	Discuss the evolution of the robo-advisory landscape, various models, and market scenarios.	Conceptual with secondary data	RAs act as efficient asset allocators, prioritizing client interests and fostering financial inclusion, moving towards holistic investment strategies.
Sironi, 2016 [36]	Discuss the relationship of RAs and Goal Based Investing in the frame of innovation as key determinants to the recent banking transformation.	Not specified	The theory of innovation explains how RAs and the gamification of Goal Based Investing jointly drive today's banking transformation.
Steennot, 2022 [85]	Discuss the services and protection offered to retail investors by RAs.	Law review (article)	RAs pose risks due to limited personal contact and reliance on algorithms. Financial intermediaries must clearly explain the concept of RAs, ensure algorithm suitability, and provide transparency.
Strzelczyk, 2017 [86]	Examine the state of financial innovation and investor protection regimes with regards to the fiduciary standard.	Law review (note)	RAs cannot act as a fiduciary as, inter alia, they do not provide the individualized portfolio analysis as a traditional fiduciary.
Tedesco, 2015 [103]	Discuss the emergence of the RA and its impact on the business model of traditional financial advisers.	Column (industry-oriented)	Investment management is ready to be commoditized. Advisors will need to leverage technologies to scale the process.
Tiberius et al., 2022 [70]	Forecast the future development of the RA industry, including market growth, competition, growth drivers, customer segments, challenges, services, technologies, and societal impact.	International Delphi study	Financial advisors must adjust to the changing market. RAs will reach a broader audience, causing significant losses for traditional firms. Human intervention will vary, but automation will grow in importance for RAs.
Tokic, 2018 [61]	Explore the case of the RA BlackRock replacing human discretion through AI.	Case analysis, US	AI is expected to replace high-level roles in investment management, including stock pickers and financial analysts, rendering human discretion obsolete.
Wexler and Oberlander, 2020 [50]	Explore the drivers of RAs, the degree of disruption incurred, and how trust in algorithmic authority supports the legitimization of RAs.	Conceptual	Drivers for RAs include rebranding after the financial crisis, an expanding client base, and the rising popularity of algorithmic authority guided by AI. This suggests that professional service automation is poised for further growth.
Wexler and Oberlander, 2022 [91]	Examine the drivers, success, and characteristics of RAs as an early precursor of commercialized, programmed professional advice, and consider the implications of RAs for advancements in the sociology of professions.	Conceptual	The success of RAs relies on three factors: automated professional knowledge, acceptance of AI-guided algorithmic authority, and the contradictions between public perception of RAs and professional practices.
Zhang et al., 2021 [54]	Examine consumer adoption of RAs versus human financial advisers with different expertise levels.	Three experiments with US participants, survey	Consumers show a preference for highly skilled human financial advisers over RAs. However, there are no notable differences in performance expectancy and intention to hire between RAs and novice financial advisers.
Zunzunegui, 2022 [48]	Analyze the legal nature of RAs as a service platform and how it is different from traditional human advice.	Law review (article)	Robo-advice needs new regulation to address its risks. That requires to ensure correct programming of the algorithm and the skills of RA service providers in finance, data protection, and the use of digital tools.

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