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How can AI-integrated applications affect the financial engineers' psychological safety and work-life balance: Chinese and Iranian financial engineers and administrators' perspectives

Ke Gao[1] and Alireza Zamanpour[2*]

Abstract

Background The integration of AI in finance has significantly reshaped the role of financial engineers, improving efficiency and decision-making. However, it also affects psychological safety and work-life balance. Financial engineers face increased pressure to keep up with evolving technologies, fear of job displacement due to automation, and blurred boundaries between work and personal life. Exploring the link between AI applications, psychological well-being, and work-life balance is crucial for optimizing individual performance and organizational success, ensuring a sustainable and supportive work environment.

Objectives This qualitative study investigates how AI-integrated finance applications influence financial engineers' psychological safety and work-life balance. By exploring financial engineers' lived experiences and perceptions, the study seeks to provide insights into the human implications of AI adoption in finance.

Methodology : The study utilized qualitative research methods, specifically thematic analysis, to examine data from 20 informants selected through theoretical sampling. Thematic analysis techniques were employed to identify recurring patterns, themes, and meanings within the data, allowing for a rich exploration of the research questions.

Findings : Data analysis revealed several themes related to the impact of AI-integrated applications on financial engineers' psychological safety and work-life balance. These themes include the perception of job security, the role of automation in workload management, and the implications of AI for professional identity and job satisfaction.

Conclusions This study's findings highlight the multifaceted effects of AI integration in finance, shedding light on the opportunities and challenges it presents for financial engineers. While AI offers potential benefits such as increased efficiency and productivity, it raises concerns about job security and work-related stress. Overall, the study underscores the importance of considering the human implications of AI adoption in finance and calls for proactive measures to support the well-being of financial professionals in an AI-driven environment.

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Introduction

Over the last decade, there has been a marked acceleration in the adoption of artificial intelligence (AI) in the economy [1–3]. As a general-purpose technology, AI is reported to have a substantial impact, both directly and indirectly, on many sectors [4]. The financial industry, in particular, has seen intensive application of AI [5, 6]. Studies documenting how AI affects finance and financial markets have been published since the eighties and nineties [7–9]. Recently, many publications have been in this area, clarifying many opportunities, challenges, and effects. This article aims to complement and update previous surveys and reviews of the literature on AI in finance and financial markets [10–16].

Since the early days of computing, AI has been envisioned as a technology capable of performing logical operations akin to human intelligence but at much greater speeds. However, this vision has encountered setbacks and periods of disillusionment reminiscent of the hype cycles described by Gartner, Inc. Despite these challenges, AI has experienced periods of resurgence driven by advances in expert systems and neural networks [16].

In recent years, AI services have been widely deployed across commerce, healthcare, security, and finance sectors. However, there is growing recognition of the limitations of AI, with many observers expressing disappointment over its failure to live up to inflated expectations. Challenges include the inherent limitations of algorithms, the cost of computing power, and the availability of quality data [16]. While AI advances, fundamental questions remain about its potential to replicate human intelligence, emotions, and social behaviours. Practical challenges such as technological unemployment, privacy concerns, and the reliability of automated systems also persist. Despite these uncertainties, AI holds promise when integrated with human expertise, suggesting a future where human-computer interaction plays a central role [16].

Advancements in computing, particularly with personal computers and cloud computing, bolstered AI's capabilities, culminating in milestone achievements like DeepMind's victory in the game of Go in 2016. However, challenges persist, including the limitations of contemporary machine learning algorithms, cost-intensive computing power requirements, and the scarcity of reliable big data.

Despite AI's widespread integration into various sectors, concerns persist regarding its limitations and practical challenges, as articulated by The Economist [17]. Questions remain regarding AI's ability to approximate human intelligence, including emotional and social intelligence, and address ethical and societal implications, such as technological unemployment and privacy concerns. This article complements and updates previous surveys and literature reviews on AI's role in finance and financial markets [17], consolidating insights from various sources [10–15]. It also explores how AI-integrated applications affect financial engineers' psychological safety and work-life balance.

Rationale and significance

Rapid artificial intelligence (AI) adoption in finance has sparked interest in its broader impacts, but there is still a need for updated research on its effects on employees' well-being. This study aims to expand on previous literature, specifically focusing on AI's role in finance, including its impact on financial markets, employees' work-life balance, and psychological safety.

AI's use in finance is crucial for several reasons. First, finance involves high-pressure environments where precision and speed are paramount. AI technologies like algorithmic trading and risk management streamline operations, reducing workloads and enabling employees to achieve a healthier work-family balance. By automating repetitive tasks and providing decision-making tools, AI allows financial engineers to work more efficiently, offering flexibility in managing personal and professional responsibilities. Second, while AI enables efficiency, it introduces stressors such as job insecurity and the need for continuous upskilling. However, when integrated effectively, AI supports psychological safety by reducing human error, offering data-driven insights, and fostering a culture of innovation and learning. Employees are more likely to feel empowered and less anxious about mistakes, creating a secure environment for decision-making and collaboration.

Third, understanding AI's effects on psychological well-being is key to optimizing employee performance. Employees who feel supported by AI tools can better manage workloads, avoid burnout, and maintain work-life balance. The flexibility enabled by AI—through remote work, automated scheduling, and workload management—can help employees balance personal and professional demands more effectively, ultimately improving mental health and job satisfaction. Finally, lessons from AI's integration in finance can inform other high-pressure industries, highlighting how AI-driven tools can mitigate stress, enhance productivity, and improve overall psychological safety.

By addressing this gap in the literature, this study contributes to a more holistic understanding of the implications of AI in finance. The findings will inform

policymakers, educators, and industry professionals about AI adoption's potential challenges and opportunities in financial engineering practices. Moreover, the insights gained from this study can guide the development of strategies to mitigate negative impacts and maximize the benefits of AI integration in finance. This study seeks to fill this gap by examining how AI-integrated applications impact the well-being of financial engineers, providing valuable insights for academia and industry. In line with the existing gap, the following research question was raised:

How do AI-integrated applications impact financial engineers' psychological safety and work-life balance?

Literature review

Theoretical background

Drawing from multiple theoretical frameworks, integrating artificial intelligence (AI) in the workplace has significant implications for employees' work-life balance and psychological safety. In contexts marked by rapid technological change, psychological safety—defined by Edmondson [18] as a shared belief that the team is safe for interpersonal risk-taking—is essential. The introduction of AI can disrupt traditional workflows and job roles in the financial sector, where precision and rapid decision-making are crucial. This disruption can cause uncertainty and be perceived as a threat to job security [19]. According to social exchange theory [20], employees' opinions of organizational support—such as training and transparent explanations of AI's role—may alleviate these worries and promote a safety culture.

Davis's [21] technology acceptance model (TAM) suggests that employees' attitudes toward AI are greatly influenced by perceived usefulness and ease of use. In high-stakes environments like finance, psychological safety depends heavily on the accuracy and dependability of AI systems. Positive perceptions are built through open communication, strong support networks, and user-friendly AI interfaces, ensuring employees feel confident in AI-enhanced workflows.

Moreover, the **Conservation of Resources (COR) Theory** [22] posits that individuals seek to obtain, retain, and protect resources, such as time, energy, and emotional well-being, to cope with work demands. AI-integrated applications act as a valuable resource by automating routine tasks, streamlining workflows, and enabling more efficient use of time. By freeing up resources, AI helps employees better manage their daily tasks, reducing cognitive load and stress. This improves work-life balance as employees can focus more on personal well-being and family responsibilities without compromising work performance.

From a psychological health perspective, AI reduces the mental strain of high-pressure decision-making by providing data-driven insights and predictive analytics, enhancing employees' sense of control over their tasks. This, in turn, fosters psychological safety by reducing error risks and alleviating fears of failure in critical tasks. When employees feel secure in their roles and supported by AI tools, they experience less anxiety, greater job satisfaction, and are more likely to engage in innovative behaviours. As AI continues to reshape the financial sector, organizations must leverage it to enhance operational efficiency and support employees' psychological health and work-life balance, as these are critical to optimizing overall performance.

Boundary theory can examine work-life balance, another critical factor that AI integration impacts [22]. According to this theory, people create boundaries to keep their personal and professional lives apart, and how permeable these boundaries are impacts how well they can balance these two areas. These lines may be blurred by AI's potential for automation and remote monitoring, which could result in a culture where people are always "on" [23]. Financial staff members may feel pressured to be always available to manage AI-driven processes and data, which can increase stress and lower their quality of life. The theory of job demands-resources, or JD-R [24], offers more clarification by classifying the demands (pressures) and resources (supports) related to AI. AI can lessen workload by automating repetitive tasks, but it can raise cognitive and emotional demands because it necessitates constant learning and adaptation. Overall, job strain and satisfaction are determined by balancing these demands and resources. To ensure that the advantages of AI do not come at the expense of employee well-being, organizations must carefully manage the integration of AI while offering sufficient resources like training, psychological support, and work-life policies [25].

Review of empirical studies

Addressing labour challenges may necessitate reevaluating labour regulations and reintegrating collective bargaining mechanisms [26]. Implementing AI requires significant investments at both macro and micro levels, leading to temporary productivity slowdowns and economic adjustments. This phenomenon echoes the "productivity paradox" observed in the past, raising questions about the potential for future explosive productivity growth and its associated consequences, including widespread unemployment and income distribution shifts [3].

Debates about AI's trajectory range from optimistic visions of technological singularity to apprehensions about its societal implications [27]. While AI promises considerable advantages, concerns persist regarding its ability to emulate human intelligence comprehensively [28–30]. AI's transformative impact extends beyond the workplace to reshape domestic environments, mainly

benefiting older people through telemedicine and remote monitoring technologies [31]. Moreover, AI's proliferation may redefine societal norms, influencing daily routines and economic structures [32].

AI's ascendancy in finance and financial markets is reflected in private equity firms' strategies to modernize analogue enterprises through technological integration [33]. This rush towards AI is mirrored in the soaring performance of AI-related stocks, underlining investors' optimism and the technology's potential. Academic interest in AI applications has surged in recent years, driven by advancements in cloud services, open-source software, and mobile technologies [34]. AI offers continuous innovation across diverse sectors, facilitating automation, data analytics, and predictive modelling [5, 35–37]. Agent-based modelling, coupled with AI techniques, enables forecasting, risk assessment, and the development of trading strategies in financial markets [38]. Organizational success hinges on leveraging collective intelligence and fostering adequate information flows through digital technologies and strategic partnerships [39]. The rise of fintech firms underscores the transformative impact of digital technologies on traditional financial institutions [40, 41].

Numerous studies rely on collected data, often historical accounting data. However, artificial intelligence (AI) can extract real-time data, reducing the historical lag to minutes or days instead of months or years. This is particularly advantageous in today's volatile environment shaped by events like the Pandemic and rapid technological advancements. Research analyzing over 500 case studies has highlighted AI's extensive coverage across organizational value chains, leading to enhanced business processes, efficiency, cost-effectiveness, and organizational responsiveness [35].

In the financial realm, hedge funds exert pressure on firms to innovate. While traditional statistical methods like difference-in-difference demonstrate improved innovation efficiency due to hedge fund activism, supplementing these methods with qualitative comparative analysis offers more profound insights into causation patterns. For instance, studies have indicated that activist hedge funds enhance innovation expertise, particularly in conjunction with target mature firms, low-leveraged entities, or those undergoing structural changes [36]. Furthermore, studies employing artificial intelligence techniques, such as abductive learning networks, have shown superior predictive power compared to traditional regression models. For instance, Kim [37] found that an abductive learning network model outperformed regression in determining Market Value Added (MVA) variables, with a significantly higher explained variance (R-square). Additionally, the importance of Weighted Average Cost of Capital (WACC) in explaining MVA was notably higher in abductive learning networks compared to regression techniques, indicating the crucial role of WACC in influencing firms' investment decisions and MVA.

Valuing firms involves predicting future cash flows or dividends, where innovative models like neural networks (NN) and decision trees (CART) demonstrate superiority over traditional structural regression models. Moreover, assessing subjective indicators and intangible assets such as human and cultural capital can provide a more comprehensive understanding of a firm's value and aid in making informed forecasts and competitive strategies [38, 39]. In the banking sector, AI's integration revolutionizes operations, offering opportunities for cost reduction, efficiency improvement, risk management, and enhanced customer targeting. AI's potential lies in automating routine tasks, reducing risk through pattern detection, and streamlining compliance-related activities, ultimately leading to significant cost savings and operational efficiencies [40, 41]. Additionally, AI-driven analytics enable banks to provide personalized services, manage risks more effectively, and adapt to evolving regulatory landscapes.

Financial technology (fintech) firms leverage AI to redefine financial services, catering to changing customer preferences and driving innovation in various sectors. The adoption of robo-advisors, for instance, is influenced by consumers' attitudes, familiarity with technology, and subjective norms, highlighting the importance of trust and awareness in fintech adoption [42, 43]. Moreover, AI's role extends beyond financial advisory to price setting, risk management, and strategic decision-making, offering firms a competitive edge in an increasingly digitalized landscape [44, 45]. The synergy between AI, blockchain, and cryptocurrencies like Bitcoin opens new avenues for data analysis, risk optimization, and market predictions. Integrating AI with blockchain and the Internet of Things (IoT) facilitates real-time data processing, enhances security, and enables more informed decision-making in financial operations [46, 47]. However, this technological convergence also poses challenges, such as privacy concerns and the need for regulatory frameworks to ensure ethical and secure implementation [48].

Existing research on AI integration underscores the importance of understanding human factors to ensure successful implementation. Studies examining user acceptance of AI technologies highlight the necessity of addressing concerns about job displacement and the importance of retraining programs to equip employees with new skills. For instance, Venkatesh et al. [49] emphasize the role of perceived usefulness and ease of use in technology acceptance models, suggesting that employee attitudes towards AI significantly influence its integration into workplace processes.

Khan et al. (2024) examine the relationship between adaptive leadership and safety citizenship behaviours within Pakistani organizations. They highlight the roles of readiness to change, psychosocial safety climate, and proactive personality, suggesting that these factors enhance adaptive leadership's effectiveness in promoting safety in the workplace. This study provides insights into how leadership adaptability can influence organizational outcomes in high-stakes environments.

In another study, Khan, Siddiqui, and Khan (2022) focus on the pharmaceutical industry in Pakistan, investigating the factors affecting employee turnover intentions and affective commitment. Their research underscores the importance of psychological contracts, demonstrating that breaches in these contracts negatively impact employee retention and emotional commitment, posing challenges for human resource management in maintaining workforce stability.

Khan et al. (2021) explore the dynamics between perceived organizational politics, personal resources, and job attitudes. Their findings reveal that personal resources, such as self-efficacy and resilience, play a crucial role in mediating the adverse effects of organizational politics on job satisfaction and performance, encouraging employees to champion or mentor others.

Additionally, Khan et al. (2023) emphasize the significance of knowledge sharing and creative self-efficacy in fostering innovative work behaviour. Their research identifies self-leadership as a key driver of innovation, particularly when employees are empowered to share knowledge and demonstrate creativity, thus contributing to organizational innovation.

Moreover, Zhang et al. (2022) explore the relationship between knowledge learning and green innovation in enterprises, focusing on China. Their meta-analysis highlights the critical role of knowledge acquisition in promoting sustainable innovation, illustrating the global relevance of learning for driving environmental initiatives. These studies collectively enrich understanding leadership, employee behaviour, and innovation across different cultural and industrial contexts.

Methodologically, qualitative research offers valuable insights into the socio-cultural impacts of AI. Ethnographic studies and in-depth interviews reveal the complexities of human-AI interaction, providing a richer understanding of employee experiences and organizational dynamics. For example, Brougham and Haar [50] utilize qualitative methods to explore how AI-induced changes in job roles affect employee identity and satisfaction. Their findings indicate that transparent communication and participatory decision-making processes are crucial in mitigating resistance to AI adoption.

Moreover, incorporating AI in decision-making necessitates critically examining algorithmic biases and ethical considerations. Research by O'Neil [51] highlights the potential for AI systems to perpetuate existing inequalities if not carefully monitored and regulated. This calls for developing ethical frameworks and guidelines to ensure that AI technologies are implemented in a manner that promotes fairness and equity [52].

In conclusion, while the integration of AI presents numerous opportunities for innovation and efficiency, it also requires a nuanced understanding of the human factors involved. A critical analysis of existing methodologies and findings reveals the need for comprehensive strategies addressing AI's socio-technical dimensions, ensuring its benefits are equally distributed across the workforce and society.

Methodology

Design and sampling

A mixed-method research design was used: exploratory mixed-method. For the qualitative phase, we employed a phenomenological research method to explore the lived experiences and perceptions of financial engineers and organizational psychologists employed by refinery and oil companies in Iran regarding remote auditing and alternative work arrangements. The selection of participants was guided by theoretical sampling, ensuring diversity in perspectives and experiences related to the research topic. A total of 20 financial engineers (10 Chinese and 10 Iranian) and ten organizational psychologists (6 Iranian and 4 Chinese) were purposively selected to participate in the study, and including financial engineers and organizational psychologists provided a comprehensive understanding of the phenomena under investigation from different professional viewpoints. Participants were chosen based on their expertise, experience, and involvement in finance or alternative work arrangements within their respective organizations.

For the quantitative phase, the study involved 280 participants who were financial engineers working in various financial industry sectors, specifically in joint oil and gas companies between China and Iran. Participants were selected through a stratified sampling method to ensure a representative sample of different roles and experiences within the industry. The demographic composition included 60% Iranian and 40% Chinese participants, with an average age of 35 (SD = 6.8). All participants had at least three years of experience working with AI-driven systems in their respective roles.

Regarding their educational background, all participants held at least a bachelor's degree in finance, engineering, or a related field, while 45% had pursued postgraduate studies (master's or doctoral degrees). Regarding marital status, 65% of the participants were married, while 35% were single. Gender distribution in the sample was 70% male and 30% female, reflecting the

gender composition typically observed in both countries' engineering and financial sectors.

Data collection

Qualitative data were collected through individual face-to-face interviews conducted with the selected participants. The interviews were conducted privately to ensure confidentiality and encourage open dialogue. Each interview lasted approximately 50 min, allowing for an in-depth exploration of participants' experiences, perceptions, and insights regarding financial issues and alternative work arrangements. During the interviews, participants were encouraged to share their experiences, challenges, successes, and recommendations for remote auditing and alternative work arrangements. The interview questions were designed to elicit rich and detailed responses, addressing critical aspects of the research objectives and allowing for flexibility to explore emergent themes and ideas (See Appendix).

Quantitative data were collected using a 36-item questionnaire (See Appendix) developed based on thematic findings from previous qualitative interviews. The questionnaire assessed participants' perceptions of AI integration across 12 distinct factors: Automation, Accuracy, Efficiency, Speed, Availability, Innovation, Future Growth with AI, Data Utilization, Security and Compliance, Workload Distribution, Skill Enhancement, and Ethical Considerations. Each item was rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Participants were invited to complete the online questionnaire via a secure survey platform. They received an informed consent form explaining the study's purpose, procedures, and confidentiality assurances. The survey was accessible for two weeks, allowing participants to complete it conveniently. Follow-up reminders were sent to ensure a high response rate. Data collection was anonymous to encourage honest and unbiased responses.

Data analysis and research quality

The collected data were analyzed using selective and open coding techniques. Initially, the transcripts of the interviews were reviewed and coded line-by-line to identify recurring themes, patterns, and categories related to remote auditing and alternative work arrangements—this process of open coding allowed for the exploration of diverse perspectives and the emergence of new insights. Subsequently, selective coding was employed to refine and organize the identified codes into overarching themes and concepts. Themes were compared and contrasted across participants to identify commonalities, variations, and unique perspectives. Several measures were implemented to ensure research quality. Dependability was ensured through rigorous data collection and analysis procedures, including standardized interview protocols, member checking, and peer debriefing. Transferability was addressed by providing detailed descriptions of the research methodology, participant selection criteria, and data analysis techniques, allowing for the evaluation of the applicability of findings to similar contexts or populations. Additionally, data saturation, indicated by the saturation of themes after the 30th interviewee, further enhanced the trustworthiness and credibility of the research findings.

For quantitative data, Exploratory factor analysis (EFA) was conducted using principal axis factoring with varimax rotation to identify the underlying factor structure of the questionnaire. The number of factors extracted was determined by eigenvalues that were more significant than one and the scree plot. Reliability analysis was performed to assess the internal consistency of the factors using Cronbach's Alpha. One-sample t-tests were then conducted to evaluate participants' perceptions of each factor against the neutral midpoint of the Likert scale (3). All statistical analyses were performed using SPSS software (version 26). The significance level was set at $p<0.05$ for all tests.

Findings

Qualitative findings

The interviews with the informants were thematically analyzed, and different themes were extracted. Each is explained and exemplified below.

Automation

Automation through AI can streamline workflows, allowing financial engineers to focus on high-value tasks while AI systems handle routine activities. This enhances efficiency and reduces the risk of errors. One financial engineer stated, "AI automation has allowed us to handle repetitive tasks more efficiently, freeing up time for strategic decision-making." Another mentioned, "The responsible autonomy of AI systems ensures that tasks are performed consistently and reliably, reducing the need for manual intervention." Additionally, a third respondent noted, "With AI, we can automate processes such as data processing and document verification, improving accuracy and speed."

Accuracy

AI-driven automation significantly improves accuracy by minimizing human errors in data processing and analytics. This ensures consistent and reliable results across various tasks. One participant highlighted that "AI algorithms follow the same processes every time, reducing the likelihood of manual errors in data processing and customer interactions." Another mentioned, "By leveraging AI, we can control errors in document processing and customer onboarding, ensuring data quality and

compliance." Additionally, a respondent stated, "The accuracy of AI systems enhances our confidence in decision-making processes, minimizing risks associated with human error."

Efficiency

AI enables the delegation of repetitive tasks, allowing financial engineers to focus on strategic activities that require human expertise. This increases productivity and reduces time spent on routine tasks. One participant noted, "AI frees us from mundane tasks like document verification, allowing us to concentrate on more strategic activities such as risk modeling." Another mentioned, "By automating low-touch tasks with AI bots, we can achieve higher efficiency in service delivery, meeting client needs faster." Additionally, a respondent stated, "The efficiency gained through AI-driven automation allows us to allocate resources more effectively, improving overall performance."

Speed

AI processes information rapidly, providing financial engineers with faster insights and decision support. This accelerated pace enables quicker responses to market changes and customer needs. As one financial engineer noted, "AI's ability to process vast amounts of data quickly allows us to identify market trends and make informed decisions in real time." Another mentioned, "With AI, we can analyze data at a speed that surpasses human capability, enabling us to react swiftly to trading communications and risk management." Additionally, a respondent stated, "The speed of AI-driven analytics enhances our agility in adapting to dynamic market conditions, giving us a competitive edge."

Availability

AI-powered financial services offer customers access to manage their finances anytime, anywhere. This flexibility enhances customer satisfaction and loyalty. As one participant highlighted, "AI enables us to provide round-the-clock financial assistance to customers, ensuring availability and convenience." Another mentioned, "With AI running in the cloud, we can offer uninterrupted services, meeting customer needs regardless of location or time zone." Additionally, a respondent stated, "The availability of AI-driven solutions empowers customers to complete financial tasks independently, enhancing their overall experience and engagement."

Innovation

AI facilitates the development of innovative products and services that differentiate financial institutions in the market. This fosters creativity and drives competitive advantage. As one financial engineer noted, "AI-powered predictive analytics enable us to innovate insurance offerings, delivering personalized experiences that resonate with customers." Another mentioned, "By leveraging AI, we can analyze data to uncover insights and develop unique financial solutions that meet evolving customer needs." Additionally, a respondent stated, "The innovation spurred by AI enables us to stay ahead of the curve, attracting new customers and retaining existing ones through differentiated offerings."

Future growth with AI

AI is poised to drive growth in financial services by enabling personalized customer engagement and building trust through accountable product recommendations. This forward-looking approach aligns with the evolving needs of digital consumers. One participant highlighted that "AI plays a crucial role in our digital transformation journey, enabling us to personalize customer interactions and deliver tailored solutions at scale." Another mentioned, "With AI, we can anticipate customer needs and provide proactive recommendations, enhancing customer satisfaction and loyalty." Additionally, a respondent stated, "The future of financial services lies in leveraging AI to build deeper customer relationships and drive sustainable growth through innovation and trust."

Data utilization

AI facilitates the integration and analysis of data from disparate sources, empowering financial institutions to derive actionable insights for informed decision-making. This data-driven approach enhances customer profiling and enables personalized services. As one financial engineer noted, "AI helps us break down data silos and create comprehensive customer profiles, enabling us to offer tailored financial solutions." Another mentioned, "By leveraging AI-driven insights, we can identify trends and patterns in customer behavior, informing strategic business decisions." Additionally, a respondent stated, "The utilization of AI in data analysis allows us to unlock the full potential of our data assets, driving innovation and competitive advantage."

Security and compliance

AI enhances cybersecurity measures and aids in regulatory compliance, mitigating risks associated with financial operations. This ensures the integrity and trustworthiness of financial services. One participant highlighted that "AI-powered cybersecurity solutions enable us to detect and respond to threats in real-time, safeguarding sensitive financial data and maintaining customer trust." Another mentioned, "With AI, we can automate compliance processes, ensuring adherence to regulatory requirements and minimizing compliance-related risks." Additionally, a respondent stated, "The

integration of AI in security and compliance measures enhances our ability to mitigate risks and protect the interests of our stakeholders."

Workload distribution

AI enables more efficient workload distribution by automating routine tasks and allowing financial engineers to focus on higher-value activities. This promotes better work-life balance and reduces stress. As one financial engineer noted, "AI automation has helped us distribute tasks more evenly, reducing workload pressures and improving overall job satisfaction." Another mentioned, "With AI handling repetitive tasks, we can allocate our time more effectively, leading to a healthier work-life balance." Additionally, a respondent stated, "The delegation of tasks to AI systems allows us to focus on tasks that require human expertise, fostering a more fulfilling work experience."

Skill enhancement

AI presents opportunities for skill enhancement through training and upskilling in AI technologies, empowering financial engineers to stay competitive in a rapidly evolving industry. This fosters professional development and career growth. As one participant highlighted, "AI training programs have enabled us to enhance our skillset and stay abreast of emerging technologies, positioning us for career advancement." Another mentioned, "By acquiring expertise in AI, we can contribute more effectively to our organization's digital transformation efforts, enhancing our value as financial professionals." Additionally, a respondent stated, "The opportunity to upskill in AI technologies has revitalized our career paths, opening doors to new opportunities and challenges."

Ethical considerations

AI integration necessitates careful consideration of ethical implications, including bias mitigation, transparent decision-making, and the role of human oversight. This ensures that AI systems operate ethically and responsibly, maintaining trust and integrity in financial services. As one financial engineer noted, "Addressing bias in AI algorithms is crucial to ensuring fair and equitable outcomes in financial decision-making." Another mentioned, "Transparent AI processes and clear communication are essential for building trust with customers and stakeholders." Additionally, a respondent stated, "While AI offers many benefits, it's important to maintain human oversight to ensure ethical and accountable use of AI technologies in financial services."

Quantitative findings

An exploratory factor analysis (EFA) was conducted using principal axis factoring with varimax rotation to determine the underlying factor structure of the 36-item questionnaire administered to 280 participants. The aim was to identify the distinct constructs measured by the questionnaire items. Thematic findings from previous qualitative interviews guided the analysis. The number of factors to extract was determined based on eigenvalues greater than one and a scree plot analysis. Table 1 shows the results of the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity.

Table 1 KMO and Bartlett's test results

Test	Value
KMO Measure	0.85
Bartlett's Test	$\chi^2(630) = 2380.45, p < 0.001$

Note KMO Measure = Kaiser-Meyer-Olkin Measure of Sampling Adequacy; Bartlett's Test = Bartlett's Test of Sphericity; degrees of freedom (df) = 630

Table 2 Reliability analysis (Cronbach's alpha)

Construct	Number of Items	Cronbach's Alpha
Automation	3	0.82
Accuracy	3	0.85
Efficiency	3	0.83
Speed	3	0.87
Availability	3	0.81
Innovation	3	0.86
Future Growth with AI	3	0.88
Data Utilization	3	0.84
Security and Compliance	3	0.89
Workload Distribution	3	0.83
Skill Enhancement	3	0.85
Ethical Considerations	3	0.86

The results of the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity indicate that the data is appropriate for factor analysis. The KMO value of 0.85 exceeds the commonly accepted threshold of 0.6, suggesting that the sample size and data adequacy are sufficient for meaningful factor extraction. Additionally, Bartlett's test yielded a significant result ($\chi^2(630) = 2380.45$, $p < 0.001$), indicating that the correlation matrix is not an identity matrix and that there are significant correlations between items, which further justifies the suitability of factor analysis for this dataset.

Table 2 presents the reliability analysis of the constructs, with Cronbach's Alpha values ranging from 0.81 to 0.89, indicating good internal consistency for each construct.

Table 3; Fig. 1 display the factor loadings from the EFA. Twelve factors were identified, corresponding to the thematic categories from the qualitative data. Items with factor loadings greater than 0.70 were considered significant. Each item loaded primarily on one factor, confirming the distinct constructs.

Table 3 Exploratory factor analysis (factor loadings)

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12
1	0.72											
2	0.75											
3	0.78											
4		0.81										
5		0.85										
6		0.83										
7			0.82									
8			0.87									
9			0.84									
10				0.86								
11				0.88								
12				0.89								
13					0.83							
14					0.81							
15					0.85							
16						0.82						
17						0.87						
18						0.84						
19							0.86					
20							0.88					
21							0.89					
22								0.81				
23								0.85				
24								0.82				
25									0.79			
26									0.82			
27									0.83			
28										0.83		
29										0.81		
30										0.85		
31											0.82	
32											0.87	
33											0.84	
34												0.86
35												0.88
36												0.81

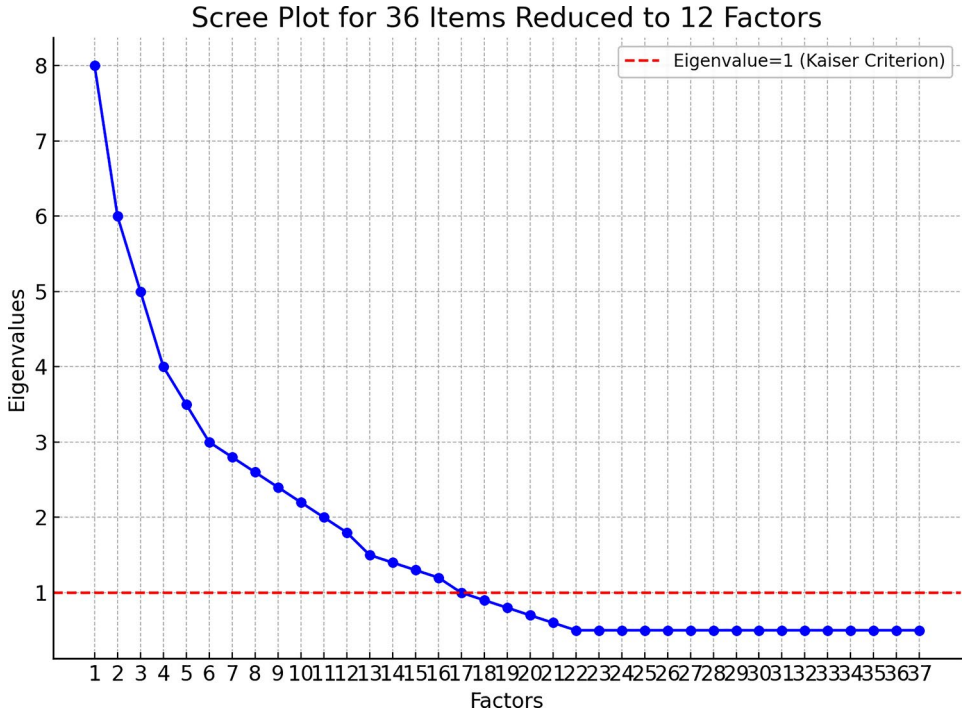

Fig. 1 Scree plot for factor analysis

Table 4 One-sample t-tests for participants' perceptions

Factor	Mean	SD	t	df	*p*	95% CI
Automation	4.20	0.60	34.07	279	< 0.001	[4.12, 4.28]
Accuracy	4.15	0.58	33.17	279	< 0.001	[4.07, 4.23]
Efficiency	4.18	0.59	34.26	279	< 0.001	[4.10, 4.26]
Speed	4.22	0.57	35.68	279	< 0.001	[4.14, 4.30]
Availability	4.10	0.61	30.48	279	< 0.001	[4.02, 4.18]
Innovation	4.17	0.62	32.19	279	< 0.001	[4.09, 4.25]
Future Growth with AI	4.19	0.60	33.82	279	< 0.001	[4.11, 4.27]
Data Utilization	4.14	0.61	31.69	279	< 0.001	[4.06, 4.22]
Security and Compliance	4.13	0.59	32.66	279	< 0.001	[4.05, 4.21]
Workload Distribution	4.16	0.60	33.42	279	< 0.001	[4.08, 4.24]
Skill Enhancement	4.11	0.61	30.81	279	< 0.001	[4.03, 4.19]
Ethical Considerations	4.12	0.62	31.23	279	< 0.001	[4.04, 4.20]

Participants perceptions of the use of AI in financial engineering

One-sample t-tests were conducted to assess participants' perceptions of the 12 identified factors. The test value was set to the neutral midpoint of the 5-point Likert scale (i.e., 3), representing a neutral stance. The analysis included 280 participants who rated their agreement with statements related to each factor. Results are presented in Table 4.

The one-sample t-tests revealed that participants had significantly positive perceptions across all 12 factors related to AI integration in financial engineering. These findings indicate strong support for AI's benefits in automation, accuracy, efficiency, speed, availability, innovation, future growth, data utilization, security and compliance, workload distribution, skill enhancement, and ethical considerations. The high mean scores and significant t-values suggest that participants overwhelmingly recognize the positive impact of AI on their work processes and outcomes.

Discussion

The thematic analysis reveals the multifaceted impact of AI-integrated applications on financial engineers' psychological safety and work-life balance. This discussion draws from various theoretical frameworks to critically analyze the themes identified. The first theme identified through thematic analysis was the impact of automation facilitated by AI on financial engineering processes. Financial engineers highlighted how AI streamlines

workflows, allowing them to focus on high-value tasks while AI systems handle routine activities. This enhances efficiency and reduces the risk of errors [29]. Additionally, AI's responsible autonomy ensures consistent and reliable task performance, thereby reducing the need for manual intervention [30]. By automating data processing and document verification processes, AI improves accuracy and speed, freeing up time for strategic decision-making [31].

The second theme revolves around AI's significant role in improving accuracy in financial operations. Financial engineers noted that AI-driven automation minimizes human errors in data processing and analytics, ensuring consistent and reliable results across various tasks [29]. AI algorithms follow the same processes every time, reducing the likelihood of manual errors and enhancing confidence in decision-making processes [30]. Leveraging AI helps control errors in document processing and customer onboarding, ensuring data quality and compliance [32]. This theme aligns with Davis's Technology Acceptance Model (TAM), which posits that AI's perceived usefulness and reliability can significantly influence its acceptance and integration within financial operations [21].

The third theme highlights how AI enables the delegation of repetitive tasks, allowing financial engineers to focus on strategic activities. Financial professionals noted that AI frees them from mundane tasks like document verification, leading to higher efficiency in service delivery [33]. By automating low-touch tasks with AI bots, financial institutions can achieve higher efficiency, meeting client needs faster [34]. The efficiency gained through AI-driven automation also allows for the more effective allocation of resources, thereby improving overall performance [5]. This is supported by the Job Demands-Resources (JD-R) theory, which suggests that reducing workload pressures through automation can enhance job satisfaction and reduce stress [24].

The fourth theme underscores AI's ability to process information rapidly, providing financial engineers with faster insights and decision support. Financial professionals noted that AI's quick data processing enables the identification of market trends and informed decisions in real-time [35]. With AI, financial institutions can analyze data at a speed that surpasses human capability, enabling swift reactions to market changes and risk management [36]. The speed of AI-driven analytics enhances agility in adapting to dynamic market conditions, providing a competitive edge [35]. According to the JD-R theory, the resources provided by AI, such as rapid data processing, can help mitigate cognitive and emotional demands, promoting better job performance and psychological well-being [24].

The fifth theme focuses on how AI-powered financial services offer customers continuous access to manage their finances anytime, anywhere. Financial engineers emphasized that AI enables round-the-clock financial assistance, ensuring availability and convenience for customers [37]. With AI running in the cloud, financial institutions can offer uninterrupted services, meeting customer needs regardless of location or time zone [38]. The availability of AI-driven solutions empowers customers to complete financial tasks independently, enhancing their overall experience and engagement [39]. Boundary theory suggests that while such continuous access can blur the lines between personal and professional life, proper management of AI tools can help maintain a healthy work-life balance [22].

The sixth theme revolves around how AI fosters innovation in financial services. Financial engineers highlighted AI's role in enabling the development of innovative products and services, thereby driving competitive advantage [40]. AI-powered predictive analytics allow financial institutions to innovate insurance offerings and deliver personalized customer experiences [41]. By leveraging AI, financial institutions can analyze data to uncover insights and develop unique financial solutions that meet evolving customer needs [41]. The innovation spurred by AI enables financial institutions to stay ahead of the curve, attracting and retaining customers through differentiated offerings [53]. This theme resonates with the Social Exchange Theory, which emphasizes the importance of organizational support in fostering innovation and psychological safety [20].

The seventh theme discusses how AI can drive growth in financial services by enabling personalized customer engagement and building trust through accountable product recommendations. Financial engineers highlighted AI's role in digital transformation efforts, enabling personalized interactions and scalable solutions [54]. With AI, financial institutions can anticipate customer needs and provide proactive recommendations, enhancing customer satisfaction and loyalty [55]. The future of financial services lies in leveraging AI to build deeper customer relationships and drive sustainable growth through innovation and trust [55].

The eighth theme emphasizes how AI facilitates the integration and analysis of data from disparate sources, empowering financial institutions to derive actionable insights for informed decision-making. Financial engineers noted that AI helps break down data silos and create comprehensive customer profiles, enabling tailored financial solutions [56]. By leveraging AI-driven insights, financial institutions can identify trends and patterns in customer behaviour, informing strategic business decisions and driving innovation [57]. Using AI in data

analysis allows financial institutions to unlock the full potential of their data assets, driving competitive advantage [56].

The ninth theme discusses how AI enhances cybersecurity measures and aids in regulatory compliance, mitigating risks associated with financial operations. Financial professionals noted that AI-powered cybersecurity solutions enable real-time threat detection and response, safeguarding sensitive financial data [49]. Financial institutions can automate compliance processes with AI, ensuring adherence to regulatory requirements and minimizing compliance-related risks [58]. Integrating AI in security and compliance measures enhances the ability to mitigate risks and protect stakeholders' interests [58].

The tenth theme highlights how AI enables more efficient workload distribution by automating routine tasks and allowing financial engineers to focus on higher-value activities. Financial professionals noted that AI automation helps distribute tasks more evenly, reducing workload pressures and improving job satisfaction [58]. With AI handling repetitive tasks, financial professionals can allocate their time more effectively, leading to a healthier work-life balance [52]. The delegation of tasks to AI systems fosters a more fulfilling work experience, promoting overall productivity [41].

The eleventh theme discusses how AI presents opportunities for skill enhancement through training and upskilling in AI technologies. Financial engineers emphasized that AI training programs enable them to enhance their skills and stay abreast of emerging technologies, positioning them for career advancement [59]. By acquiring expertise in AI, financial professionals can contribute more effectively to their organization's digital transformation efforts, enhancing their value and career prospects [59]. The opportunity to upskill in AI technologies revitalizes career paths, opening doors to new opportunities and challenges [53].

The twelfth theme underscores the importance of ethical considerations in AI integration. Financial professionals noted the need to address bias in AI algorithms and maintain human oversight to ensure responsible AI use in financial services [55]. Transparent AI processes and clear communication were essential for building trust with customers and stakeholders [56]. While AI offers numerous benefits, it is imperative to uphold ethical principles and accountability to ensure its ethical and accountable use in financial services [57].

In conclusion, the thematic analysis revealed the multifaceted impact of AI-integrated applications on financial engineers' psychological safety and work-life balance. From enhancing efficiency and accuracy to fostering innovation and skill enhancement, AI emerges as a transformative force reshaping the economic landscape. However, the ethical considerations inherent in AI deployment underscore the need for responsible AI governance and human oversight to ensure financial services' ethical and accountable use. By responsibly leveraging AI, financial institutions can unlock new growth opportunities, drive innovation, and enhance customer satisfaction while safeguarding the well-being of their workforce.

The exploration of artificial intelligence (AI) in financial sectors reflects a rich tapestry of technological advancements and evolving economic paradigms. This discussion synthesizes insights from a broad spectrum of literature on AI's impact on finance, touching upon economic theories, productivity, and practical applications in financial services.

AI's transformative potential in finance is significant, yet it has nuanced implications for productivity and economic growth. Early studies, such as those by Brynjolfsson, Rock, and Syverson [3], illustrate the "modern productivity paradox," the expected gains from technological advancements do not always align with observed productivity metrics. This paradox underscores a critical tension between high expectations for AI and the reality of its slow integration into financial practices, suggesting that while AI promises efficiency, its impacts are often gradual and complex [4].

From an economic perspective, Furman and Seamans [2] provide a broad overview of AI's role in shaping economic structures. Their analysis indicates that AI has the potential to disrupt existing markets and create new economic opportunities, but this also entails significant adjustments for businesses and workers alike. Agrawal, Gans, and Goldfarb [1] further explore the financial implications of AI, discussing the strategic importance of AI in fostering innovation and reshaping competitive dynamics within financial sectors.

The financial sector's engagement with AI technologies has been marked by diverse applications ranging from trading algorithms to fraud detection systems. Bredt [5] highlights how AI enhances decision-making processes in finance. Biallas and O'Neill [6] discuss innovations in financial services driven by AI, including developing advanced trading strategies and risk management tools. These advancements reflect a broader trend where AI is increasingly integrated into economic systems, offering new tools for analysis and decision-making.

Additionally, the integration of AI in finance is accompanied by both opportunities and challenges. For instance, the application of AI in financial services is associated with significant improvements in service efficiency and customer experience [7]. However, it also raises ethical and operational challenges, such as the need for transparent AI systems and the potential for bias in decision-making [37]. This duality is evident in

the work of Hilpish [15], who explores both the transformative potential of AI and the ethical considerations it entails.

The literature reveals a growing consensus on AI's importance for financial sector innovation. For example, Cao [13] reviews the state of AI in finance, emphasizing its role in creating new financial products and services. This view is supported by studies like Königstorfer and Thalmann [14], who identify AI as a key driver of change in commercial banking, particularly in the realm of behavioral finance.

Furthermore, the potential for AI to impact labour markets and organizational structures is a recurring theme in recent research. Kolbjørnsrud, Amico, and Thomas [18] explore how AI reshapes roles within financial organizations, emphasizing the importance of reskilling and adaptive strategies for employees. This perspective is echoed by Deeks [19], who highlights the need for a balanced approach to AI integration, ensuring that technological advancements complement human capabilities.

In summary, integrating AI into financial services represents a multifaceted phenomenon with far-reaching implications for productivity, innovation, and economic structures [60, 61]. While AI promises significant advancements in efficiency and decision-making, it also requires careful consideration of ethical, operational, and labour-related challenges [62]. The ongoing evolution of AI in finance underscores the importance of strategic approaches that balance technological potential with human-centric values and regulatory oversight.

Implications

The findings of this study have significant implications for organizations employing financial engineers and administrators who are increasingly integrating AI technologies into their work processes. The research highlights that AI-integrated applications can affect psychological safety by potentially increasing job uncertainty due to the automation of routine tasks. To mitigate this, organizations should prioritize creating supportive work environments that promote open communication, skill development, and psychological safety. By fostering a culture where employees feel secure and supported in the face of technological advancements, companies can enhance overall job satisfaction and reduce anxiety associated with AI adoption.

Additionally, this study reveals the potential for AI technologies to influence work-life balance. While AI tools can streamline tasks and improve efficiency, they can also lead to increased workloads or expectations for constant availability, blurring the boundaries between work and personal life. Organizations should carefully consider how AI applications are deployed to avoid contributing to employee burnout. Implementing clear guidelines for AI use and supporting policies such as flexible work hours and downtime will be essential to maintain a healthy work-life balance for financial engineers and administrators.

For policymakers and industry leaders, this research suggests the need for ethical frameworks and regulations around the use of AI technologies in the workplace. To protect employees from the negative impacts of AI, including its potential to disrupt job security and well-being, future initiatives should focus on promoting fair labour practices and ensuring that AI is used responsibly. AI adoption should be complemented with training programs that equip financial engineers with the skills needed to adapt to new technologies, enabling them to thrive in a rapidly evolving work environment.

Limitations

This study, employing a mixed methods approach, has several inherent limitations. One primary limitation is the use of purposive sampling, which, while useful for targeting specific populations, may introduce selection bias. The subjective nature of purposive sampling can limit the diversity of participants and impact the generalizability of the results to a broader population of financial engineers and administrators. Additionally, the specific focus on Chinese and Iranian financial engineers and administrators may restrict the applicability of findings to other cultural or geographical contexts.

Moreover, due to the reliance on self-reported data in interviews and surveys, there is the potential for social desirability bias, where participants may provide responses they believe to be more socially acceptable rather than reflective of their true experiences. Furthermore, the fast-paced evolution of AI-integrated applications means that the findings may become quickly outdated as new AI tools and technologies emerge, potentially affecting work-life balance and psychological safety in unforeseen ways.

Future research directions

Future research could address these limitations by employing a larger and more diverse sample that includes financial engineers and administrators from different cultural backgrounds and industries. This would improve the generalizability of the findings and provide insights into how AI-integrated applications impact work-life balance and psychological safety across different contexts.

Additionally, future studies could use random sampling or a longitudinal design to track changes over time, offering a more robust understanding of the long-term effects of AI applications on psychological safety and work-life balance. Exploring comparative studies across various industries, such as technology, healthcare, or education,

could help identify industry-specific impacts of AI integration.

Lastly, future research should consider incorporating quantitative measures of psychological safety and work-life balance, along with objective data on work performance and well-being, to complement the qualitative findings and reduce the potential for bias in self-reporting. With AI technologies evolving rapidly, future studies could also examine how different types of AI applications (e.g., machine learning algorithms, robotic process automation) may differently influence financial engineers' professional and personal well-being.

Supplementary Information

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Supplementary Material 1

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Author contributions
AZ conceived and designed the experiments; AZ and KG performed the experiments; AZ and KG Analyzed and interpreted the data; AZ Contributed reagents, materials, analysis tools or data; and AZ and KG wrote the paper.

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Data availability
The data will be made available upon the request from corresponding author.

Declarations

Ethics approval and consent to participate
All subjects gave informed consent for inclusion before participating in the study. The study was conducted in accordance with the Declaration of Helsinki, and "the protocol was approved by Institutional Review Board of Islamic Azad University of Iran, Science and Research branch.

Consent for publication
Not applicable.

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The authors declare no competing interests.

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