(REVIEW ARTICLE)

# Algorithmic Trading and AI: A Review of Strategies and Market Impact

Wilhelmina Afua Addy [1, *], Adeola Olusola Ajayi-Nifise [2], Binaebi Gloria Bello [3], Sunday Tubokirifuruar Tula [4], Olubusola Odeyemi [5] and Titilola Falaiye [6]

[1] Independent Researcher, St Louis, Missouri, USA.

[2] Department of Business Administration, Skinner School of Business, Trevecca Nazarene University, USA.

[3] Kings International School Port-Harcourt, Rivers State Nigeria.

[4] Ignition Ajuru University of Education, Rivers State, Nigeria.

[5] Independent Researcher, Nashville, Tennessee, USA.

[6] Independent Researcher, Nigeria.

## Abstract

This review explores the dynamic intersection of algorithmic trading and artificial intelligence (AI) within financial markets. It delves into the evolution, strategies, and broader market impact of algorithmic trading fueled by AI technologies. Examining the symbiotic relationship between advanced algorithms and AI, the review navigates through the various strategies employed, shedding light on their implications for market efficiency, liquidity, and overall stability. From high-frequency trading to machine learning-driven predictive analytics, this review unveils the multifaceted landscape of algorithmic trading in the era of AI, presenting both opportunities and challenges for financial markets. The review begins by tracing the historical development of algorithmic trading, emphasizing the paradigm shift with the integration of AI. From traditional programmatic trading to the emergence of sophisticated algorithms driven by machine learning and deep learning, the evolution sets the stage for a comprehensive understanding of the subject. An in-depth analysis of diverse algorithmic trading strategies unfolds, covering areas such as trend following, statistical arbitrage, market making, and sentiment analysis. The incorporation of AI introduces adaptive learning capabilities, enabling algorithms to evolve and optimize strategies based on real-time market conditions. Exploring the impact of algorithmic trading on financial markets, the review examines how AI-driven strategies contribute to market efficiency, liquidity provision, and price discovery. It dissects the implications for traditional market structures, regulatory considerations, and the potential risks associated with algorithmic dominance. Acknowledging the transformative power of algorithmic trading with AI, the review critically assesses the challenges and ethical considerations. From algorithmic bias to systemic risks, the review delves into the darker corners of this technological advancement, prompting a reflection on the need for responsible and transparent practices. The review concludes by peering into the future trajectory of algorithmic trading fueled by AI. Anticipated innovations, regulatory responses, and the evolving landscape of financial markets are discussed, offering insights into the ongoing transformation and potential disruptions in the realm of algorithmic trading. In essence, this review provides a nuanced perspective on the intricate relationship between algorithmic trading and AI, offering a comprehensive understanding of their strategies and the transformative impact on financial markets.

**Keywords:** Algorithmic; Trading; AI; Strategies; Market Impact

## 1. Introduction

Algorithmic Trading, a paradigm shift in financial markets, represents the intersection of advanced technology and financial strategies (Currie *et al.*, 2022). At its core, algorithmic trading involves the use of pre-programmed instructions

---

* Corresponding author: Wilhelmina Afua Addy

to execute trading orders at optimal conditions (Yadav, 2018). In recent years, the integration of Artificial Intelligence (AI) has propelled this practice into new dimensions, revolutionizing how financial markets operate (El Hajj and Hammoud, 2023).

Algorithmic Trading, often referred to as algo-trading or black-box trading, refers to the use of computer algorithms to automate the process of trading financial instruments (Pothumsetty, 2020). These algorithms are designed to follow a set of predefined rules and execute trades at speeds and frequencies impossible for human traders (Gerner-Beuerle, 2022). This approach has become increasingly prevalent in global financial markets, shaping the dynamics of trading across various asset classes.

The infusion of Artificial Intelligence into algorithmic trading has brought about a transformative era (Rahmani and Zohuri, 2023). AI, encompassing machine learning and deep learning, allows algorithms to learn from data, adapt to changing market conditions, and make intelligent decisions without explicit programming (De Bruyn *et al.*, 2020). The integration of AI techniques adds a layer of complexity and adaptability, enabling trading algorithms to analyze vast datasets, identify patterns, and optimize strategies in real-time (Kunduru, 2023).

The symbiosis of algorithmic trading and AI has far-reaching implications for financial markets, influencing liquidity, price discovery, and overall market efficiency (Verma and Sehgal, 2023). This review seeks to delve into the intricate strategies employed in algorithmic trading, exploring how AI technologies have redefined these strategies. Furthermore, it aims to unravel the impact of algorithmic trading on market dynamics, shedding light on its ethical considerations, regulatory landscape, and the evolving trends that will shape the future of financial markets. As the financial industry continues to embrace technological advancements, understanding the nuances of algorithmic trading and AI becomes imperative for traders, regulators, and stakeholders alike. This review serves as a comprehensive exploration of the strategies employed and the market impact wrought by the amalgamation of algorithmic trading and AI.

## 2. Algorithmic Trading and AI: A Historical Overview

The history of algorithmic trading and artificial intelligence (AI) is a fascinating journey through the evolution of financial markets, technological advancements, and the transformative impact of automation on trading strategies (Azeema *et al.*, 2023). This comprehensive review delves into the key milestones, technological breakthroughs, and paradigm shifts that have shaped the landscape of algorithmic trading and AI. Algorithmic trading traces its roots back to the mid-20th century, with early attempts to automate trading strategies. In the 1950s and 1960s, mainframe computers facilitated the development of basic algorithms for executing trades. However, it wasn't until the 1980s that algorithmic trading gained momentum, thanks to advancements in computing power and the emergence of electronic exchanges.

The advent of electronic exchanges in the 1980s marked a pivotal moment in the history of algorithmic trading. The shift from traditional floor trading to electronic platforms paved the way for faster order execution and increased liquidity. Algorithms were employed to optimize trade execution, leveraging speed and efficiency. The 1990s witnessed a surge in technological advancements, including the development of sophisticated algorithms and the widespread adoption of quantitative trading strategies (Hilbert and Darmon, 2020). The use of historical data and mathematical models became integral to algorithmic trading. The introduction of decimalization in the early 2000s further fueled the need for advanced algorithms to navigate smaller price increments. The 2000s saw the rise of high-frequency trading, a subset of algorithmic trading characterized by ultra-fast execution speeds and high order-to-trade ratios. HFT firms capitalized on colocation services and direct market access to gain a competitive edge (Zaharudin *et al.*, 2022). This era witnessed both praise for improved market liquidity and concerns about market fragmentation and systemic risks.

The last decade has been marked by the integration of machine learning techniques into algorithmic trading strategies. Machine learning algorithms, including neural networks and deep learning, have enabled traders to analyze vast datasets, identify patterns, and make more informed decisions. This era also saw the emergence of AI-driven trading platforms and robo-advisors. As we move into the present and future, the use of AI in trading continues to evolve. Quantum computing, natural language processing, and reinforcement learning are poised to redefine trading strategies. Ethical considerations, algorithmic bias, and regulatory frameworks are gaining prominence as the industry grapples with responsible AI applications (Du and Xie, 2021).

In conclusion, the history of algorithmic trading and AI reflects a continuous quest for efficiency, speed, and precision in financial markets. From early computational experiments to the machine learning revolution, each era has

contributed to the ever-evolving landscape of algorithmic trading, shaping the way financial markets operate today (Swathi and Pahuja, 2024).

## 3. Evolution of Algorithmic Trading

Algorithmic Trading, or algo-trading, has undergone a remarkable evolution, transforming the landscape of financial markets (Dananjayan *et al.*, 2023). The roots of algorithmic trading can be traced back to the 1970s and 1980s when exchanges began transitioning from manual to electronic trading systems. Early algorithms were relatively simple, executing predefined instructions based on price and volume data. These algorithms laid the foundation for what would later become more sophisticated and intelligent trading strategies.

The evolution of algorithmic trading is inseparable from the rapid advancements in technology. The transition from open outcry to electronic trading platforms marked a pivotal moment, enabling faster execution and increased market efficiency. With the advent of high-frequency trading (HFT) in the late 20th century, algorithms started to execute orders at speeds measured in microseconds, capitalizing on arbitrage opportunities and market inefficiencies. As computing power increased and costs decreased, algorithmic trading strategies became more complex. Traders began incorporating statistical models, technical indicators, and quantitative analysis into their algorithms (Nti *et al.*, 2020). This era saw the rise of proprietary trading firms specializing in algorithmic strategies, leveraging cutting-edge technologies to gain a competitive edge.

The integration of Artificial Intelligence (AI) into algorithmic trading represents the next chapter in this evolutionary journey. Machine Learning (ML) and Deep Learning (DL) techniques have become instrumental in enhancing the capabilities of trading algorithms (Sonkavde *et al.*, 2023). AI allows algorithms to adapt, learn from historical data, and make decisions based on patterns and trends that may elude human analysis. AI-powered trading systems can process vast amounts of data in real-time, identifying nuanced correlations and anomalies. This adaptability is particularly valuable in dynamic market conditions, where strategies need to evolve to stay relevant. Sentiment analysis, natural language processing, and predictive modeling are among the AI-driven approaches reshaping algorithmic trading. Moreover, the emergence of AI has facilitated the development of algorithmic strategies beyond traditional asset classes. Cryptocurrencies, commodities, and other alternative investments have witnessed the application of AI-driven algorithms, providing new avenues for traders and investors (Rahmani *et al.*, 2023).

In summary, the evolution of algorithmic trading has been marked by a historical shift from manual to electronic trading, technological advancements enabling high-frequency strategies, and the transformative integration of AI. This progression has not only increased the speed and efficiency of trading but has also opened up new dimensions of complexity and adaptability, ushering in an era where algorithms are not just tools but intelligent entities capable of learning and evolving (Roslan and Ahmad, 2023). As we navigate the impact of these changes, it becomes essential to understand the historical context and technological milestones that have shaped the present state of algorithmic trading.

## 4. Core Strategies in Algorithmic Trading

Algorithmic trading has revolutionized financial markets, introducing a diverse array of strategies that leverage computational power and real-time data analysis. Understanding these core strategies is crucial for traders and investors navigating the dynamic landscape of algorithmic trading. Trend following is a fundamental strategy in algorithmic trading, relying on the identification and exploitation of price trends. Algorithms using this strategy analyze historical price data to recognize patterns and trends, making predictions about future price movements (Nabipour *et al.*, 2020). By going long in an uptrend or short in a downtrend, trend-following algorithms aim to capitalize on sustained price movements. Moving averages, relative strength indicators, and other technical analysis tools are commonly employed in trend-following strategies.

Statistical arbitrage, or stat arb, involves exploiting pricing inefficiencies in financial instruments based on statistical models. Algorithms using this strategy identify relationships between different securities, such as pairs of stocks, and execute trades when deviations from historical price relationships occur (Ayala *et al.*, 2021). The goal is to capture short-term market anomalies and profit from the convergence of prices. Mean reversion strategies, cointegration analysis, and correlation-based models are common techniques employed in statistical arbitrage.

High-frequency trading is characterized by the execution of a large number of orders at extremely high speeds. HFT strategies aim to capitalize on small price discrepancies and market inefficiencies, often holding positions for very brief

periods, sometimes just milliseconds (Hossain, 2022). Market-making, liquidity provision, and arbitrage opportunities in fragmented markets are key areas where HFT excels. To execute orders swiftly, HFT relies on advanced algorithms and direct market access (DMA) to exchanges.

Machine learning (ML) has become a game-changer in algorithmic trading, allowing systems to learn from data and adapt to changing market conditions. ML-based approaches include various techniques such as supervised learning, unsupervised learning, and reinforcement learning. These algorithms analyze historical data, identify patterns, and make predictions about future price movements. The advantage of ML is its ability to uncover non-linear relationships and adapt to evolving market dynamics. Understanding the nuances of each strategy is essential, as they come with their unique risks and rewards (Ibekwe *et al.*, 2024). Trend following may struggle in ranging markets, statistical arbitrage is sensitive to model assumptions, high-frequency trading demands low-latency infrastructure, and machine learning requires continuous adaptation to changing market conditions.

In conclusion, core strategies in algorithmic trading provide a diversified toolkit for traders seeking to navigate financial markets. Whether capitalizing on trends, exploiting statistical relationships, executing high-frequency trades, or leveraging machine learning, these strategies reflect the adaptability and complexity introduced by algorithmic trading in the quest for alpha. As the landscape continues to evolve, staying abreast of these strategies is crucial for participants in the algorithmic trading arena (Etukudoh *et al.*, 2024).

## 5. Market Impact and Efficiency

Algorithmic trading, driven by artificial intelligence (AI), has significantly transformed financial markets, influencing market liquidity, altering price discovery mechanisms, challenging traditional trading practices, and prompting regulatory considerations. Understanding the market impact and efficiency of these technologies is essential for market participants, regulators, and investors alike (Ezeigweneme *et al.*, 2024).

Algorithmic trading, with its high-speed and automated execution, has a notable impact on market liquidity. Liquidity refers to the ease with which an asset can be bought or sold without causing a significant price change. Algorithmic strategies, especially those involved in market-making and high-frequency trading, contribute to increased liquidity by providing continuous buy and sell orders. This enhanced liquidity can lower transaction costs for investors and reduce bid-ask spreads. However, concerns arise during periods of extreme market volatility, where algorithms may contribute to sudden liquidity evaporation (Ilojianya *et al.*, 2024).

Price discovery, the process by which market prices are established, is intricately linked to algorithmic trading. AI-driven algorithms analyze vast datasets and react to market information rapidly, influencing the discovery of fair market prices. These algorithms contribute to more efficient price adjustments as they process new information swiftly (Bharadiya, 2023). However, the prevalence of algorithmic trading can also lead to increased market correlations, where various assets move in tandem. This phenomenon can impact traditional fundamental analysis, challenging the ability to discern individual asset values. Algorithmic trading and AI have reshaped traditional trading practices in profound ways. The speed and automation introduced by algorithms have made traditional manual trading methods less competitive. Traders who do not embrace algorithmic strategies may struggle to keep pace with the efficiency, accuracy, and speed of their algorithmic counterparts (Chesterman, 2021). This shift challenges the role of human intuition in trading decisions and underscores the importance of technological adaptation.

The rise of algorithmic trading has prompted regulators worldwide to address new challenges associated with these technologies. Ensuring market fairness, preventing market manipulation, and maintaining systemic stability are key regulatory concerns. Regulators have implemented measures such as circuit breakers, market surveillance tools, and restrictions on certain algorithmic practices to mitigate risks (Lee and Schu, 2022). Striking a balance between fostering innovation and safeguarding market integrity remains an ongoing challenge for regulators.

In conclusion, the market impact and efficiency of algorithmic trading and AI are multifaceted, influencing liquidity, shaping price discovery, transforming traditional trading practices, and prompting regulatory considerations. As these technologies continue to evolve, market participants and regulators must adapt to the changing landscape. Balancing innovation with risk management will be essential to harness the benefits while safeguarding the integrity and stability of financial markets (Patel, 2024).

## 6. Ethical and Regulatory Landscape

The integration of artificial intelligence (AI) in algorithmic trading has brought forth a complex ethical and regulatory landscape, requiring careful consideration of algorithmic bias, risks, regulatory frameworks, and ethical considerations (Lee, 2020). One of the significant ethical challenges in algorithmic trading involves the potential for bias in AI models. Algorithmic bias occurs when machine learning models produce results that systematically disadvantage or favor certain groups. In trading, bias can manifest in various forms, such as discriminatory order execution or unequal access to market information. Ensuring fairness and mitigating bias in algorithmic trading algorithms is crucial to maintain market integrity. Market participants and developers must implement measures to identify and address bias, promoting fair and equitable trading environments.

The adoption of AI in trading introduces new risks and challenges. The complexity of AI algorithms may lead to unintended consequences, such as system malfunctions, excessive market volatility, or flash crashes. Moreover, the lack of interpretability in some AI models poses challenges for understanding the rationale behind trading decisions. Systematic risk may arise if multiple algorithms react similarly to market events, amplifying their impact. Risk management strategies, stress testing, and ongoing monitoring are essential to address these challenges and ensure the stability of financial markets (Ellis *et al*., 2022).

Regulators play a pivotal role in overseeing algorithmic trading practices and mitigating associated risks. Regulatory frameworks vary globally, but commonly address issues such as market manipulation, insider trading, and system resilience. Authorities often require market participants to implement risk controls, conduct regular testing, and adhere to pre-established guidelines. Regulatory bodies, such as the Securities and Exchange Commission (SEC) in the United States or the European Securities and Markets Authority (ESMA) in Europe, continue to evolve their frameworks to keep pace with technological advancements (Priem, 2022). Striking a balance between fostering innovation and maintaining market integrity remains a key challenge for regulators.

Ethical considerations are paramount in the development and deployment of algorithmic trading strategies. Transparency, accountability, and the responsible use of AI are critical aspects of ethical trading practices. Market participants must prioritize customer protection, ensure fair competition, and avoid actions that could harm market stability. Ethical guidelines may encompass disclosing the use of algorithms, ensuring transparency in decision-making processes, and establishing mechanisms for addressing unintended consequences. A robust ethical framework is essential to build trust among market participants and the public (Umoh *et al*., 2024).

In conclusion, navigating the ethical and regulatory landscape of algorithmic trading and AI requires a comprehensive approach. Addressing algorithmic bias, managing risks, complying with regulatory frameworks, and upholding ethical considerations are integral to fostering a resilient and ethical trading environment. As these technologies continue to evolve, ongoing collaboration between market participants, developers, and regulators is essential to strike the right balance between innovation and ethical responsibility (Lescrauwaet *et al*., 2022).

## 7. Case Studies and Real-world Examples

Algorithmic trading and AI have left an indelible mark on financial markets, shaping success stories, contributing to market disruptions, and presenting ethical challenges (Chiu and Lim, 2021). Examining case studies provides valuable insights into the impact of these technologies. Renaissance Technologies, led by mathematician James Simons, stands as a pioneer in quantitative trading. Their Medallion Fund has achieved remarkable returns using sophisticated algorithms to identify patterns and execute trades. The success of Renaissance Technologies exemplifies how algorithmic trading can outperform traditional approaches, showcasing the potential for substantial financial gains (How and Cheah, 2023).

Numerous high-frequency trading (HFT) firms, like Virtu Financial and Citadel Securities, have thrived by leveraging ultra-fast algorithms. These firms capitalize on executing a high volume of trades at lightning speed, exploiting minute price differentials. The success of HFT exemplifies how speed and precision in algorithmic execution can lead to profitability (Alaminos *et al., 2023*). On May 6, 2010, the U.S. experienced a flash crash, where the Dow Jones Industrial Average plunged nearly 1,000 points in minutes. The rapid and unexpected market decline was partially attributed to algorithmic trading. High-frequency trading algorithms exacerbated the volatility, triggering a cascade of sell orders. This incident underscores the potential risks associated with algorithmic trading, requiring continuous monitoring and circuit breakers to prevent such disruptions.

In 2012, Knight Capital Group faced a severe financial setback due to a software glitch in its algorithmic trading system. The glitch led to a series of unintended stock orders, resulting in a loss of over $400 million in less than an hour. This example highlights the importance of robust risk management and testing procedures in algorithmic trading systems. Instances of market manipulation using algorithmic trading have raised ethical concerns. Spoofing and layering, where traders place and quickly cancel large orders to create a false impression of market demand, have been subject to regulatory scrutiny (Njemanze *et al.*, 2008). These cases underscore the need for vigilance and regulatory measures to curb unethical practices. Ethical lapses also manifest in algorithmic bias, where trading algorithms inadvertently favor or disadvantage certain groups. For instance, biased algorithms may execute trades or provide information that disproportionately affects specific demographics. Identifying and rectifying such biases is crucial for maintaining fairness and integrity in financial markets.

In conclusion, the success stories, market disruptions, and ethical challenges presented by algorithmic trading and AI offer valuable lessons. While success stories demonstrate the potential for innovation and profitability, market disruptions emphasize the need for robust risk management. Ethical lapses underscore the importance of vigilance and regulatory oversight to ensure fair and transparent markets. The evolving landscape of algorithmic trading requires ongoing efforts to strike a balance between innovation and the responsible use of these technologies (Abdallah and Salah, 2024).

## 8. Future Trends and Innovations

The landscape of algorithmic trading and artificial intelligence (AI) is poised for continuous evolution, driven by advancements in technology, regulatory responses, and the potential for disruptive innovations (Liu *et al.*, 2020). Exploring future trends provides insights into the trajectory of these transformative forces. The advent of quantum computing holds the promise of solving complex mathematical problems at unprecedented speeds. In algorithmic trading, quantum algorithms could revolutionize optimization processes and risk management. The ability to perform complex calculations rapidly may lead to more sophisticated trading strategies and enhanced decision-making capabilities.

Machine learning algorithms are expected to become more sophisticated, adapting to changing market conditions with greater agility. Reinforcement learning, in particular, may enable algorithms to continuously learn and optimize trading strategies based on real-time feedback. As machine learning models evolve, they are likely to contribute to more accurate predictions and enhanced trading performance. Incorporating NLP into algorithmic trading systems can revolutionize information processing. Algorithms capable of extracting insights from vast amounts of unstructured data, including news articles and social media, can make more informed trading decisions (Hansen and Borch, 2022). NLP may become integral in sentiment analysis, providing a deeper understanding of market sentiment and trends.

As algorithmic trading becomes more reliant on AI, regulators are likely to focus on ensuring ethical and fair practices. Scrutiny over algorithmic bias, transparency, and accountability will likely intensify, leading to the development of regulations that mandate responsible AI usage in financial markets (Goodman and Trehu, 2022). Given the global nature of financial markets, regulatory bodies may collaborate more closely to establish standardized frameworks for algorithmic trading. Coordinated efforts could enhance cross-border supervision, address regulatory arbitrage, and create a harmonized approach to managing the risks associated with algorithmic trading (Azzutti, 2022).

The rise of decentralized finance, powered by blockchain technology, has the potential to disrupt traditional financial systems. Algorithmic trading strategies may integrate with DeFi platforms, enabling peer-to-peer trading, liquidity provision, and decentralized exchanges (Xu *et al.*, 2023). This shift could democratize access to sophisticated trading tools and reduce reliance on traditional intermediaries. Addressing the challenge of understanding complex AI models, the adoption of explainable AI in algorithmic trading can enhance transparency (Larsson and Heintz, 2020). Regulatory bodies and market participants may seek algorithms that provide clear explanations for their decision-making processes, fostering trust and mitigating concerns related to opaque AI systems (Kaur *et al.*, 2022). Future algorithmic trading systems may prioritize risk-awareness by incorporating real-time risk management mechanisms (Varga *et al.*, 2021). These algorithms could dynamically adjust trading strategies based on changing market conditions to mitigate risks and enhance overall portfolio stability.

In conclusion, the future trends and innovations in algorithmic trading and AI are characterized by a convergence of cutting-edge technologies, increased regulatory scrutiny, and the potential for disruptive advancements. Evolving technologies like quantum computing and advanced machine learning will reshape algorithmic strategies, while regulatory responses aim to ensure ethical and responsible AI usage (Ajani *et al.*, 2024). The landscape may witness the

emergence of decentralized finance and risk-aware algorithms, contributing to a dynamic and transformative future for algorithmic trading. Market participants and regulators must stay adaptive to navigate these changes effectively.

## 9. Conclusion

As we conclude our review of algorithmic trading and artificial intelligence (AI), it becomes evident that the intersection of technology and finance is reshaping the landscape of financial markets. This review has delved into the historical evolution, core strategies, market impact, ethical considerations, case studies, and future trends in the realm of algorithmic trading and AI.

Through this comprehensive review, we have uncovered key insights into the transformative power of algorithmic trading and AI. From the historical roots of algorithmic trading to the emergence of advanced strategies such as trend following, statistical arbitrage, high-frequency trading, and machine learning-based approaches, the evolution has been marked by technological advancements and strategic innovations. The market impact, encompassing liquidity, price discovery, and regulatory considerations, has highlighted both the positive contributions and challenges associated with algorithmic trading.

Ethical and regulatory considerations have come to the forefront, necessitating a closer examination of algorithmic bias, fairness, and the broader impact of AI-driven trading practices. Case studies have illustrated the successes, disruptions, and ethical lapses in the real-world application of algorithmic trading, offering valuable lessons for market participants and regulators. Algorithmic trading and AI present a dual-edged sword, offering unparalleled opportunities for efficiency, liquidity, and innovation, while concurrently posing risks related to ethical lapses, market disruptions, and regulatory challenges. The efficiencies gained through automation, real-time data analysis, and advanced prediction models have redefined how financial markets operate. However, these opportunities need to be balanced with a keen awareness of the ethical implications and potential risks associated with algorithmic decision-making.

The trajectory of algorithmic trading and AI points toward a future marked by continual evolution. As technology advances, quantum computing, machine learning enhancements, and natural language processing are poised to redefine trading strategies and information processing. Regulatory responses are expected to address the ethical use of AI and establish frameworks that promote responsible practices. The potential disruptions and innovations, such as the rise of decentralized finance (DeFi) and explainable AI (XAI), will likely play pivotal roles in shaping the future landscape. Risk-aware algorithms, coupled with advancements in technology, will enhance the adaptability and resilience of algorithmic trading systems.

In conclusion, the review underscores the dynamic and transformative nature of algorithmic trading and AI in financial markets. Striking a balance between opportunities and risks is paramount, requiring collaboration between market participants, regulators, and technologists. The future trajectory is one of continued innovation, where responsible and ethical practices will be integral to sustaining the integrity and efficiency of financial markets. As we navigate this ever-evolving landscape, vigilance, adaptability, and ethical considerations will be the guiding principles for a harmonious integration of technology and finance.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to disclosed.

## References

[1] Abdallah, M. and Salah, M., 2024. Artificial Intelligence and Intellectual Properties: Legal and Ethical Considerations. *International Journal of Intelligent Systems and Applications in Engineering*, *12*(1), pp.368-376.

[2] Ajani, S.N., Khobragade, P., Dhone, M., Ganguly, B., Shelke, N. and Parati, N., 2024. Advancements in Computing: Emerging Trends in Computational Science with Next-Generation Computing. *International Journal of Intelligent Systems and Applications in Engineering*, *12*(7s), pp.546-559.

[3] Alaminos, D., Salas, M.B. and Fernández-Gámez, M.A., 2023. High-Frequency Trading in Bond Returns: A Comparison Across Alternative Methods and Fixed-Income Markets. *Computational Economics*, pp.1-92.

[4] Ayala, J., García-Torres, M., Noguera, J.L.V., Gómez-Vela, F. and Divina, F., 2021. Technical analysis strategy optimization using a machine learning approach in stock market indices. *Knowledge-Based Systems*, *225*, p.107119.

[5] Azeema, N., Nawaz, H., Gill, M.A., Khan, M.A., Miraj, J. and Lodhi, K., 2023. Impact of Artificial Intelligence on Financial Markets: Possibilities & Challenges. *Journal of Computing & Biomedical Informatics*, *6*(01), pp.287-299.

[6] Azzutti, A., 2022. The algorithmic future of EU market conduct supervision: a preliminary check. In *Digitalisation, Sustainability, and the Banking and Capital Markets Union: Thoughts on Current Issues of EU Financial Regulation* (pp. 53-98). Cham: Springer International Publishing.

[7] Bharadiya, J.P., 2023. Machine learning and AI in business intelligence: Trends and opportunities. *International Journal of Computer (IJC)*, *48*(1), pp.123-134.

[8] Chesterman, S., 2021. " Move fast and break things": Law, technology, and the problem of speed. *Singapore Academy of Law Journal*, *33*, pp.5-23.

[9] Chiu, I.H.Y. and Lim, E.W., 2021. Technology vs ideology: how far will artificial intelligence and distributed ledger technology transform corporate governance and business?. *Berkeley Bus. LJ*, *18*, p.1.

[10] Currie, W.L., Seddon, J.J. and Van Vliet, B., 2022. From decision optimization to satisficing: Regulation of automated trading in the US financial markets. *Information & Management*, *59*(8), p.103721.

[11] Dananjayan, M.P., Gopakumar, S. and Narayanasamy, P., 2023. Unleashing the algorithmic frontier: Navigating the impact of algo trading on investor portfolios. *Journal of Information Technology Teaching Cases*, p.20438869231189519.

[12] De Bruyn, A., Viswanathan, V., Beh, Y.S., Brock, J.K.U. and Von Wangenheim, F., 2020. Artificial intelligence and marketing: Pitfalls and opportunities. *Journal of Interactive Marketing*, *51*(1), pp.91-105.

[13] Du, S. and Xie, C., 2021. Paradoxes of artificial intelligence in consumer markets: Ethical challenges and opportunities. *Journal of Business Research*, *129*, pp.961-974.

[14] El Hajj, M. and Hammoud, J., 2023. Unveiling the influence of artificial intelligence and machine learning on financial markets: A comprehensive analysis of AI applications in trading, risk management, and financial operations. *Journal of Risk and Financial Management*, *16*(10), p.434.

[15] Ellis, S., Sharma, S. and Brzeszczyński, J., 2022. Systemic risk measures and regulatory challenges. *Journal of Financial Stability*, *61*, p.100960.

[16] Etukudoh, E.A., Nwokediegwu, Z.Q.S., Umoh, A.A., Ibekwe, K.I., Ilojianya, V.I. and Adefemi, A., 2024. Solar power integration in Urban areas: A review of design innovations and efficiency enhancements. *World Journal of Advanced Research and Reviews*, *21*(1), pp.1383-1394.

[17] Ezeigweneme, C.A., Umoh, A.A., Ilojianya, V.I. and Adegbite, A.O., 2024. Telecommunications Energy Efficiency: Optimizing Network Infrastructure for Sustainability. *Computer Science & IT Research Journal*, *5*(1), pp.26-40.

[18] Gerner-Beuerle, C., 2022. Algorithmic trading and the limits of securities regulation. *Vand. L. Rev*, *1607*, p.1619.

[19] Goodman, E.P. and Trehu, J., 2022. Algorithmic Auditing: Chasing AI Accountability. *Santa Clara High Tech. LJ*, *39*, p.289.

[20] Hansen, K.B. and Borch, C., 2022. Alternative data and sentiment analysis: Prospecting non-standard data in machine learning-driven finance. *Big Data & Society*, *9*(1), p.20539517211070701.

[21] Hilbert, M. and Darmon, D., 2020. How complexity and uncertainty grew with algorithmic trading. *Entropy*, *22*(5), p.499.

[22] Hossain, S., 2022. High-Frequency Trading (HFT) and Market Quality Research: An Evaluation of the Alternative HFT Proxies. *Journal of Risk and Financial Management*, *15*(2), p.54.

[23] How, M.L. and Cheah, S.M., 2023. Business Renaissance: Opportunities and challenges at the dawn of the Quantum Computing Era. *Businesses*, *3*(4), pp.585-605.

[24] Ibekwe, K.I., Ohenhen, P.E., Chidolue, O., Umoh, A.A., Ngozichukwu, B., Ilojianya, V.I. and Fafure, A.V., 2024. Microgrid systems in US energy infrastructure: A comprehensive review: Exploring decentralized energy solutions, their benefits, and challenges in regional implementation.

[25] Ilojianya, V.I., Usman, F.O., Ibekwe, K.I., Nwokediegwu, Z.Q.S., Umoh, A.A. and Adefemi, A., 2024. Data-Driven Energy Management: Review of Practices in Canada, Usa, And Africa. *Engineering Science & Technology Journal*, *5*(1), pp.219-230.

[26] Kaur, D., Uslu, S., Rittichier, K.J. and Durresi, A., 2022. Trustworthy artificial intelligence: a review. *ACM Computing Surveys (CSUR)*, *55*(2), pp.1-38.

[27] Kunduru, A.R., 2023. Artificial intelligence advantages in cloud Fintech application security. *Central Asian Journal of Mathematical Theory and Computer Sciences*, *4*(8), pp.48-53.

[28] Larsson, S. and Heintz, F., 2020. Transparency in artificial intelligence. *Internet policy review*, *9*(2).

[29] Lee, J. and Schu, L., 2022. Regulation of algorithmic trading: frameworks or human supervision and direct market interventions. *European Business Law Review*, *33*(2).

[30] Lee, J., 2020. Access to finance for artificial intelligence regulation in the financial services industry. *European Business Organization Law Review*, *21*, pp.731-757.

[31] Lescrauwaet, L., Wagner, H., Yoon, C. and Shukla, S., 2022. Adaptive Legal Frameworks and Economic Dynamics in Emerging Tech-nologies: Navigating the Intersection for Responsible Innovation. *Law and Economics*, *16*(3), pp.202-220.

[32] Liu, H.Y., Maas, M., Danaher, J., Scarcella, L., Lexer, M. and Van Rompaey, L., 2020. Artificial intelligence and legal disruption: a new model for analysis. *Law, Innovation and Technology*, *12*(2), pp.205-258.

[33] Nabipour, M., Nayyeri, P., Jabani, H., Shahab, S. and Mosavi, A., 2020. Predicting stock market trends using machine learning and deep learning algorithms via continuous and binary data; a comparative analysis. *IEEE Access*, *8*, pp.150199-150212.

[34] Njemanze, P.C., Njemanze, J., Skelton, A., Akudo, A., Akagha, O., Chukwu, A.A., Peters, C. and Maduka, O., 2008. High-frequency ultrasound imaging of the duodenum and colon in patients with symptomatic giardiasis in comparison to amebiasis and healthy subjects. *Journal of Gastroenterology and Hepatology*, *23*(7pt2), pp.e34-e42.

[35] Nti, I.K., Adekoya, A.F. and Weyori, B.A., 2020. A systematic review of fundamental and technical analysis of stock market predictions. *Artificial Intelligence Review*, *53*(4), pp.3007-3057.

[36] Patel, K., 2024. Ethical Reflections on Data-Centric AI: Balancing Benefits and Risks. *International Journal of Artificial Intelligence Research and Development*, *2*(1), pp.1-17.

[37] Pothumsetty, R., 2020. Application of Artificial Intelligence in Algorithmic Trading. *Int. J. Eng. Appl. Sci. Technol.*, *4*(12), pp.140-149.

[38] Priem, R., 2022. A European distributed ledger technology pilot regime for market infrastructures: finding a balance between innovation, investor protection and financial stability. *Journal of Financial Regulation and Compliance*, *30*(3), pp.371-390.

[39] Rahmani, A.M., Rezazadeh, B., Haghparast, M., Chang, W.C. and Ting, S.G., 2023. Applications of artificial intelligence in the economy, including applications in stock trading, market analysis, and risk management. *IEEE Access*.

[40] Rahmani, F.M. and Zohuri, B., 2023. The Transformative Impact of AI on Financial Institutions, with a Focus on Banking. *Journal of Engineering and Applied Sciences Technology. SRC/JEAST-279. DOI: doi. org/10.47363/JEAST/2023 (5)*, *192*, pp.2-6.

[41] Roslan, F.A.B.M. and Ahmad, N.B., 2023. The rise of AI-powered voice assistants: Analyzing their transformative impact on modern customer service paradigms and consumer expectations. *Quarterly Journal of Emerging Technologies and Innovations*, *8*(3), pp.33-64.

[42] Sonkavde, G., Dharrao, D.S., Bongale, A.M., Deokate, S.T., Doreswamy, D. and Bhat, S.K., 2023. Forecasting stock market prices using machine learning and deep learning models: A systematic review, performance analysis and discussion of implications. *International Journal of Financial Studies*, *11*(3), p.94.

[43] Swathi, G. and Pahuja, A., 2024. FinTech Frontiers: Cloud Computing and Artificial Intelligence Applications for Intelligent Finance Investment and Blockchain in the Financial Sector. *International Journal of Intelligent Systems and Applications in Engineering*, *12*(4s), pp.654-659.

[44] Umoh, A.A., Adefemi, A., Ibewe, K.I., Etukudoh, E.A., Ilojianya, V.I. and Nwokediegwu, Z.Q.S., 2024. Green Architecture and Energy Efficiency: A Review Of Innovative Design And Construction Techniques. *Engineering Science & Technology Journal*, *5*(1), pp.185-200.

[45] Uzougbo, N.S., Akagha, O.V., Coker, J.O., Bakare, S.S. and Ijiga, A.C., 2023. Effective strategies for resolving labour disputes in the corporate sector: Lessons from Nigeria and the United States.

[46] Varga, S., Brynielsson, J. and Franke, U., 2021. Cyber-threat perception and risk management in the Swedish financial sector. *Computers & security*, *105*, p.102239.

[47] Verma, P. and Sehgal, S., 2023. Leveraging Artificial Intelligence for Enhancing Customer Experience and Efficiency in the Banking Industry. In *AI and Emotional Intelligence for Modern Business Management* (pp. 282-310). IGI Global.

[48] Xu, J., Paruch, K., Cousaert, S. and Feng, Y., 2023. Sok: Decentralized exchanges (dex) with automated market maker (amm) protocols. *ACM Computing Surveys*, *55*(11), pp.1-50.

[49] Yadav, Y., 2018. Algorithmic trading and market regulation. *Global Algorithmic Capital Markets: High Frequency Trading, Dark Pools, and Regulatory Challenges*, p.232.

[50] Zaharudin, K.Z., Young, M.R. and Hsu, W.H., 2022. High-frequency trading: Definition, implications, and controversies. *Journal of Economic Surveys*, *36*(1), pp.75-107.