

Enhancing Financial Markets Efficiency Using AI Applications: Case of Saudi Arabia Market -Tadawul

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Abstract: This study examines the strategic integration of artificial intelligence (AI) technologies in Saudi Arabia's financial market "Tadawul", with a focus on its congruence with national development objectives and operational efficacy. The research findings indicate a growing adoption of AI applications in pivotal areas, including algorithmic trading, market surveillance, and asset management, yielding tangible enhancements in operational efficiency, predictive accuracy, and risk mitigation. Notably, the study reveals a direct alignment between AI integration and the strategic imperatives outlined in Saudi Arabia's Vision 2030 and the National Strategy for Data and Artificial Intelligence (NSDAI).

Keywords: Artificial intelligence; Financial Markets; AI Applications; Saudi Arabia; Tadawul Market.

1. Introduction

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The Fourth Industrial Revolution, characterized by groundbreaking technological advancements in artificial intelligence (AI) and machine learning (ML), is revolutionizing the business landscape and redefining traditional policy-making paradigms. The exponential growth of data in the Internet era, marked by its sheer volume, variety, and velocity, has been instrumental in propelling AI to the forefront of innovation. Although the financial services industry was initially slow to adopt AI, it has now become a dominant force, consistently featuring on lists of key trends shaping the future of the financial sector.

The integration of Artificial Intelligence (AI) and Machine Learning (ML) in financial markets has gained significant momentum over the past few years, transforming the way financial institutions operate and interact with their customers. One of the most significant trends emerging from the adoption of AI in finance is the enhancement of risk management. By analyzing vast amounts of historical data, market trends, and economic indicators, AI algorithms can provide more accurate forecasts, allowing financial institutions to make informed investment decisions, manage risks more effectively, and optimize their portfolios. For example, AI-powered trading systems can execute trades at the optimal time,

maximizing returns and minimizing losses. This predictive capability is particularly valuable in the inherently volatile and unpredictable financial markets. AI is also making a significant impact in the area of fraud detection and prevention. Traditional methods of fraud detection often fall short due to their inability to keep pace with the sophisticated tactics employed by fraudsters. In contrast, AI systems can analyze transaction patterns in real-time, flagging suspicious activities and preventing fraudulent transactions before they occur. Machine learning algorithms continuously learn from new data, improving their accuracy and reducing false positives, thereby safeguarding the financial ecosystem. Furthermore, AI is driving innovation in personalized financial services. By analyzing customer data, AI can offer tailored financial products and services that meet individual needs and preferences. This level of personalization was previously unattainable and is now helping financial institutions build stronger relationships with their customers and enhance customer loyalty. As AI continues to evolve, it is likely to play an increasingly important role in shaping the future of the financial industry. The ability of AI to analyze vast amounts of data and provide actionable insights is revolutionizing the way financial institutions operate. AI-powered systems can identify patterns and trends that may not be apparent to human analysts, enabling financial institutions to make more informed decisions and stay ahead of the competition. Additionally, AI can help financial institutions to improve their operational efficiency, reduce costs, and enhance customer experience. Overall, the integration of AI and ML in financial markets is driving significant changes in the industry. As the technology continues to evolve, it is likely to play an increasingly important role in shaping the future of finance. Financial institutions that adopt AI and ML will be better positioned to succeed in a rapidly changing market, while those that fail to adapt may be left behind.

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Despite growing interest and investment in AI-based financial tools, empirical academic research examining the real-world impact of AI integration on market efficiency and performance particularly in the Saudi context remains limited. Most existing literature focuses on mature financial systems in the U.S. or Europe, leaving a research gap regarding how AI can enhance emerging capital markets in the Gulf region. Furthermore, there is a need to critically evaluate whether the adoption of AI in the Tadawul market has translated into tangible improvements in terms of operational efficiency, risk mitigation, and market resilience.

This study aims to address this gap by investigating the effectiveness of AI applications in enhancing the performance and stability of the Saudi financial market, with a specific focus on Tadawul. The research employs a case study that relies on descriptive analytical approach to assess how AI tools are currently being used, and how these align with the strategic objectives of Vision 2030.

1.1. Research Problematic

Based on the above, we pose the following question: **How effective are artificial intelligence applications in enhancing the performance, and efficiency of the Saudi financial market “Tadawul”?**

1.2. Importance of the study

the significance of this research paper lies on shedding light on the effectiveness of Artificial intelligence technologies in the field of finance and financial markets, and highlighting their benefits, challenges, and the transformative changes they are bringing to the Saudi financial markets.

2. Fundamentals of Artificial Intelligence technology in financial markets:

2.1 Defining the Concept of Artificial Intelligence

To gain a profound understanding of artificial intelligence (AI), it is crucial to dissect the meanings of its constituent terms.

Intelligence refers to the capacity to perceive, comprehend, and learn from novel situations or circumstances, encompassing the ability to adapt, reason, and problem-solve.

On the other hand, **artificial** describes anything created through human ingenuity and intervention, distinguishing such creations from entities that exist naturally without human input.

By combining these two terms, artificial intelligence can be succinctly described as human-engineered intelligence embedded within machines or computers, which encompasses the notion of endowing machines or computers with the original cognitive faculties of humans.

This positions AI as a scientific discipline with the overarching aim of enabling machines to execute tasks that necessitate intellectual capabilities, thereby simulating human thought processes and behavior.

The term “Artificial Intelligence” (AI) was officially coined and defined by John McCarthy at the time as the science and engineering of making intelligent machines (Christopher et al., 2021), and It has been also defined by a multitude of experts in the field.

According to Copeland and Proudfoot, AI entails the development of computer systems capable of undertaking tasks traditionally requiring human intellect, such as visual perception, speech recognition, decision-making, and translation (Copeland et Proudfoot, 2007). These tasks, which were previously the exclusive domain of humans, are now being increasingly performed by machines, thereby blurring the lines between human and artificial intelligence (Zakharov, 2021).

Marvin Lee Minsky further elaborates on AI as the creation of computer programs that engage in tasks that, when performed by humans, are considered satisfactory due to the requirement of advanced mental operations, including cognitive learning, memory structuring, and critical reasoning (Marly & al., 2020).

This highlights the complex and multifaceted nature of AI, which involves not only the replication of human intelligence but also the creation of novel forms of intelligence that can complement and augment human capabilities.

AI systems are characterized by their ability to exhibit intelligent behavior, analyzing their surroundings and taking actions autonomously to a certain extent to fulfill designated objectives. This autonomy is made possible by the use of advanced algorithms, machine learning techniques, and data analytics, which enable AI systems to learn from experience, adapt to new situations, and improve their performance over time. Furthermore, AI systems are designed to interact with humans and other machines, thereby creating complex networks of intelligence that can facilitate decision-making, problem-solving, and innovation. The characteristics of AI systems, including their ability to learn, reason, and interact, have far-reaching implications for various fields, including healthcare, finance, education, and transportation, and are likely to transform the way we live, work, and interact with one another.

From these definitions, it is clear that artificial intelligence encompasses a broad spectrum of efforts directed towards crafting computerized systems capable of mimicking human-like behavior and thought processes. This enables these systems to undertake tangible tasks in a

seamlessly integrated manner, marking a significant milestone in the intersection of technology and human intellect.

2.2 The Evolution of AI in Finance: A Historical Review

The increasing prevalence of artificial intelligence in the financial sector has been driven by a combination of factors that expedite the development of fintech, foster the growth of AI and machine learning, and prompt financial institutions to leverage these technologies to reduce costs, mitigate risks, enhance service quality, and boost profitability. A notable example of this trend is the enduring popularity of Bayesian Statistics, a machine-learning algorithm that has been widely employed in the financial domain since the 1960s. The widespread adoption of Bayesian Theory in finance can be attributed to its extensive application in auditing, where it provides auditors with objective and rational probability assessments, thereby enabling more accurate evaluations and minimizing the impact of personal biases. By utilizing Bayesian models, auditors can make more informed decisions, taking into account various uncertain factors that may influence their judgment, and reducing the likelihood of misjudgments caused by emotional or subjective factors. Initially, the integration of AI and finance focused on utilizing computational power to alleviate the workload of financial practitioners, automating routine tasks, and enhancing data analysis capabilities. However, by the 1980s, Expert Systems, which are intelligence systems based on knowledge, began to be used in finance to predict market trends, identify patterns, and offer customized financial plans. These systems typically comprise six components, including a knowledge base, database, inference engine, explanation facility, knowledge acquisition mechanism, and user interface. The knowledge base contains domain-specific information and rules, while the database stores relevant data; the inference engine applies the rules to the data to generate conclusions; the explanation facility provides justifications for the conclusions; the knowledge acquisition mechanism enables the system to learn from experience; and the user interface facilitates interaction between the user and the system. Notably, researchers such as Hodgkinson and Walker have developed rule-based Expert Systems to facilitate decision-making processes, including credit application evaluations for corporate credit loans. These systems can analyze large datasets, identify relevant factors, and apply rules to determine creditworthiness, thereby streamlining the decision-making process and reducing the risk of human error. Similarly, others, like Janulevicius and Goranin, have established risk management Expert Systems to support small and medium-sized enterprises in addressing data security analysis challenges due to limited resources. By leveraging AI and machine learning, these systems can identify potential vulnerabilities, detect anomalies, and provide recommendations for mitigation, thereby enhancing the overall security posture of the organization (Xie, 2019).

In the 1990s and early 2000s, more sophisticated machine learning techniques emerged, driven by advances in computational power and the availability of large datasets. During this period, AI applications began to include predictive modeling for market trends and risk assessment. Algorithmic trading also gained traction, with firms deploying automated systems to execute trades based on predefined rules and strategies. The use of machine learning algorithms, such as decision trees and random forests, enabled financial institutions to identify complex patterns in data and make more accurate predictions.

The advent of deep learning in the 2010s represented a significant leap forward in AI capabilities. The increased computational power and the development of advanced neural network architectures enabled the processing of vast amounts of financial data with greater accuracy. Deep learning models began to outperform traditional machine learning techniques in tasks such as market prediction and fraud detection. The use of convolutional neural

networks (CNNs) and recurrent neural networks (RNNs) enabled financial institutions to analyze large datasets, identify patterns, and make predictions with greater accuracy.

The rise of big data and cloud computing further accelerated the adoption of AI in finance, providing the infrastructure necessary to handle the complex and voluminous data involved in financial analysis. The use of cloud-based platforms enabled financial institutions to store, process, and analyze large datasets, reducing the need for on premise infrastructure and increasing scalability.

Today, AI continues to evolve, with ongoing advancements in machine learning algorithms, neural network architectures, and natural language processing (NLP) techniques. The integration of AI with other emerging technologies, such as blockchain and quantum computing, is expected to further enhance its impact on financial markets, driving innovation and efficiency in financial operations. The use of AI in finance is becoming increasingly widespread, with applications in areas such as risk management, portfolio optimization, fraud detection, and customer service.

2.3 Types of AI Used in Financial Markets

Artificial intelligence (AI) has revolutionized the financial industry in recent years. Various types of AI are being used to improve efficiency, accuracy, and decision-making in financial markets. Here are some of the most common types of AI used in finance:

2.3.1 Machine learning algorithms: Machine learning algorithms (ML) is a subset of artificial intelligence (AI) that empowers computers to learn from large datasets and make informed predictions or decisions. Since the accuracy of these algorithms is known to improve with greater quantities of data to train on, the growing availability of such data in recent years has brought renewed interest to these algorithms (Burrell, 2016). In the realm of finance, one of the core principles of ML is the classification and analysis of financial data using a combination of fundamental and technical indicators. Fundamental indicators provide a comprehensive view of a company's financial health, market position, and economic factors. On the other hand, technical indicators are used to analyze statistical trends based on market activity, including price movements, volume, and momentum.

2.3.2 Deep learning: Deep learning is a subset of machine learning that involves the use of neural networks to analyze complex data (Ramakant Chandanshive & al., 2023). In recent years, deep learning has been increasingly applied to financial markets, with the goal of improving investment decisions, risk management, and portfolio optimization.

2.3.3 Natural language processing: Natural Language Processing (NLP) is a vital AI technology that enables computers to understand and interact with human language. By analyzing and interpreting text data from diverse sources, including financial news, social media, and earnings reports, NLP algorithms can extract insights into market trends and investor sentiment. This information can then be leveraged to inform trading strategies and support decision-making processes, providing a valuable edge in the financial markets (Rehan, 2024).

To sum this up, Artificial intelligence (AI) has significantly impacted the finance industry through optimization and automation, leveraging machine learning, deep learning, and natural language processing. While AI has the potential to enhance financial analysis and fintech applications, some experts remain skeptical about its capabilities, questioning whether it can truly deliver on its promises.

3. The impact of adopting AI applications on financial markets

The advent of Artificial Intelligence (AI) has brought about a seismic shift in the financial industry, radically changing long-standing practices and presenting fresh avenues for expansion and innovation. AI's influence spans the entirety of finance, including fraud detection, algorithmic trading, risk management, and customer service, yielding unprecedented levels of insight, efficiency, and competitive edge. The following points delve into the far-reaching benefits that AI has introduced to the financial sector.

3.1 Fraud Detection

AI has also made a profound impact on fraud detection in finance, enabling institutions to proactively identify and prevent illicit activities. Machine learning algorithms scrutinize transaction data in real-time, pinpointing suspicious patterns and anomalies that may indicate fraudulent behavior. By leveraging AI, banks and credit card companies can effectively detect unauthorized transactions, prevent identity theft, and combat money laundering, thereby safeguarding both their own interests and those of their customers from financial harm (Kumar & Sharma, 2019).

3.2 Algorithmic Trading

The incorporation of Artificial Intelligence (AI) into algorithmic trading marks a significant milestone in the evolution of this field. Leveraging Machine Learning (ML) and Deep Learning (DL) techniques, trading algorithms can now be empowered to learn from historical data, identify complex patterns, and make informed decisions that may surpass human capabilities (Sonkavde & al., 2023). By harnessing the power of AI, trading systems can rapidly process vast amounts of data in real-time, uncovering subtle correlations and anomalies that can inform more effective trading strategies. This adaptive capacity is particularly crucial in today's dynamic markets, where the ability to evolve and adapt is essential for success. The integration of AI-driven approaches, such as sentiment analysis, natural language processing, and predictive modeling, is revolutionizing the landscape of algorithmic trading. Furthermore, the advent of AI has enabled the development of algorithmic strategies that extend beyond traditional asset classes, including cryptocurrencies, commodities, and alternative investments, thereby providing traders and investors with new and innovative opportunities (RAHMANI et al., 2023).

3.3 Risk Management

The integration of AI has significantly enhanced risk management practices in finance, enabling institutions to more effectively assess and mitigate potential risks. Machine learning algorithms analyze a diverse range of data sources, including market trends, historical data, and macroeconomic indicators, to identify patterns and anticipate potential risks. By leveraging AI, financial institutions can detect fraudulent activities, predict market fluctuations, evaluate credit risks, and ensure regulatory compliance, ultimately protecting their assets and minimizing losses (Chan et Wang, 2020).

3.4 Customer Service

The introduction of AI-powered chatbots and virtual assistants has revolutionized customer service in the financial industry. These sophisticated systems engage with customers in a natural, conversational manner, offering tailored recommendations, addressing queries, and facilitating transactions with ease. By automating routine tasks and providing around-the-clock support, AI-driven customer service solutions significantly enhance operational efficiency, reduce costs, and elevate the overall customer experience (Li et Zhang, 2018).

3.5 Portfolio Management

AI-powered portfolio management platforms leverage advanced analytics and machine learning techniques to optimize investment strategies and tailor portfolios to individual

preferences and risk tolerances. These platforms analyze market trends, economic indicators, and investor behavior to make data-driven investment decisions, maximizing returns while minimizing risks. By providing personalized investment advice and automated portfolio rebalancing, AI-driven portfolio management solutions democratize access to wealth management services and empower investors of all backgrounds to achieve their financial goals (Divya et al., 2024).

In conclusion, the influence of artificial intelligence on financial markets is profound and far-reaching. Through the automation of routine operations, the optimization of data analysis, and the enhancement of fraud detection and risk management, AI technologies enable financial institutions to operate with greater efficiency, lower costs, and improved decision-making outcomes for market participants. Beyond these operational gains, AI reshapes the structural functioning of financial markets through several interrelated channels, notably fraud detection, algorithmic trading, risk management, customer service, and portfolio optimization. Collectively, these dimensions constitute a comprehensive analytical framework for assessing market efficiency, resilience, and innovation in contemporary financial systems. As AI continues to evolve, its capacity to transform market dynamics and redefine industry practices is expected to expand further. Accordingly, this theoretical framework provides the basis for the subsequent empirical analysis, which applies these concepts to the Saudi stock market Tadawul in order to examine how AI-driven mechanisms have been operationalized within its institutional and technological structure.

Ultimately, the integration of AI will be a pivotal factor in shaping the future of financial markets, fostering a more agile, responsive, and resilient industry.

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4. Key Concerns and Challenges in the Adoption of AI in Financial Markets

The increasing integration of Artificial Intelligence (AI) and Machine Learning (ML) in financial markets presents a multitude of challenges that must be addressed to ensure responsible adoption.

Ethical considerations are at the forefront of these challenges, with privacy being a significant issue due to the extensive use of data in AI and ML operations (Joanna et al., 2017). As financial markets increasingly adopt these technologies, questions surrounding the protection and utilization of sensitive information become increasingly important. Furthermore, AI systems must be designed to prevent bias and ensure fair outcomes, particularly in decision-making processes such as credit scoring and risk assessments (Jordan, 2019). The accountability for AI operations also poses an ethical dilemma, as it is unclear who should be held responsible in the event of detrimental consequences resulting from an AI-driven process.

Regulators face a daunting task in keeping pace with the rapid advancements in AI and ML technologies while ensuring transparency, explainability, and compliance (Yeung, 2017). The complexity and opacity of AI and ML models can make it difficult for individuals and regulators to understand the decision-making process, underscoring the need for interpretable models that provide insight into their operations (Burrell, 2016). Additionally, financial institutions employing AI and ML must navigate a range of financial regulations, including anti-money-laundering laws and data protection policies, to ensure compliance (Zeng et al., 2019).

The increasing use of AI in algorithmic trading raises concerns about potential market disruptions. For instance, AI systems trained on the same data or adopting similar strategies may lead to herding behavior, exacerbating market volatility (Ait-Sahalia & Sağlam, 2024).

Moreover, the potential for AI-driven trading systems to act on false or misleading signals, resulting in drastic market moves, poses a significant systemic risk. (Leal et al., 2016)

Ultimately, while AI and ML offer tremendous potential for improving the efficiency, accuracy, and effectiveness of financial markets, their implementation is not without serious ethical, regulatory, and systemic challenges. To address these challenges, it is crucial to adopt a responsible and thoughtful approach to AI and ML adoption, one that prioritizes robust regulatory oversight, ethical standards, and systemic risk monitoring. By doing so, we can harness the benefits of AI and ML while minimizing their risks and ensuring a more stable and equitable financial market.

5. Saudi Arabia's Strategic Framework for the Integration of Artificial Intelligence into the Financial Sector

5.1 Overview of the Tadawul Market

Saudi Stock Exchange, commonly referred to as Tadawul, is the primary stock exchange in Saudi Arabia. Established in 2007, it is the largest stock exchange in the Middle East and North Africa (MENA) region. As the primary exchange in the Kingdom of Saudi Arabia, Tadawul plays a pivotal role in the country's financial system, facilitating capital formation, investment diversification, and economic growth. The exchange is regulated by the Capital Market Authority (CMA), which oversees the market's operations, enforces regulations, and ensures compliance with international standards. As of 2024, Tadawul is part of the Saudi Tadawul Group Holding Company, a conglomerate comprising four subsidiaries:

- *The Tadawul Exchange*: The main stock exchange platform, where securities are traded.
- *Securities Depository Center Company*: Responsible for the safekeeping and settlement of securities.
- *Securities Clearing Center Company*: Handles the clearing and settlement of trades.
- **Wamid**: A technology-focused subsidiary, driving innovation and digital transformation in the market.

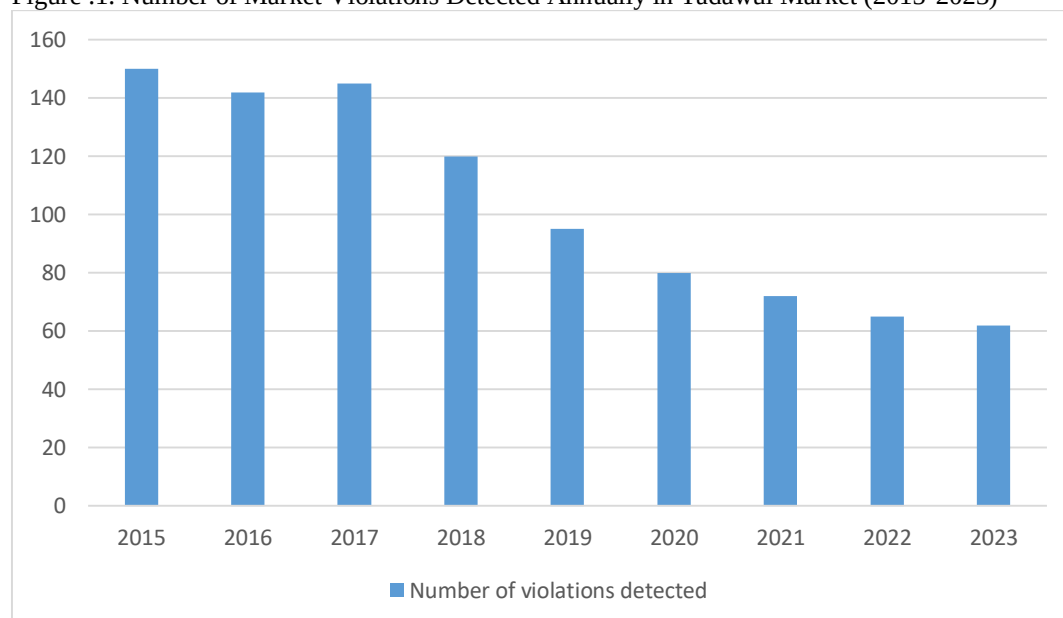
Tadawul's market capitalization has surpassed \$3 trillion, primarily driven by the listing of Saudi Aramco, the world's largest initial public offering (IPO) to date, as well as other state-owned giants. This milestone has been complemented by a surge in listings from private sector companies, which has contributed to the diversification of the market and enhanced its appeal to investors. In recent years, Tadawul has undergone significant transformations aimed at enhancing market efficiency, transparency, and global competitiveness. Notably, its inclusion in major global indices such as MSCI, FTSE Russell, and S&P Dow Jones has increased its visibility and accessibility to international investors. Furthermore, the Capital Market Authority (CMA) has implemented various regulatory reforms to align the market with international best practices, including enhanced corporate governance and disclosure requirements. Additionally, Tadawul has invested heavily in technology, introducing new platforms and systems enabled by artificial intelligence to improve trading efficiency, reduce costs, and enhance the overall investor experience.

5.2 AI Applications within Tadawul Market

The burgeoning integration of artificial intelligence (AI) into the operational and regulatory frameworks of the Tadawul market is a paradigmatic shift, with multifaceted applications across various domains. Specifically, AI and machine learning (ML) are being deployed in three primary areas: market surveillance and regulatory compliance, predictive analytics and trading optimization, and investor services and automation.

From a regulatory perspective, the Capital Market Authority (CMA), in collaboration with Wamid and other digital transformation entities, has implemented AI-based surveillance systems to strengthen the detection and prevention of fraudulent market practices. These systems are designed to identify market manipulation, insider trading, and abnormal price movements in real time by leveraging advanced natural language processing (NLP) and anomaly detection algorithms. By continuously monitoring trading activity, corporate disclosures, and news sentiment, AI-driven surveillance has significantly enhanced regulatory oversight and reduced the likelihood of undetected market fraud compared to the pre-AI environment, as evidenced by the consistent decline in detected violations following the introduction of AI-based systems. As illustrated in figure1 bellow, which demonstrates a clear downward trend in detected market manipulation cases from 2015 to 2023, coinciding with the phased implementation of AI-based surveillance systems. While detected violations were relatively high prior to widespread AI adoption, a sustained decline is observed in subsequent years, suggesting improved deterrence and early detection of abusive trading behaviors. This trend indicates that enhanced real-time monitoring and anomaly detection may have reduced both the occurrence and persistence of manipulative practices. However, other factors such as regulatory reforms and increased market awareness may also have contributed to this decline.

Figure .1. Number of Market Violations Detected Annually in Tadawul Market (2015-2023)



Source: Author's own elaboration based on Tadawul and Capital Market Authority (CMA) annual reports.

In the realm of trading and analytics, AI models are being employed for algorithmic trading, portfolio optimization, and volatility forecasting. Institutional investors and fintech firms are developing AI-driven solutions for predictive modeling of Tadawul-listed securities, incorporating both structured and unstructured data sources. These sources include, but are not limited to, earnings reports, geopolitical news, macroeconomic indicators, and social media sentiment analysis. The integration of these diverse data sources enables the creation of more accurate and comprehensive predictive models, which can inform investment decisions and optimize portfolio performance, thereby mitigating potential risks and maximizing returns. Figure 2 provides an empirical illustration of this trend by showing the increasing use of AI-supported trading and analytical tools in the Tadawul market, as reflected in the growth of average daily trading volumes over time. This trend suggests that AI-enabled trading and analytics have contributed to higher market liquidity and more efficient information processing. While broader economic factors may

also influence trading activity, the observed pattern is consistent with the growing integration of AI technologies within the Saudi capital market.

Figure .2. Average Daily Trading Volume in Tadawul Before and After AI Adoption



Source: Author's own elaboration based on Tadawul and Capital Market Authority (CMA) annual reports.

Furthermore, the launch of Sahmi, an AI-powered investor assistant developed under the auspices of Fintech Saudi, underscores the growing emphasis on AI in retail investor engagement. Sahmi utilizes AI-driven chatbots and virtual assistants to provide personalized investment advice and portfolio management services to individual investors, thereby enhancing their overall investment experience and fostering a more inclusive and participatory market.

In addition to these developments, Tadawul has invested in distributed ledger technology (DLT) and real-time data analytics platforms, which enable smart order routing and optimized settlement procedures. The Wamid platform, in particular, serves as a digital infrastructure enabler for AI applications, offering a suite of tools for big data processing, cloud computing, and algorithm training. This infrastructure supports the development and deployment of AI models, facilitating the integration of AI into various aspects of the Tadawul market and enabling more efficient and effective decision-making.

The increasing adoption of AI in the Tadawul market is expected to yield numerous benefits, including enhanced market efficiency, improved regulatory oversight, and more informed investment decisions. As the market continues to evolve, it is likely that AI will play an increasingly prominent role in shaping the future of trading, investing, and regulatory compliance in the Tadawul market, thereby contributing to the development of a more robust, resilient, and inclusive financial ecosystem.

5.3 The future of AI in Saudi Arabia alignment with 2030 vision

Saudi Arabia has demonstrated a clear national commitment to becoming a global leader in artificial intelligence (AI) by 2030, with a strategic focus on integrating AI technologies across key sectors, particularly finance. This ambition is deeply aligned with Saudi Arabia's Vision 2030, a comprehensive framework that seeks to diversify the Kingdom's economy and drive sustainable growth. This vision is built around three central axes: A vital society, a thriving economy, and an ambitious nation; from which ninety-six strategic objectives branch out. In support of this vision, the Kingdom has launched several initiatives under the supervision of the Saudi Data and Artificial Intelligence Authority (SDAIA), including the Global AI Summit, a premier platform that brings together global leaders, experts, and

innovators to shape the future of AI and explore its potential to drive economic growth, improve lives, and create a more sustainable future. By harnessing the power of AI and fostering a culture of innovation, Saudi Arabia aims to unlock new opportunities, drive entrepreneurship, and create a more prosperous and diversified economy, ultimately achieving its goal of becoming a global leader in AI by 2030.

5.3.1 National Strategy for Data and Artificial Intelligence (NSDAI): is a long-term national strategy was launched at the first Global AI Summit, through this strategy, the Kingdom aims to empower the private and public sectors. By 2030, the National Strategy for Data and AI aims to accomplish a set of ambitious objectives, comprising sixty-six goals that are either directly or indirectly dependent on data and AI. Specifically, the Kingdom aspires to emerge as one of the top fifteen countries globally in the field of Artificial Intelligence (AI), secure a spot among the top ten nations in the Open Data Index, and rank within the top twenty countries in terms of publishing research related to data and AI.

Additionally, the strategy targets training 40% percent of the workforce in basic skills to eliminate data and AI illiteracy, developing a pool of twenty thousand data and AI specialists and experts, attracting local and foreign investments amounting to SAR75 billion, and fostering entrepreneurship by supporting over three hundred startups in the data and AI sector (saudipedia, 2020) .

5.3.2 NEOM AI Challenge: in collaboration with NEOM, the Global AI Summit has launched an initiative comprising three key tracks: leveraging AI in decision-making, adaptive inspection, and machine-executable legislation to accelerate processes and keep pace with rapid local advancements. The objective of this challenge is to empower innovators and entrepreneurs, foster national and international capabilities within small and medium-sized enterprises globally, and propel them towards new frontiers in innovation (saudipedia, 2020).

5.3.3 International Center for Artificial Intelligence Research and Ethics (ICAIRE): established on July 25, 2023, the center is a global hub dedicated to advancing artificial intelligence (AI) research and ethics worldwide, in line with UNESCO's guidelines on AI ethics. The center's mission is to facilitate international collaboration in AI research and development, promote awareness of AI ethics, cultivate AI expertise, and offer policy advice. To achieve this, the center operates on four core strategic pillars:

- Fostering research and development in AI to drive innovation
- Enhancing awareness and communication about AI ethics to promote responsible AI practices
- Strengthening and supporting AI capacity building to empower individuals and organizations
- Providing expert recommendations on AI policies to inform decision-making

By working together with international partners, the center aims to promote the development of AI that is aligned with human values and benefits society as a whole. (saudipedia, 2020)

With these initiatives, The Ministry of Finance has undergone a profound digital transformation, achieving remarkable milestones that have significantly enhanced the

efficiency, transparency, and development of government operations and procedures. This transformation has enabled a shift from paper-based to digital transactions, automation of financial processes, faster completion times, enhanced transparency in financial transactions, improved customer service, a simplified user experience, greater operational efficiency, cost reductions, and the capability to perform advanced financial data analysis and future forecasting. These advancements reflect the Ministry's commitment to providing advanced digital solutions and enhancing the efficiency and transparency of government operations, thereby supporting the realization of Vision 2030 and strengthening the competitiveness of the Saudi economy.

6. Potential Risks in Adapting AI in Saudi Arabia's Financial Market

The adoption of artificial intelligence (AI) in Saudi Arabia's financial market offers substantial opportunities for efficiency enhancement and innovation; however, it also entails a set of risks that must be carefully managed within an appropriate regulatory and legislative framework. These risks cannot be assessed in isolation but should be evaluated in relation to the institutional and legal readiness of the Saudi financial system, particularly in the context of the Saudi Stock Exchange Tadawul.

One of the most significant risks associated with AI adoption is related to data privacy and cybersecurity. AI systems depend heavily on large volumes of sensitive financial and personal data to operate effectively. (Alshammari, 2023) Any breach, misuse, or unauthorized access to such data may result in severe legal consequences and reputational damage for financial institutions. In this regard, Saudi Arabia has enacted the Personal Data Protection Law (PDPL), which provides a foundational legal framework governing the collection, processing, and storage of personal data. While the PDPL represents an important step toward protecting data rights, the increasing reliance on real-time data analytics, cross-platform data integration, and cloud-based AI solutions raises concerns regarding the adequacy of enforcement mechanisms and the need for more detailed regulatory guidelines specifically tailored to AI-driven financial applications.

Another critical risk stems from algorithmic bias and the opacity of AI decision-making processes. AI algorithms may inadvertently perpetuate or amplify existing biases embedded in historical data, leading to unfair or discriminatory outcomes. (Al-Baity, 2023) This risk is particularly relevant in financial market applications such as algorithmic trading, market surveillance, credit assessment, and investor profiling. Although the Capital Market Authority (CMA) has established governance principles aimed at ensuring market fairness and transparency, the current regulatory framework does not explicitly mandate algorithmic explainability or systematic auditing of AI models. The absence of such requirements represents a regulatory gap that could undermine confidence in AI-driven financial decisions and calls for the introduction of clearer supervisory standards addressing algorithm design, testing, and accountability.

Systemic risk and market stability also constitute major concerns in the context of AI adoption. The growing use of algorithmic and high-frequency trading systems may increase the likelihood of herding behavior, rapid price fluctuations, and unintended feedback loops during periods of market stress. While Saudi Arabia's financial regulatory framework includes market surveillance mechanisms and trading halt procedures, the speed and complexity of AI-based trading systems necessitate more advanced, real-time supervisory tools. Enhancing the technological capacity of the CMA to monitor algorithmic interactions and assess systemic risk dynamically would therefore be essential to preserving market stability.

In addition to market-related risks, the increased automation enabled by AI may lead to job displacement, particularly in roles characterized by routine and repetitive tasks. This could generate social and institutional challenges, including workforce resistance and skills mismatches. Moreover, the high costs associated with implementing and maintaining AI

systems represent a financial risk, especially when the return on investment remains uncertain or when technological solutions fail to deliver the expected performance gains.

Issues surrounding transparency, responsibility, and the potential misuse of AI systems may lead to public mistrust and regulatory backlash if not properly addressed. Furthermore, reliance on external technology providers and foreign expertise may expose Saudi financial institutions to geopolitical risks, such as supply chain disruptions or restrictions on technology transfers, potentially hindering the long-term development of domestic AI capabilities.

In light of these considerations, it is essential for financial institutions and regulators in Saudi Arabia to adopt a proactive and responsible approach to AI governance. This includes strengthening data security measures, enhancing algorithmic transparency, investing in regulatory technology (RegTech), and developing clear accountability frameworks. By continuously adapting the regulatory and legislative infrastructure to the evolving nature of artificial intelligence, Saudi Arabia can mitigate associated risks while maximizing the benefits of AI integration in its financial market.

7. Conclusion

This study demonstrate that the integration of artificial intelligence technologies into Saudi Arabia's financial market is both strategically aligned with the country's national development goals and operationally effective in enhancing core financial functions. The research indicates that AI tools have been increasingly deployed in areas such as algorithmic trading, market surveillance, investor behavior analysis, fraud detection, and asset management. These applications contribute to measurable improvements in operational efficiency, predictive accuracy, and risk mitigation.

The findings reveal that the deployment of AI technologies corresponds directly with the strategic objectives outlined in **Saudi Arabia's Vision 2030** and the **National Strategy for Data and Artificial Intelligence (NSDAI)**. Notably, AI integration in financial services supports several Vision 2030 targets, including:

- Strengthening the resilience and global competitiveness of the financial market.
- Enhancing the digital infrastructure and adoption of advanced technologies.
- Increasing the private sector's contribution to GDP through technological innovation.
- Creating new high-skilled employment opportunities in data science and AI.
- Attracting foreign direct investment by modernizing market platforms and regulatory frameworks.

Overall, the results confirm that artificial intelligence acts as a transformative enabler in Saudi Arabia's financial market and serves as a critical component in achieving the broader economic diversification and innovation objectives of Vision 2030. The continued expansion of AI capabilities, supported by government policy, institutional commitment, and technological investment, is expected to further strengthen the Kingdom's position as a leading digital financial center in the Middle East.

- Recommendations

- Enhance awareness and education within the Tadawul market regarding artificial intelligence technologies and their financial applications, particularly among brokers, listed companies, and investors, in order to address concerns, improve acceptance, and promote informed use of AI-based systems.
- Encourage market participants operating in the Saudi Stock Exchange to invest in AI-powered solutions by highlighting their potential benefits in improving trading efficiency, execution accuracy, market liquidity, and decision-making processes.
- Foster collaboration between artificial intelligence experts, financial professionals, fintech firms, and Tadawul's technological entities to develop AI solutions that are specifically adapted to the operational needs and regulatory environment of the Saudi financial market.
- Prioritize the management of ethical considerations related to the use of artificial intelligence in Tadawul, including algorithmic bias, transparency, and accountability, in order to strengthen market integrity and maintain investor trust.
- Offer targeted training programs and professional development initiatives supported by Tadawul and relevant regulatory bodies to upskill financial market professionals in artificial intelligence technologies and their applications, ensuring readiness to meet the demands of an increasingly digital and automated market environment.

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