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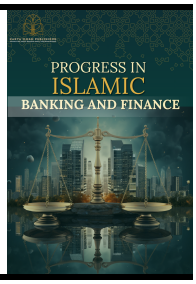

Artificial Intelligence and Blockchain Technology in Islamic Banking: Importance, Advantages, and Challenges

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ABSTRACT

In recent years, Islamic financial and banking institutions have begun using artificial intelligence (AI) technologies to enhance their efficiency, automate operations, improve service quality, and increase their competitive advantages. This paper aims to highlight the importance of AI—both centralized and decentralized—and its role in improving the performance of Islamic banks and the quality of their services. The paper presents the key features of centralized and decentralized AI and the opportunities they provide for Islamic banks to enhance their operations and services in an intensely competitive market environment. The study recommends that Islamic banks intensify their efforts in the field of AI applications by developing the necessary infrastructure, training staff, and implementing measures to ensure data safety, security, privacy protection, and transaction transparency. It also recommends that supervisory and regulatory bodies in central banks and relevant authorities work toward establishing governance frameworks and standards for the use of AI in Islamic banks.

1. Introduction

The rapid development of artificial intelligence, as a product of modern technology, has led to its widespread application across various fields, including the banking and financial sectors [21,28,29]. Many companies and institutions in both the public and private sectors have shifted from traditional business methods to the use of AI tools. According to published statistics in 2023, the global AI market was valued at approximately USD 207.9 billion and is expected to reach USD 1.5 trillion by 2030, reflecting the rapid growth of this field [11].

Despite the expansion of AI applications across many sectors, concerns have arisen regarding the centralization of AI technologies. Centralized AI models, controlled by a few large companies, raise issues related to data privacy, security procedures, and bias in applications. It has been observed that

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over 80% of AI systems are owned by major tech firms in industrialized countries, thereby granting them control over massive amounts of data. This has led to the emergence of Decentralized Artificial Intelligence (DeAI) as an alternative technology to limit the dominance and monopoly of large corporations over AI systems and their extensive use of big data. Innovation and development efforts have enabled decentralized AI to overcome the problems of centralization by distributing the computational power of AI systems across a more transparent, secure, and equitable framework. This approach leverages the integration of Blockchain Technology with AI systems. The combination of blockchain's immutable and transparent nature with the advanced capabilities of AI has empowered decentralized AI systems to enhance privacy, increase security, and enable data sharing. Thus, decentralized AI can be defined as the distribution of control or decision-making authority away from a central administrative entity. In this regard, decentralized AI represents a radical transformation in the development and use of artificial intelligence and offers an effective tool for addressing the challenges associated with traditional, centralized AI systems.

The primary issue driving the adoption of decentralized AI technologies is the need to confront and overcome the risks associated with centralized AI use. This paper seeks to identify the weaknesses and risks surrounding centralized AI and thus justify the expansion of decentralized AI technologies in financial and banking institutions. The main risks can be summarized as follows:

- Data Privacy Risks: Centralized AI systems require vast amounts of data to function effectively. This data is often stored and processed by a single entity, making it a prime target for cyberattacks and breaches. In recent years, serious breaches have occurred—such as the 2020 data breach involving the personal information of millions of users from a leading AI company—underscoring the severe risks tied to storing sensitive information in centralized systems.
- Central Server Failure: Centralized AI models are inherently vulnerable to attacks due to their reliance on central servers and unified data repositories. A successful breach could jeopardize the entire system due to the lack of distributed processing and storage in centralized AI networks. The connection between the agent and the data provider remains the most vulnerable point in centralized AI platforms.
- Bias and Inaccuracy in Decision-Making: Centralized AI models are often developed and trained by teams with similar backgrounds, perspectives, and biases, which means they do not adequately represent diverse user groups. This can result in biased decisions, especially in critical areas such as recruitment and finance. Furthermore, since centralized AI systems learn from historical data, they may inherit and reproduce existing biases and inequalities, resulting in unfair and inaccurate outcomes.

This paper derives its theoretical importance from the need to clarify the role of AI in enhancing the performance of Islamic banks. Practically, it focuses on the opportunities and challenges Islamic banks face in using decentralized AI and proposes development policies for its application in Islamic banking. This paper adopts a descriptive and analytical methodology. It includes an introduction and three main sections: the first section discusses the nature of artificial intelligence; the second explores the concept and features of blockchain technology; the third investigates the role of decentralized AI in Islamic banks and the main challenges associated with its use. Finally, the paper concludes with a summary of key findings, recommendations, and policy implications.

2. The Nature of Artificial Intelligence and Blockchain Technology

2.1 Definition of Decentralized Artificial Intelligence

Decentralized Artificial Intelligence (DeAI) is defined as the redistribution of AI components—computation, data, and decision-making—across a distributed network. This contrasts with traditional AI systems, which rely on centralized platforms such as Google. Decentralized AI operates through a system known as blockchain technology, one of the most prominent technologies concerned with recording transactions on distributed devices in the form of blocks or interconnected data structures. These operations are carried out consistently across the records on the devices, ensuring a high degree of transparency, security, and inclusivity when sharing information within a business network [25,26].

Decentralized AI refers to a type of AI system that uses blockchain technology to distribute, process, and store data across a network of blocks. Users can benefit from pre-trained AI models on their local devices, allowing them to access services and carry out operations without relinquishing control of their data to a centralized authority or sharing outcomes with third parties. It also preserves privacy by avoiding the transfer of core personal data [31].

2.2 Definition of Blockchain Technology

Blockchain is a technology that allows a person or company to securely transfer valuable assets to another party without the involvement of any intermediary. Blockchain consists of a series of immutable records or data blocks managed by a group of computers that are not owned by any single entity. These blocks are secured and linked using cryptographic principles. Essentially, the blockchain is a distributed, encrypted, and secure database that allows participants within a network to create a trustworthy record of transaction data without the need for a third party [7,20].

Blockchain technology is based on four main components [1].

1. Block: The fundamental unit of construction, composed of a group of transactions within the chain, such as money transfers.
2. Data: The individual transaction or sub-process carried out within a single block.
3. Hash: A digital fingerprint of the transaction, also referred to as the electronic signature, generated using a blockchain algorithm to produce a unique number.
4. Timestamp: The precise time at which the transaction is recorded in the chain.

The blockchain network is an autonomous platform that is not subject to any central authority. It is essentially a shared, immutable ledger, with open and accessible information available to anyone. Therefore, anything built on the blockchain is inherently transparent, and blockchain transactions are free of direct cost.

2.3 Types of Blockchain Networks

According to AWS, there are four main types of decentralized or distributed blockchain networks:

1. Public Blockchain Networks

Public blockchains operate permissionless, allowing anyone to join. All participants have equal rights to read, edit, and validate the blockchain. Public blockchains are mainly used for the exchange and mining of cryptocurrencies such as Bitcoin, Ethereum, and Litecoin [18].

2. Private Blockchain Networks

Controlled by a single organization, private blockchains—also known as managed blockchains—determine who can become a member and what rights they possess within the network. These blockchains are only partially decentralized due to their restricted access.

3. Hybrid Blockchain Networks

Hybrid blockchains combine features of both private and public networks. Companies can establish permissioned private systems alongside public frameworks. This allows them to control access to specific blockchain-stored data while keeping the remaining data public. Smart contracts are used to enable public members to verify whether private transactions have been completed.

4. Consortium Blockchain Networks

Consortium blockchain networks are managed by a group of organizations that share the responsibility of maintaining the blockchain and defining data access rights. These are often preferred in industries where multiple organizations share common objectives and benefit from shared responsibility. For example, the Global Shipping Business Network Consortium is a nonprofit blockchain consortium that aims to digitize the shipping industry and foster collaboration among maritime operators [14].

2.4 Key Features and Advantages of Blockchain Technology

The reason blockchain has gained such popularity and widespread adoption lies in its decentralized nature, the fact that it is not owned by a single entity, and its immutability, which ensures that no one can tamper with the data stored within it. Additionally, it is transparent, making it impossible for anyone to track the data it contains without proper permissions. According to Javaid *et al*., [17] and Saleh [24], blockchain technology is distinguished by the following key characteristics and advantages:

- Decentralization: Decentralization in blockchain refers to the transfer of control and decision-making from a centralized entity—whether an individual, organization, or group—to a distributed network. The use of decentralized blockchain networks offers a high degree of transparency.
- Immutability: This means records cannot be changed or altered. Once a transaction is recorded in the shared ledger, no participant can tamper with it. If a transaction contains an error, a new transaction must be added to reverse the mistake. Both transactions remain visible to the entire network.
- Automated Consensus: The blockchain system establishes rules for participant agreement before recording transactions. No new transaction can be registered unless most network participants approve it.
- Advanced Security: Blockchain systems offer a high level of security and trust essential for modern digital transactions. A common concern is the manipulation of core software to produce counterfeit money. However, blockchain uses three core principles—encryption, decentralization, and consensus—to build a highly secure software system that is virtually immune to tampering. There is no single point of failure, and no single user can alter transaction records.
- Improved Efficiency: Inter-business transactions often require considerable time and operational procedures, especially when dealing with compliance, regulations, and third-party oversight. The use of blockchain—with its transparency and smart contracts—makes such business transactions faster and more efficient.
- Accelerated Auditing: Companies need to be able to create, exchange, archive, and reconstruct electronic transactions securely and in an auditable manner. Blockchain records are time-stamped and ordered chronologically, allowing for faster and more transparent auditing processes.

2.5 Core Technologies of Decentralized Artificial Intelligence

Decentralized AI operates through the integration of advanced technologies, creating a framework for secure, efficient, and collaborative AI systems. The two foundational technologies driving this transformation are blockchain and federated learning. These technologies address the issues associated with centralized AI systems and provide a scalable foundation for decentralized AI applications [11,13,23].

1. Blockchain and Distributed Ledgers

- Immutable and Transparent Data Storage: Blockchain technology is a key tool in decentralized AI. It provides immutable, transparent, and secure data storage. In traditional AI models, data is centralized and controlled by a single entity, which increases the risk of data manipulation and misuse. Blockchain addresses these issues by storing data across a distributed ledger, within secure, time-stamped blocks [14].
- Smart Contracts: Smart contracts play a vital role in decentralized AI by ensuring the integrity and transparency of operations, unlike traditional systems where trust is centralized. Key features of smart contracts in decentralized AI include [11,12].
- Verifiability: Smart contracts rely on the principle of verifying all changes to the data. Any operational data must undergo verification before being modified, ensuring transparency and accuracy in decentralized AI models.
- Deterministic Operations: Smart contracts guarantee deterministic behavior, meaning outcomes are predictable and protected from external interference. This ensures that any change in AI systems is reliable and verifiable, eliminating the risks of unauthorized or erroneous modifications.
- Atomic Swaps: Smart contracts ensure that transactions are either fully executed or not executed at all. This prevents partial updates and maintains consistency across all components of the AI model or system.

2. Federated Learning and Collaborative Models

- Concept of Federated Learning: Federated learning is a decentralized approach to training AI models. Instead of relying on a centralized dataset, the model is trained across multiple decentralized devices or servers. This method allows an AI system to learn from a wide range of data sources while ensuring that the data remains on local devices, thereby preserving privacy. In federated learning, each device or server trains the model on its own local data and then shares only the model updates, not the data itself, with a central server. These updates are then aggregated to improve the overall model.
- Data Privacy and Security: One of the most important benefits of federated learning in decentralized AI is its ability to preserve data privacy and security. Since the data never leaves the local devices, the risks associated with centralized data storage—such as breaches or unauthorized access—are significantly minimized. This makes federated learning particularly valuable in sensitive sectors like healthcare, finance, and personal data management, where privacy concerns are paramount. For example, in healthcare, hospitals can train AI models on patient data without sharing the data itself, thereby complying with strict privacy regulations while still benefiting from collective insights.
- Collaborative AI Models: Federated learning also facilitates the creation of collaborative AI models, where multiple stakeholders—such as companies, research institutions, or even individual users—can contribute to AI development without disclosing their private or sensitive data. These

collaborative models allow for a more diverse range of inputs, leading to more robust and accurate AI outcomes. By making the training process participatory, federated learning ensures that AI models are not biased by the limited perspectives of a single entity, but instead reflect a broad spectrum of experiences and data.

- Scalability and Efficiency: Another major advantage of federated learning is its scalability. As the number of participants in the network increases, the model becomes stronger and more capable of handling increasingly complex tasks. Moreover, by distributing the computational workload across multiple devices, federated learning reduces the burden on any single server, resulting in more efficient processing and faster training times. This scalability is critical for decentralized AI applications that need to process large volumes of data or operate in real-time environments, such as autonomous vehicles or smart cities.

3. Decentralized Artificial Intelligence and Islamic Banks

Decentralized artificial intelligence is rapidly emerging as a transformative force across various industries, offering innovative solutions to complex challenges by harnessing the combined power of AI and blockchain technology. The integration of decentralized AI systems is no longer theoretical—it is already being implemented in key sectors, including banking and finance. Islamic banks, like other financial institutions, can benefit significantly from this development. Some of the key advantages include:

- Increased Productivity: By delivering high-quality products and services, AI can help Islamic banks boost their profitability and market share. AI-driven financial product development can aid Islamic banks in designing offerings that are compliant with Shariah principles. AI can analyze data and understand customer preferences to create more personalized products [4].
- Early Detection of Fraud and Hacking Activities: Decentralized AI can play a crucial role in identifying fraudulent activities and hacking attempts within banking systems. By analyzing real-time transaction data, AI models can detect abnormal patterns that indicate potential fraud. Moreover, the decentralized nature of the system ensures transparency and reduces the operational and data-related risks, thereby enhancing public trust in the Islamic banking ecosystem.
- Reduced Costs and Device Strain: Centralized AI systems often lead to higher transaction costs and performance bottlenecks on servers. In contrast, blockchain-based systems, composed of multiple nodes, eliminate the need for intermediaries—particularly beneficial in sectors like finance, where traditional processes rely heavily on clearinghouses for payment settlements.
- Speed and Efficiency: The ability of AI to process and analyze big data enables faster and more efficient operations. This allows Islamic banks to better understand market trends, customer behavior, and risk factors.
- Risk Management: AI-powered risk management tools can help identify risks with greater accuracy and speed. In the context of Islamic banking, AI can enhance the management of risks associated with Shariah-compliant financial products, as well as identify suitable investment opportunities.
- Investment Decision-Making: AI can be used for data analysis to support more intelligent investment decisions, including: predicting asset performance, identifying potential investment opportunities, and optimizing investment portfolios.

3.1 Decentralized AI's Response to Issues in Centralized AI and Blockchain Technology

3.1.1 Data privacy and ownership

Decentralized AI systems built on blockchain technology enable individuals to retain control over their data and support the decentralization of information. Blockchain technology can verify data contributions while keeping the actual data decentralized. This reduces the risk of misuse and empowers users to determine how their data is used in a fair, secure, and privacy-preserving manner.

3.1.2 Transparent decision-making

Decentralized AI leverages blockchain's transparency to make AI operations visible to all users. Every action or decision taken by the AI system on the blockchain can be traced, enhancing accountability and trust. This transparency is particularly critical in areas where unbiased decision-making is essential—such as loan approvals, customer application assessments, and credit history evaluations.

3.1.3 Privacy and security in decentralized AI

One of the most important advantages of decentralized AI is its ability to protect privacy and ensure security. In traditional AI systems, user data is sent to centralized servers for processing—a high-risk practice, as centralized systems are prime targets for hackers. Major breaches of centralized databases have exposed personal data of millions and led to growing skepticism and diminished trust in such systems.

Decentralized AI addresses this issue by keeping data on the user's device. For instance, instead of sending health data to a central server, decentralized AI can process this data locally on a smartphone or wearable device. Moreover, the use of blockchain in decentralized AI systems adds an extra layer of security by providing a tamper-proof ledger of all data transactions. This means data cannot be altered or accessed without proper authorization, thus significantly reducing the risk of breaches.

This model respects both user privacy and security. There is no longer a need to share sensitive information with third parties since computations occur locally. This aligns with the increasing demand for privacy-preserving technologies, particularly in regions with strict data protection regulations, such as the General Data Protection Regulation (GDPR) in the European Union.

3.1.4 Democratizing access to AI

Decentralized AI makes artificial intelligence more accessible to everyone. Traditional AI systems require significant financial and technical resources to operate, making them inaccessible to smaller organizations and individuals [30]. In contrast, decentralized AI distributes computational loads across many nodes, so no single node requires extensive infrastructure. This allows even individuals with limited resources to participate in AI development or benefit from AI tools. For example, decentralized AI-powered platforms allow developers to contribute AI models to a shared marketplace, which anyone can access and use—fostering innovation and global collaboration. For end users, this means more affordable AI applications. Small businesses can use AI tools without the high costs of centralized systems, and developers from underrepresented regions can contribute to and benefit from decentralized AI networks, enhancing innovation worldwide.

3.1.5 Financial services

In finance, decentralized AI is redefining how transactions are conducted and secured. By integrating AI with blockchain, decentralized financial platforms can offer services that are more independent, secure, and privacy-conscious. For example, decentralized AI can analyze spending patterns to provide financial advice or detect fraudulent transactions in real time. Since this occurs on a decentralized network, users are less vulnerable to centralized breaches. This also aligns with the principles of Decentralized Finance (DeFi), which aim to remove intermediaries and make financial services more accessible [30].

However, concerns remain regarding the ethical implications of adopting decentralized AI, including job displacement, bias in decision-making, and broader structural shifts. Applying AI could lead to job losses and increase the likelihood of irrational or biased decisions. Given that Islamic financial institutions collect and process highly sensitive personal and financial data, concerns about data privacy and security are particularly pronounced. It is essential that Islamic financial institutions address these concerns and ensure the integration of AI technologies is done in an ethical and responsible manner, aligned with Shariah principles and in a way that safeguards the interests of all stakeholders.

4. The Role of Artificial Intelligence in the Islamic Banking Sector

Artificial intelligence has led to a major transformation in the banking sector, significantly impacting Islamic banking by presenting both opportunities and challenges [8,9,16,19]. Decentralized AI in particular has the potential to revolutionize Islamic banking by improving performance, increasing efficiency, reducing costs, strengthening risk management, facilitating banking services, ensuring data privacy and security, and enhancing operational efficiency, customer experience, risk management, and decision accuracy [10,28]

1. Automating Shariah Compliance:

One of the most prominent challenges facing Islamic finance is ensuring that financial products and services comply with Shariah law. AI plays a vital role in simplifying and accelerating Shariah compliance checks [15].

Smart Contracts: Smart contracts based on AI and blockchain technologies ensure transparency and compliance by automatically executing financial agreements once all Shariah conditions are met.

2. Natural Language Processing (NLP):

AI-based NLP tools analyze contracts and legal documents to ensure compliance with Shariah rules more quickly and at lower cost compared to manual reviews.

3. Regulatory Reporting:

AI systems streamline documentation of Shariah compliance and facilitate reporting to regulators, enhancing trust and efficiency [27].

For instance, a financial institution in Saudi Arabia implemented an AI-powered compliance tool to evaluate sukuk (Islamic bonds), ensuring they meet ethical requirements while reducing the approval time by approximately 30%.

Enhancing Sukuk Issuance and Management

Saudi Arabia Islamic finance sector holds a global leadership position in sukuk issuance—an essential Islamic finance instrument. AI contributes significantly to improving this process through:

• Risk Assessment: Machine learning models evaluate market conditions and issuer creditworthiness and provide real-time insights to structure sukuk more effectively.

• Investor Matching: AI algorithms match sukuk issuers with investors based on their risk tolerance, investment goals, and ethical preferences—expediting capital raising.
• Lifecycle Management: AI-powered platforms monitor sukuk performance, ensuring timely repayments and compliance throughout the bond's lifecycle.
• Customized Financial Products: AI helps Islamic banks in the Kingdom offer financial products tailored to clients' needs while complying with Shariah. This is achieved through AI advisors and data-driven insights.

4.1 Challenges of Using Decentralized AI in Islamic Banks

Despite its benefits, decentralized AI faces key challenges, particularly the need for diverse data sources to ensure fair and unbiased outcomes.

- Infrastructure Requirements: One of the most pressing challenges is the infrastructure needed to support distributed systems. Decentralized AI requires a network of nodes capable of handling big data, which demands significant resources. The greatest challenge currently lies in building the infrastructure necessary to process all data and computations across a unified network—something that is complex to manage [2].
- Standardization: Lack of standardization is another obstacle. As different organizations build their own frameworks for decentralized AI, compatibility becomes an issue. There is a pressing need to establish common standards to allow platforms to communicate and interoperate. For example, if all data used to train an AI model comes from the United States, how can we trust that the model will understand and serve people in other regions of the world with different cultural contexts?
- Ethical Use: While decentralized AI is transparent, its use must still be ethical and responsible. Developers must guard against misuse—such as biased or harmful AI models—and implement safeguards to prevent these issues [22]. It is already known in the industry that fair and unbiased AI comes from diverse, open-source, and publicly collected data.
- Potential Cybersecurity Risks: Despite its advantages, technologies such as decentralized AI and blockchain remain vulnerable to certain cybersecurity risks [3]. The absence of central authority may become a liability in cases of storage failures or loss of user keys, making platform access difficult. Moreover, the inability to independently verify identities can pose serious security threats.
- Jurisprudential Challenges: Another critical issue involves Shariah-related legal concerns regarding the formation, validity, and conditions of contracts [15]. One of blockchain's defining features—its decentralization and publicly shared ledgers—has implications for contractual requirements. For example, if contract registration is done via blockchain, it becomes irreversible. This raises questions under Islamic jurisprudence: Does the irrevocable nature of blockchain registration invalidate contracts that involve the option to revoke? Would the contract be valid if the condition is void? Or would the contract itself be invalid? These questions remain subject to interpretation and ijtihad (juristic reasoning) across different Islamic schools of thought [5].
- The banking sector has begun to adopt blockchain technology, even though this technology was originally intended to challenge the role of banks as intermediaries in the field of payments. The participation of banks in numerous pilot efforts to explore the use of blockchain technology has proven beneficial in addressing deficiencies in various payment systems. The use cases of blockchain technology in the banking sector are not limited to domestic payment transactions but also include its application in cross-border payments and international remittances. An additional

specific application area is in securities settlements. The application of blockchain technology by some banks in the banking sector has revealed three main challenges as follows:

- The banking sector faces shortcomings related to the scalability and performance capabilities of blockchain platforms. One of the main challenges is that most blockchain platforms have been unable to handle the required transaction loads and the speeds that current methods can achieve. Another challenge lies in the lack of appropriate legal and regulatory frameworks centered around blockchain. Additionally, the lack of interoperability between blockchain systems and other traditional systems presents a significant obstacle to the implementation of blockchain in the sector. It has been found that the lack of interoperability is the primary deterrent to the mass adoption of the technology, as institutions have been unable to share transactions and data seamlessly across different systems, as required. As a result, they have been unable to fully benefit from the advantages of adopting this technology of decentralized artificial intelligence. There are technological, regulatory, and environmental considerations that must be considered when dealing with the implementation of blockchain. The key technological considerations identified include selecting an appropriate blockchain platform, ensuring data privacy and security, scalability, and flexibility.

5. Conclusion and Recommendations

The main findings and recommendations are summarized as follows:

- Centralized artificial intelligence presents significant risks that can be mitigated through decentralization. By distributing control and data across a wider network, decentralized artificial intelligence enhances privacy, security, and fairness, while promoting participatory and open access to this transformative technology. As artificial intelligence continues to grow in significance and impact, transitioning toward decentralization will be crucial to ensuring that AI serves the interests of all, rather than a select few. Centralization and monopolization raise serious concerns regarding data usage, including privacy violations, security breaches, and biases in data exploitation.
- Decentralized artificial intelligence mitigates these risks by distributing processing and storage across the network, making it more resilient to attacks. The decentralized nature of blockchain technology ensures, for example, that even if one node is compromised, the integrity of the entire system remains intact. Moreover, decentralized AI allows data to remain distributed across multiple nodes based on multiparty computing principles, which reduces the risk of a single point of failure and enhances overall privacy. Furthermore, expanding the scope of zero-knowledge proof technology enables the secure transmission of data pipelines, as the communication between the agent and the data provider is the most vulnerable element in AI platforms.
- While decentralized AI promotes participatory development and training processes, it enables broader individual involvement. This diversity in input can help reduce biases and result in more equitable and fair AI systems.
- Decentralized artificial intelligence also plays a pivotal role in democratizing access to AI technology. In the centralized model, the ability to develop, deploy, and benefit from AI is concentrated in the hands of a few companies, resulting in innovation monopolization and limiting its benefits, tailoring them to serve a few entities. In contrast, the decentralized AI model removes these barriers by allowing small institutions, developers, and individuals to participate in the AI ecosystem, providing the opportunity to share and widely distribute the benefits of AI.
- Artificial intelligence has become a key driver in Islamic banking. Its role has expanded across various domains such as data analysis, decision-making, risk management, and fraud detection.

With AI's ability to analyze data swiftly and deeply, Islamic banks can make more accurate and efficient decisions, in addition to identifying potential market opportunities.

- It is evident that AI systems rely on fundamental pillars—computing, data, and models—which are currently dominated by major corporations due to their computational power and advanced models. However, the introduction of decentralization in data collection, storage, and computing power can make AI more scalable and break the monopoly held by large companies and powerful alliances.
- The integration of artificial intelligence and blockchain technology in decentralized AI systems paves the way for a transparent and flexible digital environment that is user-controlled. It also enhances privacy and transparency, addressing many of the limitations surrounding centralized AI models.

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