ARTIFICIAL INTELLIGENCE AS A GLOBAL TREND IN DEVELOPING BLOCKCHAIN TECHNOLOGY

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ABSTRACT

This study aims to highlight the role of artificial intelligence in enhancing blockchain technology and its applications by analyzing trends and growth patterns worldwide, both in the financial sector and other innovative fields.

The study reaches several conclusions, the most significant of which is that, despite the decline in investments in the financial technology sector over the last two years (2022 and 2023), there is actual and expected growth in blockchain technology on a global scale, projected to reach double-digit figures (with expected growth of more than 162 billion US dollars in 2024). This demonstrates investors' confidence in the technology and its expanding uses beyond the financial and banking sectors. Applications of artificial intelligence have further enhanced the use of blockchain technology across various fields (such as education, healthcare, video games, etc.), and its high level of

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security supports financial inclusion and provides services to underserved populations.
Keywords: Blockchain technology; Artificial intelligence; Growth; Industry.
JEL classification : G24 ; G32.

L'INTELLIGENCE ARTIFICIELLE COMME UNE TENDANCE MONDIALE DANS LE DÉVELOPPEMENT DE LA TECHNOLOGIE BLOCKCHAIN

RÉSUMÉ

Cette étude vise à mettre en lumière le rôle de l'intelligence artificielle dans l'amélioration de la technologie ou de l'industrie de la Blockchain en analysant les tendances et la croissance des applications de la Blockchain dans le monde entier, que ce soit dans le secteur financier ou dans d'autres domaines innovants.

L'étude a abouti à plusieurs conclusions, la plus importante étant que malgré le déclin des investissements dans le secteur de la technologie financière au cours des deux dernières années (2022 et 2023), il existe une croissance réelle et prévue de la technologie Blockchain à l'échelle mondiale à deux chiffres (croissance prévue en 2024 de plus de 162 milliards de dollars américains), ce qui démontre la confiance des investisseurs dans cette technologie et ses utilisations étendues au-delà du système financier et bancaire. Les applications de l'intelligence artificielle ont renforcé l'utilisation de cette technologie dans divers domaines (éducation, santé, jeux vidéo, etc.), et son niveau élevé de sécurité favorise l'inclusion financière et fournit des services aux populations défavorisées.
Mots Clés : Technologie Blockchain ; Intelligence Artificielle ; Croissance ; Industrie.

الذكاء الاصطناعي كتوجه عالمي لتطوير تقنية البلوك تشين (Blockchain)

ملخص

تهدف هذه الدراسة لإبراز دور الذكاء الاصطناعي في تعزيز تقنية أو صناعة البلوك تشين (Blockchain) وذلك عبر تحليل اتجاهات ونمو تطبيقات البلوك تشين في العالم سواء المجال المالي أو في مجالات مبتكرة أخرى.

توصلت الدراسة إلى جملة من النتائج أهمها أنه رغم انخفاض الاستمارات في قطاع التكنولوجيا المالية في السنتين الأخيرتين (2022 و 2023)، إلا أنه يوجد نمو فعلي ومتوقع في تقنية البلوك تشين على المستوى العالمي بأرقام عشرية (نمو متوقع في سنة 2024 بأكثر من 162 مليار دولار أمريكي)، وهو يوضح ثقة المستثمرين في هذه التقنية واتساع استخداماتها لتتجاوز النظام المالي والمصرفي، حيث عززت تطبيقات الذكاء الاصطناعي استعمال هذه التقنية في مختلف المجالات (التعليمية، الصحية، ألعاب الفيديو،...إلخ)، كما أن درجة الأمان العالية التي تتمتع بها هذه التقنية يجعلها تدعم الشمول المالي وتوفر خدمات لفئات أخرى مخدومة وغير مخدومة.

الكلمات المفتاحية: تقنية البلوك تشين (Blockchain)؛ ذكاء اصطناعي؛ نمو؛ صناعة.

INTRODUCTION

The field of artificial intelligence (AI) has made remarkable progress and has become a widely discussed term, particularly as it has transformed data analysis into an automated process. This has sparked fears among some about machines taking over human jobs, although reality remains far from such a scenario. The origins of AI date back to the post-World War II era, with the development of computer programs simulating human intelligence in games and solving puzzles. These innovations paved the way for the evolution of traditional systems, which eventually crystallized into modern AI systems.

Many countries are transitioning from traditional economic models to knowledge- and learning-based economies by leveraging modern technologies, including big data and AI. These technologies have brought about fundamental changes in nearly every sector.

Blockchain technology is one of the significant advancements in finance and business, emerging as a key outcome of the Fourth Industrial Revolution. Experts predict that blockchain will profoundly impact all aspects of individual and societal life, driving economic and commercial activity through a global shift toward adopting these technologies and enhancing AI systems, thereby increasing their efficiency and expanding their applications across various domains.

Study Problem:

The problem of this study can be formulated in the following main question: To what extent do artificial intelligence applications contribute to the growth and development of the blockchain industry worldwide**?**

Study Hypotheses:

This study proceeds from the following main hypotheses: There is a strong correlation between artificial intelligence and blockchain technology as significant technological advancements within the Fourth Industrial Revolution, despite differences in their nature and applications.

The study adopts a descriptive-analytical approach, focusing on identifying the characteristics of the phenomenon, describing its nature, and examining the relationship between its variables (AI and blockchain technology). Data was collected, analyzed, and interpreted to draw conclusions. Additionally, the research incorporates the latest academic studies, including scholarly articles, international reports, and specialized websites that highlight the impact of AI on the blockchain industry or technology.

The study aims to introduce blockchain technology by highlighting its components and operational mechanisms, examine the relationship between AI and blockchain technology, and identify the current and future applications of blockchain technology in line with the advancement of AI applications.

The importance of the study stems from two aspects. The first aspect focuses on understanding the elements and characteristics of the study. AI has become a global trend embraced by countries, institutions, and research centers due to its capabilities in automating production processes, controlling costs, and minimizing errors, which are nearly non-existent. Despite the relative novelty and rapid growth of blockchain technology, it is considered revolutionary across all fields, particularly in the financial and banking sectors. Moreover, the interconnectedness between blockchain technology and AI applications adds further significance. The second aspect emphasizes the global utilization of these technologies, aiming to maximize their benefits on an international scale.

1- CONCEPTUAL FRAMEWORK OF ARTIFICIAL INTELLIGENCE

1.1- Concept of Artificial Intelligence

Artificial Intelligence (AI) can be defined as a branch of computer science focused on automating intelligent behavior. As a subset of computer science, AI must be grounded in sound theoretical and applied principles, including data structures for knowledge

representation, algorithms for applying that knowledge, and programming languages and techniques for their execution.

However, the concept of artificial intelligence is not universally defined or fully understood. While we may confidently recognize intelligent behavior when we encounter it, it remains uncertain whether anyone can provide a sufficiently specific definition of intelligence that would help in evaluating a computer program deemed to be intelligent, especially given the rapid advancements and complexities of the human mind (Luger, 2008, p. 04).

Artificial Intelligence (Intelligence Artificielle) consists of two words, each with its own meaning. "Intelligence," according to the Webster dictionary, refers to the ability to perceive, understand, and learn new situations or conditions. In other words, the keys to intelligence are perception, understanding, and learning. The word "artificial" is associated with the act of making or creating. Therefore, the term applies to anything resulting from an activity or action that involves artificially shaping things, distinguishing them from those that exist naturally without human intervention.

Artificial intelligence is a term that typically encompasses a variety of mental capabilities, such as the ability to analyze, plan, solve problems, and simulate mental processes rapidly. It also includes the ability for abstract thinking, gathering and organizing thoughts, language comprehension, and quick learning. While the general concept of intelligence among people includes all of these attributes and is often strongly associated with memory strength, psychology recognizes intelligence as a behavioral characteristic independent of creativity, personality, wisdom, and even memory retention (Simud & Dahmani, 2022, p. 90).

From another perspective, Artificial Intelligence (AI) is conceptualized as programmed systems designed to think and act similarly to human intelligence. It involves the experimental aspect of computer science, which focuses on programming intelligent machines capable of performing various tasks using their cognitive abilities.

Similarly, AI has been viewed as a means to create computers, robots controlled by computers, or software that mimics intelligent thinking similar to the human mind.

Furthermore, Longinus Chukwudi et al. describe Artificial Intelligence as software endowed with the capability to perform tasks that were traditionally the domain of the human brain. These tasks include acquiring and processing knowledge, making judgments, understanding relationships, and generating original ideas.

From another perspective, Artificial Intelligence refers to the ability of a computer system to monitor its experiences, learn from them, and simulate human intelligence in decision-making. It is also recognized as programmed software designed to mimic the behavior and expertise of human experts, storing human knowledge and experience and converting it into commands used to solve accounting problems and perform various accounting tasks.

It is worth noting that Artificial Intelligence aims to create intelligent machines capable of interacting in ways similar to humans. This rapidly changes how financial organizations and functions operate, enhancing operational efficiency with minimal effort (Bin Hamada & Mohammed, 2022, p. 760).

From the above, it can be concluded that Artificial Intelligence is one of the most prominent modern sciences to have emerged from the technological revolution known as the Fourth Industrial Revolution. It introduced smart applications in various fields related to human life, such as autonomous vehicles, medical diagnosis and healthcare, the Internet of Things, and more. These applications aim to find solutions to the various difficulties and challenges individuals may face by simulating the tasks and activities typically performed by human behavior. Recently, Artificial Intelligence has garnered widespread interest from academics, governments, institutions, and individuals alike.

1.2- Applications of Artificial Intelligence

Research conducted by the PWC (as the official project adviser) identified over 80 applications of artificial intelligence. This study will discuss a selection of these applications, categorized as "change factors," for addressing the challenges facing the world, including (PWC, 2018, p. 16):

1.2.1. Autonomous and Connected Electric Vehicles

Autonomous vehicles (AVs) powered by artificial intelligence are expected to transition into a widespread service over the coming years and decades. This shift could result in significant reductions in urban transport greenhouse gas emissions through optimal road usage, improved traffic flow, ecological driving algorithms, and carpooling services in autonomous vehicles. Fleets of electric autonomous vehicles will play a crucial role in achieving tangible environmental benefits.

1.2.2. Distributed Energy Networks

Artificial intelligence can enhance the ability to forecast demand and supply related to renewable energy sources through distributed networks, while also improving energy storage and consumption efficiency. It can support load management, assist in integrating renewable energy sources and improving their reliability, and enable dynamic pricing and trading, thereby creating market incentives.

1.2.3. Smart Agriculture and Food Systems

AI-enhanced agriculture involves automated data collection, decision-making, and corrective measures through robotics, enabling early detection of crop diseases and issues, timely provision of feed to livestock, and overall improvement of agricultural inputs and yields based on supply and demand. This approach leads to increased efficiency in agricultural resource usage by reducing the consumption of water, fertilizers, and pesticides that harm vital ecological systems, while also enhancing adaptability to extreme climate conditions.

In addition to the above, there are other applications of artificial intelligence that we encounter in our daily lives, including (Khalifa, 2017, pp. 63-64):

1.2.4. Robotics

Robotics is one of the prominent forms of artificial intelligence, focusing on the design, construction, and operation of various robot or humanoid applications. It is one of the most advanced AI applications, involving the creation of a physical structure that operates based on human logic, programmed or connected to computers to perform specific tasks. As an intelligent machine, it possesses a degree of freedom to act based on the situations it encounters. In recent years, many companies have intensified their efforts to develop automated systems capable of driving vehicles, including Google, Tesla, and more recently, Apple, among others, with autonomous driving technology gradually replacing human drivers.

1.2.5. Unmanned Aerial Vehicles (Drones)

Drones have proliferated across various fields, including both those controlled remotely by human operators and those capable of making autonomous decisions, such as tracking erratic movements. Examples include drones used for border surveillance, agricultural monitoring, and parcel or food delivery. There are also drones designed for personal photography, such as the "Nixie" camera, which is strapped to the wrist, detached, and flown remotely to capture images or video footage, along with numerous other civilian applications.

1.2.6. 3D Printers

Three-dimensional printers are considered part of artificial intelligence only when they communicate with other machines. For instance, if a printer is programmed to automatically produce a specific product, it does not meet the criteria for artificial intelligence as outlined earlier. However, if it can connect with other machines to

produce a house, construct a building, or perform more complex tasks, it becomes a model of artificial intelligence. Currently, much of the research focus is on four-dimensional printers, which have the ability to produce self-assembling objects.

1.2.7. Internet of Things (IoT)

The Internet of Things is not considered an application of artificial intelligence unless machines communicate with each other (machine-to-machine communication). This means that devices such as electrical tools, furniture, electronic toys, cars, watches, glasses, clothing, shoes, and billions of other objects begin exchanging information and making decisions based on the data exchanged and analyzed. This enables them to connect automatically and instantly without human intervention.

1.2.8. Voice Assistant Programs

These programs receive voice commands from users to perform specific tasks or interact with users via voice technology. Major companies worldwide have developed models of these programs. For example, Apple created the Siri application, Amazon developed Alexa, Microsoft introduced Cortana, Google offers Google Assistant, Facebook developed Jarvis, and Nokia created Viki. Despite the variety of these programs, none can be considered superior to the others. For instance, Google Assistant excels in location searches, Apple's assistant is best for reading emails and conducting internet searches, and Alexa performs well in book purchases and e-commerce.

1.2.9. Search Results Control and News Filtering

Tweets, comments, images, videos, suggested friendships, and the ads you see online are all driven by intelligent algorithms tailored to user preferences. This represents one of the prominent models of artificial intelligence, which begins by analyzing the user, understanding their preferences, and suggesting content accordingly.

For example, if you search for a specific topic on Google or watch a video on YouTube, the platform starts suggesting other related videos. This principle applies to all of your searches.

1.2.10. Machine Learning

There is ongoing scientific debate about whether machines truly "learn," but researchers agree that many applications combine both learning and artificial intelligence. Regardless of this debate, machine learning aims to enhance a machine's ability to learn by improving its data collection, analysis, and the extraction of new relationships without the need for pre-programming by technicians. For example, computers can detect cyberattacks, analyze their type, purpose, and source, and address them automatically. Similarly, self-driving cars can adjust their routes based on road conditions or predict destinations the owner might prefer, among other applications.

1.2.11. Mass Surveillance

Assigning the task of monitoring surveillance camera screens to one or more individuals may not be effective for security, threat monitoring, or identifying sources of danger, especially in public places. However, security algorithms can efficiently handle this task by distinguishing individual movements, anticipating potential threats, and issuing alerts. These algorithms can also recognize faces and identify individuals present at the location.

1.2.12. Automated Customer Query Response Systems

Many companies have developed artificial intelligence systems capable of analyzing customer queries and responding to them effectively, often without the customer realizing they are interacting with an AI system rather than a human customer service representative. These systems are used in live chat support services on company websites, such as those provided by Microsoft, Norton, and IBM.

1.2.13. Purchase Prediction

Many companies have developed artificial intelligence technologies capable of predicting customer needs based on their purchasing behaviors or health conditions. For example, Amazon and Target, two major retailers in the United States, have created intelligent systems that predict customer needs by analyzing extensive purchasing data. These systems then send product recommendations to customers' homes that may align with their future needs. Similarly, Netflix has developed an AI system capable of recommending movies to its customers based on their previous viewing choices.

2- INTRODUCTION TO BLOCKCHAIN INDUSTRY

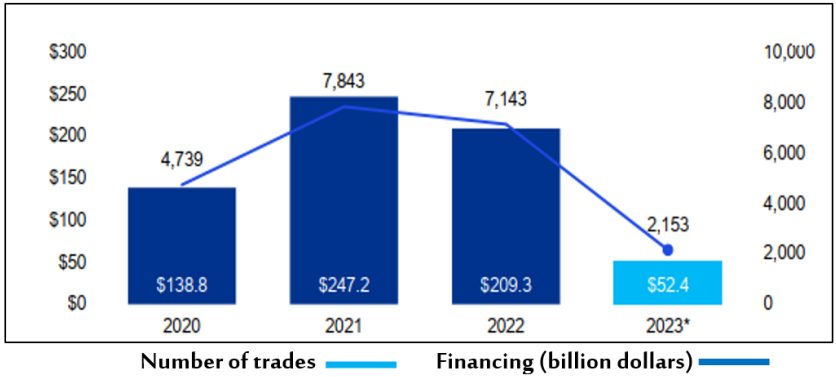
Blockchain technology emerged as a result of the significant digital transformations, also known as the Fourth Industrial Revolution, witnessed globally, leaving a mark across various sectors.

2.1- Evolution of Global Investments in Financial Technology (Fintech)

According to a report by KPMG (2023), global funding in the field of financial technology decreased from $63.2 billion across 2,885 deals in the second half of 2022 to $52.4 billion across 2,153 deals in the first half of 2023. The results for the second quarter of 2023 were particularly weak, with only about $18 billion invested globally—the lowest funding level for the fintech sector since the third quarter of 2017.

Meanwhile, fintech funding in the Americas (North and South America) increased from $28.9 billion across 1,323 deals in the second half of 2022 to $36 billion across 1,011 deals in the first half of 2023, with $34.9 billion from 809 deals in the United States alone. However, funding in other regions of the world decreased significantly. In the Europe, Middle East, and Africa (EMEA) region, fintech funding fell from $27.3 billion across 963 deals in the second half of 2022 to $11.2 billion across 702 deals in the first half of 2023. Similarly, in the Asia-Pacific region, funding dropped from $6.7 billion across 583 deals to $5.1 billion across 432 deals (Caplain, 2023, p. 5).

Figure 1. Total Global Funding Activity (Venture Capital, Private Equity, Mergers and Acquisitions) in the Fintech Sector (2020-2023)



Source: Compiled by researchers based on (Ruddenklau , 2023, p. 08)

Based on figure (01), we observe a rise in global investments (funding operations) in the financial technology sector in 2021, reaching $247.2 billion compared to $138.8 billion in 2020. Additionally, merger and acquisition deals also increased during the same period, rising from 4,739 deals to 7,843 deals. However, in 2022, investments in the technology sector decreased to $209.3 billion, and the number of merger and acquisition deals dropped to 7,143. Experts expect the investment volume in financial technology (Fintech) to decrease further in 2023 to $52.4 billion, with the number of Fintech sector deals limited to 2,153 merger and acquisition transactions.

The entire technology sector is currently facing significant disruptions, which also apply to financial technology (Fintech). According to many experts, this decline is attributed to several factors, particularly the weakness in overall economic indicators, which have a substantial impact on investor decisions. The recent rapid rise in inflation rates and interest rates, along with challenges specific to financial technology—such as the collapse of many cryptocurrency companies and the weak performance of the US banking sector—have made investors more cautious about investing (Caplain, 2023, p. 5). As for blockchain technology, we will examine it in detail in the following

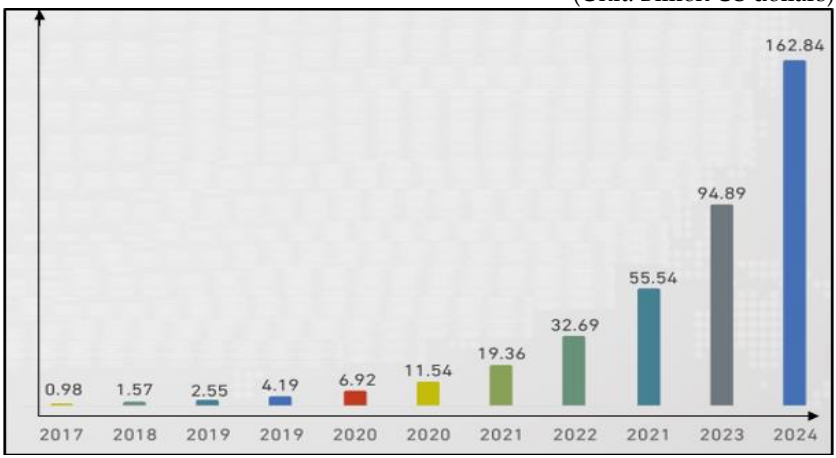
section, discussing its growth rate, future expectations, and the sectors with the largest share in the blockchain industry.

2.2- Global Outlook for Blockchain Market Growth

In 2022, the size of the Blockchain technology market was approximately $9.12 billion. According to a report by Global Arena Holding Inc. (GAHI), the global Blockchain technology market is expected to grow at a compound annual growth rate (CAGR) of 67.4%, reaching over $200 billion by 2028.

Figure 2. Global Outlook for Blockchain Industry Growth for the Period (2017-2024).

(Unit: Billion US dollars)



Source: (statista.com, 2023)

Building upon Figure (02), we observe a continuous growth in the blockchain industry worldwide. In 2017, its estimated value was $980 million, which increased significantly to over $11.54 billion by 2020, marking a more than tenfold increase compared to 2017. By 2021, it reached $55.54 billion, representing a more than fifty-fivefold increase from 2017. Experts anticipate that the growth of the blockchain industry will continue, reaching $94.89 billion in 2023 and $162.84 billion in 2024.

These figures underscore the importance and investor confidence in blockchain technology.

As noted in our previous analysis of investments in financial technology, there has been a decline in certain regions, particularly in the last two years (2022 and 2023), due to various factors discussed earlier. However, blockchain technology remains a modern innovation with vast potential applications. Its versatility allows it to support financial inclusion, as a smartphone and a blockchain application are sufficient to provide financial and other services to billions of both served and underserved individuals. This positions blockchain technology as a promising and expansive industry.

Regarding the sectors that dominate the blockchain industry, the software components and platform sector held the largest market share at 51.6% in 2022, driven by the growing reliance on Internet of Things solutions within blockchain technology. The smart contract applications sector captured the second-largest share at 30.7% in 2022. Additionally, the transportation and logistics services sector accounted for a significant portion of blockchain market revenues, reaching 21.8% in 2022, due to its ability to create transparent and immutable transaction records (Interregional Strategic Analytics, 2023, p. 3).

2.3- Concept of Blockchain Technology

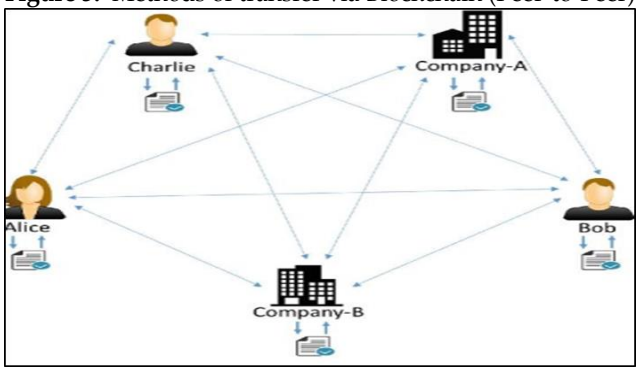
The term "Blockchain" first appeared in a study titled *Bitcoin: A Peer-to-Peer Electronic Cash System*, published in 2008 by an individual or group under the pseudonym "Satoshi Nakamoto." Initially, the term referred to the fundamental structure underlying the electronic cash system (Bitcoin) introduced in the study.

Today, "Blockchain" is used as a general term for all applications and systems based on the Distributed Public Ledger, which enables the creation of secure transactions directly between parties, without the need for an intermediary or controlling entity in the system. Blockchain technology can be defined as an encrypted information system built on a decentralized database distributed across all devices connected to the

network. It records all transaction data and modifications in a way that ensures the agreement of all relevant parties regarding the validity of the data (Al-Subaie, 2019, p. 04).

Blockchain can also be defined as a system for recording value transactions (not just monetary transactions) in a peer-to-peer manner. This eliminates the need for a trusted intermediary, such as banks, brokers, or other guarantee services, to act as a third party.

Figure 3. Methods of transfer via Blockchain (Peer-to-Peer)



Source: (Bikramaditya, Gautam, & Priyansu, 2018)

Blockchain emerged as a decentralized, open-source database, one of the key outcomes and achievements of digital currencies. It enables two or more parties to conduct financial or business transactions without the need for a trusted third party to establish trust. This database is accessible to everyone, allowing them to view its data and verify the information contained within it. Internet users can validate the authenticity of their transactions and record them in their own ledger, grouping transactions over a specified period into a block, followed by a seal to prevent tampering. Each block of transactions is linked to the previous one. In a blockchain banking system, transactions benefit from the involvement of multiple computers connected to a network and validated by numerous individuals. Blockchain also provides digital proof of ownership that is tamper-

proof, along with a complete record of the ownership chain (Hani & Yado, 2021, p. 333).

From this, we can infer that blockchain technology is an open-source digital ledger that facilitates the transfer of ownership from one party to another without requiring an intermediary. This technology ensures a high level of security for various data and transfer operations, thanks to the participation of all individuals in the ledger, provided they are connected to the internet. The process concludes by placing a seal on the block, which prevents forgery and fraud.

2.4- Elements of the Blockchain System

The blockchain consists of four fundamental elements: the block, the data, the hash, and the timestamp. These elements collectively define the blockchain, and their meanings can be clarified as follows (Haraq & Latrach, 2021, p. 216):

- **Block**: This represents the basic unit of the chain and consists of a set of operations or tasks to be performed or executed within the chain. The block contains transaction data and is divided into two parts: the block header and its contents.
- **Data**: This refers to the sub-processes carried out within a single block or the individual commands executed within the block. It represents, along with other commands and information, the block itself.
- **Hash**: The hash is a critical and distinctive feature of the blockchain, sometimes referred to as a digital signature. It is a code generated from an algorithm within the blockchain program and performs four main functions:
    - It distinguishes the chain from others by identifying and marking each block with a unique hash.
    - It links the blocks together within the chain, where each block is connected to the previous and subsequent hashes, ensuring that the hash flows in only one direction from the

originating block onward. Notably, the hash prevents modification of the created blocks.

- **Timestamp**: This indicates the time at which any operation within the chain is carried out.

2.5- Mechanism of Blockchain Operation

To clarify the mechanism of blockchain operation, let's assume the process involves transferring digital currency from person "A" to person "B." This process goes through the following stages (Bin Muhammad & Tubal, 2020, pp. 50-51):

- **Stage One**: Both person "A" and person "B" must have their own digital wallet, which is a specific account on the blockchain platform being used. Person "A" desires to transfer a specific amount of money to person "B."
- **Stage Two**: Person "A" initiates this transaction in their digital wallet, and the details are recorded in a specific ledger as a block.
- **Stage Three**: Person "A" then broadcasts this block to all parties in the network.
- **Stage Four**: Network participants verify the validity of the transaction through mining. A consensus mechanism is applied to authenticate the block.
- **Stage Five**: If the transaction is deemed valid and is approved by consensus, the block representing the transaction is added to the blockchain, making it irreversible and immutable.
- **Stage Six**: The money is effectively transferred from person "A" to person "B."

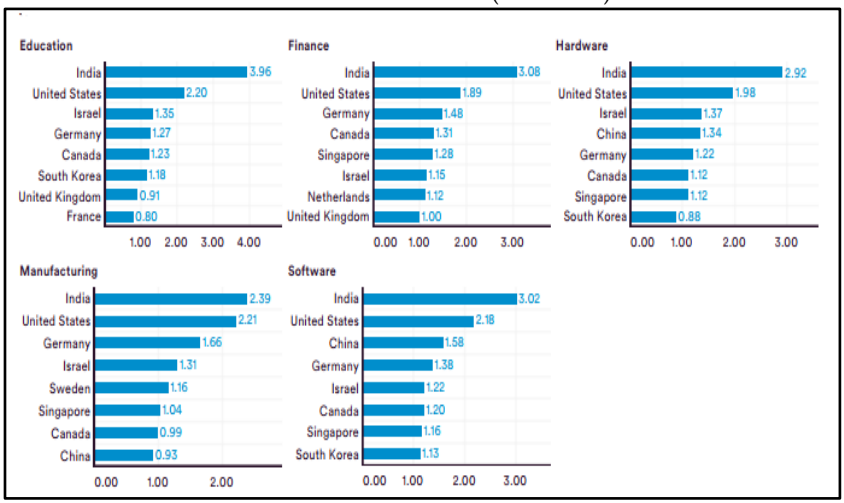
3- TRENDS IN THE GROWTH AND DEVELOPMENT OF BLOCKCHAIN TECHNOLOGY AMIDST THE AI REVOLUTION

There is a growing trend in the expansion of the blockchain industry, which is being driven by significant advancements in the field of artificial intelligence. The key trends can be outlined as follows:

3.1- Increased Applications of Artificial Intelligence in the Global Financial Industry

The global banking services market is expected to reach $140.26 billion by 2030, growing at a compound annual growth rate (CAGR) of 83.9% from 2022 to 2030. This growth is driven by the expansion of the fintech industry, advancements in information technology, increased competition, and changing customer expectations. Retail banks are increasingly adopting digital transformation and advanced technologies to enhance their operations and customer offerings, which is expected to accelerate the integration of blockchain into retail banking services (Interregional Strategic Analytics, 2023, p. 3). Furthermore, the "Artificial Intelligence Index" report highlights a significant increase in the adoption of artificial intelligence applications within the global financial sector, as shown in Figure 4.

Figure 4. Relative Penetration Rate of Artificial Intelligence Skills by Industry in Countries Worldwide (2015-2021)



Source: (Daniel Zhang, 2022, p. 150)

The "Artificial Intelligence Index" report for 2022 highlights the penetration rates of artificial intelligence skills across various industries. However, our analysis will focus exclusively on the financial sector, given its close connection with the blockchain industry. As shown in Figure 4, India leads with an integration rate of 3.08 points in the financial sector, followed by the United States with 1.89 points. Germany and Canada rank third and fourth, with scores ranging from 1.48 to 1.31 points.

3.2- Integration of blockchain technology and the Internet of Things (IoT)

Smart contracts provide a comprehensive and cohesive system capable of interacting with entities in a reliable and auditable manner. They enable the automation of complex, multi-step processes. On the other hand, IoT devices serve as interfaces with the physical world. The integration of both technologies allows for the automation of time-consuming workflows in novel ways, ensuring cryptographic verifiability, along with significant cost and time savings in operations. This synergy could lead to greater integration between IoT and blockchain technology in the future, unlocking new business models across various sectors, boosting profitability, and enhancing customer acceptance (Bin Muhammad & Tubal, 2020, p. 56).

According to a recent report by Grand View Research, the growing adoption of decentralized applications (dApps) in the blockchain industry, particularly in conjunction with the Internet of Things (Blockchain IoT), is expected to propel market growth to $12.68 billion by 2030, with a compound annual growth rate (CAGR) of 58.2% from 2023 to 2030. The combination of blockchain and IoT, often referred to as the new generation of the Internet, offers innovative solutions that significantly enhance security, transparency, and operational efficiency across diverse industries. Moreover, their integration can revolutionize data sharing, transaction trust, and process automation, opening the

door to innovative business models and profitable growth opportunities (Interregional Strategic Analytics, 2023, p. 3).

3.3- Creditworthiness Assessment

Creditworthiness refers to a set of models that guide financial decision-making in the process of granting credit to individuals by lenders. Since the 1950s, the concept and techniques of credit assessment have evolved rapidly, supported by advances in expertise and technology, to meet the growing demand from customers, especially with the emergence of credit cards. Lenders who can identify customers paying higher credit risk premiums than warranted can capture a profitable market share by offering loans at lower rates to these customers. Conversely, they can reduce losses by charging higher premiums or rejecting loan applications. Blockchain technology can provide reliable and timely information and data about both borrowers and lenders, ensuring the protection of all parties involved (Allaq & Duraid, 2022, p. 714).

3.4- Utilizing Blockchain Technology in Administrative Activities of Educational and Training Institutions

In the education sector, several universities and educational institutions in the Gulf countries have leveraged blockchain applications to enhance the processes of issuing, certifying, and verifying academic certificates. In 2019, the University of Bahrain began issuing digital diplomas encrypted using blockchain and machine learning techniques. Similarly, the British University in Dubai started issuing certificates via blockchain in 2018 to streamline the certification and verification process for graduates, educational institutions, and employers. This process allows users to quickly verify information by scanning the certificate's code through a dedicated link (Digital Certificate) available on the university's website, which provides all required details within the blockchain network. Additionally,

institutions such as King Abdullah University of Science and Technology and the Bahrain Institute of Banking and Finance organize and offer introductory projects and specialized training programs focused on blockchain applications (Al-Subaie, 2019, pp. 12-13).

3.5- The Growing Shift Towards Blockchain-based Gaming

The global gaming market is projected to reach $301.53 billion by 2030, with a compound annual growth rate of 68.3% from 2023 to 2030, according to a recent report by Grand View Research. The shift from traditional gaming to blockchain-based gaming is driven by the growing demand for intellectual property ownership, asset control within games, transparency, and new revenue opportunities. Blockchain games have the potential to revolutionize the gaming industry by capitalizing on current sector trends, offering a secure environment for developers to create, launch, and monetize their games. Additionally, these games provide a secure platform for players to buy and sell in-game currencies, which can generate real income, thereby pushing technological innovation to new heights (Interregional Strategic Analytics, 2023, p. 4).

3.6- Developing Digital Platforms for Blockchain Technology

Several platforms manage blockchain technology, allowing companies to choose one based on their specific needs or activities. These platforms primarily facilitate the buying and selling of digital currencies, serving as intermediaries in currency transactions. The acceptance of a currency within these platforms helps ensure its continuity, while any changes made by mining centers require approval from the trading platforms to prevent the rejection or exclusion of the currency from trading. Some of the most important blockchain platforms include Ethereum, Hyperledger Fabric, Quorum, Corda, Rippal, and others. It is important to note that the differences

between various blockchain versions lie in the type of incentives offered (with or without incentives, or with a virtual currency) and access permissions. Access may be open to everyone or restricted to a specific group with defined access rights (Tropea, 2020, pp. 38-39). Furthermore, the use of blockchain technology extends beyond digital currencies and their applications.

CONCLUSION

Our study revealed a strong and close connection between artificial intelligence (AI) and blockchain technology. Both are considered significant technological advancements in the modern era. Despite their differences in nature and applications, there are numerous relationships and interactions between them. Blockchain technology is relatively new, with a wide range of applications, including financial inclusion, the Internet of Things (IoT), education, and the entertainment industry, among others. Accessing blockchain services typically requires a smartphone connected to the internet and a blockchain application installed on the device, enabling billions of people to access a wide array of services.

Furthermore, blockchain is one of the fastest-growing technologies in the financial technology sector. Its growth will be further supported by advancements in the information technology industry, the adoption of digital transformation, and advanced technologies across many countries.

As for the findings and recommendations reached by the study, they are as follows:

Study Findings:

- Global investments in technology during the period (2020–2023) witnessed a significant decline, varying across countries. This was due to weak economic indicators, including high inflation rates and interest rates, the collapse of several cryptocurrency

companies, and the poor performance of the U.S. financial and banking sector.

- The period (2017–2022) experienced substantial growth in blockchain technologies. The study indicated that the global blockchain market size is expected to achieve a compound annual growth rate (CAGR) of 67.4% by 2028.
- Blockchain technology can provide tamper-proof digital proof of ownership along with a comprehensive record of the ownership chain.
- In terms of the sectors holding the largest shares in the blockchain industry (statistics for 2022):
    - The "software and platform components" sector accounted for 51.6%.
    - The "smart contract applications" sector held the second-largest revenue share at 30.7%.
    - The "transportation and logistics" sector accounted for 21.8%.
- According to the "Global AI Index," the integration of AI applications into the global financial industry has significantly increased, with India and the United States leading in incorporating AI skills into the financial sector.
- The growing reliance on decentralized applications (dApps) in blockchain technology associated with the Internet of Things (Blockchain IoT) is driving market growth, enabling innovative business models and creating lucrative growth opportunities.
- In education, many universities and educational institutions have leveraged blockchain applications to enhance the issuance, verification, and auditing of academic certificates by digitally issuing and encrypting diplomas using blockchain technology.
- Blockchain technology plays a role in developing the modern electronic gaming industry by providing a secure environment for game developers to design, launch, and monetize games

safely. It also offers a secure space for players to buy and sell in-game currencies.

- Numerous digital platforms (e.g., Ethereum, Hyperledger, etc.) are engaged in developing and managing blockchain technology. Users can choose platforms that align with their needs or activities, with these platforms also facilitating the buying and selling of digital currencies.

Study Recommendations:

Among the recommendations of the study are the following:

- Algerian authorities should keep pace with recent developments in the field of artificial intelligence, particularly in software, to open broader horizons for the development of the financial sector and blockchain technology in Algeria.
- Algerian authorities should focus on establishing blockchain platforms as a first phase, followed by providing initial services for certain sectors on these platforms, such as issuing, verifying, and auditing certificates and documents as a second phase.
- Algerian universities should organize awareness projects and specialized training programs on blockchain technologies and applications.
- Efforts should be made to enhance the efficiency of human resources in the digital domain and all aspects related to new technologies by incorporating educational and training programs into curricula that are relevant to the technological field.
- Accelerate the establishment of a legal, regulatory, and legislative framework that aligns with developments in blockchain technology and the broader Fourth Industrial Revolution.

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