On the Role of Blockchain in Evolving the Online Business Landscape

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***Abstract*—This contribution explores the business ecosystems that blockchain technology has enabled, both businesses linked to cryptocurrencies and ones that use blockchain as a distributed immutable database, though not crypto related. Moreover, a marketplace, democratizing access to General AI, is proposed.**

***Index Terms*—distributed ledger, blockchain, bitcoin, cryptocurrency, token economy, business model.**

I. Introduction

The first business application of blockchain was bitcoin [1]. When 2009 saw the business world at the beginning of the Second Great Recession, an anonymous programmer (or group of programmers) wrote a White Paper describing a new digital currency ecosystem. It contained an algorithm that governed inflation through supply limitation, while the ecosystem was completely decentralized, as no central bank, or government, was needed. However, the technologies behind bitcoin – peer to peer distributed systems, immutable distributed databases (today called distributed ledgers), consensus and cryptographic algorithms [2] existed already for at least one decade, well researched by computer scientists, and applied in practice.

Since then, blockchain has spawned a new technology, business and finance paradigm, with over 8000 cryptocurrencies. Moreover, administrations use blockchain for voting, real estate and identity records, and security-sensitive applications.

Year 2021 sees potential of a new economic downturn. As Winston Churchill said after World War II, "never let a good crisis go to waste", this paper provides an overview of the business models that can boom in the current economic climate, and the technology behind them. This is followed by an attempt aiming at bringing Artificial Intelligence (AI) into a blockchain marketplace, uniting multiple business models, in a power-distribution winner-takes-all approach.

II. Related Works

Results found here are based on a comprehensive bibliographic research of the following databases: Science Direct Elsevier, Springerlink, ACM Digital Library, Wiley Online Library, IEEE Explore, World Scientific, and Arxiv; seeking publications discussing blockchain in relation to business and modeling. The search query retrieved documents (title, abstract or main text – if available), based on keywords "blockchain", "business" and "model", not necessarily in this order.

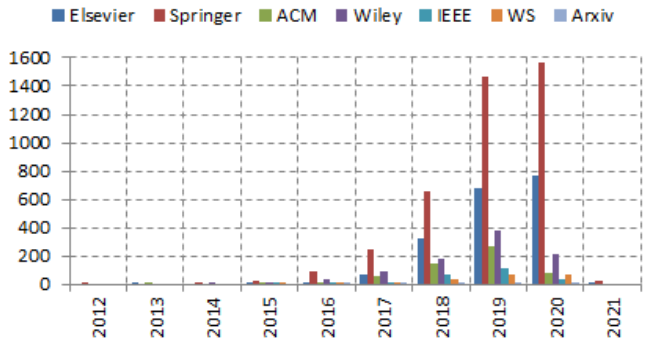

Fig. 1. Number of references in each scientific database for the period 2012 – 2021.

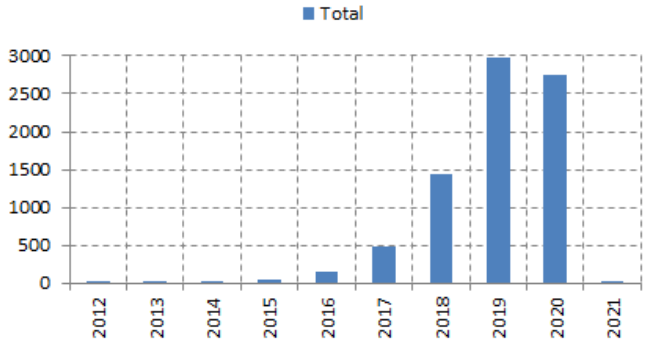

Fig. 2. Total number of references for the period 2012 – 2021.

Figure 1 displays the number of references per year for each database, while Figure 2 displays the dynamics of the total number of references per year. Overall, a total number of 7901 references have been found, and all of them were spread in the interval 2012–2021 (as many publishers practice online article publication in advance to its actual inclusion in a specific journal issue; the values were recorded on the 6th of July 2020, so number of 2020 and 2021 references was expected to grow significantly). Most importantly, we noticed that more than 90% of contributions were published during the last three years. This clearly shows the huge interest that was triggered by research on blockchain business models.

Providing an exhaustive survey of blockchain business models requires a lot more space. Hence, from each database, we selected publications that are most relevant for our purpose. Note that a comprehensive overview of blockchain based decentralized applications, with a technological and development focus, is presented in [3]. The algorithmic foundations of blockchain technology are in-depth covered in [4].

An introduction to blockchain technology, aimed at "business executives/managers", can be found in [5]. This work is based on an existing business model framework. It discusses the impact of different blockchain-related technologies, illustrated by examples from the real world applications.

In contrast, a bottom-up approach for exploring blockchain business models, based on 99 actual blockchain ventures, was proposed in [6]. Here, the main outcome is a taxonomy with 22 dimensions, and discovery of five archetypal business models: monetary value transfer, business integration, multi-sided platform, security, and offering.

Investigation into how blockchain can foster financially and socially sustainable business models can be found in [7]. Presented conclusions were based on real-world cases.

The concept, model, and applications of Decentralized Autonomous Organizations (DAO) were summarized in [8]. Here, authors propose as the main characteristics of DAO: distributed and decentralized, autonomous and automated, as well as organized and ordered. Next, they introduce a reference architecture of a DAO, comprising five layers: basic technology, governance operation, incentive mechanism, organization form, and manifestation.

A comprehensive review of blockchain technologies, including both research and non-research (i.e. promoted by practitioners) contributions can be found in [9]. In this work, a precise definition of blockchain technologies, as well as a proposal of a blockchain architectural framework, following the traditional 4 + 1 model view comprising: logical view, development view, process view and physical view, was presented, and supplemented with pertinent use cases.

Finally, an overview of key aspects and challenges of blockchain, focused on performance, is provided in [10]. This work suggests how to comprehensively evaluate blockchain applications using a proposed set of performance metrics.

III. Blockchain-Powered Business Models

Let us now present our view of blockchain-powered business models. This summary is also based on knowledge extracted from real-world reports and applications.

Entrepreneurship is probably as old as mankind, from the first man that convinced others to go hunting together, to the disruptors of the third millennium. However, let us consider Armand Peugeot, who founded the first limited liability company in 1810. In the US, the first state allowing LLCs was Wyoming in 1977 (167 years later). It took another 19 years for all 50 states to recognize LLC statutes. In Romania, the LLCs governing law was signed in 1990, as the 31st law to be signed after the communism-toppling revolution.

In comparison, in May 2016, the first DAO was proposed on the Ethereum Blockchain (which was 9 months old, with genesis block mined on July 20th, 2015; [8], [11]). This speed-to-market proves that decentralization through blockchain can be a great accelerator of innovation and a democratization force. The DAO was the biggest crowdfunding campaign at that time, with the total assets of 11.5 million ETH (equivalent of over 2.4 billion EUR, in 2020), with 0 employees, due to 100% automation, and over 18.000 stakeholders.

A. Cryptocurrencies

The first business model involving blockchain was bitcoin [1], [2]. Initially, the algorithm rewarded allocated computing power with 50 BTC every 10 minutes (average period over 2016 blocks). The first mined bitcoins had no commercial value. The first transaction is known as the "bitcoin pizzas" when a bitcoin owner offered 10000 BTC for 30$ worth of pizza. Starting at the exchange rate of 0.003$/BTC, bitcoin is trading at $\sim$ 50000$/BTC (March 2021).

Cryptocurrencies are mined (issued) via dedicated algorithms and their total supply is controlled by their algorithms. Most chains have coins issued every N minutes, depending on current settings, agreed by the community mining that currency. An exception is Ripple (XRP), which burns a small amount of the total supply at each transaction.

B. Tokens and token economy

According to [12], tokens represent units of value and provide a way of building company's own ecosystem. They are assets in a "token economy" governed by "standard economic mechanisms".According to [13], tokens are classified into utility tokens and security tokens.

The main difference between coins and tokens is that coins are rewarded for mining blockchains, while tokens are issued programmatically. They are often based on "smart contracts". By writing code in languages like Solidity, on blockchains like Ethereum, "private tokens" can be launched without need for a dedicated blockchain (and associated electricity consumption). There exist common standards for launching tokens, like ERC20 and ERC721, used by multitude of tokens traded today.

C. Initial Coin Offerings – ICO

ICO is a new funding method, representing a popular crowdfunding mechanism for digital start-ups [14]. ICOs went rampant in 2017/18 and tens of millions of euros were raised in crowdfunding campaigns. After publishing a white paper (more like a "to do plan", with a proposed timeline) smart contracts are posted on the Ethereum blockchain, and the project is advertised. Interested parties send Ether (ETH) and receive tokens, proportional to the invested amount. They would hold these tokens, often for several months, and when the project is listed for trading on an exchange, they can sell them. The expectation is to sell with profit, as during the ICO the tokens are often discounted at 10–50%. These expectations were often not met, as many tokens were never listed, while others were sold at a loss. Sometimes ICOs have been compared to the "tulip mania" craze.

D. Utility tokens

These are the easiest to deploy blockchain assets, most often used to pay for services of emitting companies. They allow easy payment integration into the backend [13]. Such payments are often cross-border, and may include collectible assets, like the game crypto kitties. Here, users bought digital cats with ETH, to breed them into very rare combinations, as the resulting kitties were high priced. At the peak moment, the entire Ethereum network was slowed, because of the number of on-chain game-based smart contract transactions.

E. Tokenized securities

Essentially, security tokens are like investment contracts that represent legal ownership of a certain asset [13]. Companies may issue "share-tokens", regulating company ownership and dividend distribution. Blockchain allowed transfer of shares from paper documents into digitally-exchangeable assets. Moreover, owners can use tokenized shares to vote without need for physical presence during shareholder meetings. Finally, blockchain allows fractional ownership of the company and easy distribution of dividends.

F. Online exchanges, centralized vs. decentralized

Centralized exchanges allow exchange of currencies, while holding custody of users' funds. They pay taxes on earnings (e.g. fees applied as sub-unitary percentages on operations). All fiat money on and off-ramps are centralized, as there is no fiat blockchain (yet) for any government-backed currency. Decentralized exchanges operate as smart-contracts, allowing exchange user-to-user, instead of using the custody/escrow of a centralized entity [12]. These businesses make money (directly in crypto [15]) from exchange fees applied to each trade. One of key drawbacks is that blockchains don't (yet) "communicate", allowing exchanges only with a single blockchain. This is likely to change in the very near future, with projects like Swingby and WBTC [16].

G. Cryptocurrency ATMs

Cryptocurrencies can serve those without bank accounts, credit cards, loans, etc. Crypto ATMs can exchange cash to crypto [17]. Since crypto can be transferred globally, these ATMs can be used as remittance endpoints. Operators can make money by charging fees transactions. Note that such fees can be dynamic, influenced by availability of cash. If a machine is running out of cash, operators can lower the fee for crypto-buy operations. This makes that machine more attractive to clients. Internet sites can offer real-time information about rates, fees, and cash availability, combined with geo-spatial information. Here, recall that cash management is expensive, due to the need of "moving cash around".

H. POS solutions

Creating a network of ATMs is expensive, and reduce profits. Hence, some companies developed software for computers/tablets, at Point of Sale locations, to allow buying/selling crypto assets [18]. This is especially useful for exchange outlets outside of major currencies (e.g. non-euro counties), where their number of is high. For example, Romania has over 960 registered exchange companies (with NACE code 6612) at 19.41 million population (1 company for 20218 persons). Considering that many of these companies have multiple branches, the actual ratio is much higher.

I. Investment brokers specialized in crypto assets

People with residual income like their money to "work" and select cryptocurrencies. Since they are extremely volatile in both short and long terms (+/- 20% per day, +/-1000% per year), many choose not to invest themselves. Specialized companies, with experienced traders, buy and sell in bulk, manage clients funds, taking a share of profits at the end of the contract [15]. They also build commercial relations with online exchanges, as they operate with crypto assets only from the contract start to the end, while the population earns their salaries, dividends, and inheritances in fiat.

J. On-chain services

Blockchains may become business ecosystems, including services paid on-chain. For example, the Domain Name Service (DNS) services, offered by many companies for regular Internet use, are replicated on the Ethereum blockchain as the Ethereum Name Service [19]. This allows users to personalize addresses (which are 42 hex characters long) into easy to remember names. Most of "big business" has done this for their addresses, especially the exchanges and mining pools.

K. Mining pools

The mining rewards are awarded to the entity that first gets correct block hash. As the network complexity grew, users started to group into mining pools, adding their processing power as a single address on blockchain, to outpace the competition and get more correct hashes faster [20]. Here, rewards are distributed proportionally to the power shared, and time involved. Such pools require "lead servers" to have good Internet connections, to run all simultaneous connections and perform software updates. The financial model consists of a 1-3% fee on the total mining reward, kept in the crypto coin.

L. Mining equipment manufacturing & hosting

While most mining is done with CPUs and GPUs, many miners migrated to ASICs, searching for better returns per Watt of electricity. After online exchanges, manufacturing crypto mining equipment is probably the most profitable business model described here. In 2017-18, buyers had to wait for 2-6 months for equipment, as supply could not keep up with demand. As a result, prices climbed very fast. Hence, some GPU manufacturers sold cards with no ports, designed specifically for crypto mining [21].

At over 1KW per machine, home mining is no viable in the Summer, when air conditioning takes up a lot of residential electricity. Also, prices per KW, at 110-240V residential outlets, are much higher than industrial 2-70KV sources. Companies have built data centers, close to solar / hydro /

wind stations, to minimize cost of energy in their data centers. Here, power, surveillance, Internet connection, are all bundled in monthly invoices for hosting the mining hardware [22].

Other companies rent mining hardware. Here, 1-2 year contracts are the norm. They provide users with a share of the mining rewards, proportional to the invested amounts, minus the monthly maintenance fees (power + staff) [23].

Finally, while many flavors of Linux are free, developers have bundled them with specialized mining software, optimized package; creating subscription-based operating systems that allow users to manage cloud based-equipment from a web interface. Users can update software, choose coins to mine, designate addresses for rewards, or restart machines, from a centralized dashboard, with prices around 2$/month [24].

M. Blockchain as a service

Running a dedicated node, for any cryptocurrency, can quickly become a job on its own. Blockchain sizes have reached TBs. They may involve software updates that have to be done quickly, while "hard-forks" are very stressful for DevOps engineers. Hence, subscription-based solutions materialized. Here, clients get API access to nodes [25].

Non-crypto blockchains can be rented, using Blockchain-as-a-service (BaaS) solution, from big providers like Microsoft Azure [26]. These are designed to allow developers to add blockchain features to the enterprise solutions, without having to set up and maintain dedicated hardware and software.

N. 3rd party explorers & wallets

Blockchains are open-source and decentralized. However, requiring end-users to have programming skills would restrict their market. Services, like blockchain explorers, allow anyone to easily navigate the blockchains; i.e. lists of blocks, transactions, and addresses, without specific programming knowledge [27]. Most of these services are funded by advertising.

Finally, wallets allow users to hold funds and move them between addresses. Initially, users had to own a "full node" for an operational wallet. Today, there are wallet apps for any device, from desktop computers, smartphones, smartwatches, to API-based solutions for browser-cloud options [28].

IV. Proposed Blockchain-Powered AI Marketplace

At the dawn of the XXI-st century, everyone is looking towards the next evolutionary step in human societal development, Artificial Intelligence (AI; [29]). While the Artificial General Intelligence (AGI) is not likely to materialize in short term, one can anticipate both opportunities and threats by looking at technology built today [30].

Throughout history, many times multiple solutions to the same problem were developed almost simultaneously (e.g. the electric light bulb). This is known as the "adjacent-possible principle" when the prerequisite technologies already exist, enabling their combination to move ahead. Today, companies develop bricks for the foundation of the first AGI solution(s). Many of life's chores have been automated (or commoditized) bringing about very different life to that at the beginning of the XX-th century:

- The car facilitates relatively safe travel.
- Washing machines save hours from the weekly chores.
- Computers allow working remotely.
- The Internet gives access to huge volumes of information.
- The Internet also offers businesses ways to automate many tasks (i.e. payments and invoicing for e-commerce sites) that scales instantly to any size, 24/7.

One way to ensure that the development of AGI brings a positive impact on the lives of human beings is to make the system affordable and with little-to-none barriers of entry. Based on the material presented thus far, we believe that a blockchain-based solution may facilitate reaching these goals. Hence, in what follows, we describe a conceptual blockchain-anchored system, which can provide a technological backbone for a positive-impact AGI. The proposed system works as knowledge-as-a-service (KaaS). In essence, it is storing the world's knowledge of facts and how-tos, with the option to use end-effectors to interact with the real world. Material presented here follows [31], which may be consulted for additional details (technical, in particular).

A. Functions needed for the development in the ecosystem

Let us start from listing "functions" that should find its way to the proposed ecosystem. This list is, obviously, open ended, as additional functions may find its way here.

- Interactive oracle – which will answer questions in natural language, based on knowledge (currently) accumulated within the blockchain; it will also consider knowledge limitations, like "provide answers using both current knowledge, and knowledge from 2 weeks ago".
- Translation, including text-to-speech and speech-to-text.
- Automated document analysis, including digital documents and those in the physical format.
- Conversation agent/partner – initially related to healthcare, over time extended to other areas. The idea is to facilitate conversations that can fill the need to communicate with someone (empathy).
- Provider of computational infrastructure – autonomously run processing and/or memory-intensive analytics/jobs "in-the-cloud".
- Co-processing for apps – billable as a service.
- Remote rendering, for video, 3D video, AR/VR/MR.
- Medical analytics & image/video processing for diagnostics & treatment plans.
- File sharing solutions, data anonymization and sharing (Data as a Service); integrating knowledge gained from this data into the KaaS blockchain, ensuring revenue for data providers and analysers; e.g. with medical imagery.
- Employee as a Service – delivery of robotic process automation (RPA) services; enabling people to find more meaningful employment, move up the income pyramid, have more fulfilling lives.
- AR/VR/MR solutions, i.e. tourism content for video glasses, avatar conversation partner, VR classrooms, etc.

- RoboticsOS – enabling vision, speech, touch, and other sensory inputs and actuation outputs.

These functions can feed for each other; e.g. an oracle can be asked and answer via voice, and in different languages.

B. Use case examples

Let us now provide some use case examples of the envisioned ecosystem. User A needs to get information from text, picture, video, hologram, etc. Using a notebook or smartphone, with system access, she formulates the need (in natural language). The system analyzes what skills it needs, and evaluates the costs of:

- Buying skills (not already owned), from the blockchain.
- Renting the necessary processing power.

Note that if resources need to be purchased, user is informed about the amount she has to deliver (in cryptocurrency).

The skills work under the following rules:

- New "endpoint" has a limited, usable out-of-the-box, set of skills.
- To gain new skills, they have to be trained using local/rented hardware or bought from the blockchain.
- When a training is completed, the user may decide to add the resulting skill into the blockchain.
- Adding a new skill will (most likely) not be free, a popular skill can be later bought by other users and deliver profit in the medium-to-long term.
- When a user buys a skill, its creator is remunerated for delivering a useful service to the ecosystem.
- Blockchain assures that users cannot resell/copy bought skills without the approval from/payment to its creator.

Note that when user upgrades a skill, its creator and upgrader should earn money from that moment forward; the proportion is to be calculated based on the new training process's impact on that skill.

Here, consider such process concerning a humanoid robot, taking care of patients in a retirement home. As soon as a new skill is available anywhere in the ecosystem, and added to the knowledge blockchain, all robots can be upgraded with it, to improve the care they can provide to their patients. Here, a "2-blockchain" architecture can support such scenario:

- The default, global blockchain, with all skills (will charge "general fees").
- A micro-blockchain (terminals/endpoints), will have skills installed in it (no extra fees charged). If equipped with sufficient processing power, it may work mostly offline, only occasionally connecting to the Internet, e.g. to get new/updated skills. This allows use of occasionally-connected terminals, if needed.

C. Technical considerations

Both PoW and PoS have been considered in this context [4]. Both have merits concerning security and have been proven to secure and power blockchain applications. The projected solution is to be a hybrid, where to enter the ecosystem one must join with PoS delegation, while the PoW will empower the owners of processing units (i.e. GPUs/ASICs) to join and offer their hardware as rentable assets. The profits from offering processing power may be high at the beginning. However, profits from delivering a much sought-after skill will likely increase.

To ensure availability of processing power, to assure that users do not wait too long for their tasks to complete (i.e. 3D video rendering at 4K or 8K), users willing to pay more may get priority processing, thus making it more profitable for the miners to run their machines on this network compared to others. This should attract more "miners" to this ecosystem, thus bringing in enough processing power to cover the demand. Hence, regardless of how high the demand is, it should be sufficiently covered by available hardware, so that tasks complete in a reasonable amount of time. However, this needs to be balanced against possible scenario of "resource starvation" where the "poor" users will never complete their jobs, as the ecosystem power will be monopolized by these willing to posy premium for their work completed "faster".

D. General considerations

Some knowledge is universally accepted, like fundamental results of mathematics (e.g. theorems of logic), while other is built on (more or less explicit) assumptions, like the concept that there is only one universe (not a multiverse). The general blockchain will allow users to add both types of knowledge. As soon as at least "facts" collide (for any reason), they should be tagged as alternative branches. For example, consider query "describe a significant world event from November 7th, 1917", the system should ask, which calendar one means, Julian or Gregorian. This is required to avoid a problem in the current human knowledge accumulation method. Problem known as Cognitive Dissonance. Here, the weight of every branch can be computed based on the number of skills (optionally multiplied with usage counters) that are built on top of it, vs. the number of skills including its alternatives. Future versions can take into account the number of sales/inquiries every skill has, and even the number of uses of every skill across a time interval. The formal reasoning mechanism can be based, for instance, on Non-Axiomatic Logic for AGI [32] or Consensus Computing [33] to deal with inconsistent and incomplete knowledge, as well as with knowledge evolution.

Overall, blockchain can provide more usefulness to humanity than just a new way to store value, or a distributed solution for computing power renting. A Generic AI is to be developed on top of this knowledge blockchain. A special feature will be to have the spin-off units bidirectionally share knowledge with the main blockchain, in an ephemerally-connected structure. The primary goal is to deliver skills on demand, with as little as possible new training time. Thus anyone using the network will see their productivity increased and their schedule cleaned up of mundane tasks.

An instantly-scaling solution is also offered by the proposed system. In today's economy, should a company need 50 employees for a task, they would have to put through training at least 50 people. Usually it is more than 50 as some either fail

training KPIs or simply leave. Using employee-as-a-service, the company buys the prerequisite skills, trains only the top-most new skills needed, and launches 50 instances. Should the task be parallelizable, the company can initiate not just 50, but 5000 instances, thus reducing the ratio between execution time and training time.

However, the end goal of the proposed ecosystem is to develop the infrastructure (both software and hardware) where each person can have a personal AGI assistant, tailored to their activities, with private knowledge saved privately, yet with inter-operable skill sets that can be replicated from one AI to another (e.g. using transfer learning).

V. Concluding remarks

The speed of societal change has consistently increased across the last 15000 years. Today we live in the fastest changing world, yet. This is, in many ways, thanks to wider adoption of computing automation. In many ways schools have yet to adapt to reflect the new requirements of today's and tomorrow's societies. The workforce is currently forced to upgrade because of intermittent quarantine conditions, restricted travel, work-from-home and study-from-home requirements.

Blockchain technology could well be the one innovation in the last 500 years to have the largest impact on today's society. And AGI is already considered to be the last invention human kind will ever need to do by itself. We owe it to future generations to get AGI right, and blockchain is today the best candidate database technology to fuel AGI safely.

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