Blockchain Technology-Based Solutions to Fight Misinformation: A Survey

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Abstract Blockchain has been around since 2009, but it isn't till the last few years that organizations have been looking into using blockchain for other applications than cryptocurrency. One of these areas is using blockchain for addressing the problem of misinformation. These emerging solutions that are being used to fight and prevent misinformation range from validating news articles, images, videos, and even entire social media platforms. Each blockchain technology-based solution has pros and cons and adopt different approaches on how they aim to prevent and fight misinformation in social media.

Keywords Blockchain · Misinformation · Fake news · Social media · Survey

1 Introduction

Mostly when one thinks of Blockchain, the first thing that may come to their mind is cryptocurrency. Today blockchain is used for more than cryptocurrency. Organizations are learning and researching about how they can use this emerging technology to solve their use cases and for building their platforms on. Blockchain is being used to solve food traceability, voting, verifying resumes, supply chains, and many other areas. One area that is emerging is using blockchain to fight and prevent misinformation. Misinformation is a growing problem on social media. Misinformation can be in the form of text, news articles, images and videos. This is a big problem when you think that factor in that about two-thirds of American adults (68%) say they at least occasionally get news on social media. About four-in-ten Americans (43%) get news on Facebook. The next most commonly used site for news is YouTube, with 21% getting news there, followed by Twitter at 12%. Smaller portions of Americans (8% or fewer) get news from other social networks

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like Instagram, LinkedIn or Snapchat [1]. To be able to solve these problems, many organizations are researching and developing blockchain solutions to help fight and prevent misinformation, and this number increases daily as new platforms are being developed. These platforms range from verifying news articles, social media content, images, and videos. Using blockchain technology to fight misinformation is emerging and the solutions that are currently available are still in research, prototype, and beta testing stages.

In this paper, we look into blockchain technology Sect. 2, to get a brief overview of what is blockchain Sect. 2.1, how it works and how organizations are using this technology for other applications besides cryptocurrency. Section 2.2 explains why use it for misinformation to verify content, images, videos, and social media. Section 3 discusses what platforms are out there and the pros and cons of each that mention they are using blockchain to fight and prevent misinformation. Section 4 discusses other blockchain platforms that are on blockchain but are not stating they are using blockchain to fight and prevent misinformation. Section 5 explains opportunities that are available for developers to be involved. Section 6 discusses ethical and policy concerns of blockchain and laws and regulations. Section 7 provides challenges of using blockchain for misinformation. Last, Sect. 8 provides suggestions that should be used to make blockchain a successful solution to fight and prevent misinformation.

2 Blockchain

2.1 What Is Blockchain

Blockchain is a collection of blocks of data. These blocks of data contain the information that a user wants to be stored on the blockchain and the hash of the previous block (Fig. 1). These blocks are spread across different computers that are linked in a peer-to-peer network. With the data being spread across nodes in the peer-to-peer network, this makes it hard to be able to hack. The data that is on the chain is verified by checking all the transactions in the chain. What was originally created for Bitcoin is now used for many other use cases, including misinformation. Advantages that blockchain has over a database is that it provides a proof of ownership and data can't be deleted from the chain, creating a transparent, traceability, and immutable record.

For the organizations that are researching and creating solutions, blockchain is a way for them to make the content transparent, traceable, and immutable. For example, if we want to verify an article, there are two ways this can be added to the blockchain. One is that all the content is uploaded to the chain or you can upload the file information to the chain. Depending on the use case, will depend on which option would be used. If a user decides to upload all of the content to be stored on the chain, this option would take up more storage, where the second option is just
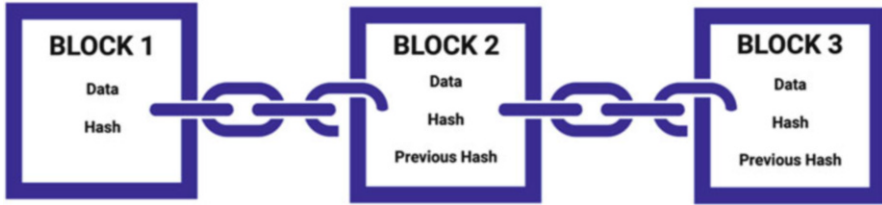
Fig. 1 Concept of Blockchain

the file information, this option would take up less storage. If a user shares the file information with another user, they would be able to verify that file is the original file on the blockchain. Using either one of these options would be able to provide proof that the file is the original and the author is the original author. Where how it is now, authors can't verify their content is there original work.

Blockchain is being used in different industries from agriculture, supply chains, and absentee voting. In agriculture Wal-Mart has partnered with IBM Food Trust for food traceability. The first produce that Wal-Mart has mandated is leafy greens. All leafy green suppliers had until September 2019 to be on Wal-Marts blockchain. Where it once took a little over 6 days to trace a mango, they are able now to trace where leafy greens came from in less than 3 s. J.B. Hunt, Tyson, and Wal-Mart are looking to use blockchain for their supply chains. Currently, when shipping from the supplier to the customer, the bill of lading is a paper form. By using blockchain, they would be able to make everything digital and be able to verify shipments. If a shipment is a refrigerated shipment, they can track this with sensors and if there is an issue it would terminate the smart contract and store this information on the blockchain along with the data from the shipping forms. This could prevent disputes that the industry currently has on shipments. In the last year, West Virginia and Utah tested a small pilot with the company Voatz (https://voatz.com) for absentee ballots. This is making it possible for voters to vote from a mobile device and make it immutable using blockchain.

2.2 Why Use It for Misinformation

Misinformation is a growing problem in news and social media outlets and is also easily spread by sharing altered content, photos, and videos. Misinformation has affected society from political campaigns, vaccinations, pesticides and GMOs in Agriculture, and many other areas. Users can set-up fake accounts and spread fake news for their agenda. One example that had everyone's attention about fake news was the presidential election in 2016. According to Truepic [2] photos and videos are acceptable to being editing to add, remove, or modify objects, changing the location information embedded in the photo or video, to make it appear as if were captured somewhere else, metadata manipulation, and using artificial intelligence to

Blockchain Solutions Developed to Help Fight Fake

Fig. 2 Blockchain Solutions that are being developed to help fight fake news

fabricate, including deepfakes. Platforms such as Facebook, Twitter, and YouTube are using algorithms, machine learning, and artificial intelligence, to find fake news and take it down from their platforms. Unfortunately, this is not enough, these solutions are not detecting all the fake news that is circulating, and content that has already done damage before it is detected. Currently, there is not a way to verify content by users, images, and videos. A user can go on the internet read an article that may not be the original article and have no idea that what they are reading isn't the truth. Images and videos are also being altered and users are swayed by what they see. By developing a blockchain solution (distribute ledger technology), companies are trying to prevent fake news by verifying content and images as they are created. This would allow users to know who the original author is and to see if what they are viewing has been altered. Figure 2 provides an illustration of the evolution of blockchain based solutions in this space. Next section provides details about each of these technologies and a comparative analysis.

3 What Platforms Are Out There and the Pros and Cons of Each

In the last 4 years platforms have been emerging to use blockchain to fight fake news. Each platform is modeled different on what they offer (Fig. 3). Out of all the platforms researched, currently only one verifies users, two offer plug-ins, and one offers an API to use for developers building applications.

Blockchain Platforms

	Content	Plug-Ins	APIs	Verifies Users
Truepic	Photos	×	×	×
Hardah One	Social Network	×	×	×
po.et	Articles	✓	✓	✓
D.tube	Video	×	×	×
Unbiased	Social-Network Search Engine	×	×	×
Trive	Browser Plug-In	✓	×	×
Publish	News Content	×	×	×
The News Provenance Project	Research Phase	Research Phase	Research Phase	Research Phase
Voice	Social-Network	×	×	✓

Fig. 3 Blockchain Solutions that are being developed to help fight fake news

3.1 Truepic

Truepic [2] is a photo and video verification platform that has sponsored with Jewelers Mutual Insurance Company, Qualcomm, Ask Me Anything, US Department of State, UNCDF, and Credibly. This platform was founded in 2015 and is growing platform with three different products and has an iOS and Android App. Their platform is based on the mission that they want to fight against disinformation by restoring trust in visual media, they claim to do their part in defending democracy again manipulation through visual deception. Besides blockchain, their platform uses computer vision, and AI for photo verification. Truepic uses a foundational technology called Controlled Capture. This technology verifies the origin, pixel contents, and metadata, as soon as the user hits the capture button. Every photo that is taken with this technology is passed through an unbroken chain of custody; from the time the capture button is pressed to the time the image is shared with the recipient. Every link in the chain of custody is logged and can be verified at any point later. Each photo and video has an unique cryptographic signature and is written to the blockchain, creating an immutable record in the distributed public

ledger [2]. Truepic App is available for iOS and Android devices. This application allows anyone user to capture and share photos and videos that have verifiable origin, pixel contents, and metadata. From the moment a user presses the capture button, Truepic's Controlled Capture pipeline receives the data directly from the image sensor, along with data from other onboard sensors such as GPS, It computes a cryptographic signature – like a digital fingerprint – for the image, and encrypts all this information for transmission to the Truepic's servers. A unique identifier is created for the image. This initiates the image's "chain of custody". The original image, along with its metadata, cryptographic signature, and the results of the verification tests are stored in the Truepic vault in perpetuity. A verification page is created for the image, allowing recipients to view the original image and the results of the verification tests. An immutable record, containing the image's cryptographic signature, is written to a public distributed ledger that is neither controlled by Truepic nor hosted on Truepic's servers. This closes the chain of custody [2]. Out of the all the platforms that are currently available, this platform is the furthest along in development and usage.

Pros of Truepic: When a user captures a photo, the metadata and GPS is stored with the photo to allow for verification and traceability. The application has been very helpful for insurance claims.

Cons of Truepic: Only works with iOS and Android devices. This will help verify images taken with these devices but not with cameras and video cameras.
To use their application, a user has to have internet connection. This can be a huge problem for users that live in Rural areas that have little to no connection and also for users that may be in a building that has poor connection.
You can still stage a photo or take a photo of an existing photo and the application will verify the photo.
There is no verification process that the user that signs up to the platform is a real person.

3.2   Po.et

The po.et [3] foundation was founded in 2017 and is currently in phase 1 of development. Po.et is building an open, universal ledger that records immutable and timestamped information about your creative content that uses their open protocols designed for interoperability with current industry standards in media and publishing. The platform exists to help content creators establish immutable, provable layers of value to help create a better web. The three problems po.et is addressing is ownership, utilization, and history [3]. This platform is great for anyone that is wanting to use their service to validate they are the owner or authors. Po.et allows content creators to integrate with plug-ins from content management

systems. The first plugin was for WordPress, and has now expanded to Drupal and Joomla!

The po.et network focuses on the following:

Attribution
The foundation of Po.et is attribution. We enable multiple new ways to reference that content through the entire network to help establish validated claims such as ownership or authorship.

Discovery
The Po.et Network builds a set of ubiquitous information based on standard protocols to lower the friction in communicating the value of our content and how it can be unlocked.

Monetization
With the combination of verifiable reputation and on-chain discovery, the Po.et Network expands the options for monetizing content in a safe, controlled way. Both public and private marketplaces can be enabled.

Reputation
Everyone can see the actions taken on the Po.et Network and establish a history of certain behaviors by entities. Each piece of new information helps us be sure of who is safe with which to engage [3].

Pros of po.et: For content creators this is a great way to validate ownership of their work.
It's easy to connect to the system using one of the content management solutions plugins.

Cons of po.et: Currently the platform only supports text, but is working on other supported file types (photos, videos, PDFs)
It can be hard to integrate with the platform if you not using one of the available plugin platforms, and you're not a developer or have someone that can integrate with their platform through the API.
There is no verification process that the user that signs up to the platform is a real person.

3.3 New York Times News Provenance Project

The News Provenance Project [4] is exploring new ways for publishers to help fight misinformation. The first phase of this project is to do technical and user research and turn this research into a proof of concept, focused on photojournalism. The first phase of this project will end late 2019. The News Provenance Project will be using IBM Hyperledger for their proof of concept and will be collaboration with IBM Garage. The project is being spearheaded by The New York Times's Research and Development team, which is made up of technologists and journalists who explore the potential of emerging technologies for journalism [4].

In developing potential solutions, The News Provenance Project has several components:

- Conducting user experience research to understand what kinds of signals and indicators are intuitive, useful and relevant to people in the context of their daily routines around news.
- Implementing a technical proof of concept exploring the potential of blockchain, in order to understand how some of its attributes— immutability and decentralization in particular— might be used to guard against manipulation and enhance users' trust in the news material they come across.
- Building a working group to collaborate on future experimentation.
- Identifying a sustainable model for adoption and participation among publishers and platforms of any proven outcomes [4].

What they hope to learn:

- Could information about a photo's digital history help people better understand the way it is produced and published?
- How much information might be helpful or necessary in sourcing a photo shared outside of its published context?
- What kinds of metadata — for example, the time and place the photo was captured, the original publisher and caption, the photo's revision history— might be important to include or prioritize?
- How helpful might a symbol or watermark be in establishing credibility?
- How might access to photo metadata change how audiences perceive photos that don't have metadata? [4]

Pros of The News Provenance Project: No pros at this time, this platform is in research phase.

Cons of The News Provenance Project: No cons at this time, this platform is in research phase.

3.4   Voice

Voice [5] is a brand-new social network that launched this year that is being developed by Block.one on top of the EOS blockchain. Currently the application is available through beta access. The Voice platform uses a special authentication system to make sure very user on Voice is an actual person. A user can create content and make their post go live and earn Voice tokens. These tokens can be used to put your content on top of other content for users to see. The user is in theory paying for their content to be placed on top like an advertising model. Where it gets interesting is that if a user raises their Voice content above your content, the user gets some of its tokens back plus some extra voice [5].

Pros of Voice: Verifies the user's identity on sign-up, to help prevent fake accounts.

Cons of Voice: All content will not be shown equally, the users will be using tokens to get their content seen above others.

3.5 D.Tube

D.Tube [6] was founded in 2017 and is a decentralized version of YouTube that enables video content producers to get paid in cryptocurrency. The D.Tube platform was built on top of the Steem Blockchain and the IPFS peer-to-peer network. This platform is modeled after YouTube, but unlike YouTube, when you share or comment on a video a user can earn cryptocurrency, the platform cannot sensor videos, this is left up to the users by voting on the videos, there is no algorithms that control the visibility of videos, and there are no ads on the platform. Users earn tokens by posting content, sharing links, and voting on the content. D.Tube was created as a new type of video sharing platform designed to offer a solution to these issues: Re-create trust with a censorship-free decentralized hosting infrastructure, fully transparent and open source code and no collection of personal data. Community-powered moderation: Content's popularity, moderation and classification is determined by user's upvotes, downvotes and tags without algorithmic alteration. A token model to reward all users: A "social blockchain" mechanism distributes cryptocurrency token rewards to all users (creators, influencers, viewers) for their social contributions (post, vote, tag) [7]. With D.Tube being a self-governed platform, the platform has leaders in place. These leaders are voted by the users. Each user is allowed to vote for 5 leaders. The top 10 leaders on the leaderboard are in charge of producing new blocks and securing the infrastructure.

Pros of D.Tube: No algorithms so all content can be shown equally.

Cons of D.Tube: The platform cannot sensor videos, only users can, if the leaders were on the same propaganda agenda.
There is no verification process that the user that signs up to the platform is a real person.

3.6 Unbiased

Unbiased [8] was founded in 2017 and is currently in beta testing. This platform is more than a social platform, they also have a search engine product. Both the social platform and search engine were developed to fight fake news by using crowdsourcing with blockchain, machine learning, and artificial intelligence. Unbiased collects the data from the search engine by using both APIs and web scraping. Unbiased platforms goal is to address human bias and quality issues, fake news, and data integrity. Unbiased is determined to present facts by bringing

everyone's opinion to one platform and present the aggregated opinion in an interactive way. They will categorize information based on source and also an advanced AI algorithm to validate the information. They will also use digital token incentives to generate ore quality, trusted data and also to crowd-source growth". The social platform is built for a user to create and share content while connecting with friends and followers, while earing cryptocurrency. Where with the search engine a user can search a topic and get insights on the topic they searched, while earning cryptocurrency for sharing the experience and helping the community [8].

Pros of Unbiased: The platform will have a search engine to search other data that was not created on their platform.

Cons of Unbiased: There is no verification process that the user that signs up to the platform is a real person.

3.7 Publish Protocol

Publish Protocol [9] conceptualized in 2018, that uses the Ethereum blockchain platform. Publish Protocol aims to restore readership and secure financial sustainability for publishers [9]. There are three different roles for Publish, these are consumers, producers, and community editors. Consumers can earn tokens by visiting a site, reading articles, leaving comments, upvoting and downvoting content, sharing content, and staking tokens. They can also earn tokens by pointing out errors in published articles. Producers are users that produce the news content, but to submit a news item, producers must stake a certain number of tokens. The two ways they can receive news tokens if an article is published and is upvoted by consumers. Community editors earn tokens by editing the content. You have to apply to become a community editor the person has to meet a minimum set of criteria [10].

Pros of Publish Protocol: By using the platform, you are verifying the news content.
Users can earn tokens, by contributing to sharing, upvoting, and downvoting.

Cons of Publish Protocol: You have to have tokens to be able to publish your content.
There is no verification process that the user that signs up to the platform is a real person.

3.8 Trive

Trive [11] was founded in 2017, and instead of being a platform, this solution is a browser extension plugin, built on Ethereum. The Trive platform is based on

spending time and resources appraising news and information for truth value. Users can use the service for $1 a month. Thrive works as a scoring platform that rates each site and when a user uses the browser plugin, a site with a low score will alert them if the site they are on is an unreliable news source [11].

Trive has 5 types of "players":

- Consumers who consume the news and send stories of interest to the marketplace for Curators to find and research;
- Curators who bid on stories and publish lists of article claims with an incentive to maximize profit, reduce research costs and deliver quality;
- Researches who are incentivized to find and document convincing true data quickly and efficiently;
- Verifiers who verify the supporting evidence collected by the Researchers above, and are awarded if/when the Researcher's err;
- Witnesses who verify research and participate in the truth scoring process, earning a small fee and enjoying the truth discovery process [12].

Each of these roles have a set of incentives that maximizes the search for the truth and minimizes gaming [12].

Pros of Trive: The way the platform verifies content through the players, has several people verifying the content.
The browser plugin can hide stories that are below a certain score if the site has been verified.

Cons of Trive: Works only on sites that have been rated.
Doesn't work on social media posts.

3.9   Hardah One

Hardah One [13], a social browser platform, development began in 2016 and is still in development. What makes their solution unique, is that their app will create a bridge between social networks: Facebook, Instagram, Google, Twitter, LinkedIn, YouTube, Netflix, ... Like other social solutions, their app will not be using filter bubbles and they will be working closely with journalists. Hardah One is also anti fake-news by using blockchain and deep learning to trace flagged fake news and reduce the spread of fake news [13].

The challenges they are solving are:

- Lack of Interoperability
- Filter Bubbles + Fake News
- Social Media Business Models

Pros of Hardah One: The app is a multimedia platform in the form of circles, allowing users to create, share [13].

Cons of Hardah One: At this time, there is not a lot of information on the development of this project to currently see what the cons are of the platform.

4 Other Blockchain Platforms

There are many more emerging social media and news platforms that are built on blockchain. These platforms run like regular social media platforms but are designed were users can earn cryptocurrency for their content. Users also use these platforms to avoid having their content censored and because there are no algorithms used on their content. These platforms however do not talk about preventing or fighting fake news.

Other Blockchain Platforms:

SocialX [14] is a social media platform that is similar to Facebook and Instagram where users can share photo and video content. This platform allows user to earn cryptocurrency for publishing, sharing, and liking content.

Steemit [15] is a website that is powered from Steem blockchain and Steem cryptocurrency. Their platform is based on that users of the platform should receive benefits and rewards for the contribution to the platform.

Appics [16] is a reward-based social media application that has content in varying categories. Users are rewarded with cryptocurrency for their contribution.

PiePie [17] is an iOS and Android application that allows users to share videos and automatically earn cryptocurrency.

Minds [18] is an open source platform that allows for Internet freedom. Users are paid in crypto for their contributions to the community.

Yours [19] is a platform where users create content with a free preview and then they put the rest of the content behind a pay wall. The users are able to set the price they want for other users to view their content.

With any new emerging technology, you have technology that succeeds and technology that fails. Three platforms that were designed to fight misinformation on blockchain and no longer around are Truthem, 4Facts, and Userfeeds.

5 Opportunities

Creating and having a solution that will work to fight and prevent misinformation will not be successful from just one person. To be able to solve the problem everyone will have to collaborate. One platform that offers an API to be able to integrate with their platforms is po.et. Developers can integrate their projects through their API. Integration content is available on their GitHub for elixir, frost JavaScript, C#, Frost-Ruby, and Frost-PHP. This platform allows for collaboration and integration with their platform. The more users that connect and use the platform the more successful it can become to helping fight and prevent misinformation.

Steem allows developers to develop on their blockchain platform for free. Steem has near-instant fee-less transactions and its built-in content specific primitives make building an engaging and functional blockchain-powered application easier than ever [20]. D.Tube is one of many applications that is built on the Steem blockchain.

Using blockchain to verify content can help prevent misinformation. Content can be changed and by using blockchain it prevents the original content from being changed and users can verify the origin on the article, image, or videos. To verity authors on blockchain, platforms can use this technology and store certifications and credentials of authors to verify they are trusted authors and publishers can check this before they decide to publish an article. Depending on how a platform is set-up you can't prevent someone from putting fake news on blockchain, this can still happen. On some platforms if a user generates fake news, users vote on the content to give it a ranking. This would push unreliable news to the bottom of a newsfeed but it's still there since you can't remove content. Clearly there are limitations to existing approaches, which present opportunities for researchers like us and others to improve existing solutions or develop new ones and open doors for innovation for researchers and practitioners alike.

6 Ethical and Policy Concerns/Issues

With any new emerging technology, laws and regulations have to catch up to the technology. Many states had bills in legislation in 2018 for blockchain. However, these bills were for defining nodes and running nodes, appointing blockchain working groups, blockchain task forces, concerns for using blockchain for state records, initiative to implement policies, and authorizing smart contracts. With this just being the beginning of regulations, there are no regulations for using blockchain to fight and prevent misinformation and if it will be valid for using in legal issues. Another issue is that some of the platforms mentioned stated that they don't censor data and have no algorithms. However, some of these platforms are using users to vote and score the content published, which is censoring data, which contradicts the statement that they are not censoring data.

7 Challenges

Using blockchain to help prevent and fight misinformation is still emerging. With all emerging technologies there are going to be challenges to overcome. The cost to develop these platforms is expensive and many of them have raised the start-up capital, but how does the platform continue to support itself after the capital runs out. Data also can't be deleted from the blockchain and storing the data will become more expensive as the data collects on the chain. Each platform has different goals and different use cases, this makes the user have to use different platforms to verify anything from photos, videos, to news articles. For users that are not wanting their

content censored, some of the platforms, for example D.Tube, says it does not censor the content. However, this may actually not be the case. It may not be the platform censoring the content, but the users that will censor the content by ranking content. Blockchain alone won't completely prevent and fight fake news. This technology will need to be paired with machine learning and artificial intelligence to make the most out of the technology. All of the platform mentioned are still in the beginning stages and everyone is wondering if blockchain will be the solution or is it just hype to fight and prevent misinformation.

8 Looking Ahead

With blockchain technology emerging, the sky is the limit for organizations to use this technology to help fight and prevent misinformation. Out of all the companies one that has come the furthest in development is Truepic. With each company focusing on different aspects of misinformation there is still room for growth. To make any solution successful there has to be collaboration. Solutions also need to be able to be used from different applications via plug-ins and APIs. The more users that can use a solution across applications the more content, images, and videos can be verified if they are authentic or not. However, if a platform doesn't verify users, how will this prevent fake users to start trying to create fake content. Any solution will need to be able to verify a user is who they say they are. Will blockchain be the solution to fight and prevent misinformation, it is still too early for an answer, but the outlook is looking positive.

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18. Minds. https://www.minds.com/
19. Yours. https://www.yours.org/
20. More transactions than bitcoin and ethereum combined, which means it can easily handle every transaction your app generates. Steem. https://steem.com/developers/