Proof of Credibility: A Blockchain Approach for Detecting and Blocking Fake News in Social Networks

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Abstract—**Rumors and misleading information detection and prevention still represent a big challenge against social network developers and researchers. Since newsworthy information propagation is a traditional behavior of most of the users in social media, then verifying information credibility and reliability is indeed a vital security requirement for social network platforms. Due to its immutability, security, tamper-proof and P2P design, Blockchain as a powerful technology can provide a magical solution to overcome this challenge. This Paper introduces a novel blockchain approach called *Proof of Credibility (PoC)* for detecting fake news and blocking its propagation in social networks. The functionality of the PoC protocol has been simulated on two datasets of newsworthy tweets collected from different news sources on Twitter. The results clarified a satisfying performance and efficiency of the proposed approach in detecting rumors and blocking its propagation.**

Keywords—*Blockchain technology; social networks; fake news detection*

I. INTRODUCTION

Sharing newsworthy information on social media platforms like Facebook, Twitter, and Instagram without evaluating its credibility has popped out a big challenge. Disseminating Misleading information and fake news across social networks represent a big dilemma against researchers and Social Network Service Providers (SNPs) [1]. The political elections are the best witness to sharing a lot of rumors patterns across social media. For instance, more than 1,000 reports on politics and election were declared as fake in the Jakarta Gubernatorial Election in 2017 [2]. Also, Fake news and misleading information can misuse the reputation of countries as well as jeopardize international relations. In 2017, the Twitter account of Qatar's state news agency had been penetrated and published false news to criticize aspects of the Arab Gulf and US foreign policy towards Iran. The neighbor countries like UAE, Bahrain, Saudi Arabia, and Egypt broke diplomatic ties

with Qatar [3]. With advances in AI technologies like Machine learning [4], deep learning [5] and digital animations [6], developing malicious social bots for propagating fake news represents a big challenge. According to Gartner's predictions for 2018, most of the people will read and believe more false news than real news by 2020 [7]. Although AI has the best opportunity of recognizing misleading information, it is seriously able to create fake content on social media. Unfortunately, recently, the power of AI algorithms for identifying fake news is lower than its ability to create it [8]. Therefore, it has become an essential need to search for an alternative robust and efficient technology for handling this problem. Developing blockchain-based solutions have the potential to change the way of information creation and propagation [9]. Blockchain can provide trustable, immutable, verifiable, reliable, and transparent transactions for designing a trusted social system [10]. In this paper, we investigate the possibility of using blockchain theory for developing a novel protocol called Proof of Credibility (PoC) able to verify shared information and detect misleading information across social networks. The proposed protocol is simulated on 1003 newsworthy tweets around the trending topic #ISIS, and 802 newsworthy tweets around the trending topic #Halamadrid which are collected from different news sources on Twitter. The results clarified the possibility of developing a standard blockchain consensus for verifying information credibility as well as blocking rumor propagation across social networks. PoC will represent the first blockchain protocol that can be utilized for solving the problem of fake news and misleading information in social networks. The rest of this paper can be organized as follows: Section 2 presents the literature review. Section 3 discusses the proposed blockchain protocol. Section 4 presents the simulation results. Finally, Section 5 presents the conclusion and future work.

II. LITERATURE REVIEW

There is a relatively small body of literature that is concerned with using blockchain as a solution tool for solving social network security problems. Moreover, unfortunately, there are relatively few historical blockchain approaches utilized for solving fake news and misleading information problem specifically. However, the literature introduced some blockchain techniques for handling specified problems in social networks. For example, A blockchain is configured as a data bank accessible by social network nodes based on rules and preferences of the nodes upon authorization by the blockchain configured data bank for facilitating social integrity networking [11]. Another work in investigating some of the recent blockchain platforms to determine if they fulfill Metcalfe's Law for modeling social media networks based on digital currency protocols [12]. The authors in [13] investigate the potential of utilizing the U-share-blockchain mechanism to enable users to manage and track all posted contents they share over the social network. Yahiatene et al. in [14] introduced a novel framework that depends on two main components: Software-Defined Vehicular Networks (SDVN) and Blockchain for authenticating the transactions and providing anonymity of data in a distributed manner across the social network. Moreover, blockchain-based social networks can be utilized for combining fog computing to develop security architecture for managing IoT systems by creating tamper-proof digital identities in a trustless domain [15]. An additional blockchain contribution to social networks is Tweet-chain [16]. Tweet-chain is a novel social network model-based on blockchain for managing public posts based on Proof of Concept protocol [17] to ensure social transaction security instead of proof of work. It can work without the required trustworthiness assumption for the social network provider. Fakechain [18] is another blockchain consensus –based on data mining algorithms for authenticating shared information [19] across the social network and detecting fake news [20]. Detecting fake news can be achieved by utilizing the functionality of Ethereum blockchain combined with the Breadth-First Search (BFS) algorithm [21].

III. PROOF OF CREDIBILITY (POC) APPROACH

Automatic rumors recognition and blocking it propagation are indeed very hard challenges to design trusted social networks. There are a number of techniques that have been developed to fight against misleading information in social networks [22][23]. The recent researches utilize the benefits of Artificial Intelligence (AI)-based techniques for detecting misleading information [24] [25]. Other methods have been based on sentiment analysis combined with IP network analysis [26] for detecting social network rumors. Moreover, some studies tried to solve this problem based on Natural Language Processing techniques [27]. However, these studies have a lot of limitations and inaccurate results in detecting fake news. For example, while AI-based techniques can help in limiting the rise of misleading information, it is not invincible. Such that, It may occasionally make a lot of False Positive and False Negative errors. So, Social network systems can be re-designed with blockchain to give control of the shared posts back to the users themselves in P2P communication. The major

advantages of utilizing blockchain-based techniques for detecting misleading information are:

1) Better privacy and protection.
2) Decentralized social network architecture.
3) User control based on a distributed content.
4) Online automatic verification for shared information.
5) Grants a robust authentication and ensures anonymity.

In this paper, we propose a novel Blockchain algorithm called Proof of Credibility (PoC) for detecting and blocking fake news in social networks. The idea behind PoC is that re-engineering the social networks as decentralized networks, where users are represented as peers. Each peer shares a distributed ledger, which represented as an immutable, cryptographically secured record of detected rumors. The distributed ledger is designed as a sequence of blocks, where each block in the blockchain represents a new detected number of rumors. For example, a new block is added to the chain if the blockchain system detected 10 rumors. Moreover, The detection functionality is executed by PoC chain code which is shared also with all peers in the social network platform. They can execute POC chain code via a blockchain browser. "Fig. 1" shows the conceptual view of the blockchain-based social network system, and Fig. 2 explains the design model of the PoC protocol.

With PoC –based social network systems there is no need for the third party to verify the shared information and identifying rumors, such that peers will do this task based on the PoC blockchain system. Each block in the blockchain involves a fixed number of fake news. This number is agreed by the peers of social networks and is defined in the PoC consensus. For example, a new block is added to the chain after identifying 100 rumors in the social networking system.

The idea behind PoC is evaluating the credibility of the source who shared the information. As we interested in newsworthy information, the source may be an online newspaper, magazine, TV-News channel, Radio, Wire services, or a blog by users. The functionality of PoC is based on the Best Match technique (BM25F) metric [28]. It can be used for evaluating the credibility of online sources of newsworthy information [29].
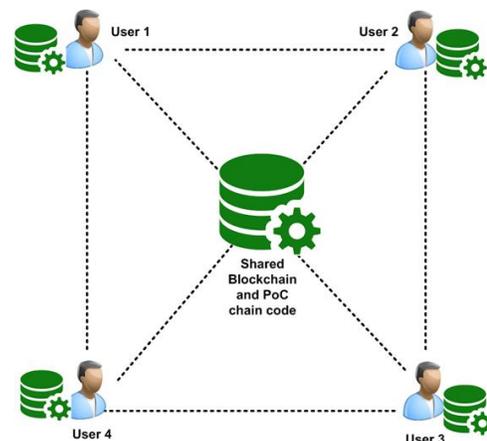

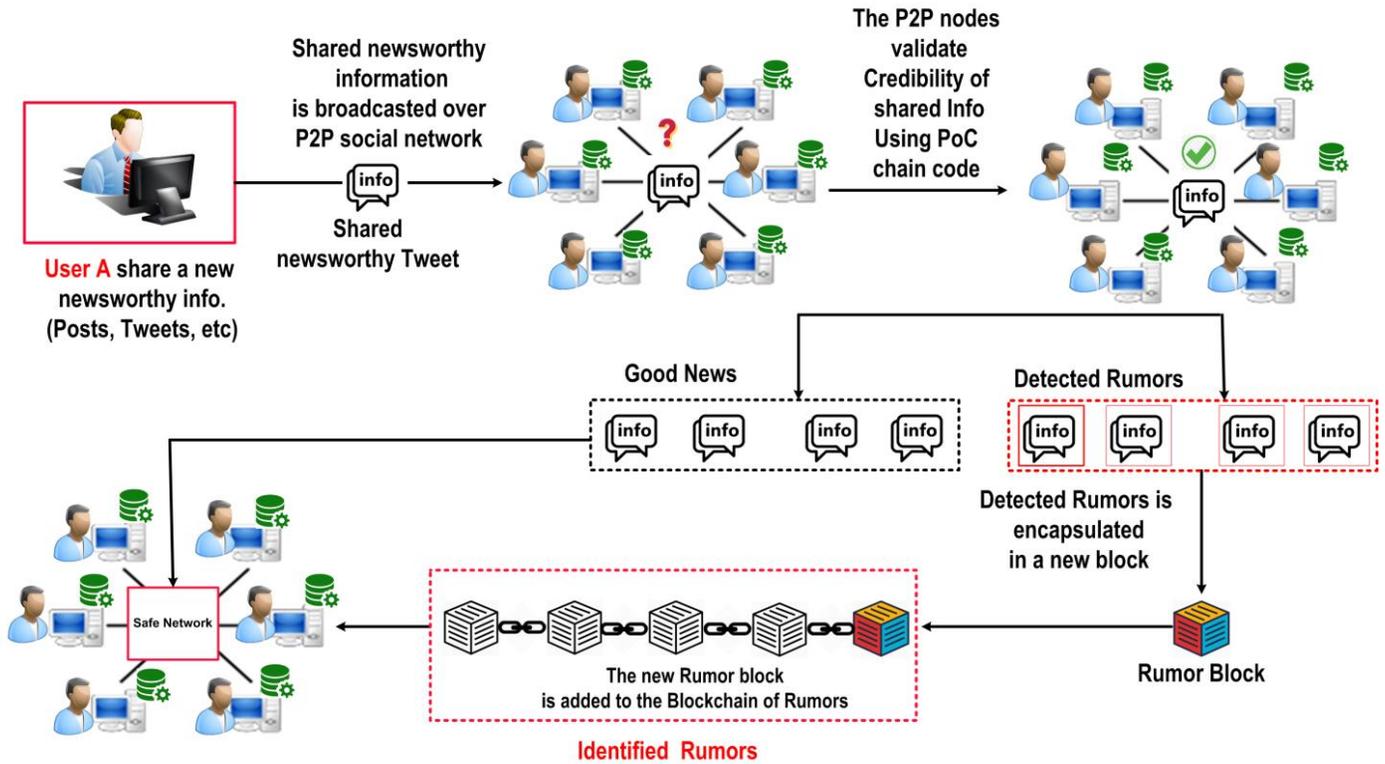Fig. 1. Conceptual view of the Blockchain-based Social Network System.

Fig. 2. Proof of Credibility (PoC) Design Model.

Source credibility can be calculated based on two dependent factors. The first factor is $W(Si)$, which is used for producing the credibility weight (W) value to Information Sources as formulated in equation (1).

$$W(S_i) = \frac{Occure \times Boost}{[(1-b)+b \times \frac{\#Posts}{\#Followers}]} \qquad (1)$$

Where *occur* is the number of *posts/ tweets* that are associated with the source S_i in all shared Posts/Tweets of a specific trending topic in a specific time *t*. *Boost* is called boost factor, which applied according to the type of the source of information as presented in Table I, the boost values are taken from News Trust [30] which is a review tool rate the news based on journalistic quality, not just popularity. So, the handled information must be classified according to the source type to assign the appropriate *boost* value from Table I. *b* is a constant, such that $0.5 < b < 0.8$. *#Posts* is the number of all posts that are shared by the source S_i. *#followers* is number of followers who follow the source S_i. The second factor is Logarithmic Ratio (LR) of the number of posts/tweets in the collection (i.e. the number of shared information within a specific period defined in PoC protocol) that share the same source of news as in equation (2).

$$LR(S_i) = Log \frac{N+n(S_i)+0.5}{n(S_i)+0.5} \qquad (2)$$

Where N is the number of *posts* in the collection and $n(S_i)$ is the number of posts, which are associated with (S_i). Finally, the Source Credibility (SC) value can be calculated as in equation (3).

$$SC(S_i) = \frac{W(S_i)}{K_1 + W(S_i)} \times LR(S_i) \qquad (3)$$

Where, K_1 is a constant value used as a free Parameter, such that $1.2 < K_1 < 2$.

TABLE. I. BOOST VALUES OF THE MOST COMMON SOURCES OF NEWSWORTHY INFORMATION [30]

News Source	Boost values
Newspapers	3.29
Magazines	3.68
TV-News Channels	3.54
Online Sites	3.69
Radio	3.60
Wire Service	3.48
Blogs	3.55

The PoC-chain code which implements the detection methodology and evaluates information credibility can be implemented as in Algorithm 1.

Algorithm 1: PoC Detection Methodology

1: Input: Time $T = \{t_1, t_2, t_3, \ldots .. t_n\}$
2: Input: News $= \{N_1, N_2, N_3, \ldots .. N_P\}$
3: Output: Blockchain of Rumors BR$= \{B_1, B_2, B_3, \ldots .. B_n\}$
4: Procedure Rumors Detection
5: While (is share news())
6: for each $N \in News$ **in** t_i Do
7: if $(N_i.url\ IsTrue())\ Then$
8: $Source\_ News \leftarrow N_i$
9: else
10: $Blog\_News \leftarrow N_i$
11: End if
12: End for
13: for each $N_i \in Source\_News$
14: $Score(N_i) = SC\ (N_i.source)$
15: $Cred_{Threshold\ 1} = \sum_{i=1}^{i=n1} \frac{Score(N_i)}{n1}$
16: if $(Score(N_i) < Cred_{Threshold})$
13: $B_j \leftarrow N_i$
14: else
15: $Good\ info\ \leftarrow Ignore\ (N_i)$
16: End if
17: End for each
18: for each $N_i \in Blog\_News$
19: $Score(N_i) = \frac{\#Reshare}{\#Fllowers} \times 100$
20: $Cred_{Threshold\ 1} = \sum_{i=1}^{i=n2} \frac{Score(N_i)}{n2}$
21: if $(Score(N_i) < Cred_{Threshold})$
22: $B_j \leftarrow N_i$ // Add N_j to the Block B_j
23: else
24: $Good\ Info \leftarrow Ignore\ (N_i)$
25: return B_j
26: $BR \leftarrow B_j$ // Add B_j to the blockchain
27: Open (New Block B_{j+1})
28: End While
29: End Procedure

IV. SIMULATION RESULTS

For investigating the realism and effectiveness of the proposed PoC approach, a simulation experiment has been applied in two datasets collected from Twitter. The two datasets are described as two trending topics (#ISIS, and #Halamadrid) that involve several newsworthy tweets that have been tweeted by multiples sources of information. The Twitter R library tool [31] has been used as a software tool for collecting tweets of each trending topic across four-time intervals. The general description of the two datasets can be summarized in Table II. The simulation results of applying the PoC algorithm on the two mentioned datasets show that the PoC algorithm could detect the fake news in the two mentioned datasets as follows, 215 tweets in block 1, 284 tweets in block two, 224 in block three, and 208 in block four as depicted in Table III. Fig. 3 depicts also the total numbers of fake news for the seven sources types of information. The results show that online newspapers are the most source type of fake news in the

#ISIS dataset, while Wire Service is the most source type of fake news in the #Halamadrid dataset. The pi plot in Fig. 4 depicts the percentages of detected fake news in the two studied datasets.

For verifying this obtained results, the set of detected fake news (i.e.931 tweets) and good news (i.e. 874 tweets) are outsourced to the Xpertin platform [32]. It has a set of the best experts in social media services. The verification results and feedback of Xpertin reported that only 91% of detected fake news is indeed fake (i.e. only 847 tweets are fake news) and 86% of good news is indeed good (i.e. only 752 tweets are good news). According to Xpertin's feedback, this result means that the PoC technique failed to recognize 84 tweets as fake tweets and 57 tweets as good tweets. So, according to True Positive (TP), False Positive (FP), True Negative (TN) and False Negative (FN) values, Precision, Recall, and Accuracy can be calculated as in equations 4, 5, 6. Fig. 5 presents the Precision, Recall, and Accuracy results of the PoC technique.

$$Precision = \frac{TP}{TP+FP} \tag{4}$$

Such that TP is the number of True Positive tweets and FP is the number of False Positive tweets.

$$Recall = \frac{TP}{TP+FN} \tag{5}$$

Such that TP is the number of True Positive tweets and FN is the number of False Negative tweets

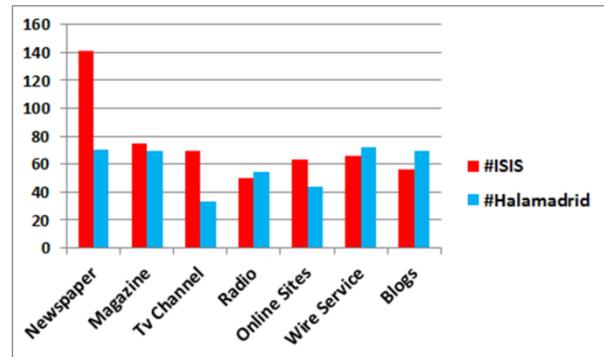$$Accuracy = \frac{TP+TN}{P+N} \tag{6}$$

Fig. 3.   The Total Numbers of Fake News for the Seven Sources Types of Information in the Two Studied Datasets after Constituting Four Blocks in the Blockchain.
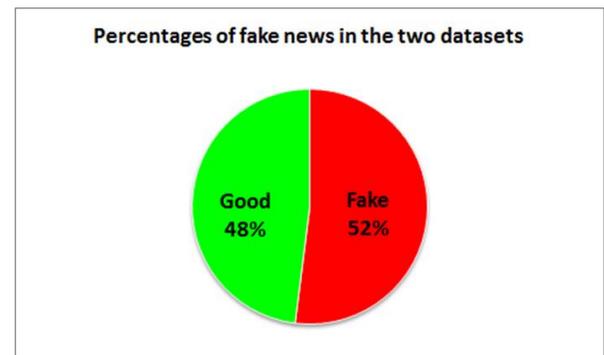

Fig. 4.   The Total Percentages of Detected Fake News in the Two Data Sets.

TABLE. II.   TWO DATASETS DESCRIPTION, #ISIS, AND # HALAMADRID

Source	#ISIS					#Halamadrid				
	# Tweets	t1	t2	t3	t4	# Tweets	t1	t2	t3	t4
Newspapers	281	66	73	59	83	183	39	46	57	41
Magazines	149	46	34	38	31	156	47	28	37	44
TV Channels	132	36	29	43	24	108	25	22	43	18
Radios	99	25	16	22	36	101	29	33	17	22
Online Sites	114	22	35	30	27	97	16	26	19	36
Wire Service	109	26	38	26	19	50	14	15	10	11
Blogs	119	25	23	39	32	107	30	22	26	29
Sum	1003	246	248	257	252	802	200	192	209	201

TABLE. III.   NUMBER OF DETECTED FAKE NEWS IN #ISIS AND #HALAMADRID DATASETS WITH RESPECT TO FOUR TIME PERIODS (I.E. 4 BLOCKS IN THE BLOCKCHAIN) AND SEVEN SOURCES

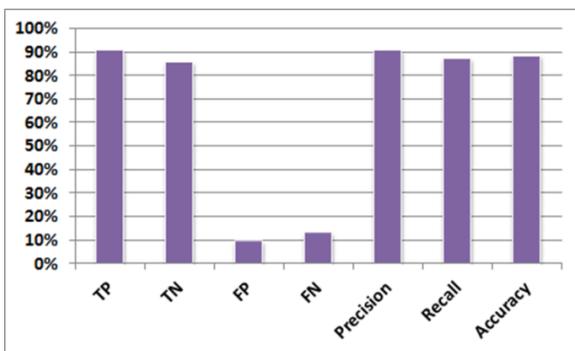| Source	t1		t2		t3		t4	
	#ISIS	#Halamadrid	#ISIS	#Halamadrid	#ISIS	#Halamadrid	#ISIS	#Halamadrid
Newspaper	41	16	44	23	22	14	34	17
Magazine	20	11	23	17	19	29	13	12
TV Channels	24	9	20	4	10	17	15	3
Radio	8	9	11	17	15	10	16	18
Online Sites	15	12	24	13	7	9	17	10
Wire Service	12	20	18	28	23	16	13	8
Blogs	6	12	25	17	14	19	11	21
Sum/Block	B1= 215		B2= 284		B3= 224		B4= 208	

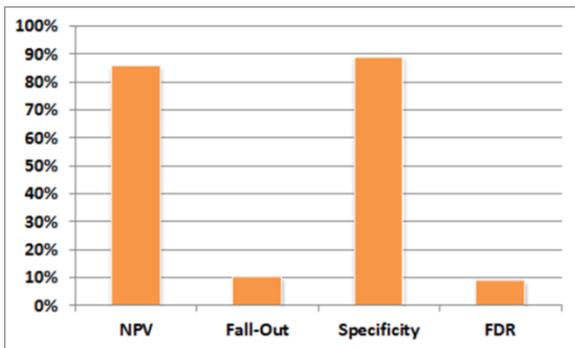Fig. 5.   TP, TN, FP, FN, Precision, Recall, Accuracy Results.

Fig. 6.   NPV, Fall-Out, Specificity, and FDR Results.

Such that P = (TP + FN), and N = (FP + TN) and TN is the True Negative tweets.

Moreover, the Negative Predictive Value (NPV), Fall-Out, Specificity, and False Discovery Rate (FDR) are evaluated for PoC mechanism as in equations 7, 8, 9, 10 and the results depicted in Fig. 6.

$$NPV = \frac{TN}{TN+FN} \qquad (7)$$

$$Fall - Out = \frac{FP}{FP+TN} \qquad (8)$$

$$Specificity = \frac{TN}{TN+FP} \qquad (9)$$

$$FDR = \frac{FP}{FP+TP} \qquad (10)$$

V.   DISCUSSION

Prior studies that have noted the importance of utilizing blockchain for detecting and preventing fake news in social networks didn't introduce a novel and real blockchain technique for solving this problem [19-23]. These studies were limited to only present some state of the art about the problem without proposing a novel blockchain-based algorithm able to detect fake news in social networks. This study set out with the aim of proposing the first blockchain consensus called Proof of Credibility (PoC) for detecting and preventing fake news and rumors in social networks. The most interesting finding of this study is the satisfied value of accuracy (89%) in detecting fake

news although the proposed algorithm is an initial blockchain algorithm that may require more functions and metrics for future improvements. Other interesting findings are the low values of Fall-Out and False Discovery Rate (FDR) which are 10% and 9% respectively in recognizing rumors and Fake news. It is somewhat surprising that about 52% of the total number of tweets in the two-handled datasets is recognized as fake news. This finding was unexpected and suggests that it should be there are more considerations to additional features (such as consistency and coherency of news, and general commons and acceptability [33]) of handled online newsworthy information for assessing its credibility in more accuracy. However, these findings support and encourage utilizing blockchain algorithms in managing and controlling the information propagation in social networks. As this result has not previously been described, and all previous studies handled the problem as jus as a theoretical investigation and review of the literature [19-23], so there are no comparison factors we can investigate. However, this study introduces the first real blockchain algorithm that can be compared with other blockchain-based algorithms in detecting fake news in social networks, which can be developed in the future. These findings must be interpreted with caution because the proposed algorithm is simulated on a limited amount of newsworthy tweets collected from two trending topics on twitter. For more accurate analysis and evaluation, the proposed algorithm should be improved and applied on benchmark and standardized datasets and should be applied within more periods of time for investigating the growth of blockchain of rumors in more tracing. However, this finding, while preliminary, suggests utilizing the first blockchain-based algorithm for managing and controlling information dissemination in social networks in order to detect fake news and misleading information. Improving the proposed algorithm with more measures of information credibility and simulating its functionality in benchmark and standardized datasets are more important issues for future research.

VI. CONCLUSION

The aim of the present research was to examine utilizing a novel blockchain-based algorithm for detecting and preventing fake news and misleading information across social networks. The study proposed a novel blockchain consensus called Proof of Credibility (PoC) for detecting fake news in social media platforms. The study has shown satisfying preliminary results obtained from simulating the proposed algorithm on two trending topics from Twitter. The experimental results have clarified the effectiveness of PoC in detecting Fake news with an accuracy of about 89 %, Fall-Out, and False Discovery Rate about 10% and 9% respectively. An implication of these results is the possibility of proposing additional blockchain algorithms for managing and controlling online information dissemination across social networks and can be compared with the proposed one. Before this study, the idea of utilizing blockchain for detecting fake news was purely anecdotal. This study was limited by the absence of a benchmark and standardized datasets for investigating PoC efficiency in more accuracy. However, this study introduces valuable insight into leveraging Blockchain and developing novel consensuses for more managing and controlling rumors propagation in social

networks. More research using benchmark datasets and controlled trials is needed for improving PoC functionality and efficiency in recognizing rumors and fake news in the next studies.

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