

When blockchain meets social-media: Will the result benefit social media analytics for supply chain operations management?

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ABSTRACT

Social media analytics is very critical in modern supply chain operations management (SCOM). However, in terms of methods, conducting social media analytics (SMA) for SCOM faces many challenges. Problems such as data accuracy (e.g., fake data), user privacy, data security, etc. are all present. Recently, with the emergence of blockchain technology (BCT), many new social media apps and platforms are developed. Motivated by the fact that (i) SMA is important for SCOM, (ii) the traditional social media (TSM) has insufficiency, and (iii) the “blockchain technology supported social media” (BSM) platforms have emerged, we explore whether and how the BSM would enhance social media analytics for SCOM. To be specific, by reviewing papers published in leading SCOM journals, we identify the applications and limitations of SMA for SCOM. Then, we conduct real case studies to examine the shortcomings of the TSM platforms and reveal features of their BSM counterparts. We investigate how the blockchain technology would potentially improve the use of SMA for SCOM. Finally, a future research agenda is proposed.

1. Introduction

1.1. Motivation and technological background

Social media refers to the mobile or network based application, which supports the creation, exchange and access of user-generated content among members (Batrincea and Treleaven, 2015; Chen et al., 2019). Popular examples of social media include Facebook, Twitter, Youtube, LinkedIn, and Instagram. It is reported that at least 80% of Americans have one social media account. In the whole world, it is estimated that there are over 3 billion users of social media platforms like Facebook, Instagram and Twitter (Mire, 2018). It is also commonly believed that social media is the modern way of connecting people and establishing friendship. The well-establishment of social media platforms and their popularity directly create a large amount of social media data. The proper use of social media data can potentially bring benefits to many real world operations and this directly leads to the emergence of social media analytics (SMA). In the literature, SMA (Zeng et al., 2010) refers to the use of analytical capabilities to analyze social media content so as to achieve a specific goal (Holsapple et al., 2014). It is mainly a passive approach which relies on retrieving the available data, instead of creating data proactively.

It is known that SMA helps business operations along the supply chain in many aspects (Wang et al., 2019a). For example, supporting product quality management in Coca Cola (Choi et al., 2018a; Singh et al., 2018), facilitating demand forecasting in businesses

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such as IBM and online fashion retailer Rue La La (Choi et al., 2018a; Cui et al., 2018; Lau et al., 2018), speeding up reaction to emergency events such as disasters (Luna and Pennock, 2018), improving engagement of customers (Holsapple et al., 2014), enhancing marketing programs (Lee et al., 2018; Kumar et al., 2019) including luxury fashion brand Louis Vuitton (Choi et al., 2018a; Chiu et al., 2018), reducing wastes (Mishra and Singh, 2018), facilitating information sharing (Wang et al., 2019a), achieving higher levels of customer services, improving business processes, encouraging innovation and yielding operational efficiency (Lam et al., 2016), etc.

However, SMA faces lots of challenges (Brooker et al., 2016). For example, social media includes dataset that is huge in size which makes it difficult to process. Social media data is also notorious of being incomplete (Stieglitz et al., 2018), unstructured (Cui et al., 2018), inaccurate or even fake, which means conducting SMA is an uneasy task. In some cases, social media data stream is dynamic (Zeng et al., 2010) which further creates challenges. Naturally, social media data is well-qualified as big data with all “V”s being satisfied (Choi et al., 2018a; Kalyan et al., 2018). Here, the “V”s include “Volume, Velocity, Variety, Variability, Veracity, Visualization, and Value”.¹ Moreover, different social media platforms have different limitations. Thus, conducting SMA is an uneasy task.

Recently, driven by the bitcoin business model and the importance of supply chain transparency, the blockchain technology arises (Chod et al., 2018; Choi et al., 2019c). The blockchain technology is commonly viewed as a distributed ledger operated in a decentralized manner. The core features of the blockchain technology include its ability to keep permanent data, and achieve high transparency and reliability of data (Choi et al., 2019b,c). The blockchain technology also features important functions such as smart contracting² and cryptocurrency which facilitate and support many innovative measures (Choi and Luo, 2019). Fig. 1.1 depicts the common features of blockchain technology. See Appendix A for more details of Fig. 1.1.

As a result, the blockchain technology is known as a disruptive force, which will potentially revolutionize many business operations. For example, the blockchain technology can be used to help trace the sources and show the details of food (as what Walmart and IBM are exploring). It is already employed for product authentication as what Everledger is doing for diamonds (Choi, 2019). The blockchain technology also helps with ethical sourcing in fashion apparel.³

In addition to the above functions, the blockchain technology is also changing social media and SMA. First, the presence of many cryptocurrency rewarding schemes can entice more users to be engaged with the social media. Second, it gives higher control power of data to users as well as the content's distribution. Third, the available data will be more authentic, reliable and secure. Fourth, the identity of creators can be traced. Thus, the issue of fake data can be addressed. Fig. 1.2 depicts how blockchain technology can be used in a social media platform. Table 1.1 shows some features of the blockchain technology, which are related to social media and SMA. Table 1.2 further summarizes some current blockchain technology supported social media platforms that aim to overcome some shortcomings of the existing traditional social media platform counterparts.

Fig. 1.2 shows how the blockchain technology is used in a social media platform. When User A posts a new thread in the social media platform, a new record is created in his ledger and announced to every node in the blockchain. Other users will verify User A's identity and the authenticity of the thread by the hash function. If the information is true, the HyperLedger will save this new record by generating a new block. What is more, User A can get cryptocurrency to compensate for his contribution from the platform. However, if other users find out that User A is a “fake” user or he is telling lies, this new record will be declined and everyone knows User A tells lies. The credit of User A will be affected (see Fig. 2.1.).

1.2. Research questions and paper's structure

Motivated by the fact that (i) SMA is important for supply chain operations management (SCOM), (ii) SMA faces many challenges, and (iii) the emergence of blockchain technology supported social media, we attempt to address the following open research questions:

1. For the social media platforms which have been used in operations analyses in the most authoritative SCOM literature, what are the major functional areas involved?
2. With respect to the commonly seen social media platforms employed for social media analytics, are there any problems?
3. What problems can blockchain technology solve for social media analytics and how? Which topical areas related to SMA for SCOM will be interesting for future research?

This paper aims to address the above three main research questions and derive the respective important insights.

To the best of our knowledge, this paper is the first study which comprehensively explores the use of blockchain technology to enhance SMA for SCOM. It includes original research (e.g., examining the real world blockchain technology supported social media (BSM) platforms). It also systematically examines the current state-of-the-arts SCOM literature on SMA and provides the latest details of blockchain technology supported social media platforms. The findings are valuable to both the practitioners and academicians. It contributes to the SCOM literature, especially in the SCOM-technology interface (Kumar et al., 2018).

This paper is organized as follows. Section 2 presents the review methodology. Section 3.1 shows the summary results of the systematic review. Section 3.2 reports some SCOM studies related to the blockchain technology. Section 4 presents the traditional

¹ <https://impact.com/marketing-intelligence/7-vs-big-data/> (accessed 14 December 2019).

² The smart contracting function refers to the ability of automating the contracting agreements in a speedy and transparent manner, following the pre-specified steps.

³ See DHL Trend Research (2018).

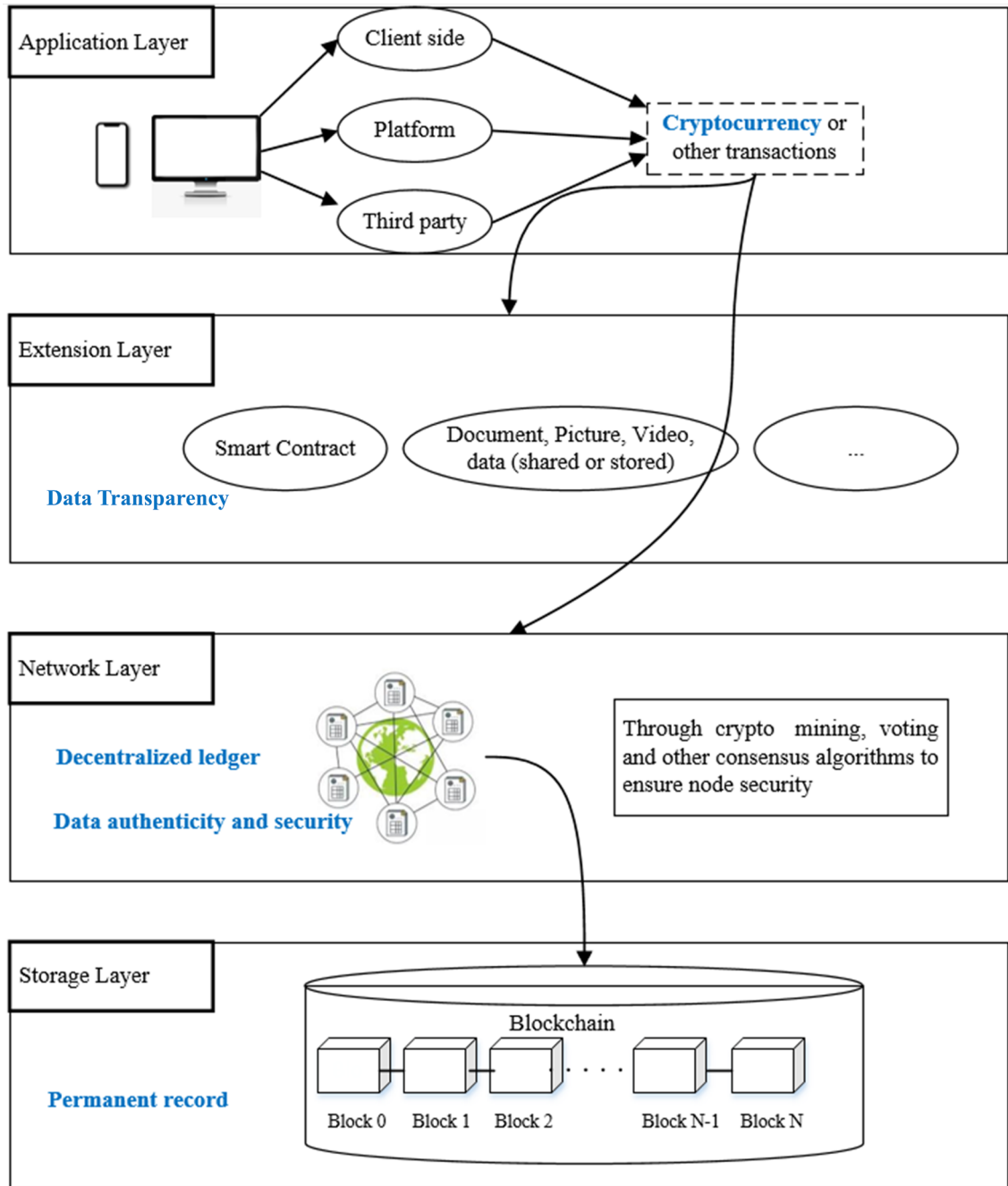


Fig. 1.1. Common features of blockchain. With references to: Ismail and Maerwala (2019). <https://www.jianshu.com/p/5e72bb776280>. https://blog.csdn.net/qj_35624642/article/details/78138077 (accessed: 26 November 2019).

social media platforms, and how SCOM can be enhanced by SMA conducted on them. TSM examples and features as well as problems of TSM platforms are also discussed. Section 5 examines the blockchain technology supported social media (BSM) platforms. Some real world BSM platforms are introduced and how specifically the blockchain technology can help is to support SMA also discussed. Section 6 presents the future research agenda and Section 7 concludes this paper with comments on research limitations. To enhance readability, a list of abbreviations used in this paper (excluding the ones for journal names) is shown in Table 1.3.

2. Methodology

To answer the research questions raised in Section 1, this paper first conducts a systematic review (Guo et al., 2019) of social

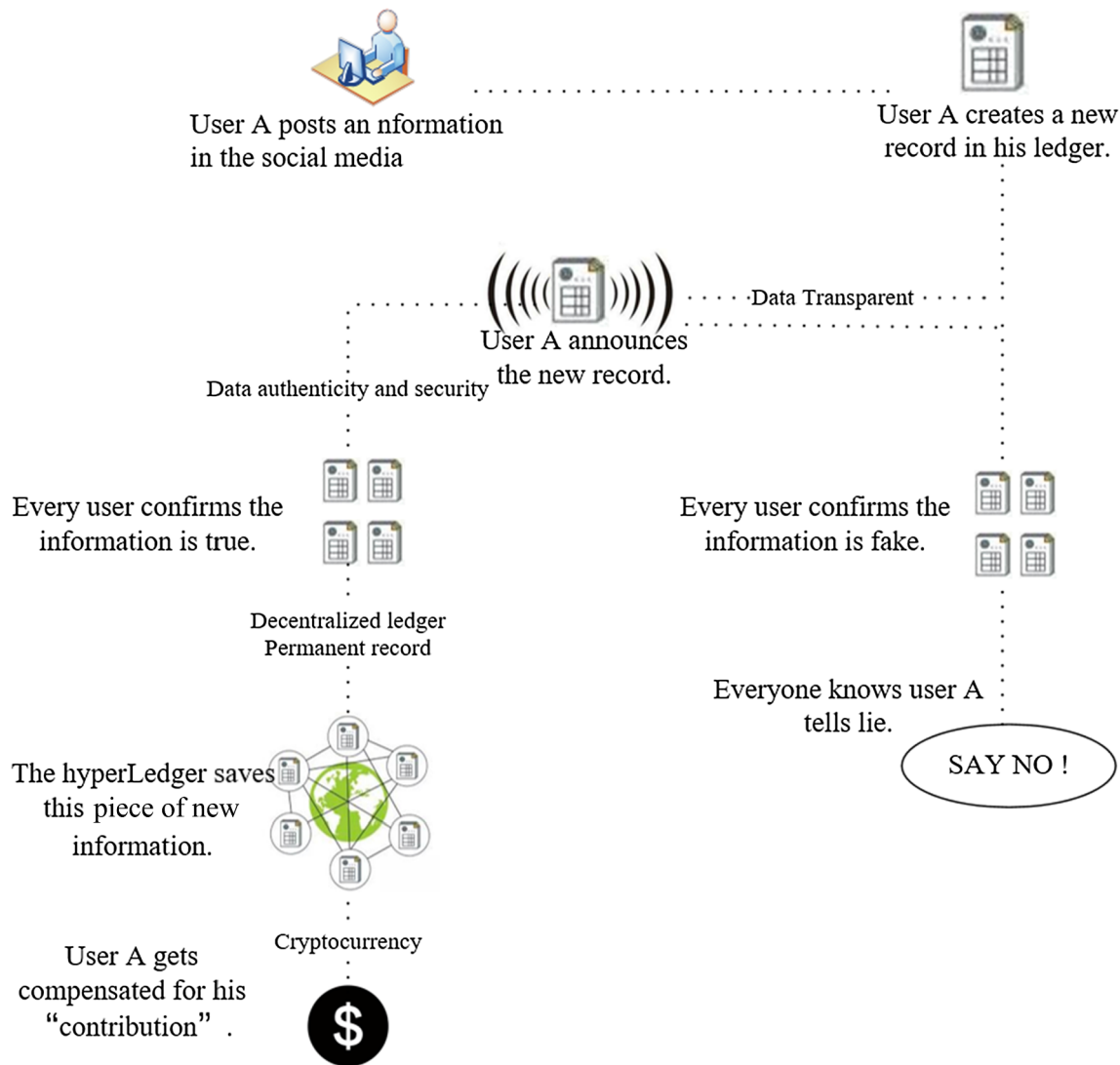


Fig. 1.2. How the blockchain technology is used in a social media platform.

Table 1.1

Features of the blockchain technology which can be applied for social media platforms.

Features	Details
Permanent record	The information cannot be edited, erased, or changed without the consent of all related stakeholders.
Data authenticity and security	The blockchain technology can help keep and share the authentic and secure data publicly which facilitate checking and verification.
Decentralized ledger	Supports parallel computing and computation.
Cryptocurrency	Provides incentive to encourage users' active participation and engagement.
Data transparency	The blockchain technology enhances data transparency.

media analytics related literature in leading SCOM journals. To be specific, for the selection of SCOM journals, we make reference to the SCM journal list,⁴ the UK's ABS journal list (levels 4 and 4*), the USA's UTD journal list,⁵ and the Australian ABDC A* journals related to logistics and supply chain management. Thus, the following journals are hence included: Decision Sciences (DSJ), European Journal of Operational Research (EJOR), International Journal of Operations and Production Management (IJOPM), Journal of

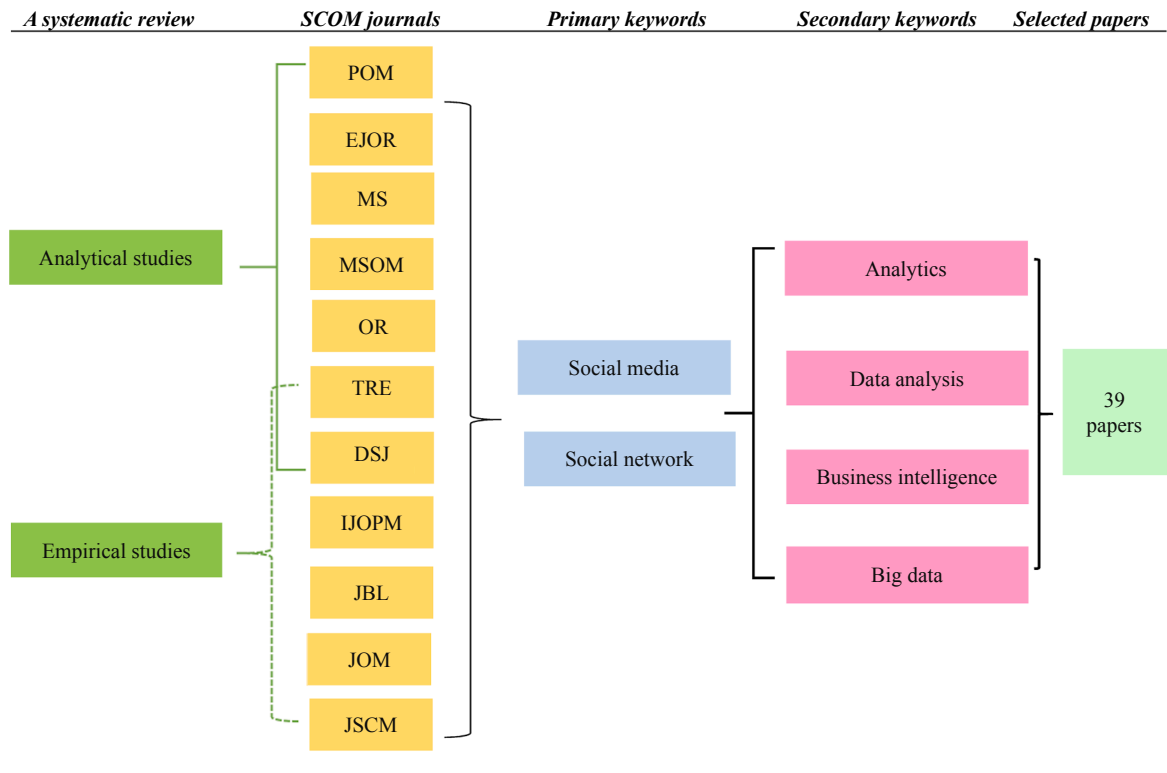
⁴ <https://jindal.utdallas.edu/the-utd-top-100-business-school-research-rankings/index.php> (accessed: 26 November 2019).

⁵ <http://www.scmlist.com/> (accessed: 26 November 2019).

Table 1.2

The TSM and BSM counterparts.

Traditional Social Media Platforms (TSM)	The Blockchain Technology Supported Social Media Platform (BSM) Counterparts
Facebook	Foresting
Twitter	Peepeth
Youtube	Dtube
Lindedin	Indorse
Instagram	Steepshot

**Fig. 2.1.** Process of selecting the research papers in this review.**Table 1.3**

A list of abbreviations.

Abbreviations	Full Forms
SMA	Social media analytics
BCT	Blockchain technology
SCOM	Supply chain operations management
TSM	Traditional social media
BSM	Blockchain technology supported social media
AI	Artificial intelligence
RBV	Resource based view
IPW	Inverse probability weighting
FS	Flash sales
API	Application programming interface
JSON	Javascript object notation

Business Logistics (JBL), Journal of Operations Management (JOM), Journal of Supply Chain Management (JSCM), Management Science (MS), Manufacturing & Service Operations Management (MSOM), Operations Research (OR), Production and Operations Management (POM), and Transportation Research – Part E (TRE).

Based on this target journal list, a deep searching process was then conducted in summer 2019 through Web of Science.⁶ In the searching, we employed the primary keywords of “social media”, and “social network” in paper’s titles, keywords, and abstracts. This ensures social media analytics is the major focus of the selected papers. In the meantime, no constraint on publication year is imposed throughout the whole searching process, since the objective of this paper is to provide a comprehensive review on the use of SMA for SCOM. Then we examined the definitions of “analytics” as all activities related to the data management. Accordingly, we supplemented the searching process by secondary keywords such as “analytics”, “data analysis”, “business intelligence”, and “big data”. We focused on the published original research and filtered out those papers which are literature reviews or discussion based. Finally, 39 papers were selected. Note that we do not find any prior review papers on the topic that we are examining and hence this paper positions itself as the pioneering review and research paper in this new and timely topic.

The distribution of filtered papers is shown in Table 2.1. It is found that most publications appear in DSJ, EJOR, POM and MS, in which DSJ publishes both analytical and empirical studies, and EJOR, POM and MS are more “analytical-oriented”. Fewer than half of the collected papers are published in the traditional empirical based journals such as LJOPM, JBL, JOM and JSCM. This finding is rather reasonable as SMA is computational in nature and hence more reviewed studies are in the analytical domain. Of course, it also means there is a big room for having more empirical based studies for SMA in SCOM.

From the collected papers, we identify the reported applications of social media analytics in the current SCOM literature. We uncover the values and problems of SMA with respect to the current social media platforms.

After that, we study and explore how BCT can overcome these problems. To be specific, we conduct original research and examine the BCT supported social media platforms in the real world. We identify their properties and then discuss how the real-world blockchain technology supported social media (BSM) platforms would enhance SMA for SCOM.

3. Literature review

A detailed literature review on the selected papers, which are selected based on the research method mentioned in Section 2, is reported in Section 3.1.

3.1. Social media analytics in SCOM

Social media has been critical in SCOM. Over the past decade, a lot of studies have been reported to explore how the proper use of data from the social media can help enhance real world operations. In the following, from the 35 selected papers published in leading SCOM journals (see Table 2.1), we further check and review the studies which have conducted technical social media data based analytics research in SCOM.⁷

Social influence: As users of social media platforms interact with one another and naturally influence one another, one critical application of SMA is to uncover the social influence in the market, which will have good implications for SCOM. In the literature, Aral and Walker (2014) conduct behavioral experiments on Facebook to explore how marketing is affected by messages sent by users in the social media. They focus on revealing the effects of social influence. Guo et al. (2015) examine social influences, which are critical for marketing strategies, by studying social media like Facebook. The authors categorize six different kinds of social interactions on online social media, in two major categories. They employ the support vector machines approach to explore these two major categories. Gunnec and Raghavan (2017) investigate the share-of-choice (SOC) strategic optimization problem. The authors highlight how to incorporate the critical social network effect, e.g., of Facebook, into SOC analysis formally. They employ a genetic algorithm based method to solve the problem. Srinivasan et al. (2017) study the broadcasting of important life events on online social networks such as Facebook, and Twitter. The authors find that the one-time-life events (e.g., weddings) have a bigger impact than other events. Chen et al. (2019) develop a method to conduct individual-level inference to identify social influences in social media platforms like Facebook, Twitter, and Flickr. They call their proposed method the “learn-simulation-approach”, which is based on well-established machine learning models. The authors computationally test the performance of the method with respect to the adoption of new products as well as repeat-purchases.

Online reviews: In addition to social influence, there is no doubt that what users of social media posted online would have important effects on others (Kumar et al., 2019). In particular, online reviews are important reference materials for consumers, e.g., when they plan to visit a restaurant or buy from a retailer. Pekgün et al. (2018) investigate the effects of consumer reviews in social media like blogs and discussion boards, as well as uncertainty in experience. The authors uncover that if consumers put more weights on negative reviews, when the consumer awareness is higher (for the product with a lower quality), the firm will charge higher prices and achieve higher profits than its higher quality competitor. Ramanathan et al. (2017) explore how social media based online customer reviews can be used in marketing to improve the satisfaction of customers. The authors examine this topic from the perspective of retail network designs. They highlight that online reviews on social media (either in Twitter or Facebook) would significantly affect customer satisfaction. Motivated by the common concerns on fake reviews posted online, Dong et al. (in press) study features of online reviews. The authors argue that consumer trust in online reviews is critically important. With the use of

⁶ As a remark, Web of Science is chosen as the searching engine for this paper, which is very popular in the academic domain (e.g., Neely (2005), and Guo et al. (2018)) because of its SCI/SSCI database’s completeness. Besides, note that all the target journals are listed in Web of Science.

⁷ Some theoretical studies which examine the role played by SMA in the companies and the respective influences are not reviewed in this section as they only treat SMA as a resource or dynamic capability.

Table 2.1

No. of SMA related papers collected from each journal (listed in an alphabetical order).

Journal	Mainly: Empirical (E) or Analytical (A)?	Number of SMA Related Papers
DSJ	E, A	6
EJOR	A	4
IJOPM	E	3
JBL	E	3
JOM	E	2
JSCM	E	1
MS	A	6
MSOM	A	1
OR	A	3
POM	A	6
TRE	E, A	4

behavioral experiments, the authors uncover that reviews which are positive, factual, and appearing on social networks (like in Facebook posts) are more important and perceived as more trustworthy than the reviews which are negative, emotional, and showing on the seller's website.

Advertising and marketing promotion: One most natural use of SMA is for marketing activities such as advertising and promotion. This is probably also the most common application area of SMA. In the literature, [Bimpikis et al. \(2016\)](#) explore via game-theory the optimal advertising strategy to individuals in social networks. The work is motivated by the fact that social media provides lots of data of consumer preferences which can facilitate target marketing. The authors establish the optimal advertising policy and show that it depends on the structure of the respective social network. [Lobel et al. \(2017\)](#) examine the use of social media's referral, such as a link or a Facebook post, to attract new customers. They derive the optimal payment scheme and explore how a linear functional form might serve as an approximation. [Lee et al. \(2018\)](#) use Facebook and the respective data to reveal the effect of social media advertisement on the level of consumer engagement. The authors make use of natural language processing algorithms to study the data. The authors uncover that direct-information content, such as the quotation of price, yields a lower level of consumer engagement when included in isolated messages while it leads to a higher level of consumer engagement level when provided together with brand specific and associated attributes. [Ghose et al. \(2019\)](#) study the consumer footprints in the online search-engine portals. They build an econometric model to investigate how consumer preferences can enhance their experience. The authors put the consumer preferences and searching costs together in the presence of both the online search engine and social media platform. [Gu and Ye \(2014\)](#) study the company's responses to customers via social media. The authors employ data retrieved from a Chinese large-scale online travel agency. They find that online social media management responses are effective especially for the customers with low satisfaction. [Chen et al. \(2015\)](#) develop a hierarchical-ensemble-learning (HEL) model to study customer response, given the large amount of user data from social media nowadays (like Twitter or other social media sites). The authors use a micro-blog dataset to prove the performance of the HEL. [Besbes et al. \(2016\)](#) study the online-content-recommendation system, which directs online surfers who read an article to the related content. The authors explore more than the click-through rate but also the engagement.

Logistics management: Traditionally, logistics management is a fundamental part of SCOM. The use of SMA also plays a role in supporting some activities in logistics management. [Fry and Binner \(2016\)](#) explore how social media (like Twitter, and other news websites) can be used for emergency logistics and evacuations. The authors propose that human behaviors are critical and develop a Bayesian statistical model based algorithm to achieve the optimal evacuation with the consideration of worsening situations. [Yoo et al. \(2016\)](#) study the application of social media for quick information dissemination for humanitarian events. The authors conduct an empirical field study to reveal how effectively information can spread over the social media network. They also use a dataset from Twitter for the Hurricane Sandy event for the investigation. [Lam et al. \(2016\)](#) argue that the social media adoption by companies (e.g., the Delta Air Lines' social media adoption on Twitter) may enhance information sharing and knowledge creation in the supply chain. Using the resource-based-view (RBV) theory on information capability of companies, they study how social media initiatives affect operational innovativeness and performance. Service recovery is important in operations. [Fan and Niu \(2016\)](#) study via exploring Tweeter the critical factors which may influence the effectiveness of service recovery. The authors highlight how the speed of recovery and the degree of severity of failure in service recovery relate to the use of social network. [Hou et al. \(2018\)](#) explore the use of social media data to enhance "delivery service" operations for e-tailers. The authors employ a game-theoretical approach to conduct the analysis. [Singh et al. \(2018\)](#) investigate the use of social media data from twitter to identify critical issues in supply chain logistics management for the food industry. The authors apply the "support vector machine (SVM)" to conduct text mining.

Forecasting: Demand prediction and sales forecasting are both critical in SCOM. In order to do a good job in demand/sales forecasting, companies have to learn from the market and collect the timeliest information. The social media hence provides the important channel for collecting valuable market data. [Ballings and Van den Poel \(2015\)](#) study social media based customer relationship management. The authors study with respect to Facebook and highlight whether in terms of demand forecasting, their proposed algorithm can predict increases in Facebook usage frequency. [Lau et al. \(2018\)](#) explore how big data can be used to enhance sales forecasting. The authors develop an efficient sentiment analysis scheme to analyze online comments (e.g., retrieved from Twitter, or Weibo) by consumers on products. They apply co-evolutionary extreme learning machines to explore the sales forecasting performance. [Choi \(2018\)](#) studies the case in which there is a "boundedly-rational" fashion retailer implementing quick response ([Choi et al., 2018b](#)). Building the model based on the Bayesian theoretical framework, the author analytically uncovers when

manipulating “social media comments” is beneficial to the fashion manufacturer with the use of a “surplus sharing contract”. Cui et al. (2018) study how the use of social media data can help to improve sales forecasting. The authors work with a fashion e-tailer to investigate how daily sales forecasting can be improved by using Facebook data. They argue that the accuracy of sales forecasting is improved with a mean absolute percentage error (MAPE) of around 12%.

Risk analysis: Risk relates to uncertainty and negative events. For risk related to human, the social media platforms provide some hints regarding the occurrence of some events. In the literature, Klausen et al. (2018) study how to use social media data for identifying extremists such as cyber-bullies and terrorists. The authors make use of Twitter accounts associated with terrorists to help search for the extremist users and develop the optimal searching policy.

Product introduction and design: Introducing new products and establishing new product designs are two important yet challenging topics in SCOM. Usually, companies do not know what customers actually want and hence there is no guarantee for the success of new product introduction or the launching of a newly designed product. SMA does provide a way for us to know the market and companies may even “test the water” by observing market responses towards the new product or design via the social media. In the literature, Aral and Walker (2011) study how firms can employ word-of-mouth as a way to influence peers and affect product design. The authors conduct a field study involving over one million peers of over 9000 experimental users of Facebook. The authors build a model for using randomized trials to uncover peer influences in social media. Abedi et al. (2014) study the optimal design of the retail network and marketing measures for new product introduction with the consideration of word of mouth. The authors derive the solution algorithms and characterize the optimal solution.

Medical treatment: SMA also plays a role in healthcare related activities. In particular, social media facilitates information exchange among individuals. Yan et al. (2019) study the scenario when patients have access to the health data of other patients and share experiences. The authors employ the theory of social-information-processing to show that positive comments and experiences, which may be shared through Twitter or other popular social sites, would affect the perceived treatment outcomes of patients.

For other applications of SMA, papers on SMA methods and remarks on the relationship between SMA and big data, refer to Appendix B.

Table 3.1 shows the summary of the papers reviewed under each topic/area, the corresponding methods employed for the social media analytics related analyses, and some insights developed in terms of the methods. From Table 3.1, we can see that the majority of studies either employ machine learning approaches or the statistical based methods in conducting SMA studies. Traditional optimization methods are also commonly seen. These three categories of scientific methods are hence the most commonly used and important ones for SMA. In addition, most topics/areas are highly related to the “market”. This is intuitive as social media platforms are the places for consumers in the market to express their views and for sellers to observe their behaviors. As modern SCOM is highly market driven (i.e. adopting the “pull process”), it makes full sense that the most commonly seen applications of SMA include forecasting, online reviews, product introduction and other marketing related operations analysis.

3.2. Blockchain technologies supported operations

Section 3.1 reports the systematic review on SMA. As this paper proposes the use of blockchain technology which is critical to enhance SMA, we review some related studies as follows. Note that as the field is very new, only very limited studies are currently published in SCOM. In the context of blockchain technology, Babich and Hilary (in press) comprehensively propose how the blockchain based technologies could be applied in SCOM. The authors propose many areas which they believe to be promising to explore. Chod et al. (2018) investigate the use of blockchain technology in supporting the financial aspects in the supply chain. The authors include features of blockchain operations (such as cryptocurrency) in their model. Wang et al., 2019b propose in the form of a discussion paper how blockchain may affect future operations of supply chains. The authors highlight the application of the theory of sense-making in their analysis. They conduct various personal interviews with several practitioners and experts related to traditional supply chain operations. They focus on revealing how the theory of sense-making can explain managers’ behaviors with the use of blockchain. Saberi et al. (2019) investigate one important functionality of blockchain, namely the smart contracting mechanism. The authors focus on how the blockchain technology may help to develop sustainable supply chains. Most recently, Choi (2019) studies the diamond authentication issue in the supply chain with the use of blockchain. The author analytically examines the impact of blockchain technology based diamond authentication schemes under different supply chain structures. This paper also examines the blockchain technology but the focal point is on its impacts on social media and SMA. This is totally different from the current reported studies in the literature.

4. Traditional social media (TSM) without blockchain technology

4.1. Enhancing SCOM by social media analytics

From the literature review, we have identified various areas where SMA has been explored in SCOM. In particular, we can easily see that most studies focus on sales/demand forecasting, promotion and advertisement, and logistics management. Other areas such as risk analysis (Asian and Nie, 2014; Choi and Lambert, 2017; Niu and Zou, 2017; Chiu et al., 2018; Choi et al., 2018b; Choi and Liu, 2019; Tian et al., 2019) for terrorists, stock returns forecasting, and product design are relatively under-studied.

In addition, as expected, the two major social media platforms that have been utilized for SMA are Facebook and Twitter. Table 4.1 summarizes the social media platforms which have been employed for studying SMA in the SCOM literature.

Table 3.1

Methods employed in the reviewed SMA studies for business operations.

Topics/Areas	Papers	Methods and Tools	Insights
Social influence	Aral and Walker (2014)	Behavioral experiments and statistics	A large-scale randomized experiment is conducted to identify the impact of tie strength characteristics and social embeddedness on influence.
	Guo et al. (2015)	Support vector machine	The method of support vector machines (SVM) is used to build a classifier for virtual community membership. Then a “two-stage probit least squares” (2SPLS) method is used to estimate the effects of social influences on virtual community membership.
	Gunnec and Raghavan (2017)	Optimization and genetic algorithm	Explicitly incorporating social network effects into the product design phase brings benefit. The genetic algorithm can yield high-quality solution.
	Srinivasan et al. (2017)	Statistics	Understanding the structure and nature of communication patterns of users in social networks is critically important for users, online social networking firms, and advertisers alike. Knowledge regarding the social network and network structure is needed in order to better understand the dynamics of communication in these networks.
	Chen et al. (2019)	Machine learning	Machine learning and simulation methods can be coordinated to perform “individual-level causal inference” and “social influence identification” in social media. Machine learning models are used to predict “user adoption behaviour”. Simulation is used to infer unobservable potential outcomes, and a counterfactual framework is used to identify the “individual-level social influence”.
Online reviews	Pekgün et al. (2018)	Optimization and game theory	Negative and positive reviews to be weighted differently in a consumer’s assessment of the valence of the posted reviews. Relative weighting of user reviews substantially affects optimal pricing decisions and profits.
	Chen et al. (2016)		It is important to capture the silent users’ comments. An “inverse probability weighting” approach can be applied to help
	Ramanathan et al. (2017)	Survey questionnaire and statistics	A loyalty and value-based network model is used to integrate operations, marketing and feedback through social media reviews. Social media reviews and unique service operations represent a significant influence on customer satisfaction.
	Dong et al. (in press)	Behavioral experiments and statistics	Positive reviews, factual reviews, and reviews appearing on social networks lead to “perceptions of greater benevolence, ability, and integrity” than negative reviews, emotional reviews, and reviews appearing on retailer sites, respectively. Analysis of covariance is used to examine the individual and joint effects of the review attributes on the “three review trustworthiness dimensions”.
Advertising and marketing promotion	Bimpikis et al. (2016)	Optimization and game theory	Effects of the network structure and the “word of mouth” on the outcome of marketing competition between the firms is studied by a game-theoretic model.
	Lobel et al. (2017)	Optimization and game theory	A symmetric Bayes-Nash equilibrium is used to study how to optimally attract new customers using a referral program.
	Lee et al. (2018)	Surveys and machine learning	The content-tagging methodology combines surveys implemented on Amazon Mechanical Turk with machine learning algorithms is useful for processing unstructured data (such as advertising content or product reviews).
	Ghose et al. (2019)	Behavioral experiments and statistics	The structural econometric model can be used to understand consumers’ preferences and costs on search engines to improve user experience under unstructured social media.
	Gu and Ye (2014)	Panel data and statistics	A panel data model that controls for regression toward the mean and heterogeneity in individual preference is effective to measure the influence of online management responses on customer satisfaction.
	Chen et al. (2015)	Machine learning algorithms and computational experiments	An improved hierarchical multiple kernel support vector machine (H-MK-SVM) is developed to integrate related data for feature selection from multiple correlated attributes and for ensemble learning in user response modeling.
	Besbes et al. (2016)	Optimization and live pilot experiment	The optimization problem that leverages both clickability and engageability is built and solved.

(continued on next page)

Table 3.1 (continued)

Topics/Areas	Papers	Methods and Tools	Insights
Logistics management	Fry and Binner (2016)	Optimization and algorithm	A Bayesian algorithm which enables the optimal evacuation to be conducted sequentially under “worsening conditions”.
	Yoo et al. (2016)	Field study and statistics	A field study that examines how information diffuses through social media networks embedded.
	Lam et al. (2016)	Panel data and statistics	Social media initiatives improve operational efficiency and innovativeness. A “system generalized method of moments” statistical approach can be applied to help.
	Fan and Niu (2016)	Grounded theory approach and statistics	The grounded theory approach is used to investigating the roles of recovery speed and failure severity in the service recovery process using social network platform.
	Hou et al. (2018)	Game theory	Using game theory to explore different competition scenarios (namely, the “Nash game” and “Stackelberg game”) for delivery service operations with the use of “social media”.
	Singh et al. (2018)	Support vector machine	Conducting text analysis via SVM to uncover the “cluster of words” which can indicate the major issues (e.g., product quality and flows) in the food supply chain.
Forecasting	Ballings and Van den Poel (2015)	Logistics regression, random forest, stochastic adaptive boosting, neural networks and support vector machines	The “Stochastic Adaptive Boosting” method outperforms the other methods in predicting increases in Facebook usage frequency.
	Lau et al. (2018)	Extreme learning machine	A parallel co-evolutionary extreme learning machine is used to enhance sales forecasting. consumer sentiments mined from big data can improve the accuracy of sales forecasting.
	Choi (2018)	Bayesian statistics	The use of social media data in fashion quick response supply chains is analysed.
	Cui et al. (2018)	Machine learning	Nonlinear boosting models outperform traditional linear models with the use of public social media data for daily sales forecasting.
New product development	Chan et al. (2016)	Mixed-methods including fuzzy AHP, TOPSIS	Multiple methods are needed to properly extract values of social media data.
Risk analysis	Klausen et al. (2018)	Statistics	Behavioral models can be used to track existing “extremist users” by identifying pairs of accounts belonging to the same user.
Product introduction and design	Aral and Walker (2011)	Behavioral experiments and statistics	“Randomized trials” can identify peer influences in social networks.
	Abedi et al. (2014)	Optimization and algorithm	The “generalized proportional hazard rate (GPHR)” model, describes demand diffusion across multiple markets and/or segments. The method can identify the optimal mix of marketing channels and expenditures in them over time.
Medical treatment	Yan et al. (2019)	Statistics	A “latent response model” is built to separately test the effects of each shared attribute information—effectiveness, side effects, compliance, and cost on patients’ treatment ratings.
Others	Huang et al. (2015)	Statistics and counterfactual experiments	“Counterfactual experiments”, with statistical analyses, demonstrate that leisure-related blogging has positive spillovers for work-related blogging.
	Sul et al. (2017)	Statistics and content analysis	The sentiment in social media postings can predict stock returns on future trading days by statistical methods. Three separate measures are used to better model sentiment. (1) the ratio of the “amount of negative sentiment to the total communication”. (2) a normalized ratio of the “overall positive or negative sentiment expressed”. (3) an unstandardized ratio of “positive to negative sentiment”.
	Ma et al. (2019)	Big data analytics	Using big data from Twitter to investigate the “overbooking crisis” in an airline.
	Syed et al. (2019)	Analytic hierarchy processing (AHP)	An AHP based “Identity Management Value Model” helps quantify the achievement of objectives on a social media site.

4.2. TSM examples and features

From the review, Facebook and Twitter are the two dominating TSM platforms used for social media analytics in SCOM analysis (see Table 4.1). In the following, we examine them.

As we can see from the literature review, SMA is especially prominent with Facebook and Twitter. This finding can partially be explained by the availability of their Application-programming-interfaces (APIs) which are publicly accessible online. A lot of software applications hence arise aiming to help get data from them and conduct further analyses. However, there are also challenges.

Twitter supports social media analytics as it works with Gnip to provide Twitter’s data available to companies all around the world to use. For general public, Twitter provides access to some data via its API. To be specific, by default of Twitter’s accounts, the

Table 4.1

The social media platforms used for SMA.

Social Media Platforms	Applications	Related References
Facebook	Sales/demand forecasting	Ballings and Van den Poel (2015), Cui et al. (2018)
	Social influence identification	Aral and Walker (2014), Guo et al. (2015), Gunnec and Raghavan (2017), Srinivasan et al. (2017) ¹ , Chen et al. (2019)
	Online reviews	Ramanathan et al. (2017), Dong et al. (in press)
	Product design	Aral and Walker (2011)
Twitter	Advertisement and marketing promotion	Lobel et al. (2017), Lee et al. (2018)
	Sales/demand forecasting	Lau et al. (2018)
	Social influence identification	Srinivasan et al. (2017), Chen et al. (2019)
	Online reviews	Ramanathan et al. (2017)
	Advertisement and marketing promotion	Chen et al. (2015)
	Stock returns forecasting	Sul et al. (2017)
	Logistics management	Fry and Binner (2016), Lam et al. (2016), Yoo et al. (2016), Fan and Niu (2016), Singh et al. (2018), Ma et al. (2019)
Blogs	Medical treatment	Yan et al. (2019)
	Risk analysis	Klausen et al. (2018)
	Online reviews	Pekgün et al. (2018)

¹ Some references use both Facebook and Twitter, e.g., Srinivasan et al. (2017) and Chen et al. (2019).

users' posts, mentions and replies (i.e. "Tweets") are public (even though individual users can modify to make some of their "Tweets" invisible for privacy reasons). It is noted that over 90% of Twitter's accounts are public and less than 10% are private (Batrincea and Treleaven, 2015). In addition, for those public accounts, Tweets are stored in a data exchange format called "JSON" (Javascript object notation) and they are available via Twitter's "Search API" which makes them available for social media analytics. Batch data (past) and real-time data are available via "Search API" and "Streaming API", respectively. It is important to note that APIs in Twitter are not fully open for any users and developers. There are restrictions, such as an upper bound on the API usage rate for individuals (Brooker et al., 2016).

Facebook, similar to Twitter, also provides its data via API. However, its privacy policy makes it more complicated for social media analytics. To be specific, Facebook stores data in the object format and provides different kinds of APIs, e.g., the "Keyword Insight API", "Search API", etc. It is known that for Facebook, many status messages are more difficult to collect compared to Twitter's Tweets because we need to obtain the authorization from users (or the users set it to be open) (Batrincea and Treleaven, 2015).

4.3. Problems of TSM platforms

From Section 4.2, we can clearly see the basic features of Facebook and Twitter. There are problems which are associated with them and other traditional social media platforms for SMA. We discuss them in more details as follows:

Data collection: Web crawling for data from social media platforms is not fully open and perfectly public. For example, Twitter imposes a rate limit for individual user (i.e. account)'s usage of the APIs for searching and getting data. Facebook has its own privacy control system which makes it even more complicated than Twitter for users to obtain data.

Incentive: At the very beginning, traditional social media platforms provide a free place for users to get together and have fun. As such, in most cases, traditional social media platforms would not provide very strong incentive to entice engagement and faithful participation of users. Nowadays, Youtube and Facebook Live would have some incentive schemes but arguably the sharing of benefit is relatively limited and lacks transparency (Mire, 2018).

Missing data: Social media data may be incomplete with many missing details. Some data are of poor quality owing to the veracity nature of social media data. All these create non-trivial challenges. Some traditional methods of ignoring the missing data would simply lead to biases. Some advanced methods are hence proposed to help (Chen et al., 2016). However, missing data is still missing and this problem is critical.

Data authentication problem: There are "bot" problems in which information posted online in social media need not be real. Companies can use machines to add comments or create posts by paying some individuals. As a result, fake information and falsified data are rather common (Holsapple et al., 2014). This is an important issue and Forbes reports that Facebook has recently been very busy dealing with the fake account issues.⁸

High volume and velocity of data: Social media data is a typical example of big data, with which the most fundamental characteristics include high volume in size and high velocity in applications requirement (Choi et al., 2018a). As a result, traditionally, the right software architecture and storage technology must be present to overcome this challenge.

⁸ <https://www.forbes.com/sites/andrewarnold/2018/05/29/how-social-media-can-benefit-from-blockchain-technology/#3a85124b1018> (accessed: 16 November 2019).

Table 4.2

Problems associated with the social media platforms (in Table 3.1).

Social Media Platforms	Problems	Related References
Facebook	Privacy issues of Facebook are more complicated than Twitter, making it even more difficult to get the data.	Batrinca and Treleaven (2015)
Twitter	Not totally open and available without restrictions to users. There is a rate limit for individual entity (i.e. account)'s usage of APIs.	Brooker et al. (2016)
Traditional Social Media Platforms (including Facebook and Twitter)	Incentive: In most cases, traditional social media does not provide strong enough incentive to entice engagement and faithful participation of users.	Stieglitz et al. (2018), Mire (2018)
	Unstructured data: Social media data are in different formats, including texts, photos, videos, sounds, etc.	Cui et al. (2018)
	Missing data: Data may be incomplete or of low quality owing to the veracity nature of social media data	Stieglitz et al. (2018)
	High volume and velocity of data: It is necessary to find the right software architecture and storage technology	Choi et al. (2018a)
	Data authentication problem: Fake information (the “bot problem”), falsified data.	Holsapple et al. (2014)

Unstructured data: Social media is a source of different kinds of data, including texts, pictures, videos, and sounds. In almost all cases, data are not given in a structured manner. This makes the use of data more difficult, especially for scientifically sound analysis for operations management. In fact, Leetaru (2019b) discovers that most currently used social media analytical tools focus mainly on texts but not on graphics or videos. Even for those which examine graphics or photos, they only examine logos. This means the full picture is missing from the scene.

Table 4.2 summarizes the problems associated with the use of Facebook, Twitter, as well as other traditional social media platforms for social media analytics.

5. Blockchain-technology-supported social media (BSM)

5.1. Real BSM platforms

After exploring the deficiencies of the traditional social media platforms in Section 4, we now examine the blockchain technology supported social media platforms in the real world. In fact, for each major TSM platform, there is usually a counterpart which is widely and commonly known.

Forexing is usually treated as the BSM platform counterpart of Facebook. It has functions very similar to Facebook by allowing users to post their own content materials for sharing on the platform. Most importantly, after posting the materials online, when other users express “like” towards the materials or content, the posters will receive rewards in the form of cryptocurrency, which is a flagship application of the blockchain technology (from its gene in bitcoin). Forexing also features the Forexing crypto-bank, which can help users to create content with the needed financial support and assistance.

For the TSM Twitter, we have Peepeth as the BSM counterpart. It is known that Peepeth employs the Ethereum blockchain to support its platform. For Twitter, we have Tweets whereas for Peepeth, we use “Peeps” to represent the posts. With the blockchain technology, “Peeps” exhibit the feature that they cannot be amended, edited, changed or deleted. As a result, permanent data as well as trustworthy data records are guaranteed. This is critically important to ensure data authenticity and quality.

For video sharing, Youtube is probably the most well-established TSM platform. With the blockchain technology, a BSM called Dtube emerges. Dtube is a decentralized video sharing platform supported by the STEEM Blockchain. It applies the IPFS P2P network technological model. It is similar to Youtube in its major applications. However, one of its strengths is to allow users to share the financial benefit in the form of “Steem currency”. The amount of financial benefit received is directly proportional to the user engagement. It also supports the choice of “advertisement-free-platform” set by users.

The BSM platform Indorse is similar to the TSM platform Lindedin. The major difference is that Indorse provides cryptocurrency as rewards when users expand their networks, endorse other users’ skills, etc. It is reported that the Indorse network tends to be more reliable and honest as “reputation” counts. Observe that there is an artificial intelligence (AI) chatbot in Indorse to validate details of the users in real time. This enhances authenticity.

For sharing photos, Instagram is the most popular TSM platform. The BSM platform Steepshot also aims to offer photo sharing functions. The major difference is that, Steepshot provides incentives to users who post photos in the form of cryptocurrency. Again, the incentive relates to the engagement of users.

Table 5.1 summarizes the BSM platform counterparts of the major TSM platforms.⁹ The roles played by blockchain technology are also concisely shown.

⁹ Note that the existence of these BSM counterparts is well-reported and noticed in practice, see Mire (2018) and Radar (2018).

Table 5.1

The blockchain technology supported social media platforms and roles of blockchain.

TSM	The BSM Counterparts	Roles of Blockchain
Facebook	Forestring	Forestring has functions similar to Facebook by allowing users to post their own materials for sharing. Interestingly, when other users like the materials or content, the posters will receive rewards in the form of cryptocurrency. There is even a Forestring crypto-bank which provides financial supports to content creators if needed.
Twitter	Peepeth	Peepeth employs blockchain technology (P.S.: The Ethereum blockchain) and the posts called “Peeps” cannot be altered, changed or deleted. So, permanent data as well as trustworthy data records are guaranteed.
Youtube	Dtube	DTube is a decentralized video sharing platform supported by blockchain (P.S.: the STEEM Blockchain). It is similar to Youtube and it allows users to share the financial benefit of in the form of “Steem currency”. It supports the choice of advertisement free by users.
Lindedin	Indorse	Indorse is similar to Lindedin but it provides cryptocurrency as rewards when users expand their networks, endorse others’ skills, etc. The network tends to be more reliable and honest as “reputation” counts. There is an artificial intelligence (AI) chatbot to validate details in real time.
Instagram	Steepshot	Steepshot has a similar function as Instagram while there are incentives to users who post photos in the form of cryptocurrency.

Table 5.2

How blockchain technology helps social media platforms to support SCOM.

Topics/Areas	Papers	Requirements	How BCT Can Help?
Social influence	Srinivasan et al. (2017) Dong et al. (in press)	Better understand the dynamics of communication in these networks Acquire Online review characteristics and trust	BTC enhances the data transparency. People can feel free to trust the information in the blockchain.
Advertising and marketing promotion	Bimpikis et al. (2016) Lee et al. (2018)	Gather vast amounts of data regarding consumers’ preferences and the structure and intensity of their social interactions for targeted advertising Utilize unstructured data	BCT enables advertiser acquired the consumers’ preferences and their social interactions more easily. BCT can organize data in a more structured way which makes the respective data usage and analysis easier.
Logistics management	Fry and Binner (2016) Yoo et al. (2016)	Emergency evacuations using social media Examine how effectively information diffuses through social media networks embedded in these platforms	BCT structure can increases information diffusion efficiency. BCT increases information diffusion efficiency.
Risk analysis	Klausen et al. (2018)	Track existing extremist users by identifying pairs of accounts belonging to the same user	BCT helps identify the user’s information and guarantees the authenticity.
Product introduction and design	Aral and Walker (2011) Abedi et al. (2014)	Create social contagion Identify the available retail facilities to carry the product.	BCT can increase social influence by decentralized ledger. Every node will be informed. BCT enables users to get the updated information timely.
Medical treatment	Yan et al. (2019)	Eliminate health information asymmetry and improve patients self-care engagement	BCT guarantees data transparency and enable patient to access others experiences more easily.
Others	Sul et al. (2017) Syed et al. (in press)	Prediction of stock returns on future trading days based on the sentiment in social media postings Identity management objectives	BCT saves permanent data record and enhances data transparency. The distributed decentralized platform facilitates information sharing. BCT can solve the problem of data authentication and fake information issue.

5.2. How blockchain technology helps

After noting that in the real world, virtually every TSM platform has a BSM platform counterpart, in which some additional and critical functions supported by the blockchain technology are present. In the following, we discuss how the blockchain technology can overcome or ease the problems raised in [Section 4](#).

First of all, in [Section 3](#), we present a summary of the methods and insights derived from the reviewed SMA papers in [Table 3.1](#). In [Table 4.2](#), we show the problems associated with each major social media platform. From them, we further explore how blockchain technology can play a role to enhance some of the discussed methods. [Table 5.2](#) shows the results.

From [Table 5.2](#), it is crystal clear that the blockchain technology can overcome many problems, including those associated with data authentication, data transparency, and information diffusion, etc. All are important and critical for SCOM. In addition to these reviewed methods related to SMA that blockchain can help, in the following, we discuss some general areas in which the BSM, with its features supported by blockchain, can enhance SMA.

Regarding difficulty in getting the data: The blockchain technology helps create a permanent data record which can be publicly available. This directly enhances data transparency, supports SMA, and also facilitates the use of information along the supply chain. This is crucial for improving operations with the use of social media. Sola is a BSM platform, which advocates the freedom of information and its distributed decentralized platform facilitates information sharing ([Mire, 2018](#)). It hence helps address

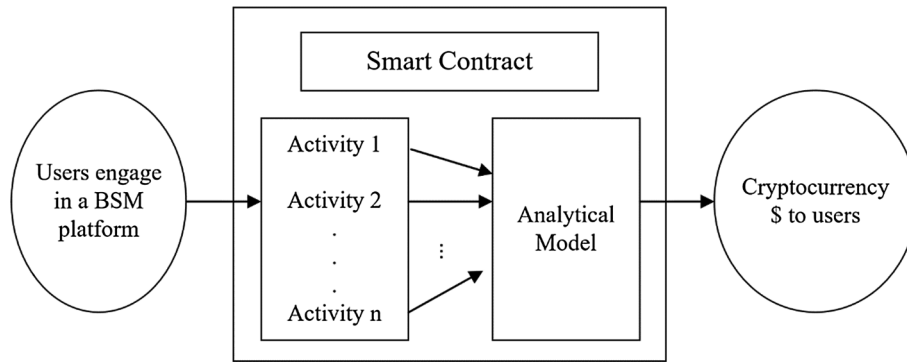


Fig. 5.1. The use of smart contracting for granting cryptocurrency to BSM users.

the data collection problem associated with the TSM platforms.

For lack of incentive to entice engagement and faithful participation of users: This problem can be fully addressed by the blockchain technology because it supports cryptocurrency. Many BSM platforms offer cryptocurrency incentives to users, in which the amounts are related to their levels of participation and engagement. BSM platforms such as Indorse, Dtube, Steepshot, Killi, Sapien, Steemit, etc. all provide incentives in the form of cryptocurrency to ensure users get compensated for their data and content. Fig. 5.1 shows how the blockchain-based smart contract (a computer program) can help to support this cryptocurrency incentive scheme to entice users to faithfully participate in the BSM platform related activities. Note that in Fig. 5.1, the analytical model represents the scientific model with formulas to help determine the right amount of cryptocurrency to be granted to each user based on her corresponding participation levels in different activities.

Regarding the unstructured data: When datasets are kept in the blockchain, it is easier for social media analysts to think of a way of exploring them by the right approach. If learning is needed, the amount of data provided by the BSM platform will help to improve the effectiveness with the use of data. Plus, most blockchain technology based databases organize data in a more structured way which makes the respective data usage and analysis easier.

For the problem of missing data: The blockchain technology can help to provide the long history of data for checking and verification. The amount of data available will be more sufficient and this helps with dampening the missing data problem.

Addressing the “high volume and high velocity” challenge: This requires the adoption of techniques in big data analytics (Choi et al., 2018a; Guha and Kumar, 2018). Having said that, the BSM platform may also provide a way to enhance the respective SMA because blockchain can facilitate information dissemination in a more transparent way (Sodhi and Tang, in press). This may facilitate the collection and retrieval of data for further processing in SMA.

For the data authentication and fake information issue: This challenging issue is well tackled by the blockchain technology. To be specific, for many BSM platforms, user identity is verified and is real. For instance, Civic is a BSM platform offering digital user identity verification services. The data and contents created by users are also recorded by the transparent blockchain system with permanent records. All these features would make data authentic and trustworthy. This will lead to more accurate SMA results to support business operations decisions. It is reported that SoMee is a BSM platform which adopts the blockchain technology to secure user data cryptographically. Moreover, the BSM platform Sapien uses blockchain to lift the level of veracity and authenticity of its posted content (Mire, 2018).

For the problem of data island: Each enterprise has its own data. Through the use of blockchain technology, data among members can be shared in a more transparent way. This directly leads to the more accurate characterization of customer features (e.g., the users of Facebook). It helps to make many market driven activities, from demand forecasting to advertising, more accurate for the targeted customers.

Guarantee the freedom of speech: In many traditional social media platforms, what we read from the posts by users may actually be censored. When the published content damages the interests of a party or affects the image of a party, even if the content is authentic and credible, it will be deleted in many cases. As a result, the freedom of speech is not well-supported and this would lead to biased data source for SMA. The blockchain technology supported social media platforms can enhance the freedom of speech by ensuring the details are real, uncensored and clear. It hence allows users of social media to truly express themselves without the central control of the platform. Using the respective data can improve the quality of recommendations by SMA.

Privacy protection: Traditional social media platforms adopt the centralized database approach. When they are being attacked by cyber criminals, users’ personal data will be lost. This creates some doubts to whether real data should be kept on the social media platforms. The blockchain technology is a decentralized ledger which adopts the distributed network to store data. It is known to be very secure and it is basically impossible for cyber criminals to attack. With user privacy being well-protected, users are willing to put more real data that they want to share on the social media and the data that can be used for SMA will be of a higher quality.

5.3. Graphical illustrations and further discussions

Based on the above discussions, Figs. 5.2 and 5.3 depict the scenarios with TSM and BSM, respectively.

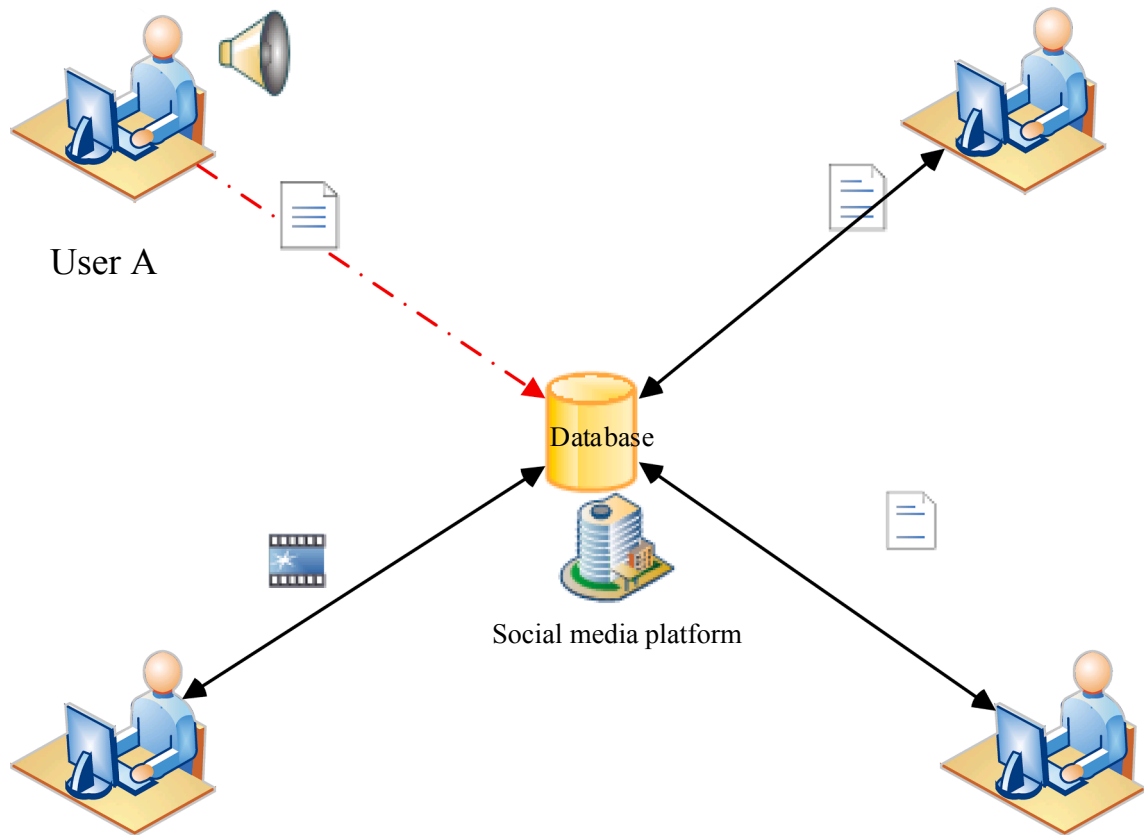


Fig. 5.2. The traditional social media (TSM) platform.

From Fig. 5.2, we can see that in the TSM, every user posts messages or gets information through the platform. All the user data are stored in and manipulated by the central database. For example, when User A posts a new message, it may actually be censored by the platform. The other users can only access the new message through the platform.

From Fig. 5.3, we can observe that in the BSM, datasets of users are stored by a decentralized ledger. When User B posts a new message, everyone in the blockchain system is informed, as shown by the red dot lines. The blockchain technology helps create a permanent data record which can be publicly available and achieve data transparency as shown in the blue dot lines. The information cannot be edited by the social media platform without the consent of all the users. It hence guarantees the freedom of speech. It also helps to solve the problem of missing data and ensure data authenticity and security. What is more, BSM provides an incentive to entice engagement and faithful participation of all users. The users can get compensated for their “contribution” (e.g., in providing data and creating content) in the form of cryptocurrency.

Figs. 5.4 and 5.5 illustrate the major steps involved in SMA with the use of TSM and BSM, respectively.

From Fig. 5.4, it is crystal clear that in the case with TSM, companies which conduct data analytics on the social media can crawl data from the platform. Since the problems of missing data and unstructured data may occur, companies should rebuild the missing data and standardize the data, and then de-duplicate the data. In order to solve the data authentication and fake information issue, they also need to verify the data before conducting the feature extraction. Finally, the well-processed data could be used for data analytics.

From Fig. 5.5, we can observe that in the case with BSM, since blockchain advocates the freedom of information and its distributed decentralized platform facilitates information sharing, the data collection problems associated with the TSM platform are well-addressed. In addition, the blockchain technology helps to create a permanent data record which can be publicly available; this addresses the problem of missing data. Most blockchain technology based databases organize data in a more structured way than the traditional databases, which makes the respective data usage and analysis easier. The data authentication challenge and fake information issue are well tackled by the blockchain. So, the BSM based SMA can substantially improve the efficiency of data analytics. Comparing the required steps in the TSM-based SMA and the BSM-based SMA (i.e., Figs. 5.4 and 5.5), we can find that the whole SMA process is more streamlined with the help of blockchain.

Fig. 5.6 further shows how the blockchain technology can enhance social media platforms to support SMA for SCOM. In particular, the benefits for SMA by using BSM are highlighted one by one.

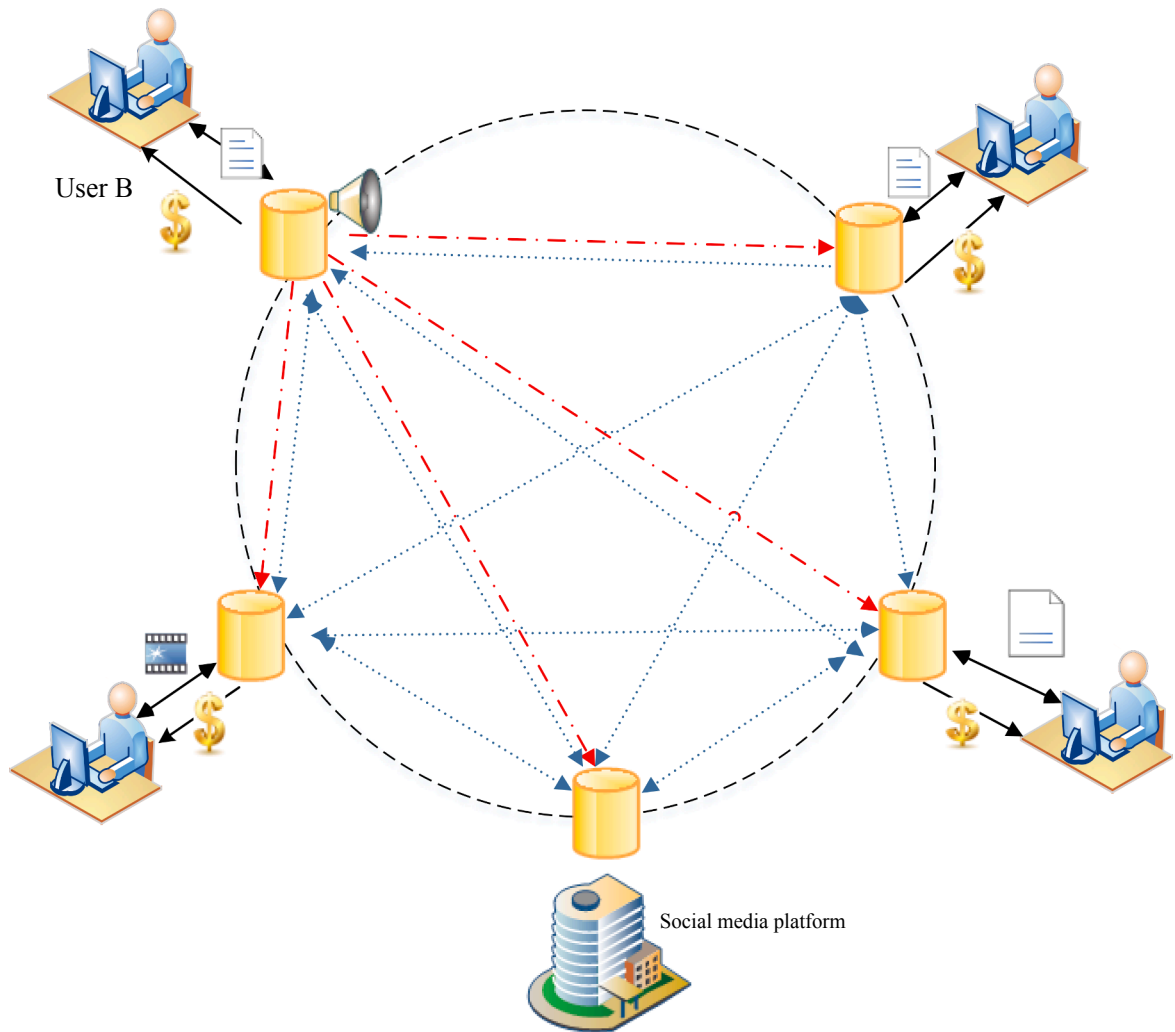


Fig. 5.3. The blockchain-based social media (BSM) platform.

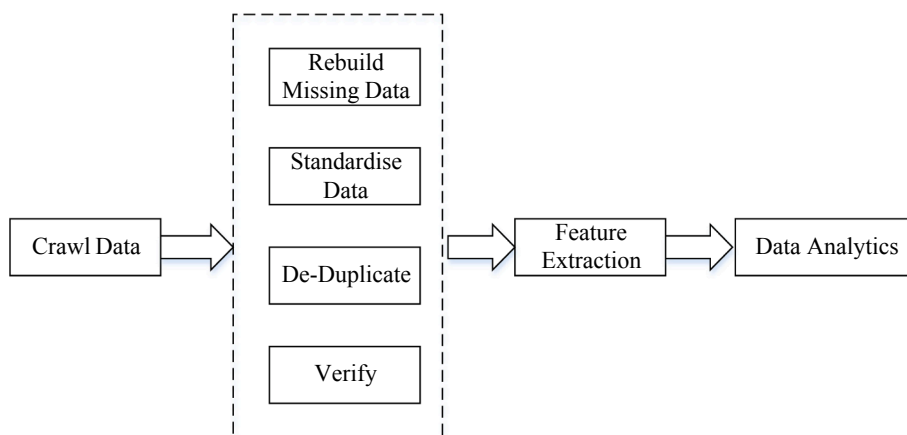


Fig. 5.4. TSM based SMA.

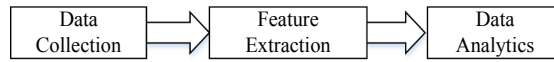


Fig. 5.5. BSM based SMA.

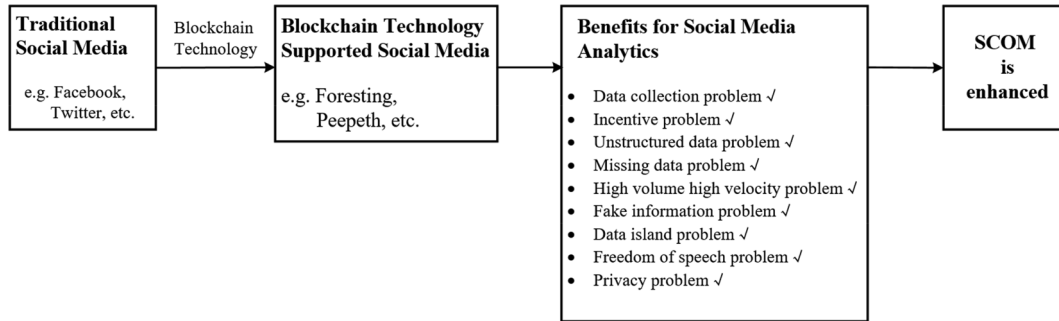


Fig. 5.6. How the blockchain technology enhances SMA for SCOM.

6. Future research agenda

From the literature review and the above detailed analyses, we identify a few areas which deserve future deeper explorations. Studying them in the future would involve different methods and approaches (e.g., analytical, computational, empirical, etc.), as detailed below.

More empirical SCOM research in SMA: As evidenced from the systematic literature review results, currently, there are much more analytical studies on SMA published in top mainstream analytical SCOM journals than the empirical counterparts. It directly means that more empirical SCOM research in SMA should be conducted as there are obviously lots of opportunities for further empirical studies in the future. In particular, currently, there are very few SMA studies with relevance to and emphasis on empirical SCOM theories. However, obviously, from the organization perspective, SMA is associated with many classic SCOM theories (Anand and Gray, 2017) such as the resource view based theory (Hitt et al., 2016), and the transactions cost theory (Grover and Malhotra, 2003). These hence provide the theoretical ground for future empirical SCOM research on SMA.

Employing BSM platforms for SMA: For applications of SMA, currently, almost all studies focus on TSM platforms such as Facebook and Twitter. It will be critically important to study the use of BSM platforms for SMA. In particular, it will be interesting to explore how the cryptocurrency incentive schemes affect the user participation in social media and how that will affect SMA, etc. Even though we argue that the blockchain technology can bring many benefits, whether there are any problems or negative impacts should be examined. Moreover, to conduct SMA on the BSM platforms may involve some new technological challenges, which also deserves deeper investigation.

Quantifying the benefits of blockchain technology for SMA: In this paper, we propose the use of BSM and argue that it is useful for SMA. However, for real world supply chain operations, conducting SMA is not without cost. It is thus important to quantitatively explore the benefits of blockchain technology for SMA, and the associated factors. The result will support new investment decisions of companies when they plan to conduct SMA on BSM platforms.

Innovative business models: SMA supports many innovative business models. Among them Groupon is one area which is highly related to social media analytics (Wang et al., 2018). How blockchain technology supported social media platforms will affect innovative business models such as Groupon and others is under-explored and deserves further explorations.

Methods of analysis: It is reported that currently, the managerial recommendations based on SMA for the same dataset can be totally different (Leetaru, 2019a). This is a direct result of the different algorithms employed in different practical SMA tools. Many tools currently employed simply put “speed” as the priority but they overlook the importance of accuracy and data quality. In future research, more emphasis should be put on exploring how the methods of analysis can be chosen with respect to quality and accuracy of the recommendations. Moreover, how the blockchain technology may play a role also deserves deeper investigation.

7. Conclusion

7.1. Summary and concluding remarks

Nowadays, social media analytics (SMA) is a part of many business operations. There is no doubt that it also helps to support many activities in the supply chain. However, the use of SMA for SCOM is far from perfect. Problems such as data accuracy (e.g., fake data), user privacy, data security, etc are all present.

Motivated by the fact that (i) SMA is important for SCOM, (ii) the traditional social media (TSM) platforms are far from perfect, and (iii) the “blockchain technology supported social media” (BSM) platforms have emerged, we have studied in this paper whether and how the BSM would enhance social media analytics for SCOM. To be specific, by reviewing papers published in leading SCOM

journals, we have found the applications and limitations of SMA for SCOM. Then, we have conducted real case studies to examine the shortcomings of the TSM platforms and uncovered features of their BSM counterparts. We investigate how the blockchain technology would potentially improve the use of SMA for SCOM. Finally, we have proposed a few important future research directions.

This paper positions itself as the pioneering study, which combines literature review and original real case research, to uncover how the use of blockchain technology would enhance SMA for SCOM. We believe that the derived findings are valuable to both the practitioners and academicians. It also contributes to the SCOM literature, especially in the SCOM-technology interface.

7.2. Limitations

We admit a few limitations. First of all, for the systematic review, even though we have tried our best to be accurate, some papers might still be missing. Second, this is an exploratory study and many BSM platforms have not yet been fully developed. As a result, our proposals and discussions are based on our own observations and other reported studies. In fact, we have searched those BSM platforms and tried to see if major enterprises like Apple, LV, Walmart have marked their presence. However, we cannot find any at the moment. Readers should thus interpret our findings with care and we believe that more industrial observations will be needed to double check the results in future studies. Third, for the data that we have considered in this paper, we refer to those “public data” that can available from the social media platforms in which companies can “crawl”. However, SMA may also refer to those “private data” that the companies possess from their own social media accounts. We argue that the difference in the availability and usage of this kind of “private data” should be similar for the cases with BSM and TSM. But further studies may still be needed. Last but not least, social media analytics with the use of blockchain can support many important operations in the sharing economy, such as rental service platforms (Sun et al., *in press*), mobile-app-web dual channel retailing (Choi, *in press*), fighting counterfeiting (Choi, 2019; Wang et al., *in press*), and enhance sustainable operations (Shi et al., *in press*; Cai et al., 2019; Choi and Luo, 2019; Li et al., *in press*; Fung et al., *in press*; Guo et al., 2020). These should deserve deeper explorations in the future. Moreover, a multi-methodological research approach (Chiu et al., 2011, *in press*; Choi et al., 2016, 2019a; Sheu and Choi, 2019; Guo et al., 2020) can be employed during the research process so as to reveal more scientifically sound results and insights.

CRedit authorship contribution statement

Tsan-Ming Choi: Conceptualization, Investigation, Methodology, Validation, Formal analysis, Writing - original draft, Visualization, Writing - review & editing. **Shu Guo:** Investigation, Writing - review & editing. **Suyuan Luo:** Investigation, Writing - review & editing, Validation, Visualization.

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Appendix A. Details of Fig. 1.1

In Fig. 1.1, we describe the common features of blockchain through four layers. Usually, users interact with the system through the top layer, called the Application Layer, which is similar to various software interfaces in the computer. The Application Layer is the BTC supported platform that people can actually use directly, e.g., the diamond authentication platform, social media platform, financial platform, etc. When people use this layer, cryptocurrency or other transaction will easily be involved. For example, people can earn or use cryptocurrency in a financial platform and a third party will also help to record the transaction. The cryptocurrency or other transactions will spread or used in other layers. The second layer is the Extension Layer which is similar to an extended application with analytical power. It is designed to make blockchain products more powerful and useful. For example, people can use the smart contract or the BSM to share and store data. For the smart contract, if certain conditions are met, the contract will automatically execute, such as automatic transfer of securities, automatic payment, and so on. The third layer is the Network Layer. By BCT, the data is stored in a decentralized mode. The node and the shared news are guaranteed to be authentic and secure through crypto mining, voting and other consensus algorithms. The bottom layer is the Storage Layer, in which information is stored in blocks and establish the chain. The data is verified and recorded by every node in the chain, which guarantees the permanent and transparent ledger of data is kept.

Appendix B. More reviews on SMA

Other applications: Other related studies on SMA's applications include the following works. Huang et al. (2015) explore the blogging behaviors of workers in a company. The authors examine the workers' consumption behaviors as well as content creation in social media. They interestingly show that if companies impose restriction on leisure blogging, the employee performance will be negatively affected. Sul et al. (2017) demonstrate empirically, by using millions of Twitter posts (on individual companies), how Twitter postings would affect the stock returns of the corresponding companies. They prove that for companies with a sufficiently small number of followers, the Twitter postings have a significant impact on the respective companies' stock-returns within a 20-day

period. Ma et al. (2019) employ Twitter data on an airline to conduct analysis on the overbooking challenge. The authors propose how the big data from social media can effectively enhance revenue management for airline operations. Motivated by the fact that identities of individuals on social media can be faked, Syed et al. (in press) study the identity management issue on social media. The authors argue that on social media, proper identity management needs a value perspective. They conduct a multiple-objectives decision making analysis. Using Facebook as an example, they quantify the achievement of their proposed method.

Methods for SMA: In addition to the applications we reviewed in Section 3.1, since SMA relates to the use of social media to extract, manipulate and process data to generate important insights and knowledge, many different approaches and methods for SMA are discussed in the literature. For instance, in terms of methods, Chan et al. (2016) propose a hybrid approach to manipulate social media data which are unstructured, subjective, and diverse. The authors present a case study (based on Samsung Mobile's Facebook page) to show the effectiveness of the proposed method. Chen et al. (2016) develop a method, called IPW (inverse-probability-weighting) to reduce the bias derived from the incomplete nature of many online review data. They conduct a real case analysis on the online reviews in Blockbuster.com and show that their proposed IPW method is effective and practical. Massimino (2016) explores techniques on web-crawling. The author first defines important concepts for web-crawling. They then give specific examples and highlight some probable problematic areas. Sodero and Rabinovich (2017) explore flash sales (FS) business operations on the Internet. FS refers to the case when retailers purchase excessive inventories of a product from the spot market with predetermined time duration. The authors establish a demand prediction model which considers the points made by consumers in social media (including forum posts) associated with different deals.

SMA and big data analytics: As a remark, SMA is also related to big data analytics and emerging technologies in the Industry 4.0 era (Tang and Veulenturf, 2019). In this domain, Waller and Fawcett (2014) study how emerging technologies such as additive manufacturing (also called "3D printing"), which are connected to both the Internet and the social media online communities, would affect supply chain operations. The authors focus on the reduction of cycle time upon the implementation of these technologies. Schoenherr and Speier-Perro (2015) examine big data analytics in supply chain systems by conducting a survey among professionals in supply chain management. The authors discuss future research on the topic. Zhan and Tan (in press) investigate how the use of big data can improve supply chain operations. The authors establish a well-integrated analytical infrastructure for this purpose. Klumpp and Zijm (in press) study social issues with humans when logistics operations are under the transition to artificial intelligence (AI) automation. The authors propose a theoretical framework and discuss how human trust to AI may affect technological innovation.

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