Social Media in Operations and Supply Chain Management: State-of-the-Art and Research Directions

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Recently, industrial and academic communities in the operations and supply chain management (OSCM) field are paying increasing attention to social media. However, the value of social media in OSCM is quite unclear, and more investigations are still needed. To pave the way for a directed future research, this paper systematically reviewed and synthesised 152 peer-review journal papers to identify research focus and gaps in this area, supported by an appropriate conceptual framework. The result reveals that the research interests in this area have increased dramatically within the last decade across various industries and regions. Different companies' OSCM activities, such as sourcing and delivery, can benefit from employment of social media. This paper also indicates that future research can explore the value of social media in sourcing, delivery, product return and reverse logistics activities, forecasting and inventory management, and product development and production.

Keywords: social media; social networking site; Twitter; Facebook; WeChat; operations management; supply chain

1. Introduction

Social media concerns 'a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user generated content' (Kaplan and Haenlein 2010, 61). It has dramatically changed the way individuals create, communicate, and collaborate (Aral et al. 2013), with channels being formed to enable individuals to connect and share information from social applications (Ahmed et al. 2019). Social media also plays an important role for organizations. Internally, social media allows communication between employees to promote speed, visibility, and traceability inside companies (Leonardi et al. 2013). Externally, social media allows companies to communicate with customers or the wider public (Gu and Ye 2014), enabling them to build good customer relationships (Chae 2015).

The value of social media for business management has been investigated from multiple disciplinary perspectives. For example, in information management, reviews by Ngai et al. (2015) and Alavi and Denford (2011) suggested social media can improve the efficiency of information sharing and knowledge management. In human resource management, Poba-Nzaou et al.'s (2016) review identified the challenges of adopting social media in organisations' human resource management activities. To consolidate and extend the previous literature, this paper examines social media's value for Operations and Supply Chain Management (OSCM), an aspect that appears to be poorly understood despite calls for research from multiple scholars (e.g. Lam et al. 2016; Chae 2015). Although the literature shows some evidence of social media being employed in OSCM, such as in vehicle routing (e.g. Albuquerque et al. 2016) and supplier selection (e.g. Lin et al. 2018), in practice few managers understand how to use social media for supply chain planning (Natoli 2013). A distinctive feature of this research area is its lack of consolidation through detailed literature reviews, providing justification for the systematic review conducted in the current study. The aim of the paper is to identify the landscape of current social media research for OSCM, from which viable research directions will be generated. Four research questions (RQs) are proposed to address this aim:

RQ1: What kind of OSCM activities can benefit from the social media?

RQ2: What are the functions of social media in OSCM activities?

RQ3: How can different social media functions influence OSCM activities?

RQ4: What are the viable future research directions in this area?

The article is organised as follows. In section 2, the method by which the systematic literature review was conducted is introduced. In section 3, results generated from the review are presented, including the analysis of current landscape of research in this area and the

research topics summarised based on different OSCM activities and different social media functions. In section 4, the in-depth mechanisms of how different functions of social media can influence the performance of different OSCM aspects are discussed. In section 5, the future research directions are generated based on the review results, with propositions proposed. The managerial implications, limitations and conclusions of this paper are summarised in section 6.

2. Methodology

A systematic review of English language articles was conducted following the procedures prescribed by Denyer and Tranfield (2009), locating all published and in-press peer-reviewed journal articles through to the end of June 2019. The keywords in Table 1 were developed from a pilot review of literature, feedback from an interim conference paper (Huang et al. 2018), and a subsequent team discussion. We acknowledge that terms such as 'social media' and 'social networking site' are often used interchangeably (e.g. Trusov et al. 2009), and both were included. We drew also on Kaplan and Haenlein (2010), who employed 'Web 2.0' and 'user generated content' as key attributes of social media, and on Kozinets' (2002) netnography article which discussed 'online community'. Finally, we included several of the most prolific commercial applications of social media. All these terms were combined with OSCM concepts, and were used to search papers in their title, abstract and keywords from three frequently used databases, namely EBSCO, ABI/INFORM, and Scopus.

[Table 1 near here]

To compliment this broad database search, we also focused on specific journals related to OSCM field and listed in the Operations and Technology Management area in the Academic Journal Guide 2015 (Chartered Association of Business School 2015, 38-39), applying the search terms to the full article text.

An initial search identified 1475 papers from databases, and 492 from OSCM journals. After checking duplication, 1253 unique papers were identified. We then checked the relevance of papers, and the papers were first filtered by reviewing abstracts and, where appropriate, full text reading. We only selected papers whose context was related to OSCM and which contained substantive evidence regarding OSCM performance improvement through social media usage. Specifically, based on our exclusion criteria (in Figure 1), we removed those papers which (1) had a research context irrelevant to OSCM, (2) had no clear connection between social media and OSCM, and (3) only contained passing reference about social media usage in OSCM to support papers' arguments. As a result, 136 relevant articles were selected. To ensure that the search was comprehensive, the reference lists of each paper were reviewed, along with recommendations made by the databased providers for 'related articles'. This yielded a further 16 papers. The full process is shown in Figure 1 and led a sample size of 152 papers.

[Figure 1 near here]

To answer the **RQ1** and **RQ2**, the coding process categorised and synthesised papers from two perspectives. The papers were firstly coded from the OSCM perspective, summarising different OSCM *activities* observed in the research (e.g. sourcing, delivery, etc.) to answer **RQ1**. To answer **RQ2**, the papers were coded from the social media perspective,

summarising different *functions* of social media, such as using social media to facilitate 'inter-organisational information exchange'. After that, to answer **RQ3**, a conceptual framework containing two mechanisms about how different social media functions can influence OSCM activities were proposed. Finally, to answer **RQ4,** research gaps were generated from review results, with the aid of the conceptual framework. The first three **RQ**s address our aims on depicting current status of social media research in OSCM, while the **RQ4** aims to summarise the viable future directions.

3. Results

In this section we firstly provide an overview of overall landscape of this field by summarising temporal, sectorial, and geographic trends. Next we link the published works to different OSCM activities, before finally providing a detailed categorisation by social media functions.

3.1 Overview

We identified the earliest relevant article in 2008, with steady growth commencing five years later (Figure 2). Whilst a plethora of journals have published articles in this area, we note that repetitive publication is particularly found in OSCM journals (Table 2). Figure 3 shows the focal sectors for the research, based on the North American Industry Classification System (US Census Bureau 2017), while Figure 4 depicts the countries/regions where the research studies were investigated and/or where the empirical data for the research was collected from. Combined, these overview findings suggest social media for OSCM is growing in research

interest across a variety of journals, industrial sectors, and geographies, underlining the relevance of the current study.

[Figure 2 near here]

[Table 2 near here]

[Figure 3 near here]

[Figure 4 near here]

3.2 OSCM activities

To answer **RQ1**, papers were coded from the perspective of OSCM activities. We carefully and rigorously developed our coding scheme based on several iterative rounds of reading and coding all sampled papers as well as team discussion. The scope of each code is described in Table 3. We first employed the widely used Supply Chain Operations Reference (SCOR) model (APICS Supply Chain Council 2017) as a framework to code the papers, and five generic OSCM activities, namely 'planning', 'sourcing', 'making', 'delivery' and 'return', were selected and adapted to build our initial coding scheme. However, after the first round of coding, we found there were papers focusing on (1) marketing-OSCM interface and (2) product development which are not addressed in SCOR model. As previous literature on OSCM indicated that marketing and product development are also important activities in OSCM

(Mentzer et al. 2001; Cooper et al. 1997), we extended the coding scheme. A new code, 'marketing', was included to cover activities related to marketing-OSCM interface. In addition, we merged topics related to social media applications in product development and product manufacturing, and changed the 'making' code to 'product development and production'. Moreover, SCOR model focuses on physical OSCM, but substantive selected papers were found related to service supply chain, such as bank services, insurance, public transportation (e.g. railway and underground) etc. Therefore, we extended the scope of each code to include service supply chain elements by referring existing literatures (Ellram et al. 2004; Baltacioglu et al. 2007; Giannakis et al. 2018). After the second round, however, we found 'planning' code was too broad to describe different planning activities. Thus, we decomposed all different planning activities shown in the sampled papers into three components, namely (1) demand forecasting and inventory management, reflecting planning in sourcing and making activities, (2) vehicle scheduling and transport arrangement, reflecting planning in delivery activities, and (3) return forecasting, reflecting planning in return activities. We then developed a new code, 'demand forecasting and inventory management' to code the first component, which is consistent with coding practices in previous OSCM systematic literature reviews (e.g. Nguyen et al. 2018; Choi et al. 2018). We then categorised the other two components into 'delivery' and 'return', respectively. In the final round, we observed that there were still substantive papers related to general operations and supply chain risk management, but the topics covered in these papers cannot be precisely described and categorised into the previously developed codes. Therefore, drawing on the coding practices from other systematic literatures in OSCM (e.g. Choi et al. 2018), we developed a new code, 'operations and supply chain risk management' to cover topics related to social media applications in business risk management operations and supply chain, as well as emergency and disaster management in humanitarian operations. All the seven codes can cover the majority of OSCM activities mentioned in the

selected papers, and the rest of the activities, including OSCM interface with general human resource management, general knowledge management and general sustainability were categorised into 'general' activity.

Therefore, after the coding process, seven distinct OSCM activities as well as a group of 'general' activities were identified. We highlight these findings in Table 3, drawing on some of the more significant contributions in the subsequent discussion.

[Table 3 near here]

3.2.1 Demand forecasting and inventory management

Demand forecasting and inventory management are essential parts of OSCM and good practices of both can mitigate demand uncertainty, improve customer service level, and increase supply chain efficiency (Dejonckheere et al. 2003; Hofmann 2017). To achieve accurate demand forecasting, capturing demand information and understanding customer are necessary (Chong et al. 2017). Meanwhile, good inventory management requires companies to share information related to inventory management across the supply chain (Irani et al. 2017). As social media can facilitate the exchange of rich and timely information (Chae 2015; O'Leary 2011), companies can integrate it into forecasting and inventory management processes to mitigate the forecast inaccuracy and suboptimal inventory management decisions.

As rich information can be embedded into different forms of social media data, like text, sentiment, picture and videos, companies can capture market trend and understand customer requirements to support forecasting through analysing social media data. To uncover such information, statistical analysis, sentiment analysis and machine learning algorithms are

applied (e.g. Ma and Zhang 2015; Cui et al. 2018). Using these methods enables companies to integrate different social media data, including volume-based indicators (Ma and Zhang 2015), sentiment scores (Sodero and Rabinovich 2017; Lau et al. 2018; Yuan et al 2018), video information (Papanagnou and Matthews-Amune 2018) and mixed indicators (Cui et al. 2018; Hou et al 2017; Chong et al. 2016; See-To and Ngai 2018; Chong et al. 2017) into their current forecasting systems to achieve a more accurate and responsive demand estimation.

Social media can also support inventory management. By applying big data analytical techniques to social media, companies can capture information to coordinate demand and inventory volume (Wood et al. 2017; Roden et al. 2017; Irani et al. 2017). The information captured can contribute to mitigating rationing game and bullwhip effect (Hofmann 2017) and support more rational replenishment decisions (Choi 2018). In addition, through instant inventory and warehouse information sharing within and between companies using social media, companies can perform timely response and make better decisions for inventory management (Cherrett et al. 2015; O'Leary 2011).

3.2.2 Marketing

The involvement of customers through social media means that operations and marketing share an interface, and previous studies identified that marketing can influence the efficiency and effectiveness of OSCM (Min and Mentzer 2000). The sampled literature shows social media can enhance OSCM performance by integrating social media marketing into demand generation and customer relationship management.

Through posting advertisement information on social media platforms, companies can promote product and brand awareness to generate more sales (e.g. DiPietro et al. 2012; Irani et

al. 2017). By applying data mining techniques, companies can analyse the text and sentiment of customers' social media posts to evaluate and adjust marketing strategies (e.g. Mishra et al. 2017; Roden et al. 2017). Several papers mentioned that through manipulating social media information, such as disseminating fake positive reviews (Lee et al. 2018; Choi 2018), companies can generate more profits.

Apart from demand generation, companies can use social media to build and maintain customer relationships and improve customer loyalty. By building a social media community, companies can engage different customers (e.g. Jafari et al 2015). Companies can also use social media as a channel to send gifts to enhance customer relationship and loyalty (Liu and Liu 2009).

3.2.3 Sourcing

Sourcing contains all business processes enabling companies to obtain products and services from suppliers, and good sourcing management can contribute company's competitiveness in the market (Ben-Daya et al. 2019). Sourcing activities include in-house or outsourcing decision making, supplier selection, procurement management, etc. (Chopra and Meindl 2016).

The sampled papers indicate social media can enhance two types of sourcing activities. Firstly, companies can use social media to management suppliers. By using big data analytical techniques and operational research methods, companies can approach and capture public comments on suppliers' performance in the social media. Considering such 'public voice' can enable companies to more effectively select suppliers and evaluate their performance (O'Leary 2011; Lin et al. 2018). Companies can also use social media to build communities to engage suppliers and foster good supplier relationships (Markova and Petkovska-Mirčevska 2013;

Irani et al. 2017) which stimulate knowledge sharing among suppliers (Grant and Preston 2019). Secondly, social media data can be used as 'raw material' for a certain type of companies whose main business is collecting, aggregating, and then selling aggregated data to customers (Hartmann et al 2016). Under this business model, the social media platform becomes a sourcing channel while the data in social media forms the 'products' that companies sell.

3.2.4 Product development and production

The sampled literature indicates that social media is valuable for product development and production. Companies that develop and produce appropriate products that fulfil customer needs can gain higher customer satisfaction (Zhang et al. 2019). Appropriate product development and production are achieved through accurate identification of customer requirements and good supplier integration (Jin et al. 2016; Petersen et al. 2005). The information exchange facilitated by social media among relevant stakeholders like supply chain partners and the public can stimulate product development ideas (Sigala 2014), lead to collaborative product development (Irani et al. 2017), and enable information capturing for production process innovation and redesign (Wang et al. 2015).

For example, by employing datamining techniques and machine learning algorithms to social media data, insights on customer preferences and requirements can be automatically captured from social media posts, online review comments, and online community dialogues (e.g. Chan et al. 2017; Jin et al. 2016; Jiang et al. 2017; Abrahams et al. 2015). Companies can then apply the captured insights to facilitate product design and optimise different product features. Companies can also elicit innovative ideas from customers by communicating and interacting with them in online communities directly (e.g. Sigala 2014; Liu and Liu 2009;

Romero and Molina 2011). Through direct communication, companies can leverage the 'wisdom of the crowd' and generate more customer-centred design ideas. Companies can also virtually create and launch products using certain social media platforms such as Second Life, proactively testing ideas and gaining feedback to facilitate product improvement (Sigala 2014; Irani et al. 2017; Leung et al. 2013). Finally, social media can also allow companies to communicate people within companies or across the supply chain to facilitate the generation, shaping, and sharing of product development ideas to enable effective internal and inter-organisational collaboration on product development (e.g. Bertoni and Larsson 2011; Irani et al. 2017).

Companies can also use social media to improve manufacturing and service generation processes. By employing social media mining or big data analytical techniques, companies can identify improvement opportunities for manufacturing and service generation processes from customers' public social media posts and online comments to support the process adjustment and redesign (e.g. Mishra et al. 2017; Singh et al. 2018; Sigala 2014). Alternatively, manufacturing and service process redesign ideas and opportunities can also be shared within companies or across supply chain partners through social media, improving operations and supply chain efficiency (e.g. Wang et al. 2015; Chirumalla 2013; Weichhart et al. 2018).

Finally, social media can work as a repository of relevant information for product development and production. For example, it can store product experts' information to assist quick expert identification and location in the companies (Chirumalla et al. 2018; Bertoni and Larsson 2011; Chirumalla 2013). It can also store documents about product development and production and make them available to various stakeholders for real-time adjustments, enabling better collaborations among different stakeholders (Irani et al. 2017).

3.2.5 Delivery

Product delivery is important to OSCM, and the performance of delivery is closely linked to overall OSCM efficiency (Ben-Daya et al. 2019). Operations have traditionally focused on transportation in the physical delivery of materials, however, modern service companies fulfil their orders virtually.

With physical goods delivery, companies can capture useful transportation-related information such as road closures and traffic accidents from public social media posts using social media mining and big data techniques (e.g. Albuquerque et al. 2016; Gu et al. 2016). By integrating such information into scheduling process, companies can improve the efficiency of vehicle routing and delivery scheduling. Transportation-related information can also be communicated within or between companies through social media to support delivery and transportation process and improve supply chain performance (e.g. O'Leary 2011; Cherrett et al. 2015).

Conversely, social media can work as a distribution channel for services/virtual products. For example, social media can be used to deliver customer support service (e.g. Fan and Niu 2016; Gu and Ye 2014) or customer education (e.g. Sigala 2014; Löfstedt and Holmberg 2016). For companies such as news agencies, social media can be employed to deliver virtual products such as news (e.g. Hernandez Serrano et al. 2015; Bloom et al. 2016). By using social media, service and virtual products can be easier to deliver in a timely and economical way.

3.2.6 Production return and reverse logistics

Return and reverse logistics concern the practices enabling the reverse flow of products or materials from their point-of-consumption to recapture their value (Chan et al. 2012). Efficient return and reverse logistics practices can increase companies' profitability (Dowlatshahi 2010). Additionally, increasing expectations and pressure from governments and the public concerning 'green' and sustainable practices also require companies to improve their return and reverse logistics performance (Srivastava and Srivastava 2006). Our review indicates social media can work on two aspects of return and reverse logistics.

Firstly, social media can contribute to better decision making in reverse logistics activities. Timely information sharing on reverse logistics issues between supply chain partners in social media enables companies to make responsive decision (Orenstein et al. 2016; Irani et al. 2017). In addition, by applying social media mining techniques to social media posts and comments, companies can more accurately forecast product return rate (Minnema et al. 2016; Sahoo et al. 2018).

Moreover, social media supports the customer communication in the return processes. By publicly disseminating recall information in social media, companies can reach more customers and enhance the recall efficiency (Bernoff and Li 2008). In addition, when customers have product return issues, customers can directly communicate with companies through social media and solve the issues speedily (Bhattacharjya et al. 2016; Bhattacharjya et al. 2018).

3.2.7 Operations and supply chain risk management

Good risk management practices can enhance OSCM performance (Aqlan and Lam 2015). Risks can arise from supply and demand miscoordination, or from disruptions of normal supply chain operations (Kleindorfer and Saad 2005). To cope with risks and disruptions, practices including risk identification, risk assessment, risk mitigation, and risk monitoring/control are widely adopted in OSCM (Ho et al. 2015).

Considering business operations and supply chain specifically, social media enables companies to capture information to sense risks and disruptions, as well as to identify misinformation about the situation by using big data analytical techniques such as machine learning (e.g. Albuquerque et al 2016). Information related to risks and disruptions can be automatically extracted from unstructured posts, online reviews, and community dialogues (e.g. Jiang et al. 2017). In addition, companies can disseminate information related to risks and disruptions to inform the public and mitigate the possible side effects (e.g. Cottrill et al. 2017; Gu and Ye 2014). Finally, companies can use social media to share risk-related information within companies or across the supply chain, improving supply chain transparency and increasing the likelihood of identifying supply chain disruptions (e.g. Irani et al. 2017).

Social media can also support humanitarian operations and disaster management. As with business applications, organisations can capture information and gain situational awareness from social media to support decision making during humanitarian operations (e.g. Huang and Xiao 2015; Swaminathan 2018). Information including victim locations, resource requirements, and disaster damage can be traced and extracted by using big data techniques (e.g. Onorati et al. 2019). In addition, organisations can use social media to disseminate information to the public and mitigate disaster effects (e.g. Markenson and Howe 2014; Hadi and Fleshler 2016), or they can request donations and supports from the public through social

media (Lai 2017). Finally, through sharing information within or across organisations in social media, organisations can coordinate humanitarian aid efforts with other parties involved in the disaster and emergency (e.g. Yates and Paquette 2011). By leveraging the power of the crowd, the efficiency of humanitarian operations and disaster management can be improved under the help of social media.

3.2.8 General activities

Several sampled papers cover OSCM interface with human resource management, knowledge management, and sustainability. Although such activities are not specifically linked with OSCM, the topics and contexts of these papers are closely related to OSCM. Therefore, we summarised these activities as 'general' activities.

Firstly, social media can be used to recruit supply chain managers and workers (Fletcher et al. 2016; Fisher et al. 2014; Chae 2015) or humanitarian organisations' volunteers (Lai 2017; Griswold 2013; Wamba et al. 2017) by disseminating information to the public and communicating with job candidates in the social media platform. Companies can also use social media to share materials such as videos to facilitate employee training (Azhar et al. 2019). Secondly, social media can facilitate companies' knowledge management including collecting and sharing knowledge generally related to OSCM (Grant 2016; Billington and Davidson 2013). Finally, social media information can provide insights to support sustainable decision making (Tseng 2017; Tseng et al. 2019a), improve companies' sustainable supply chain capabilities (Tseng et al. 2019b), or facilitate the implementation of companies' sustainability initiatives (Williams et al. 2014).

3.3 Different functions of social media

To answer **RQ2**, the papers were coded from the perspective of different functions of social media. The existing literature indicates that companies exchange information with different internal and external parties in the supply chain (Thomé et al. 2014; Coyle et al. 2016). Internally, information flows among different functional departments, while externally, information flows between focal companies and their partners (e.g. upstream suppliers), or between focal companies and the public or the end customers (Singh and Power 2014; Mentzer et al. 2001). Previous research on social media confirmed its value on supporting both internal and external information exchange (Ngai et al. 2015). More specifically, literature (e.g. Lam et al. 2016; Irani et al. 2017) suggests that three common types of the information flow can occur in the social media, namely information flow *between companies and public/customers*, *within companies* (e.g. among employees), and *across companies* (e.g. across supply chain). This reflects three different functions of social media in companies' OSCM: 1) enabling company-public information exchange, 2) enabling intra-organisational information exchange and 3) enabling inter-organisational information exchange, where the first and the last functions support the external information exchange while the second supports the internal information exchange. Therefore, by adapting this internal-external information exchange perspective, sampled papers were coded based on these three different functions to fully capture the value of different aspects of social media in OSCM. To fit the purpose of this paper, we define each function as:

(1) *company-public information exchange function*: companies use social media to receive, disseminate or capture OSCM-related information from customers/public.

(2) *inter-organisational information exchange function*: companies use social media to receive, disseminate or capture OSCM-related information from other companies/organisations.

(3) *intra-organisational information exchange function*: employees inside the same companies use social media to receive, disseminate or capture OSCM-related information from other employees.

To differentiate 'receive' and 'capture' in function (1) to (3), we consider 'receive' as a way in which individuals or companies obtain OSCM information by directly communicating with others through social media, while 'capture' as a way in which individuals or companies obtain OSCM information by observing and analysing others' social media posts without direct communication involved. For example, using big data techniques to collect and analyse social media to generate insights belongs to 'capture'.

Additionally, the literature suggests that social media can work as a repository to store information (e.g. Wang et al. 2015; Chirumalla 2013) or as a decision support system to facilitate decision making (e.g. Cherrett et al. 2015). Arguably, these applications are different from the applications described in the previous three functions, as there is no direct information exchange occurring in the repository or the decision support system. Instead, social media here essentially works as a supportive software to indirectly facilitate the flow of information. For this 'support' function, more specifically, literature from information and knowledge management suggests that the repository can enable a better access to the necessary information by storing the information and knowledge acquired by the companies (Alavi and Denford 2011; Hemsley and Mason 2013), while the decision support system can better integrate and present the information acquired from different sources and support the managers to better exploit the information in decision making process (Sauter 2014; Yam et al. 2001),

which essentially contributes to a more efficient information exchange. Therefore, the repository and decision support system function of social media in OSCM are coded as 'support' function:

(4) *Support function*: companies use social media as a repository to store useful OSCM information and knowledge or use it as a decision support system to facilitate OSCM decision making.

[Figure 5 near here]

Figure 5 summarises the number of papers within each function and indicates that most papers are related to company-public information exchange function (136 papers) while much less research related to intra- (15 papers) and inter-organisational (19 papers) information exchange functions, as well as the support function (7 papers). In addition, different functions also contain various applications. We now provide a more detailed analysis below for each function.

3.3.1 Company-public information exchange function

When using social media to communicate with customers/public, companies both receive and disseminate information. The mode of communication with customers/public can be one-to-one, one-to-many, many-to-one, and many-to-many, while the information flow can be unidirectional or bi-/multi-directional. For example, airline companies use social media to communicate with customers regarding service problems and to provide possible solutions (Fan and Niu 2016). This is one-to-one/many bi-directional communication where companies

both receive and disseminate information. As one-to-many unidirectional communication, Cottrill et al. (2017) provided the example of a transport company which publicly posts transport disruption information (e.g. street closures) in their official Twitter account, informing potential passengers to choose other alternative routes or modes. Finally, Bhattacharjya et al. (2016) found that when e-retailers use social media to communicate delivery-related issues with customers, multiple companies can engage into the discussion and problem-solving processes for the same issue. This application essentially is many-to-one/many multi-directional communication with many different social media users involved.

Companies can also capture new information by observing or analysing public social media posts without direct communication with customers/public. Some research (e.g. Guo et al. 2016) showed relatively simple manual analytical techniques can generate useful insights, such as adopting manual content analysis on customer social media feedback for tourist attraction management and generating insights on effective service operations practices. Other research, however, proposed more sophisticated approaches like machine learning algorithms to capture information such as transportation accidents information (Zhang et al. 2018b) or customer preference on product design (Jiang et al. 2017; Jin et al. 2016) to support OSCM.

3.3.2 Inter-organisational information exchange function

Inter-organisational information exchange through social media can also involve two or more parties with uni-/bi-/multi-directional information flows, and companies receive or disseminate information to other companies in this process. For example, Bertoni and Larsson (2011) illustrated one-to-one communication with bi-directional information flows where a company can use social media platform to discuss product development issues with its supplier company. Examples of many-to-many communication with multi-directional information exist where a

company uses a social media group to integrate multiple suppliers, and all companies communicate collaboratively in the group (Irani et al. 2017). An example of one-to-many communication is that a company can use social media to send shipment needs to its logistics providers (O'Leary 2011).

A company can also capture information from other companies' social media posts. For example, Swain and Cao's (2019) research illustrated that sentiment analysis can be applied to inter-organisational social media data to examine inter-organisational collaboration, trust and commitment level. In addition, companies analysing the social media posts of suppliers can understand the behaviours of suppliers' knowledge sharing (Grant and Preston 2019).

3.3.3 Intra-organisational information exchange function

Social media can also be applied to internal information exchange within a company, facilitating internal communication between employees, and enabling them to receive and disseminate information to their colleagues. For example, the internal communication on product development using social media is faster and more convenient than using traditional communication technology, and the one-to-one or many-to-many communication improves the efficiency of product development (e.g. Wang et al. 2015; Bertoni and Larsson 2011). In addition, using social media to share logistics and inventory information between shop managers and drivers can improve logistics performance, as one-to-many and many-to-many communication can enhance the supply chain transparency (Cherrett et al. 2015).

Furthermore, employees can also capture information from social media posts of their colleagues. By observing others' posts, employees can access and capture information posted by other employees for product development (Chirumalla et al. 2018; Chirumalla 2013). In the

humanitarian operations process, through observing others' posts in social media in the organisation, employees can use the captured information and knowledge to facilitate and adjust their own work, which can speed up the disaster response process (Yates and Paquette 2011).

3.3.4 Support function

Here, social media works as a tool to support the information exchange without direct information flow. Two types of applications are identified from the sampled literatures. Firstly, social media can work as a repository to store information. Text data (Wang et al 2015), images (Yates and Paquette 2011), audio and video material (Chirumalla et al. 2018) can be stored in social media such as in blogs (Irani et al. 2017). In addition, applications like social bookmarking can store information about personnel expertise (Bertoni and Larsson 2011), enabling quick expert location and connection within or across organisations. The data stored in social media can contain rich contextual information and can help others better understand and utilise it (Chirumalla 2013).

Furthermore, social media can be creatively used as a decision support system. One paper (Cherrett et al. 2015) illustrated that by inserting dashboard function into social applications, shop managers can view information about inventory level and delivery status in social media and use it to support logistics decision making.

3.4 Summary of results

Figure 6 summarised the research distribution by different OSCM activities and social media functions. From the perspective of OSCM activities, it can be observed that the main focus lies

at operations and supply chain risk management as well as product development and production, with each having more than 50 papers. Delivery, marketing and demand forecasting and inventory management activities also receive adequate attentions and they are all discussed by 20 or more papers. However, product return and reverse logistics and sourcing gain least investigation, with 7 and 6 papers, respectively. The reduced focus on these two activities thus probably implies scope for more research. From the perspective of social media functions, Figure 6 (together with Figure 5) indicates that the mostly discussed function is company-public information exchange function which is followed by intra- and inter-organisational information exchange functions, and the support function is least mentioned. The focus on company-public information exchange function may suggest that the current applications of social media in OSCM mainly focus on the external interaction and information exchange between companies and the public/end customers.

[Figure 6 near here]

Moreover, through the lens of combining perspectives of OSCM activities and social media functions, more insights can be generated. It can be observed that, in each OSCM activity, the research effort on each social media function is different. Firstly, the research on company-public information exchange function is listed in the first place in all OSCM activities except sourcing where such function attracts fewer efforts. This can be explained as sourcing activities mainly involve interaction between companies and their suppliers so that there can be relatively less information exchange between companies and the public. Thus, the scholars have not prioritised this function in sourcing. In addition, the intra- and inter- organisational information exchange functions earn some research efforts in operations and supply chain risk

management, product development and production, and sourcing, while they received almost no attention in other activities. This can be because, compared with other activities, operations and supply chain risk management, product development and production, and sourcing need frequent internal or inter-organisational communication and information sharing. Therefore, such activities urgently require a tool to improve their performance on intra- or inter-organisational information exchange. Compared with traditional information technology (e.g. email, telephone), social media here can probably work better to fulfil companies' requirements on information exchange in these three activities (Irani et al. 2017). Finally, although support function gains some explorations in product development and production, it generally receives very little research attention in each OSCM activity. This might indicate that although social media can be occasionally used as a repository, and creatively used as a decision support system, such applications currently are not well developed and cannot outperform the traditional repository and decision support system technology and applications in OSCM.

To sum up, the results indicate that different OSCM activities and different social media functions are explored in the sampled literature, with some activities and functions gaining more research attention. For each individual activity, multiple functions are adopted to improve its performance. While for different OSCM activities, each function can probably bring more significant benefits on certain activities, while less on others, depending on the different requirements on information exchange of the activities. This essentially reflects the ways that each function contributes to the performance improvement in different OSCM activities can be quite diverse. In addition, as summarised in above subsections, there are rich and different applications in each function, which further suggests the diversity and complicity of the ways how social media functions work on OSCM performance improvement. Under such circumstances, to better understand the value of social media in OSCM, as well as to direct future research to respond to calls from previous literature (Lam et al. 2016; Chae 2015), it is

necessary to explore the underlying mechanisms governing all different and diverse ways that enable social media functions to influence OSCM activity performance, which leads to the **RQ3**. Thus, by deeply reviewing and synthesising the content of sampled papers, we conceptualised two in-depth mechanisms and created a unified framework to connect social media functions with OSCM activities in section 4.

4. Mechanisms of social media's influence on OSCM activities

To answer **RQ3** and to deeply understand the diverse ways enabling social media to contribute to the OSCM performance, here we consider the in-depth mechanisms about how different social media functions can influence OSCM. To do so, we proposed the framework shown in Figure 7 based on our synthesis of results and insights generated from the sampled papers after carefully reviewing and summarising them. It indicates that although the ways how social media impacts different activities of OSCM are different and diverse, the inner mechanisms governing these ways can be categorised into two specific types: the *connecting tool* mechanism and the *data source* mechanism. Drawing evidence from our sampled papers, the framework shows that the performance improvement on different OSCM activities is enabled by improved level of communication efficiency and effectiveness as well as sensing capability. All four functions can contribute to improve communication efficiency and effectiveness based on social media acting as a connecting tool. Company-public information exchange function and inter-organisational information exchange function can contribute to improve the sensing capability based on the data source mechanism, with their contribution moderated by OSCM social media analytic capability. We provide a detailed description on both mechanisms below.

[Figure 7 near here]

4.1 Connecting tool mechanism

We define the connecting tool mechanism where social media connects isolated individuals/organisations and enables more *effective and efficient communications* in operations and supply chain activities. The OSCM performance increase is derived from tighter connections within companies or across supply chain by employing different social media functions, as richer and timely information can be shared under such connections (Lam et al., 2016). From a social network perspective, it means social media creates links between isolated nodes and facilitate the form of an information-rich network for the firms and whole supply chain. According to Burt (2004), an information-rich social network which is low in cohesion and spans structural holes can be expected to lead a high performance. The use of social media, compared with traditional communication technologies, makes users (individuals or organisations in our context) more visible and enables them to have a more diverse contacts from various parties, which gradually enriches the information in the network (Wu 2013).

Compared with traditional communication technologies (e.g. email, telephone), the sampled literature showed that connections enabled by social media promote two types of interactions for OSCM activities. The first type of interaction generates from links between two previously completely unconnected nodes, while the second emerges from links between two nodes whose previous connections involve many intermediaries. The former type enhances the network reach, while the latter shortens the network distance, which means richer information can be shared in a timelier manner (Burt 2009). In addition, information integrity can also be achieved as a shortened transmission distance reduces the probability of information distortion (Zhang and Venkatesh 2013).

The sampled literature showed that both types of interactions can be achieved by the social media functions. For example, in product development, through the company-public information exchange function, companies can easily reach all customers and discuss with them about product design in social media platform (e.g. Sigala 2014), or even enable them to co-design products instantly (e.g. Andreadis 2015). Such reach can be unrealistic if the traditional communication approach is employed, such as email or telephone in which only a small sample of customers can be reached. The company-public information exchange function can also shorten the network distance. For example, when customers have logistics-related issues, customers can communicate directly with logistics providers through social media rather than contact the supplier of their products first (Bhattacharjya et al. 2016). Compared with traditional approaches, social media removes the intermediary communication between customers and the product suppliers, thereby shortening the transmission distance.

The intra- and inter-organisational information exchange can also promote both types of interaction. For example, Bertoni and Larsson (2011), Chirumalla (2013) and Wang et al. (2015) demonstrated how, by using social media inside and across the organisations, employees having problems related to OSCM can quickly locate and form links with experts within or across the organisations to discuss solutions. In addition, social media enables different employees across departments or organisations to work collaboratively, which can simplify operational processes and reduce the unnecessary intermediary communications (Lam et al. 2016; Bernoff and Li 2008). Compared with online conference or email, social media platforms can better overcome the temporal constraints of different parties during the project, and the project can be updated in real-time by each party through the platform (Irani et al. 2017). The removal of temporal constraints enhances work efficiency (Zhang and Venkatesh 2013), and connections enabled by the intra-/inter-organisational information exchange can be expected to improve communication efficiency and effectiveness in OSCM.

Finally, when social media provides a support function, the information stored in social media can be accurately shared and automatically associated to its author (Chirumalla 2013; Chirumalla et al. 2018), indirectly supporting both types of interactions and enabling efficient and effective communications.

Under the connecting tool mechanism, high communication efficiency and effectiveness enabled by social media can lead to performance improvements in different aspects of OSCM. For example, for product development and production, customer preferences and supply risks of new product can be communicated faster and more accurately through connecting customers and suppliers using social media platform (Irani et al. 2017). For delivery and reverse logistics, social media can form closer connections between companies and logistics providers, as well as between logistics providers and customers, enabling a more straightforward and efficient communication and leading to the better delivery service level (Bhattacharjya et al. 2016; Cherrett et al. 2015). For inventory management, real-time information related to inventory level and warehouse can be quickly spread through different parties connected by social media across supply chain to coordinate logistics and inventory management activities (Cherrett et al. 2015; O'Leary 2011). For risk management, using social media, companies can quickly detect emergencies or supply chain disruptions and gain situational awareness by developing connections with those affected (Cottrill et al. 2017). Further, useful information and guidance can be publicised through official social account to reach more victims to facilitate disruption effect mitigation (Wamba et al. 2017).

To summarise, as a connecting tool, social media enables new and shorter connections, leading to more efficient and effective communications within OSCM activities, and eventually higher OSCM performance.

4.2 Data source mechanism and its moderator

Here we first define and discuss the second mechanism, data source mechanism, and then explore the mechanism's moderator, OSCM social media analytic capability.

4.2.1 Data source mechanism

We define the data source mechanism where social media works as a data source to support operations and supply chain analytics and enables a higher sensing capability of companies. In this definition, 'data' concerns all accessible social media posts, and sometimes the data volume is large and considered as big data (Chae 2015). The data includes not only the posts sent to companies through social media (e.g. customers comments for new product design), but also all other possible relevant posts which are not intended for sharing with companies but accessible in the social media platform. For example, social media users share transportation accident information in social media publicly. Such social media posts are not meant to share to any company, but companies can analyse these posts to facilitate their vehicle scheduling (Zhang et al. 2018b). Operations and supply chain analytics here refer to apply the AI/big data techniques, statistical analysis or other analytical methods (e.g. qualitative content analysis) to analyse data for OSCM activities. Unlike when social media is a connecting tool, we emphasise here the data volume is relatively large, and valuable information and insights need to be extracted by using data analytical techniques rather than through social media communication.

Mining and analysing the rich information embedded into social media data enable companies to identify and better understand the market opportunities and threats relevant to operations and supply chain activities, which means companies can configure resources to seize opportunities or tackle threats (Chae 2015). From a dynamic capability perspective, it

essentially enhances companies' sensing capability (Song et al. 2015) which is defined as 'the ability to spot, interpret, and pursue opportunities in the environment' (Pavlou and El Sawy 2011, 247). With high sensing capability, companies can have sustainable competitive advantages (Teece, 2007). Specifically, the sampled papers revealed that the sensing capability can be mainly improved by analysing the data generated from company-public information exchange (e.g. Jin et al. 2016; Zhang et al. 2019; Lai et al. 2018), although a few papers also showed the potential for analysing data generated from inter-organisational information exchange (e.g. Grant and Preston 2019; Grant 2016; Swain and Cao 2019). Companies can receive or capture the user-generated data from social media platform, and use various data analytical techniques combining artificial/business intelligence, such as machine learning (e.g. Albuquerque et al. 2016; Abrahams et al. 2015), and manual coding and qualitative content analysis (e.g. Guo et al. 2016; Fan and Niu 2016) to extract valuable information.

Under the data source mechanism, the sampled papers indicated that different OSCM activities can benefit from the high sensing capability enabled by social media. For example, in forecasting and inventory management, market trends and fluctuations can be sensed by adding social media analytics into traditional time series forecasting methods (e.g. Chong et al. 2017), leading to a better replenishment decisions (e.g. Cui et al. 2018; Roden et al. 2017). For deliveries, traffic accidents can be sensed through social media analytics, enabling the better rescheduling of the delivery routes (e.g. Albuquerque et al. 2016; Zhang et al. 2018b). For product development, mining social media data by using big data techniques enhances understanding about the customer preferences in which companies can sense new opportunities for future product/service design (e.g. Jiang et al. 2017; Maiyar et al. 2018). For sourcing, companies can more effectively evaluate supplier performance from analysing social media data (Lin et al. 2018). For reverse logistics, integrating social media data analytics into product return rate forecasting can lead more accurate forecasting results (Minnema et al. 2016),

contributing to the reverse logistics coordination. For supply chain risk management, mining social media data can enable automatic risks and disruptions detection and facilitate the resource reconfiguration to tackle and mitigate the possible side effects (e.g. Chae 2015; Singh et al. 2017).

To summarise, social media as a data source enables operations and supply chain analytics, which enhances sensing capability and contributes to improved OSCM performance.

4.2.2 'OSCM social media analytic capability' as a moderator for data source mechanism

Although the social media functions can facilitate the OSCM performance improvement through data source mechanism, companies can only leverage the value of social media data if they have a good ability to collect valuable data and generate useful insights through appropriate social media data analysis. By synthesising existing research on business analytics, social media analytics and big data analytics (Arunachalam et al. 2018; Kamble and Gunasekaran 2019; Gupta et al. 2019; He et al. 2015; Wang et al. 2016) and to fit the purpose of this paper, we define a construct, *OSCM social media analytic capability*, as

> *the ability that companies collect, store and monitor high quality data (e.g. texts, pictures, videos) relevant to OSCM from social media, analyse the collected data with appropriate techniques (e.g. AI/big data techniques, qualitative content analysis), and correctly interpret and utilise the analysis results to support OSCM decision making*

Drawing on the evidence from sampled papers, we regard this construct as a moderator of data source mechanism, meaning that only companies with high OSCM social media analytic capability can leverage the value of social media to enhance sensing capability. In explanation,

we follow the definition of this construct and discuss the activation of data source mechanism from three aspects: the quality of data source, the techniques of data analysis and the interpretation and utilisation of analysis results.

Firstly, collecting and analysing high quality social media data are necessary for OSCM. As social media can be a source of big data, it is characterised as high volume and produced and updated in a high velocity (Hofmann 2017). This not only means various information can be captured, but also suggests that not all accessible data is necessarily valuable to OSCM. Some data can be meaningless while other data can be incomplete. In addition, social media data can be purposefully manipulated by others (e.g. Lee et al. 2018; Choi 2018), and misleading information can be embedded. In these cases, data quality is low, and collected data cannot accurately reflect the market situation. The results generated by analysing low quality data do little help or could even harm decision making (Hofmann 2017). Therefore, the prerequisite to leverage social media data source mechanism is to capture high quality raw data before conducting analysis.

In addition, as social media data is characterised as high data variety, it contains different data forms (e.g. texts, pictures, videos) and is usually unstructured (O'Leary 2011). Therefore, traditional data analytical methods (e.g. regression) are not readily applied to such data, and novel methods should be built and employed, such as AI/big data analytics and social media mining (Lau et al. 2018). For example, for text data, natural language processing can be used, while for pictures and videos, image processing may be helpful. However, to use these new techniques, companies need to be supported by developed infrastructures and human resources (Arunachalam et al. 2018). Moreover, compared with social media text analysis, the methods to analyse pictures and videos are less developed in OSCM field, as no sampled paper addresses the picture analysis and very few papers address video analysis. It can be argued that

richer information might be contained in pictures and videos, as visual materials tend to convey more contextual information and makes companies sense the market trend and situation better. The lacking in picture and video analysis can hide the value of social media. Therefore, appropriate analytical techniques are necessary and the ability of companies to build and use appropriate analytical techniques is essential to leverage data source mechanism and enhance sensing capability.

Finally, correct interpretation and utilisation of analysis results are essential to the sensing capability improvement. Compared with traditional operational information source (e.g. point of sale data), the insights generated from social media data analytics essentially provide managers an extra source of information for decision making. It is inevitable that managers need to consolidate the new information generated from social media to their previous information and make decisions. However, how to combine the two and adjust decisions accordingly can be problematic, as sometimes the information suggested from social media analytics can conflict with previous information (Hofmann 2017), and incorporation of different information sources into decision making can lead to bias and suboptimality (Wood et al. 2017). Therefore, to accurately sense the market opportunities and allocate resources to pursue them, proper interpretation and utilisation of results of social media analytics is important.

To summarise, high OSCM social media analytic capability can leverage the social media data source mechanism to enhance sensing capability.

5. Future research directions

Based on the analysis in the previous sections, we now propose valuable future research directions. We first provide general research opportunities by different sectors and countries, and then summarise the gaps by different OSCM activities. Inspired by the conceptual framework in section 4 and by thoroughly reviewing the papers, we rank these gaps as primary and secondary directions. All these topics are tightly related to the most common and important OSCM activities. The primary directions include topics in section 5.2 which are highly valuable but explored by very few papers (i.e. no more than three), and whose feasibility is suggested from the two mechanisms. We believe that even a small research effort on these topics can be expected to largely extend the current research boundaries and improve the efficiency and effectiveness of OSCM. Therefore, we prioritise them as the primary directions. The secondary directions in section 5.3 include topics which are valuable and explored by a number of papers (i.e. more than three), but where further opportunities exist. Compared with the primary directions, although the secondary directions are important as well, what needs to be done is to refine and synthesise the previous relevant research in each topic and to develop more efficient models and tools in various contexts. It means more research efforts are expected to further leverage the value of social media in OSCM activities in secondary directions, which makes us put them in the second place. A graphic summary of topics for future research is in Figure 8.

[Figure 8 near here]

5.1 Research opportunities by sectors and countries

From Figure 3, the top three industrial sectors are manufacturing, retail, and health care/social assistance. By contrast, the research on social media in some other common industries like transportation and warehousing (e.g. railway service, airport service, underground service) and finance and insurance (e.g. bank service, insurance service) is much less. Office of National Statistics (2018) show that these two industries combined account for around 15% of total GDP in the UK in 2018. Therefore, opportunities exist for broadening the range of sectors examined and increasing the research on social media in OSCM in these two industries.

Moreover, Figure 4 indicates that research on social media use in OSCM is particularly focused on the USA, UK and China, while relatively less in other countries/regions, which may hide the value of social media in OSCM. According to a recent survey (Clement 2019), the top five countries/regions with highest active social media usage penetration are the UAE, Taiwan, South Korea, Singapore, and Hong Kong, but in our sampled papers, social media use in these countries/regions are under-explored. However, they have world-famous industries which can be relevant to OSCM research. For example, Taiwan is famous for semiconductor manufacturing, while Singapore and Hong Kong have excellence in maritime transport. As social media is commonly used in these countries/regions, examining how these industries benefit from it there for OSCM is currently an interesting opportunity.

5.2 Primary directions by topics

From the sampled papers, we suggest two primary research streams. The first stream relates to sourcing management, including supplier relationship management and supplier selection. The second stream relates to the return and reverse logistics, including product return

communication and return rate forecasting. As our results indicate that both streams are quite new and receive much less research attention, we provide propositions to guide future research.

5.2.1 Sourcing

The first direction, inspired from the connecting tool mechanism, is to explore the value of social media in supplier relationship management. Previous literature indicated effective communication between companies and their suppliers can lead to good buyer-supplier relationship (Larson and Kulchitsky 2000). Effective communication between suppliers and companies can be achieved when richer information is shared frequently and collaboratively in a timely manner (Cannon and Homburg 2001; Joshi 2009). According to the connecting tool mechanism, social media can create an information-rich network with reduced temporal constraints and intermediaries in the communication path, thus enabling richer information to be communicated in a timely and less biased manner between suppliers and companies. This can contribute to a more effective company-supplier communication and thus develop better company-supplier relationship. Therefore, we propose proposition 1:

P1. *Adopting social media in communication between companies and their suppliers can positively contribute to the company-supplier relationship.*

Specifically, empirical research will be particularly valuable in confirming this proposition as current research only tackle this issue conceptually. Furthermore, exploring the barriers and enablers for the adoption of social media in supplier relationship management will give a balanced perspective.

The second direction, inspired from the data source mechanism, can explore the value of social media data in supplier selection. Selecting proper suppliers can enhance supply chain

efficiency and competitiveness (Sevkli 2010). However, the supplier selection process can be subjective and fail to sufficiently consider voices from all stakeholders (Ho et al. 2010). The voice of customers, as the most important stakeholder group for a company, should be considered directly in the supplier selection process (Lin et al. 2018). As discussed in the data source mechanism that social media data contains rich customer information, it can thus enable companies to sense customer requirements and expectations which can be potentially relevant to supplier selection. Companies can also sense possible supplier risks from customer comments in social media (O'Leary 2011). Therefore, incorporating social media data can be expected to lead more effective supplier selection. However, as indicated from OSCM social media analytic capability, only companies with high OSCM social media analytic capability can extract valuable insights from social media to support supplier selection. Thus, we propose proposition 2a, 2b:

P2a. *Compared to supplier selection without social media data, incorporating social media data in supplier selection can contribute to more effective selection process.*

P2b. *OSCM social media analytic capability moderates the influence of social media data on supplier selection effectiveness.*

Specifically, future research can develop novel supplier selection methods incorporating social media data into selection processes, and empirically examine if suppliers selected by incorporating social media data will contribute to companies' OSCM performance.

5.2.2 Product return and reverse logistics

The first direction of this stream, inspired by the connecting tool mechanism, can investigate the value of social media on product return communication between companies and customers.

Existing research suggested that companies' communication support service on customer product return is one of the most important factors for good return management, as timely and effective communication between companies and customers can ensure the return-related issues to be solved properly and quickly (Ahsan and Rahman 2016). Indicated by the connecting tool mechanism, companies can use social media to create interactive links with customers and smooth the information flow between companies and customers. Thus, social media can be expected to effectively reach customers and enable a faster and more efficient communication in the return process than the traditional technologies like email or telephone. Although sampled papers revealed the feasibility of this direction (e.g. Bhattacharjya et al. 2016; Bernoff and Li 2008), both conceptual and empirical exploration is largely lacking. Thus, we develop proposition 3:

P3*. Adopting social media in communication between companies and customers can positively contribute to the product return performance.*

In particular, future research can empirically explore how social media can contribute to more effective communication in product return process, and the risks associated with using social media in return processes. For example, when customers need to return products, companies can ask customers to provide the photo of receipts for the products or other personal details in social media. If customers post such information in social media, customer privacy might be exposed to public, which can cause some problems. Therefore, future research can explore the proper way of company's social media communication with customers in return processes to inform the development of regulations and best practices to guide companies to improve their communication effectiveness and eliminate the associated risks.

Inspired by data source mechanism, the second direction can explore how to leverage social media data to support return rate forecasting. Product return rate forecasting is important

to return management, as it will guide remanufacturing plans, capacity allocation decisions and inventory replenishment policies (Krapp et al. 2013). However, obtaining an accurate return forecast is difficult, and many factors affecting return flow need to be considered into the return forecasting process (Agrawal et al. 2015). As suggested from our data source mechanism, the factors can be sensed by analysing social media posts from customers, such as product reviews (Sahoo et al. 2018; Minnema et al. 2016). Therefore, incorporating social media data into the return forecasting process is feasible and promising, and we thus propose proposition 4a and 4b:

P4a. *Compared to traditional return rate forecasting, incorporating social media data into return rate forecasting processes can lead better forecasting performance.*

P4b. *OSCM social media analytic capability moderates the influence of social media data on return rate forecasting performance.*

Specifically, future directions can explore what kind of social media data can be good indicators of return flow, and novel forecasting methods incorporating social media data can be developed.

5.3 Secondary directions by topics

We suggest three streams for secondary directions: delivery, demand forecasting and inventory management, and product development and production. Compared with the primary directions, the secondary directions have gained more research focus and been explored from multiple aspects. In other words, different from the primary directions, the value of social media on OSCM in the secondary directions is confirmed by previous research, and opportunities in secondary directions lie at refining and synthesising the existing research. Therefore, we do

not provide propositions but to depict the current status of each topic and summarise opportunities for future research.

5.3.1 Delivery

Here, we focus on the topics related to physical delivery and suggest future directions can build more novel methods to analyse delivery-related social media data. The sampled papers indicated the feasibility of mining and analysing social media data to facilitate delivery. Compared with traditional methods of collecting and analysing transportation-related information from news reports or government announcements, social media enables a timelier transportation report with more contextual information embedded for delivery and scheduling decision making (Gu et al. 2016). However, although the sampled papers proposed various algorithms to leverage the value of social media data to facilitate delivery, these algorithms only focus on the textual data. It can be reasonably argued that for transportation emergency and incidents, pictures, videos and live streams in social media can probably reflect the real situation and contain more contextual information. Therefore, failing to analyse these types of data may hide the value of social media. In addition, there are just a few papers applying the algorithms to scheduling processes in companies' daily operations (e.g. Albuquerque et al. 2016), while others are still in experimental stage (e.g. Gu et al. 2016). Therefore, whether the developed algorithms can be integrated well to companies' transportation information system and eventually improve delivery and transportation performance remains uncertain.

Based on such thoughts, we recommend future research can develop more novel algorithms to incorporate other data types (e.g. pictures, videos, live streams) when analysing transportation-related social media posts, and empirically examine how newly developed algorithms can be integrated into traditional transportation information system. In addition, as

the social media data used in transportation and delivery planning can contain the personal and private information such as the home or workplace address, research should explore risks in intruding customer privacy associated with the data collection, analysis and storage processes, informing the policy and regulation development to guide companies' proper use of social media data in transportation and delivery planning.

5.3.2 Demand forecasting and inventory management

For this stream, we suggest that future research can focus on building more efficient and economical forecasting methods incorporating social media data. Although some forecasting methods, such as machine learning (e.g. Chong et al. 2017) and autoregression (e.g. See-To and Ngai 2018) have been proposed to analyse different social media data (e.g. text, sentiment, numerical data), many of them are still industry-specific and in experimental stage. Therefore, more algorithms need to be developed and their performance need to be tested in multiple industries. In addition, new methods incorporating social media can need large volume of data with different types when compared to traditional forecasting approaches (Cui et al. 2018). If companies apply the new methods in their sales forecasting, they may need to invest in their information infrastructures and human resources. However, if the investment needed for the new method is considerable, it can be unaffordable for companies, especially for small companies. Therefore, economical methods should be built.

In summary, we suggest future research can develop more efficient and economical forecasting methods incorporating social media data and test their performance in different industries.

5.3.3 Product development and production

Here, we focus on the research of social media analytical techniques to facilitate product development. The sampled papers contain plenty of algorithms and techniques developed for mining customers' opinions in social media to inform product design (e.g. Jin et al. 2016; Chan et al. 2017), indicating that the way to utilise social media data in product development is understood in academia. However, as most techniques proposed are experimental and context specific, their performance in other empirical domains (e.g. different industries) remains uncertain. Therefore, for the future research, there is value in empirically comparing the performance of various techniques in product development under different contexts, and using the strengths of different techniques in different context to refine these techniques and improve their suitability and efficiency.

6. Conclusion

Although social media has been explored in many different business management disciplines, it has gained less research attention in OSCM. To pave the way for future research, this paper carried out a systematic review consolidating a plethora of emerging concepts to present an evaluation of current research, and notable gaps meriting future investigation. To the best of our knowledge, this is the first systematic literature review summarising and synthesising papers focusing on how social media can facilitate OSCM.

We believe this paper can contribute to existing research from three aspects. Firstly, through a thorough reviewing of OSCM papers, this paper depicts the current landscape of social media research in OSCM. This includes generating research trends and revealing that this area gains increasing interests in wide range of industries and regions. This paper also

complements systematic reviews considering big data in OSCM (e.g. Choi et al. 2018) as well as those examining social media's impact in other areas of management (e.g. Ngai et al. 2015; Poba-Nzaou et al. 2016). Distinct OSCM activities that particularly use social media are identified in this paper, including forecasting and inventory management, marketing, sourcing, product development and production, delivery, return and reverse logistics, and operations and supply chain risk management. Moreover, four functions of social media are generated, including functions of facilitating information exchange i) between companies and the public, ii) within companies and iii) across different organisations and supply chain, and the function of iv) supporting information flow. Through OSCM activities and social media functions, this paper articulates the general picture of this area for interested researchers to conduct further investigations.

Secondly, this paper explained the mechanisms about how social media can influence the diverse activities in OSCM. This paper links different OSCM activities and social media functions through the connecting tool mechanism and the data source mechanism, summarising that social media can enhance OSCM performance through improving communication effectiveness and efficiency and sensing capability in operations and supply chain activities. These newly summarised mechanisms contribute to the theoretical research in existing information system research, and they can also provide theoretical basis for further research to test social media's value in OSCM empirically.

Finally, this paper generates new directions for future research. Research topics are segmented as primary and secondary directions based on their research value and the volume of research obtained so far. Specifically, we recommend prioritising research on social media applications in sourcing and reverse logistics, although opportunities exist for applications in delivery, demand forecasting and inventory management, and product development and

production. The proposed future research directions together with the propositions can open venues for future research to theoretically and empirically investigate the social media's value in OSCM.

6.1 Practical implications

There are multiple practical implications that arise from this paper. We separate these into two parts. Firstly, we believe the practices suggested in this paper can enable practitioners to use social media more effectively in OSCM. Secondly, we consider the practical implication of social media on Industry 4.0 with a particular emphasis.

6.1.1 Helping OSCM practitioners use social media effectively

The implications for practitioners are three-fold. Firstly, for those working in the companies, this paper can enhance their understanding about social media's value on OSCM. It identified routes for managers to use social media to enhance OSCM efficiency in multiple ways rather than just through social media marketing. These include generating accurate sales forecasting, designing customer-centred products, selecting appropriate suppliers, and resolving reverse logistics problems. In addition, by recognising the different social media functions summarised in this paper, managers can utilise the internal and external social media to boost their information exploration and exploitation processes, thereby improving their information and knowledge management practices.

Secondly, the social media applications in OSCM summarised in this paper can also enhance customer understanding about how to use social media to make their voice heard by companies in relation to operations and supply chain activities. The practices mentioned in this

paper can teach customers to flexibly use social media to inform companies of their opinions, preferences and problems for product development, manufacturing, delivery service, product return and other activities through social posts, online reviews, and community interactions. In such ways, customer requirements can be fulfilled better, and problems are expected to be solved in a timely manner.

Finally, although this paper revealed that companies can benefit from exploitation of social media data, it also indicated that how companies use social media data for OSCM activities is largely unregulated. Some of the applications using social media data to inform demand forecasting or to capture customer preference can potentially intrude into customers' privacy and violate business ethics. Therefore, by identifying the plethora of OSCM applications for social media data in this study, we essentially suggest that this is an area where regulations are probably necessary, and provide a basis from which societal and policy decisions may be developed.

6.1.2 Social media and industry 4.0

This paper also generated implications on how social media can be used to meet the challenges of the Industry 4.0. To achieve Industry 4.0, high level integration within companies and across value chain is necessary, as well as good collaboration among parties inside and outside of companies (Oesterreich and Teuteberg 2016). The practices summarised in this review inform companies about how to use social media to enhance communication efficiency and effectiveness to improve internal and external integration and collaboration, which can contribute to the Industry 4.0 development. Moreover, social media is also a source of big data. By analysing big data, companies can build smart factory and implement intelligent manufacturing (Yan et al. 2017) which are the important components of Industry 4.0. This

paper summarised practices about how market trends and customers preference information can be dynamically collected and analysed from social media big data (e.g. See-To and Ngai 2018; Lai et al. 2018), informing companies effectively using social media on autonomous and intelligent product design, improvement and manufacturing. In addition, the practices about analysing transportation data in social media for vehicle scheduling (Liu and Qu 2016; Gu et al. 2016) can also inform software development to support autonomous vehicle operations and smart city development. Therefore, this paper can work as a guideline on using social media for Industry 4.0 development.

6.2 Limitations and concluding remarks

Although this paper generated practical implications and theoretical insights, there are still some limitations. By focusing on the value perspective of social media, we do not fully consider the possible disadvantages and risks in OSCM generated by using social media. It is worth noting that such issues are also lacking in discussion in the reviewed papers. Although social media enables rich information exchange and lead to better communication and information transparency among different parties, companies which use social media in their OSCM can have data security issues. As social media data can be publicly accessible, companies might be exposed to the risk of unintentional information leakage. Private and important information involving strategic OSCM decisions of companies could be hacked from social media and even then obtained by their competitors (O'Connor 2016). Apart from data security risk, another possible risk can be social media reputations. Although social media can work to communicate customers with different OSCM issues, such as delivery, after sale service and product return, the failure of companies in their products and services will also be posted by customers on social media. Such online word-of-mouth can be accessed by others easily, and OSCM failures

and scandals can be quickly spread and amplified (Fu et al. 2013), which can severely affect the companies' reputation. In this paper, we do not focus on how to mitigate the OSCM risk induced by social media use, and this can be a good future topic.

Furthermore, while confirming the value of social media in OSCM, we do not formally address how to realise its value if considering obstacles generated from other information technologies of companies and supply chain partners. Although social media provides additional information for OSCM decision making, how to make the most of such information to improve OSCM efficiency can depend on companies' own capability to integrate such information with other information technologies. Hofmann (2017) and Wood et al. (2017) both mentioned the potential issue when companies make decisions based on social media information and other operational information together. Sometimes, if information reflected from social media conflicts with operational information from other source, it essentially complicates the decision process and makes managers difficult to decide rather than supplements more insights to support the decision making. As Wu et al. (2006) indicated that good information technology alignment and integration can contribute high supply chain management capabilities, future research can explore how to integrate social media into the current information system of companies and supply chain, and make it more compatible with other information technologies.

In this paper, we reviewed and synthesised 152 papers investigating social media's value on OSCM. We summarised the research from OSCM activities and social media functions. We then built a framework to connect social media functions and the performance of different activities in OSCM through two mechanisms, and identified a number of future research directions. As suggested in the review, this area is still not well-explored, and we

believe more research is necessary in the future to better release the value of social media in OSCM and enhance companies' performance.

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Table 1. Search terms for paper sampling

Search terms related to social media	**Search terms related to OSCM**
'social media', 'social networking site', 'user generated content', 'web 2.0', 'online community', 'Facebook', 'Twitter', 'Tweet', 'YouTube', 'Blog' 'Wechat', 'Weibo'	'operations', 'supply chain'

Table 2. Number of papers published in each journal

Journal title	No. of articles	%
International Journal of Production Research	12	8%
Production and Operations Management	9	6%
Production Planning and Control	8	5%
Annals of Operations Research	7	5%
Journal of Cleaner Production	5	3%
Supply Chain Management: An International Journal	5	3%
International Journal of Operations and Production Management	4	3%
International Journal of Information Management	4	3%
Transportation Research Part C	4	3%
European Journal of Operational Research	3	2%
International journal of Production Economics	3	2%
Computers and Industrial Engineering	2	1%
Disaster medicine and public health preparedness	2	1%
International Journal of Logistics Research and Applications	2	1%
International Journal of Physical Distribution and Logistics Management	2	1%
Information and management	2	1%
International Journal of Disaster Risk Reduction	2	1%
Journal of Operations Management	2	1%
Manufacturing Letters	2	1%
Transportation Research Part E	2	1%
Journals with single paper	70	46%

Table 3. Categorisation of OSCM activity

OSCM activities: Demand forecasting and inventory management (20 articles)	
Scope: topics related to demand forecasting and inventory management/control with the aid of social media.	
Themes under this activity:	**Reference**
1. Demand forecasting by social media mining	
1) Forecasting accuracy improvement by social media mining	Sodero and Rabinovich (2017); Cui et al. (2018); Wood et al. (2017); Hou et al. (2017); Hofmann (2017); Lau et al. (2018); Chong et al. (2017); Ma and Zhang (2015); Chong et al. (2016); Roden et al. (2017); Papanagnou and Matthews-Amune (2018); See-To and Ngai (2018); Yuan et al. (2018); Swain and Cao (2019); Serrano-Cinca et al. (2010); Wang et al. (2019)
2. Inventory management	
1) Inventory management performance improvement by social media mining	Wood et al. (2017); Hofmann (2017); Choi (2018); Roden et al. (2017); Irani et al. (2017)
2) Inventory information sharing within companies or across supply chain	Cherrett et al. (2015); O'Leary (2011)
OSCM activities: Marketing (31 articles)	
Scope: topics related to marketing and OSCM interface, including demand generation and customer relationship management with the aid of social media.	
Themes under this activity:	**Reference**
1. Demand generation	
1) Promotion and advertising	DiPietro et al. (2012); Irani et al. (2017); Burnes and Choi (2015); Chae (2015); Elghannam et al. (2017); Mabić et al. (2017); Bernoff and Li (2008); Leung et al. (2013); Schaupp and Bélanger (2013); Sigala (2011); Roy et al. (2014); Harvey Chaputula and Patrick Majawa (2013); Bos and Owen (2016); Meixner et al. (2013); Romero and Molina (2011); Bloom et al. (2016); Xu et al.

	(2016); Yan et al. (2018); Cao et al. (2018); Majumdar and Bose (2019)
2) Customer preference understanding	Mishra et al. (2017); Ramanathan et al. (2017); Roden et al. (2017); Halale et al. (2015); Sigala (2011)
3) Social media review manipulation	Choi (2018); Lee et al. (2018)
2. Customer relationship building	
1) Building customer community in social media	Jafari et al. (2015); Markova and Petkovska-Mirčevska (2013); O'Leary (2011); Azhar et al. (2019)
2) Gift sending through social media	Liu and Liu (2009)

OSCM activities: Sourcing (6 articles)

Scope: topics related to purchase and receipt of products and supplier management with the aid of social media.

Themes under this activity:	**Reference**
1. Supplier management	
1) Supplier performance evaluation	O'Leary (2011); Lin et al. (2018)
2) Supplier relationship management	Markova and Petkovska-Mirčevska (2013); Irani et al. (2017); Grant and Preston (2019)
2. Sourcing channel	
1) Social media data as 'raw material' for certain type of data-driven companies selling aggregated data	Hartmann et al. (2016)

OSCM activities: Product development and production (57 articles)

Scope: topics related to design and redesign products, services, and production processes, as well as manufacturing products with the aid of social media.

Themes under this activity:	**Reference**
1. Product development:	

1) Product development idea capturing by social media mining	Guo et al. (2017); Gal-Tzur et al. (2014); Guo et al. (2016); Irani et al. (2017); Chan et al. (2017); Jin et al. (2016); Chan et al. (2016); Abrahams et al. (2015); Mishra and Singh (2018); Jiang et al. (2017); Mishra et al. (2017); Chae (2015); Singh et al. (2018); Consoli (2012); Ravi et al. (2017); Chirumalla (2013); Leung et al. (2013); Abrahams et al. (2012); Brochado et al. (2019); Narayanaswami (2018); Zhang et al. (2019); Bi et al. (2019); Maiyar et al. (2019); Lai et al. (2018)
2) Product development idea elicitation by communicating and interacting with customers in social media	Sigala (2014); Jafari et al. (2015); Bertoni and Larsson (2011); Liu and Liu (2009); Markova and Petkovska-Mirčevska (2013); DiPietro et al. (2012); Irani et al. (2017); Hernandez Serrano et al. (2015); Burnes and Choi (2015); Sun and Xu (2018); Romero and Molina (2011); Halale et al. (2015); Bernoff and Li (2008); Leung et al. (2013); Gu et al. (2017); Schaupp and Bélanger (2013); Jiang et al. (2016); Roden et al. (2017); Graham and Smart (2010); Sigala (2011); Shih et al. (2014); Bloom et al. (2016); Harvey Chaputula and Patrick Majawa (2013); Andreadis (2015); Cao et al. (2018)
3) Virtually launching product in social media to test product development ideas	Sigala (2014); Irani et al. (2017); Leung et al. (2013)
4) Product development idea sharing within companies or across supply chain	Bertoni and Larsson (2011); Irani et al. (2017); Halale et al. (2015); Chirumalla (2013); Chirumalla et al. (2018); Swain and Cao (2019); Cheng and Krumwiede (2018)
2. Manufacturing and service generation	
1) Innovative idea capturing using social media mining for manufacturing or service generation processes improvement	Sigala (2014); Mishra et al. (2017); Singh et al. (2018)
2) Innovative idea exchange within companies or across supply chain for	Lam et al. (2016); Wang et al. (2015); Chirumalla (2013); Michaelides et al. (2013a); Michaelides et al. (2013b); Mills et

manufacturing or service generation processes improvement	al. (2019); Weichhart et al. (2018); Ollus et al. (2011); Andreadis (2015)
3. Information storage for product development and production	
1) Repository for information related to product development and production.	Bertoni and Larsson (2011); Irani et al. (2017); Lam et al. (2016); Chirumalla (2013); Chirumalla et al. (2018)

OSCM activities: Delivery (32 articles)

Scope: topics related to product and service delivery with the aid of social media.

Themes under this activity:	**Reference**
1. Physical product delivery	
1) Transportation-related information mining from social media to support vehicle routing and delivery	Albuquerque et al. (2016); Chen et al. (2016); Gal-Tzur et al. (2014); O'Leary (2011); Gkiotsalitis and Stathopoulos (2016); Liu and Qu (2016); Gu et al. (2016); Han et al (2018); Zhang et al. (2018b); Kirac and Milburn (2018); Narayanaswami (2018); Neuhold et al. (2018)
2) Transportation and shipment information exchange within companies or across supply chain	O'Leary (2011); Cherrett et al. (2015)
2. Service/virtual product delivery	
1) Service delivery through social media	Liu and Liu (2009); Cottrill et al. (2017); Fan and Niu (2016); Bhattacharjya et al. (2016); Gu and Ye (2014); Burnes and Choi (2015); Chae (2015); Bernoff and Li (2008); Leung et al. (2013); Sigala (2011); Nisar and Prabhakar (2018); Wuest et al. (2015); Sigala (2014); Löfstedt and Holmberg (2016); Yan et al. (2018); Bhattacharjya et al. (2018); Cao et al. (2018)
2) Virtual product delivery through social media	Hernandez Serrano et al. (2015); Bloom et al. (2016)

OSCM activities: Product return and reverse logistics (7 articles) **Scope:** topics related to product return and reverse logistics operations with the aid of social media	
Themes under this activity:	**Reference**
1. Informing reverse logistics decision making	
1) Reverse logistics information exchange within companies or across supply chain	Irani et al. (2017); Orenstein et al. (2016)
2) Product return forecasting support	Minnema et al. (2016); Sahoo et al. (2018)
2. Customer communication in product return and recall	
1) Return service communication using social media	Bhattacharjya et al. (2016); Bhattacharjya et al. (2018)
2) Recall information dissemination to public	Bernoff and Li (2008)

OSCM activities: Operations and supply chain risk management (59 papers) **Scope:** topics related to business operations and supply chain risk management as well as humanitarian operations and disaster/emergency management with the aid of social media.	
Themes under this activity:	**Reference**
1.Business risk management	
1) Risk and disruption identification through social media mining	Albuquerque et al. (2016); Guo et al. (2016); Gal-Tzur et al. (2014); O'Leary (2011); Cottrill et al. (2017); Irani et al. (2017); Bhattacharjya et al. (2016); Abrahams et al. (2015); Wu et al. (2017); Jiang et al. (2017); Chae (2015); Gu et al. (2016); Zhang et al. (2018b); Abrahams et al. (2012); Swain and Cao (2019); Narayanaswami (2018); Zavala and Emmanuel Ramirez-Marquez (2019)
2) Risk-related information sharing within companies or across supply chain	O'Leary (2011); Cottrill et al. (2017); Irani et al. (2017); Orenstein et al. (2016)

3) Risk-related information dissemination to public	Cottrill et al. (2017); Irani et al. (2017); Fan and Niu (2016); Bhattacharjya et al. (2016); Gu and Ye (2014); Chae (2015); Sigala (2011); Nisar and Prabhakar (2018); Narayanaswami (2018)
2. Humanitarian operations and disaster management	
1) Emergency and disaster information identification through social media mining	Markenson and Howe (2014); Sangameswar et al. (2017); Griswold (2013); Huang and Xiao (2015); Onorati and Díaz (2016); Grabowski and Roberts (2011); Chen et al. (2016); Hadi and Fleshler (2016); Imran et al. (2015); Foresti et al. (2015); Papadopoulos et al. (2017); Yoo et al. (2016); Swaminathan (2018); Lai (2017); Jennings et al. (2017); Oxendine and Waters (2014); Riccardi (2016); Webersik et al. (2015); Singh et al. (2017); Onorati et al. (2019); Han et al (2018); Ma and Yates (2017); Wamba et al. (2017); Ma and Yates (2014); Kirac and Milburn (2018); Zhang et al. (2018a); Shan et al. (2019); Panteras and Cervone (2018); Wu et al. (2018); Kumar and Singh (2019); Comrie et al. (2019); Kim and Hastak (2018); Dutt et al. (2019)
2) Emergency and disaster information dissemination to public	Markenson and Howe (2014); Griswold (2013); Grabowski and Roberts (2011); Hadi and Fleshler (2016); Yoo et al. (2016); Lai (2017); Oxendine and Waters (2014); Riccardi (2016); Fry and Binner (2016); Wamba et al. (2017); Elbanna et al. (2019); Comrie et al. (2019)
3) Humanitarian management information sharing within or across organisations	Grabowski and Roberts (2011); Wukich et al. (2017); Lai (2017); Wamba et al. (2017); Yates and Paquette (2011)
4) Resource and donation request in social media	Lai (2017)

OSCM activities: General activities (14 articles)

Scope: other topics related to OSCM, including OSCM interface with general human resource management, knowledge management and sustainability.	
Themes under this activity:	**Reference**
1. Human resource management	
1) Supply chain manager/worker recruitment	Fisher et al. (2014); Chae (2015); Fletcher et al. (2016); Azhar et al. (2019)
2) Humanitarian organisation volunteer recruitment	Griswold (2013); Lai (2017); Wamba et al. (2017); Elbanna et al. (2019)
3) Employee training via social media	Azhar et al. (2019)
2. Knowledge management	
1) Supply chain knowledge sharing and creation	Grant (2016); Billington and Davidson (2013)
3. Sustainability	
1) Facilitating sustainable operations' benchmarking and implementation	Tseng (2017); Williams et al. (2014); Tseng et al. (2019a); Tseng et al. (2019b);

Figure 1. Sampling process

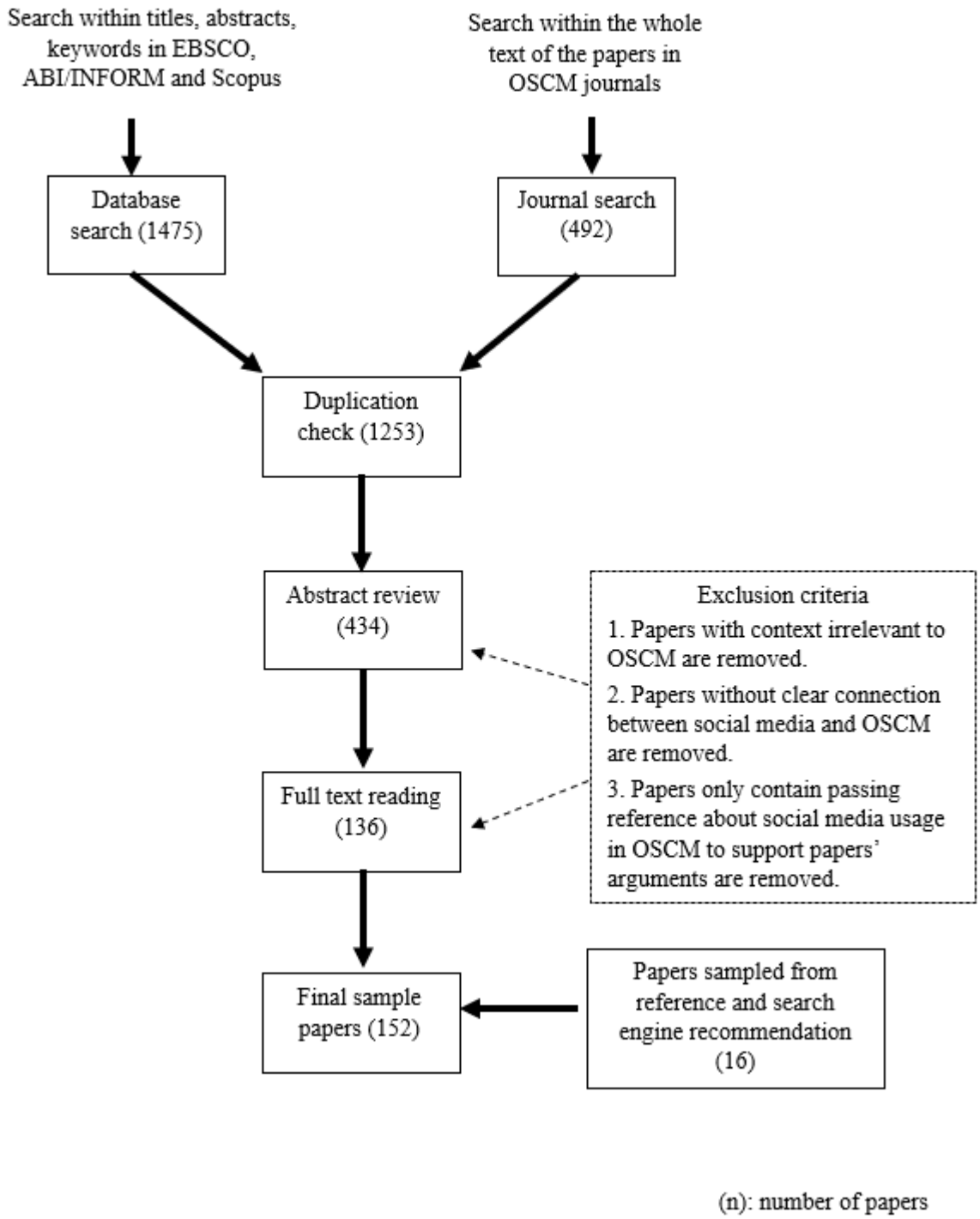

Figure 2. Number of papers published each year

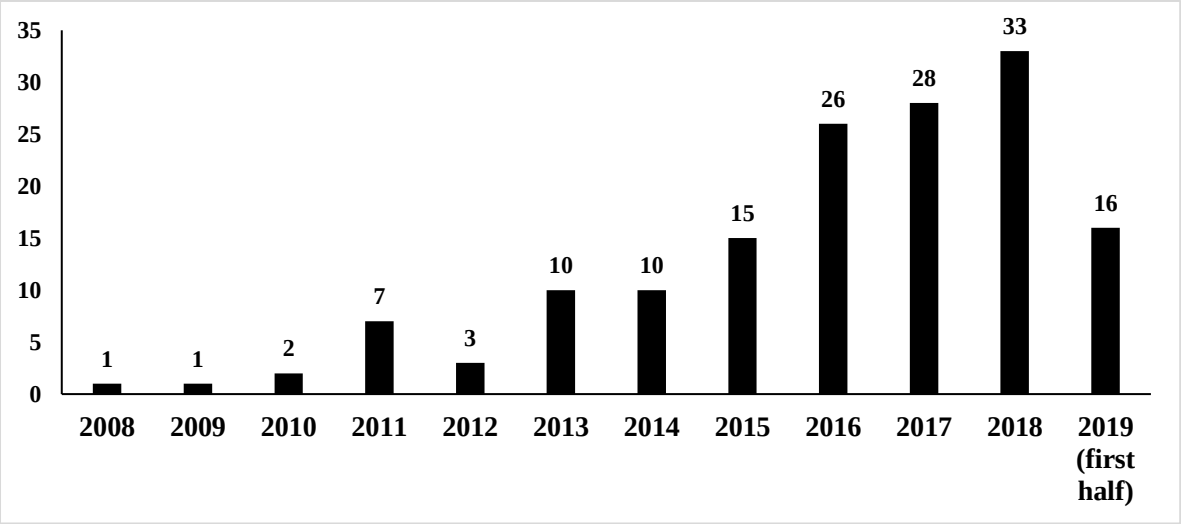

Figure 3. Sector distribution for sampled papers

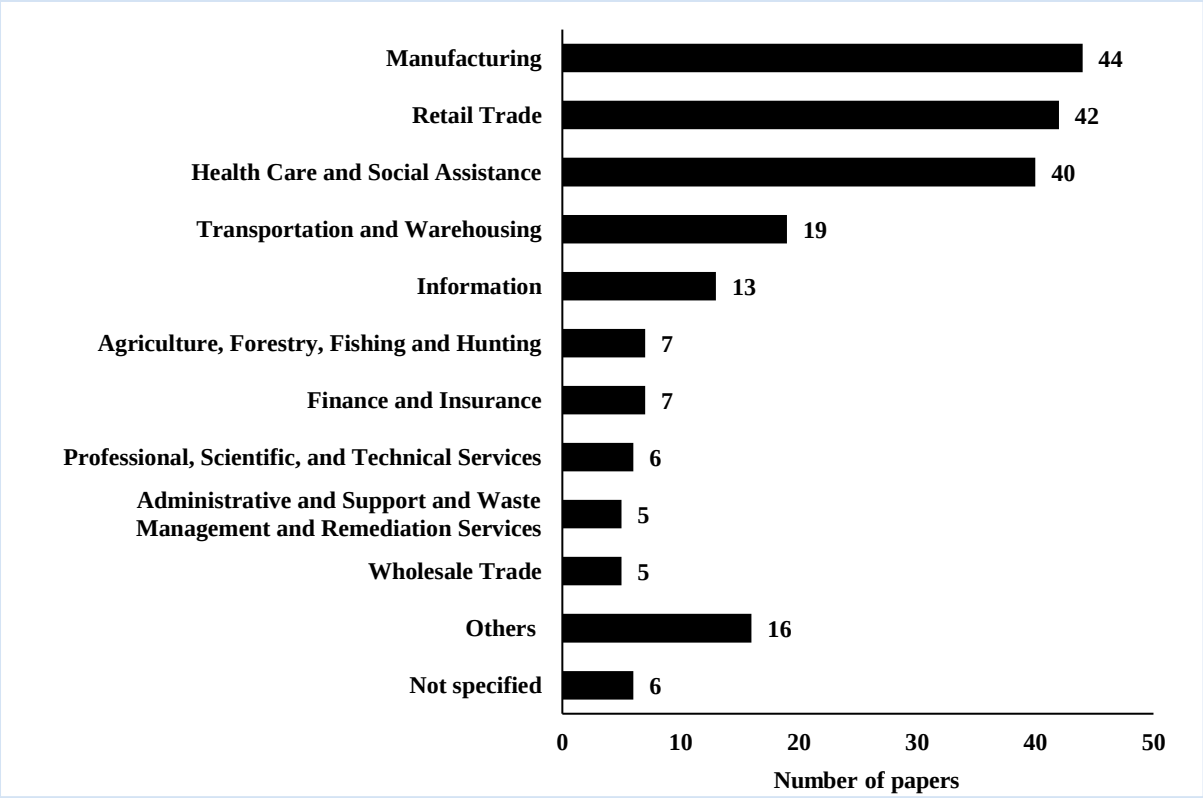

Figure 4. Country/region distribution for sampled papers

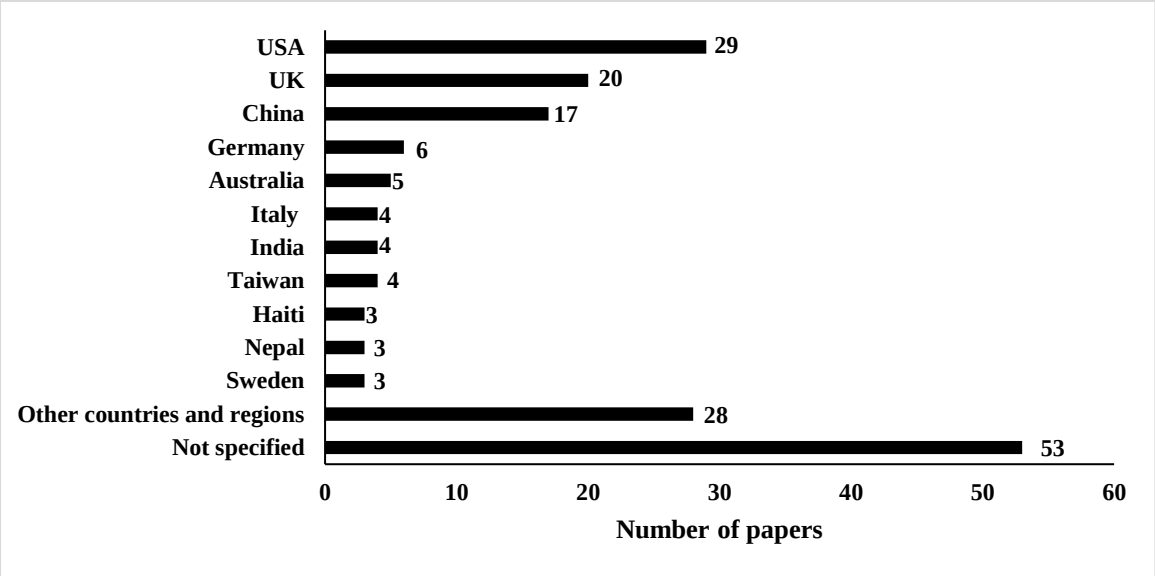

Figure 5. Different social media functions in OSCM

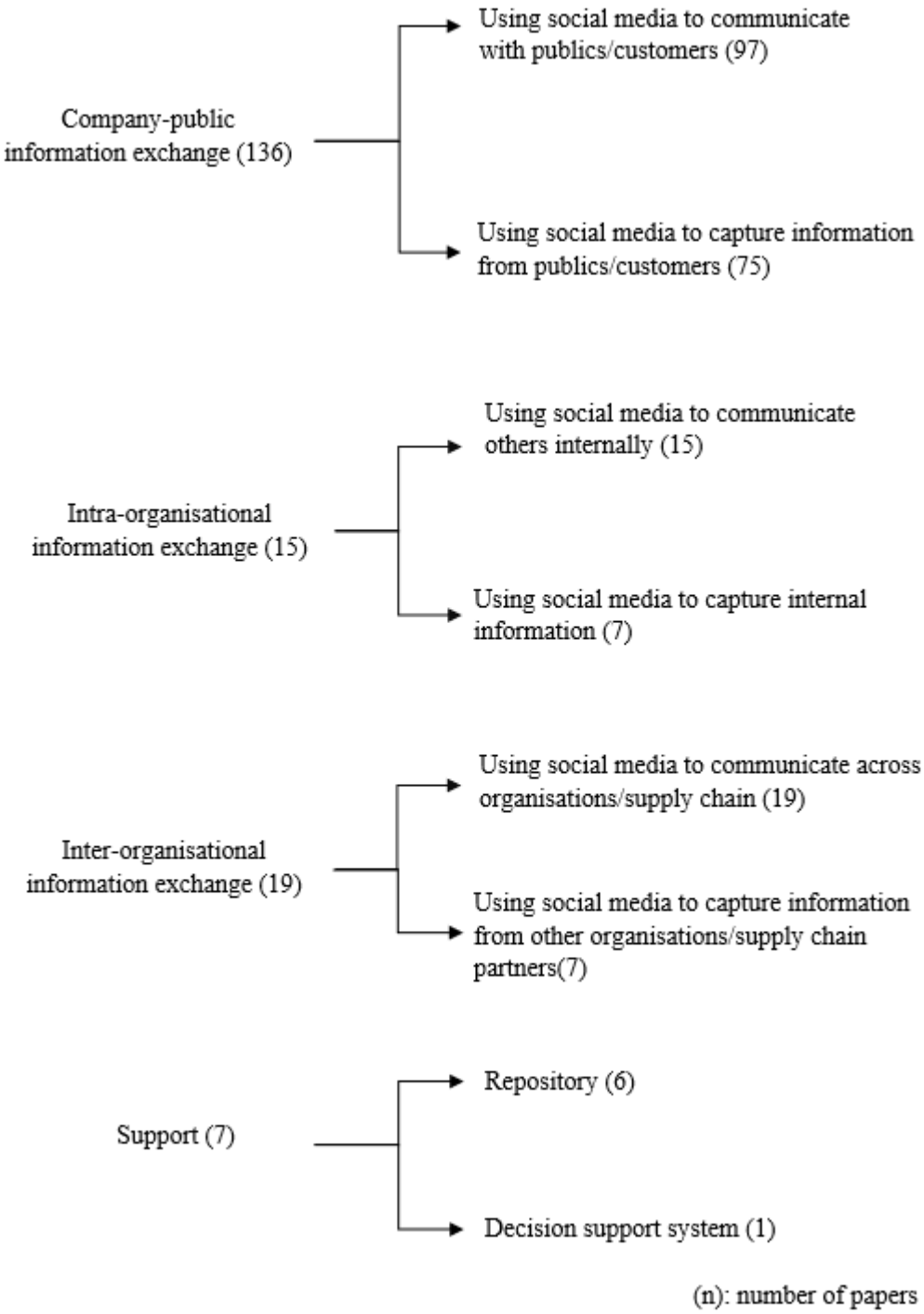

Figure 6. Research distribution by OSCM activities and social media functions

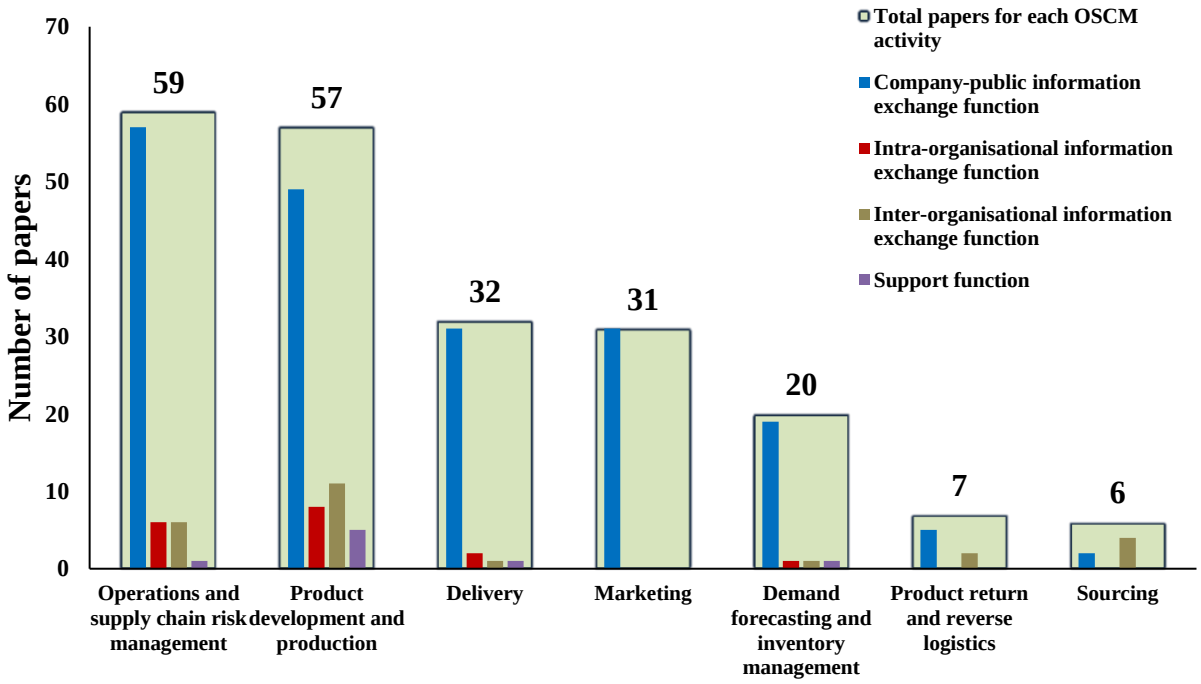

Figure 7. Mechanisms of how social media can influence different aspects of OSCM

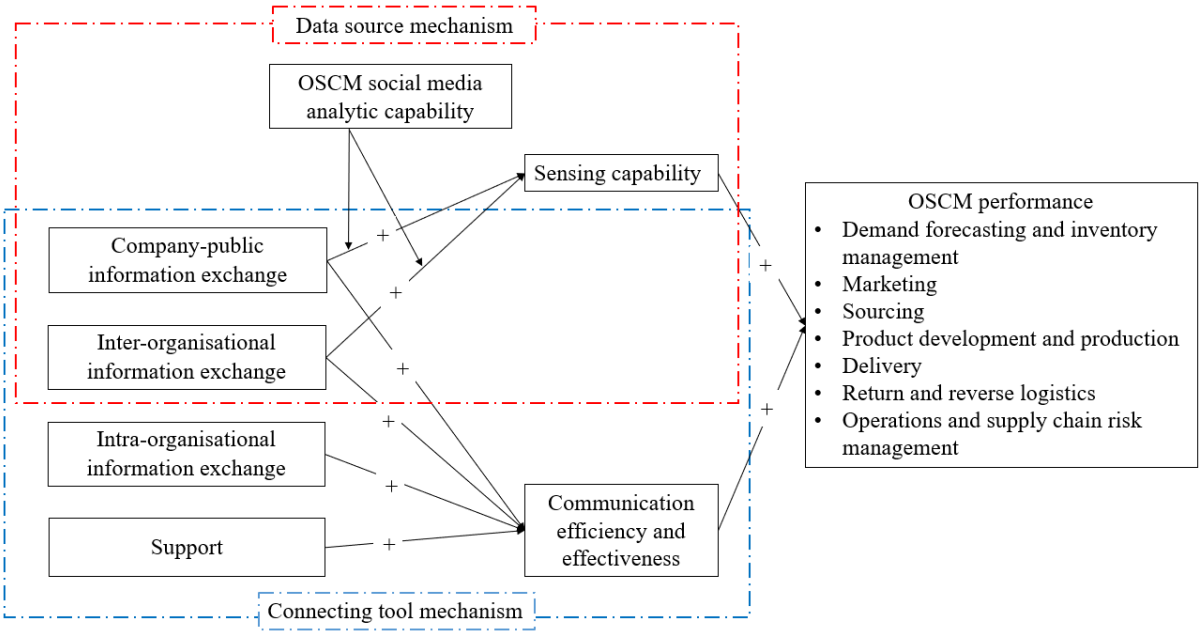

Figure 8. Future research directions for social media in OSCM