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Social media in supply chains and logistics: Contemporary trends and themes

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Abstract

Although social media have been employed in various business and management scientific domains, their use and role in relation to supply chains has been scant. This paper addresses the gap and adds to this body of knowledge by providing new data and original insights and by showcasing emerging, contemporary trends and themes. Over a period of 4 months we downloaded tweets that contained the #supplychain and/or the #logistics hashtags. After cleaning the data and filtering tweets in English we analysed 76,378 posts, using different analytical techniques. Our work shows the key trends emerging where various supply chain management technologies play a dominant role. Blockchain is the leading technology followed by artificial intelligence. The increased role of last mile logistics is also shown which can be related to e-commerce and customer service. Supply chain technologies are also clustered and interlinked in a related dendrogram and, automation is linked to robots and robotics, analytics is linked to data, artificial intelligence is linked to IoT and machine learning. Similar interlinkages are illustrated for other trends impacting contemporary supply chains. This research provides direction to supply chain managers for the key trends and themes emerging in their profession, and a new graph-based measure to understand the topology of the social media mindset landscape. In turn, such trends can offer valuable insights as to how the industry is developing and help proactively identify areas of potential investment.

Keywords: social media, tweets, contemporary trends and themes, supply chain management, logistics

1. INTRODUCTION

Several academic studies have examined trends in logistics and supply chain management over the past twenty years. For example, Bowersox et al. (2000) identified ten mega-trends illustrating the challenges posed for supply chain managers and logisticians. These trends included a shift from: a) customer service to relationship management, b) adversarial to collaborative arrangements, c) forecast to endcast d) experience to transition strategy, e) absolute to relative value, f) functional to process integration, g) vertical to virtual integration, h) information hoarding to sharing, i) managerial accounting to value-based management, and j) training to knowledge-based learning. The authors stressed that these transformative trends will contain some risks for their implementation including "real time connectivity, channel balance of power, vulnerability of global operations and vulnerability stemming from strategic integration, information sharing and technology investment" (Bowersox et al., 2000, p.14). Similarly, focusing on the European context, Skjoett-Larsen (2000) identified various trends impacting future logistics operations and he predicted that the globalisation of the supply chain, strategic partnerships and e-commerce will have an impact in the following five years, whilst trends such as virtual enterprises, green supply chains and process-oriented management will become prevalent in the following five to ten years. Ballou (2007) continued this discussion about trends and the future evolution of logistics and supply chain management. He noted among other themes the emergence of a revenue generation strategy for the supply chain, which could be equally important as the cost reduction one, the need for coordination and collaboration between firms including trust, the role of information sharing between channel members considering technological advances and the organisational merger of operations, purchasing and logistics under the supply chain function. The above issues were also highlighted by Storey et al. (2006), who noted the critical role of outsourcing for the future transformation of supply chains including a need for cross-boundary workings. They also stressed the role of globalisation in contemporary supply chains as it is evident in global sourcing, as well as volatility in customer demand and increased competition. From 2010 onwards, these papers were followed and supported by similar reports by primarily consulting companies, few academic institutions and major logistics operators. For example, Gartner has published relevant reports over the past few years highlighting the major trends impacting on the future supply chain (Pettey, 2019). Similarly, PwC (2019) has identified in similar reports the key trends influencing the transport and logistics sectors in various geographical areas and industry contexts. DHL (2018) has also published over the past few years the DHL Trends Radar which stresses the role of various social, business and technological trends impacting on supply chains in the next five years. Likewise, similar work was undertaken recently by the logistics team at Cranfield School of Management (U.K.) illustrating the key logistics and supply chain management trends impacting on specific sectors (including the logistics sector) in the next five years (Bourlakis et al., 2017). A common thread of these reports is the future, dominant role of information technology and the impact of subsequent technological advancements in the supply chain. The latter has been also noted recently by relevant academic papers stressing advancements such as: big data and supply chain analytics (Hazen et al., 2014; Waller and Fawcett, 2013; Speranza, 2018; Gunesakaran et al., 2017; Lamba and Singh, 2017; Wang et al., 2016), blockchain (Tapscott and Tapscott, 2017; Saberi et al., 2019; Treiblmaier, 2018; Francisco and Swanson, 2018; Kshetri, 2018; Min, 2019), robotics and automation (Dadzie et al., 1999; Oesterreich and Teuteberg, 2016), digitalisation in supply chains (Oesterreich and Teuteberg, 2016; Buyukozkan and Gocer, 2018; Ivanov et al., 2019), drones and last mile delivery (Kull et al., 2007; McKinnon, 2016; Karak and Abdelghany, 2019; Kunze, 2016), augmented reality (Cirulis and Ginters, 2013; Hofmann and Rüsch, 2017), Autonomous vehicles (Bechtsis et al., 2018; Boerkamps et al., 2000; Speranza, 2018), Internet of Things (Manavalan and Jayakrishna, 2019; Hofmann and Rüsch, 2017), artificial intelligence (Klumpp, 2018; Min, 2010; Baryannis et al., 2019). A key message from these papers is that these technologies and applications influence and shape current, contemporary supply chains.

Another major observation in relation to these academic papers and reports is that specific methodological approaches have been followed. These include, among others, the use of secondary data such as reports, books, material published in press and trade periodicals, company websites (Bourlakis et al., 2017; Skjoett - Larsen, 2000) and interviews with industry experts and senior managers representing major companies (Storey et al., 2006) as well as with research partners and customers of these organisations (DHL, 2018). More importantly, it is evident that social media have been underutilised, as a research methodological tool, in diagnosing trends in logistics and supply chain management contexts. To our knowledge, this is the first research paper aiming to unravel the potential role of social media content in identifying such trends. Subsequently, our work focused on analysing a specific set Twitter posts during a defined timeframe as "tweets about timely issues and challenges tend to be more widely diffused than others" and "tweets concerning new trends (e.g. #BigData) and issues (#risk, #sustainability, #manufacturing) in supply chain management are propagated widely". (Chae, 2015, p.253) As such, this can be a viable proposition as, on many occasions, managers and practitioners have paved the way for many developments in relation to supply chain management. Given the above, our overarching research objective is to illustrate the major, current trends in logistics and supply chain management, by examining the current viewpoints discussed on social media. More specifically our work will answer the following research questions:

1. *What are the major, current trends influencing supply chain? What is the role of the recent technological advances in relation to supply chains?*

2. *What are the interrelationships and interconnections between these trends?*

3. *How do user mindsets as expressed by what they are posting about compare to other users and how do mindsets compare to each other?*

By addressing the above questions, we aim to fill a major gap in the academic literature, due to a scarcity of relevant, up-to-date work analysing current trends in logistics and supply chain management via the use of relevant social media in general and tweets in particular.

The paper is structured as follows. The next section presents the relevant literature related to using social media and big data for identifying trends and gaining useful practical insights. In turn the paper presents the methodology followed, especially with regard to data collection, processing and analysis. Our results are then discussed and put into the perspective of previous studies and current practice, before the paper concludes by offering suggestions for future research.

2. Literature Review

Social media are defined as "a group of internet-based applications that build on the ideological and technological foundations of Web 2.0 and allow the creation and exchange of user generated content" (Kaplan and Haenlein, 2010, p.61). These social media platforms help people to share ideas and information irrespective of their physical location and their popularity has increased dramatically over recent years. Over the past few years social media have increasingly become more popular. In 2019, active social media users have reached 3.4 billion (or 45% of the global population), up 9.1% since the year before (Hootsuite, 2019). These users have on average 8.9 social media accounts, on which they spend 2 hours and 16 minutes daily. In addition, 24% of Internet users use social media for work purposes.

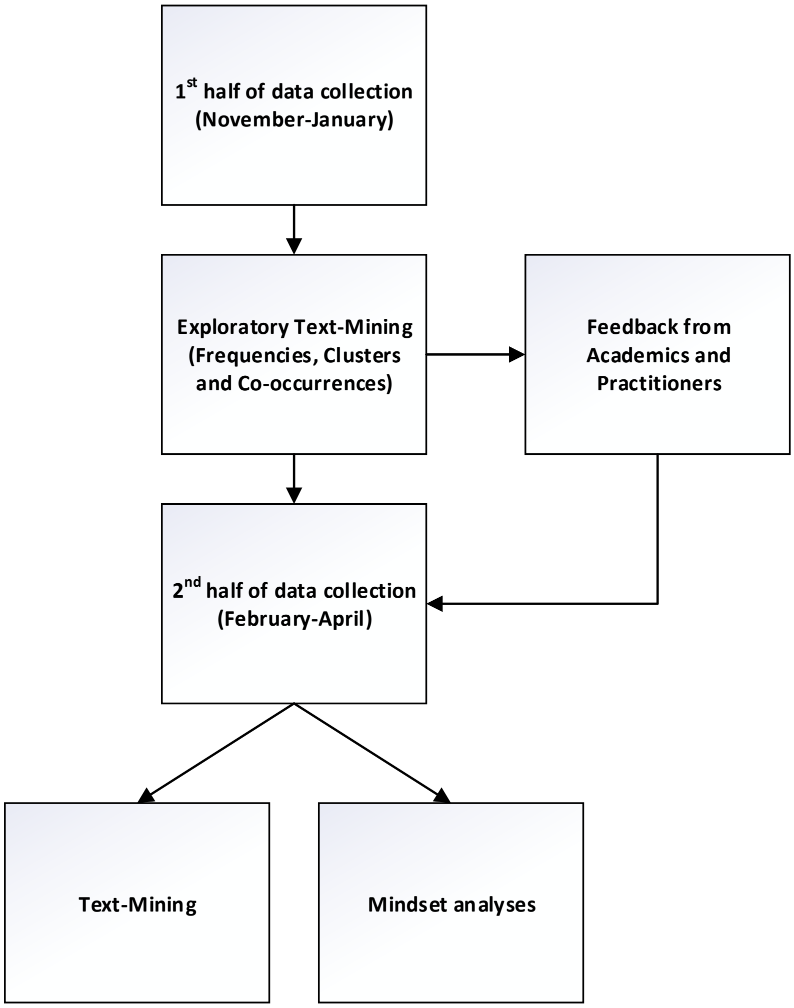
Statistics like the above provide a clear indication as to how important social media are not just for personal, but also for professional applications. For example, social media have been employed to support addressing various management-related challenges, including customer satisfaction (Ramanathan et al., 2017) and collaborative product development (Porter and Donthu, 2008), while firms are increasingly employing them to be close to their customers, utilising them as a sales and marketing tool (Gamboa and Goncalves, 2014). In addition, Lam et al. (2016) point out the effective use of social networking of internal members of a company and the benefits for firms via these intra-organisational communications, including operational efficiency and innovativeness. The supply chain management field has been slow to embrace the role of social media and, with a few exceptions, there has been limited use of them in supply chain practice and research. For example, Chae (2015) illustrated numerous insights for the role of tweets for various supply chain practices, while Fan and Niu (2016) identified factors affecting the effectiveness of service recovery strategies. In addition, O'Leary (2011) showed the capabilities of various social media platforms and their subsequent impact on supply chains including: a) the integration of social media information into supply chain technology systems such as radio frequency identification, b) the development of better relationships between supply chain members and c) the acquisition of better insights for various operational and business issues especially the ones which may not be easily identified or accessible. Singh et al. (2018) also considered twitter data to identify supply chain management issues in the food sector, while Tan et al. (2015, p.223) demonstrated the key role of twitter data (and big data) in the supply chain and operations management domain "as an important driver of innovation and a significant source of value creation and competitive advantage" for company managers. Similarly, in the e-retail logistics context, Bhattacharjya et al. (2016) analysed the effectiveness of customer service exchanges via Twitter involving customers and e-retailers in relation to logistics such as delivery queries. Their work identified possible ways which e-retailers can consider, in their attempt to improve their provision of this logistics-related customer service via Twitter and it highlighted a lack of communication exchange between e-retailers and their logistics companies on the Twitter platform resulting in a poor customer service. Focusing on the daily sales forecast challenge, Cui et al. (2018) analysed operational information (e.g. sales, advertising etc.) related to an online apparel retailer and combined it with social media information from Facebook. They showed that this combination can result in improvements of the accuracy of these sales forecasts which, in turn, can have a major impact on other supply chain management functions such as procurement and stock management. Finally, Fisher et al. (2014) demonstrated the increasing role of social media during the recruitment of global supply chain managers and proposed various stages which companies can follow when utilising social media for this activity. More broadly, analysing social media posts can offer useful insights as to the current and potentially future areas of significance in supply chain management. Given the vast amount of data generated, applying big data analytical techniques can identify trends and themes that are of interest to both practitioners and academics, bringing new insights to our understanding of human networks and communities (Boyd and Crawford, 2012). Big data analytics generate such insights by applying statistics to data sets that demonstrate three important qualities: a) velocity i.e. the increasing speed with which data is created, b) variety, which refers to a wide range of unstructured data, and c) volume, which is the amount of data that can be collected and analysed (Wang et al., 2016). These qualities carry an idealistic expectation about the potential to offer insights into a problem (Boyd and Crawford, 2012). As such, pragmatic expectations that are driven by the research/practice question and not by the data itself should be applied (Papagiannidis et al., 2018). Otherwise big data sets can have the opposite effect, obfuscating any important trends (Graham and Shelton, 2013).

3. METHODOLOGY

3.1 Research Design

Our methodology consisted of three key sub-studies which are outlined in Figure 1 below. Our data collection took place in two stages, each lasting about 2 months. We conducted an exploratory analysis between these stages which made it possible to refine the data processing and analysis. It also made it possible to seek feedback from logistics and supply chain management academic experts and practitioners in the field. Specifically, we conducted two focus groups with academic experts where each group featured 4 participants and we conducted interviews with 5 logistics and supply chain managers. During the focus groups and the interviews, we discussed our preliminary findings and sought their views on them. Their input was extremely helpful as it confirmed many of our findings and it provided new insights for the key issues emanating from our work. The rest of this section presents the methodological steps in more detail, especially when it comes to the big-data collection, processing and analysis.

Figure 1: The research design adopted



3.2 Data collection, processing and analysis

Twitter posts that contained either #supplychain or #logistics were collected using Twitter's API. 325,671 posts were collected from 21st November 2018 to 1st of April 2019, i.e. about 4 months and 1 week. The data collection took place in two stages with the preliminary analysis taking place in early February.

In order for pre-processing to be undertaken, the posts and their meta-information (date, language, user etc) were entered into a mySQL database. Non-English posts (based on the meta information set in each tweet) and any duplicate posts were removed, leaving 139,692 posts to analyse. The exploratory analysis suggested that a significant number of tweets were job adverts. Although examining job adverts longitudinally can be a useful proxy for identifying market trends, they are not as valuable for a cross-sectional analysis that is not focused on operational needs. As such, we identified and filtered tweets related to job advertisement based on the source, user and content. The filtering resulted in the final dataset of 76,378 Twitter posts.

Using a PHP (recursive backronym of PHP: Hypertext Preprocessor) script, a number of pre-processing steps were applied before the analysis. These included converting posts to lowercase, removing HTML tags and links, decoding HTML characters, removing twitter handles and links and stripping non-alphanumeric characters. We have also replaced key acronyms with full terms (e.g. AI with artificialintelligence and SCM with supplychainmanagement) to ensure a more consistent treatment of such terms. To illustrate this in practice the pre-preprocessing this message "Electronic Air Waybill (Eawb) brings air cargo connectivity, confidentiality & efficiency, helps reduce operational costs & speed up the delivery of air freight shipments

https://t.co/ykjKo88Phj #Eawb #eAirWayBill #Customs #Trade #Import #Logistics https://t.co/Tp2xn3AC6d" became "electronic air waybill eawb brings air cargo connectivity confidentiality efficiency helps reduce operational costs speed delivery air freight shipments eawb eairwaybill customs trade import logistics".

The processed text was then entered into QDAMiner and WordStat for the text-mining analysis. QDA Miner is a qualitative data analysis software package for coding, annotating, retrieving and analysing collections of documents and images, while WordStat is a content analysis and text mining software program. In total, the corpus contained 974,421 words, i.e. about 12.8 terms per tweet.

To explore the mindsets of user, and their relationships, a mindset vector was constructed for each user based on the topic cluster of his/her posts. We first grouped the processed posts by user, resulting in one group of processed text messages for each of the 23,268 unique users. Based on the significant topic clusters of keywords identified from the text-mining analysis, we computed a unique mindset vector for each user, and compared the similarities between users based on the geometrical angle between these mindset vector in the vector space.

4. RESULTS AND FINDINGS

4.1 Text Mining

Lematisation was performed to reduce the terms into their underlying lemmas so they can be analysed as a single item. We performed an analysis that helped identify the most frequently featured terms. Table 1 tabulates the number of occurrences of each term, the % based on the total number of keywords that were included in the analysis (top 300) and the number and % of cases of a keyword appearing. Finally, the last column is the term frequency-inverse document frequency (TF-IDF), a weighting scheme which reflects how important a term is to a document in a corpus. For terms that appeared many times in the corpus, but were only contained in a small subset of the documents, a high TF-IDF score was assigned.

Table 1: The 50 most frequently used featured terms

	FREQ	% SHOWN	NO. CASES	% CASES	TF • IDF
SUPPLYCHAIN	49569	11.41%	42508	55.65%	12615.2
LOGISTICS	41535	9.56%	36810	48.19%	13166.7
BUSINESS	6777	1.56%	6268	8.21%	7358.7
BLOCKCHAIN	6677	1.54%	5365	7.02%	7701.2
TECHNOLOGY	5622	1.29%	5222	6.84%	6550.4
SHIP	5457	1.26%	4778	6.26%	6568.7
INDUSTRY	5205	1.20%	4901	6.42%	6207.9
FREIGHT	4400	1.01%	3880	5.08%	5694.2
ARTIFICIALINTELLIGENCE	4244	0.98%	3425	4.48%	5722.2
COMPANY	4093	0.94%	3935	5.15%	5271.9
TRUCK	4052	0.93%	3129	4.10%	5622.4
TRANSPORTATION	4001	0.92%	3775	4.94%	5225.5
IOT	3691	0.85%	3319	4.35%	5027
MANAGEMENT	3531	0.81%	3343	4.38%	4798
PROCUREMENT	3505	0.81%	2983	3.91%	4936.1
WAREHOUSE	3451	0.79%	3082	4.04%	4811.2
SERVICE	3365	0.77%	3107	4.07%	4679.5
TRANSPORT	3344	0.77%	3060	4.01%	4672.4
ECOMMERCE	3341	0.77%	3017	3.95%	4688.7
DELIVERY	3304	0.76%	2873	3.76%	4707
MANUFACTURING	3232	0.74%	2967	3.88%	4559.2
SOLUTION	3120	0.72%	2974	3.89%	4398
RETAIL	3080	0.71%	2738	3.58%	4452.2
INNOVATION	2585	0.60%	2401	3.14%	3884.2

GLOBAL	2584	0.60%	2473	3.24%	3849.5
CUSTOMER	2434	0.56%	2280	2.99%	3711.9
WORK	2426	0.56%	2322	3.04%	3680.5
DIGITAL	2376	0.55%	2200	2.88%	3660.3
DATA	2364	0.54%	2064	2.70%	3707.4
TIME	2349	0.54%	2257	2.96%	3592.6
CARGO	2159	0.50%	1935	2.53%	3446.4
TECH	2117	0.49%	2049	2.68%	3326.7
SUPPLYCHAINMANAGEMENT	2067	0.48%	1910	2.50%	3311.2
FUTURE	1995	0.46%	1932	2.53%	3185.9
HGV	1947	0.45%	1824	2.39%	3157.9
TEAM	1940	0.45%	1840	2.41%	3139.2
BREXIT	1905	0.44%	1490	1.95%	3257.1
WORLD	1878	0.43%	1802	2.36%	3055.9
TRADE	1841	0.42%	1649	2.16%	3066.6
NEWS	1830	0.42%	1763	2.31%	2995.2
FOOD	1827	0.42%	1540	2.02%	3097.6
DRIVER	1787	0.41%	1463	1.92%	3069.6
PRODUCT	1766	0.41%	1656	2.17%	2938.5
IMPROVE	1756	0.40%	1702	2.23%	2900.9
OPERATION	1754	0.40%	1681	2.20%	2907.1
MARKET	1693	0.39%	1587	2.08%	2848.3
EVENT	1652	0.38%	1383	1.81%	2878
COST	1613	0.37%	1518	1.99%	2744.8
DISTRIBUTION	1583	0.36%	1493	1.95%	2705.2

We then performed topic extraction, requesting 20 clusters. Given that tweets are rather short in length, the option of segmenting data by document, paragraph or sentence was not expected to make any significant difference. As such it was set to segmentation by document. Topic extraction was achieved by WordStat computing a word by a document frequency matrix. Once this matrix was obtained, a factor analysis with Varimax rotation was computed in order to extract a small number of factors. All words with a factor loading higher than a specific criterion were then retrieved as part of the extracted topic. A value of .25 was used for the minimum factor loading for a word to be retained in the factor solution. Increasing the cut-off value reduces the number of words, keeping only the more representative ones, while reducing it can include words that are less characteristic of the extracted topic. A word can be associated with more than one factor, a characteristic that more realistically represents the polysemic nature of some words as well as the multiple contexts of word usage.

As per the search criteria used (also reflected in the frequency table), we expected the first two clusters to be related to supply chain logistics. This was shown to be the case as per the name and keywords features in each cluster (Table 2). Only keywords that met the factor loading cut-off criterion were included in descending order of factor loading. The %VAR column shows the % variance explained, while FREQ shows the total frequency of all items listed in the keyword's column. Finally, the cases and % cases display the number and percentage of cases containing at least one of the items listed in the keyword column.

Table 2: Topic extraction

NAME	KEYWORDS	EIGEN VALUE	% VAR	FREQ	CASES	% CASES
SUPPLY CHAIN PROCUREMENT	PROCUREMENT; PURCHASE; SOURCE; SUPPLYCHAIN; SUPPLYCHAINMANAGEMENT	1.47	1.37	48972	43186	56.54%
LAST MILE LOGISTICS	DELIVERY; COURIER; LASTMILE; SUPPLYCHAIN; LOGISTICS	1.34	1.49	40989	37504	49.10%
SMART MANUFACTURING	IOT; INDUSTRY; MANUFACTURING; SMART	2.21	1.44	12697	10501	13.75%
CUSTOMER SERVICE	VISIT; WEBSITE; SERVICE; INFORMATION; PROVIDE; CONTACT; CUSTOMER	1.33	1.26	9829	8144	10.66%
HGV DRIVER	HGV; DRIVER; TRUCK; ROAD; DRIVE; CAR; VEHICLE	2.02	1.87	10224	7289	9.54%
E-COMMERCE	ECOMMERCE; RETAIL; FULFILLMENT; RETAILER; BRAND; MARKETING	1.64	1.39	9046	7275	9.52%
IOT	FINTECH; CYBERSECURITY; SECURITY; BLOCKCHAIN; BIGDATA; IOT; MARKETING	1.22	1.45	7537	6729	8.81%
AIR FREIGHT	AIRFREIGHT; CARGO; FREIGHT; AIR; FREIGHTFORWARDING; AVIATION	3.35	1.6	8416	6403	8.38%
RISK & QUALITY MANAGEMENT	COMPLIANCE; QUALITY; SAFETY; HEALTH; RISK; MANAGEMENT	1.57	1.38	7206	6353	8.32%
MARITIME	MARITIME; SHIP; PORT; CONTAINER	1.41	1.43	7450	6070	7.95%
AUTOMATION	ROBOTICS; ROBOT; AUTOMATION; ARTIFICIALINTELLIGENCE; MACHINELEARNING; DRONE; AUTOMATE	1.44	1.59	8183	6022	7.88%
WAREHOUSING; WMS	LOGISTICS; WAREHOUSE; ROBOTICS; SUPPLYCHAIN; WAREHOUSING; DISTRIBUTION; WMS	1.28	1.41	6258	5508	7.21%
COST; EFFICIENCY	COST; EFFICIENCY; REDUCE; IMPROVE; INCREASE	1.39	1.32	6279	5137	6.73%
VEHICLE; TRANSPORT	SERIES; VEHICLE; INDIA; TRANSPORT; GROUP; ROAD	1.32	1.33	5211	4786	6.27%
FREIGHT TRANSPORTATION	TRANSPORTATION; CARRIER; SHIPPER; TRUCK; FREIGHT	1.21	1.17	4804	4602	6.03%
EXPORT / IMPORT; CHINA	IMPORT; EXPORT; TRADE; TARIFF; CHINA; CUSTOM	1.73	1.68	5701	4063	5.32%
DIGITAL TRANSFORMATION	DIGITAL; TRANSFORMATION; DIGITALTRANSFORMATION	1.3	1.28	4238	3661	4.79%
SUPPLY CHAIN ANALYTICS	ANALYTICS; BIGDATA; DATA; MACHINELEARNING; ARTIFICIALINTELLIGENCE	1.26	1.38	4031	3459	4.53%
BREXIT / UK	BREXIT; UK; DEAL; HAULAGE	1.3	1.25	3999	3380	4.43%
CASE STUDY	CASE; STUDY	1.33	1.2	1262	1062	1.39%

We then explored co-occurrence, which was defined as each instance in which two words appeared in the same Tweet. Jaccard's coefficient was used for estimating these. This coefficient is computed from a fourfold table as a/(a+b+c), where a represents cases where both items occur, and b and c represent cases where one item is found, but not the other. WordStat uses an average-linkage hierarchical clustering method to create clusters from a similarity matrix. The result is presented in the form of a dendrogram. In the dendrograms of the figures presented below, the vertical axis is made up of the items and the horizontal axis represents the clusters formed at each step of the clustering procedure. Words that tend to appear together are combined at an early stage while those that are independent from one another or those that do not appear together tend to be combined at the end of the agglomeration process.

For instance, in the case of Figure 2, interesting insights can be gained with regards to how supply chain 4.0 and digital technologies such as big data analytics, blockchain Artificial Intelligence, IOT, Fintech can be used to underpin innovation and organisational digital transformation in the supply chain and logistics industry.

Figure 2: Part of the dendrogram focusing on supply chain 4.0 and digital technologies

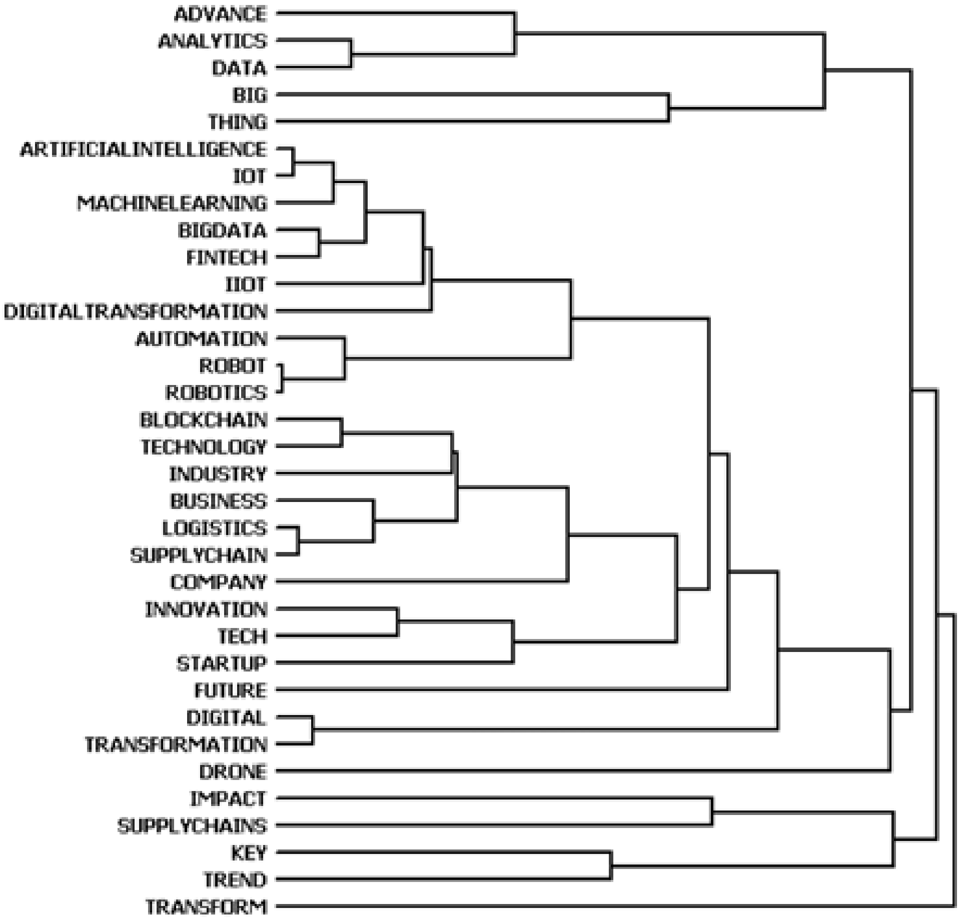


Figure 3 shows part of the dendrogram that focuses on cost reduction, efficiency improvement and optimisation of supply chain processes via automation and some of these processes are related to inventory management and warehousing management.

Figure 3: Part of the dendrogram focusing on efficiency/optimisation

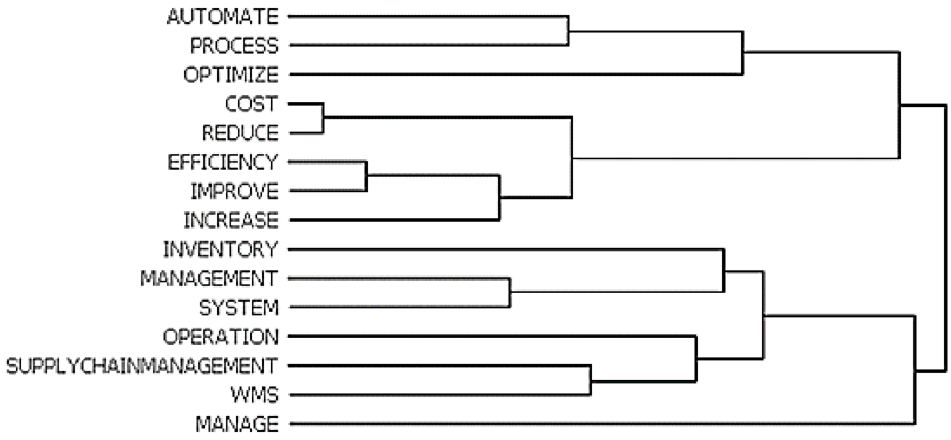


Figure 4 illustrates the major challenges taking place in the current, international trade such as Brexit and the trade rivalry between USA-China which have dominated the commercial world for some time. In addition, both issues have significant repercussions on domestic and international supply chains involved.

Figure 4: Part of dendrogram focusing on current, challenging international trade deals

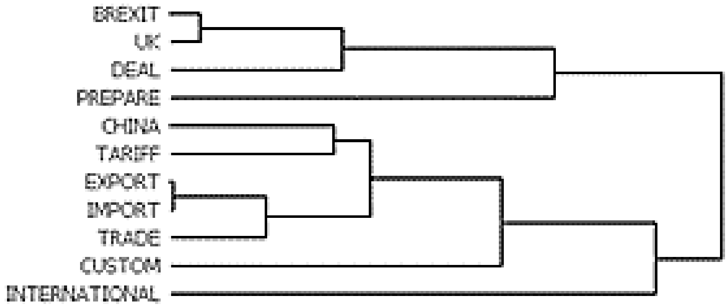
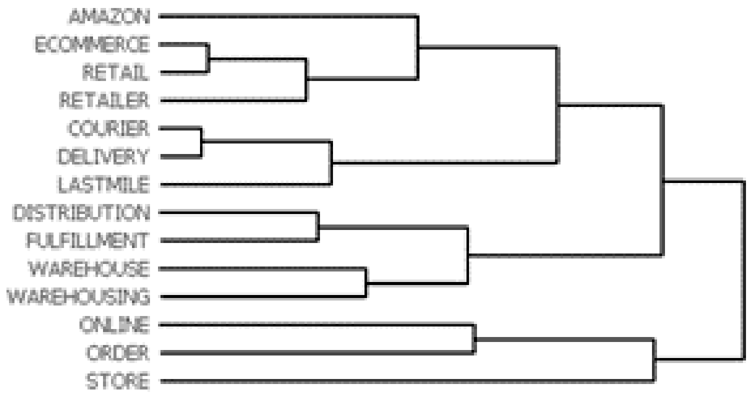


Figure 5 illustrates the e-commerce phenomenon which has transformed the retail supply chain over the past few years. It also signifies the role of Amazon, the leading e-commerce retailer, which has been very innovative implementing numerous, cutting-edge technologies in its supply chain.

Figure 5: Part of the dendrogram focusing on e-commerce logistics



4.2 Mindset Analysis

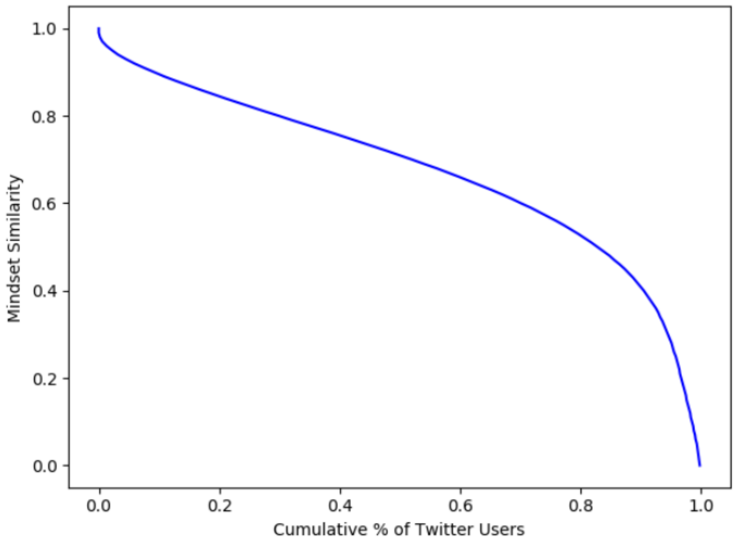
With regards to our third research question, we performed an analysis of how Twitter users were connected with mindsets as expressed in their posts (using the same 76,378 tweets as in the previous section). Our objectives were to see how topics were connected through users, and whether readily available social media statistics from Twitter contain information about how influential the mindsets of users are. In order to measure the mindsets of Twitter users, a topic vector was constructed for each of them. We first grouped the processed posts by user, resulting in one group of processed text messages for each of the 23,268 unique users. During the text-mining analysis, we identified 110 significant keywords for 20 topic clusters. We can thus use a 20-dimension topic vector to represent each of the 110 keywords. We then attached the corresponding keyword topic vector to a user if the keyword was mentioned in the tweet message. With all keywords identified for a user, we used the average of all attached keyword topic vector as the mindset vector of the user. Among all the users, about 3.8% of them did not mention any of the 110 keywords in their Twitter messages. The final set of users with a mindset vector available was 22,382.

To see how mindsets were distributed across users, we measured the mindset similarity between two users by cosine similarity. The mindset similarity was thus calculated by the following formula:

$$\frac{\vec{A} \cdot \vec{B}}{|A| \cdot |B|}$$

The mindset similarity can range from -1 to 1. When it is 1, the two mindsets are completely the same. When it is -1, the two mindsets are opposite. When it is 0, the mindsets are unrelated. For each of the 250,465,771 pairs of users, a mindset similarity was computed. The distribution of the mindset similarities across all users was as shown in Figure 6.

Figure 6: Distribution of the mindset similarities across all users



There were quite a number of users sharing the same mindset. More specifically, there were 4,763,884 pairs (about 9% of all) of users who had an identical mindset (the similarity being at least 0.9), while there were about 32% (160,226,965) of all user pairs with a rather similar mindset (a similarity greater than or equal to 0.7).

Given the above similarities found, we did further processing to retain only unique mindset vectors. Users with the same mindset were grouped together and represented by the same mindset vector. This processing resulted in 10,192 unique mindsets. To analyse the relationships among user mindsets, a graph was constructed connecting every user as a graph node with every other. This processing resulted with a graph of 51,933,336 edges. We used the values of the mindset similarities between two nodes as the edge weight. Then, we simplified the graph by retaining only the most significant mindset similarities (strong links between user mindsets), through the use of the maximum spanning tree algorithm. In graph theory, a maximum spanning tree is a subgraph that is a tree (i.e., a graph without cycles) which includes all vertices of the original graph, with the minimum possible number of edges carrying the maximum of total edge weights (i.e., it eliminates edges with low mindset similarities). A spanning tree of a connected graph is the maximal set of edges of the graph that contains no cycle, or as a minimal set of edges that connect all vertices[1]. This is similar to setting a threshold to remove the edge, but using a maximum spanning tree allows us to let the threshold be data driven, instead of determining it by ourselves. With the resulting graph representing the relationships between user mindsets, we used the eigenvector centralities of the mindset nodes as the influence scores, measuring how influential the user mindsets were. In graph theory, eigenvector centrality (also called eigencentrality) is a measure of the influence of a node in a network. Relative scores were assigned to all nodes in the network based on the concept that connections to high-scoring nodes contribute more to the score of the node in question than equal connections to low-scoring nodes. A high eigenvector score means that a node is connected to many nodes which themselves have high scores.

When looking at the influence of a user in a social network, we usually refer to the number of followers and the number of friends. These statistics are convenient as they are readily available from Twitter. But such social media statistics represent only the immediate neighbourhood of a node in a social network graph. Other effects coming from the bigger network, or the overall topology of the bigger network a node is situated within, are ignored. Our graph-based influence score, on the other hand, captured the influential power of user mindsets based on the whole topology of the mindset graph, instead of just the immediate neighbourhood. We thus conjectured that the influence score contains additional useful information on top of the traditional measures of counts of followers and friends. To test this hypothesis, we did a correlation analysis between our mindset influence scores and the corresponding counts of followers and friends for each user mindset (a total of 10,192). The count of followers for a user mindset is the average number of followers of all users with the mindset. The same applied to the count of friends of a user mindset. From Table 3, we can see that mindset influence scores do contain additional useful information on top of conventional measures of social media influence from counts of followers and friends, as the correlations are low and insignificant. In the context of social media influence, the readily available Twitter measures (follower and friend counts) may tell us the level of message visibility from a particular user to his/her immediate neighbourhood. However, these cannot capture how influential the mindset of a user is, as this depends on how close and related user mindsets are. Our graph-based influence score, on the other hand, captured the influential power of user mindsets based on the whole topology of the mindset graph, instead of just the immediate neighbourhood.

Table 3: Correlation of Mindset Influence Scores with Number of Followers and Friends

	Count of Followers	**Count of Friends**
Correlation Coefficient	0.0129666	0.006251
p-value	0.1905526	0.528065337

4.3 Discussion

Table 1 shows the most frequently used terms and key issues emerging. Specifically, supply chain and logistics have a top ranking, which is an expected result. Equally, transport-related activities (e.g. ship, freight, truck, transport / transportation) occupy the 6th, 8th, 11th, 12th, 18th positions, confirming the critical role of transportation within supply chains. In addition, various technologies have a prominent placing in the top 20 of this Table, with blockchain, technology, artificial intelligence and Internet of Things (IOT) occupying the 4th, 5th, 9th 13th positions respectively. This finding justifies the primary role of technologies and relevant applications in modern supply chains and it is also evident that blockchain is a technology widely considered by managers to have a prominent position compared to other technologies. Table 1 generates a few more useful insights, including the strong placing of both procurement and warehousing. Procurement is nowadays a holistic function supporting end-to-end supply chains responsible for the sourcing of raw materials or final products whilst warehousing is still the "backbone" of modern supply chain systems. It is also evident that procurement has replaced purchasing as the favourite term between managers for the "buying" activity. A surprising finding is that both manufacturing and global are not in our top 20 of used terms, whilst e-commerce occupies a higher position. The latter signifies the dominant role of e-commerce activities within supply chains, including the transformational impact made by specific companies like Amazon. Brexit is another term in our top 40, which is largely expected considering the ongoing, important discussions between the UK and the European Union and the likely impact of Brexit on European and global supply chains.

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[1] Spanning trees are used to minimize the cost of power networks, wiring connections, piping, and so on, and the Internet and other telecommunications networks generally have transmission protocols that automatically establish spanning tree chains of links. We use them here to highlight the most important empirical mindset simlarities in our dataset.

Table 2 clustered these terms and provided similar insights. Procurement is now linked with the supply chain, which is logical considering that the procurement function aims to provide the right amount of sourcing (materials etc.) to the rest of the supply chain in order to operate smoothly. Last mile logistics enjoys the second position, building on the critical role of e-commerce and retail and in the major changes happening over the past few years in relation to omni channel and product deliveries as required by consumers; subsequently, customer service is placed 4th in the analysis. Manufacturing emerges in the third position whilst various aspects of transportation (vehicles and freight transportation, maritime) and a range of technologies dominate the remainder of the table. However, compared to Table 1, these technologies are now clustered and interlinked and this is a major contribution of this work. Specifically, IOT includes cybersecurity, blockchain, fintech and big data whilst under the Automation cluster, other key technologies are listed, including robotics, drones and artificial intelligence. Similarly, the heightened role of automation in warehousing is evident under the Warehousing / Warehousing Managing Systems (WMS) cluster followed by the Digital Transformation cluster and Supply Chain Analytics, which includes issues such as big data, data analytics and machine learning. Risk and quality management is another key cluster emerging in this analysis. This is not surprising considering the numerous geopolitical and other risks taking place worldwide (e.g. earthquakes, tsunamis, Brexit, US trade with China, cybersecurity etc.) and the significant, subsequent disruption to supply chain operations.

Figure 2 provided a comprehensive picture of most major technologies impacting contemporary logistics and supply chains such as artificial intelligence, big data, analytics, drones, IoT and machine learning to name a few. More importantly, these technologies are linked in this dendrogram and, therefore, automation is linked to robots and robotics, analytics is linked to data, artificial intelligence is linked to IoT and machine learning. The latter provides a “conceptual” map which can be invaluable to managers and practitioners aspiring to understand these technologies. Lastly, these technologies have a major, influential impact on supply chain and logistics operations including key innovations, digital transformation and creation of start-ups as noted in the dendrogram.

Figure 3 highlights the aspects of cost reduction and operational efficiency improvement which have been primary business objectives for supply chain operations. In this dendrogram, both are supported (and linked) by the automation of processes and subsequent optimisation. This is largely expected as the implementation of automation can minimise cost and create other operational efficiencies and it was initially implemented in functions related to inventory management and warehouse management as it is also illustrated in Figure 3. For example, the use of robots has transformed modern warehouses resulting in the faster and cost-efficient replenishment of inventory. Automation is expected to transform other supply chain operations in the near future including transportation where we have already witnessed the use of autonomous vehicles.

Figure 4 noted the key, contemporary challenges in international trade such as Brexit and the trade rivalry between USA-China. These are major political issues and, depending on the final trade agreement, they could have a significant impact on export and import activities for European, US and Chinese supply chains involved. Subsequently, relevant tweets have been generated as both issues can be very disruptive for supply chains. This disruption is expected to have a wide-ranging and international impact considering that, nowadays, we are dealing with global supply chains in most industries and sectors. For example, a disruption in a USA-China trade deal (e.g. via large tariffs being imposed) could have a negative – “snowball” impact on other national supply chain members which contribute to the US or Chinese supply chain by, inter alia, providing raw materials or even supporting assembly production lines.

Figure 5 illustrates under a succinct manner the key components of e-commerce logistics. Specifically, the whole process starts with the online consumer order, followed by picking products / fulfilment at the warehouse. Then, the last mile materialises where we have a delivery by a courier to consumer’s home or alternatively a “click and collect” option where consumers could pick up the product ordered in the retailer’s store (as shown in the dendrogram) or from other collection points such as the local post office or a locker in a train station when returning back from work. Amazon is the only e-commerce retailer stated in this dendrogram which denotes its highly influential and leading position in the e-commerce sector. Another reason is that Amazon has been pioneering the development and implementation of numerous, innovative technologies in its supply chain related to automation, artificial intelligence, drones and robots to name a few.

Figure 6 visually displays the distribution of mindset similarities across all users. About 9% of all users shared almost identical mindsets, with a similarity of at least 90% (i.e. 0.9), while 32% among all user pairs had a similarity score of over 70%. This is a fascinating result, as the overall topology of the social media, and the underlying interactions between users, may be extremely complicated, the mindset landscape resulted from user communications is still of manageable and understandable complexity. This high-level similarity among user mindsets also highlights the usefulness of using social media to find trends in supply chain management. Major trends are there and the extraction of them is feasible given the big cluster of similar user mindsets. This particular topology of mindset similarities also means that discovering the influential mindsets is not just possible, but also very useful in making social media a useful platform for monitoring, and perhaps also testing, new supply chain management concepts.

5 CONCLUSIONS

5.1 Theoretical and Practical Contributions

Almost twenty years ago, academic work analysed the major role of various trends impacting future supply chains. For example, Bowersox et al. (2000) noted the shift from vertical to virtual integration and from information hoarding to sharing, Skjoett-Larsen (2000) noted the role of strategic partnerships and e-commerce and Ballou (2007) noted among other themes the role of information sharing between channel members due to technological advancements and the organisational merger of operations, purchasing and logistics under the supply chain function. Equally, over the past ten years, various consulting companies specialising in the supply chain domain, leading logistics companies and few academic institutions have published relevant reports (see for example Bourlakis et al., 2017; DHL, 2018; Pettey, 2019; PwC, 2019). These reports have identified various technological, political, social and business trends impacting on supply chains. However, their contribution has been towards listing these trends in terms of their high or low impact on supply chains and the expected future time horizon (1-5 years) when this impact will materialise. More importantly, these papers and reports do not show under a detailed manner the interrelationships and interconnections between many of these trends in general and between the technological ones in particular.

Our work has extended the above work by co-stressing the prominent role of technologies in current supply chains. Specifically, a range of technologies (e.g. blockchain, artificial intelligence, automation, big data etc.) is illustrated with blockchain commanding the highest position amongst them. Recently, blockchain has gained a significant momentum in some sectors (e.g. the food sector) followed recent scandals related to traceability and, subsequently, major multinational organisations have invested and implemented this technology in their supply chain operations (see Hackett, 2017 for the cooperation by, inter alia, IBM, Unilever, Nestle, Wal-Mart). Artificial intelligence and IoT occupy leading positions in our work signifying that these technologies will be the ones where companies are currently investing or will invest largely in the near future. Another aspect of our work relates to the leading role of transport-related activities (e.g. ship, freight, truck, transport / transportation) which command high positions in our analysis. This confirms the major role of transportation in current and future supply chains which will coexist and will be aligned to the aforementioned technologies as part of the wider, future supply chain system. The above input has also addressed the first research question related to identifying the major, current trends influencing supply chain and the role of the recent technological advancements towards supply chains.

Additionally, this paper has shown the direct linkage between procurement and supply chain management as procurement occupies a dominant role in contemporary supply chains. More importantly, it has shown the leading role of last mile logistics considering the recent, phenomenal growth of e-commerce and the importance of excellent customer service for products ordered online. These issues are shown succinctly in our analysis with last mile logistics, customer service and e-commerce occupying the 2nd, 4th and 6th position in Table 2. Amazon is the only company identified in our analysis indicating the major role of retailers in many modern supply chains in general (compared to the declining role of manufacturers) and its dominant role in the e-commerce sector in particular. Another reason could be the fact that Amazon has been a significant innovator by developing and introducing a plethora of technological advancements in its retail supply chain. Our work has also shown the introduction of similar technological advancements in the manufacturing sector too with smart manufacturing emerging as a major issue (3rd in Table 3).

Another major contribution of our work is the exposure of clear and meaningful interrelationships and interconnections between these trends as per our second research question. Specifically, we have shown that IOT incorporates cybersecurity, blockchain, fintech and big data, automation is linked to robotics and drones, analytics is related to data and artificial intelligence is linked to IoT and machine learning. Moreover, we have exposed the increasing role of digital transformation and supply chain analytics incorporating issues such as big data, data analytics and machine learning. Risk and quality management is another major issue emerging in our analysis taking into account various political (e.g. Brexit and US-China trade deal) and other challenges (e.g. food scandals, earthquakes, tsunamis etc.). Supply chain risk management is a key element of contemporary supply chains (Jüttner et al., 2003) where managers aim to be proactive in addressing relevant disruptions and the recent implementation of blockchain provides evidence that companies work on this to minimise risk and improve quality management. Overall, this paper has illustrated numerous trends and specific, overarching factors emerge which we have categorised them as supply chain functional-related factors (e.g. logistics, transportation, procurement, technology etc.), contextual-related factors (Brexit, US trade with China) and hygiene-related factors (e.g. risk and quality management etc.). Surprisingly, sustainability and green-related issues have not enjoyed high positions in our work considering the pivotal role they command in modern supply chains worldwide as noted in reports and papers (see for example Rao and Holt, 2005; DHL, 2018; Seuring and Müller, 2008), but both were classified outside the top 50 most frequent cited items in our analysis.

With regards to our third research question, a related direction of understanding the social media landscape is about identification of influential users. Most social media platforms, including Twitter, show the number of followers and friends a user has, as these are the most popular and straightforward way to measure user influence (Montangero and Furini, 2015; Fabi et al., 2016). In studying influences among social media users, essentially, we are looking at the similarities of their mindsets. Simple follower and friend counts can only reflect immediate neighbourhood connections. The probability of one influencing the other, and the wider diffusion effect of the larger social network cannot be captured. This leads to many studies looking at the possibility of using other social network-based measures, such as centralities, to capture those effects (Aleahmad et al., 2015). Our work has demonstrated the overlap among user mindsets and helped identified influential mindsets. We further developed a mindset influence score to measure the influential power of a user mindset. This gave managers additional useful information from the bigger network of mindsets clustered by similarity, which is not available from conventional, readily available social media measures, as shown in our statistical tests.

Finally, our work has generated many insights which will be extremely beneficial to supply chain managers and practitioners. Specifically, it provides a "conceptual" map showing the interrelationships and interconnections between these trends and relevant technologies which will support managers' understanding of modern supply chains. Subsequently, it provides a roadmap for the implementation of these technologies in supply chains which can be an excellent guide to technology-phobic managers. More importantly, our work has highlighted the major role of blockchain in current and future supply chains and it is a technology which managers need to start considering very carefully for further implementation. Other technologies have also been revealed in this analysis (e.g. artificial intelligence, IoT etc.) commanding strong positions which managers need to be aware of. The ongoing success of Amazon (and other e-commerce retailers such as Alibaba) provides further evidence to the critical role of these technologies and how their strategic implementation in supply chains should be urgently considered by supply chain managers. Overall, our work could serve as an awakening call for supply chain managers as it has stressed the current and future dominance of Supply Chain 4.0 technologies based on the trends noted.

5.2 Limitations and Future Research

Future research can extend our work in a number of ways. Firstly, our analysis considered a single social media platform. The public nature of the discussion as well the relative short length of messages may have affected how users expressed themselves. Collecting longer posts from multiple online fora could have offered a more comprehensive account of the discussions undertaken. When it comes to the users themselves, our data features posts from more than 23k users. As such it was not feasible to segment users into groups (e.g. practitioners vs. academics) and undertake a comparative analysis, as such a process would have been a manual one based on scarce information. Such a comparison would have been of interest, though, as it would have made it possible to compare and contrast the views between the two groups. In addition, although our data spanned a period of about 4 months, this was not considered sufficient for undertaking a longitudinal analysis. Potentially buying the data sets for a significantly longer period of time could make it possible to perform such an analysis. Finally, with the nature of the dataset we have been highly focused on supply chain management and logistics; we successfully analysed the underlying mindsets of users. With a dataset more generally attached to a wider set of topics within the supply chain management domain over a longer period of time, it is worthwhile to further study the dynamics of the mindset landscape over time. The latter research will be invaluable considering that supply chain management is a very dynamic domain with many changes happening over the past few years due to the emergence of various, innovative and disruptive technologies and with this dynamism expected to continue in the future.

REFERENCES

Aleahmad, A., Karisani, P., Rahgozar, M. & Oroumchian, F. (2015). OLFinder: Finding opinion leaders in online social networks. Journal of Information Science, 42, 5, pp.659-674

Ballou, R. H. (2007). The evolution and future of logistics and supply chain management. European Business Review,, 19, 4, pp.332-348

Baryannis, G., Validi, S., Dani, S. & Antoniou, G. (2019). Supply chain risk management and artificial intelligence: state of the art and future research directions. International Journal of Production Research, 57, 7, pp.2179-2202

Bechtsis, D., Tsolakis, N., Vlachos, D. & Srai, J. S. (2018). Intelligent Autonomous Vehicles in digital supply chains: A framework for integrating innovations towards sustainable value networks. Journal of Cleaner Production, 181, pp.60-71

Bhattacharjya, J., Ellison, A. & Tripathi, S. (2016). An exploration of logistics-related customer service provision on Twitter: The case of e-retailers. International Journal of Physical Distribution & Logistics Management, 46 6/7, pp.659-680

Boerkamps, J. H. K., Van Binsbergen, A. J. & Bovy, P. H. L. (2000). Modeling Behavioral Aspects of Urban Freight Movement in Supply Chains. Transportation Research Record, 1725, 1, pp.17-25

Bourlakis, M., Wilding, R., Reefke, H. & Habib, F. 2017. Impact of Disruptive Trends on Logistics & Supply Chain Management Practices. Cranfield School of Management and Knight Frank LLP.

Boyd, D. & Crawford, K. (2012). CRITICAL QUESTIONS FOR BIG DATA. Information, Communication & Society, 15, 5, pp.662-679

Buyukozkan, G. & Gocer, F. (2018). Digital Supply Chain: Literature review and a proposed framework for future research Computers in Industry, 97, 157-177

Chae, B. (2015). Insights from hashtag #supply chain and twitter analytics: Considering twitter and twitter data for supply chain practice and research. International Journal of Production Economics, 165, pp.247-259

Cirulis, A. & Ginters, E. (2013). Augmented Reality in Logistics. Procedia Computer Science, 26, pp.14-20

Cui, R., Gallino, S., Moreno, A. & Zhang, D. J. (2018). The Operational Value of Social Media Information. Production and Operations Management, 27, 10, pp.1749-1769

Dadzie, K. Q., Johnston, W. J., Dadzie, E. W. & Yoo, B. (1999). Influence in the organizational buying center and logistics automation technology adoption. Journal of Business & Industrial Marketing, 14, 5/6, pp.433-444

Dhl 2018. Logistics Trends Radar: Delivering Insight Today, Creating Value Tomorrow, . DHL Trend Research, Deutsche Post DHL Group.

Fabi, #225, Riquelme, N., Gonz, P., #225 & Lez-Cantergiani (2016). Measuring user influence on Twitter. Inf. Process. Manage., 52, 5, pp.949-975

Fan, Y. & Niu, R. H. (2016). To tweet or not to tweet? Exploring the effectiveness of service recovery strategies using social media. International Journal of Operations & Production Management, 36, 9, pp.1014-1036

Fisher, R., Mcphail, R., You, E. & Ash, M. (2014). Using social media to recruit global supply chain managers. International Journal of Physical Distribution and Logistics Management, 44, , 8/9, pp.635-645

Francisco, K. & Swanson, D. (2018). The Supply Chain Has No Clothes: Technology Adoption of Blockchain for Supply Chain Transparency. Logistics, 2, 1, pp.2

Gamboa, A. M. & Goncalves, H. M. (2014). Customer loyalty through social networks: Lessons from Zara on Facebook. Business Horizons, 57, 6, pp.709-717

Graham, M. & Shelton, T. (2013). Geography and the future of big data, big data and the future of geography. Dialogues in Human Geography, 3, 3, pp.255-261

Gunesakaran, A., Papadopoulos, T., Dubey, R., Wamba, S. F., Childe, S. J., Hazen, B. & Akter, S. (2017). Big data and predictive analytics for supply chain and organizational performance. Journal of Business Research, , 70, pp.308-317

Hackett, R. (2017). Walmart and 9 Food Giants Team Up on IBM Blockchain Plans [Online]. Available: http://fortune.com/2017/08/22/walmart-blockchain-ibm-food-nestle-unilever-tyson-dole/ [Accessed 29th of April 2019].

Hazen, B. T., Boone, C. A., Ezell, J. D. & Jones-Farmer, L. A. (2014). Data quality for data science, predictive analytics, and big data in supply chain management: An introduction to the problem and suggestions for research and applications. International Journal of Production Economics, 154, pp.72-80

Hofmann, E. & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics.

Hootsuite. (2019). The Global State of Digital in 2019 Report [Online]. Available: https://hootsuite.com/pages/digital-in-2019 [Accessed 29th April 2019].

Ivanov, D., Dolgui, A. & Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. International Journal of Production Research, 57, 3, pp.829-846

J. Bowersox, D., Closs, D. & Stank, T. (2000). Ten Mega-Trends That Will Revolutionize Supply Chain Logistics.

Jüttner, U., Peck, H. & Christopher, M. (2003). Supply chain risk management: outlining an agenda for future research. International Journal of Logistics Research and Applications, 6, 4, pp.197-210

Kaplan, A. M. & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. Business Horizons, 53, pp.59—68

Karak, A. & Abdelghany, K. (2019). The hybrid vehicle-drone routing problem for pick-up and delivery services. Transportation Research Part C: Emerging Technologies, 102, pp.427-449

Klumpp, M. (2018). Automation and artificial intelligence in business logistics systems: human reactions and collaboration requirements. International Journal of Logistics Research and Applications, 21, 3, pp.224-242

Kshetri, N. (2018). Blockchain's roles in meeting key supply chain management objectives.

Kull, T. J., Boyer, K. & Calantone, R. (2007). Last-mile supply chain efficiency: an analysis of learning curves in online ordering. International Journal of Operations & Production Management, 27, 4, pp.409-434

Kunze, O. (2016). Replicators, Ground Drones and Crowd Logistics A Vision of Urban Logistics in the Year 2030.

Lam, H. K. S., Yeung, A. C. L. & Cheng, T. C. E. (2016). The impact of firms' social media initiatives on operational efficiency and innovativeness. Journal of Operations Management, 47-48, pp.28-43

Lamba, K. & Singh, S. P. (2017). Big data in operations and supply chain management: Current trends and future perspectives. Production Planning & Control: The Management of Operations, , 28, 11-12, pp.877-890

Manavalan, E. & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. Computers & Industrial Engineering, 127, pp.925-953

Mckinnon, A. C. (2016). The Possible Impact of 3D Printing and Drones on Last-Mile Logistics: An Exploratory Study. Built Environment, 42, 4, pp.617-629

Min, H. (2010). Artificial intelligence in supply chain management: theory and applications. International Journal of Logistics Research and Applications, 13, 1, pp.13-39

Min, H. (2019). Blockchain technology for enhancing supply chain resilience. Business Horizons, 62, , 1, pp.35-45

Montangero, M. & Furini, M. TRank: Ranking Twitter users according to specific topics. 2015 12th Annual IEEE Consumer Communications and Networking Conference (CCNC), 9-12 Jan. 2015 2015. 767-772.

O'leary, D. E. (2011). THE USE OF SOCIAL MEDIA IN THE SUPPLY CHAIN: SURVEY AND EXTENSIONS. Intelligent Systems in Accounting, Finance and Management, 18, 2-3, pp.121-144

Oesterreich, T. D. & Teuteberg, F. (2016). Understanding the implications of digitisation and automation in the context of Industry 4.0. Comput. Ind., 83, C, pp.121-139

Papagiannidis, S., See-To, E., Assimakopoulos, D. & Yang, Y. (2018). Identifying industrial clusters with a novel big-data methodology: are SIC codes (not) fit for purpose in the Internet age? Computers & Operations Research, 98, October 2018, pp.355-366

Pettey, C. (2019). Gartner Top 8 Supply Chain Technology Trends for 2019 [Online]. Gartner Available: https://www.gartner.com/smarterwithgartner/gartner-top-8-supply-chain-technology-trends-for-2019/ [Accessed 2019 29th April].

Porter, C. E. & Donthu, N. (2008). Cultivating trust and harvesting value in virtual communities. Management Science, 54, 1, pp.113-128

Pwc. (2019). Five Forces Transforming Transport and Logistics, [Online]. PwC CEE Transport and Logistics Trend Book. Available: https://www.pwc.com/hu/hu/kiadvanyok/assets/pdf/transport-logistics-trendbook-2019-en.pdf [Accessed 2019].

Ramanathan, U., Subramanian, N., Parrott, G., Parrott, G., Subramanian, N. & Ramanathan, U. (2017). Role of social media in retail network operations and marketing to enhance customer satisfaction. International Journal of Operations & Production Management, 37, 1, pp.105-123

Rao, P. & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? International Journal of Operations & Production Management, 25, 9, pp.898-916

Saberi, S., Kouhizadeh, M., Sarkis, J. & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. International Journal of Production Research, 57, 7, pp.2117-2135

Seuring, S. & Müller, M. (2008). Core issues in sustainable supply chain management – a Delphi study. Business Strategy and the Environment, 17, 8, pp.455-466

Singh, A., Shukla, N. & Mishra, N. (2018). Social media analytics to improve supply chain management in food industries. Transportation Research: Part E, 114, 398-415

Skjoett-Larsen, T. (2000). European logistics beyond 2000. International Journal of Physical Distribution & Logistics Management, 30, 5, pp.377-387

Speranza, G. M. (2018). Trends in transportation and logistics. European Journal of Operational Research, 264, pp.830-836

Storey, J., Emberson, C., Godsell, J. & Harrison, A. (2006). Supply chain management: Theory, practice and future challenges. International Journal of Operations & Production Management, 26, 7, pp.754-774

Tan, K. H., Zhan, Y., Ji, G., Ye, F. & Chang, C. M. (2015). Harvesting big data to enhance supply chain innovation capabilities: An analytic infrastructure based on deduction graph. International Journal of Production Economics 165, , pp.223-233

Tapscott, D. & Tapscott, A. (2017). How Blockchain Will Change Organizations. MIT Sloan Management Review, 58, , 2, pp.10-13

Treiblmaier, H. (2018). The impact of the blockchain on the supply chain: a theory-based research framework and a call for action. Supply Chain Management: An International Journal, 23, 6, pp.545-559

Waller, M. A. & Fawcett, S. E. (2013). Data Science, Predictive Analytics, and Big Data: A Revolution That Will Transform Supply Chain Design and Management. Journal of Business Logistics, 34, 2, pp.77-84

Wang, G., Gunasekaran, A., Ngai, E. W. T. & Papadopoulos, T. (2016). Big data analytics in logistics and supply chain management: Certain investigations for research and applications. International Journal of Production Economics, 176, pp.98-110