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Social media data analytics to improve supply chain management in food industries

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ABSTRACT

This paper proposes a big-data analytics-based approach that considers social media (Twitter) data for the identification of supply chain management issues in food industries. In particular, the proposed approach includes text analysis using a support vector machine (SVM) and hierarchical clustering with multiscale bootstrap resampling. The result of this approach included a cluster of words which could inform supply-chain (SC) decision makers about customer feedback and issues in the flow/quality of food products. A case study in the beef supply chain was analysed using the proposed approach, where three weeks of data from Twitter were used.

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1. Introduction

In the modern era, food is a crucial commodity for consumers, as it has a direct impact on their health (Caplan, 2013; Swaminathan, 2015; Tarasuk et al., 2015). The food supply chain is more complicated than the manufacturing and other conventional supply chains, owing to the perishable nature of food products (La Scalia et al., 2015; Handayati et al., 2015). Food retailers aim to adjust their supply chain to become consumer centric (a supply chain designed as per the requirements of end consumers by addressing organisational, strategic, technology, process, and metrics factors) by taking into account various methods, including market surveys, market research, interviews, and offering the opportunity to consumers to provide feedback within the retailer store. However, food retailers are not able to attract large audiences by following these procedures; thus, their data sample is small. Any decisions made based on a smaller sample of customer feedback are prone to be ineffective. With the advent of online social media, there is substantial amount of consumer information available on Twitter, which reflects the true opinion of customers (Liang and Dai, 2013; Katal et al., 2013). Effective analysis of this information can provide interesting insight into consumer sentiments and behaviours with respect to one or more specific issues. Using social media data, a retailer can capture a real-time overview of consumer reactions regarding an episodic event. Social media data are relatively inexpensive, and can be very effective in gathering the opinions of large and diverse audiences (Liang and Dai, 2013; Katal et al., 2013). Using different information techniques, business organisations can collect social media data in real time, and can use it for the development of future strategies. However, social media data are qualitative and unstructured in nature, and are often large in volume, variety, and velocity (He et al., 2013; Hashem et al., 2015; Zikopoulos and Eaton, 2011). At times, it is difficult to handle them using the traditional operation and management tools and techniques for business purposes. In the past, social media analytics have been implemented in various supply chain

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problems, predominantly in manufacturing supply chains. The research on the application of social media analytics in the domain of the food supply chain is in its primitive stage. In the present work, an attempt has been made to use social media data in the domain of the food supply chain to transform it into a consumer-centric supply chain. The results from the analysis have been linked with all the segments of the supply chain to improve customer satisfaction. For instance, the issues faced by consumers of beef products, such as discoloration, presence of foreign bodies, extra fat, and hard texture, have been linked to their root causes in the upstream of the supply chain. First, data were extracted from Twitter (via the Twitter streaming application programming interface (API)) using relevant keywords related to consumer opinion on different food products. Thereafter, pre-processing and text mining was performed to investigate the positive and negative sentiments of tweets, using a support vector machine (SVM). Hierarchical clustering of tweets from different geographical locations (world, UK, Australia, and the USA) using multiscale bootstrap resampling was performed. Furthermore, root causes of issues affecting consumer satisfaction were identified and linked with various segments of the supply chain to render it more efficient. Finally, recommendations for a consumer-centric supply chain were prescribed.

The organisation of the paper is as follows: Section 2 explores various issues associated with big-data applications, including Twitter and other social media platforms. In Section 3, a new framework of social-media data analytics adopted in this study is described in detail. Section 4 provides an implementation of the proposed framework on a case study in the beef supply chain. It also details the comparison of several sentiment-mining techniques, as well as their results. Section 5 comprises the identification of issues affecting consumer satisfaction and their respective means of mitigation within the supply chain. Section 6 explains the managerial implications on the supply chain decisions. Finally, the paper is concluded in Section 7.

2. Related work

In literature, distinct frameworks have been proposed for the investigation of big-data problems and issues associated with the supply chain. Hazen et al. (2014) have determined the problems associated with the quality of data in the field of supply chain management. Novel procedures for the monitoring and the managing of data quality have been suggested. The importance of the quality of data in the application and further research in the field of supply chain management has been mentioned. Vera-Baquero et al. (2016) have recommended a cloud-based mechanism, utilising big-data procedures to efficiently improve the performance analysis of corporations. The competence of the framework was revealed in terms of delivering the monitoring of business activity comprising big data in real time with minimum hardware expenses. Frizzo-Barker et al. (2016) have performed a thorough analysis of the big-data literature available in reputed business journals. They considered 219 peer reviewed research papers, published in 152 business journals from 2009 to 2014. Both quantitative and qualitative investigation of the literature was performed by utilising the NVivo 10 software. Their investigation revealed that the research work conducted in the domain of big data is fragmented and primitive in terms of empirical analysis, variation in methodology, and theoretical grounding.

Twitter information has emerged as one of the most widely used data source for research in academia and practical applications. In the literature, there are various available examples associated with practical applications of Twitter information, such as brand management (Malhotra et al., 2012), stock forecasting (Arias et al., 2013) and crisis management (Wyatt, 2013). It is anticipated that there will be a swift expansion in the utilisation of Twitter information for numerous other purposes, such as market prediction, public safety, and humanitarian relief and assistance (Dataminr, 2014). In the past, Twitter data-based studies have been conducted in various domains. Most research work is conducted in the area of computer science for various purposes, such as sentiment analysis (Schumaker et al., 2016; Mostafa, 2013; Kontopoulos et al., 2013; Rui et al., 2013; Ghiassi et al., 2013; Hodeghatta and Sahney, 2016; Pak and Paroubek, 2010), topic detection (Cigarrán et al., 2016), gathering market intelligence (Li and Li, 2013; Lu et al., 2014; Neethu and Rajasree, 2013), and gaining insight of stock market (Bollen et al., 2011). There are various works which have been conducted in the domain of disaster management (Beigi et al., 2016), such as studies on dispatching resources in a natural disaster by monitoring real-time tweets (Chen et al., 2016) and on exploring the application of social media by non-profit organisations and media firms during natural disasters (Muralidharan et al., 2011). Analysis of Twitter data has also been conducted by researchers in the domain of operation management; such analyses include capturing big data in the form of tweets to improve the supply-chain innovation capabilities (Tan et al., 2015), investigating the state of logistics-related customer service which is provided by e-retailers on Twitter (Bhattacharjya et al., 2016), examining the process of service recovery in the context of operations management (Fan et al., 2016), developing a framework for assimilating social media into the supply chain management (Sianipar and Yudoko, 2014; Chae, 2015), determining the ranking of knowledge-creation modes by using extended fuzzy analytic hierarchy process (Tyagi et al., 2016), exploring the amalgamation of conventional knowledge management and the insights derived from social media (O'leary, 2011), improving the efficiency of the knowledge-creation process by developing a set of lean thinking tools (Tyagi et al., 2015a), and optimising the configuration of a platform via the coupling of product generations (Tyagi, 2015b).

Researchers have employed numerous methods for the extraction of intelligence from tweets, which are listed in detail in Table 1. For instance, Ghiassi et al. (2013) used n-gram analysis and artificial neural networks for determining sentiments of brand-related tweets. Their methodology offered improved precision in the classification of sentiments, and minimised the complexity of modelling as compared to conventional sentiment lexicons. However, their study was conducted by offsetting

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