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Characterizing the Interactions of a Multinational Engineering Services Company on Twitter

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***Abstract*— For organizations, social media systems (SMSs) provide new means for communication and collaboration with many classes of external stakeholders. As an industry based on knowledge and design, it is not surprising that the engineering sector has adopted SMSs of various types to improve the flow of information, and the collaboration, between its workers, and with its external stakeholders. Twitter (twitter.com) is one widely-used social media tool employed by individuals and organizations. Recent social media research has proposed content analysis as an important element of understanding what is being shared by participants in social media 'conversations'. The work presented here uses publicly available data for analysis and visualization to characterize the engagement of a multinational engineering services company on the Twitter SMS. Specifically, it uses text analytics and visualization to address the proposal in the research literature that content analysis of tweet text will be a useful approach to characterizing the high-level online conversations taking place on Twitter. The research presented here provides useful insights, as well as offering a methodology for future work.**

***Index Terms*— social media, engineering services, data visualization, Twitter**

I. Introduction

ONLINE social media systems (SMSs) have created new ways for individuals to communicate, share information and interact with a wide audience [1]. For organizations, SMSs provide new means for communication and collaboration with many classes of external stakeholders [2], [3], [4], [5]. For individual knowledge workers, developing contacts and finding out information are popular uses of SMSs [6]. Many organizations are adopting internal enterprise SMSs to improve staff communication and collaboration, and to support and operationalize the informal organizational networks that are often at least as important as the formal organizational structure [7], [8], [9], [10]. For design-based organizations, SMSs can provide a mechanism for implementing open innovation approaches [11]. SMSs can be used to 'crowdsource' design ideas and input from customers and external experts [12], and also from a wider range of employees within the organization than who would traditionally have been able to contribute to the design effort [13].

As an industry based on a knowledge and design profession, it is not surprising that the engineering sector has adopted SMSs of various types to improve the flow of information, and the collaboration, between its workers, and with its external stakeholders [1], [14], and a wide range of examples can be found documented in the literature, including:

- Engineering support and space flight operations control at NASA [15];
- Sharing best-practice project management knowledge in a multinational petrochemical company [16];
- Using profiles and activities of SMS users to identify knowledge domain experts [17];
- A repository for knowledge in globally distributed technology development projects [18];
- Risk and crisis communication in safety, health and environmental activities [4];
- Professional networking opportunities for those seeking employment in the industry [19];
- A timely professional learning channel [20];
- A marketing channel for new products and ideas [2];
- One source of 'big data' for improving manufacturing performance, including sustainability performance [21].

There exists some published literature on how engineering consulting/services organizations are using social media. As part of an integrated marketing strategy for engineering services, SMSs allow the segmentation of audiences to a high level of granularity, and hence for brand messages to be highly focused [22]. Market intelligence is the gathering of information that drives innovation and provides engineering services companies with a competitive advantage. Intelligence tools and techniques include gathering data from SMSs, potentially in combination with content interpretation methods such as natural language processing [3]. Engineering services companies depend on teamwork and information sharing, and have been reliant on the social networks of engineers long before the existence of online SMSs. However, SMSs offer new ways for engineers to informally share information [23], and companies can capitalize on this channel by the deliberate introduction of an organizational SMS [24]. Corporate responsibility (CR) reporting is common in business, especially for larger engineering services companies. Whereas websites have commonly been employed to disseminate CR information online, this has traditionally been a one-way 'push' of information to stakeholders. The development of SMSs has provided an online channel for CR reporting that is potentially much more interactive [25].

Twitter (twitter.com) is one widely-used social media tool

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employed by individuals and organizations [2]. Twitter is a 'microblogging' service where users can post quick, short messages (up to 140 characters at the time of this research, but now doubled to 280) called 'tweets' [4] to their 'followers' who have subscribed to their Twitter account [15]. Tweets may contain links to other online material such as photos and websites [20]. A user can 'retweet' to all of their followers a tweet that they receive from another user [9]. Tweets can be directed specifically to other named user accounts, or broadcast generally to all followers of the sending account. Including the 'handle' of another Twitter account in a tweet is a 'mention' of that user [4]. Except for the content of tweets from protected (private) accounts, all tweets are effectively broadcast to 'the world' and are publicly discoverable via a search [17].

Evaluation of the impact of social media activities is not straightforward [26]. Analysis of the content of social media posts has been used to characterize the nature of the communication on social media platforms [27], including specifically for the text content of tweets [28]. Other recent social media research has proposed content analysis as an important element of understanding what is being shared by participants in social media 'conversations' [12], [29], including for the Twitter social media platform [30]. The work presented here uses publicly available data for analysis and visualization to characterize the engagement of a multinational engineering services company on the Twitter SMS. Specifically, it uses text analytics and visualization to address the proposal in the research literature that content analysis of tweet text will be a useful approach to characterizing the high-level online interactions taking place on Twitter. The research presented here provides useful insights, as well as offering a methodology for future work.

II. Method

A ruling was obtained from the relevant institutional human research ethics committee that the collection and use of publically accessible Twitter data were exempt from formal ethics approval for the research purposes proposed. In the work presented here, no Twitter accounts are identified by name. A multinational engineering services company known to have an active presence on Twitter was chosen as the focus of this research project. The Twitter application programming interface (API) allows data to be directly collected from the system [17], [28], [27]. The functioning of the Twitter system means that the results from an API search for mentions of an account are limited in quantity and time period [31], [2]. To build a longitudinal record of tweets from, and mentions of, an account requires the routine capturing and compilation of Twitter search results. By accessing the Twitter API, the NCapture program [32] is able to capture publicly available Twitter data at that point in time. Twitter 'mention' data rely on the Twitter public search interface, so there is no guarantee that the mention data set here is complete, however weekly data collection should ensure that coverage is good/representative.

From the beginning of 2016 until the end of June 2017, weekly searches for tweets from, and mentions of, the Twitter account of the target engineering services company were performed and the results were captured. The NVivo program [33] was used to convert the captured Twitter data into Microsoft Excel [34] spreadsheets for further processing and analysis. The Twitter data set was separated into three sets of six months in duration, and each these biannual data sets were further separated into two subsets: i) tweets from the company; and, ii) mentions of the company. The text analytics software package KH Coder [35] was used to analyze and visualize the text content of the six Twitter data subsets to show the major themes present. KH Coder supports a range of text data analysis and visualization methods – the one used here was the multidimensional scaling (MDS) plot [36].

The text analysis process included stop word removal – removing those parts of English speech that occur frequently (e.g. 'a', 'the', 'I', etc.) but which add little to the analysis. Consolidation of inflected words to their root form (e.g., 'acquires', 'acquired', etc. to 'acquire') was performed via lemmatization [37]. MDS computes a measure of 'distance' between all pairs of text terms, and then seeks a lower (here two) dimensional representation of the terms, such that original distance values between all term pairs are displayed with the least possible error [36]. Here we used the Jaccard distance measure [38] and the Kruskal method for dimensional reduction [39]. Based on specifying the minimum frequency of occurrence of a term for inclusion in the MDS analysis and visualization, terms appear as circles/bubbles in the plot, and the relative frequency of terms is indicated by the size of their bubble.

As the search key, the name of the engineering services company under investigation naturally appears in every tweet in the data set, and due to its overwhelming frequency of occurrence, it would have had a significant impact on the analysis and resultant visualizations if left in the data set. For the analysis presented here, the name of the company was omitted from the analysis to allow other details of the tweet text data to become more prominent. The resultant MDS visualizations contained the names of some other identifiable people, organizations, etc. These were de-identified using unique generic identifiers: person = 'persx' (where x is a unique number); public sector or non-profit organization = 'orgx'; subsidiary of the company under investigation = 'subsx'; other companies = 'compx'; URL = 'urlx'; hashtag = 'htagx'; and, city = 'cityx'.

Two-dimensional planar projections of text term elements of tweet content have been used previously as an approach to visualize the narrative conversation in Twitter data [40]. Here paired MDS visualization results from the biannual sets of tweet text content 'from' and 'to/about' the target engineering services company were used as a method to see the large-scale 'conversation' between the company and its audiences on the Twitter social media platform. The dominant themes articulated by both 'sides' are revealed, and the level of congruence or otherwise between the company and corresponding Twitter participants in the biannual time period windows can be seen. The results obtained and a discussion of the observed results are presented.

III. Results and Discussion

Table I provides descriptive statistics for the Twitter data set obtained here.

TABLE I
DESCRIPTIVE STATISTICS FOR TWITTER DATA SET

Date	Tweets from	Tweets to/about	Total
Jan-Jun 2016	844	1871	2715
Jul-Dec 2016	753	1786	2539
Jan-Jun 2017	360	3715	4075
Totals	1957	7372	9329

It can be seen that the volume of both tweets from, and mentions of, the target company have varied over time. Tweets from the company declined significantly over the 18 month period, especially in the first half of 2017. Conversely, mentions of the company on Twitter have increased significantly over the same period. The ratio of mentions to tweets has varied from more than 2:1 to more than 10:1. This indicates that the company achieves a high level of online interest and engagement via Twitter, garnering, on average, multiple mentions by others for every tweet sent. The total of 9329 tweets recorded contained 137102 words.

Within individual MDS plots, the relative size of the bubbles provides a comparison of the relative frequency of occurrence of terms. However, this comparison does not hold between MDS plots here, as each is based on different total numbers of tweets. Fig. 1 shows the MDS visualization of tweet text content from the engineering services company account during the period 1 January – 30 June 2016.

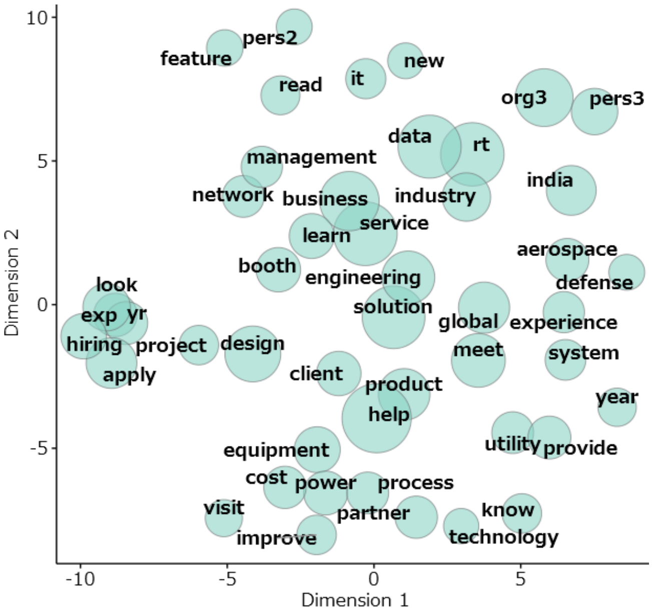

Fig. 1. MDS plot for tweet content from the company January-June 2016.

Key features apparent in Fig. 1 include:

- In the center, not surprisingly for a multinational engineering services company, 'engineering solution', 'business service', 'client', 'global', etc. can be seen;
- At the left is a tight cluster of terms from regular tweets looking for/hiring, candidates with 'X yrs experience';
- At the bottom are terms from tweets about improved use of power and/or equipment to cut process costs;
- At the right are terms noting particular company experience related to 'aerospace' and 'defense'.

Fig. 2 shows the MDS visualization of tweet text content mentioning the company during the period 1 January – 30 June 2016.

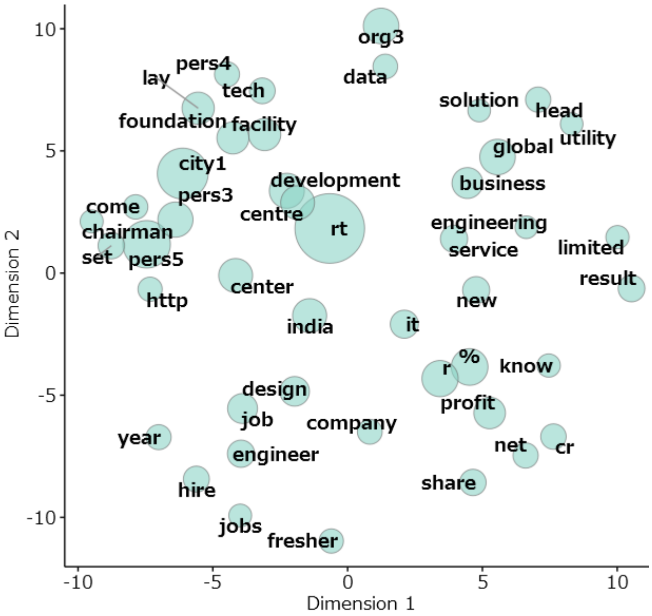

Fig. 2. MDS plot for tweet content about the company January-June 2016.

Key features apparent in Fig. 2 include:

- At the top left are terms related to the opening of a new facility in a regional city ('city1'), including a number of senior company office holders and public officials;
- At the top 'org3' is a national IT industry association;
- At the top right are terms from tweets about an advertised senior vacancy ('global head business development');
- At the lower right there is a group of terms related to public reporting of the company's financial results;
- At the lower left are terms related to graduate ('fresher') employment opportunities at the company.

Note that near the center of Fig. 2, the terms 'center' and 'centre' can be seen. These are actually associated with the cluster at the top left. The 'facility' was a development center, and was sometimes spelled 'development centre'. This shows the operation of MDS visualization, and how it successfully clusters associated terms. Fig. 3 shows the MDS visualization of tweet text content from the company account during the period 1 July – 31 December 2016.

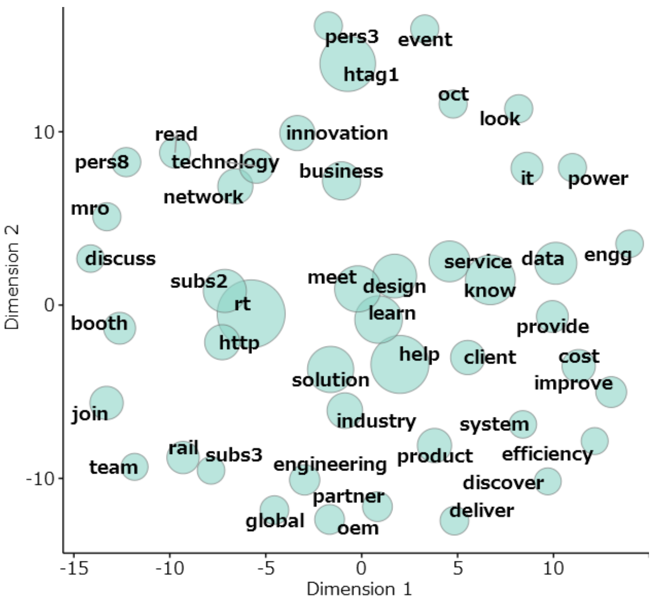

Fig. 3. MDS plot for tweet content from company July-December 2016.

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Key features apparent in Fig. 3 include:

- Again, in the center are generic engineering services terms such as ‘design’, ‘service’, ‘client’, ‘solution’, etc.;
- At the top, ‘htag1’ was a promotional hashtag used on SMSs, including in conjunction with ‘pers3’ (a senior company office holder) speaking at ‘event’;
- At lower right, terms associated with economizing, including ‘cost’, ‘improve’ and ‘efficiency’ appear;
- At the bottom, an offering of OEM services to global partners’ can be seen;
- At the lower left, the rail engineering subsidiary (‘subs3’) is identified, with mentions of the ‘rail team’.

Fig. 4 shows the MDS visualization of tweet text content mentioning the company during the period 1 July – 31 December 2016.

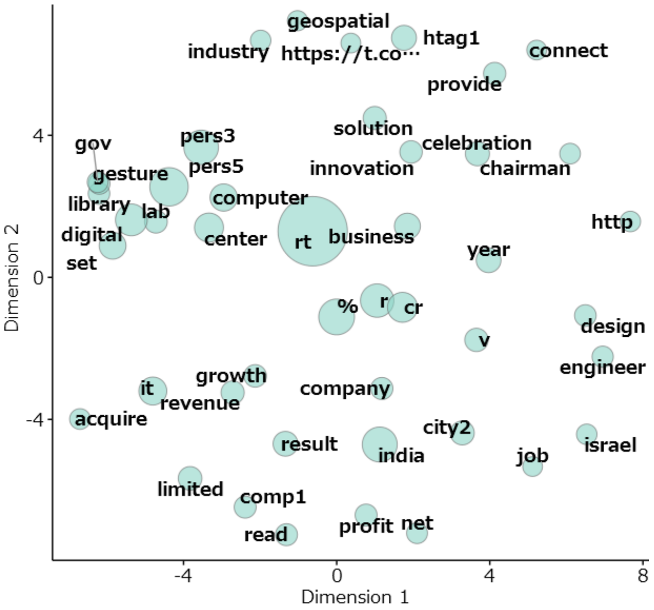

Fig. 4. MDS plot for tweet content about company July-December 2016.

Key features apparent in Fig. 4 include:

- At the top, terms associated with a popular online news story about developments in the geospatial industry can be seen, including part of the URL included in tweets;
- At the left is a cluster of terms associated with a public official (‘pers5’) acknowledging the contribution of the company in funding libraries and computer labs in a number of regional areas;
- From the center across the lower left quadrant are various terms from many tweets about the publicly reported financial performance of the company.

Further evidence of the operation of the MDS algorithm can be seen at the lower right. Separate sets of tweets mention an ‘engineering design job’ and a ‘job in city2’. In an attempt to best represent its relationship with both groups of terms, the term ‘job’ has ended up located in an intermediate position between them in the resultant visualization. Fig. 5 shows the MDS visualization of tweet text content from the company account during the period 1 January – 30 June 2017.

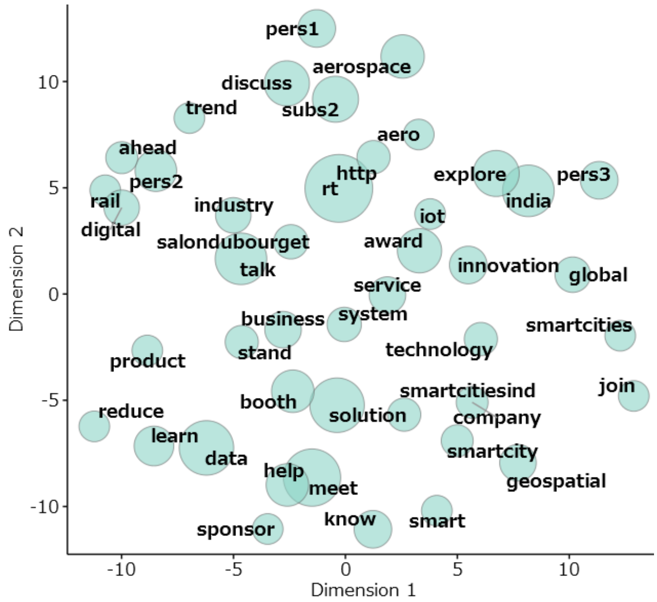

Fig. 5. MDS plot for tweet content from the company January-June 2017.

Key features apparent in Fig. 5 include:

- At the top are terms associated with the appearance of ‘pers1’ in the media discussing aerospace sector trends, and ‘subs2’ is the aerospace subsidiary of the company;
- At the top left are terms associated with ‘pers2’ presenting at a trade conference on the prospect for artificial intelligence and other digital technologies in the rail sector;
- In the lower right quadrant, several terms related to a ‘smart cities’ expo can be seen;
- Near the center, the terms ‘innovation’ and ‘award’ appear, and are related to an award won by the company.

As noted in Table I, the MDS visualization in Fig. 5 was based on the smallest set of tweets/text. This has perhaps impacted on the clarity of this MDS plot, with it exhibiting less obvious clustering than the other figures. Fig. 6 shows the MDS visualization of tweet text content mentioning the company during the period 1 January – 30 June 2017.

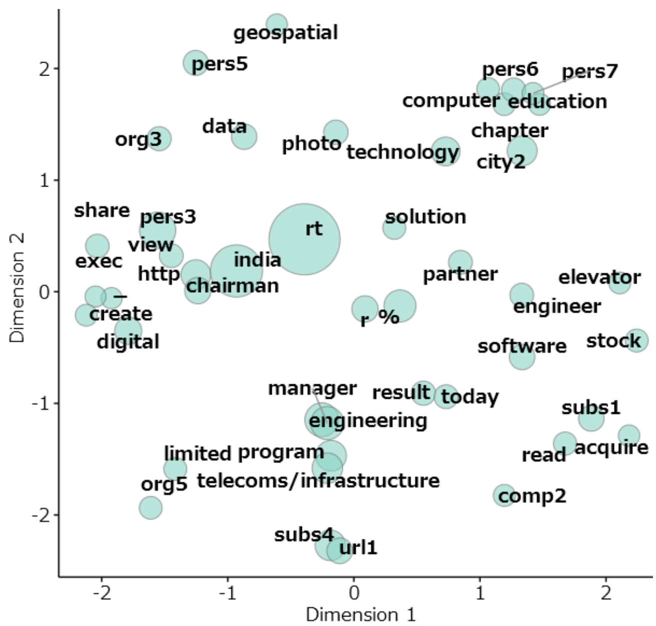

Fig. 6. MDS plot for tweet content about the company January-June 2017.

Key features apparent in Fig. 6 include:

- At the top right is a cluster of terms associated with the opening of a computer education facility operated by a charitable trust in 'city2', to which the company had provided some financial support;
- At the lower right are a series of terms related to news of the acquisition by the company (via a stock purchase) of a software company with the name 'subs1';
- At the bottom are terms related to tweets noting a job vacancy for an 'engineering manager' at 'subs4' in a 'telecoms/infrastructure' role, along with the link 'url1';
- At the left, terms can be seen from tweets reporting 'pers3', a senior company office holder, sharing views on advancing the national digital economy;
- In the center region there are terms related to public reporting of the company's financial results – 'result', 'today, '%' and 'r' (Rupee).

Examining the paired MDS visualizations for the biannual tweet data sets 'from' and 'to/about' the target engineering services company reveals limited congruence in the major themes apparent. The January-June 2016 plots (Fig. 1 and 2) both mention 'org3', a national IT industry association, and both mention employment opportunities, though refer to different job openings. The July-December 2016 plots (Fig. 3 and 4) both mention hashtag 'htag1', suggesting some impact and engagement for that social media promotion by the company. The January-June 2017 plots (Fig. 5 and 6) show no real common terms. Fig. 2, 4 and 6 show that many of those mentioning the company on Twitter are doing so in the context of the financial performance of the company – this was perhaps the most consistent theme in the tweet text that occurs across the entire period under consideration. If the company has addressed its financial results in its posts on Twitter, it is at a level not frequent enough to register in the MDS visualizations here.

These results suggest that the company and its followers on Twitter are not really interacting around a set of common themes, and that there is only a limited social media 'conversation' occurring. The Twitter audience, while mentioning the company, is largely talking about issues that do not feature in the corresponding company visualizations. Such mentions are commentary or discussions on Twitter about the company by third parties, and SMSs can amplify (both positively and negatively) the impact of such conversations about an organization between stakeholders. Such conversations occur continuously, whether the organization is listening or not, and can be an influential form of marketing that the company needs to be cognizant of.

Retweets ('rt' in the MDS plots) are one sign of interaction on Twitter – they indicate the deliberate 'passing on' of a received tweet. In the 'from' plots (Fig. 1, 3, and 5) the relative sizes of the 'rt' bubbles (compared to all bubbles) are smaller than for the corresponding 'to/about' plots (Fig. 2, 4, and 6). Examining the tweet data shows that, on average across the period considered, 15.1 per cent of tweets from the company were retweets, whereas 35.1 per cent of tweets mentioning the company were retweets. So, more than a third of the tweets mentioning the company originated from message sharing on Twitter, whereas more than four out of five tweets originating from the company did not exhibit this same type of interactivity.

In the 18 month period studied, the number of tweets from the company decreased by nearly two and half times, whereas the number of mentions of the company doubled. The end result of this was that by mid-year 2017 there were ten times as many tweets about the company as there were originating from the company. A company is unlikely to want or need to respond to every mention of itself on social media, and it may strategically apportion its SMS efforts between a range of social media platforms. However, in a period of increased interest in the company on Twitter, the company has apparently significantly reduced its presence – this is a potential marketing and stakeholder engagement opportunity forgone. The characteristics of the recorded Twitter data from the company suggest that it is largely engaged in a unidirectional, 'megaphone' style of communication and marketing campaign, with only a limited effort to engage with the relatively high level of third party interest in the company on Twitter.

IV. Conclusion

Online social media systems are important for engineering services companies, providing new ways to communicate and interact with their customers, stakeholders and other interested parties. Here text analytics was proposed as a method for the visualization of Twitter text content, including as an approach for the representation of the high-level 'conversations' occurring between an engineering services company and its stakeholders on Twitter. Multidimensional scaling was applied to biannual subsets of an 18 month data set for an engineering services company with an active Twitter presence. There was only a very limited level of congruence observed between the terms present in the paired MDS plots.

Generally, the themes apparent in the visualization of the tweet text of the Twitter audience of the company were different to the messages broadcast from the company. Just as the level of Twitter activity mentioning the company was increasing significantly, the company had apparently scaled back its level of Twitter engagement. On Twitter, mentions by third parties are ephemeral and, without access to commercial Twitter archive data sources, are effectively soon no longer available. So, if an organization wants to be aware of how it is being referred to on the Twitter SMS, it is obliged to monitor such conversations on an on-going basis, otherwise they will be lost if not captured in near real-time.

The method proposed and piloted here offers a way for organizations to visualize the large-scale conversations about themselves on Twitter, and to assist with key strategic uses of social media, including quantifying the scale of activity, and characterizing the nature and level of congruence in social media interactions with their stakeholders.

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