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Research paper

Social media marketing of IT service companies: Analysis using a concept-linking mining approach

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ABSTRACT

The IT service industry values the experience of social familiarity, which is based on routine interactions with suppliers and customers and is at the frontier of social media marketing. To further understand how IT service companies use social media to engage their customers or potential leads, the objectives of this research are to delineate the differences between IT service companies' use of social media and users' expectations based on knowledge extracted from user-generated content on Twitter. We applied a text mining approach called two-tier concept-linking analysis to extract patterns in Twitter posts from top IT service companies as well as the related tweets from the Twitter users. We further compare the yearly similarities and differences of the key concepts from the company's official account and from the users. Besides, the key concepts between users' expectations and IT service companies' social media use were compared on the basis of first-tier concepts and further elaborated by their corresponding second-tier concepts. Our approach contributes to further understand the socio-cognitive insights underlying the dynamic social media data, from which organizations and individuals in charge can note the objectives they wish to maintain and the marketing gaps they wish to improve on.

1. Introduction

Social media has diversified into various communication platforms, on which netizens share moments from their lives, build relationships, and acquire information (Kreiss, 2016). A forecast estimated that more than 50 billion devices will be connected to the Internet by 2020 (Khan et al., 2014) ; the vast amount of user-generated and word-of-mouth content have become the digital footprints recording how people browse social media. Nowadays, the phenomenon of big data availability creates new advantages for the marketing sector, which now has access to a large volume of data of great variety and velocity (Laney, 2001), high value (Hashem et al., 2015), and veracity (Bello-Orgaz, Jung, & Camacho, 2016). In this context, social media is disrupting and revolutionizing marketing, and has been doing so for a long time (Bello-Orgaz et al., 2016). According to Statista (2015), worldwide social advertising revenue is forecasted to reach US$30.99 billion in 2016 or 6% of the US$550 billion global advertising market. Social media marketing is gaining increasing popularity as an essential technological tool for improving marketing effectiveness and efficiency (Chen, Kim, & Lin, 2015) and has emerged as a crucial research area from the perspective of how customer relationships are facilitated (Yadav & Rahman, 2017).

Social media outlets provide excellent means for fostering customer relationships and enhancing marketing decisions (de Vries, Gensler, & Leeflang, 2012; Mas-Tur, Tur-Porcar, & Llorca, 2016; Micu, Micu, Geru, & Lixandroiu, 2017). Research typically focuses on the implementation of social media marketing from the aspect of a business-to-consumer (B2C) business model, but investigating the application of a business-to-business (B2B) model has been gaining favor among academics; the insights from these B2B studies have generated promising implications for organizations. For instance, the role of soft skills among organizational relationships and how to best demonstrate these skills through social media marketing were investigated, and the results showed that reliable products, recognizable logo, and strong website are necessary, but insufficient, factors for increasing brand equity. Another essential determinant was the adoption of social customer relationship management to display emotional intelligence to stakeholders, thereby enhancing the brand image (Hutchins & Rodriguez, 2018). In the B2B model, information technology (IT) service companies attempt to tailor an effective solution fulfilling the needs of business partners who manage their organizations by using complex business processes. The IT service industry values the experience of social familiarity, which is based on routine interactions between suppliers and customers (Huh & Park, 2018) and is at the forefront of social media marketing. According

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to the forecast, 50% of IT services market growth through 2019 will be associated with enabling customers' digital business strategies; this trend has changed IT service providers' business plans across all aspects (Roy, Sullivan, & Tan, 2018). Therefore, IT service firms must embrace digital trends and web 2.0 technology to adapt their marketing strategies and services offering. In this context, how IT service companies manage their social media platforms and the users perceive and respond to these activities can provide significant insights for academics and practitioners.

However, social media studies discussing on the IT service industry are scant. Most relevant investigations have focused on B2C companies (Armstrong, Delia, & Giardina, 2016; Chan & Guillet, 2011; Liu & Park, 2015; Semotiuk, Semotiuk, & Ezcurra, 2015; Seo & Park, 2018). To further understand how IT service companies use social media to engage their customers or potential leads, the objectives of this research are to delineate the differences between IT service companies' use of social media and users' expectations based on knowledge extracted from user-generated content on Twitter social media platform. Classical data-gathering and analysis methods no longer seem adequate to understand this new spectrum of social media and identify the frequent updates of user-generated content. Hence, we used a text mining approach called two-tier concept-linking analysis to extract cognitive patterns in Twitter posts. The reason why we chose Twitter as the only source of social media data is because it provides more amenable to an ongoing, public dialogue than Facebook (Ebner, Lienhardt, Rohs, & Meyer, 2010). Organizations can consider Twitter as an excellent approach to reach, interact with and understand the consumer than other social media platforms (Hays, Page, & Buhalis, 2013). Using hashtag to collect training data from Twitter proved useful for text mining (Rajesh & Mathivanan, 2017), while Facebook may offer too many distractions (Jones, 2011). In text mining analytics, the concept linking structure resembles a cognitive network in a defined multi-order association to easily and intuitively comprehend the context around a key concept (Chakraborty, Pagolu, & Garla, 2014). The linking strength was based on calculating the statistical probability of co-occurrence between two terms in the corpus. In our study, relevant tweets were retrieved by our coded crawler from the official accounts of the five largest IT service companies in 2016 and 2017. Through implementing this two-tier concept mining analysis, the hidden social media marketing strategy adopted by the competitors can be inferred, which help companies to adjust their social media approach. We also identified the yearly cognitive patterns of the social media users' opinions about the major IT service companies, which can help companies to design social media marketing campaign for better attentions from the social media users. In addition, the similarities and differences between users' expectations and IT service companies' social media use were compared on the basis of first-tier concepts and further elaborated by their corresponding second-tier concepts. As social media has become increasingly crucial, which has led companies to use it as an effective platform for marketing and customer management (Seo & Park, 2018; Swidan & Hassaballah, 2013), our social media mining results can help IT service companies to enhance their customer relationship management and marketing decision. To the best of the authors' knowledge, this is the first study to investigate social media marketing on the IT service companies from both the users' and organizations' perspectives. Our approach contributes to further understanding the socio-cognitive insights underlying the dynamic social media data, from which organizations and individuals in charge can note the objectives they wish to maintain and marketing gaps they wish to improve on.

The remainder of this study is structured as follows: Section 2 reviews the relevant literature regarding social media use in terms of the application of marketing and customer relationship management. Section 3 describes the methods used to retrieve the relevant Tweets regarding social media marketing as well as the algorithm used to analyze the concept-linking network. Section 4 presents the social media mining results from the perspectives of users' expectations and the social media activities of top IT service companies. Finally, Section 5 presents the implications and contributions of this study as well as suggestions for future research.

2. Literature review

Social media in the application of marketing has been gaining in academia and business because of its ability to improve marketing effectiveness and efficiency, which is due to its speed, low cost, and broad reach (Vance, Howe, & Dellavalle, 2009) and ability to improve brand equity (Godey et al., 2016). Michaelidou, Siamagka, and Christodoulides (2011) studied 102 SMEs in the United Kingdom and demonstrated that social media marketing is mostly suitable for attracting new customers and building relationships. Moreover, Wang, Malthouse, Calder, and Uzunoglu (2017) revealed that targeted customers are exposed to more digital contacts as well as consume more digital content, which nurtures greater engagement and reveals better business development opportunities. Therefore, many studies have aimed at gain a deeper understanding of social media in marketing application. For instance, Swani, Brown, and Milne (2014) studied the B2B and B2C models of Fortune 500 companies based on 7,000 Tweets and suggested that the adoption of B2B in social media is lower than that of B2C because of a lack of understanding of social media marketing. Dewan, Ho, and Ramaprasad (2017) used word-of-mouth and the observational learning effect as well as individual consumption behavior to suggest that social media context proximity has a greater influence than does popularity. In this era of intensive social media usage, customers can block marketing messages, easily compare prices, and even distribute false testimonies to the global community; thus, companies must integrate their customer relationship management (CRM) strategy with social media (Malthouse, Haenlein, Skiera, Wege, & Zhang, 2013). From the perspective a consumer's sense of belonging, the investigation of Kim and Drumwright (2016) explore the influence of social relatedness on consumer engagement and relationship developing, and the results reveal that consumers' perceived social relatedness moderates the effects of consumer motivation on engagement, consuming intention, and satisfaction. A similar study argues that an organization can consider the social media investments to be the resources inputs to building new marketing-related capabilities, and the use of social media in marketing strategies can be a means of enhancing customer engagement and firm performance (Wang & Kim, 2017). In the digital era, social CRM strategies, such as Twitter, may represent a new tool for enhancing CRM. Nisar and Prabhakar (2018) examined 2.47 million Tweets of 14 train operators in London during 2014–2015 and showed the effectiveness of Twitter in improving CRM through improving consumer experience, specifically enabling consumers to minimize delays and cancellations.

The research by Lakkala (2011) on 143 Finish enterprises in technology industry demonstrated the lack of attention toward adopting social media into existing ecosystem, where only 9 percent of respondents were confident with their social media understanding, and only 15 percent planned to develop social media strategy for integration into their business process. Rodriguez, Peterson, and Krishnan (2013) researched on social media technology adoption by 1,304 B2B's salespeople to understand how B2B companies perform in this new digital marketing medium. Their results indicated that 27% or 356 sample of overall population of this research were from IT Industry category, which is among the industries significantly influenced by social media. The mean range of social media influence was from 10.18 for technology-hardware to 12.40 for technology service. While education industry had the highest mean 12.50, aerospace and defense had the lowest mean 7.67. Yu, Duan, and Cao (2013) examined 52,746 messages from 824 firms' various social media and conventional media sources to investigate whether social media performed better than conventional media in influencing stock performance. Among the sample, IT related industry category is represented by Software

Publishers as much as 18.4% of the 824 firms. Results of longitudinal and cross-sectional indicate that blog had the best positive impact on return while forum had negative impact; and Twitter sentiment had positive effect on risk. Veldeman, Van Praet, and Mechant (2015) researched on 92 Belgian B2B companies and found out that 40.8% of B2B IT companies showed better maturity in using social site networking comparing to B2B companies in general. The combination of qualitative and quantitative research method uncovered the distinguish characteristics of B2B IT companies, such as; more familiar with technology, higher innovativeness, better capacity (i.e. time, ability, environment, organizational limits), and prior stakeholders use of technology. Another insight available from cases study survey research by Keinänen, Karjaluoto, and Kuivalainen (2015) on 82 senior, middle or general manager of IT service companies operating in Northern Europe. Results showed low reachability of social media toward industrial customers. Therefore, it is important for B2B IT service companies to be selective in deciding which social media service to use and focus more resources on customer-engagement strategy by understanding customer behavior. Vlietland and Van Vliet (2015) case study researched at the multinational financial service provider and its supply IT organization to understand how social media enhanced IT incident handling in IT-enabled financial service. The research on 15 planned interview and 86 complementary identified the impediment of data sharing due to complexity of information sharing, specifically tacit knowledge, which is essential for troubleshooting the IT incident. Social media was proposed as one of the ways to empower IT incident handling by enabling tacit knowledge sharing due to its characteristic as data which is highly personal and hard to formalize. Social media integration into existing business process can also be utilized beyond marketing and organizational purpose. Wang, Hsiao, Yang, and Hajli (2016) investigated whether marketing strategy in B2B IT industry can be incorporated with online social media by using co-innovation online community strategy. The study shows the positive influence of 190 IT-related business professional's social identity and social comparison mediating the co-innovation activities, which then increase brand awareness of potential customers. The development of social media is not merely a potent for marketing improvement in IT industry, but also in improving IT incident handling.

3. Methodology

Mining on social media is the "process of representing, analyzing, and extracting patterns from social media data" (Zafarani, Abbasi, & Liu, 2014, p. 16). Numerous studies have applied such an approach to understanding public opinion toward specific topics. For example, Sobkowicz, Kaschesky, and Bouchard (2011) and Stieglitz and Dang-Xuan (2013) proposed opinion formation frameworks based on the analysis of user-generated content on social media for modeling, simulating, and forecasting political opinions online. Dredze (2012) used social media mining to explore highly concerning health topics discussed on Twitter as well as how tweets can augment existing public health capabilities and enable new ones. Chen, Vorvoreanu, and Madhavan (2014) argued that students' informal conversations on social media (e.g., Twitter) reveal their educational experiences, opinions, feelings, and concerns about the learning process. Twitter is an effective social channel for disseminating news and expressing opinions about social issues; moreover, it provides valuable resources for learning about users' expectations, topics of great concern, and public opinions. Because of its asymmetric following model, openness to the public, and well-documented application programing interface, Twitter is a prolific social resource for gathering public opinions and real-time information in different fields of research (Gu, Qian, & Chen, 2016; Vaccari, Chadwick, & O'Loughlin, 2015). According to the statistics from Statista (Statista, 2019), total number of monthly active Twitter users is more than 320 million and around 21% of all internet users use Twitter. All of the above are the reasons why we used Twitter as the source of social media data in this study. Data from Instagram and Pinterest were not considered in this study, because both platforms are based primarily on the sharing of visual contents, which are not applicable for the text mining analysis. A Python-coded crawler and a Twitter search application programming interface were applied to collect relevant tweets, which were retrieved from between January 1, 2016, and December 31, 2017, from the official Twitter accounts of the five largest IT service companies, namely Accenture, Fujitsu, IBM, NEC, and Hewlett Packard Enterprise (HPE). In each year, the tweets of each company were differentiated into official-account and user posts; Table 1 presents the results. This research only discusses the cases of Accenture, Fujitsu, IBM, and HPE, because NEC posted less than 1,000 tweets in each of our investigation years.

Table 1
Number of tweets.

IT service firm	Number of tweets from official account		Number of tweets from users	
Year	2016	2017	2016	2017
Accenture	1,807	821	4,377	998
Fujitsu	1,697	1,903	1,535	1,125
IBM	1,170	1,062	24,510	17,038
NEC	613	390	1,835	1,700
HPE	1,008	748	4,325	1,187

Corpus, a collection of textual documents, served as the basic unit for our analysis. In this study, a tweet was considered a single document, and 20 corpora were analyzed independently. We performed a two-tier concept-linking analysis based on calculating the strength of association between terms. Each tweet in a corpus was tokenized into a collection of terms, and each corpus was represented into a bag-of-words. Irrelevant characters, such as controls, digits, and graphics, were removed from the corpus to obtain a tidy dataset. The metadata of terms, such as synonyms and parts of speech, were determined by using the Natural Language Processing algorithm embedded in SAS Text Miner. To simplify the analysis, we kept both nouns and proper nouns but neglected all other parts of speech. Accordingly, the textual dataset of each corpus was then transformed into a term-to-document matrix. After counting, the term-frequency statistics were manually scrutinized to screen out irrelevant terms, such as *winter* and *tomorrow*, and combine synonyms or abbreviations if necessary, such as *IBM* and *International Business Machine*. We then quantified co-occurrence among terms. The strength of association was defined as the statistical probability between two terms based on their co-occurrence in the corpus; the higher the strength of association, the stronger the conceptual relevance between two terms. For a given pair of terms, the strength of association between a $term_a$ and the associated $term_b$ for r given tweets was calculated based on the following equations:

$$Strength\ \ of\ \ Association = \log_e\left(\frac{1}{prob_k}\right) \tag{1}$$

Furthermore, the sum of probabilities was calculated as

$$prob_k = \sum_{r=k}^{r=n} \frac{n!}{r!(n-r)\ !} p^r (1-p)^{(n-r)}, \tag{2}$$

where n is the number of tweets that contain $term_b$, k the number of tweets that contain both $term_a$ and $term_b$, and $p = k/n$ the probability that $term_a$ and $term_b$ co-occur, assuming that they are independent of each other (Chakraborty et al., 2014). Accordingly, the first-tier concepts were extracted based on their strength statistics with the company name. Similarly, the second-tier concepts were extracted based on their strength statistics with the first-tier concepts. We can construct a concept-linking network to depict the cognitive patterns behind the tweets. Here in this paper, we deconstructed the network into the most

associated first-tier concepts and their associated second-tier concepts. The advantage of our approach comes from the identified concepts, as major concepts of representing the IT service company, which provide a summary of the corpus and the links between these concepts that maintain the underlying semantic structure. In the two-tier concept analysis, we identified the first-tier concepts strongly associated with the concept of each IT service company. The first-tier concepts represented the most crucial concepts regarding IT service companies from either the organizational or user perspective. However, to more thoroughly understand the whole status, we required more information to elaborate the first-tier concepts. Therefore, the second-tier concepts, which strongly exhibited the concepts of the first-layer concepts, were also identified. By synergizing the concept-linking in the two-tier concept analysis, the manner in which IT service companies manage their social media platforms and the users' expectations were outlined.

4. Results of social media mining

The text mining analysis generates the average number of 8 first-tier concepts each year for the 5 IT service consulting companies' tweets including IBM, Accenture, Fujitsu, HPE, and Twitter users' tweets about the aforementioned companies. Since every individual first-tier concepts links to multiple second-tier concepts, the further scrutiny on second-tier concepts and the tweet examples explicates and elaborates the insight of the associated first-tier concepts. The first-tier concepts and tweet examples are mentioned in quotation mark " ", while the second-tier concepts are formatted italic.

4.1. Key patterns of IT service companies' tweets

In the following sections, we discuss how to apply the concept-linking approach to identify the yearly tweet patterns of the major IT service companies. Our outcomes illustrate how competitors' possible marketing strategy can be detected through the identification of the key concepts from their posts on Twitter.

4.1.1. IBM

Regarding IBM's tweets on its official social media, the text mining analysis generates 8 first-tier concepts in each year. Table 2 summarizes these first-tier concepts with the associated second-tier concepts, where the numbers next to the first-tier concepts are their strength statistics related to the term "IBM". The majority of first-tier concepts in 2 years relate to technology or branding image that IBM would like to promote on Twitter. While "apple" is the concept with the strongest ink in 2016, "trustibmz", "inclusion" and "fellow" are the strongest ones in 2017. The second-tier concept related to "apple" is enterprise, which indicates that the focus of IBM's Twitter campaign in 2016 is its support to Apple's enterprise solutions. Meanwhile, 2017 key concepts "trustibmz" with its second-tier concept data and "inclusion" with commitment show that IBM's social media strategy is to let customers trust its data security and its long-standing commitment to diversity and inclusion. IBM also promoted the pioneering works of its top "fellows" (such as Chieko) on Twitter.

For the 2016 results, other terms such as "watsonhealth", "icymi", "pc", "quantumexperience", "researcher", and "partnership" were identified as the key concepts of IBM's social media marketing. The first-tier concept "Watsonhealth" and its associative second-tier concepts, including *truvenhealth, treatment, cancer, care,* and *patient*, demonstrate the concern of IBM on applying big data analysis and technology in early diagnosing and treatment of cancer and other diseases. "icymi" is the abbreviation of "in case you miss it" that IBM uses on social media to pin the technology news highlights on its Twitter page. For example, "ICYMI: The Open Zika project crowdsources compute power to help accelerate Zika virus research" is a tweet related to "icymi" and its second tier concept *virus*. Tweets about the "partnership" between IBM and *VMware*, a global company in cloud infrastructure & digital workspace technology is noteworthy in 2016. "QuantumExperience" is a hashtag that IBM often uses on social media in 2016, referring to the online platform that gives users in the general public access to a set of IBM's prototype quantum processors via the Cloud. Tweets containing this hashtag can be seen as "The IBM #QuantumExperience marks a new era for cloud computing" or "The coaxial cables in this dilution refrigerator send inputs and outputs to help enable the IBM #QuantumExperience." The first-tier concept "company" and its associative second-tier concepts *energy, business* implicates the increasing number of companies in different businesses are applying big data analytics and machine learning to enhance their operation planning. "Weather company" indicates the IBM's acquisition of a weather company to expand its IoT network.

While technology topics on IBM's Twitter account in 2016 highlights the role of data and technology application in health care domain, energy business or weather forecasting; IBM aims to communicate its excellent product/service quality to social media users through its social media in 2017. The first-tier concept "mainframe", as tweeted "On April 7, 1964 the IBM System/360 mainframe was announced, changing computing forever", indicates the original computer frame of IBM, from whose concept the latter IBM computer prototypes are built. The second-tier concept *IBMZ*, as tweeted "Introducing IBM Z, IBM's mainframe built for a new era of data protection" or "IBM Z can run more than 12 billion encrypted transactions per day", refers to IBM modern computer product lines and indicates the high built quality of IBM product. *Art, designer, story* indicate that stories, video links about

Table 2
First-tier concepts and second-tier concepts from IBM's concept links.

2016		2017	
watsonhealth	0.85	**mainframe**	0.89
truvenhealth, treatment, cancer, care, patient		ibmz, art, security, designer, story	
icymi	0.57	**cloud**	0.75
virus, network, garage, development, acquisition		ibmcloud, customer, center, contingent, country, forbes, transformation	
apple	1.00	**fellow**	1.00
enterprise		asakawa, chieko, life	
partnership	0.68	**trustibmz**	1.00
iot, ceo, ibmwow, stage, vmware		data	
pc	0.87	**program**	0.90
machine		leadership, development, stem	
company	0.63	**inclusion**	1.00
ibmwatson, business, energy, weathercompany		commitment	
quantumexperience	0.86	**enterprise**	0.82
antartica		AI	
researcher	0.73	**Diversity**	0.75
breakthrough		culture	

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Table 3
First-tier concepts and second-tier concepts from Accenture's concept links.

2016		2017	
oow16	0.67	**Application**	0.46
service		management, service	
workday	0.57	**ellynjshook1**	0.56
analysis, hr, solution, technology		tune, conversation, CHRO, iwd2016, inclsusionstartwithI	
oracle	0.41	**wef17**	0.41
techvision2016, leader		aiforgood, davos, cet, reshmasaujani, futureworkforce, AI, panel	
capacity	0.45	**people**	0.38
transformation, supply chain, partner, client, salesforce		tech, environment, workplace	
survey	0.60	**leader**	0.35
trend, consumer		marketspace, woman leader, idc, insipringwomen	
acquisition	0.60	**liquid**	0.71
dgroup		application	
digital	0.59		
digital transformation, disruption, digital strategy			
cloud	0.49		
transition, df16, MSignite, public cloud			

Table 4
First-tier concepts and second-tier concepts from Fujitsu's concept links.

2016		2017	
Service	0.60	**Service**	0.67
withk5youcan, cloud, incredible thing, enterprise service		inclusivity, great workforce diversity, technology, cloud, topic	
k5	0.44	**k5**	0.73
hybridit, oenstack, emeia		service, region, germany	
tour	1.00	**Servicenow**	0.90
fujitsuwt, sponsor, event, Sweden, innovation		AR, platform, gdpr, enablingdigital, BOS, VR, demo	
life-cycle solution	1.00	**Intellegentengineering**	0.88
resource, solution, sap transformation		downtime, failure	
eternus	0.80	**server**	0.69
cs200c, commvault, storage, infrastructure, fujitsuforum, palmsecure, demo, security		benchmark, family, world record, primergy, m12, primequest	
challenge	0.52	**Sap**	0.60
big challenge, retail, channel, video, byod		Hana, erp, Frankfurt, next-generation, operation, bridgestone	
scholarship	0.94	**Workstation**	0.86
leader		celcius m770, desktop, scenario	
		euroshop	1.00
		connectedretail, experience, retail	

the art of design and build process of IBMZ mainframe are also post highlights on IBM's social media. "Cloud" with its second-tier concepts including *IBMcloud, customer, center, country, transformation*, as tweeted "the IoT and IBMCloud are being used to help reduce agricultural water usage worldwide" or "IBM operates nearly 60 cloud data centers in 19 countries across 6 continents", indicate the pioneering and leading position of IBM cloud service. "Diversity" and its second-tier concept *culture*, as tweeted "IBM is proud of our long-standing commitment to fostering diversity, acceptance and inclusion", demonstrate the pride of IBM in inspiring the cultural diversity in organization as a development dynamic.

4.1.2. Accenture

Regarding Accenture's tweets on its official social media, the text mining analysis generates 8 first-tier concepts in each year. These first-tier concepts and the associated second-tier concepts are summarized in Table 3. Although the tweet contents in 2016 and 2017 emphasize on different regards; however, first-tier concepts in the 2 years indicate the similar practices such as technology trend, technology event/conference, and customer issues. From technology trend perspective in 2016, first-tier concepts including "capacity", "digital", cloud", "acquisition", "workday" underline the importance of executing digital transformation and digital strategy in businesses, through which optimizing the business growth, supply chain management and customer relationship management. Second-tier concepts such as *supply chain, Salesforce, transformation* representing the first-tier concept "capacity", *digital transformation,* and *digital strategy* representing "digital" provide the insight to the associative first-tier concepts. Besides, "cloud" and its associative second-tier concepts including *transition, public cloud, df16, MSignite* is among the pinned tweets that Accenture announce to social media. Tweets can be found as "Discover the benefits of more rapid public cloud migration and how to make the transition to mass migration." *Df16* and *MSignite* indicate the Dreamforce 2016 and Microsoft Ignite technology events respectively. Accenture also executes variety of consumer "surveys" to gain the in-depth understanding on customer's need and *consumer*' consumption *trends.* Meanwhile, "workday" implies that the integration of Accenture's Workday cloud-bases management software in businesses would enhance the management efficiency of businesses. First-tier concepts "oow16", which has the strongest relationship with Accenture, indicate the Oracle Open World 2016.

While the technology issues in 2016 portray the importance of digital transformation in businesses, the technology perspective in 2017 highlights the importance of improving the gender equality and environmental protection alongside the growth of IT industry. The 2017 first-tier concepts "application", "liquid" (with the strongest link) imply that the application research Liquid Studio of Accenture would help enterprises accelerate technology application development. In the same course of technology practice, the first-tier concepts "Ellynijshook1", "people", and "leader" and associative second-tier concepts *IWD16, environment, woman leader, inspiring women* indicate the important role of women in IT industry. "WEF17" refers to the World Economic Forum 2017 and highlight the substantial contribution of technology in worldwide economic thriving.

4.1.3. Fujitsu

Regarding Fujitsu's tweets on its official social media, the text mining analysis generates 8 first-tier concepts in each year. Majority of the first-tier concepts in 2016 and 2017 associate with the technology trend and technology application; while "life-cycle solution", "service", K5", "Eternus", "challenge", "scholarship" are technology issue-related concepts in 2016; first-tier concepts "service", "servicenow", "intellgentengineering", "server", "K5", "SAP", "workstation" represents

Table 5
First-tier concepts and second-tier concepts from HPE's concept links.

2016		2017	
Cloud	0.47	**Cloud**	0.56
mix, solution, smb, capacity, research, Microsoft		public cloud, platform, enterprise, hybrid	
Infrastructure	0.52	**Server**	0.48
composable, control, computing, cloud, hybrid infrastructure		proliant, industry-standard, solution, gen10	
hpehelion	0.56	**automation**	0.40
hperoadshow		oneview	
rsac	0.60	**cost**	0.45
malware		hybridit, capacity	
dsvirginracing	0.44	**infrastructure**	0.62
pariseprix, race		HPEsynergy, vision	
formula	0.49	**Data**	0.74
tech, team, hpe_bgdata, driver, car		apps, IoT, city	
mrrobot	0.57	**customer**	0.42
hacker, life		space, partner	
storage	0.50	**tech**	0.71
HPE synergy		dwanimation, leader, AI, car, company	

technology practices in 2017. The strength statistics and the associated second-tier concepts of the first-tier concepts are summarized in Table 4. “Service” and “K5” are common concepts in both years that mutually indicate the K5 cloud service of Fujitsu and the emergence of *Hybrid IT*, which would be highly contributable to *enterprise service* management. The first-tier concepts “life-cycle solution” with the strongest link calls for the *SAP transformation*; while “Eternus”, implying the Hybrid Storage Systems of Fujitsu, highlights the necessity of data security that is explicated by second-tier concepts *security, Palmsecure*. “Challenge” implies that the application of technology and big data analysis in retail business would solve the existing challenges in retail industry. Second-tier concept *video* implicates that real-time video analysis is the powerful tool to enhance the retailing operation. Meanwhile, the “scholarship” programs would inspire and attract more talents to visualize their careers in IT industry. From the technology perspective, cloud service is the common concern in 2016 and 2017; in addition, server platform, SAP, visual reality (VR), augmented reality (AR) platform are also among technology related highlights on Fujitsu’ Twitter page. The first-tier concept “Euroshops” stands for The World's Number 1Retail Trade Fair, marks the collaboration between Fujitsu and retail industry.

4.1.4. HPE

Regarding HPE’s tweets on its official social media, the text mining analysis generates 8 first-tier concepts in 2016 and 7 first-tier concepts in 2017 (Table 5). Up to 7 first-tier concepts including “infrastructure”, “HPEHelion”, “DSVirginracing”, “mrrobot”, “storage”, “cloud” relate to technology trend and technology application in 2016; the strongest concept “RSAC” and its second-tier concept *malware* indicates the RSA Conference, which is the leading cybersecurity event across the globe. The first-tier concept “infrastructure”, which emphasizes on *hybrid infrastructure, composable* infrastructure and *cloud* infrastructure, underline and communicate the excellence of HPE IT infrastructure to social media. While *composable* infrastructure refers to a framework whose physical compute, storage and network fabric resources are treated as services; *hybrid infrastructure* indicates an IT infrastructure that combines traditional IT, private, managed and public clouds. “DSVirginracing” and its associative concepts including *race, parisepix* together with “formula” and its second-tier concepts *tech, team, HPE_bigdata, driver,car* indicate the collaboration between HPE and the racing team DSVirginracing, which is the formula E racing team established by the partnership between Envision Virgin Racing Formula E team and DS Automobiles. Tweets, such as “DSVirginRacing FormulaE uses HPE_BigData to win races” and “HPE + DSVirginRacing: working together to develop electric vehicle technology with FormulaE”, implicate the in-depth collaboration between HPE and the racing team not only on the race track but also aim to develop the electric vehicle technology as a move toward the carbon-dioxide emission reduction. “Mrrobot” is an American drama thriller television series that revolves cybercrime and hacker topics. IBM mentions about “Mrrobot” as z precaution that “Cybercrime is dramatic on TV, but the stakes can be just as high in real life. Tune into #MrRobot, presented by HPE.” The first-tier concepts “storage” and “cloud” emphasize on the crucial role of data storage platforms such as *HPE infrastructure* and HPE *cloud* solution on small and medium businesses. “HPEHelion” is a portfolio of open-source software and integrated systems for enterprise cloud computing. The second-tier concept *HPEroadshow* indicates the marketing activity of HPE on the cloud computing network and the IT infrastructure.

The 2017 first-tier concepts including “server”, “automation”, “cost”, “infrastructure”, “cloud”, “tech” associates with the technology practices. “Server” and its associative second-tier concepts *Proliant, gen10, industry-standard, solution* refers to variety of servers developed by HPE including Proliant server, a brand of server computers originally developed and marketed by Compaq, but currently marketed under the name of HPE. The first-tier concept “automation” and its second-tier concept *Oneview* indicate the converged infrastructure management platform that provides a unified interface for the administration of software-defined systems in a data center. “Cost” and its second-tier concept *HybridIT* proposes that the application of the Hybrid IT platform developed by HPE would help reduce storage cost for businesses. Similar to “infrastructure” in 2016, the 2017 first-tier concepts “infrastructure” and “cloud” and the associative second-tier concepts *HPESnergy, public cloud, hybrid* also implies the data storage platform, network system, cloud service, and hybrid cloud infrastructure developed by HPE. HPE Synergy refers to a combination of storage, computing and networking equipment in one chassis, along with management software that can quickly configure the hardware automatically to provide just the resources needed to run an application. As the extension to the first-tier concepts “DSVirginracing” and “formula” in 2016 that suggest the collaboration of HPE with racing team and smart electricity vehicle manufacturing industry, the first-tier concept “tech” in 2017 and its second-tier concepts *DWanimation, car, AI* exhibit the expansion of collaborative network of HPE with movie industry and smart electricity automotive industry, using AI. HPE also addresses concern on “data” issue that focus on *IOT* and *apps* development for healthcare and other domains on HPE’s social media.

4.2. Key patterns of social media users’ tweets towards IT service companies

In this section, we discuss how the concept-linking approach can help us to identify the yearly patterns of the Twitter users’ opinions about the major IT service companies. This information is helpful for the companies to design marketing campaign that can attract social media users’ attention.

4.2.1. IBM

Regarding social media users’ tweets about IBM, the text mining analysis yields 8 first-tier concepts in each year; common first-tier concepts of the 2 years are “cloud”, “blockchain”, “IoT’, “innovation”, “Microsoft”. The 2016 first-tier concepts including “big data”, “analytics”, “data” represent data issue category. Meanwhile, concepts such as “cloud”, “IoT”, and “innovation” are associated with the technology

Table 6
First-tier concepts and second-tier concepts from Twitter users’ opinions about IBM.

2016		2017	
cloud	1.00	**cloud**	0.98
awscloud, architect, ustream, cloud data, IBMcloud, hybrid, VMware, services		genband, container, army, cloudexpo, IBMcloud, hybrid, VMware, uc	
blockchain	0.99	**blockchain**	0.98
insurtech, bank, traceability, hyperledger, fintech, bitcoin, blockchain technology		bitcoin, coindesk, dlt, hyperledger, fintech, IBMblockchain	
IoT 0.99	0.99	**IoT**	0.98
platform, developer, factory, Honda, sensor, IBMIoT		digitalhealth, paloaltontwks, predictions, sensor, IBMIoT, ATT, infographic, Nokia	
innovation	1.00	**innovation**	0.99
collaborative innovation, technology, Ontario, security innovation, digital innovation, blockchain innovation center, innovation lab, innovation sector		legal department, technology, cloud era, busy building, IBMresearch, disruption	
Microsoft	1.00	**Microsoft**	0.99
Amazon, Oracle, SAP, Facebook, Google, mattermark, Amazon, Apple, Netflix		Amazon, Sap, Facebook, Oracle, blockchain industry leader	
big data	1.00	**Ibmwatson**	0.96
bigdata service, F1, unstructured, mastercard, helpstoptb, AI, Hadoop		IBMamplify, dfraim, holiday prediction, hrblock, tech advancement, Einstein	
analytics	1.00	**AI**	0.98
datascience, massive, fraud, edge		Mit, human, ML, artificialintelligence, lab, principle, machinelearning	
data	0.94	**Tech**	0.98
scientist, dashdb		Qualcomm, Paypal, Tesla, Spacex, Amazon, Emc, tech company	

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practices. Meanwhile, the 2017 first-tier concepts including "cloud", "AI", "IoT", "innovation", "tech", "IBMWatson" represent the related technology issues. "Blockchain" and "Microsoft" respectively refer to application of technology in business and technology companies in 2016 and 2017. The summary of the first-tier concepts and the associated second-tier concepts are shown in Table 6, where the numbers indicate the strength of the first-tier concepts with the term "IBM".

From the technology perspective, "cloud", "IoT", and "innovation" are major concerns of social media users in 2016. "Cloud" is elaborated by second-tier concepts *cloud data, IBMcloud, VMware, hybrid*; while *VMware* and *IBMcloud* indicate the VMware solutions on IBM cloud that enable cloud adoption fast and easy, *hybrid* refers to the IBM hybrid cloud platform. "IoT" is mostly discussed with its application on the improvement of vehicles sensors, explained by second-tier concepts *Honda, sensor, IBMIoT*. "Innovation" in 2016 addresses the interest of social media users on *collaborative collaboration, security innovation, digital innovation, blockchain innovation center*. Similar to "cloud" in 2016, the first-tier concept "cloud" in 2017 also emphasizes on IBM cloud service, VMware, hybrid cloud platform, expressed by second-tier concepts *IBMcloud, VMware,* and *hybrid.* The extension of social media users' interest on "cloud" topic in 2017 is seen on *Genband* and *UC* topics that indicate the unified communication solutions and security of real-time communication developed by Polycom Ribbon. "IBMWatson" indicates IBM Watson, which is the IBM's suite of enterprise-ready AI services, powered by the latest innovations in machine learning and committing to provide the highest security on customers' data and insights. The associative second-tier concept *HRBlock* indicates the tax preparation services company H&R Block that integrates Watson of IBM to increase the accuracy of its business output. While the topic of HPE's smart sensors applying on *Honda* vehicle manufacturing draw attention of social media users as discussing about "IoT" and "big data" in 2016, as tweeted "@IBM @Honda to implement > 160 sensors in F1 cars powered by @IBMWatson #IoT #bigdata"; the engagement of Twitter users shifted to *digital health*, *infographic* and network carriers and handset device manufacturers such as *ATT* and *Nokia* in 2017. Respect to the application of technology in business, first-tier concept "blockchain" of 2016 and 2017 implies the identical interest of social media users on *fintech, hyperlegger blockchain, bitcoin*.

4.2.2. Accenture

Regarding social media users' tweets about Accenture, the text mining analysis generates 8 first-tier concepts in 2016 and 9 first-tier concepts in 2017 (Table 7). "Fintech", "innovation", "tech" and "business" are the common concepts of Twitter users about Accenture in these 2 years. The 2016 first-tier concepts including "fintech" and "business" are related to applications of technology in business. Concepts such "innovation", "tech", "cloud", "leaders" are associated with technology innovation practices. While the concept of "consumer" regards customer issues, "Avanadeinc" refers to a global professional services company providing IT consulting and services focused on the Microsoft platform. On the other hand, in 2017, first-tier concepts "fintech", "blockchain", "insurtech", and "business" involve with technology applications in business. The concepts of "AI", "tech", "innovation", and "IOT" are related to technology innovation practices.

Although the first-tier concepts regarding Accenture in 2 years largely indicate the similar issues; however, the differences of social media users' in-depth concerns in 2016 and 2017 are observable on each domain. Regarding technology application in business, while "fintech" is the major concern of social media users in 2016; this category extends to "fintech", "insurtech", and "blockchain" in 2017. The second-tier concepts elaborate "fintech" in 2016 as focusing on *fintech investment, startup, global insurance market* and *retail banking*. Meanwhile, "fintech" in 2017 emphasizes on the worldwide dissemination of the term as highlighted by second-tier concepts *mpgvip, makeyourownlane, defstar5*; noted that @MPGViP is a content marketing platform that makes viral videos and the hashtags *makeyourownlane* and *defstar5* are related to fintech and insurtech marketing campaigns and repeatedly used in number of tweets by @MPGVip and social media users when discussing about the fintech practice. In respect to technology innovation, the first-tier concept "tech" in 2016 is highlighted by second-tier concepts *robotic, tech,* and *woman*, which indicate the rise of robot technology, and social media concerns on how technology can bridge the gender gap and gender equality in technology industry. Instead, concerns of social media users on "tech" in 2017 focus on the customer experience and payment methods, expressed by second-tier concepts *CX* and *real-time global payment*. "Innovation" in 2016 regarding Accenture is illustrated by *robotics, niche open innovation* and *food business*; while "innovation" in 2017 emphasizes on health-care technology, expressed by second-tier concept *healthtech*. *Oracle, java* capture social media users' attention as they discuss about "cloud" of Accenture in 2016; while *machine learning, chatbots,* and *SpaceX, big data, AR* abbreviated from augmented reality are favorite topics as social media users tweet about "AI" and "IoT" of Accenture in 2017.

Table 7
First-tier concepts and second-tier concepts from Twitter users' opinions about Accenture.

2016		2017	
Fintech	1.00	**Fintech**	1.00
fintech investment, Asia, startup, insurtech, global insurance market, retail banking		Makeyourownlane, banking, MPGVip, defstar5	
innovation	0.95	**Innovation**	1.00
Robotics, robotvalley, niche open innovation, scale, execution, foodbusiness		Hub, healthtech, Houston, challenge,Bangalore, Germany, efma_news	
Tech	1.00	**Tech**	0.97
Robotics tech, woman, huffpostwomen, freelancer, yahoofinance, scm_news		Payment, real-time global payment, building, network, CX, trust	
Cloud	1.00	**IoT**	0.99
Towergate, developer Oracle, Java		AR, bigdata, SpaceX, IBMamplify, EMC	
Business	0.92	**Business**	1.00
Cloud resource, digital business, globalgoals, high-velocity business, AWSsummit		Weconnection, citi, GCfest, India, ProcterGamble, enterprise, platform, leadership	
Leaders	0.96	**AI**	1.00
Designthinking, ASAservice, NGAhr, IDC, BPO, hfsblueprint, Infosys, professional		Robotics, ML, chatbots, customer, UI, machinelearning	
consumer	1.00	**Blockchain**	1.00
Survey, bank research report, screen, mega-trend, interruption, age		Bitcoin, cryptocurrency, regtech, infosec, wealthtech	
Avanadeinc	1.00	**Insurtech**	1.00
CRM, Microsoft, supermarketofthefuture, ACAI, digitalbanking, onwindows		Insurance, btc, insurer	
		Microsoft	0.92
		Apple, Google, Oracle, Facebook, Amazon, Sap	

4.2.3. Fujitsu

In relation to social media users' tweets about Fujitsu, the text mining analysis yields 8 first-tier concepts in each year. Common first-tier concepts of the 2 years are "enablingdigital", "IoT", "solution", and "cloud". Majority of the first-tier concepts in 2016 including "enablingdigital", "IOT", "transformation", "fujitsu_uk", "cloud", and "solution" are associated with the technology issues. Most of the 2017 first-tier concepts are also related to the technology issues including "enablingdigiatal", "IoT", "AI", "solution", "partnership", and "cloud". Meanwhile, "SUSECon" demonstrates the technology event/conference, which is the annual global technical conference for SUSE customers, partners and community enthusiasts, geared to the needs of the enterprise IT consumer. The summary of the first-tier concepts and the associated second-tier concepts are shown in Table 8, where the numbers are the strength statistics of the first-tier concepts with the term "Fujitsu".

The concerns of social media users toward technology issues of Fujitsu in 2016 and 2017 are elaborated by second-tier concepts. The

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Table 8
First-tier concepts and second-tier concepts from Twitter users' opinions about Fujitsu.

2016		2017	
Enablingdigital	1.00	**Enablingdigital**	1.00
process, organization, Success, AirBnb, aibazin, i-cio		Business, digital transformation, action, collaboration, people	
IoT	1.00	**IoT**	1.00
people, non-technical guide, mwc16, ubiquitousware, value		digitaltransformation, value, iota, analytics, service	
cloud	1.00	**cloud**	0.97
cloud security, K5, concern, Abrabban, dcdnews		openstack, service, hyperconverged, expansion, K5	
solution	1.00	**solution**	0.96
production, efficiency, internetofthings, fintech, enterprise		premise, hyperconverged system, Data, center, analytics, fujitsuforum, management, managenow	
Business	0.99	**AI**	0.95
business benefit, Lenovo, pc business, IoT, digital inclusion		artificialintelligence, global partnership, worker heat stress, qb_it, sap	
transformation	1.00	**partnership**	1.00
human centric approach, oracle, digital, society, positive impact, gamble		VMWare, organization, impact	
fujitsu_uk	1.00	**Customer**	1.00
hybridit, award, centric, fujitsuforum, gratcliffe, xtravirt, top tip		fujitsuworldtour, retail, age	
Oracle	1.00	**susecon**	1.00
Japanese, cloud deal, drive, cloudcomputing		Prague, sponsor, cornerstone, cloud-in-a-box, HPE, Microsoft, user, keynote	

first-tier concept "enablingdigital" that appears on Twitter as a hashtag in both 2016 and 2017 indicates the digital transformation process in various industries. While "enablingdigital" in 2016 highlights the successful examples of companies such as AirBnb in online lodging industry as integrating digital element in their operation; the "enablingdigital" in 2017 emphasizes the equally imperative roles of human and technology in digital transformation process, as tweeted "People, Actions, Collaboration & Technology are crucial for #digital transformation #enablingdigital @fujitsu_global". The shared first-tier concept "cloud" in both years mutually implies the Cloud Service K5, known as the world's largest open source digitalization platform. While the first-tier concept "solution" in 2016 focuses on the enhancement of production efficiency and fintech using internet of things, expressed by second-tier keywords *efficiency, production, fintech, internetofthings*; the 2017 "solution" emphasizes the importance of *data analytics* and *hyperconverged system*, known as a software-defined infrastructure that decouples infrastructure operations from the system hardware and converges them at the hypervisor level into a single building block. The first-tier concepts "transformation" and "IoT" focus on people as key element for the success of digital transformation impact on society, highlighted by second-tier concepts *human centric approach, positive impact, society*; however, the digital transformation is also considered gamble to social media users, as tweeted "70% of digital transformation projects a gamble" or "4 in 5 retail digital transformation projects are gamble." Concept "partnership" of 2017 indicates the collaboration of Fujitsu and VMware, known as a subsidiary of Dell Technologies that provides cloud computing and platform virtualization software and services.

4.2.4. HPE

The text mining result regarding social media users' tweets about HPE is illustrated in Table 9. The majority of first-tier concepts in both years relate to technology issue and data issue. The 2016 first-tier concepts include "dsvirginracing", "product", "separation", "software", and "idea" are associated with technology issues, while "analytics", "data" involve with data issue. From technology perspective, the social media users address their concerns on sustainability concept of HPE in

Table 9
First-tier concepts and second-tier concepts from Twitter users' opinions about HPE.

2016		2017	
Analytics	0.98	**Technology**	1.00
expert, NYSE, store, bigdata, suite		woman, leader, cloud28plus, adoption, stadium, drive, intel	
mwc16	1.00	**customer**	1.00
congress, mobile, nfv, essential facet, brocade, opennfv		value, partner, Accenture, service, Infosys, choice, option, infosight	
data	0.99	**Microsoft**	1.00
small business, protection, software, VMware		azurestack, cloud28, award, suse, cloudxp10, sophos	
dsvirginracing	1.00	**event**	0.97
all-electric racing series		wipro, arubaemea, hpe_uki, docker, galway, mobility	
product	1.00	**innovation**	1.00
hpe product, generation, hpe_labs, environment		Nvidia, startup, BASF, journey, story, hpc, history	
separation	1.00	**Sap**	1.00
internal decision, service		Hana, hpesapalliance, space, b2b, panel, software	
software	1.00	**AI**	0.98
hpegs16, government, summit, engineer, hpe_careers, designer, developer		Machinelearning, artificialintelligence, organization, bigdata	
idea	0.96	**Storage**	1.00
tech, progress, challenge, sustainability, global problem		nimblestorage, backup, hpesynergy, enterprise, data, 3par	

2016. Environmental friendly IT products and sustainable production are among largely discussed IT-related topics. Second-tier concepts including *global problem, sustainability* representing the first-tier concept "idea", and *HPE product, environment* denoting the first-tier concept "product" identically implicate the sustainability concept in production and environmental protection in IT service companies. The first-tier concept "dsvirginracing" indicates the formula E racing team that is established by the partnership between Envision Virgin Racing Formula E team and DS Automobiles. The associative second-tier concept *all-electric racing series* demonstrate the interest of social media users on the collaboration between HPE and DS Virgin Racing team to promote the world's first all-electric racing series, which also advocate the sustainability concept and carbon emission reduction. The first-tier concept "separation" and its second-tier concepts *internal decision, service* indicate the concerns of social media users on the division of Hewlett-Packard into two companies, with the launch of HPE. From data perspective in 2016, second-tier concepts such as *big data* representing the first-tier concept "analytics" and *software, small business, protection, vmware* representing "data" indicate the concerns of social media users on the attempt of HPE to enhance the management capability of small businesses by using big data and visual analytics.

Meanwhile, 5 first-concepts including "technology", "innovation", "SAP", "AI", and "storage" of the 2017 concept linking result indicate the shift of interest of social media users from sustainability concept in 2016 to highly technical practices in 2017. The first-tier concept "technology" implies the worldwide cloud computing services marketplace Cloud 28 + sponsored by HP, and stresses on the crucial role of woman in IT service companies, as expressed by second-tier concepts *cloud28plus, woman*. The "innovation" and its associative second-tier concepts *Nvidia, startup, BASF* indicate that innovation in IT service is imperative in many domains such as graphic cards manufacturing, startup, and even chemistry industry. BASF is a chemical company that selects HPE Apollo System supercomputer for global chemical research to help reduce computer simulation and modeling times from months to days. "Storage" with it associative second-tier concepts *Nimblestorage, HPESynergy* demonstrate the merit of HPE storage system. While HPE Nimble Storage refers to a predictive flash storage technology developed by Nimble Storage; HPE Synergy combines storage, compute and network equipment in one chassis, along with management software

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Table 10
Cross comparison between IT service companies and Twitter users.

2016	IBM		Accenture		Fujitsu		HPE	
	Company	User	Company	User	Company	User	Company	User
Similarity	quantumexperience watsonhealth icymi Apple company researcher partnership	cloud big data innovation Microsoft analytics IoT	cloud survey workday	cloud consumer business	K5 service	cloud Oracle	dsvirginracing formula rsac mrrobot cloud storage	dsvirginracing product
Difference	pc	blockchain	oow16 capacity acquisition digital Oracle	fintech innovation leaders tech Avanadeinc	life-cycle solution Eternus challenge scholarship tour	enablingdigital IoT business transformation solution fujitsu_uk	infrastructure HPEHelion	analytics mwc16 separation software idea

2017	IBM		Accenture		Fujitsu		HPE	
	Company	User	Company	User	Company	User	Company	User
Similarity	cloud enterprise	cloud innovation Microsoft tech			K5 service SAP euroshop servicenow	cloud solution customer enablingdigital	customer cost tech cloud server	customer storage AI innovation technology
Difference	mainframe trustIBMZ program inclusion diversity fellow	IBMWatson AI blockchain IoT	application ellynjshook1 wef17 people leader liquid	AI fintech tech blockchain innovation insurtech business IoT Microsoft	intellegentengineering server workstation	AI partnership IoT SUSEcon	automation infrastructure data	Microsoft event SAP

that can quickly configure the hardware automatically to provide just the resources needed to run an application. The first-tier concept "customer" with its second-tier concept *Infosys* indicates the collaboration between HPE with Infosys, known as a global company in consulting, technology and next-generation services, to offer an integrated end-to-end mainframe modernization solution that provides global enterprise customers robust hardware and advanced software architecture.

4.3. Cross comparison between the tweets from companies and from the Twitter users

As the insight of IT service companies' concept links and social media users' concept links toward IT service perspective are elaborated in previous sections; hence this section aims to observe the differences and similarities in opinion patterns between companies and social media users through first-tier concepts in 2016 and 2017. Our approach can help the IT service companies to narrow the gap between their social media marketing strategy and the Twitter users' expectation. Several first-tier concepts between companies and social media users, although different in word composition, are considered similar due to indicating the corresponding issues. Summary of the similarities and differences in opinion patterns between companies and social media users is shown in Table 10.

Regarding IBM, the similarity in opinion patterns between the firm and their social media followers is significant in 2016. The first-tier concept "Quantumexperience" from the firm's concept link and the concept "cloud" from the social media users' concept link refers to the cloud service issue of IBM in 2016. "Watsonhealth" and "big data" indicate the application of big data in industries, from which "Watsonhealth" denotes the use of big data in health-care industry and "big data" clarify the involvement of big data in vehicle manufacturing industry. "Apple", "company" from company's concept link and "Microsoft" from social media users' concept link mention about technology companies or those companies that integrate IT service in their operations. Although seemingly dissimilar; however, "partnership" and "IoT" indicate the collaboration of IBM with other companies based on IoT platform. While the concept "partnership" indicates the collaboration of IBM with Honda to deploy IoT in producing smart sensor for vehicles, the concept "IoT" propose the collaboration of IBM with VMware. "Researcher" and "data", "analytics" correspondingly indicate the data issues. In 2017, the similarity in opinion patterns between the firm and their social media followers is less apparent than in 2016. Only the shared concept "cloud", and "enterprise" of the firm and "innovation", "Microsoft", "tech" of the social media users are observed to represent similar issues. IBMWatson, AI, blockchain, IoT. "Mainframe", "trustIBMZ", "program", "inclusion", "diversity", "fellow" focus on the marketing of IBM product quality, and the unique diversified, inclusive organization culture of IBM; while "IBMWatson", "AI", "blockchain", "IoT" focus on the technology applications in businesses using AI, IoT such as fintech or telecom network and handset device manufacturing.

Regarding Accenture, while "cloud" is the shared concepts from concept links of both Accenture and social media users, the concept "survey" from Accenture concept link and "consumer" from social media users' concept link mutually indicate the concern on consumer survey. "Workday" from the company's concept link and "business" from social media users' concept link correspondingly imply the digital transformation in business. On the other hand, the dissimilarity in opinion patterns between the firm and their social media followers is significant in 2016. From social media user perspective, "fintech" that regards its investment and global insurance market, "innovation" that focuses on robotics, food business, and "tech" that emphasizes on how

IT industry brings up the gender equality. From the company's viewpoint, nevertheless, Accenture's "acquisition" of Dgroup, "digital" strategy, and "capacity" of supply chain that would be improved and transformed with the technology involvement are prevalent among tweets posted by Accenture in 2016. In 2017, the dissimilarity in opinion patterns between the firm and their social media followers is noteworthy. The company's concerns on technology applications on management ("application", "Liquid"), the determinant role of "people" in the age of AI, the importance of women in IT service development ("ellynjshook1", "leader") are largely addressed on the company's Twitter. However, social media users prefer to tweet about technology innovation of Accenture ("AI", "innovation", "IoT", "Microsoft"), and technology applications in businesses ("fintech", "blockchain", "insurtech", "tech", "business").

Regarding Fujitsu, the similarity in opinions between the company and social media users on Fujitsu's K5 cloud service, which also supports Oracle, is observed. Hence "K5" and "service" from the company's concepts links and "cloud" and "Oracle" from social media users' concept links are corresponding in 2016. The company focuses on "lifecycle solution" for SAP transformation, "Eternus" known as the hybrid storage system, "challenge" for retail industry that could be solved by technology application such as real-time video analysis system. Meanwhile, as mentioning about Fujitsu, the social media users preferably tweet about successful stories of businesses that integrate digital element and IT in their core operation such as AirBnb through the hashtag "enablingdigital", and technology innovation ("IoT", "transformation"), and Fujitsu's technology applications in businesses, fintech and production ("business", "solution") in 2016. The similarity in opinions between the company and social media users is more apparent in 2017. While "K5" and "service" from company's concept links and "cloud" from social media users' concept links indicate the K5 cloud service of Fujitsu, "SAP" and "solution" imply industrial standard control systems. "Euroshop" and "customer" mutually demonstrate the concerns on technology application in retail industry. Concepts of "enablingdigital" and "servicenow" corresponding indicate the digital transformation, AR/VR platforms. Dissimilarity in opinions between the company and social media users is also observed since the company highlights the excellence of its hardware products and server ("workstation", "intelligentengineering", "server"), while social media users favorably concern about technology innovation ("AI", "IoT") and "partnership" of Fujitsu in 2017.

Regarding HPE, the similarity and dissimilarity in opinions between the company and social media users are observed in 2016. The first-tier concepts "DSVirginracing", "formula" from the company's concept links and "DSVirginracing" from social media users' concept links consistently indicate the partnership between HPE and a racing team in racing sport, and expand to the collaboration with a vehicle manufacturer in making electric cars. "RSAC", "Mrrobot", "cloud" from the company's concept link and "data" from social media users' concept link correspondingly imply the necessity of data security for small and medium businesses. "Product" and "storage" equivalently implicate the storage system and hardware products of HPE in 2016. On the other hand, the firm concerns on the "infrastructure" including composable infrastructure, hybrid infrastructure, computing infrastructure, cloud infrastructure and the marketing activities of its product and service; while the social media users preferably tweet about "analytics", "software", the "separation" of Hewlett-Packard into HP Inc. and HPE, and "idea" on sustainability. The similarity in opinions between the company and social media users is more apparent in 2017. The concept "cost" from the company's concept links and "storage" from social media users' concept links correspondingly indicate that the innovative storage system of HPE would help reduce operation cost for businesses. "Tech" from the company's concept link and "AI", "innovation" from the company's concept link describe the application of technology innovation in business and production, such as car manufacturing that integrates AI to for the making of smart cars or chemical company that use supercomputer of HPE to reduce computer simulation and modeling times. On the other hand, while the company addresses "automation", "data", and "infrastructure" concerns on its Twitter page; the social media users favorably tweet about "Microsoft", "event", "SAP" solution for business to business.

5. Conclusion

The research discusses how to apply concept linking approach to investigate the marketing insights of IT service companies from both firm perspective and social media users' viewpoint. The first-tier concepts showcase the overview of IT service company landscapes based on companies' tweets and social media users' tweets, from which the first-tier concepts from companies' concept-linking network with cognitive patterns highlight the shift of opinion patterns of companies toward IT service companies. The IT service companies can also analyze the hidden social media strategy adopted by the competitors by identifying the key concepts from their tweets, which can help companies to adjust their social media marketing agilely. The first-tier concepts from social media users' concept links indicate the preference of interest and cognitive patterns of social media users regarding IT service domain as discussing about those aforementioned IT service companies. The related second-tier concepts and tweet examples delve into the deeper layer of the matters and enlighten the socio-cognitive insights of companies' opinion and social media users' viewpoints on IT service companies. This information is helpful for the companies to design marketing campaign that can better attract social media users' attention. In addition, we spotlights the similarity/dissimilarity of opinions and major concerns between IT service companies and Twitter users in different years on the following ground. This approach can increase the accuracy in learning social media opinions, because first-tier concepts and associated second-tier concepts were extracted directly from thousands of tweets after being calculated by multiple text mining algorithms. Our approach can also help the IT service companies to narrow the gap between their social media marketing strategy and the Twitter users' expectation. We have illustrated the comparison results and discussed how the companies can react to these differences in Section 4.3.

Based on our social media mining results from 2016 and 2017, all first-tier concepts represent major trends of IT service companies, which include technology and innovation, technology applications in businesses, data issues, customer/consumer issue, data issues, technology companies, and technology events/conferences. For example, regarding tweets posted by IBM, the majority of first-tier concepts and the associative second-tier concepts in 2016 and 2017 relate to technology trend and innovation issue that highlights the service and hardware products of the company such as IBM cloud service or IBM computers. The mining results also show the important trend of technology applications on businesses such as fintech, block chain or energy industry, and healthcare industry. From social media user perspective, the concerns on major IT service companies in 2016 from Twitter followers address the consistent issues that proposed by company's tweets, although the first-tier concepts from social media users' concept link are not identical with those first-tier concepts from company's concept link regarding word composition. However, the similarity in opinion patterns between the firm and their social media followers is less apparent in 2017. Regarding tweets posted by Accenture, while the first-tier concepts in 2016 and the associative second-tier concepts underline the importance of executing digital transformation and digital strategy in businesses, through which optimizing the business growth, supply chain management and customer relation management; the first-tier concepts and the associative second-tier concepts in 2017 highlights the importance of improving the gender equality and the advocacy toward sustainability concept and environmental protection alongside the growth of IT service companies. From social media user perspective, the dissimilarity in opinion patterns between the firm and their social

media followers is significant in both 2016 and 2017. In short, our approach can help the IT service companies to narrow the gaps of their social media marketing strategies between the companies and the customers by identifying and comparing the key concepts of their posts as well as the posts from the users on social media.

In addition to the social media mining approach discussed in this study, future research may consider adopting other approaches to further explain the insights of IT service companies from social media platforms. Other analysis tools can be applied to provide various perspectives on social media opinions toward IT service companies. Future studies may explore other social media platforms, such as Facebook and YouTube, to evaluate whether the findings of social media mining would differ from those obtained in this study. However, it might be challenging to make such comparisons because different social media platforms have different mechanisms and target to direct users to different information. For example, YouTube does not feature the re-tweet function. Hence, individual researchers or organizations may use various social media tools to examine IT service companies on different purposes. The insights on IT service domain from companies' concerns and social media users' viewpoints that are extracted from various social media platforms would proliferate the understanding on IT service dimension and contribute to the monitoring of up-to-date progress of such companies, from which noticing the achievements to keep up and the drawbacks to improve; hence this issue would be worthy of further investigation. Companies can also refer to social media mining to observe the efficiency of their social media content management and communication to social media users.

Declaration of Competing Interest

None.

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