Entrepreneurial Oriented Discussions in Smart Cities: Perspectives Driven from Systematic Use of Social Network Services Data

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Abstract. The concept of the "smart city" has become popular in scientific literature and international policies in the past two decades. Smart cities are known as a system of physical infrastructure, the ICT infrastructure and the social infrastructure exchanging information that flow between its many different subsystems. The "smart cities" concept has been introduced with various dimensions among those, the embedded ICT infrastructure in smart cities is playing a decisive role among the functions of the system. One of the important derivatives of ICT is the new communication mediums known as Social Network Services (SNSs) which is emerging and introducing additional functionalities to "smart cities". This paper seeks to advance the understanding of SNSs in smart cities for evaluating the effects on the innovation and entrepreneurial ecosystem. This agenda has been tackled by a rigorous methodological approach in order to capture and evaluate the presence of entrepreneurial oriented discussion in a popular SNSs medium (Twitter).

Keywords: Smart Cities, Social Network Services, Start-ups, Content Analysis.

1 Introduction

Population growth and the urbanization associated to that are recognized as the contemporary challenges that seeks novel, efficient, effective, and economic approaches to better governance. Challenges for developing the infrastructures and services needed to be addressed so to increase communities living standards. The emergence of the "smart city" concept can be considered as a response to such challenges ensuring that cities can develop economically, whilst protecting the environment and quality of life for citizens. Smart technologies is offering cities exciting possibilities for the provision of new services and integrated city infrastructures, as well as supporting innovation, digital entrepreneurship, and sustainable city development [10]. According to World Economic Forum [47], a growing number of cities around the world are implementing ambitious smart city programs and projects across a range of themes including governance, local economic development, citizen participation, urban living, the natural and built environment, and sustainable transport.

An in-depth analysis of the existing literature revealed that the smart city is a multi-faceted concept with many elements and dimensions. Descriptions of smart cities are now including qualities of people and communities as well as ICTs. The smart cities are known as a system of physical infrastructure, the ICT infrastructure, and the social infrastructure exchanging information that flows between its many different subsystems [2]. It might even be noticeable that major cities can serve as a good representation of a nation's economic success or failure. According to Beattie [4] that's because the tricky business of development and urbanization can play a big role in a country's economic prosperity. Entrepreneurship and innovation is the major concern for an economy consequently within the boundary of a city therefore, the competitiveness of a city today is determined by its innovativeness and economic strength [3]. While researchers have realized that smart cities are more entrepreneurial than others [28,34], an analysis of the detailed characteristics accounting for this higher entrepreneurial activity within smart cities has not been conducted.

One of the major resources connected to the success of smart cities is the societal capital or cultural capital within the city boundaries. The emphasis on the role of social capital in urban development is promoted in parallel to technical aspects of a city [25]. The importance of human and social capital has been recognized by smart city definitions from previous literature, and it has been seen as a fundamental aspect of any smart city [2,11,27,40]. Social capital has also been seen as an important dimension for facilitation of innovation and entrepreneurship in smart cities. Smart cities have the infrastructure to bridge and facilitate the connectivity of society for entrepreneurial activity. Despite the recognition of the importance of the human and social capital aspect in smart cities, the measurement and assessment of this aspect has remained a challenge. Performance measurement studies on smart cities dimensions, especially on social and human capital, are subject to being outcome indicators that, by their nature, involve medium- to long-term observation and detection times [30]. The results of this issue are the lack of insight coming from society and incapability to absorb the information coming from society.

In this research, the attempt is to study the smart city social and human capital performance measurement concerning innovation and entrepreneurship oriented activity. Due to ICT advancements, smart cities have the infrastructure to bridge and facilitate the connectivity of society. Within the broad spectrum of ICT application, the emerging presence of the mass media communications such as Social Network Services (SNSs) and social media has not been taken into account for studying innovation and entrepreneurship ecosystem in smart cities. Publicly available data sources such as Twitter have facilitated massive data collection which can leverage the research at intersection of social sciences, data sciences, and indicator design, thus informing the research community of major opinions and topics of interest among the general population [45,48] that cannot otherwise be collected through traditional means of research (e.g., surveys, interviews, focus groups) [17]. On the other hand, citizens are empowered to use technology oriented common platform to communicate among themselves, which resulted in inclusive use of social network services among citizens. Yet despite this interest, there seems to be very limited understanding of what the "social networking services" or "social media" exactly represent and do to societies. In our presented case, we saw

social media discussion as a curtail pillar in regulating entrepreneurial oriented discussions in smart cities. Therefore, this paper explores the social network services role in smart cities from the innovation and entrepreneurial ecosystem vantage point. We aim to address the following research questions:

- How can smart cities leverage the presence of SNSs for entrepreneurial oriented activities in innovation ecosystem?
- Utilize social network services data to identify the presence of impactful entrepreneurial discussion (a methodological approach).

This agenda has been tackled by a rigorous methodological approach in order to capture and evaluate the presence of entrepreneurial oriented discussion in a popular SNSs outlet (Twitter). A thorough process of detecting and capturing relevant tweets was performed to evaluate the usage of SNSs in promoting innovation and entrepreneurial oriented discussions. Based on the recognized Smart City Index, London city has been selected to utilize the methods for capturing social capital on innovation and entrepreneurial activity.

2 What are smart cities?

Cities are considered as key role players in social and economic aspects in global perspectives, and therefore in order to understand the importance of cities as future key elements, the definitions of "smart cities" will be explored in this section. United Nations Population Fund indicates that in the year 2008 about 3.3 billion people, which is more than 50 percent of global population, lived in urban areas. This estimation is expected to increase to 70 percent by 2050 according to a United Nations report [44]. The urbanization figure in Europe is currently 75 percent of the population and the number is expected to reach 80 percent by 2020 [44].

The advantage point of smart cities as a structure to enable the pre mentioned movements has been seen on the opportunity for information exchange that flows between its many different subsystems [20]. A comprehensive definition of smart cities by Nijkamp and Kourtit [33] "Smart cities are the result of knowledge-intensive and creative strategies aiming at enhancing the socio-economic, ecological, logistic and competitive performance of cities. Such smart cities are based on a promising mix of human capital (e.g. skilled labor force), infrastructural capital (e.g. high-tech communication facilities), social capital (e.g. intense and open network linkages), and entrepreneurial capital (e.g. creative and risk-taking business activities)". Hence, a recent classification by Neirotti et al. [32], define two major domains for the smart city concept with regard to the exploitation of tangible and intangible urban assets: (1) hard domain, which concerns energy, lighting, environment, transportation, buildings, and health care and safety issues and (2) soft domain, which addresses education, society, government, and economy. Shapiro [36] and Holland [24] argue over soft domain aspect of smart cities such as human capital rather that hard domain aspects like ICT; as the driver of smart city creation. According to Caragliu et al. [11] a city is smart "when investments in human and social capital and traditional (transport) and modern (ICT) communication

infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (p. 70). Descriptions of smart cities are now appreciating the soft domain aspects like qualities of people and communities as well as ICTs [2,31]. The new perspective that aims to inspire the sense of community among citizens get insights from the previous bottom-up knowledge scheme and recognize the importance of factors that emulates the concept of smart communities where members and institutions work in partnership to transform their environment [5]. Smart communities makes conscious decisions on technology use for tackling societal challenges which results not only in the increase of quality life but also a means to reinventing city's capabilities for new communal practices [16]. The California Institute for Smart Communities could be exemplify among the first to focus on how communities could become smart and how a city could be designed to implement information technologies [1].

The vast range of contexts has led to the formation of a diverse and nebulous smart city design space, where there is little consensus over what smart cities are and what form they should take. This inhibits communal discourse and slows down the development and widespread deployment of smart city technologies and policies [24]. More crucially, it is a barrier to citizen engagement and bottom-up design. Communities are unlikely to engage with, identify, and then design solutions for civic problems while the smart city concept is incoherent, unapproachable, and hard to measure. The agenda for this research is to study the bridge between the soft and hard domain aspects of smart cities and smart communities embedded. On one hand, the hard domain side is where infrastructures such as ICT have a decisive role in the functions of the smart city. On the other hand, the term has also been applied to soft domains where approaches towards culture and social inclusion in a smart city that supposed to offer environments for an entrepreneurship accessible to all citizens. The taken aspect of the smart cities in this research concerns ICT provided opportunities such as social network services and therefore social capital utilization for entrepreneurial oriented activities. Data in social network services as a communication platform will be utilized to study the content and discussions on the innovation and entrepreneurship in on smart city while the general procedure to systematically deal with SNS data will be described. Further, with having the data analyzed and operationalization of the extracted simplified metrics, we attempt to investigate the influential content in SNS regarding the innovation and entrepreneurial discussions. Therefore, the conceptual framework for approaching smart cities within the focus of this research should offer insights regarding the operationalization of social network services data and the effect magnitude of a content in SNS in the context of innovation and entrepreneurship discussions.

3 Innovation and Entrepreneurial Ecosystems and the Role of Social Network Services

Innovation and entrepreneurship concepts are highly intertwined and dependent on each other and are recognized as the core critical components for the wealth and competitiveness of cities and countries [43]. Innovation is an inherently human endeavor, and

successful innovation happens when people with skills, experience, and capabilities come together to understand or predict, and then address existing challenges while entrepreneurship is the attempt to setting up and scaling the efforts [15].

Smart cites are introduced as the territories that connects the physical, the IT, the social, and the business infrastructure to leverage the capability of learning and innovation, which is built-in the collective intelligence of the city and its population [23]. The smart infrastructure of cities can tackle the existing challenges in innovation and entrepreneurship ecosystems. In particular, the role of ICT services as one of the dimensions of smart cities can enhance the innovation and entrepreneurship ecosystem. Smart cities have the infrastructure to bridge and facilitate the connectivity of society and in general the social capital for entrepreneurial activity. With the emergence of social network services in the past decade, a new medium has been created to present the society that has not gotten the proper attention yet. The social infrastructure, such as intellectual and social capital, presented by SNSs is an indispensable endowment to the smart cities as it allows, "connecting people and creating relationships" [2]. ICTs also offer new avenues for openness by providing access to social media content and interactions that are created through the social interaction of users via highly accessibly Web-based technologies.

Social media platforms had significant growth over the last decade. According to online statistics and market research source Statista [39], over 70 percent of internet users were social network users in the year 2017 and these figures are expected to grow. It is estimated that the number of social media users will increase from 2.34 billion in 2016 to 2.95 billion in 2020 [39]. Social networking is one of the most popular online activities with high user engagement rates and expanding mobile possibilities. The growth of the SNS's user base is universal and now been increasingly populated and used by much diverse age groups [25]. The growth of social network services is unprecedented that are now so well established and considered a major visited services in internet that doesn't change much from year-to-year [13]. The recent evaluation of actively used social networking services by Pew Internet indicates Facebook as the dominance platform including the owned service of Instagram by 76 percent of active user's login while Twitter is reported to have 42 percent of active user's login [12].

It is therefore reasonable to say that social media represent a revolutionary new trend which have the potential to enhance existing and foster new cultures of openness [6]. Social media empowers its users by the ability to inexpensively publish or broadcast information as it gives them a platform to effectively democratize information and communication real time. Yet, despite the all facilitation of information creation and dissemination, there seems to be very limited understanding of what the "social media" or "social networking services" exactly represent and eventually do to societies. Meanwhile, smart city programs which have received great publicity, there has been less discussion about the evaluation and measurement regimes of societal and soft domain aspects in smart cities. The lack of metric for grasping the societal activities has been depicted in the 'Global Innovators: International Case Studies and Smart Cities' [10] report that notes the inadequacy of existing evaluation approaches which tended to be non-standard, and focused on implementation processes and investment metrics rather than city outcomes and impacts.

This paper aims to investigate the social capital on innovation and entrepreneurship within the smart cities by diving to social networking services as the derivative of one of the major dimensions of smart cities. This research presents utilization of SNSs in understanding and capturing entrepreneurial oriented discussions and further investigates the various profile type impact on SNSs regarding entrepreneurial oriented discussions.

4 Methods

In this section, I share the approach on utilizing computational advancement to analyzing social network services data in a systematic process. The approach uses semantic and linguistics analyses for detecting major topical discussion in the twitter as the SNS platform under study. The following section will describe a general process on SNSs data collection, topic discovery and topic-content analysis. Furthermore, the analysis interpretation discloses insightful characteristics of tweets regarding their topic of discussion and the characteristics of the content generator.

4.1 Systematic Approach to Analyze Social Network Services Data

The data in SNSs often comes unstructured as information that is not organized in a pre-defined manner and not necessarily presents a pre-defined data model. Unstructured information is typically text-heavy, but may contain data such as dates, numbers, and facts as well. Advancements in data mining and text analytics will be obtained in this study to analyses the SNSs data for insightful information.

In this paper, the focus is on getting insight from SNSs as a major component in smart cities regarding entrepreneurial oriented activity. The overall architecture to process data in SNSs is composed and presented graphically in Figure 1. The considered data is collected on Twitter (twitter.com). However, the process has a high extent of generalizability to most of the data in SNSs platforms. The present process included three major phases: capture, curate and consume. In addition, each phase has two subphases consequently according for Figure 1.

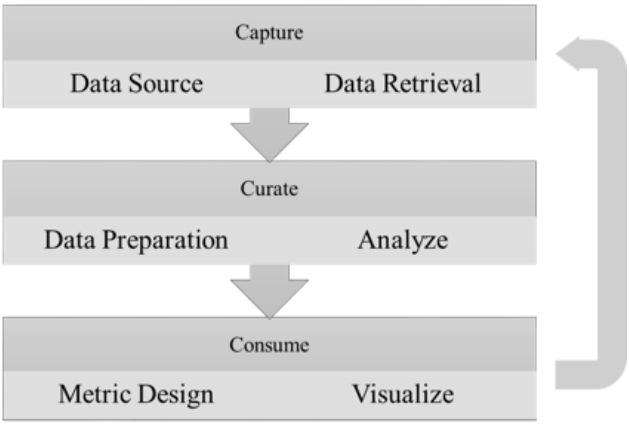

Fig. 1. SNSs systematic data analysis.

Capture: This is the process of collecting data, which contains the selection of the data source, searching for the data and collecting data for other usage. Inputting the searching query is the primary way to specify the content, which is of any interest to retrieve. Various specifications can be implemented, such as keywords, length, date, etc. in order to target the topic of interest. In other words, the required data is obtained by set of criteria embedded with the search query. Some SNSs platforms such as Twitter offer the possibility to retrieve data via the live stream.

Curate: Data curation is a broad term used to indicate processes and activities related to the organization and integration of data collected from various sources. Data retrieval methods are often loosely controlled, resulting in out-of-range values. The data preparation task is performed to reduce the irrelevant and redundant data present in the collected set. This task is necessary for the forthcoming steps so to normalize the data for a better knowledge discovery results. Data analysis can be very subjective to the context of the study and expected results, but the two primary task in analysis can be mentioned as data feature extraction and data classification. The intent for feature extraction is to facilitate the further distinctions and categorization of the data. This task will drive values (features) from the data regarding the context of the knowledge discovery process. Classification of the data occurs in order to reduce the dimensionality of the data. It's an approach derived from the general hypothesis of the knowledge discovery task so to distinguish the best-fit data points from the mass. In this case study, topic modeling has been performed in order to understand the major important cluster of discussions regarding their topics.

Consume: This refers to publishing a presentable format of the information derived from the data. The insights from the results can be provided in visually appealing way or can be used as a metric to be combined with other data points for further interpretations. Having the systematic social network services data analysis explained, the next section, the presented procedure will be applied on a case study.

4.2 Evaluating Entrepreneurial Oriented Activity in Twitter : London City Case Experiment

The background literature discusses the importance of emerging social network services in smart cities and the need for investigating the effect of entrepreneurial discussions in innovation ecosystem. In this section, we utilize the systematic approach on analyzing SNSs data and emphasize on the new ways of benchmarking for social capital by focusing on social network services. In order to solidify the objective, an experiment has been condicted so to detect and capture entrepreneurial discussions on one of the dominant social network services called Twitter. A popular microblogging tool Twitter, has seen a lot of growth since it was launched in October 2006; is an online news and social networking service where users post and interact with messages called ”tweets”, restricted to 140 characters. Twitter users can post their opinions or share information about a subject to the public. Twitter has 316 million users worldwide [14], providing a unique opportunity to understand societal discussions and in this study case a way to comprehend entrepreneurial oriented discussion.

The initial interest of the study was to capture innovation and entrepreneurial oriented discussion from social network services as one of the major themes that needs studying in smart cities. Start-ups are considered as a good representation of societal practice of entrepreneurship. Start-ups are increasingly seen as significant contributors to national job-creation [38]; employment and gross national product data demonstrated the shift to an innovative start-up dominated economy [38]. Therefore, fostering the start-up ecosystem is seen as the measure for improving national economy [35]. The study case experiment has been conducted to collect the activity related to the start-up ecosystem in the studied country so to capture the relevant societal discussions oriented towards innovation and entrepreneurship.

Twitter is an SNS platform, which well represents and acts as support infrastructure for start-ups, which organically are socially active. The study took the initiative to collect a sample of tweets from a region (country) and extract features (words and hashtags) related to start-up activities; we have applied techniques to decompose hashtags, analyze them, and reuse the information extracted for classification purposes. Twitter provides application programming interface (APIs) to access tweets and information about posted content and users. The potential bias of Twitter APIs was discussed by a recent research [20]. Twitter data has been used for a wide range of studies such as stock market [8], brand analysis [22] and election analysis [41]. The unique characteristics and features of Twitter as a microblogging service are illustrated in Figure 2.

Post	Body	Urls
		Usermention
		Tween Lang
		Media (Video, Picture)
		Hashtag
	Provider	FollowesCount
		Follwed by Count
		Profile Description
	Location	Country/City /State
	Like counts	
	Link	
	Retweet count	
	Posted time	

Fig. 2. Twitter Meta data illustration.

With respect to Twitter's characteristics, a multi-component semantic and linguistic framework was developed to collect Twitter data, prepare and analyze the data and discover insightful information. In order to demonstrate the steps for utilizing SNSs data for valuable insights, a high ranked smart city has been selected. London considered as one of the top smart city in global scale [18,21] and as the English is the dominant language; this will facilitates the text analytics tasks. With respect to Twitter's characteristics, the search queries were constructed in a way that captures the most relevant content regarding start-up scene and the entrepreneurial activity.

4.3 Data collection (Capture)

This phase attempt was to collect relevant tweets using Twitter's Application Programming Interfaces (API) [42]. We have benefited from popular hashtag recommender toolkits such as http://hashtagify.me, "https://ritetag.com" and "https://www.trendsmap.com" to discover the relevant hashtags and their proximities to the innovation and entrepreneurial oriented discussions. Figure 3 is illustrating the hashtags proximity with the subject of our initial search (#startup #startups #entrepreneur #tech #sme #innovation #entrepreneurship #startuplife # hackathon) which obtained for detecting the extended hashtags and relevant discussions.

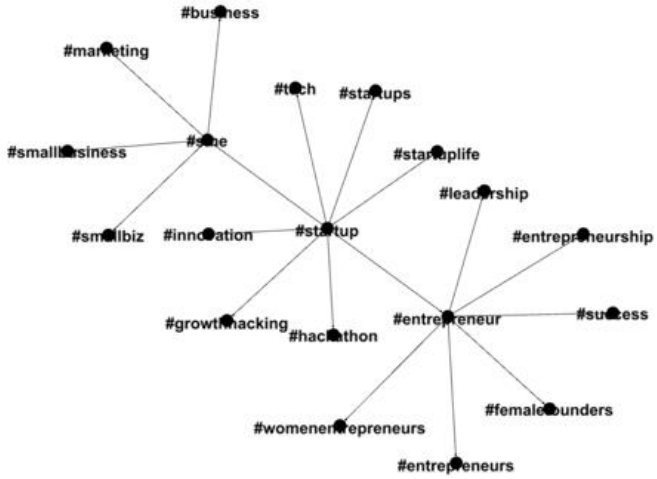

Fig. 3. Twitter hashtag proximity distance.

Twitter's API provides both historic and real-time data collections. The latter method randomly collects 1 percent of publicly available tweets. We used the real-time method to randomly collect 10 percent of publicly available English tweets using several pre-defined hashtags related queries mentioned previously within a specific period. We used the extended query to collect approximately 4 thousand related tweets between 06/01/2017 and 08/30/2017. The data will be available in the following link "https://goo.gl/mZumDp". Table 2 shows a sample of collected tweets textual content, users and overall interaction (sum of likes and retweets) for each tweet in this research.

4.4 Curate

This phase, the analysis of tweets by data feature extraction and data classification has been advanced. Regarding the SNSs data which is collected from twitter. The investigations began with an empirical analysis of the dynamics of the discussions in the Twitter. The topical structure of discussions has been studied. Further, we will investigate the characteristics of the major content producers. The Twitter analytic process was facilitated by Azure cloud computing platform (azure.microsoft.com) which the pipeline of the process can be seen in Figure 4.

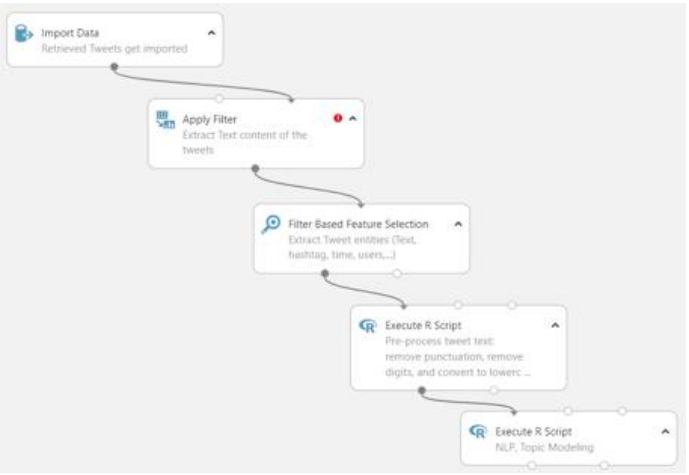

Fig. 4. Twitter content analysis with Azure Cloud Computing Platform.

After importing the retrieved tweets as the input data, a filtering process applies to structure and reduce the noise of the data. The data feature extraction distinguishes the valuable data points such as number of retweets, likes, profile identifications and the textual content of the tweets as we will leverage these data point for further insights. One classification task for analyzing tweets; topic modeling has been utilized in order to reveal the topical formation of the discussion. Topic modelling can be described as a method for finding a group of words (i.e. topic) from a collection of documents (in our case tweets) that best represents the information in the collection. It can also be thought of as a form of text mining – a way to obtain recurring patterns of words in textual material [37]. There are many techniques that are used to obtain topic models in this study we leveraged Latent Dirichlet Allocation (LDA) and the consequent visualization toolkit developed for that (LDAviz) so to visually show the major twitter discussion topics [7]. The next section we will represent the classification calculation results visually.

4.5 Results (consume)

So far, we were able to encapsulate the entrepreneurial oriented activity via focusing on start-up scene in the smart city of London. The dynamic relevant discussions in social network services (in this study Twitter) were captured and curated to transform the SNSs data into insightful information. The dynamic discussions and interactions on SNSs regarding entrepreneurial oriented matters can represent the social capital as explained in earlier sections. In this section, we will dive deeper into SNSs data in order to detect the most influential content and type of content generator profiles associated. A categorization analysis task will be performed into the textual content of the SNSs data in order to get a broad overview and distinguish the general topic of discussions.

The analysis of topical structure of SNSs discussion with LDA is visualized in Figure 5, which illustrates the general topical theme of discussions. The six major clusters are

named based on the major keywords mentioned under each topic. The visualization also revels the size of the discussion proportional to other topics via their circle size and indicates the distance of topics in two dimensional distance map.

Fig. 5. Intertopic Distance Map.

As part of data consumption and insight generation task, with having the meta data of each posted tweet and the associated profile under each of the topics, the influential profiles based on their overall interaction (Number of retweet and likes received for the post) can be detected. This information will reveals how contents (tweets) gets attentions in different topics regarding their content generators. The motivation for content generators in twitter profile categorization stems largely from the fact that humans as intelligent individuals impose complex factors on the consumption and dissemination of information on SNSs [26,29]. Therefore, as the different profile types have different purposes and cater to different needs, the categorization of content generators in each of the six topical discussions will help us to measure the impact and influence each category is making. The categorization definitions and process inspired from Uddin et al. [43] and due to the study intentions, three major different types of Twitter profile defined and were developed which are as follows:

Personal profiles: These accounts contain personal content, have no ties to business, and do not mention corporate or brand information. They are created by individuals who do not wish to be identified with their employer. Technically, the accounts have been created to acquire news, learn, have fun, etc. Generally, these individuals exhibit low to mild behaviour in their social interaction. *Professional profiles:* Personal users who communicate their professional views on Twitter. They share useful information on specific topics and are involved in healthy discussion related to their specialist interests and expertise. Professional users tend to be highly interactive; they follow many and are followed by many. *Corporate and business profiles:* Different to personal and professional users in that they follow a marketing and business agenda on Twitter. Their

profile description accurately describes their motives, and similar behaviour can be observed in their tweeting patterns. Frequent tweeting and less interaction are the two key factors that separate business users from both personal and professional users. The type of content will be primarily corporate. Such accounts are often managed by company teams working under a specific brand name related to the company, providing corporate news and support.

Under each of the six discussion topics, profiles ranked based on their tweet interaction ratio (number of retweets + number of likes) were manually looked and categorized according to the three major profile descriptions. Figure 6 is an illustration of the manual categorization of the top content generator profiles.

Interaction by count of Retweets	Personal profiles	Professional profiles	Corporate and business profiles
Educational	35	96	52
Motivational	40	65	18
Promotion	10	62	31
News	5	26	56
Events	12	31	24
Viral/Marketing	0	18	17

Interaction by count of Likes	Personal profiles	Professional profiles	Corporate and business profiles
Educational	24	187	37
Motivational	18	275	87
Promotion	14	33	12
News	44	87	125
Events	65	77	42
Viral/Marketing	0	18	25

Fig. 6. Categorization of tweets based on topic and generator.

As it can be observed from Figure 6, professional users have more influence in overall. In topical content categories, professional users are generating the highest influence in educational, motivational, promotion and events type of topics. Corporate and business profiles tend to be more influential in news category, educational, and promotional after professional users. Counting the likes, the calculation reveals that professional users have more interaction, especially in educational and motivational content category, while business profiles have the higher interaction in the news category and motivational category in second order. Personal profiles have the lowest influence among the other two profile categories in both retweets and count of likes. The difference in distribution of interaction is that motivational and educational receives the highest retweets and in the calculation of like counts, the high-interacted categories will shift to events and news.

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